Class 9

SCIENCE

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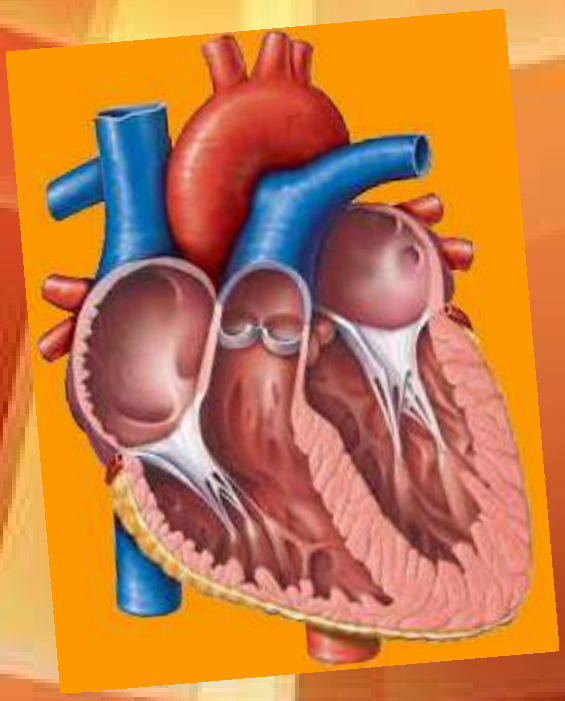

SCIENCE

Class IX

BOARD OF SECONDARY EDUCATION, RAJASTHAN, AJMER

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Class - 9

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Foreword

For students, textbook is the basis of sequential studies, confirmation, review and future studies. The level of school text book becomes very important from the content and teaching - method's perspective. Text-books should not be made insentient or to glorify things. Even today text-books are an important instrument of teaching-learning process, which cannot be ignored.

For the last few years the syllabus of Board of Secondary Education, Rajasthan was felt to be lacking in representation of linguistic and cultural events of Rajasthan. Keeping this in view the state government decided to implement its syllabus through Board of Secondary Education, Rajasthan, for the students of class 9-12. In accordance to this, Board, has got assembled the text-books for classes 9 to 11 from the session 2016-17 based on the set syllabus. Hope these text books will be instrumental in providing the students with originality of thought process, contemplation and expression.

Prof. B.L. Choudhary
Chairman
Board of Secondary Education Rajasthan
Ajmer

Preface

This text-book of science for class IX of Board of Secondary Education Rajasthan has been written for the creative learning of the students.

According to the syllabus, fifteen chapters have been compiled in this text-book. Recent information has been incorporated at relevant points which will enhance the utility and content of the text book.

In the text-book information regarding our great scientists and their achievements, nature of substance, structure and major activities of living beings, bio-diversity, Nakshtra and Rashis, Environment, Health, Effect of Yoga on health, Natural Resources and Conservation etc., have been incorporated.

Important points have been outlined at the end of each chapter which will help students while studying. From examination preparation point of view, objective questions, very-short answer type, short-answer type and Essay type questions have been included.

The technical words have been used in the text in accordance with the standard dictionaries. Figures, charts and tables have been used in the text-book, as per the need. The sequentiality of content has been maintained in the text. Efforts have been made to maintain the level according to the students of class IX.

Suggestions are invited from intellectuals, authors and teachers. Despite all efforts, some errors may have persisted in the present text. The suggestions of readers are welcomed in this aspect too. Your suggestions will go a long-way in the betterment of the present text.

Convenor

CONTENTS

Chapter-1

Bharat and Science

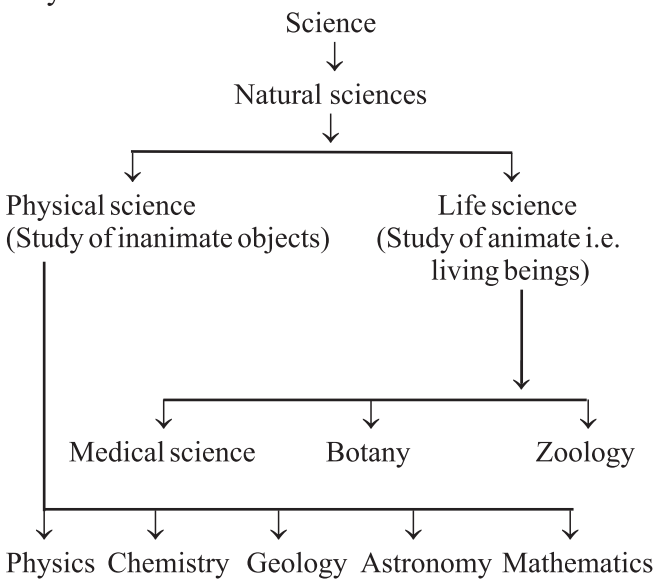
The entire world appears to be beautiful, orderly and uncomplicated because of the various inventions and discoveries of science. Hence we can say that it is an 'era of science'. Virtually, science is a collaborative human effort. Basically, it is the means to understand properly, the laws and resources of nature.

1.1 Meaning of Science :- The word "Vigyan" has been mentioned in Rig-veda. It has been derived from the sanskirt word "Vigyanam" [Vi + gya + lyu T pratyaya (i.e. verb as object)]. 'Vi' means 'specific' and 'gya' refers to 'knowledge'. Hence the word 'science' refers to 'specific knowledge. For example 'rain', it is an outcome, to experience it, is knowledge. The 'what' and 'how' of the entire process from cloud formation to the rains, is a specific knowledge and is studied under science.

The term 'science', in english, has been derived from the Latin word 'scientia' which means 'to know'. It is difficult to define science in exact words but a valid definition can be :- "The organised body of knowledge acquired by the systematic study of the structure and behaviour of the physical and natural world through observation and experiment is known as science." The prime purpose of science are as under :

(a) To understand the functioning of nature and to interpret it comprehensively.
(b) To obtain information by studying the principles of nature and validating them experimentally.
(c) To control nature by applying the interpretations from the observations of significant experiments.
(d) To use the resources available in nature for resolving problems and making human life more pleasant and of high quality.
(e) To know the scientific genesis (origin) of the customs and traditions prevalent in the society.

1.2 Branches of Science : Science prevails in every sphere of life. Hence efforts were made to classify it so as to make its study convenient. At the outset it can be classified into Natural sciences, Social sciences and Technical sciences. But the nature of actual science is visible in Natural sciences only.



In order to further simplify the study of science these broad branches are sub-divided into more than 100 branches. In the current age the following contemporary branches have made special contribution to human welfare :

(a) Genetic engineering
(b) Computer science
(c) Information Technology
(d) Bio-technology

1.3 Scientific method : To think about the events occurring around us in a scientific manner is the scientific method. It has following steps :

(i) To identify the problem
(ii) To formulate i.e. make a hypothesis
(iii) To formulate a testifiable hypothesis
(iv) To collect data
(v) To test the hypothesis
(vi) To draw the result
(vii) To re-test it
(viii) To generalise the theory

Thus by following these steps solution to every problem can be worked out, which can be retested by anyone under the same circumstances. Considering this ideology, presenting various aspects of society and nature in a scientific manner, led to the use of the word science with certain subjects, like - Social science, Political science etc.

1.4 The Tradition of Science in Bharat :

Evidence has been found to suggest that science was thriving in this subcontinent, even in 3000 B.C. The remnants of the cities of Harappa and Mohan-jo-daro, of the Indus Valley Civilisation, exhibits that these cities were well-planned and there the systems for water-supply and sewage were highly developed. They were highly efficient in agriculture, brick-construction, industries and handicrafts. Their clothes were made of cotton.

There exists evidences of 2000 B.C. which manifests the scientific temper of the Aryans. It was considered that the universe was controlled by a natural law. Each religious ritual was performed in especially constructed Temples, in accordance with the position of various celestial bodies, at auspicious moment of time. Thus they were conversant with astronomy and had knowledge of mathematics and geometry. Their almanac (an annual calender containing important dates and statistical information such as astronomical data - 'Panchang') was based on the movements of both the Sun and the Moon. They had the knowledge of various constellations and the various months were named on their basis.

The proposition that diseases were caused by the changing seasons, very minute organisms and genetic reasons, was widely accepted. The Ayurvedic system of diagnosis and treatment was prevalent. In Ayurveda was well developed. Later on, the Arabians and the Greek also adopted Ayurveda. Indian medicines were in great demand in the regions of the Roman empire.

Prior to the 18th century only seven metals were known. It was then after, that, the sequel of discovery of new elements was initiated. The seven metals, which have been mentioned in the most ancient Sanskrit literature, including Rig-Veda, Yajur-Veda and Atharv-Veda, are Gold, Silver, Copper, Iron, Tin, Lead and Mercury. The antiquity of Vedas has been resolved to be thousands of years before Christ. Hence we can claim the existence of Chemistry in Bharat, thousands of years before Christ. Bharat has had an ancient tradition of high quality in metallurgy. This is indicated by the archeological evidences having 95 to 99% purity of various metals like Iron, Copper, Silver, Lead etc. and availability of alloys like brass.

Nalanda, Varanasi and Takshila Universities were well known in 400 B.C. Unprecedented progress was made in Mathematics, Astronomy and medical science. Sushrut had redressed the chopped nose of a patient way back in 600 B.C. (i.e. before twenty-six centuries from the present). He is known as the 'Father of Plastic Surgery' The Arabic translation of his Sushruta-Samhita is known as the Kitab Shah Shun al-Hindi or the Kitab i-Susurud.

Twenty centuries ago, Charak in "Charak Samhita" has stated "How can the physician who does not understands the body of the patient with his lamp of knowledge and understanding, cure the disease. First of all he must study all the factors affecting the patient and then proceed with the treatment. Prevention of a disease is more important than its treatment."

Rishi Kanada proposed the concept of atom in 500 B.C. In 200 B.C. Rishi Patanjali explained that in human body there are subtle (non-physical) energy channels called nadis and energy points referred to as Chakras. The eight Chakras are : Muladhaar, Svadhisthana, Manipura, Hridaya, Anahata, Vishuddhi, Ajna and Sahasrara. [i.e. 'root support', 'ones' own base', 'jewel city', 'heart', 'unstruck', 'especially pure', 'command' and 'thousand petaled']. Eight steps (charan) or positions (stithiyan) have been suggested to keep them activated. They are yamas (Universal moral ethical rules), Niyamas (Means to keep one self virtuous in a disciplined manner), Asana (postures), Pranayaam (restraining the breath) Pratyahara (bringing near one's thoughts and awareness to within i.e. divert them from external world), Dharana (concentration), Bhawana (contemplation i.e. meditation) and Samadhi, (Most animate state i.e. the spiritual state in which the mind loses the sense of its own identity). The last step is the most difficult one. In it the person feels himself to be energetic, self-controlled and filled up with capabilities.

1.5 Contribution of Bharat in the Development of Science : Aryabhatta was the first person to state that Earth is round and it rotates on its axis which results in the formation day and night. Moon shines by the light of sun.

Brahmagupt was the mathematician who made the rules to work with zero, for the first time. The title of "Ganak Chakra Churamari" was bestowed upon by the famous mathematician Bhaskar. He gave the two branches of mathematics : Algebra and Mathematics.

The discovery made by the scientist, who provided 'new radiations' to the world, Chandra Shekhar Venkat Raman, came to be known as the 'Raman Effect'. He received the Nobel Prize in Physics in 1930. 'Raman Effect' was demonstrated by him on 28th February. This day is celebrated as National Science Day. 'Raman effect' is that amazing effect by which the nature of light changes when it passes through a transparent medium. This medium can be either solid, liquid or gas. Raman effect prooved to be one more important instrument for scientists, after the invention of laser, because of its powerful light radiation.

Homi Jehangeer Bhabha explored a new particle 'Meson'. It was under his directions, that three atomic reactors, Apsara, Cirus and Zerlina, were established. One of the comets has been named bappu-bok-newkirk after the name of the first Indian astronomer MK Vainu Bappu (Manali Kallat Vainu Bappu). Jagdish Chandra Bose discovered sensations in plants.

The promoter of chemical industry in India, Prafulla Chandra Ray, discovered mercurous nitrate in 1896. His book 'The History of Hindu Chemistry' received immense reputation.

1.6 Bhartiya Scientists :

1.6.1. Birbal Sahani (1891-1949)

Dr. Birbal Sahani was born on 14 November 1891, at the home of Prof. Ruchi Ram Sahani, at Bhera, a village in Shahpura district of West Punjab (Pakistan). After his graduation from Punjab University, he obtained his B.Sc. degree from London University, Britain. He was the first Bhartiya to obtain D.Sc. degree from Cambridge. The Royal Society of London honoured and glorified him by appointing him as its Fellow (FRS : Fellow of Royal Society). Dr. Birbal Sahni was the fifth Bhartiya to obtain this prestigious award.

Dr. Sahni was a great paleobotanist of Bharat. Study of the vegetation of the ancient era was a new science for this country. It is known as the Paleobotany.

Dr. Sahni discovered a new group of fossil plants. They are gymnosperms (naked seeded) : Pines and other trees of their species which are known as pentaxylales. This attracted the attention of the entire world. The theory of sliding of continents away from each other was authenticated by his paleobotanical studies. According to this theory the continents keep on sliding on the earth surface like a boat glides on the surface of water of a river.

Dr. Sahni researched on the living vegetation for the first time. Then, he again explored the traces of Bhartiya vegetation. He investigated many remnants of Bhartiya vegetation and published their detailed descriptions in 'Philosophical Transection' and many other journals. Other researches made by him - Theory of Continental Division, Age of the Southern Plateau, Himalayan upliftment after the origin of Glossopteris vegetation etc. - were helpful in solving many complex systems. The Birbal Sahni Institute of Paleobotany, established by him, is the first institute of its sought.

1.6.2. Meghnad Saha (1893-1953)

Meghnad Saha was borne on 6th October, 1893 at the home of Jagannath Saha and Bhuveneshwari Devi in the Seoratali village, in the Dhaka district of Eastern Bengal (Bangladesh). Full of love for his nation, at the age of thirteen years Saha along with three other students was rusticated from the school since he had taken a leave as a protest against the welcome ceremony being organized for the Governor Sir Bamfylde Fuller and instead, participating in the strike against the Bengal partition. He had to pay a heavy price. He was deprived of his scholarship and had to take

admission in a private school by giving more fee. He did his M.Sc. in Mathematics from Calcutta University. Sharat Chandra Bose and Netaji Subhash Chandra Bose were three years junior to him. His teachers were Sir Jagdish Chandra Bose, Sir Prafulla Chandra Ray and D.N. Mallik.

In those days Thermodynamics, Relativity and atomic theory were the new themes in physics. Saha read many books on these subjects and taught very well. While reading and preparing notes on Agnes Clerke's book, about Sun and Stars, he faced problems regarding the temperature of the stars, their internal structure, organisation and the phenomenon when sunlight passed through water drops or prism, forming a spectrum.

As a solution to these problems, Saha proposed the ionisation formula, which can be used to explain the presence of spectral lines. With the help of this formula astronomers are able to find out the temperature, pressure and internal structure of the Sun and other stars. It was a big discovery in the field of Stellar physics.

The temperature, internal structure and organisation of the stars etc. are studied under Astro-physics.

He established the Saha Institute of Nuclear Physics and got the first Cyclotron of Bharat.

After studying the reasons of floods he suggested many river valley projects, including the Damodar Valley, Bhakra Nangal and Hirakud.

1.6.3 Professor Satyendra Nath Bose (1894-1974)

Satyendra Nath Bose was born on 1 January 1894 in the home of father, Surendra Nath Bose and mother, Amodini Devi. He did his M.Sc. in Physics from Kolkata University. He worked with Madame Curie and Albert Einstein.

According to the amendment done by Bose, the initial statistical methods of Maxwell and Boltzmann's 'kinetic molecular theory' could also be applied to photons and electrons. Bose's modified demonstration became famous by the name of 'Bose- Einstein statistics'. Presently, there are two statistical methods for analysis of the array of initial particles, which have divided all the particles into two parts : boson and Fermion. This classification is based on the spinning quality of the particles.

American scientist Enrico Fermi established that the spin quantum number of particles like electron, proton, neutrino, neutron etc, rotating on their axis, is a complete multiple of half; i.e. half, one and a half, two and a half etc. These particles were named after him as Fermion. Indian scientist Satyendra Nath Bose found that the spin quantum number of particles like photons, piemizon, alpha particles, gravitons etc is an interger i.e. zero, one, two, three etc. These particles were named Bosons after him.

The fifth form of matter has been named as the Bose-Einstein condensate (B.E.C.). BEC is prepared by cooling a gas having density as low as one lakh part of that of the normal air, at very low temperature.

Working in the sphere of chemistry he prepared a chemical by bringing about internal changes in the atom of sulphonamide, which, till date is prevailing in the form of eye-drops.

His dedication for hindi language is obvious by his statement "So, in this country there are people who do not like the language in which their mother sung lullabies for them and instead, like the language in which foreigners have rebuked them." S.N. Bose was a member of Rajya Sabha also.

1.6.4 Bhaskaracharya First (600 BC - 680 BC)

Bhaskaracharya I was born at Bori village, in Parbhani district of the state of Maharashtra in 7th century.

Bhaskaracharya I was the first mathematician to write numbers according to the Hindu decimal system. The numbers were written in words or analogy i.e. symbol and not in figures. For example moon for one; pair, wings or eyes for two since they always occur in pair; the five sense organs for number five etc.

Aryabhatiya-bhashya is the oldest prose work in sanskrit on mathematics and astronomy. It was written in 429 century. Bhaskaracharya I wrote two texts named Mahabhaskariya and Laghubhaskariya. Later on they were translated in Arabic also.

In Mahabhaskariya text a rational expression to express the value of trignometric

function sin x has been given. This formula is attractive and easy and a sufficiently abstract value of sin x is obtained.

$$\sin x \approx \frac{16x\,(\pi - x)}{5\pi^2 - 4\pi\,(\pi - x)}$$

$$0 \leq x \leq \frac{\pi}{2}$$

This formula is said to be stated by Aryabhatta. In it the relative error of the values of sin x is less than 1.9%. Maximum deviation being

$$\frac{16}{5\pi} - 1 \approx 1.859\%$$

which is at $x = 0$.

Bhaskaracharya I made a statement for prime number P that $1 + (P-1)$ is divisible by P. Later on it was proved by Al - Haitham and also Fibonacci. Now-a-days it is referred to as the Wilson's theorem.

Bhaskaracharya I stated a theorem, $8x^2 - 1 = y^2$, which is now known as the Pell equations. Here Bhaskaracharya I raised a query "Tell the numbers whose square when multiplied by 8 and 1 is added to the product, gives the square of another number."

For example in $8x^2 + 1 = y^2$, if $x = 1$ then $y = 3$. This is written in short as $(x, y) = (1, 3)$. Similarly $(x, y) = (6, 17)$.

In ancient Bharat many such great scientists, philosophers and mathematicians were there whose investigations are very important for the modern world formations and have proved to be the milestones.

1.7 Scientific achievements of Contemporary Bharat : Achievements of Bhartiya scientists are there in various spheres. If the supreme award, Nobel Prize is regarded, the recipients include : C.V. Raman in 1930, Har Govind Khurana in 1983, Venkatraman Ramakrishnan in 2009. Some of the articles developed and invented in Bharat are as follows :

Button, Kajal, Chess, Calico, Crescograph, Crucible, Steel, Ruler, Shampoo, Indigo dye, Refinement of sugar, Test-tube baby etc.

The first underground atomic testing was successfully accomplished by Bharat at Pokran in 1974 and the second test was conducted at Khetolai. In 1975, Bharat's first artificial satellite Aryabhata was launched.

Satellite named Rohini was launched by Indian Space Research Organization (ISRO) using the launch vehicle SLV-3, that was made in Bharat. GSLV-DS which uses indeginous Bhartiya Cryogenic engine was launched in 2014.

Bharat's first mission to Moon, Chandrayaan-1, was launched on 22 October 2008. By finding water in lunar environment for the first time, this mission, Bharat has registered its forceful presence in the present era.

The Mass Orbital Mission was launched on 24 September, 2014.

On 16 December 2015, ISRO successfully demonstrated its ability to deploy multiple satellites in different orbits, on same flight, by using PSLV C-29, which was launched from Satish Dhawan Space Centre, Sriharikota.

Inspired by the Bhartiya Yog Darshan, UNO decided to celebrate 21 June as International Yog Day, all over the world. It is a matter of Pride for Bharat.

Thus, Bharat has demonstrated its role in many sphere of science. Many Bhartiyas working from various places all over the world are benefitting the entire globe with their knowledge.

Still there is immense potential of inventions and discoveries in the latest domains of science, hence the bhartiyas must come forward in this direction.

IMPORTANT POINTS

1. The knowledge acquired by the systematic study of nature and validated by experimentation is known as science.
2. Selection of a problem, making a hypothesis, testing it, obtaining result from it and generalising it by making theory; is the scientific method.
3. The Harappa and Mohan-jo-daro civilisations of 3000 BC are the evidence of the developed Bhartiya science.
4. The father of plastic surgery, Sushrut, had healed a damaged nose, 26 centuries ago.
5. 200 years before christ (BC) the sage Patanjali's

Yog Darshan was prevalent for healthy life.

6. Brahmgupt who provided information about zero was a Bhartiya Mathematician.
7. C.V. Raman was given the Nobel Prize in 1930 for the discovery of Raman Effect.
8. Birbal Sahani was a paleobotanist.
9. Meghnad Saha provided information about astrophysics.
10. A theorem given by Bhaskarachrya I is currently in practice by the name Pell's equation.

Questions
Objective Questions

Q.1 Which substance was discovered by Prafulla Chandra Roy, the promoter of chemical industry in Bharat?
(a) Sodium chloride
(b) Mercurous nitrate
(c) Sulphuric acid
(d) Ammonium chloride

Q. 2 Birbal Sahni was related to which sphere of science?
(a) Chemistry
(b) Paleobotany
(c) Physics
(d) Computer Science

Q. 3 The name of first Bhartiya scientist to work in the domain of astrophysics is :
(a) Birbal Sahni
(b) Satyendra Nath Bose
(c) Einstein
(d) Meghnad Saha

Q. 4 Bharat's first mission to moon 'Chandra yaan-1' was launched on which date ?
(a) 22 October 2008
(b) 5 November 2013
(c) 15 August 2015
(d) 28 February 2015

Q. 5 Who is known as the Father of Plastic Surgery?
(a) Charak (b) Sushrut
(c) Kanad (d) Patanjali

Very Short Answer type Question :

Q. 6 Give the name of the text composed by Sushrut.

Q. 7 To which mathematician was the title of 'Ganak Chakra Chudamani' given, by Brahmgupt?

Q. 8 When is the National Science Day Celebrated?

Q. 9 Who wrote the book "The History of Hindu Chemistry"?

Q. 10 By what name, is the branch of science which deals with the study of vegetation of the past era, known as?

Q. 11 Which scientist gave the ionization theory in Physics?

Q. 12 Under the superivision of which scientist was the first cyclotron in Bharat inducted?

Q. 13 Give the name of the Bhartiya scientist who gave the 'Bose Einstein Statistics'.

Q. 14 When is the World Yog Day celebrated?

Q. 15 When was the Mass Orbiter Mission launched?

Short Answer Type Questions :

Q. 16 Write the two important works accomplished by Bhaskaracharya I.

Q. 17 Which substance was used by Prof. Satyendra Nath Bose to prepare eye drops?

Q. 18 What are bosons?

Q. 19 How is the 'Bose-Einstein condensate' obtained?

Q. 20 What is 'Roman Effect'?

Q. 21 What is studied under astrophysics?

Q. 22 Which three atomic reactors were established by Homi Jehangir Bhabha?

Q. 23 Name the Arabic translation of Sushrut Samhita.

Q. 24 Write the names of the three main branches of biology.

Q. 25 Define science.

Essay type Questions:-

Q. 26 Write the different steps of scientific methods.

Q. 27 Name the eight stages of yog as given by Patanjali.

Q.28 The researches done by Dr. Birbal Sahni proved helpful for which spheres of science?

Answer key

1 (b) 2 (b) 3 (d) 4 (a) 5 (b)

Chapter-2

Structure of Matter and Molecule

2.1 Matter

Different objects present around us, like- water, air, salt, book, computer etc., are all matter. Every object that occupies space has mass and which can be sensed with the five sense organs, is termed as matter.

When we say that matter has mass, it means that it has weight. The more heavy an object is, greater will be its mass. Matter occupies space means that it has volume.

2.1.1 Properties of Matter :

1. There is empty space between the particles of matter.
2. The particles of matter are in a state of constant motion.
3. The particles of matter attract each other.

2.1.2 Types of Matter

Matter can be divided into two types on the basis of its components :

1. Pure Matter : Matter which has only one type of ingredient or component is known as pure matter.

For example : Iron, Gold, Water, Oxygen, etc. Elements and components are pure matter.

2. Impure Matter : Matter which has more than one type of ingredients or components are known as impure matter.

For example : Cold drink, soil, air etc. Mixtures are impure matter.

2.1.3 States of Matter :

On the basis of physical state, matter can be classified into three phases :

(i) Solid (ii) Liquid (iii) Gas

For example : $H_2O_{(g)}$ gaseous phase - steam
$H_2O_{(l)}$ liquid phase - water
$H_2O_{(s)}$ solid phase - Ice

Now scientists are considering five states of matter by including

(iv) Plasma

(v) Bose - Einstein Condensate (BEC)

2.1.4 Characteristic Properties of Matter:

The three basic states of matter can be identified on the basis of their specific properties.

1. Solid State:

There are numerous substances in solid form all around us. For example : Piece of wood, stone, pencil, pen, computer, salt etc. Following are the characteristic properties of the solid state :

(i) Solid has a definite shape

(ii) Solid has a definite volume

(iii) The density of solid is more

(iv) Compressibility of solid is negligible

(v)A high inter-molecular force of attraction is present in between the particles of solid state.

(vi) Diffusion in particles of solid is extremely less.

2. Liquid State :

Water, mustard oil, kerosene etc. are the examples of liquid. The volume of liquid is definite but its shape is not; they take the shape according to the vessel. Liquid can flow. Liquid can be poured or spread. The properties of liquid are intermediate between solid and gas.

The characteristic properties of liquid state are :

(i) Shape of liquid is not definite.

(ii) Volume of liquid is definite.

(iii) The density of liquid is more than that of gas but less than that of solid.

(iv) The compressibility of liquid is very less.

(v) The inter-molecular force of attraction between the particles of liquid is weak.

(vi) Diffusion in particles of liquid is less than that in gas but more than that in solid.

3. Gas State :

The air present around us is the best example of the gas state, other examples include - Oxygen, Nitrogen, Argon, Carbon-di-oxide etc.

Following are the characteristic properties of the Gas state :

(i) The shape of gas is not definite and it

takes the shape of the vessel, in which it is placed.

(ii) The volume of gas is not definite and it take its volume according to the shape of the vessel.

(iii) The density of gas is very less.

(iv) The compressibility of gas is very high.

(v) The inter-molecular force of attraction between the particles of gas is negligible.

(vi) The diffusion in the particles of gas is very high. Hence it quickly spreads every where.

The distance between the particles of gas is too much. They can be brought near each other by applying high pressure and reducing the temperature and can be liquefied. The name of CNG, used as a fuel, is Compressed Natural Gas. LPG is Liquefied Petroleum Gas.

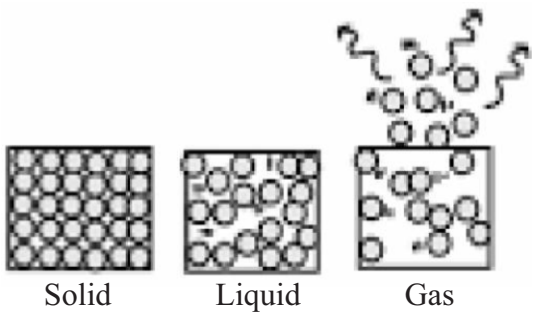


Fig. 2.1 States of Matter

2.2 Kanad Theory :

Ancient Bhartiya and Greek philosophers have always been astonished by the unknown and invisible forms of matter. Ideas had been expressed in Bharat about the concept of indivisibility of matter, as early as, in about 500 BC.

Bhartiya philosopher Maharshi Kanad had postulated that if we go on dividing matter, we will be obtaining smaller particles and in the end we will reach the limit when the particle obtained cannot be further divided i.e. that minutest particle will be indvisible. He named this indivisible, minute particle as the 'parmanu'. Another Bhartiya philosopher Pakudha Katyayana explained this idea in an elaborate form and stated that these particles are usually found in linked forms, which provide us with the different types of matter (element, compound, mixture).

Approximately at the same time i.e. 460 to 370 BC, Greek philosopher Democritus and Lencippus, suggested that if we keep on dividing matter a point will be reached when the particle obtained cannot be divided further. They termed these indivisible particles as atoms (i.e. uncuttables).

All the above mentioned views were on the basis of philosophical ideas. In 1808 John Dalton proposed the Atomic Theory and the credit of discovering atom was given to him.

Dalton suggested the view of divisibility of matter which was then considered philosophical. The minutest, indivisible particles of matter, which were termed atom by the Greek philosophers, were designated by Dalton also, as atom. This theory of Dalton was based on the laws of chemical combination. Dalton's Atomic Theory provided rational analysis of the law of Conservation of Mass and Law of Definite Proportions.

2.3 Atom :

According to Dalton's Atomic Theory, all matter, whether element, compound or mixture, are made up of minute particles called atom. Atoms are the minutest particles. Their shape is approximately of the range of 10^{-10} m.

The atoms of most of the elements cannot exist independently. Atoms form molecules and ions. These molecules or ions group in large numbers to form matter, which can be seen, felt or touched by us.

2.4 Molecule :

Generally molecule is a group of two or more atoms which are joined together by chemical bonds, which cannot be separated by general physical methods.

Therefore, the minutest particle of an element or compound which can exist independently and expresses all the characteristic properties of that compound, is termed as a **molecule**. For example : molecules of salt, molecules of phosphorus etc.

2. 5 Elements :

Group of same type of atoms is known as Element. For example : Gold, silver, iron, sulphur etc. Till date 118 elements are known.

The molecule of an element is made up of a combination of one or more than one atoms. For example : Molecules of Argon, Helium etc. are made up of a single atom of the element while the

two types of molecules of oxygen are O_2 and O_3 which are made up of two and three atoms of oxygen, respectively. O_2 is known as di-oxygen and O_3 is known as Ozone.

The number of atoms of an element present in a molecule is known as the **atomicity** of that element. The atomicity of oxygen in ozone is 3.

2.6 Compound :

The substance formed by the chemical combination of 2 or more than two elements in a definite ratio is termed as a **Compound**. For example: Salt, Water, Ammonia, Sulphuric acid etc. The smallest particle of a compound which can exist independently and possess all the properties of the compound is known as a **molecule of the compound**. For example : Water : molecular formula H_2O, Ammonia : molecular formula NH_3 etc.

2.7 Mixture :

The substance formed by mixing two or more than two elements or compounds in uncertain quantity, is known as a **mixture**. There is no chemical bonding between its components. Hence they can be separated by simple physical methods for example : air is a mixture, whose components includes N_2, O_2, CO_2, H_2O etc.

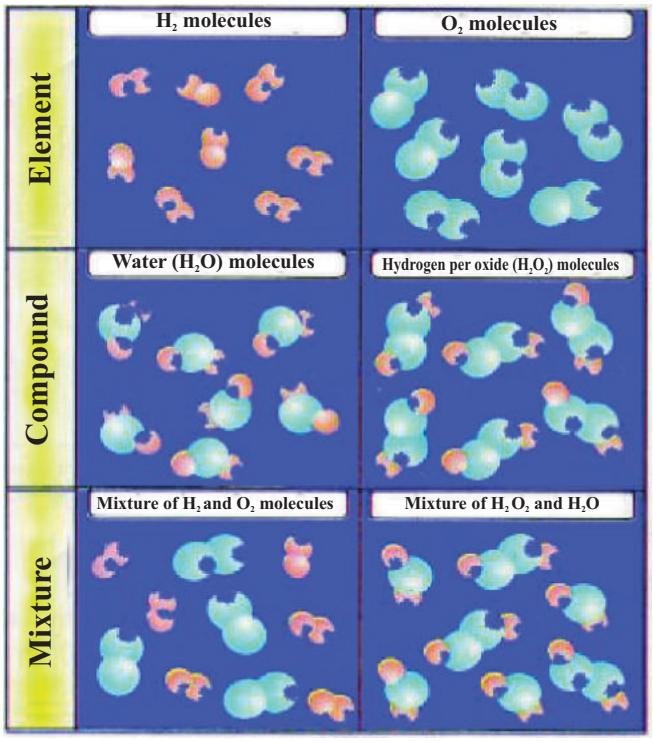


Fig. 2.2. : Elements, Compounds and Mixtures

Mixtures can be classified into two types :

2.7.1 Homogeneous mixture :

The mixture in which all the components are in the same stage and phase are known as homogeneous mixtures. For example : air, solution etc.

2.7.2 Heterogeneous mixture :

The mixture in which all the components are in different stage and phase are known as heterogeneous mixtures. For example : Milk, Cloud, Smoke etc.

2.8 Physical and Chemical Changes :

Whenever a matter varies its physical and chemical properties it is known as a change. For example : colour, smell, state, nature, molecular formula etc. Change of any type is a process. These changes can be of two types.

2.8.1 Physical change :

Changes in which the chemical properties of matter remain the same but the physical properties changes, are known as physical change. For example : Water is obtained on heating ice, here the solid state liquefies but chemically both are the same i.e. the molecular formula for both is H_2O.

$$\underset{\text{ice}}{H_2O_{(s)}} \rightarrow \underset{\text{water}}{H_2O_{(l)}}$$

2.8.2 Chemical change :

Changes in which the chemical properties of matter changes i.e. a new chemical substance is formed as a result of the change, are known as chemical change. Example : Carbon-di-oxide is obtained on burning carbon in oxygen. Here Carbon is in solid state and oxygen is in gaseous state. The carbon-di-oxide obtained is in gaseous state. Here along with the state even the molecular formula has changed

$$\underset{\text{Carbon}}{C_{(s)}} + \underset{\text{Oxygen}}{O_{2(g)}} \rightarrow \underset{\text{Carbon-di-oxide}}{CO_{2(g)}}$$

In the given picture tearing of paper is a physical change while its burning is a chemical change.

Fig. 2.3 Physical and Chemical changes

2.9 State Change of Matter and its Effect :

Whenever there is a change in the state of matter, primarily, the distance between its particles, the energy of its particles and the position of the particles change.

2.9.1 Effect of Temperature :

On being heated the kinetic energy of the particles increases. When solid is heated, the rate of vibration of its particles increases. The energy provided by the heat extends across the force of attraction between the particles. Because of this the particles leave their set location and start moving independently. A stage is reached when the solid melts and become liquid.

The temperature at which the solid melts down to liquid is termed as the **melting point** of that substance. The melting point of ice is 273.16ºK.

The process of melting i.e., conversion of solid into liquid state is also known as **fusion**.

"The heat energy required to change one kilogram of a solid into liquid, at its melting point, under one atmosphere pressure, is known as the **latent heat or enthalpy of fusion** i.e. melting."

On being heated, the kinetic energy of liquid particles increase further resulting in the conversion to gaseous state. The temperature at which liquid changes to gas is known as its **boiling point**.

"The heat energy required to convert one kilogram of liquid, at one atmosphere pressure, at its boiling point, into the vapour state, is known as the **latent heat or enthalpy of vapourisation**".

2.9.2 Effect of Pressure :

When pressure is applied the gas particles come close together. When the distance between these particles decreases, gaseous state changes into to the liquid state. But this liquid cannot be solidified by applying immense pressure because the compressibility of liquid is very less.

2.10 Purification of Matter :

In nature majority of the matter is present in impure form. Hence their purification is essential. There are different methods of purifying different substances.

2.10.1 Filtration :

Filtration is a method to separate solid from liquid in a heterogenous mixture. In filtration the solid matter is collected on the filter paper in the form of a residue and the liquid is obtained as filterate, when the mixture is passed through a filter paper. Example : Separating water from the sandy water.

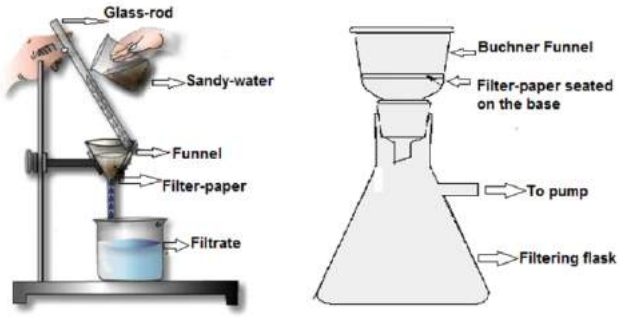


Fig. 2.4 Filtration

2.10.2 Crystallisation :

Crystallisation is the phenomenon of formation of solid crystals from the saturated solution.

The crystallisation technique of separating solid from liquid starts with vapourisation. However, in crystallisation when the solution becomes very concentrated, vapourisation is stopped. The concentrated solution thus obtained when cooled gradually, results in the formation of crystals, which can be seperated by filteration. For example - seperating sugar from sugar syrup, making crystal sugar, obtaining salt crystals from saline solution etc.

2.10.3 Sublimation :

Sublimation is the property of some substances, by virtue of which, they change directly from solid state to vapour state without liquifying

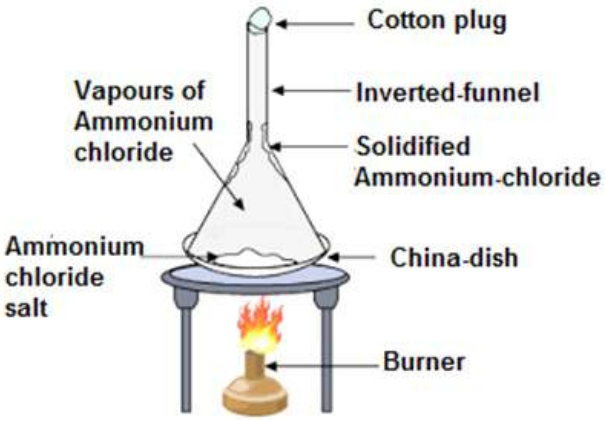


Fig. 2.5 Sublimation

and the vapours when cooled form solid without changing over to the liquid state. For example : Ammonium chloride (Sal ammoniac), iodine, camphor, Naphthalene etc exhibits the property of sublimation.

Separating a mixture of salt and sal ammoniac (Sodium chloride and Ammonium chloride) :

On being heated, the sal ammoniac from the mixture vapourises while the salt is left behind. These vapours cool down on the inverted funnel placed on the mixture being heated and thus converts back into pure sal ammoniac.

2.10.4 Differential extraction :

This is a technique to separate two immiscible liquids from each other. For example oil and water.

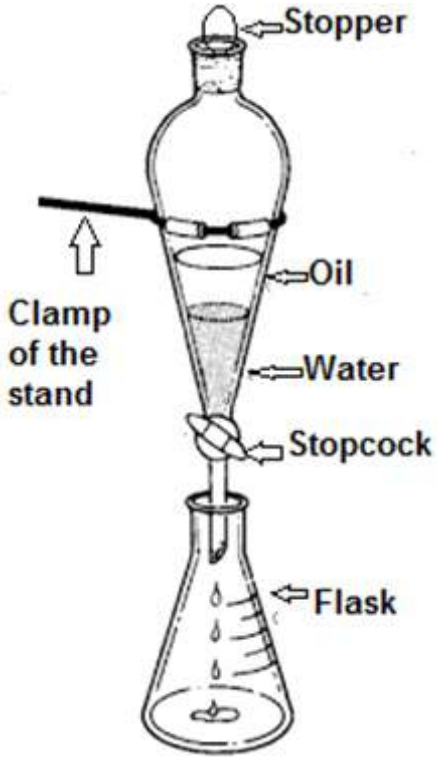


Fig. 2.6 Separating funnel

When poured in a separating funnel the two liquids in the mixture form separate layers. When the stop-cork is opened, the heavy liquid comes out first then the lighter liquid is obtained.

2.10.5 Distillation :

When soluble solid is present in a liquid, the liquid from the mixture vapourises on being heated and on cooling these vapours, pure liquid is obtained because of condensation. This process is known as **distillation**. Example water distillation etc.

Vapourisation

Impure liquid → Vapour

Condensation

↓

Pure liquid

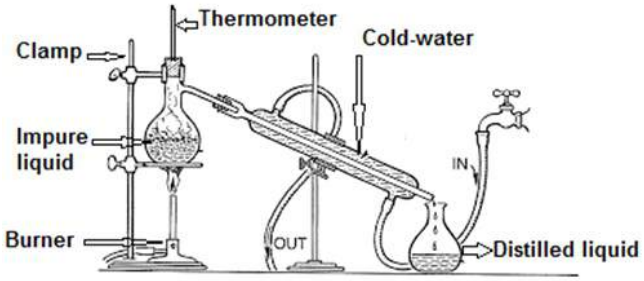
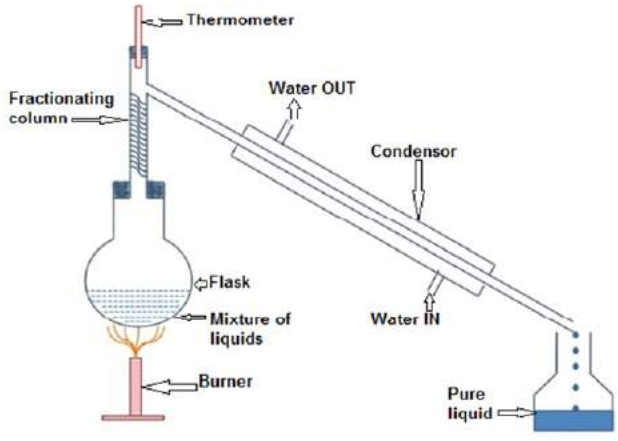


Fig. 2.7 Distillation

2.10.6 Fractional Distillation :

If the boiling point of two liquids do not have sufficient difference, they cannot be separated by simple distillation. Such liquids vapourise at the same temperature range and then condense together. In such a situation fractional distillation is made use of.

When the mixture is heated each liquid vapourises at its boiling point. Their vapours when passed through fractioning column and condensed, yield the different liquids. First the liquid with lower boiling point is obtained and then, that with higher boiling point. Example : Various



2.8 Fractional distillation

components like petrol, diesel, kerosene, vaseline etc are separated from petroleum by fractional distillation.

Important Points

1. Water, Air, Stone - all are matter.
2. There are primarily three physical states of matter - solid, liquid and gas.
3. The information regarding atom was first of all given by Maharshi Kanad.
4. Atomism was given by John Dalton.
5. Molecules are formed by chemical combination of atoms in a definite proportion.
6. Matter is present in the form of element, compound and mixture.
7. There are two type of molecules - elemental and compounds.
8. Mixture is formed by combining matter in indeterminate or definite proportions.
9. Conversion of ice into water is a physical change while breaking of ice molecules into hydrogen (H_2) and oxygen (O_2) is a chemical change.
10. The matter can be purified by crystallisation, distillation, fractional distillation, differential extraction, filteration etc.

Questions

Objective type questions :

Q. 1 When did Maharshi Kanad provided information regarding atom?
(a) 500 BC (b) 100 BC
(c) 460 BC (d) 1808 AD

Q. 2 The atomicity of oxygen in ozone is :
(a) 1 (b) 2
(c) 3 (d) 4

Q. 3 Which of the following substance is not solid at room temperature ?
(a) Salt (b) Alum
(c) Oxygen (d) Sal ammoniac

Q. 4 The temperature at which liquid changes to solid is known as :
(a) melting point
(b) boiling point
(c) freezing point
(d) condensation temperature

Q. 5 Which of the following options, is a mixture?
(a) Water (b) Brass
(c) Iron (d) Salt

Very short answer type questions :

Q. 6 Who was the first person to impart information about atom?
Q. 7 What is the approximate size of atom?
Q. 8 Write the molecular formula of water.
Q. 9 Which type of mixture, is the mixture of oil and water?
Q. 10 By which method can water be separated from the sandy water?
Q. 11 What is the atomicity of oxygen in di-oxygen?
Q. 12 Give an example of a monoatomic molecule.
Q. 13 Which is the state of matter whose shape and volume are constant?
Q. 14 Give the full form of C.N.G.
Q. 15 What is the process of conversion of liquid into vapours, known as?

Short answer type questions :

Q. 16 What is melting point? Define.
Q. 17 Write the definition of the latent heat of vapourisation?
Q. 18 Write one difference between an element and a compound?
Q. 19 What is a mixture? Give one example.
Q. 20 Write four properties of the liquid state.
Q. 21 What is a physical change? Give one example.
Q. 22 Explain the effect of pressure on the liquefaction of gases.
Q. 23 Write any three specialities of matter.
Q. 24 Which type of mixture can be separated using a separating funnel?
Q. 25 Define compound. Give one example.

Essay type Questions :

Q. 26 Explain the effect of temperature on the conversion of different phases of matter.
Q. 27 Explain sublimation with the help of a well labelled diagram.
Q. 28 Write three differences between solid, liquid

and gas.

Q. 29 Write two differences between physical and chemical changes.

Q. 30 How is matter purified by distillation? Explain with the help of a diagram.

Answer Key

1 (a) 2 (c) 3 (c) 4 (c) 5 (d)

Chapter-3

Atomic Structure

Since ancient times man has been inquisitive about the change of form of matter, for example when salt is added to water it becomes invisible but its taste is there in the water. On being burnt coal converts into ash. Matter can be grounded to form fine powder. The invisibility and divisibility of matter was well known to the Greek and Bhartiya philosophers, way back before Christ.

It was way back in 6th BC, Maharshi Kanad, the Bhartiya philosopher, had said, "Matter can be divided into small particles but the utlimate minutest particle will remain indivisible." Kanad named it 'Parmanu'. Another Bhartiya Philosopher Kaccayana stated that these 'particles' are present in combined form which give different forms to matter. At about the same time, Greek philosophers Democratic and Leucippus called these indivisible particles as atoms which means 'cannot be cut' or 'indivisible' in other words which cannot be divided further. All these views were based on philosophy and did not have a practical basis. In 1808, scientist John Dalton gave the 'Atomic Theory' on the basis of chemical combination, conservation of matter and laws of definite proportions.

The main points of the theory are as under :

1. All the matter is composed of small particles called 'atoms'.
2. Atoms are indivisible particles which can neither be destroyed nor can be created.
3. All the atoms of an element are similar.
4. Atoms of different elements have different properties.
5. The atoms of different elements combine with each other in whole number proportions to form the molecule of compounds.
6. Chemical change is basically the combination, dissociation and reconfiguration of atoms.

By the end of nineteenth century, series of different experiments, made it clear that some small particles are present in atoms which are known as sub atomic particles.

3.1 Physical particles of atom and their discovery :

3.1.1 Electric immersion tube : There is a long glass tube having metal electrode on both ends. A vacuum pump is connected to it, with the help of which the pressure in the tube can be increased or decreased. Even vacuum can be created in the tube with its help.

3.1.2 Discovery of electron : J.J. Thomson created high vacuum in immersion tube and applied high voltage on the metal electrode. He observed that green fluorescence is generated on the walls of the tube.

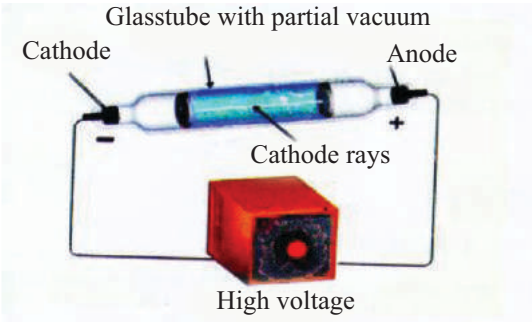


Fig. 3.1 : Formation of Cathode Rays in the Immersion tube

With the help of his experiments, Thomson confirmed that on applying high voltage in vacuum there is flow of electricity in the tube from cathode to anode, in the form of rays. Thomson termed these rays - the cathode rays.

Properties of Cathode rays :

1. They move in straight line.
2. They produce fluorescence.
3. They are affected by electric and magnetic fields.
4. When they pass through a gas, they ionise it.
5. They are made up of negatively charged

particles.

6. The e/m (charge/mass) i.e. ratio of charge to mass of these particles is uniform.
7. Primarily they are the matter waves.

According to J.J. Thomson, cathode rays are made up of negatively charged particles which he named as the electrons and their mass was found to be 1/1837 of the hydrogen atom.

Experiments on the properties of the cathode rays proved that in the atom there is a negatively charged particle, electron, which can be separated from the atom. The atomic electricity is neutral, hence the remaining part of the atom from which electron have been removed, should be positively charged.

3.1.3 Discovery of Proton : In 1886, E. Goldstein used perforated cathode in the immersion tube and observed new type of rays at low pressure and high voltage, which were termed as positive rays. They are also known as the anode rays.

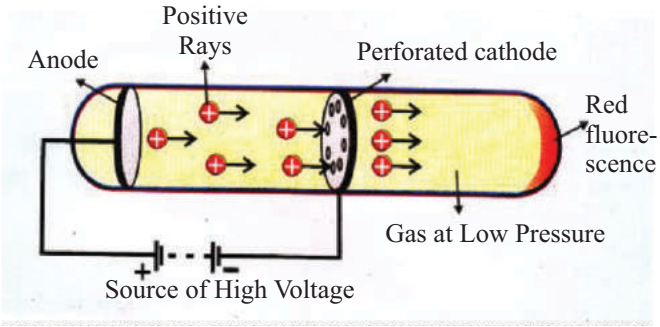


Fig 3.2 : Formation of positive rays in the immersion tube.

Properties of the Positive rays :

1. Positive rays move in a straight line.
2. Their charge to mass ratio (charge/mass i.e. e/m) depends on the nature of gas present in the tube.
3. They are affected by the electric and magnetic fields.
4. They are made up of positively charged particles.
5. They also are matter rays.

In 1919 this positive particle was identified as the proton and it was stated that in the atom the positively charged protons are also present along with the electrons. The atom is neutral because the number and charge of both is equal. The mass of proton is 1837 times greater than that of the electron.

3.2 Thomson's Atomic Model :

After the confirmation of the presence of electron and proton in the atom, Thomson in 1898 said that the atom is a positively charged sphere in which are embedded the negatively charged electrons. He compared it with the dessert "Plum pudding" in which dry fruits are present scattered within the cake. We can understand it by using the example of water melon. The fleshy part of which is the positive region and the seeds present in it may be considered the electron. This model was named as the ' Plum Pudding Model '.

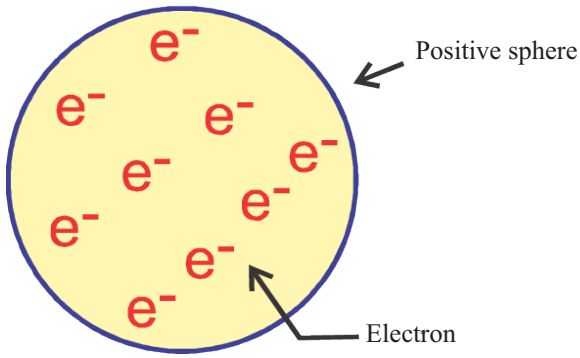


Fig. 3.3 Thomson's Atomic Model

Shortly, after some time, this model was rejected as it could not interpret the alpha particle dispersion experiments done by Rutherford.

3.3 Rutherford's Experiment and the Nuclear Atomic Model :

In 1911, Ernest Rutherford bombarded a thin screen i.e. foil of gold (100 nanometer or 10^{-7} meter thick) encoated with zinc sulphide, with alpha particles (Helium nuclei). The following observations were made by this experiment :

1. Most of the particles went out straight, without scattering.
2. Some particles scattered at an angle of 90° and some at 120° angle.
3. One out of 20,000 particles, however scattered at an angle of 180° i.e. returned on the same path after colliding with the foil.

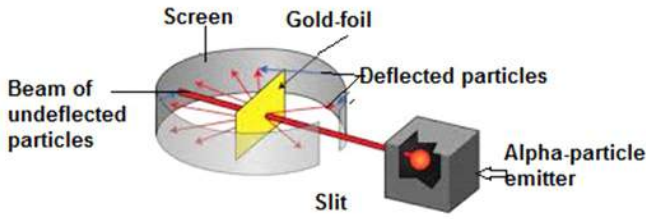


Fig. 3.4 Rutherford's Dispersal Experiment

3.3.1 Rutherford deduced the following inferences from his experiment of dispersal of alpha particles on the gold sheet :

1. Major part of an atom is a void.
2. The entire positive charge of the atom is concentrated at a point.
3. The space occupied by the positive charge is very less as compared to the volume of the atom.

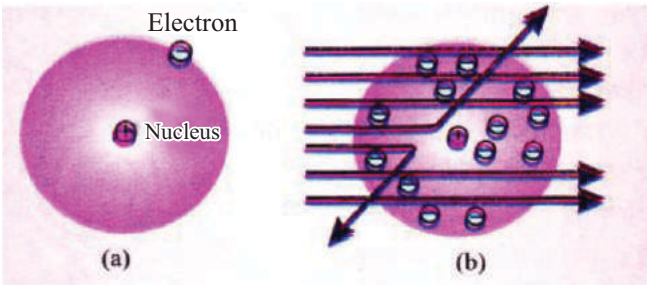


Fig. 3.5 Alpha particle dispersion by the nucleus of the metal atom

3.3.2 On the basis of these inferences Rutherford proposed the nuclear atomic model. The main points of this model are :

1. The entire positive charge and mass of an atom is concentrated in a small part, the nucleus, at its center. The radius of the nucleus is 10^{-15} meter.
2. Major part of the atom is void, in which the negatively charged electrons revolve at high speed on circular path, around the nucleus. These circular paths are known as orbit or shell or orbital.
3. The 'electrostatic force of attraction' between the positively charged nucleus and the negatively charged electrons is balanced by the centrifugal force of the electrons revolving at high speed.
4. The atom is electrically neutral because the total negative charge on electrons is equal to the total positive charge of the nucleus.

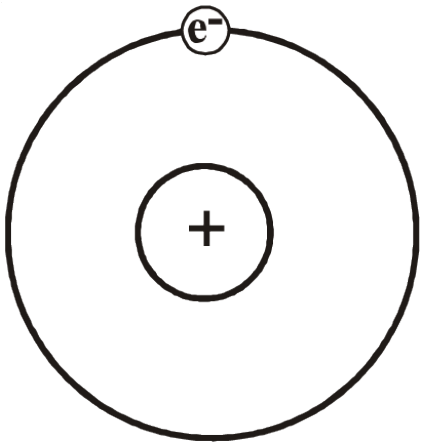


Fig. 3.6 Rutherford's Atomic Model

3.3.3 Drawback of the Rutherford's Atomic Model.

1. The negatively charged electron, revolving round the positively charged nucleus, will emit energy radiations because of acceleration; as a result, the energy will continuously decrease and ultimately the electron will fall into the nucleus. Hence the atom will not be stable.

2. Rutherford could not explain the definite path for electrons.

3.4 Discovery of Neutrons :

Atomic studies revealed that the mass of atom is more than total mass of electron and protons present therein. In 1920, Ernest Rutherford suggested the presence of neutral particles in the atom but in was difficult to identify them because they were without any charge. In 1932 the neutral particles, neutrons, were discovered, whose mass was found to be equal to that of protons. James Chadwick discovered neutrons.

3.5 Bohr's Model of Hydrogen Atom :

Rutherford's atomic model was not in accordance with the laws of Physics. In 1912 Neil Bohr presented a new atomic model based on

concepts. The main postulates of the Bohr's hydrogen atom model, based on the quantum theory, are as under :

1. In the hydrogen atom electron moves in circular orbits of definite radius and energy. These orbits are represented by 1, 2, 3, 4 ..... or K, L, M, N, O.

2. The angular velocity of electrons in these orbits (mvr) is equal to or $h/2\pi$ or its multiple. Here h is Planck's constant, m = mass of electron v = velocity of electron and r = radius of the orbit.

3. There is no change in energy of the electron revolving in a particular orbit but energy is emitted and absorbed respectively when electron moves from higher orbital to lower orbital or lower orbital to higher orbital.

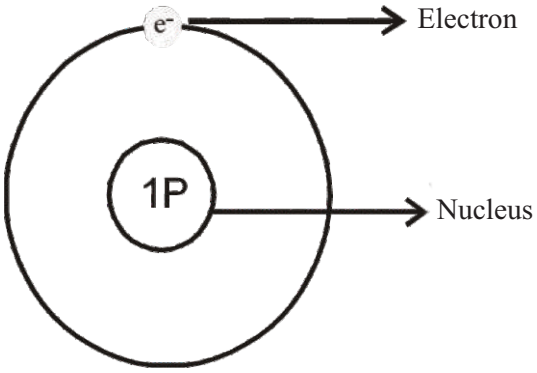


Fig. 3.7 Hydrogen Atom Model

Atomic radius is the distance between the nucleus and the outermost orbital (shell) of an atom dissociated from a compound. But neither can an atom be dissociated nor can the distance of the shell from outermost orbital, be measured in a simple way. Therefore the atomic radii can be explained in the following manner :

3.6.1 Covalent radius :

Covalent radius is half the distance of single covalent bond formed between similar atoms. For example half of the distance between the nuclei of two chlorine atoms is 99A° which is considered to be its atomci radius ($1A° = 10^{-8}$ cm).

3.6.2 Metallic radius :

Metallic radius is half of the total distance between the nuclei of the two adjacent atoms in a metallic cluster. This is its atomic radius.

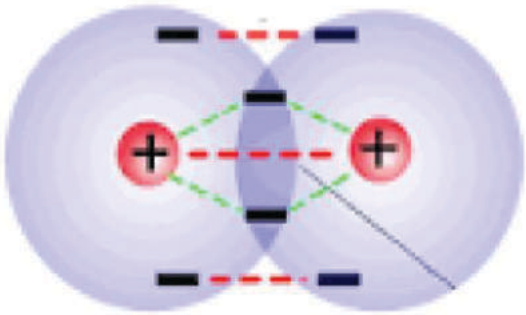


Fig. 3.8 Covalent Radii

3.7 Atomic Mass :

According to Dalton's atomic theory, each element has its characteristic atomic mass. Dalton's theory can easily explain the law of constant proportion, hence, inspired by it the scientists advanced towards measuring the atomic mass and relative atomic mass, using the combination rules. Practically the mass of atom is due to the protons and neutrons present in it. They are also known as nucleon because of their presence in the nucleus. Thus the entire mass of an atom is in its nucleus. The atomic mass of oxygen, which is, 16amu (atomic mass unit) is because of the presence of 8 protons and 8 neutrons in it. Similarly the mass of nitrogen atom is 14 amu (indicating 7 neutron + 7 protons).

"The total number of nucleons (number of proton + neutron) present in the nucleus of an atom is known as its mass number." Mass number is represented by 'A'. "The number of protons present in an atom is known as the atomic number." It is denoted by 'Z'. It can be related to A as under :

$$A = Z + n$$

where A = mass number
Z = atomic number
n = Number of neutrons

3.8 Atomic weight :

With the studies regarding atomic structure, the knowledge of e/m (i.e. ratio of charge to mass) of the electron had developed. Over period of time, even the atomic weight was determined. In the beginning the weight of atoms was calculated in relation to that of the smallest atom, i.e. of hydrogen, which was taken as unit. The atomic

weight was defined as - "The atomic weight of an element is that number which indicates how heavy is the atom of the element as compared to the hydrogen atom".
In 1961, the twelfth part of Carbon-12 isotope was accepted as the international standard atomic mass unit. According to this "the atomic weight of any element is the average weight of all the isotopes of that element as compared to one twelfth part of the carbon-12 isotope". In other words it is the ratio of the average mass of all the isotopes of that element to one twelfth of the mass of an atom of carbon-12.

Atomic weight of an element

$$= \frac{\text{Weight of one atom of the element}}{\text{Weight of 1/12 part of the C-12 isotope.}}$$

Atomic weight and atomic number of elements

S. No	Element	Atomic number	Mass number	Atomic weight in amu
1.	Hydrogen	1	1	1.008
2.	Helium	2	4	4.003
3.	Carbon	6	12	12.001
4.	Nitrogen	7	14	14.007
5.	Oxygen	8	16	15.99
6.	Sodium	11	23	22.99
7.	Magnesium	12	24	24.31
8.	Aluminium	13	27	26.98
9.	Chlorine	17	35	35.453

3.9 Avogadro Number

Hydrogen and oxygen reacts to form water :

$$2H_2 + O_2 \rightarrow 2H_2O$$

In this reaction 2 molecules of hydrogen react with one molecule of oxygen to form two molecules of water. The amount of substances taking part in a reaction can be determined easily and their amount can be easily represented by the number of its molecules or atoms. Hence, to make the understanding of the amount of substances, convenient, a new unit 'mole' was proposed. According to the mole hypothesis "The mass of one mole of a substance is equal to its gram atomic weight or the gram molecular weight."
According to this definition :

The weight of 1 mole of the substance
18 gms water (H_2O)
17 gms ammonia (NH_3)
44 gms carbon-di-oxide (CO_2)
12 gms carbon (C)
24 gms magnesium (Mg)

In one mole of every substance, the number of its particles (atoms, ions, molecules) is definite, which is known as the Avogadro number and its value is 6.022×10^{23}. In 18 gms of water there are 6.022×10^{23} molecules of water or 6.022×10^{23} atoms of oxygen and 2 (6.022×10^{23}) atoms of hydrogen. This has been named in honour of the Italian scientist Amedeo Avogadro.

The concept of mole can be understood with the help of an example :

Determine the number of oxygen and hydrogen atoms and of the water molecules in 2.5 moles of water.

Solution :

Charge and mass of the fundamental particles of atom

Name the Particle	Symbol	Nature	Charge		Mass	
			in Columb	in Unit	in amu	in kg
Electron	e	negative	1.6×10^{-19}	–1	0.0005485	9.109×10^{-31}
Proton	p	positive	1.6×10^{-19}	+1	1.007277	1.672×10^{-27}
Neuton	n	neutral	zero	zero	1.008665	1.674×10^{-27}

Number of molecules in 1 mole of water
= Avogadro number
$= 6.022 \times 10^{23}$
$\therefore$ Number of molecules in 2.5 mole of water
$= 2.5 \times 6.022 \times 10^{23}$
$= 15.055 \times 10^{23}$ molecules of water

Number of hydrogen atoms in one molecule of water = 2
$= 2 \times 6.022 \times 10^{23}$ atoms

Therefore, number of hydrogen atoms in 2.5 moles of water
$= 2.5 \times 2 \times 6.022 \times 10^{23}$
$= 30.110 \times 10^{23}$ atoms of hydrogen

Number of oxygen atoms in one molecule of water = 1

Number of oxygen in one mole of water = $1 \times 6.022 \times 10^{23}$

Therefore, number of oxygen atoms in 2.5 moles of water
$= 2.5 \times 1 \times 6.022 \times 10^{23}$
$= 15.055 \times 10^{23}$.

The volume of one mole of a substance at normal temperature and pressure is 22.4 litre, i.e., at NTP the weight of 22.4 litre of every gas is equal to its molecular weight. This is used in related to weight calculations.

3.10 Position of electron :

In an atom the electrons revolve around the nucleus in definite orbitals. These orbitals were represented by Bohr as K, L, M, N, O or 1, 2, 3, 4, 5. The number of electrons in each orbital is $2n^2$ where n is the number of orbitals.

Accordingly, as per Bohr's hypothesis, the maximum number of electrons in the outermost shell can be eight.

Orbit	Name of the orbit	No. of electrons
1	K	$2\times1^2=2$
2	L	$2\times2^2=8$
3	M	$2\times3^2=18$
4	N	$2\times4^2=32$
5	O	$2\times5^2=50$

Accordingly, the distribution of electrons in the atoms of the first 20 elements of the periodic table will be as under :

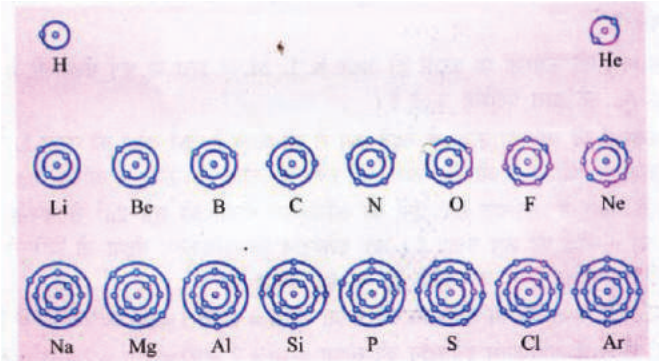


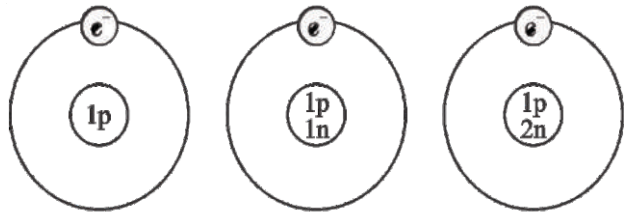
Fig. 3.9 Electron arrangement in Atoms

S. N.	Name of Element	Symbol	Atomic number	Electron arrangement
1	Hydrogen	H	1	1
2.	Helium	He	2	2
3.	Lithium	Li	3	2, 1
4.	Berilium	Be	4	2, 2
5.	Boron	B	5	2, 3
6.	Carbon	C	6	2, 4
7.	Nitrogen	N	7	2, 5
8.	Oxygen	O	8	2, 6
9.	Fluorine	F	9	2, 7
10.	Neon	Ne	10	2, 8
11.	Sodium	Na	11	2, 8, 1
12.	Magnesium	Mg	12	2, 8, 2
13.	Aluminium	Al	13	2, 8, 3
14.	Silicon	Si	14	2, 8, 4
15.	Phosphorus	P	15	2, 8, 5
16.	Sulphur	S	16	2, 8, 6
17.	Chlorine	Cl	17	2, 8, 7
18.	Argon	Ar	18	2, 8, 8
19.	Potassium	K	19	2, 8, 8, 1
20.	Calcium	Ca	20	2, 8, 8, 2

Isotopes :

According to Dalton's Atomic Theory all the atoms of an element are similar. But later on, scientists found that this was not true. They found that the mass number of the atoms of the same element may differ. Hydrogen atom is an example which has three atomic species :

Hydrogen 99.98%, Deutirium 0.15% and Tritium is present in very minute quantities.



Hydrogen $_{1}^{1}H$ Deutirium $_{1}^{2}D$ Tritium $_{1}^{3}T$

Fig 3.10 Isotopes of Hydrogen

In these atoms it was observed that in the nucleus of the hydrogen, available in excess, there is only one proton in the nucleus, while in Deuterium nucleus there is one neutron along with one proton and in the nucleus of Tritium there are two neutrons and a single proton. Thus, their atomic number is one but mass number is 1, 2 and 3 respectively. From this example we can define isotope as "Atoms of the same element whose atomic number is the same but mass number is different, are known as isotopes."

Other examples include two isotopes of chlorine : Chlorine 35 and Chlorine 37; two isotopes of carbon : Carbon -12 and Carbon-14; three isotopes of oxygen : Oxygen-16, Oxygen-17 and Oxygen 18.

3.11.1 Uses of Isotopes :

1. Uranium isotope is used as fuel in atomic reactor.
2. Radioactive isotopes are used in treatment of various diseases. For example : Iodine -131 in goiter disease and Cobalt-60 for treatment of cancer.
3. Isotopes are used to study the mechanism of chemical reactions.
4. Sodium-24 is used to study the blood circulation in human beings.

3.12 Isobars :

Isobars are the atoms of different elements whose mass number is the same but atomic number differs. For example, the mass number of calcium and argon, both, is 40 but their atomic number are 18 and 20 respectively. Similarly, mass number of Carbon-14 and Nitrogen-14, is 14 hence they are Isobars. In ths type of atoms the sum of protons and neutron is the same but in both the number of protons is different.

Important Points

1. The basic particles of atom are electron, proton and neutron.
2. The negatively charged particles in the atom are electrons.
3. The numeric value of the charge on electron and proton is the same but their sign is opposite.
4. James Chadwick discovered neutrons.
5. There are 6.022×10^{23} particles in one mole. This is known as the Avogadro number.
6. The NTP volume of 1 mole of a gas is 22.4 litres.
7. The formula to determine the maximum number of electrons in a shell is $2n^2$.
8. When the atomic number is the same but mass number is different they are known as Isotopes.
9. Isobars are elements having different atomic number and the same mass number.
10. There are three isotopes of hydrogen, Protium, Deutirium and Tritium.

Questions

Objective type Questions :

1. The Plum Pudding Model of atom was given by:
   (a) Neil Bohr
   (b) Thomson
   (c) Ernest Rutherford
   (d) Goldstein
2. The discoverer of neutron was :
   (a) C.V. Raman (b) Rutherford
   (c) J.J. Thomson (d) James Chadwick
3. The size of atom is :
   (a) 10^{-6} cm (b) 10^{-15} cm
   (c) 10^{-2} cm (d) 10^{-8} cm
4. The number of neutrons in the Deutirium Isotope of hydrogen is /are :
   (a) one (b) Two
   (c) Three (d) Not even one

Very short answer type questions :

5. What are Isotopes?
6. What are Isobar Element?
7. Write the names of the basic particles present in atoms.
8. Define atomic weight.
9. What is Atomic Number?
10. What is the charge on neutron?
11. Write the value of Avogadro number.
12. Write the name of the discoverer of proton.

Short answer type questions :

13. What is immersion tube? Explain with the help of diagram.
14. Explain the atomic model of Thomson.
15. What is mole concept? Explain.
16. Write the main points of the Dalton's Atomic Theory.
17. Write the characteristic properties of Cathode Rays.
18. Explain the Covalent Radius of atom with the help of an example.

Essay type questions :

19. Elucidate the atomic model based on Rutherford's observations of Gold foil particle scattering experiments.
20. Write the main concept of the Neil Bohr atomic model and on its basis draw the atomic structure of sodium and potassium element.
21. What are positive rays? How can they be obtained? Write their properties.

Numerical Problems :

22. The number of neutrons in an isotope of an element is 9 and mass number is 17. Name the element and state its atomic number.
23. Write the weight of 22.4 litre nitrogen at NTP in terms of gram.
24. How many atoms of carbon are present in 1.5 moles of carbon?
25. What is the number of total atoms present in 9 grams of water.

Answer Key

1. (b) 2. (d) 3. (d) 4. (a)

Chapter-4

Chemical Bond and Chemical Equation

4.1 Symbol

The chemical names of elements are represented by a minimum number of alphabet. Initially the names of the elements were derived from their place of extraction or their specific colour. For example 'Gold' has its origin from its colour and 'Copper' from the place of its original extraction 'Cyprus'. Dalton was the first scientist to use a symbol to denote a definite amount i.e. an atom of an element.

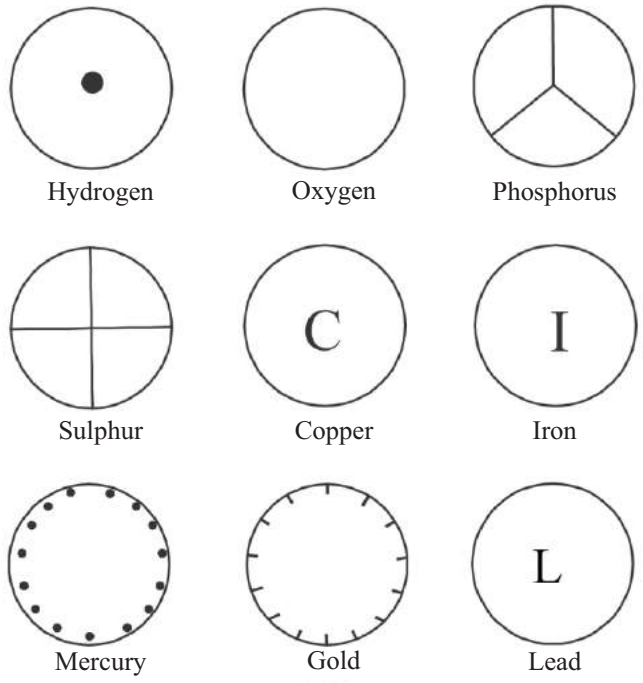


Fig. 4.1 Symbols for elements provided by Dalton

Berzelius developed a novel system of the symbols for elements, in which one or two alphabets of the name of the elements were used. Even IUPAC gives acceptance to the symbol of element on this basis. [IUPAC = International Union of Pure and Applied Chemistry.] According to this :

4.1.1 Element is expressed by the first alphabet of its English name :

Hydrogen	H
Oxygen	O
Carbon	C
Nitrogen	N

4.1.2 In cases where names of many elements initiate with the same alphabet, the first alphabet is used for one element while for others the first two alphabets are made use of. The first is written in capitals while the second in small letter.

For example :

Boron	B
Beryllium	Be
Barium	Ba
Bismuth	Bi
Carbon	C
Calcium	Ca
Cobalt	Co
Chlorine	Cl
Chromium	Cr

4.1.3 The symbols of certain elements have been obtained from their latin names. For example :

Sodium	Natrium	Na
Silver	Argentum	Ag
Gold	Aurum	Au
Copper	Cuprum	Cu
Potassium	Kallium	K
Iron	Ferrium	Fe

4.1.4 The symbols for elements with atomic number more than hundred have been taken from their numeric names and are composed of three alphabets.

For example :

Elements are named using the numeric roots of their atomic numbers.

Number	1	2	3	4	5	6	7	8	9	0
Numeric roots	un	bi	tri	quad	pent	hex	sept	oct	enn	nil

Element is named by putting together the roots, in order of the digits of their atomic number and adding 'ium' in the end. The symbol consists of the initial letter of the numerical roots that form the name.

Atomic number	Name	Symbol
101	Un-nil-unium	Unu
102	Un-nil-bium	Unb
103	Un-nil-trium	Unt
104	Un-nil-quadium	Unq

4.2 Ion

Atoms are electrically neutral because of the presence of equal number of the negatively charged particles : electrons and positively charged particles : protons.

An atom gets charged by giving up or accepting electron in its outermost orbit. These charged particles are known as ions. On the basis of the nature of charge, ions can be

(1) Positive ions (2) Negative ions

4.2.1 Cation

Cation is formed by the removal of an electron from the valence shell of the isolated gaseous atom of the element. In this process, energy is absorbed.

$A_{(g)}$ + Energy $\rightarrow$ $A^+ + e^-$

Metal atom positive ion

The energy required to remove electron from the isolated gaseous atom is known as ionization enthalpy.

The size of the cation is always smaller than that of its compliant atom because when electron is removed from the outermost shell, the force of attraction between the nucleus and the electrons increases, thus reducing its size. Normally only metal atoms form cations. The metal atoms form uni-valent, bi-valent, tri-valent, quadri-valent and penta-valent cations.

4.2.2 Anions

Anions are the negatively charged particles formed by the addition of one or more electrons in the outermost valence shell of the gaseous atom of the isolated element. The energy released on addition of the first electrons to an atom is known as electron affinity enthalpy. The size of an anion is always greater than that of its compliant atom since the electron cloud spreads because of the increase in repulsion between the electrons. Normally, non-metallic atoms form anion.

4.3 Radical :

Ionic substances, acids and bases dissolve in water and dissociate into ions which participates in reactions as a unit. They are termed as **Radical**. Radicals are of two types

(1) Simple Radical : Which are made up of only one type of atoms.

Example - Na^+, Mg^{2+}, Cl^- Br^- etc.

(2) Compound Radical : Group of two or more type of atoms having a definite charge is known as a Compound Radical

Example :NO_3^-, NH_4^+ etc.

4.3.1 Radical can be classified into two types on the basis of the charge present :

(1) Basic radical : These are metallic cation or positively charged radicals. They are also known as ash - radical because they are obtained from metallic ashes.

Example :Na^+, Mg^2, NH_4^+ etc.

(2) Acidic radical : Non-metallic anions and negatively charged radicals are known as Acidic Radical

Example :Cl^-, Br^-, NH_3^- etc.

Mono-atomic cations :

Uni-valent	Bi-valent
Sodium Na^+	Barium Ba^{2+}
Potassium K^+	Calcium Ca^{2+}
Silver Ag^+	Magnesium Mg^{2+}
Cuprous Cu^+	Zinc Zn^{2+}
Mercurous Hg_2^{+2}	Manganese Mn^{2+}
	Ferrous Fe^{2+}
	Cupric Cu^{2+}
	Mercuric Hg^{2+}
	Stannous Sn^{2+}
	Lead Pb^{2+}

Tri valent	Poly valent
Aluminium Al^{3+}	Stannic Sn^{4+}
Chromium Cr^{3+}	Arsenic As^{5+}
Ferric Fe^{3+}	

Mono-atomic Anions

Uni valent	Bi valent	Tri valent
Chloride Cl^-	Oxide O^{2-}	Nitride N^{3-}
Bromide Br^-	Sulphide S^{2-}	Phosphide P^{3-}
Iodide I^-		
Floride F^-		

Poly-atomic anions

Uni valent	Bi valent	Tri valent
Hydroxide OH^-	Carbonate CO_3^{2-}	Phosphate PO_4^{3-}

Cyanide CN^-	Sulphate SO_4^{2-}
Nitrate NO_3^-	Sulphite SO_3^{2-}
Permanganate MnO_4^-	
Acetate CH_3COO^-	

* The charge present on the ion represent its valency.
* Usually 'ate', 'ite' and 'ide' are used as suffix, in anions.
* In case of variable valencies the ion with lesser charge ends with 'ous' and 'ic' is used for those with greater charge.

4.4 Valency :

According to Bohr's Atomic Model there are a maximum of eight electrons in the outer most orbit of an atom. The outermost shells of the noble elements of Group 18 are completely filled and commonly they are chemically inactive. In other words their combining ability is zero.

The tendency of atoms of active elements to form molecules, with atoms of other elements, is considered to be an effort to fill the eight electrons in its outermost shell. In 1916 Corcel-Lewis formulated the "**Octet rule**", according to which "There is transfer or sharing of electrons between two atoms to complete the octet in the outermost (valence) shell of atom and thus the two atoms combine with each other."

The atoms of each element has a definite combining capacity, which is known as its valency. The number of electrons shared or transferred by an atom to complete the octet in its outermost shell is known as its combining capacity or valency. For example there are 1, 2 and 3 electrons in the outermost shell of sodium, magnesium and aluminium respectively, which is lost by them easily in order to achieve the octet in the outermost orbit. Therefore their valency is 1, 2 and 3 respectively.

The number of electrons in the outermost shell of oxygen and fluorine is 6 and 7, respectively. It is easy for them to gain 2 and 1 electrons in order to complete their octet in the outermost shell. Therefore their valency is calculated by subtracting 6 and 7 from eight. Hence, the valency of oxygen is 2 and that of fluorine is 1. In some exceptions the octet rule is not followed, which will be studied in higher classes.

4.4.1 Variable Valency : In some elements the valency is not specific, instead they have more than one valency. This is known as **variable valency**. The variable valency of certain elements is as under :

Element	Symbol	Valency
Copper	Cu	1 and 2
Mercury	Hg	1and 2
Tin	Sn	2 and 4
Iron	Fe	2 and 3
Phosphorous	P	2 and 5
Lead	Pb	2 and 4

4.5 Molecular Formula :

Molecule is a group of two or more than two atoms which are bound to each other by chemical bonds. Molecule is the smallest particle of an element or a compound which exhibits all of their properties and which can exist independently.

The combination of the symbols of elements which represent the molecule of an element or a compound is known as its molecular formula.

We can get the following facts from the molecular formula :

(1) The chemical name of the substance is known, for example Potassium Chloride.

(2) Details of the component elements of the compound can be known, for example in H_2O there are two elements : hydrogen and oxygen.

(3) The information about the total number of atoms in the molecule is obtained, for example in H_2SO_4 there are two atoms of hydrogen, one of sulphur and four atoms of oxygen.

(4) The molecular weight can be determined if the atomic weight is known.

Molecular formulae of Simple Compounds :

Often, the molecular formulae of the simplest binary inorganic compounds are known by the symbols of their constituent elements and their valencies.

When an element combines with other elements, they do so in the reverse proportion of their respective valencies. Therefore while writing the molecular formula, first the positive radicals are written on left side and the negative radicals on the right side along with their valencies superscripted. Then after, their valencies are written as crossover subscript to get the molecular formula. In case of need, the valencies are written in simple proportions.

The formula for poly-atomic ions are written within the brackets and their number is subscripted outside.

For example $Al_2(SO_4)_3$

4.5.1 Compounds having mono-atomic ions:

1. The formula for hydrogen flouride is obtained as under

Therefore the molecular formula will be HF.

2. Hydrogen sulphide

Therefore the molecular formula will be H_2S.

3. Calcium chloride :f

Therefore the molecular formula will be $CaCl_2$.

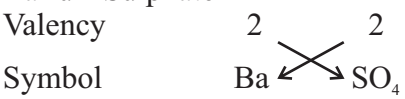
4. Calcium oxide :

Here the molecular formula will be CaO instead of Ca_2O_2.

When the valencies are the same, the simplified formula is written in a simple ratio.

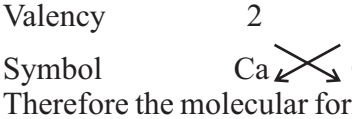
4.5.2 Compounds having poly atomic ions

1. Barium Sulphate



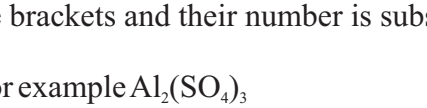
Therefore the molecular formula will be $BaSO_4$.

2. Calcium hydroxide



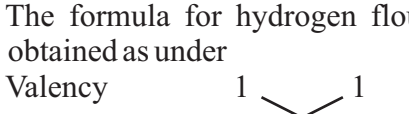
Therefore the molecular formula will be $Ca(OH)_2$.

3. Aluminium sulphate



Therefore the molecular formula will be $Al_2(SO_4)_3$.

4. Ammonium carbonate



Therefore the molecular formula will be $(NH_4)_2CO_3$.

4.6 Chemical Bond :

Chemical bond is the force of attraction present between the component particles (ions, atoms etc.) of a molecule which binds them together.

Atoms share or transfer electrons to complete their octet arrangement. In doing so, the atoms combine with each other forming molecules. After bond formation, the total energy of the molecule is less than the total of the energy of the independent atoms. This decrease in the energy of the molecule increases its stability as compared to that of the atoms. In other words, lesser the energy more stable will be the molecule. Chemical bonds are of many types; like ionic bond, covalent bond, co-ordinate bond, metallic bond etc.

4.6.1 Ionic bond : The electronic configuration of the cationic shell has one electron which can be easily removed by supplying energy. This energy is known as **ionisation enthalpy**.

$Na_{(g)}$ + ionisation enthalpy $\rightarrow$ $Na^+ + e^-$

(2, 8, 1) (2, 8)

On the other hand, an electron can be added to the outermost shell (valence shell) of chlorine (2, 8, 7) to obtain the stable configuration (2, 8, 8). The energy released in doing so is known as the **electron gain enthalpy**.

$Cl + e^-$ $\rightarrow$ Cl^- + electron gain

(2, 8, 7) (2, 8, 8) enthalphy

When sodium atom reacts with chlorine, it donates one electron and the chlorine atoms accepts one electron. Thus two oppositely charged ions are obtained because of the transfer of electron. The mutual electrostatic force of attraction between the two, keeps, them together. As a result, a chemical bond is built between the two ions. **Ionic bond** is the force of electrostatic attraction that develops

between the oppositely charged ions. It is also known as the **electro valent bond**.

The compounds having ionic bonds are known as ionic compounds.

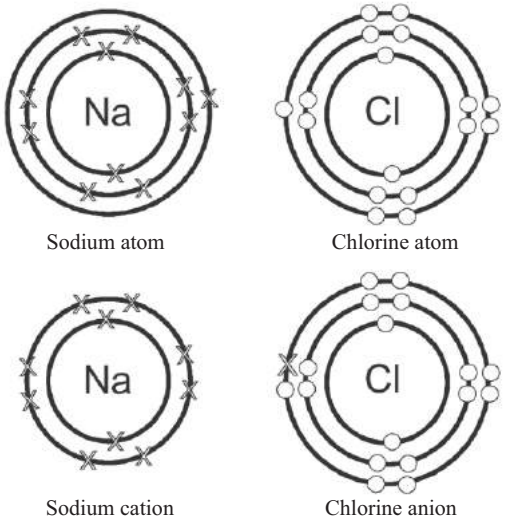
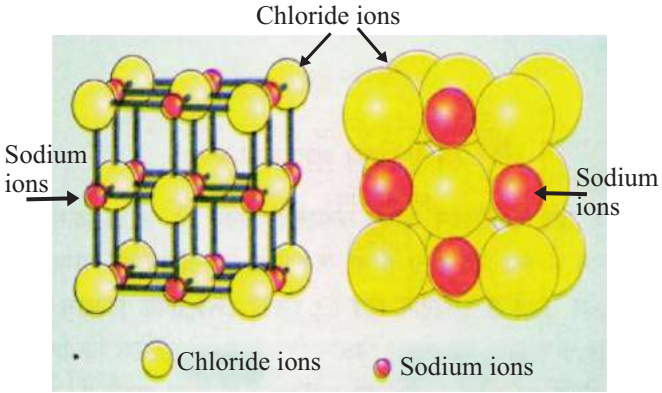


Fig. 4.2 Formation of NaCl molecule by the ionic bond between one sodium and one chlorine atom.

In the crystals of ionic compounds the ions are arranged in such a manner that each cation is surrounded by a definite number of anions and vice versa, as a result a clustered shape is formed. Like, in sodium chloride crystal, each sodium cation (Na^+) is surrounded by six chloride ions (Cl^-) and each chloride anion is surrounded by six sodium ions. The force of attraction responsible for binding these ions together is absolutely and completely the electrostatic force. The crystal is electrically neutral because of the presence of equal number of cations and anions.



4.3 Arrangement of ions in sodium chloride

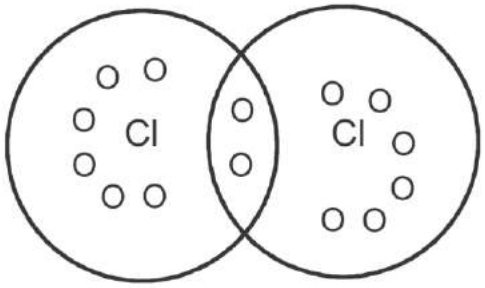
Properties of ionic compounds :

1. **Nature :** Ionic compounds are usually crystalline solid, hard and brittle.
2. **Melting point and Boiling point :** More energy is required to break the ionic crystal because of the presence of strong force of attraction between the charged ions. Therefore their melting point and boiling point is high.
3. **Solubility :** Ionic compounds are soluble in polar solvents (like water) and are insoluble in non-polar solvents (like benzene ether etc.)
4. **Conductivity :** Ionic compounds are good conductors of heat and exhibit electric conductivity in molten state.
5. Ionic compounds exhibit ionic reactions which occur at high rate.

4.6.2 Covalent bond : Besides ionic compounds there are compounds whose molecules do not have ions. For example, water.

Similarly, ionic bonds are not present in the molecules of non-metallic elements also. A covalent bond is formed by the sharing of one or more than one valence electrons between the binding atoms. Single bond is formed by the sharing of one-one electrons from each atom, a double-bond by sharing two-two electrons while the three-three electron sharing, result in the formation of triple bond. When two or more than two atoms bind together, electrons of the valence shell are shared, forming electron pairs to get octet. This type of bond is known as covalent bond. The compounds having covalent bonds are known as covalent compounds.

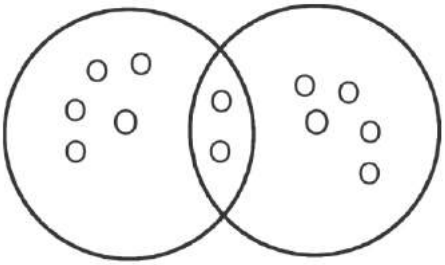
(i) Single Bond : The electronic configuration of chlorine is 2, 8, 7. The chlorine atom has a tendency to accept electron easily. Two chlorine atoms can



Cl–Cl

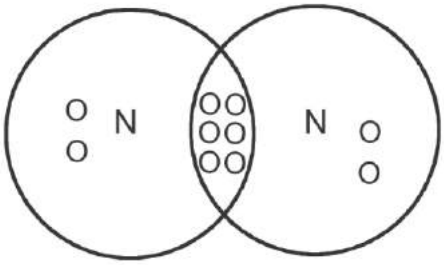
complete their octet by sharing one electron from the valence shell of each atom. The electron pair obtained by sharing is present in the middle of the nuclei of the two chlorine atoms and is under the combined effect of both the nuclei.

(ii) Double Bond : When there is sharing of two pairs of electrons between the two atoms, a double bond is said to be formed. For example : This type of bonding occurs between oxygen atoms.



O = O

(iii) Triple Bond : If three-three electrons from each atom are shared between the two atoms, a triple bond is formed. For example in nitrogen this type of bond is formed.

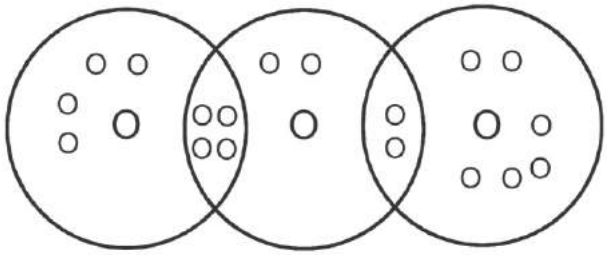


N ≡ N

Properties of Covalent Compounds :

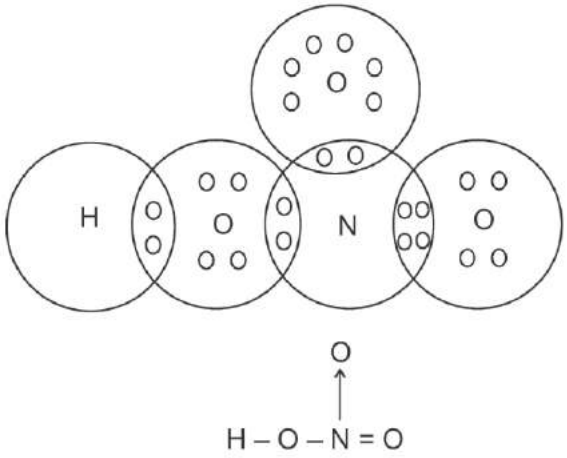
1. **Physical state :** These compounds are present in all three states : solid, liquid and gas. Generally they are soft; diamond and sand being the exceptions.
2. **Melting point and boiling point :** Generally, their melting and boiling points are low.
3. **Solubility :** They are soluble in non-polar and carbonic solvents.
4. **Conductivity :** They are bad conductors of electricity and heat. (exception : graphite)
5. The covalent compounds generally exhibit atomic reactions which takes place at slow rate.

4.6.3 Coordinate bond : Coordinate bonds are a type of covalent bond in which the electron pair for the bond formation is provided by only one atom but sharing is between both the atoms. For example in case of ozone molecule.



O = O → O

Nitric acid molecule



Prerequisite conditions for formation of coordinate bond :

1. The atom must have at least one lonely electron pair after the completion of its octet.
2. The other atom must have a deficiency of at least one electron pair.

4.7 Chemical Equation :

Representation of any reaction in the form of molecular formulae and symbols is known as

chemical equation. For example the reaction of calcium oxide (lime) with water, resulting in the formation of calcium hydroxide, is expressed as :

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

Reactants Product

The substance taking part in a reaction is known as reactant or substrate and the substance formed as a result of reaction is known as the product.

4.7.1 Writing the chemical equation :

1. In a chemical equation the reactants are written on the left hand side of an arrow, which points towards the products, written towards its right hand side.
2. If there are more than one reactant or product, a plus sign is written between them. Like in the above reaction $CaO+H_2O$ has been written.
3. The number of each type of atom present in the reactants and products are made equal on both sides of the arrow by increasing or decreasing the number of molecules. This process is known as balancing of the equation.

4.7.2 Characteristics of Chemical Equation:

The following information is provided by the chemical equation of any reaction.

1. The reactants and products of the reaction.
2. If the reaction is balanced, the number of molecules of the reactants participating in the reaction and the number of molecules of the product formed.
3. Reaction shows the equivalent quantities of the substances.
4. If the reactants or products are in gaseous state their volume is known.

4.7.3 Limitations of the chemical equations:

1. The physical state of reactants and products cannot be known by the equation.
2. Information regarding the concentration of reactants and products is not provided.
3. Reversibility or irreversibility of the reaction is not known.
4. Exothermic or Endothermic nature of reaction is not known.
5. No information about the temperature and pressure at which the reaction takes place.
6. The information regarding completeness of reaction is not made available.

These drawbacks can be overcome by the following means :

1. For representing the physical state, (s) is mentioned for solid, (*l*) for liquid and (g) for gas. For example:
   $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$
2. Simple arrow is replaced by $\rightleftharpoons$ to represent reversible reaction.
3. The amount of energy is written as product. When the reaction is exothermic a positive sign is used while when it is an endothermic reaction a negative sign is made use of.
   $SO_{2(g)} + O_{2(g)} \rightarrow SO_{3(g)} + 694.6\,kJ$
   $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)} - 53.6\,kJ$
4. The temperature and pressure at which the reaction occurs is written on the arrow.
   $N_2 + 3H_2 \underset{200\ atm}{\overset{723°K}{\rightleftharpoons}} 2NH_2$
5. Information regarding catalyst is given by writing above or below the arrow.

Important Points

1. Berzillius developed a new system for the symbols of elements.
2. The Latin name for sodium is Natrium.
3. The actual number of atoms of different elements present in a molecule of a compound is known by the molecular formula.
4. The force of attraction between two ions is known as IonicBond.
5. Ionic compounds are solid and brittle.
6. Covalent Bond is formed by sharing electrons in equal number, by two atoms.
7. The Co-ordinate Bond is represented by an arrow.
8. Covalent bond is represented by a dash (–).

Questions

Objective type :

1. The symbol for sodium is
   (a) S (b) Si
   (c) Na (d) Ni
2. The formula for carbonate radical is
   (a) CO_3 (b) CO_3^{2-}
   (c) CO_3^{-1} (d) CO
3. The name of the bond present in sodium chloride is :
   (a) Ionic bond (b) Covalent bond
   (c) Metallic bond (d) Hydrogen bond
4. The element exhibiting variable valency is :
   (a) Na (b) Ca
   (c) K (d) Cu
5. The formula for calcium oxide is
   (a) Ca_2O_2 (b) CaO_2
   (c) CaO (d) Ca_2O
6. The generator of the modern system of symbols for elements was :
   (a) Berzillius (b) John Dalton
   (c) Rutherford (d) Neil Bohr
7. The molecule with covalent bond is :
   (a) H_2O (b) NaCl
   (c) CaO (d) $CaCO_3$
8. Fe is the symbol for :
   (a) Iron (b) Copper
   (c) Gold (d) Silver

Very short answer type questions :

9. What are radicals?
10. Define ionic bond.
11. Write the symbol and Latin name of Potassium.
12. Define Molecular formula.
13. Write the formula for calcium carbonate.
14. Write the formula of a tri valent acidic radical.
15. What are anions?
16. What is valency?

Short answer type questions :

17. "The size of cation is smaller than the total size of the atoms that make it." Explain.
18. Explain variable valency with the help of an example.
19. What is a co-ordinate bond? Give an example.
20. Explain the energy of ionization.
21. Explain double and triple bond with the help of examples.

Essay type Questions :

22. Differentiate between covalent and ionic bonds.
23. Write the molecular formula of the following :
    (i) Sodium carbonate
    (ii) Zinc sulphide
    (iii) Aluminium oxide
    (iv) Ferric sulphate
    (v) Barium chloride
    (vi) Magnesium carbonate
24. Balance the following reactions :
    (i) $KClO_3 \rightarrow KCl + O_2$
    (ii) $BaCl_2 + AgNO_3 \rightarrow AgCl + Ba(NO_3)_2$
    (iii) $Mg + HCl \rightarrow MgCl_2 + H_2$
    (iv) $NaOH + Cl_2 \rightarrow NaCl + NaOCl + H_2O$

Answer Key

1. (c) 2. (b) 3. (a) 4. (d) 5. (c)
6. (a) 7. (a) 8. (a)

Chapter-5

Concept of Life

5.1 Major Differences between Living and Non-Living :

We come across both living and nonliving things in our day-to-day life. At times it is easy to differentiate between the two but sometimes it is difficult. We can classify things present at our home and in our surrounding environment into living and nonliving. For example furniture, radio, television and buildings belong to the non-living category and plants and animals belong to the living category. We can establish differences between the two categories on the basis of some features (Table 5.1).

5.2 Various Hypothesis Related to Origin of Life :

According to the theory of biological evolution, various types of unicellular and multicellular organisms have developed from some unicellular organism similar to a simple Amoeba. This evolution took place over millions of years.

Various scientists gave their views and hypothesis regarding the origin of life. They are as follows :

(1) Spontaneous Generation (Abiogenesis)

During ancient times it was believed that frogs, snakes, mice, alligators etc originate spontaneously when the sun rays heat the mud on river banks. Von Helmont was of the opinion that a shirt soaked in sweat when placed with wheat straw, spontaneously generates mice in 21 days.

(2) Cosmozoic Theory (Theory of Panspermia)

This theory was put forward by Liebig, Calvin and Arrhenius and Crick, a French and Leslie Orgel supported it. According to this theory the first organism reached earth from some unknown planet of the universe, in the form of showers of minute spores and evolved in the favourable environment of the earth. This led to the origin of life. This theory, however, was not accepted by many scientists because no organism could reach earth from the universe in living condition.

(3) Theory of Biogenesis

In 1668 Francesco Redi proposed biogenesis and rejected spontaneous generation or

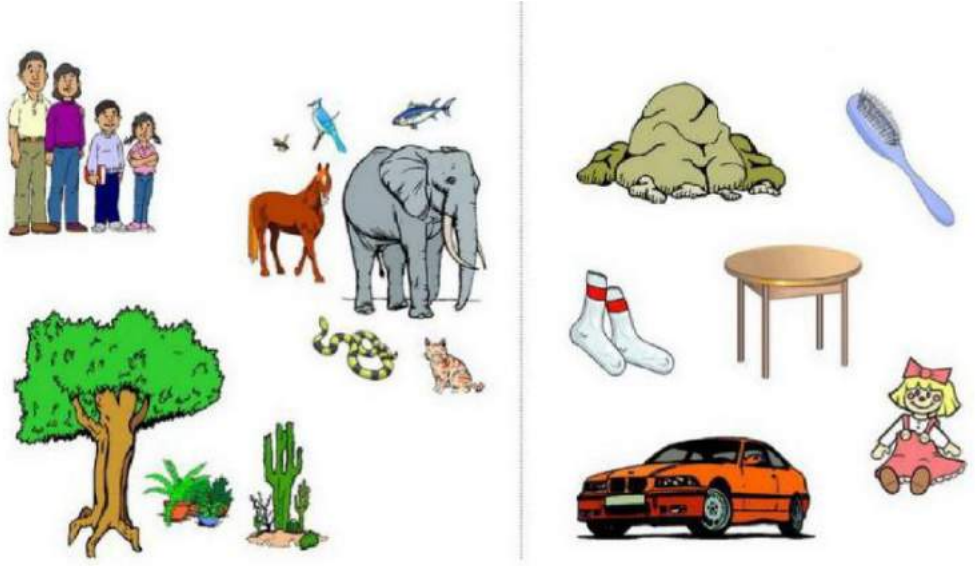


Fig. 5.1 : Difference between living and non living

Table 5.1
Differences between Living and Non-Living

Character	Living	Non-Living
(1) Reproduction	Reproduction is prevalent, in them. This is a very specific character of living beings. They are capable of producing organisms similar to themselves. It is because of this that survival of organisms is maintained.	Non-living are not capable of reproducing.
(2) Growth and Development	Living being, exhibit development. Growth also is a specific character. Animals grow upto a particular age but in plants growth is a life long process.	There is no development. Non-living does not exhibit growth.
(3) Cellular organisation	Cells are present in it. A definite organisation of tissues and organs is present.	There is no cellular organisation.
(4) Respiration	Respiration occurs. In living beings energy is obtained by oxidation of organic substances. This process is known as Respiration.	Respiration does not take place. It is not required.
(5) Nourishment	Needs Nourishment because in living beings food is required for obtaining energy. Plants synthesize food on their own by photo-synthesis and animals depend on plants and other organisms for their food.	Nourishment is not needed by non-living because they do not require energy.
(6) Metabolism	Metabolism takes place. Both catabolism and anabolism occurs.	Metabolism does not occur.
(7) Excretion	Exhibits excretion. Passing out unwanted substances from the body is a characteristic feature of living beings.	Excretion does not take place.
(8) Reaction or Response	Reaction occurs, living beings exhibit response for various stimuli; for example we remove hand in response to contact with hot object.	In non-living no response occurs against any stimuli.
(9) Movement or Locomotion	Locomotion or movement is the act of moving body or a part there of, change of place or posture etc. Living beings have organs for locomotion.	They do not have any inherent or intrinsic movement.

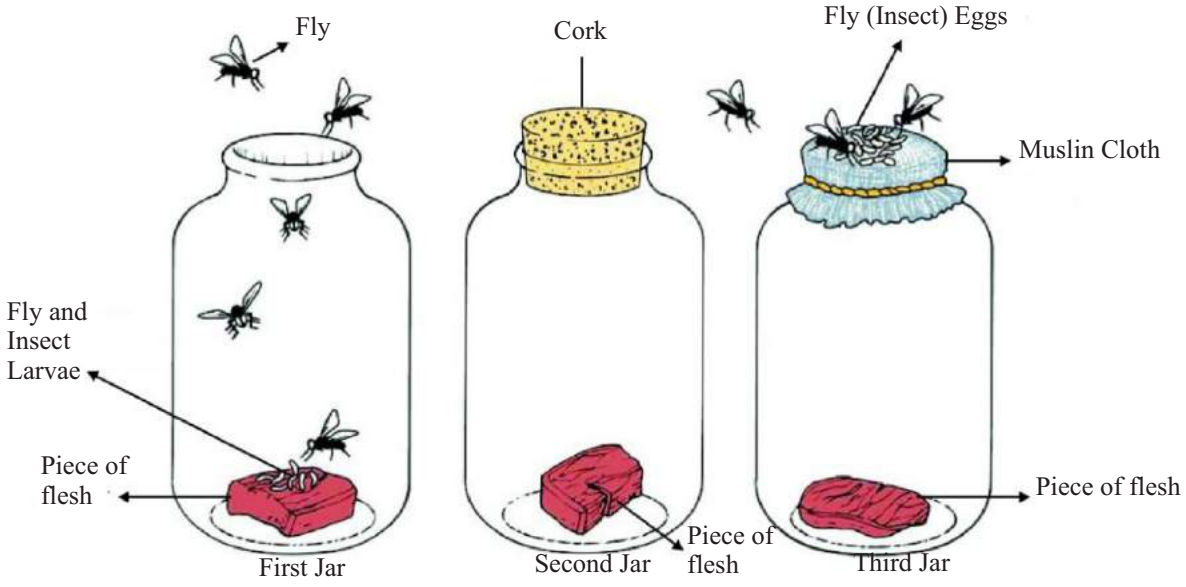


Fig. 5.2 : Experiment of Francesco redi

Abiogenesis. According to him the origin of life is only possible from the organisms. He boiled the flesh of fish, snake etc to kill all the organisms present on it. Then he placed these flesh pieces in different jars. The first jar was left open, the second was covered with a cork and the third was covered with a fine muslin gauze. After a few days Redi observed that in the first jar flies and maggots appeared. In the second jar there were no flies or maggots and in the third jar flies laid eggs on the gauze. The larvae developed in the third jar only if any egg could pass through the gauze. He inferred that organisms could originate from other organisms only.

Louis Pasteur also refuted the theory of spontaneous generation by his experiments. (Fig 5.3) For his experiment he used flasks with S-shaped tubular neck. He boiled yeast powder along with sugar syrup in these jars and left them to cool. Even after some days neither any micro-organisms developed in it nor was the broth spoiled. However, when left open by removing the S-shaped tube from the neck, micro-organisms developed and the broth was contaminated.

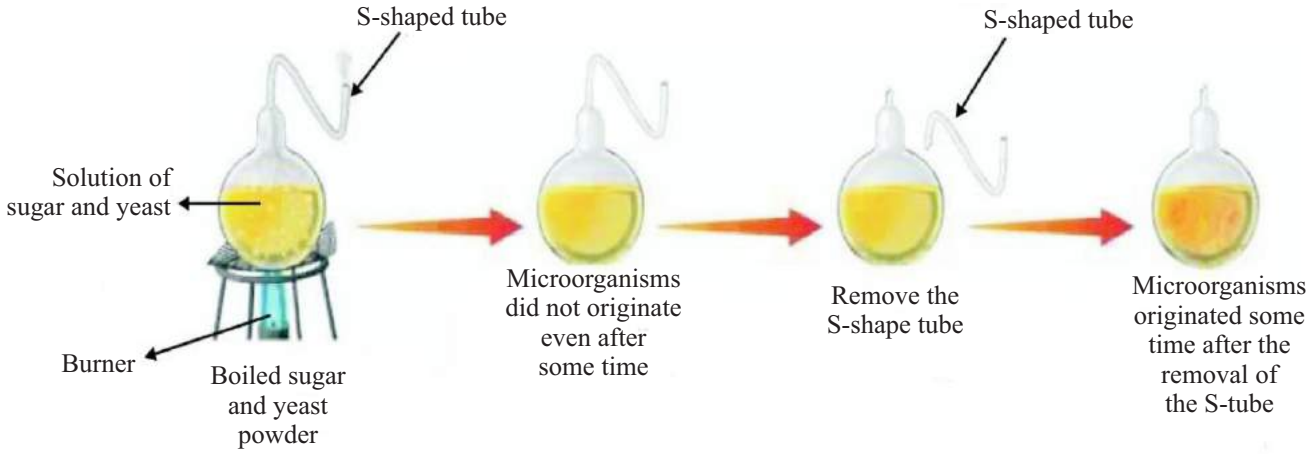


Fig. 5.3 : Experimental conducted by Louis Pasteur which refuted Spontaneous Generation

(4) Oparin Thoery

The famous Russian bio-chemist, A.I. Oparin proposed a hypothesis regarding origin of life, in 1924, on the basis of his studies. According to this hypothesis only carbonic compounds were present on primordial earth which were present in dissolved condition in the oceanic waters. Gradually specific or complex organic (carbonic) compounds were formed from these simple organic substances. Ultimately it was from the aggregates of these complex organic substances that there was development of such a creation which had characteristics of life. The entire process of the origin of life was divided by Oparin in seven stages :

(i) **First stage :** According to scientists the age of earth is 5-6 billion years. It originated from a mass of hot cosmic dust and gases that was moving rapidly in the universe. Various planets were formed by the division of this massive block. Earth was one of them. The temperature of the primitive earth was 5000-6000ºC. The hydrogen, carbon and oxygen molecules were present in it in abundance. Their mutual reactions resulted in the formation of compounds like water, ammonia and methane. Over a period of time the temperature of the earth reduced, as a result these compounds started solidifying and liquefying and clouds were formed. Gaseous ammonia and methane started accumulating in sea-water through the rain waters. Some minerals also reached the oceans along with river waters. Finally, the first organism originated by the chemical synthesis of these compounds.

(ii) **Second stage :** The initial environment of earth was of reducing nature because of excess of hydrogen. After billions of years, when the earth temperature reduced, simple hydrocarbons started forming by the condensation of methane. These simple organic molecules formed complex organic molecules like sugars, glycerine, fatty acids amino acids, pyrimidines, purines etc. The earth crust was hardened because of solidification of many compounds. Thus Lithosphere was formed.

(iii) **Third stage :** Various organic compounds like sugars, glycerine, amino acids, fatty acids, purines and pyrimidines formed by chemical synthesis, started boiling in the water bodies, just like soup. This resulted in their mutual combination forming complex organic molecules like carbohydrates, fats, proteins and nucleic acids, which laid the basis of origin of life.

(iv) **Fourth stage :** Nucleoproteins and other macro molecules were formed by the mutual reactions of carbohydrates, fats, proteins and nucleic acids. Certain specific nucleoproteins had the capability of replication because of which, replication was made possible. Replication resulted in increase in the amount of nucleoproteins and this lead to competition. New nucleoproteins were formed by mutation of some existing nucleoproteins. In this way, the process of evolution of nucleoproteins was established.

(v) **Fifth stage :** During this stage the first cell evolved. With the reduction of nutrients available in the sea water, competition between nucleoproteins started. The sticky nature of the newly formed mutated nucleoproteins resulted in formation of their aggregates. They remained in such groups and got a regular supply of nutrients.

(vi) **Sixth stage :** During this stage evolution started on the basis of nourishment methods in the primitive organisms. Parasitic, saprophytic, chemo-tropic and phototropic organisms evolved.

(vii) Seventh stage : The amount of usable oxygen in the environment started increasing with the gradual increase in number of photosynthetic organisms. Gases like CO_2 and N_2 were formed by reaction of free oxygen with methane and ammonia. It was because of these processes that the primitive atmosphere converted into the present day atmosphere. Oparin's hypothesis was practically demonstrated by Miller's experiments.

Miller's Experiments :

In 1954, scientist from Chicago, Stanley Miller, reproduced the conditions prevalent on primitive earth, i.e. 3 to 4 trillion years ago, to explain the origin of life. Miller boiled a mixture of methane, ammonia and hydrogen along with water in his apparatus for days together. The vapours formed were condensed. Thus mixtures of various gases were formed by their mutual reaction. After one week he observed a red coloured substance in the flask. Chemical analysis revealed the presence of various organic substances like alanine, glycine, glycerine etc. It was inferred from this experiment that life originated on earth in a similar manner. (Fig. 5.4)

5.3 Search of life in Extra-terrestrial Environment :

During the initial phase entire universe was in the form of a dot. Edwin Hubble postulated that when we look at the space, we observe that the galaxies and planets are moving away from each other. In our solar system there is possibility of existence of life on the planets where the conditions are similar to those on the primitive earth. However, on most of the planets the temperature is either too high or too low, which is not considered favourable for life. Moreover on some planets there is no environment because of which the life could never originate on them.

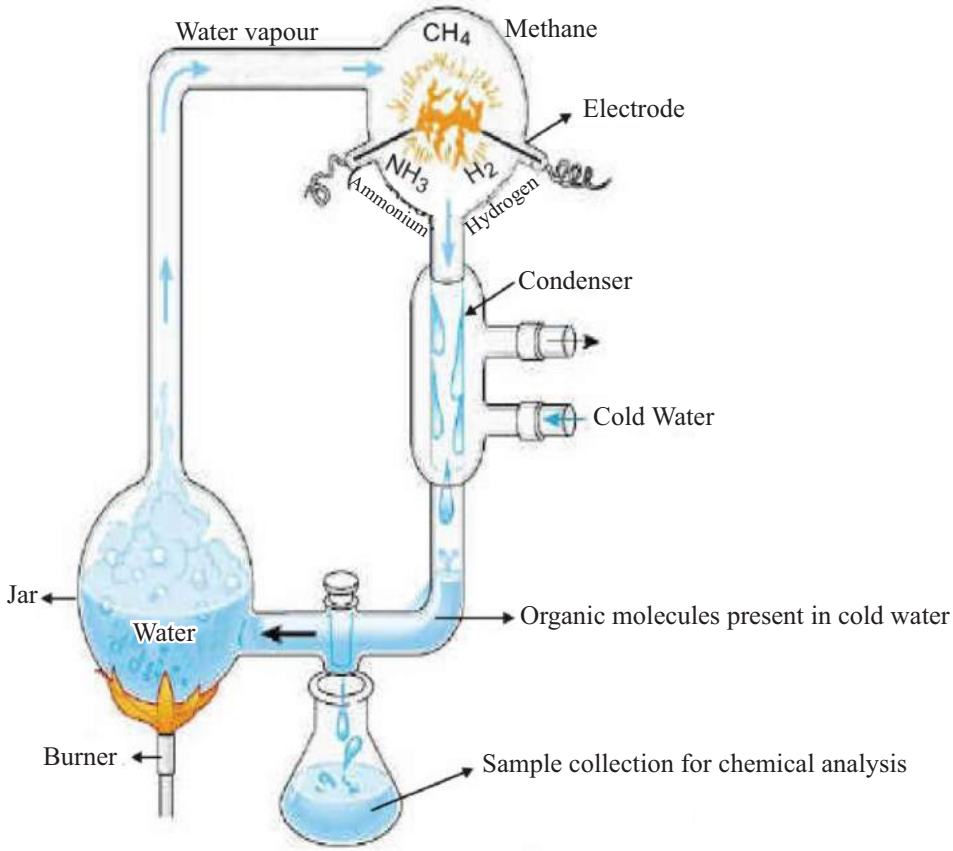


Fig. 5.4 : Miller explained the environment of primitive earth by means of an experiment

Mercury is too hot because of its nearness to the Sun, hence life is not possible on it. On Venus, the atmosphere is made up of thick clouds of carbon-di-oxide; as a result the temperature there is 200-300ºC and life is not possible there too. In the atmosphere of Jupiter, Saturn and other planets, there exists dense clouds of hydrogen, helium, methane, ammonia etc., quite similar to the primitive earth. But because of very low

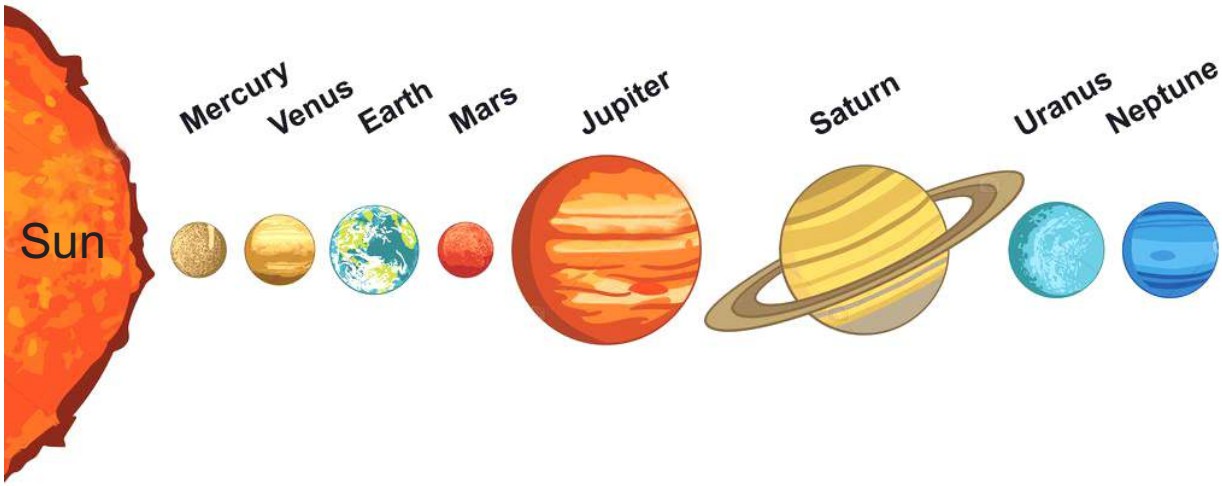


Fig. 5.5 : Solar System

temperature (–200 to –400ºF) life is not possible here. Mars is the only planet of our solar system where life may exist. It is, said that there is bitting cold on this planet and there are tornadoes of dust storms. On it, there is no life as on earth, but its geographical position is fairly good. Here the temperature during summers is 30–50ºC while during winters it may reach a low of –133ºC. The biggest mountain of the solar family is on Mars, along with huge valleys. One year on Mars is equal to 687 earth days. The first space craft was sent to this planet in the 1960 decade. CO_2 is the major component of this planet while the amount of oxygen present

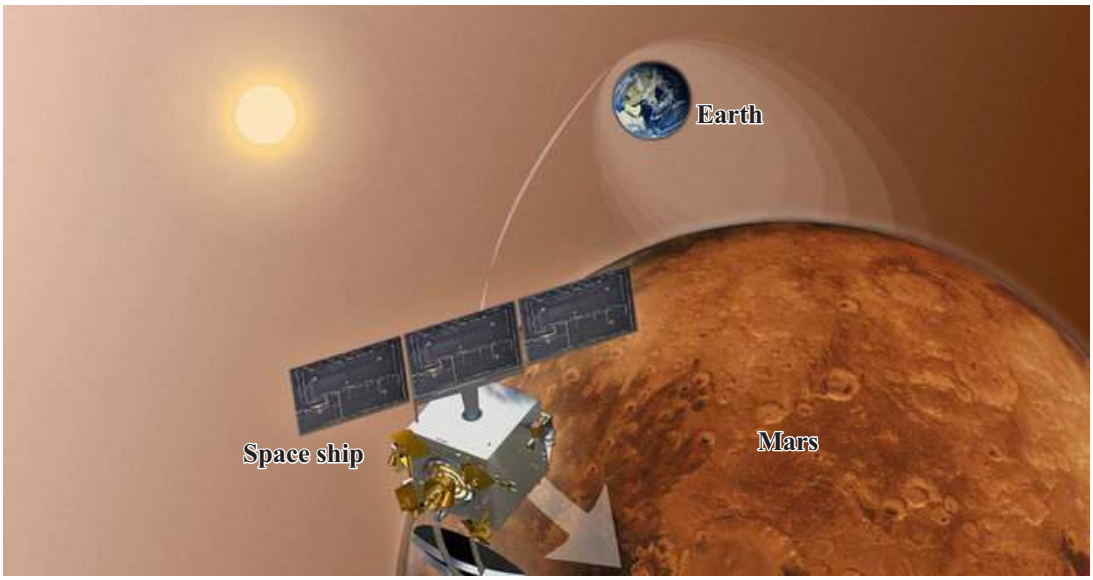


Fig. 5.6 : India's satellite launched in Mars Orbiter Mission rotating around Mars Planet

is only 0.13%. The gravitational force of Mars is very less as compared to that on earth. Yet as compared to other planets, Mars seems quite similar to the Earth. (Fig. 5.5)

Even the Mars Orbiter Mission (MOM), of Bharat, recorded success in 2014. We became the first nation in the world to register success in the first effort and that too at a considerably low cost. This Mars Orbiter will estimate the amount of methane gas in atmosphere and will also find its source. The temperature and minerals available will also be recorded. It will also note the amount of hydrogen and deutirium and will test the various particles it will come across on its outer surface. (Fig. 5.6)

In the solar system moon is closet to earth. Life is not possible on it because of lack of both, water and atmosphere.

5.4 Search of a New Planet like Earth :

By saying planet similar to earth, it refers that during summers it should be able to keep water in liquid form and the temperature and atmosphere should be like that of earth. Ultimately, after considerable efforts, a planet similar to earth was found and was referred to as the earth's "Bigger Older Cousin" or the "Big Brother". It was named as Kepler 452 b. It is 1400 light years away from earth. It is 60% bigger than earth. Kepler 452 is a star, like our Sun. It is 1.5 billion years older than Sun, nearly 20% more bright and is very hot. Kepler 452 b has orbit similar to our earth and its sun-light is received throughout the year in equivalent quantity and stretch. Scientists believe that on it there are rocks, sea and atmosphere like that on earth. Even the surface of this planet seems to be rocky and like that of the earth.

Fig. 5.7 : Earth and earth like planets Kepler 452b and Kepler 186f

Similarly another planet 186f (Kepler-186f) is also considered similar to the earth. It was discovered on 17 April 2014. Scientists are searching for planets similar to earth so that in future when earth will be uninhabitable, we may conserve life by transferring it there and ensure the survival of our race.

Important Points

1. According to the theory of biological evolution various unicelluler and multicellular organisms have evolved from some simplest unicellular organism like Amoeba.
2. Biogenesis was proposed by Francisco Redi of Italy and it refuted abiogenesis or the theory of Spontaneous Generation.
3. Even Louis Pasteur negated spontaneous generation of the basis of his experiments.
4. Oparin divided the entire process of origin of life in seven stages.
5. Stanley Miller, a scientist from Chicago, generated conditions prevalent on earth to explain the origin of life.
6. Miller filled the apparatus of his experiment with a mixture of methane, ammonia and hydrogen and boiled water in the flask continuously.
7. During the initial phase, the entire universe was in the form of a dot.
8. Mercury is very hot because of its nearness to the Sun, hence life is not possible on it.

9. On Venus the atmosphere is made up of dense carbon-di-oxide clouds which raises its temperature to 200-300ºC. Hence life is not possible .
10. Jupiter, Saturn and other planets have dense clouds of hydrogen, helium, methane and ammonia in its atmosphere, which is very much similar to that of the primitive earth. But life is not possible on these planets because of extremely low temperature. (–200 to –400ºF).
11. Mars is the only planet of our solar system on which life may exist.
12. The gravitational force on Mars is very less as compared to that on Earth but otherwise, Mars is very much similar to Earth as compared to other planets.
13. The Mars Orbiter Mission (MOM) of Bharat registered success in September 2014. We have come up as the first nation on this Earth to have achieved it in the first attempt and at a very low cost.
14. In the solar system Moon is the nearest celestial body to the earth. Life is not possible on it because of the lack of water and atmosphere.
15. After several efforts a planet quite similar to Earth has been found which is considered to be the "Big Brother" or "Bigger Older Cousin" and is named as **Kepler 452b**.
16. After **Kepler-452b** another planet resembling Earth, **Kepler-186f** has been discovered.

Questions

Objective type (Multiple Choice) Questions :

1. Besides Earth, on which planet of our Solar System is life possible ?
   (a) Mercury (b) Jupiter
   (c) Venus (d) Mars
2. Which is not a characteristic feature of living beings ?
   (a) Reproduction (b) Evolution
   (c) Growth (d) All options are wrong
3. According to Oparin's theory, Origin of life have been divided into how many stages ?
   (a) 5 (b) 6
   (c) 7 (d) 8
4. Who propounded the theory of biogenesis ?
   (a) Oparin (b) Francisco Redi
   (c) Von Helmont (d) Liebig
5. Name of the earth-like planet discovered on 17 April 2014 is :
   (a) Kepler 186 f (b) Kepler 452 a
   (c) Kepler 186 g (d) Kepler 452 b

Very short answer type questions :

6. Name the scientist who negated the theory of spontaneous generation.
7. Which are the two planets similar to earth?
8. Which scientist propounded the Cosmozoic theory?

Short Answer type Questions :

9. Explain the differences between living and non-living with the help of an examples.
10. Give on illustrated a account of the Miller's experiment.
11. Describe biogenesis.

Essay type questions :

12. Name the various hypothesis regarding the origin of life. Explain any one of them.
13. Explain the Oparin theory of origin of life.

Answer Key

Question	1	2	3	4	5
Answer	d	d	c	b	a

Chapter-6

Structure of Living Organism

6. 1 Basis of Life - Cell

The body of living organisms is made up of cells. All the activities taking place in the body of organisms take place through cells. It is obvious that the body of each organism is made up of small units known as **cells**. Thus, cell is the chief structural and functional unit of organisms.

A British scientist **Robert Hooke**, in 1665 AD, observed thin sections of cork with a microscope. He saw empty spaces or cavities and named them **cell.** Actually, the cells observed by Hooke were dead cells. In 1674, Van Leeuwenhock improved the microscope and observed living cells. The branch of science concerned with the structure and function of cell is known as **Cytology**.

Unicellular organism, is an organism whose body is made up of only one cell. For example: Amoeba, Chlamydomonas etc. Organisms whose body is made up of more than one cell are known as **Multicellular organisms**.

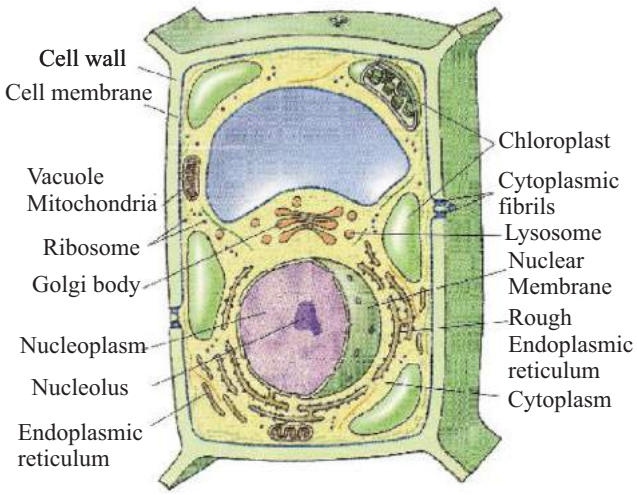


Fig. 6.1 Plant cell

All the biological processes, like, nutrition, respiration, excretion, growth and reproduction, are carried out by the single cell in a unicellular organism. In multicellular organisms, different type of cell groups are found for different functions. The cell aggregates (groups) are termed as **tissue**.

Majority of cells are minute and can be observed with microscopes only. Their average diameter is 0.5 to 20 microns. Some of the cells are very big for example the egg of an Ostrich which may range in size from 100 to 150 cm in diameter. The shape of cells vary according to the function they perform in the cells.

6.2 Cell theory and its exceptions :

On the basis of discoveries made in 19th century, scientists inferred that the body of all plants and animals is made up of cells. These cells are responsible for all the biological processes and biological characteristics. On this basis, Zoologist **Theodor Schwann** and Botanist **Mathias Schleiden** propounded the **cell theory** in the year 1838-39. According to this theory

1. The body of each living organism is made up of one or many cells.
2. The cell is the basic unit of life. All the life processes of a living being takes place in a cell.
3. The cell is the unit of heredity because hereditary material is present in its nucleus.
4. New cells are formed from the pre-existing cells.

On the basis of modern discoveries the cell theory does not appear to be logical at many points. For example, the virus do not have a cellular structure; all the organisms are not made up of cells and a prominent nucleus is not present in all the cells. In bacteria and blue-green algae a well defined nuclear membrane is not present around the nuclear material, which remains dispersed in the cytoplasm.

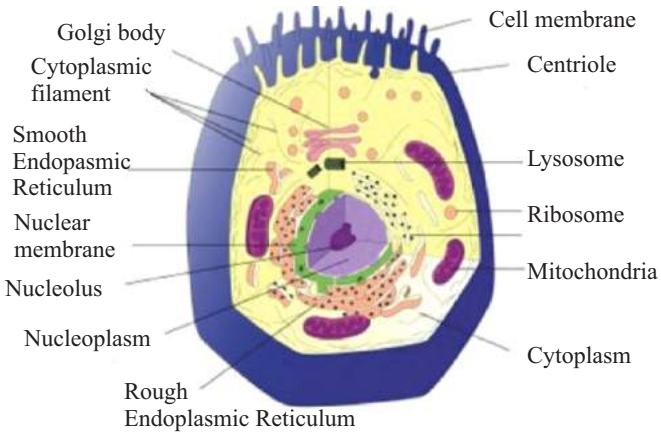


Fig. 6.2 Animal cell

6.3 Structure of a cell :

Microscopic studies have revealed that a typical eukaryotic cell has the following components :

1. Cell Membrane
2. Cytoplasm
3. Nucleus

6.3.1 Cell Membrane :

Cell Membrane is the outermost, living cover of the cytoplasm which separates the cell from the outer environment. Its thickness ranges from 75-105Aº, in different types of cells. It is a three layered cover made up of protein and phospholipid molecules.

Cell membrane controls the substances that enter or leave the cell. It permits the passage of some substances while prevents the movement of other substances. Hence it is referred to as **selectively permeable membrane**. Apart from this, cell membrane provides a definite shape to the animal cell and protects the cytoplasm.

In plant cells a non-living coat is present around the cell membrane. It is known as the **cell wall**. Cell wall is made up of cellulose, hemi cellulose, pectin and polysaccharides. The animal and plant cells are differentiated on the basis of the presence of cell wall. Cell wall gives the plant cell a definite shape and extra protection. Cell wall is absent in an animal cell.

6.3.2 Cytoplasm : The substance present in between the cell membrane and the cytoplasm, in a cell, is known as the cytoplasm. Cytoplasm is a fluid containing living structures (organelles) and non-living structures. Water, glycogen, fats and other substances are found in the fluid. The organelles present in the cell are :

1. **Mitochondria :** Mitochondria are present only in the eukaryotic cells and are absent in the prokaryotic cells. Mitochondria is also known as the '**power house**' of the cell because it produces the energy required by the cell. Their number is different in different cells of the same organism. The number of mitochondria is more in the cells whose energy requirement is more. Mitochondria was observed in 1880 by Kolliker. It was named as 'Mitochondria' by Benda.

   Mitochondria has a double-membrane. The outer membrane is smooth and flat and the inner membrane is projected in the cavity in the form of **cristae**. There are numerous stalked particles on the surface of the cristae. These particles are known as **oxysomes**. The region inner to the cristae is known as the **matrix**.

   Matrix is made up of 65-70% protein, 25% phospholipid and 0.5% RNA. Mitochondria also has DNA and ribosomes in it. The enzymes present in the mitochondria are responsible for the oxidation of nutrient substances during respiration.

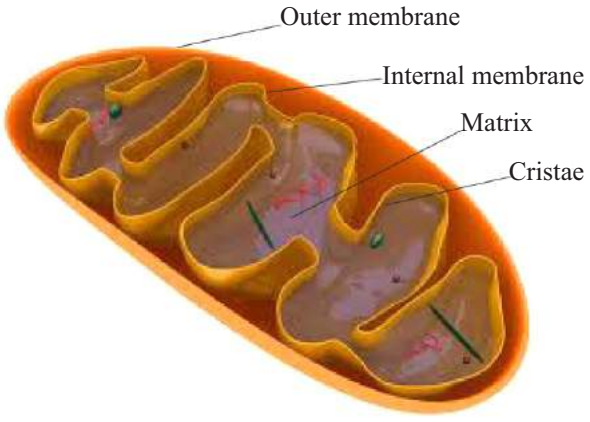


Fig. 6.3 : Mitochondria

2. **Plastids :** Plastids are present in the plant cells. Plastids appear to be of

different colour because of the presence of various pigments in it. Plastids are of different types on the basis of the different pgments present in them. For example : Chloroplast, Chromoplast and leucoplast. Chloroplast is the organelle of the cell in which carbohydrates are synthesised by the process of photosynthesis. Chloroplast is a double membrane bound organelle which are known as the outer membrane and the inner membrane. The space surrounded by inner membrane is known as the **stroma**. There is a complex membranous system in the stroma which is termed as the **thylakoid**. Thylakoid is arranged in two ways : The plate-like thylakoids are arranged like a stack of coins, known as **grana** and the thylakoids connecting two granum are known as **intergranum** (Grana-singular; Granum-plural).

The enzymes related to photosynthesis are present in the thylakoid membrane and the stroma. Even DNA and ribosomes are present in the stroma.

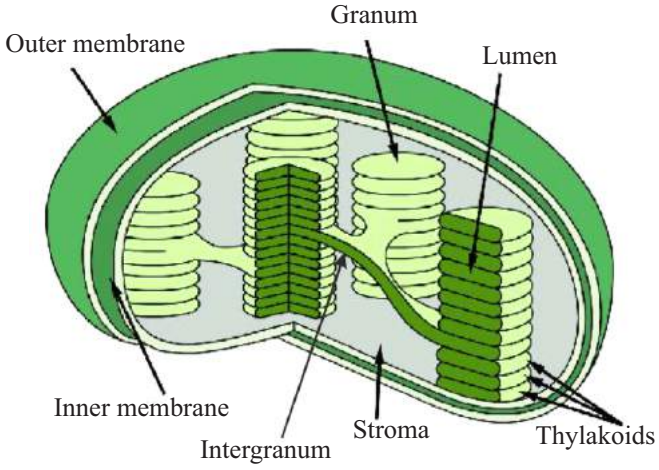


Fig. 6.4 Chloroplast

3. **Lysosome :** Lysosome was discovered by de Duve. Lysosome is a single membrane bound, sac like organelle. It is filled with granular fluid containing many hydrolytic enzymes, which break down sugar, fat, protein, nucleic acid etc. into simple molecules. Lysosomes are responsible for the breakdown of dead cell-organelles and cells. The enzymes present in it digests the entire cell once the membrane of the lysosome ruptures, therefore they are also known as the suicidal **bags**.
4. **Endoplasmic Reticulum :** The network of microtubules present between the nucleus and the cell-membrane is known as the endoplasmic reticulum. This also is a single membrane- bound structure. Ribosomes are present on the surface of **Rough Endoplasmic Reticulum** (RER) and are responsible for protein synthesis. The surface of the **Smooth Endoplasmic Reticulum** (SER) lacks ribosomes and it synthesises fat and lipid molecules.

   Endoplasmic reticulum transport substances between different parts of the cell and also between cytoplasm and the nucleus. It is also responsible for the formation of Golgi bodies.

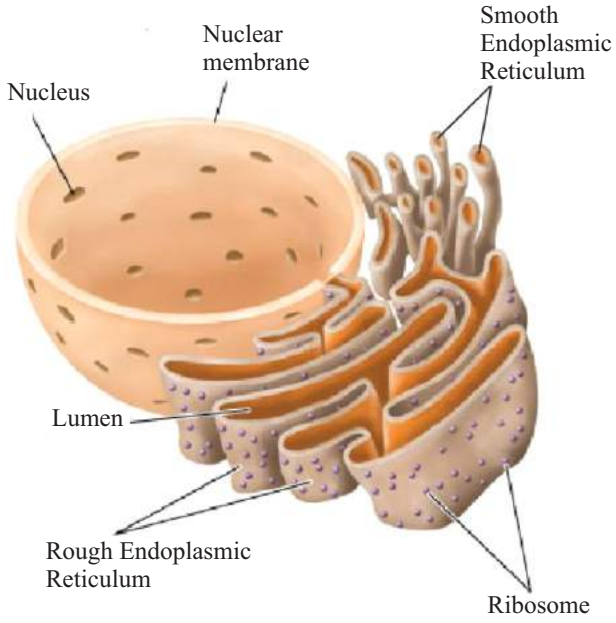


Fig 6.5 Endoplasmic Reticulum

5. **Ribosome :** Ribosome was discovered by Claude and was named as 'ribosome' by Palade. Ribosomes are present

independently in the cytoplasm and attached to the outer surface of the rough endoplasmic reticulum in the form of particles. Ribosomes are membrane less organelles i.e. they are not enclosed by membrane. They are made up of RNA and proteins. In eukaryotic cells the ribosomes are of 80S type while they are of 70S type in the prokaryotic cells. They are the sites of protein synthesis in the cell.

6. **Golgi body :** It was discovered by Camillo Golgi in 1898. It is present near the nucleus of the cell in the form of flattened tubes. It is made up of three type of structures : Vesicles, cisternae and vacuoles (sacs). It plays a major role in the synthesis and secretion of sugar, protein and pectin in the cell.

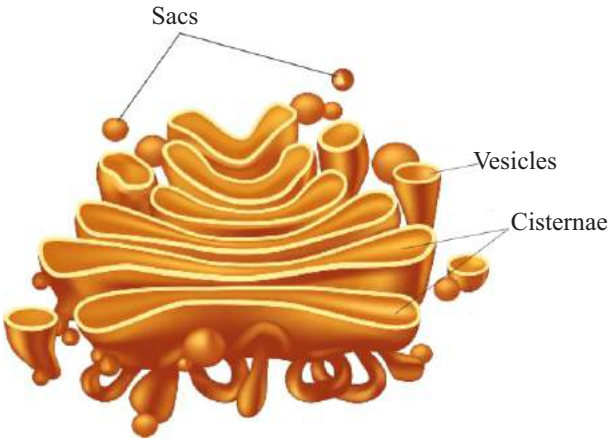


Fig. 6.6 Golgi body

7. **Centrosome :** It is mainly present in the animal cell near the nucleus in the form of a star shaped structure. Each centrosome is made up of two centrioles which are perpendicular to each other Centrosome was discovered by Van Beneden.

   Centrosome are responsible for the formation of spindle fibers in animal cells at the time of cell division. It forms the tail (flagellum) of the sperm. It forms the basal bodies of the locomotory organs of the micro-organisms i.e. the flagella and cilia.

8. **Vacuole :** The small or big, bubble like structures present in the cytoplasm of the cell are known as **vacuoles**. They are enclosed by a membrane termed as the **tonoplast**. The fluid present in the vacuole is known as the **cell sap**. Water, along with excretory substances and other waste products are present in the cell sap. Vacuoles keep the cells turgid and collects water and other waste substances. In plant cells the vacuole is quite large.

   Other organelles like **microbodies** and **peroxysomes** are also present in the cells.

6.3.3 Nucleus : Nucleus was discovered by Robert Brown in 1831. It is the most important organelle of the cell. Normally only one nucleus is present in each cell. In some cells more than one nuclei may be present. The mature Red Blood Corpuscles of human beings and the mature seive cells of plants lack nucleus.

In animal cell nucleus is spherical and is present in the center of the cell. However, in a plant cell nucleus is present near the periphery because of the presence of a large vacuole in the center.

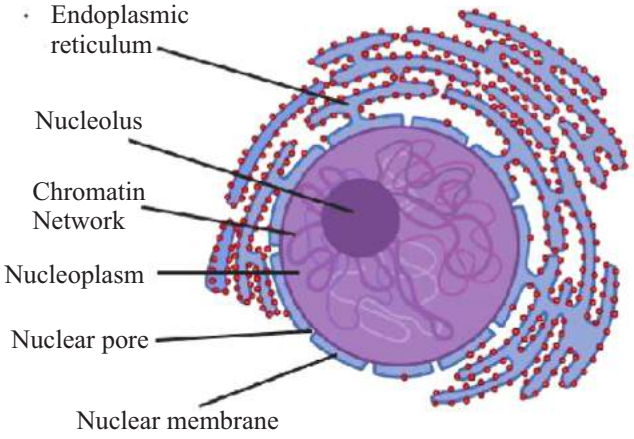


Fig 6.7 Nucleus

Nucleus is a double membrane bound organelle. Its membrane is known as the nuclear membrane. There are minute pores in the nuclear membrane through which there is exchange of substances between the cytoplasm and the

nucleoplasm. A fluid nucleoplasm is present in the nucleus. Proteins, nucleic acid and other carbonic compounds are present in this fluid. One or more small spherical structures present in the nucleus, are known as the **nucleolus**. A network of thin thread - like structures are present in the nucleoplasm. It is known as the chromatin network. At the time of cell division the threads of the chromatin network coils and appear thickened. They are known as the chromosomes. Nucleus is the main controlling organelle of the cell.

6.4 Plant and Animal cells :

The basic structure of the plant and animal cells is similar to each other, yet there are some structural characteristic on the basis of which they may be differentiated.

Character	Plant Cell	Animal Cell
1. Cell Wall	In plant cells a non-living cell wall made up of cellulose, is present around the cell membrane.	Animal Cell lacks cell wall.
2. Chloroplast	In plant cells the photo synthesizing organelle, chloroplast is present.	Chloroplast are not present in the animal cell.
3. Vacuoles	In plant cells two or more vacuoles are present.	In animal cells vacuoles are very small or are absent.
4. Centrosomes	Centrosomes are absent in the plant cell.	Centrosomes are present in the animal cell.
5. Golgi body	In plant cell, they are less developed.	They are well developed and active in animal cells.
6. Stored food	In plant cells, stored food material is in the form of starch.	The stored food in animal cell is found to be glycogen.

6.5 Cell Cycle :

In the process of cell division, daughter cell is produced by the division of parent cell. The daughter cell thus produced re-divides to produce new cells.

The various stages, from the formation of new cells to its division, are together known as the **cell cycle**.

The main phases of the cell cycle are :

1. **Interphase :** During this stage of the cell cycle the substances essential for cell division are synthesized. It is known as the phase of preparation for the cell division.
   Interphase has the following stage :
   (a) First growth period of the G-I phase : This step takes place nearly 30-40% of the time of the entire cell cycle. During this period the cell grows and the proteins and RNAs required for DNA synthesis are formed. It is the Gap-I (G-I) period.
   (b) Synthetic period or S-phase : It consumes 20-30% of the total time span of the cell cycle. The DNA is synthesized during this phase.
   (c) Second growth period or G-II phase : 10-20% time of the cell cycle duration is used in this phase of interphase. This is the Gap-2 or G-2 period in which the proteins required for the cell are synthesized.
2. **Division Phase (M-Phase) :** The remaining 5-10% time of cell cycle duration involves the division phase. During this step the nucleus of the cell divides to form two daughter nuclei and later on the cytoplasm also divides resulting in the formation of two daughter cells.

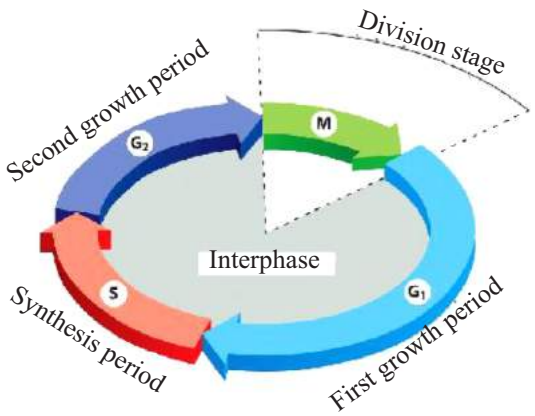


Fig. 6.8 Cell cycle

6.6 Cell Division :

New cells are always formed from the division of pre-existing cells. This pre-existing cell is known as the **Mother cell** or the **Parental cell**. The life of every multi-cellular organism starts with the uni cellular fertil`ised egg, the zygote. Embryo is formed by the division and differentiation of this cell. The embryo by repeated cell divisions develop into the multi cellular organism. Similarly, in the reproductive organs of the animals and plants, male and female gametes are formed from the reproductive mother cells. Thus the objectives, of formation of multicellular bodies and gametes, by cell division, are achieved. The rate of cell division in the growing organs of the organism, slows down after the maturation stage and is ultimately blocked.

During cell division, both, the nucleus and the cytoplasm divides but these are two different processes. The cell need not divide immediately after the nuclear division.

Types of Cell Division : The cell division is of two types depending on the number of chromosomes in the daughter cells formed.

I. Mitosis or Equational Cell Division :

Mitosis takes place in all the somatic cells i.e. in all the cells except the reproductive cells. In plants, this type of division takes place in the meristematic cells. During this type of cell division a parent cell divides into two daughter cells and the number of chromosomes in the daughter cells formed, is the same as that in the parent cell. Hence this division is also known as the **Equational Division**. The various events occurring during mitosis can be divided into the following stages :

(a) Interphase
(b) Karyokinesis
(c) Cytokinesis

(a) Interphase : This is the period in between two successive divisions when the cell prepares itself for division. During this phase the cytoplasm and the nucleus both are metabolically active. The cells synthesize and store all the essential substances required at the time of cell division.

(b) Karyokinesis : During this phase, the nucleus divides into two daughter nuclei. To simplify its study, this stage has been divided into four phases. These phases are Prophase, Metaphase, Anaphase and Telophase.

1. Prophase : Mitosis starts with prophase. During this stage :

(i) Due to condensation the chromatin material of the nucleus transforms into thin threads. These chromosomal threads are smaller in length and are thicker. They are known as the chromosomes.

(ii) During the last stages of the prophase both the chromatids of each chromosomes become more clearly visible. Both chromatids are attached with each other only at the centromere.

(iii) Nucleolus and nuclear membrane are not clear and gradually disappear by the end of prophase.

(iv) In the animal cell the centrosome divides to form two centrioles. Each centriole determines the pole.

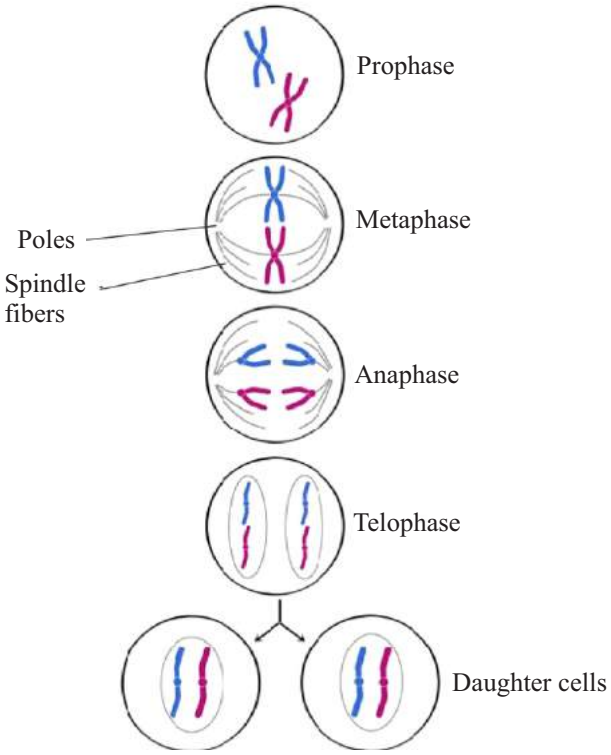


Fig. 6.9 : Different stages of mitosis

2. Metaphase :

(i) Formation of Spindle fibres and arrangement of chromosomes in the middle region of the spindle are the major events of this phase. Astral rays radiate out from each centriole. These astral rays together form the spindle fibres, which connects the centromere with the poles.

(ii) Chromosomes move towards the equatorial region and arrange themselves in such a manner that their centromeres lie at the metaphase plate with the arms of chromatids, extending outward, towards poles.

3. Anaphase :

(i) During this stage of mitosis the centromere divides, as a result the two chromatids separate from each other and are now known as Daughter Chromatids.

(ii) The daughter chromatids separate from each other and move towards

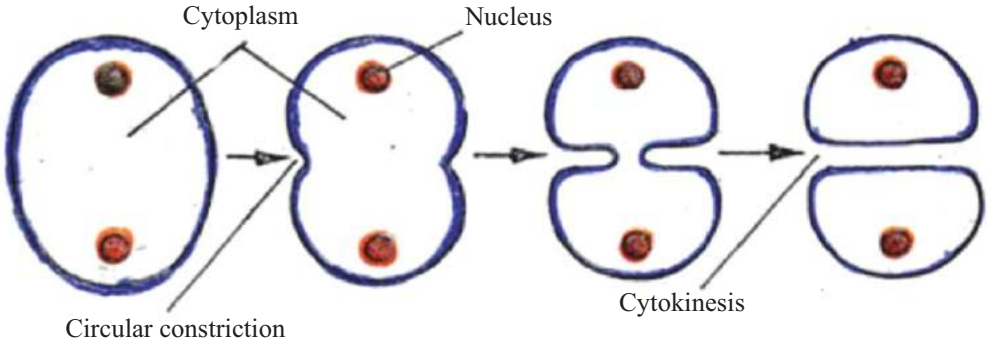


Fig. 6.10 : Cleavage Method

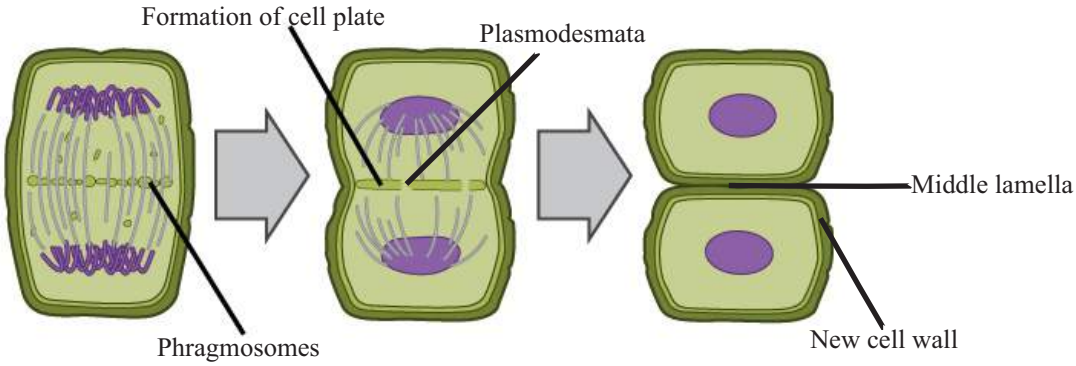


Fig. 6.11 : Cell Plate Method

II. Meiosis :

Meiosis takes place in the diploid reproductive cells at the time of reproduction. It results in the formation of haploid gametes. The number of chromosomes in the daughter cells formed, as a result of this type of division, is half of that present in the parent cell.

Stages of Meiosis : Meiosis completes in two stages. In this division the cell divides twice and results in the formation of four haploid cells from a single diploid cell. The two stages are :

1. **Meiosis I**
2. **Meiosis II**

1. Meiosis I : In this division there is the interphase prior to cell division, as is the case in mitosis. During interphase, the substances essential for the cell division are synthesized. After this the actual process of cell division begins. In meiosis I the parent cell divides to form two cells in which the number of chromosomes is reduced to half of that present in the parent cell. Hence, this stage of meiosis is also known as the **Reductive Division.** The various phases of this division are :

(a) Prophase I : It is a prolonged step consisting of complex events, as compared to the Prophase of mitosis. As in prophase of mitosis, in prophase I also there is condensation of chromosomes, division of centrosome, disappearing of nucleolus and the nuclear membrane etc. Apart from these events, the chromatids of the homologous chromosomes, i.e. the chromosomes having exactly the same genes, entwine (criss-cross) with each other, so that part of chromatids are exchanged between them. This phenomenon is known as **Crossing over**. Crossing over results in the formation of new group on genes on the homologous chromosomes. This exchange of genes taking place in homologous chromosomes during meiosis I generates variance in the traits (characteristics) of the next generation.

(b) Metaphase I : Poles and spindle fibres are formed during this stage and the homologous chromosomes arrange themselves on the metaphase plate as a double row. Spindle fibre from one pole of the cell attach to one chromosome of each pair, the other chromosome of the pair being attached to the other pole. The centromere of both chromosomes face towards the poles region i.e. metaphase plate.

(c) Anaphase I : During this stage the centromere does not divide, as it does during the anaphase of mitosis. The complete chromosome moves toward its pole because of the contraction of the spindle fibre. By the end of anaphase I a group of chromosomes is formed at each pole.

(d) Telophase I : During this stage of meiotic division the chromosomes uncoil and form the chromatin network. on both the poles nuclear membrane forms around the chromatin network and the nucleolus develops. Thus a haploid nucleus is formed at each pole. After the telophase I cytokinesis occurs in a way similar to that as in mitosis, resulting in the formation of two haploid cells.

2. Meiosis II :

In both the haploid cells formed by meiosis I one more division, similar to mitosis, takes place. It is known as Meiosis II.

In Meiosis II, two daughter cells are formed from each haploid daughter cell. Thus in Meiosis four haploid daughter cells are formed from a single diploid parent cell. The prophase of this division is not an extended process.

Significance of Meiosis : The number of chromosomes in the vegetative cells of the organisms, reproducing sexually, remains the same from generation to generation. New combinations of hereditary characters are formed by the crossing over that take place during prophase I of Meiosis. It generates

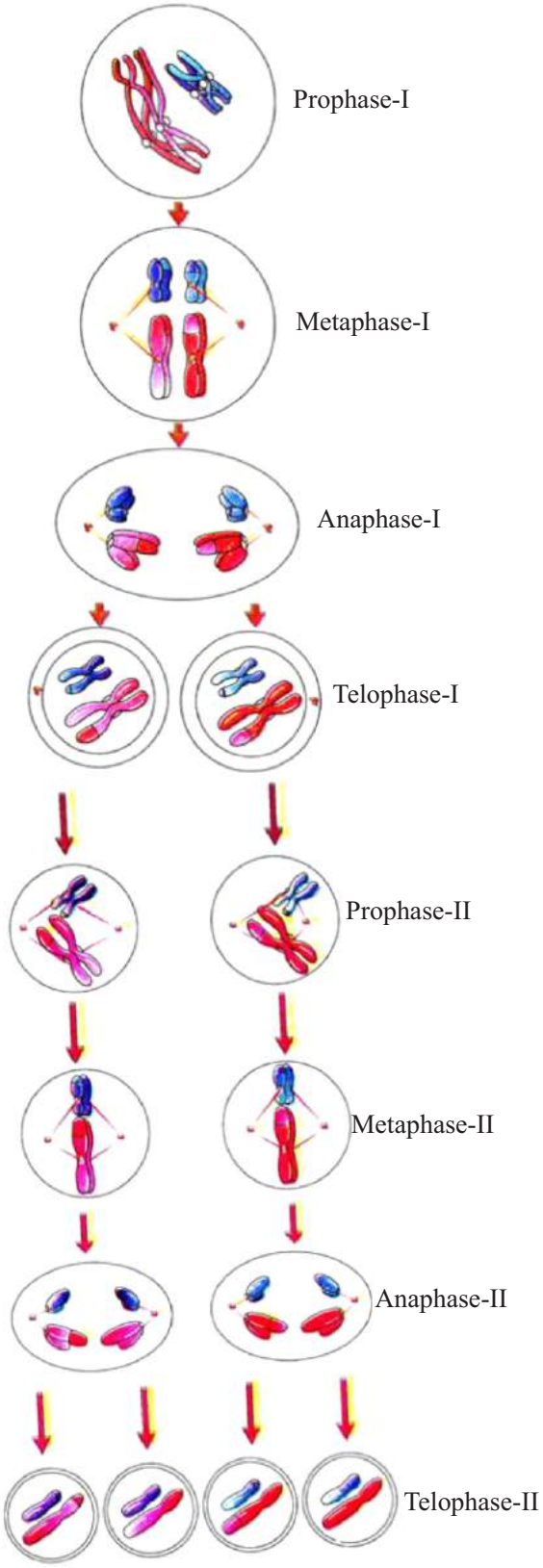


Fig. 6.12 Stages of Meiotic Division

hereditary variations in the organism, which form the basis of organic evolution.

6.7 Acellular organism - Virus :

Virus is considered to be an incomplete cell. It is not considered to be a 'cell' because it has only one characteristic feature, out of four, of a typical cell. It has hereditary material, DNA or RNA, because of which it has the capability of reproduction, heredity and mutation. In virus the cell membrane, metabolic machinery and the bio chemical mechanisms are not present. They can reproduce only in a living system.

They synthesize proteins and nucleic acids, after entering in a living cell, using its bio-synthetic machinery. This results in the increase in their number. Virus are parasites. They are found in the cells of animals, plants and bacteria. The virus remain inactive outside the nutritive cell. They can be stored in bottles like the crystalline particles of chemical compounds.

Structure of Virus : Virus are so small that they can be observed only with the help of electron microscope. They are 30 nm to 300 nm in size.

Each particle of virus is known as a **virion.** The virion consists of a protein coat, known as **capsid**, which encloses the nucleic acid : DNA or RNA.

Virus can be of three types on the basis of their source of nourishment.

(1) Animal Virus : Animal virus are present as parasites in the animal cells. Generally, the hereditary material in them is DNA, however, sometimes it may be the RNA. They are spherical or hexagonal. In human beings, diseases like small pox, polio, influenza etc are caused by virus.

(2) Plant Virus : They are parasitic on plant cells. Generally RNA is the hereditary material in them. Virus is the casual organism of the Tobacco Mosiac Disease.

(3) Bacteriophage : The virus which are parasitic on bacteria are known as the bacteriophage. The hereditary material in bacteriaphage is DNA. T_4 bacteriophage is parasitic on

Escherichia coli bacteria. It has a hexagonal head a small neck, a collar and a long cylindrical tail. There is a double stranded circular DNA in the head region.

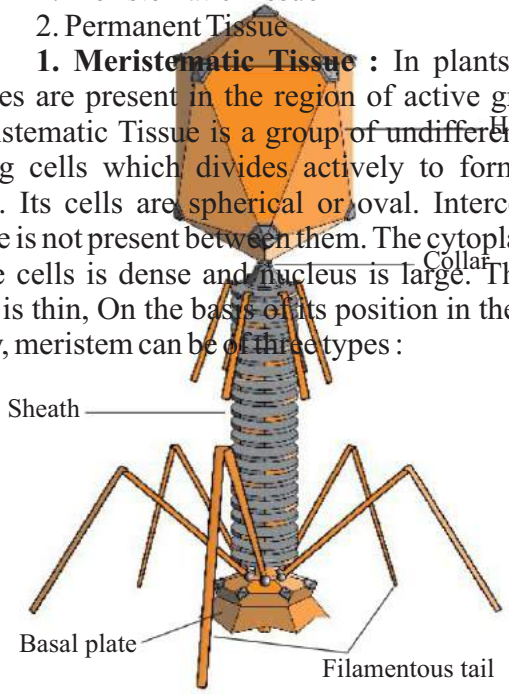


Fig. 6.13 Bacteriophage

6.8 Structure of Multicellular Organisms:

You have studied in this chapter, that in unicellular organism, all the processes like nutrition, excretion reproduction etc. are performed by a single cell. In multi-cellular organisms cells collectively form different types of tissues. Various tissues collectively form organs and organs together form a system. Now, we will study the various types of tissues present in the plants and animals.

6.9 Tissue :

"A group of cells having similar origin, development and functions, is known as a tissue."

6.10 Major Types of Animal and Plant Tissues :

A tissue performs a specific function. Tissues can be classified into two main groups on the basis of their development.

I. Plant Tissue
II. Animal Tissue

I. **Plant Tissue** :
Plant tissue are of the following types :
1. Meristematic Tissue
2. Permanent Tissue

1. Meristematic Tissue : In plants these tissues are present in the region of active growth. Meristematic Tissue is a group of undifferentiated living cells which divides actively to form new cells. Its cells are spherical or oval. Intercellular space is not present between them. The cytoplasm of these cells is dense and nucleus is large. The cell wall is thin, On the basis of its position in the plant body, meristem can be of three types :

Fig. 6.14 : Meristematic Tissue

(a) Apical Meristem : It is present in the apical region of the stem and the root. It is responsible for the increase in length of the plant.

(b) Intercalary Meristem : Actually, it is a part of the apical meristem but is separated from it because of the intervention of the permanent tissue. This tissue is present at the base of the nodes of grasses and other monocot plants.

(c) Lateral Meristem : This tissue is

present in the lateral regions of the stems and roots. The thickness of the stem and root increases because of the activity of this tissue.

2. **Permanent Tissue :**

Permanent Tissue is a group of undividing cells which are differentiated, having a definite shape and size and are responsible for specific functions. Permanent Tissue are of two types :

1. Simple Tissue 2. Complex Tissue

(a) Simple Tissue : Simple tissue is made up of similar cells having same origin, shape and functions.

Simple tissue are of the following types :

(a) Parenchyma (b) Collenchyma

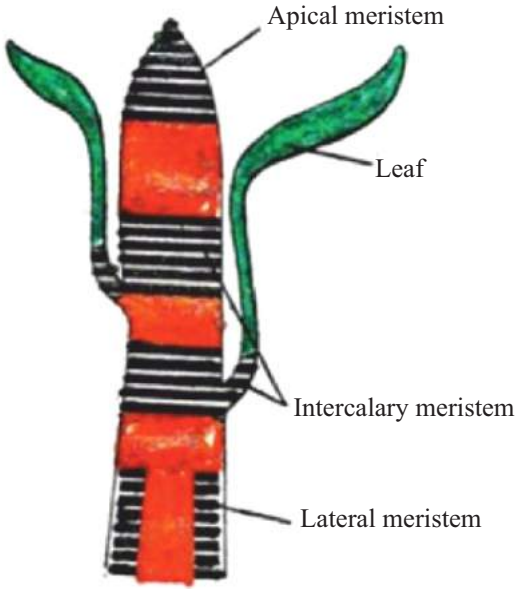


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Fig. 6.15 Parenchyma

(b) Collenchyma : The cells of this tissue are living and roundish oval or polygonal. In these cells, cell walls are thickened at the inner and outer corners of the intercellular spaces. The thickening of the cell wall are due to the deposition of cellulose and pectin. This tissue provides flexible strength to plant parts.

Fig 6.16 : Collenchyma

(c) Sclerenchyma : The cells of this tissue are generally elongated, narrow with tapering ends. The cell wall is uniformly thickened because of the lignin depositon. Their lumen is destroyed i.e. is not present and the mature cells lack cytoplasm. They are dead cells and are present in hard parts of the plant. It provides mechanical strength to the plant.

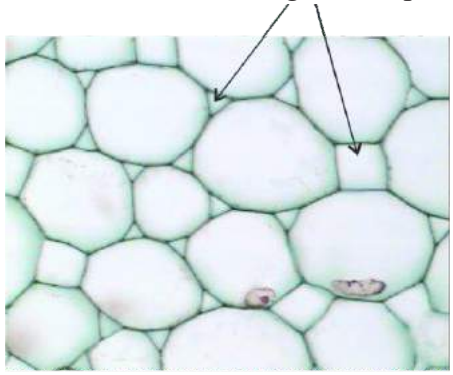
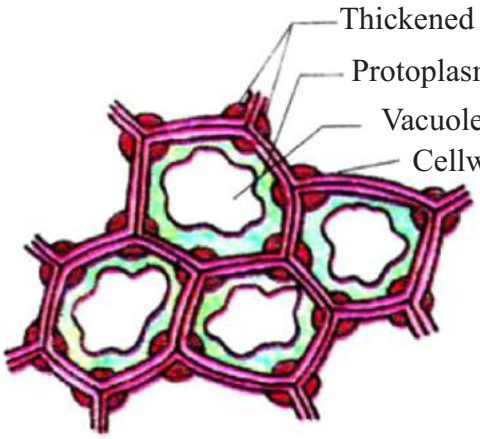


Fig. 6.17 : Sclerenchyma

(B) Complex Tissue : Complex tissues are made up of more than one type of cells. These cells, together, function as a unit. All the cells of this type of tissue

cooperate with each other to perform some specific function. Complex tissue are of two types :

(a) Xylem : The main function of Xylem is conduction of water and



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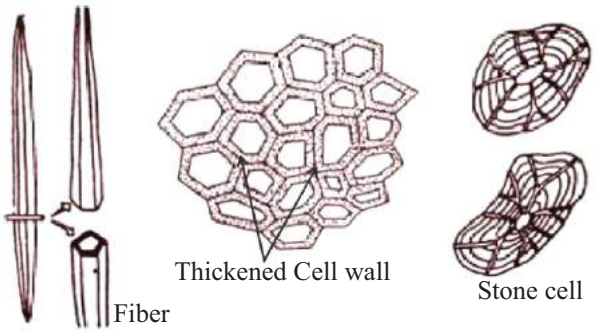

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with broad lumen. They join with each other forming a tube like structure. Even their cell walls are lignified and they are dead cells. **Xylem fibres** are elongated thin cells with obliterated cell lumen because of thick lignin depositions. They are dead cells. **Xylem parenchyma** are thin walled living cells like other parenchymatous cells.

(b) Phloem : The main function of phloem is conduction of food material in the stem and roots of the plant. Phloem has four types of cells

(i) Sieve tubes
(ii) Companion cells
(iii) Phloem fibres
(iv) Phloem Parenchyma

Sieve tubes are living cells with soft wall and large lumen. Their length is more as compared to their width. The cross walls at the ends of the sieve tube cells is perforated. These perforated transverse walls are known as the **sieve plates**. Nucleus is not present in these cells. Food material is transferred in soluble state through the sieve tubes in the plants. Adjacent to each sieve tube is a parenchymatous cell with dense cytoplasm and a large nucleus. It is known as the **companion cell** and controls the sieve tube. The fibres present in the phloem are made up of sclerenchymatous cells. They are the only dead cells of the phloen tissue. Their walls are lignified and they provide mechanical strength. They are known as the **bast fibres**. Phloem parenchyma are like the normal parenchyma.

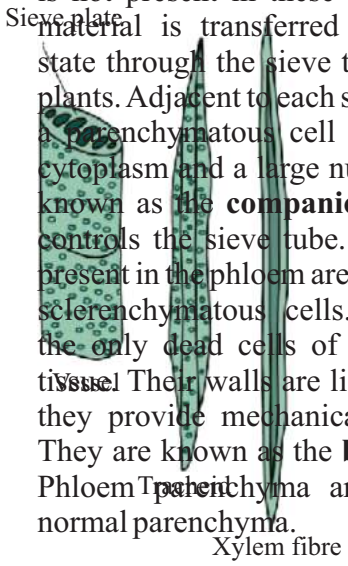


Fig. 6.19 Phloem

II. Animal Tissue : In multicellular animals there are mainly four type of tissues on the basis of their function and structure :

1. Epithelial Tissue
2. Connective Tissue
3. Muscle Tissue
4. Nervous Tissue

1. Epithelial Tissue : The epithelial tissue covers the body surface of the animals, thus, it is in contact with body fluid on one side and the environment on the other side. It also lines the body cavity. The epithelial tissue is of two types on the basis of arrangement of layers : **Simple Epithelium** and **Stratified Epithelium.** The simple epithelium is made up of a single layer of cells. It forms the lining of the body cavity and the vessels. The simple epithelium is of different types on the basis of the form of the cells. The squamous epithelium is made up of flat scale-shaped cells; cuboidal epithelium made up of cuboidal cells and columnar epithelium made up of elongated thin cells. The stratified epithelium is made up of two or more than two layers of cells. It lines the body parts where frictional phenomenon occurs. For example the skin of animals is a stratified epithelium.

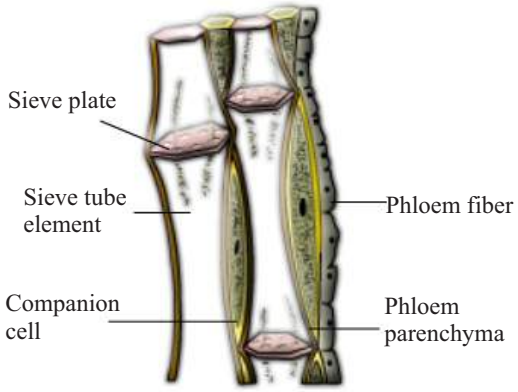


Fig. 6.20 Epithelium Tissue

2. Connective Tissue : This tissue binds and supports the body parts, hence it is known as the connective tissue. It includes the loose connective tissue, cartilage, bone, adipose tissue and blood.

Except blood, the cells of all connective tissues secrete a structural proteins known as the collagen tissue. It is the most abundant protein in the body. It provides strength, elasticity and flexibility to the tissue. The cells of this tissue also secrete poly saccharides which function as a matrix between the cells of the connective tissue and the collagen fibers. Cartilage is present in the nose of human beings, the external ear lobes etc. Bone is a mineral-rich, solid connective tissue. it forms the structural frame-work of the soft parts of the body and provides support and protection to other tissues.

Adipose tissue is a loose connective tissue which is present beneath the skin. Fat is stored in the cells of this tissue. Blood is a fluid connective tissue, containing plasma, Red Blood Corpuscles, White Blood Corpuscles and Thrombocytes. Blood transports various substances in the body.

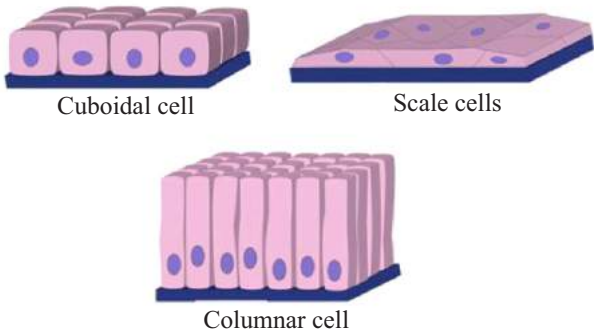
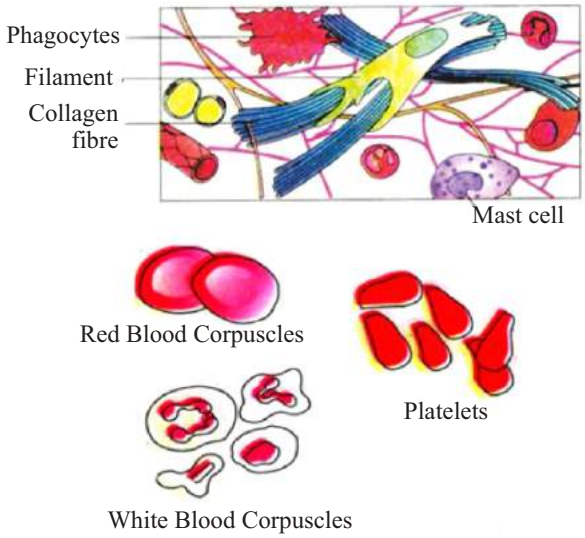


Fig. 6.21 : Connective Issue

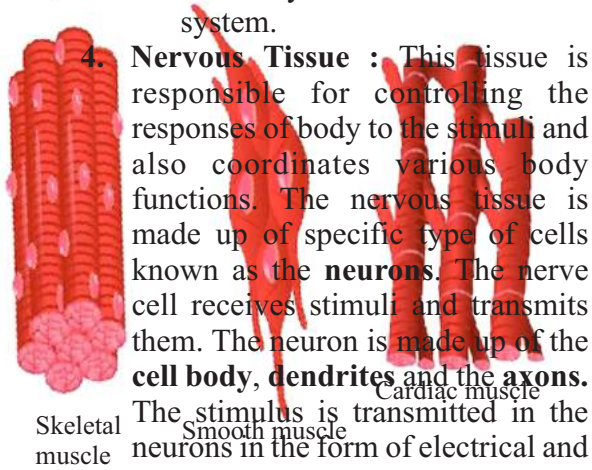
3. **Muscular Tissue :** It is made up of elongated, cylindrical fibres, arranged parallel to each other. Each fibre is made up of many fibrils, known as the myofibrils.
   All the muscle fibres contract in an integrated manner in response to a stimulus and again relaxes. Body and its organs move in response to environmental stimuli by the activity of the muscular tissue.
   The muscle tissue are of three types :
   (a) Skeletal muscles
   (b) Smooth muscles
   (c) Cardiac muscles

Fig. 6.22 : Muscular Tissue



muscles are located in the inner walls of the internal body organs like the digestive tract, reproductive tract etc. They are known as the '**unstriated muscles**' because they lack stripes and since they are not under the voluntary control of the nervous system, they are also known as the '**involuntary muscles**'.

(c) **Cardiac muscles :** They are the heart muscles. They are **striated** because of the presence of stripes but are **involuntary** because they are not under the voluntary control of the nervous system.



4. **Nervous Tissue :** This tissue is responsible for controlling the responses of body to the stimuli and also coordinates various body functions. The nervous tissue is made up of specific type of cells known as the **neurons**. The nerve cell receives stimuli and transmits them. The neuron is made up of the **cell body**, **dendrites** and the **axons.** The stimulus is transmitted in the neurons in the form of electrical and chemical signals, which are known as impulse.

6.11 Structure of Organs and Systems :

So far we have studied, in this chapter, about different type of tissues and the cells present therein. Now we are going to study about the structure and functions of the various systems made up of these tissues.

On the basis of their organization and position, the plant tissue system may be of three types :

1. Epidermal tissue system
2. Ground tissue system
3. Vascular tissue system

1. **Epidermal tissue system :** The epidermal tissue system is the outermost covering of the plants. It consist of the epidermal cells pores and trichomes (hairy outgrowths). The cells of the

epidermis are barrel shaped and are present close to each other. They are the parenchymatous cells. A waxy coating is present on the outer surface of the epidermis. It is known as the **cuticle**. Pores are present on the epidermis of plants which perform the function of transpiration and exchange of gases with the atmosphere. Trichomes and other hairy outgrowths are present on the cells of the epidermis. The hair present on the roots are known as the **root hairs**. They are unicellular. The hairs present on the stems may be multicellular or unicellular and are known as the **epidermal hairs**. Root hairs absorb water and minerals and the trichomes or the epidermal hairs may be of secretory nature. They reduce transpiration.

2. **Ground Tissue System :** The tissue present between the epidermis and the vascular tissue system is known as the ground tissue. It is made up of parenchyma, collenchyma and sclerenchyma.
3. **Vascular tissue system :** Xylem and phloem are present in the vascular tissue system. Together the two type of tissues form the vascular bundles which perform the function of transportation of different substances, like water, minerals, food etc. in the plant body.

As it is in plants, in animals also tissues together form the systems, organs and organ systems. In animals the various systems formed by the tissues, include : Nervous system, epidermal system, muscular system, digestive system, respiratory system, excretion system, reproductive system etc.

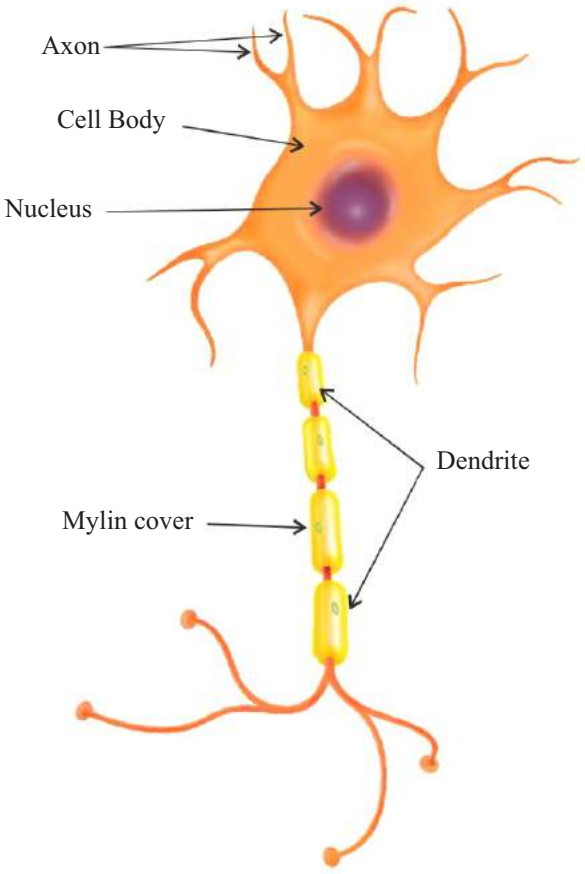


Fig. 6.23 Neuron

Important Points

1. Cell is the structural and functional unit of the body of organisms.
2. The longest cell of the human body is a neuron.
3. The cell membrane is made up of molecules of protein and lipid.
4. The cell wall of plant cell is made up cellulose, hemicellulose, pectin and polysaccharides.
5. Mitochondria is also known as the power house of the cell.
6. Lysosomes are also known suicide bags.
7. Cytokinesis in plant cell takes place by the formation of cell plate while in animal cell it is by means of cleavage method.
8. In plant cell the stored food is in the form of starch while in animal cell it is in form of glycogen.
9. Various stages from the time of cell formation to its division are known as the cell cycle.
10. The number of chromosomes remains the same from generation to generation by meiotic division.
11. In the stem of a plant, there is increase in length because of the activity of apical meristem while the lateral meristem results in the increase in

thickness of the stem.
12. In plants, xylem and phloem are the conductive tissue.
13. In animals, epidermal tissue, connective tissue, muscular tissue and nervous tissue are present.
14. Blood is a type of connective tissue.

Questions

Objective type questions :

1. Which cell organelle is known as the suicide bag ?
   (a) Mitochondria (b) Lysosomes
   (c) Ribosomes (d) Nucleus
2. The nucleus was discovered by :
   (a) Robert Brown (b) Robert Hooke
   (c) Leuwenhoek (d) Schleiden
3. DNA is synthesized during which stage of cell cycle ?
   (a) G-1 phase (b) S phase
   (c) M phase (d) G-2 phase
4. The tissue responsible for imparting flexible strength to plants is :
   (a) Parenchyma (b) Collenchyma
   (c) Sclerenchyma (d) None of the above
5. Write the name of the scientist who observed a living cell for the first time.
6. Write the names of any two unicellular organisms.
7. Name the longest cell of the human body.
8. What is the function of cell wall in a plant cell?
9. Name the plastids present in the plant cell.
10. What is the function of ribosomes in a cell?
11. Which type of cell division takes place in somatic cells?
12. Why is the meiotic division also known as the reductive division?
13. Cytokinesis takes place in plant cells by which method?
14. Which substance in deposited on the cell wall of the collenchymatous tissue?

Short answer type questions :

1. What are unicellular and multicellular organisms? Give examples.
2. Explain the cell theory.
3. Explain the structure and function of mitochondria.
4. Write four differences between animal cell and plant cell.
5. Why lysosomes are known as the suicide bags.
6. Describe the structure and function of the nucleus.
7. Explain the cell cycle.
8. Explain the methods of cytokinesis in plant and animal cells.
9. Explain the metaphase of mitotic division with the help of suitable diagram.
10. Explain the anaphase movement in relation to the cell division.
11. Write the significance of meiosis.
12. Explain the structure and function of xylem.
13. Draw a well labelled diagram of a neuron.
14. Describe the various type of muscles present in animals.
15. Explain the structure of a virus and draw a well labelled diagram of a bacteriophage.

Essay type answer questions :

1. Draw a well labelled diagram of a plant cell and describe the structure and function of the following organelles :
   (a) Chloroplast (b) Endoplasmic reticulum
   (c) Mitochondria (d) Nucleus
2. What is mitosis? Describe the various phases of mitosis with the help of suitable diagrams.
3. What is a tissue? Describe the types of simple tissue with the help of suitable diagram.
4. Describe the various type of tissues present in the animals.
5. Give account of the following :
   (a) Vascular bundle
   (b) Neuron
   (c) Bacteriophage
   (d) Sclerenchyma

Answer Key

1. b 2. a 3. a 4. b 5. b

Chapter-7

Biodiversity

7.1 Meaning and significance of Biodiversity:

Many clades are present around us (Clade is a group of biological organisms that share features inherited from a common ancestor). All the living beings differ from each other in some way or the other. On earth, on one hand there are the microscopic bacteria, whose size is just a few microns, while on the other hand are the 30 meter long Blue whale and the 100 meter tall trees of Red Wood in California. Some pine trees stay alive for hundreds of years while the life span of some insects is only of a few days. The unlimited variety of organisms present around us is known as the **biodiversity.**

Biodiversity refers to the diversity present in various life forms. It indicates the different living beings available in a particular habitat or specific area. According to an estimate, nearly one crore species are present on the earth while, currently, we know only about 20 lakh of them. Rich diversity of plants and animals is present on the earth in the regions lying between the Tropic of Cancer and the Tropic of Capricorn. Hence this region is known as the **Mega biodiversity region**.

7.2 Need of Classification :

All the organisms present on the earth are classified on the basis of their similarities and differences and some specific characteristics. Such classification helps in identifying and studying the organisms and understanding their utility. Here by 'characteristics of the organism' we mean some specific form or specific function of that being, on the basis of which it may be differentiated from other organisms.

7.3 Major groups of animals and plants :

Biologists, like Ernst Haeckel (1894), Robert Whittaker (1959) and Carl Woese (1977) have tried to categorize the living organisms into groups called **kingdom**. These kingdoms were made on the basis of the cellular structure, source of nutrition and body organisation.

There are five kingdoms in the five kingdom hypothesis proposed by Whittaker : Monera, Protista, Fungi, Plantae and Animalia. These kingdoms have been further subdivided into categories like Phylum (Division), Class, Order, Family, Genus.

7.3.1 Monera : These are the prokaryotic organisms. These organisms lack organised nucleus and organelles. On the basis of their type of nutrition they may be autotrophic or heterotrophic. Reproduction is by conjugation. Example : Bacteria, Blue-green algae (Cyanobacteria), Mycoplasma.

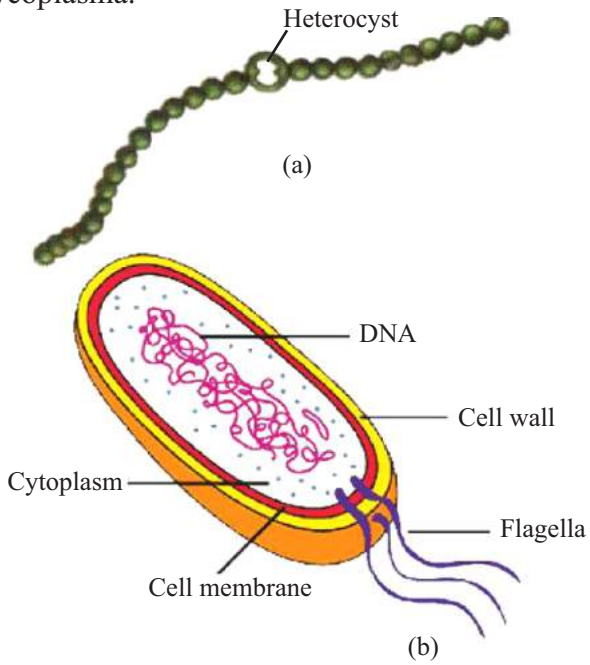


Fig. 7.1 : Organisms of Kingdom Monera
(a) Nostoc (b) Bacteria

7.3.2 Protista : It comprises the unicellular eukaryotic organisms. Their cells contain a well organised nucleus and membrane bound cell organelles because they are eukaryotes. These organism have structures like cilia and flagella for

locomotion. Asexual reproduction in these organisms is by cell fusion while sexual reproduction is by the formation of zygote.

Example : Unicellular algae, diatoms, protozoa

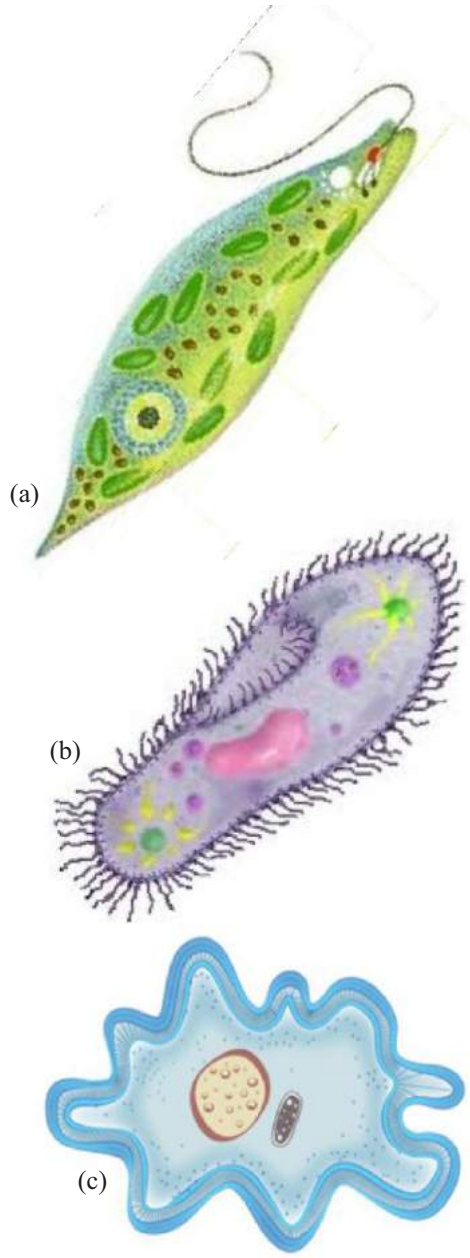


Fig. 7.2 : Organisms of the Kingdom Protista (a) Paramecium (b) Euglena (c) Amoeba

7.3.3. Fungi : They are the heterotrophic, eukaryotic organisms. Most of the fungi are parasitic. They absorb their nourishment from the dead and decaying organic matter. Hence they are known as **saprophytic**. Some of the fungi depend on living plants and animals for their nutrition. They are known as **parasitic**. This type of fungi, i.e. parasitic fungi, cause disease in plants and animals. Some species of fungi live in association with blue green algae (cyanobacteria). This type of mutually beneficial association is known as **symbiosis**. These symbionts are together known as **lichens.**

Generally, the fungi are filamentous, but yeast, which is unicellular, is an exception. The long thread like structures are known as the mycelium. The cell wall of fungi is made up of chitin and polysccharides. In fungi, vegetative reproduction takes place by budding and fragmentaion; asexual reproduction by spores and sexual reproduction by ascospores, basidiospores etc. Example : Yeast, mushroom etc..

Fig. 7.3 Fungi (Mushroom)

7.3.4. Plantae : This kingdom is made up of multicellular eukaryotic organisms. They are autotrophic and prepare their own food by photo-synthesis. Plants have been categorised in the divisions : Thallophyta, Bryophyta, Pteridophyta Gymnosperms and Angiosperms on the basis of differentiation in the plant body, tissues for the conduction of water and other substances in the plant body, seed bearing capacity etc.

(a) Thallophyta : In the plants of this division, the body structure is not differentiated into root, stem and leaves. Such type of undifferentiated plant body

is known as a **thallus**. Eg. : Algae.
Vegetative, asexual and sexual reproduction takes place in the algae. Vegetative reproduction takes place by fragmentation, asexual reproduction by spores and sexual reproduction by the fusion of the two gametes. Example : *Chlamydomonas, Volvox, Chara*.

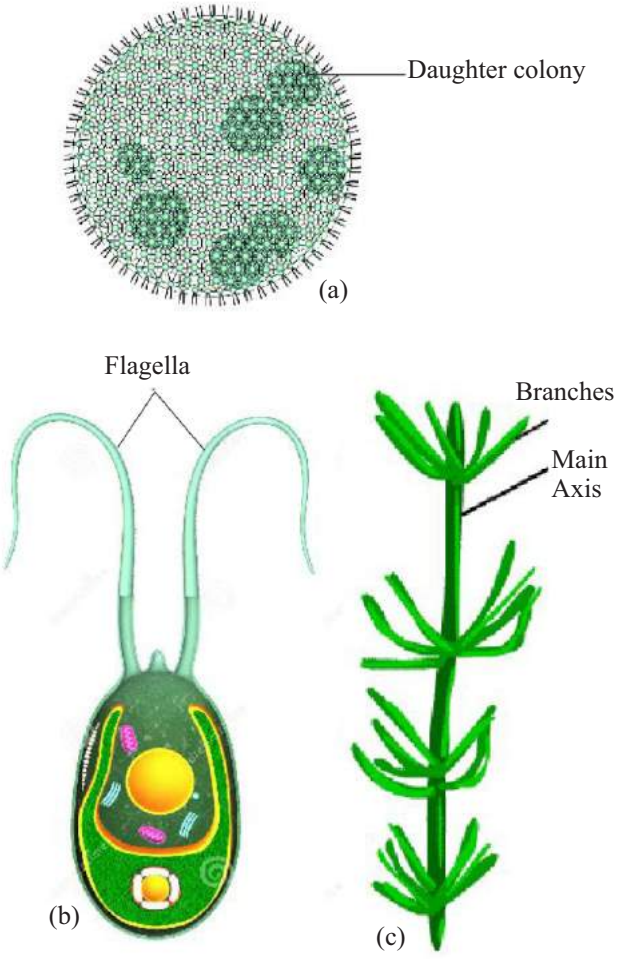


Fig. 7.4 Thallophyta
(a) *Volvox* (b) *Chlamydomonas* (c) *Chara*

(b) Bryophyta : The plants of this division are also known as the **amphibians** of the plant kingdom. They are known as amphibians because they can survive on land but depend on water for sexual reproduction. These plants lack the actual root, stem and leaves instead have the root-like, leaf-like and stem-like structures. They are connected with the substratum by means of unicellular or multicellular rhizoids.
Liverworts and mosses are there in the bryophytes, in which asexual reproduction is by the fragmentation of the thallus or by special structures known as the gemma and the sexual reproduction occurs by the fusion of the antherozoid and egg produced by the antheridia and archegonia of the gametophyte respectively. Example : *Marchantia*, *Funaria*.

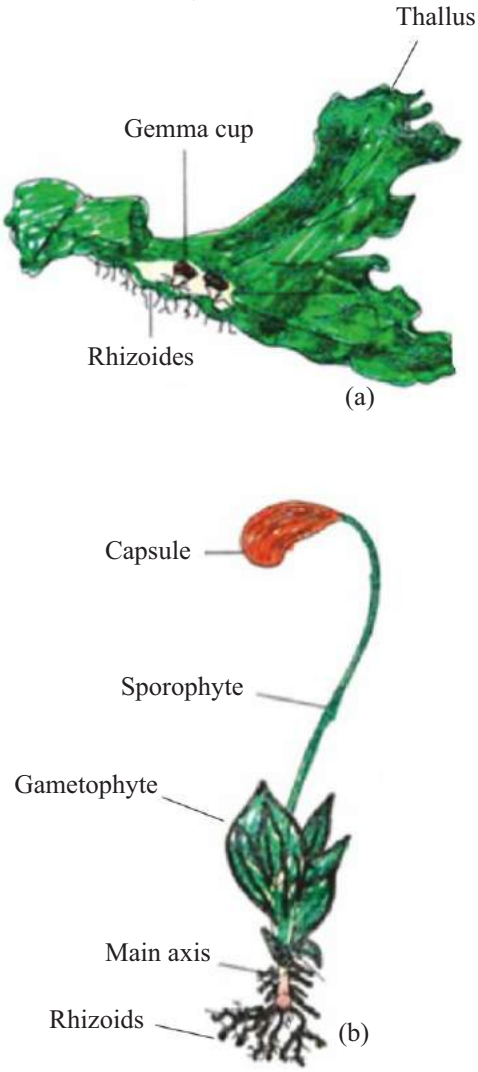


Fig. 7.5
Bryophyta : (a) Liverwort - *Marchantia*
(b) Moss - *Funaria*

(c) Pteridophyta : The plant body of the members of this division is differentiated into root, stem and leaves. They have xylem and phloem for the conduction of water and other substances within their body. Usually they are present in moist places.

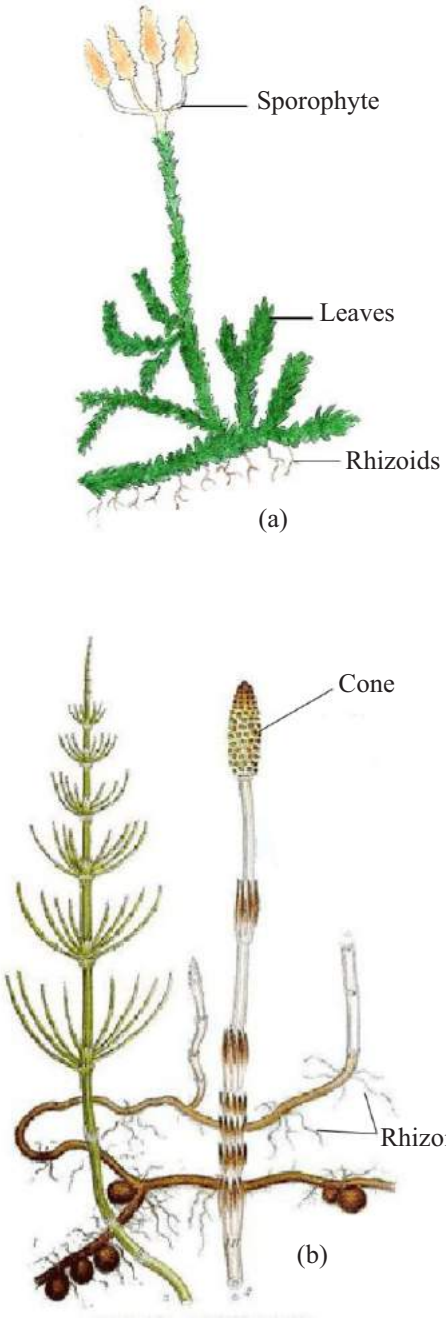


Fig. 7.6 Pteridophyta
(a) *Selaginella* (b)*Equisetum*

The thallophyta, bryophyta and pteridophytes have inconspicuous reproductive organs. They do not produce fruits and seeds. So, they are known as **Cryptogams**. Pteridophytes, however, have a vascular system, i.e. xylem and phloem are present. Hence they are also known as the **vascular cryptogams.** In the division pteridophyta reproduction is by means of spores and the union of sperms and eggs produced by the antheridia and archegonia respectively.
Example : *Marsilia*, *Selaginella*, *Equisetum*.

(d) Gymnosperms : (Gymno = uncovered or naked; sperma = seeds) Gymnosperms are the plants in which the ovules are not protected by the ovary and they remain open i.e. are not covered before or after fertilisation. They are also known as the **naked-seeded plants**. Gymnosperms are medium to tall trees or are shrubs. They have a tap root and in some plants of this group there is symbiotic association between their roots and fungi. This association is known as the **mycorrhizal association**. Example *Pinus.* In some gymnosperms like *Cycas,* the nitrogen fixing cyanobacteria are associated with small special type of roots called the **corraloid roots.** Reproduction in gymnosperms is by means of spores and the fusion of antherozoids and the egg.
Example : *Cycas, Pinus.*

Fig. 7.7 Gymnosperms (*Cycas*)

(e) Angiosperms : (Angio=covered; sperma=seed). Angiosperms are the plants in which the seeds are 'covered' within the fruits. In other words, their seeds develop within the ovary which later on form the fruit. They are known as the **flowering plants**.

The food in their seeds is either stored in the cotyledons or in the endosperms. On the basis of the number of cotyledons present in the seeds, they may be monocot (having single cotyledon) or dicot (having double cotyledon). Reproduction in these plants may be vegetative or sexual. In sexual reproduction there is fusion of the male gamete and the female gamete.

Example : Mustard, Mango, Banyan.

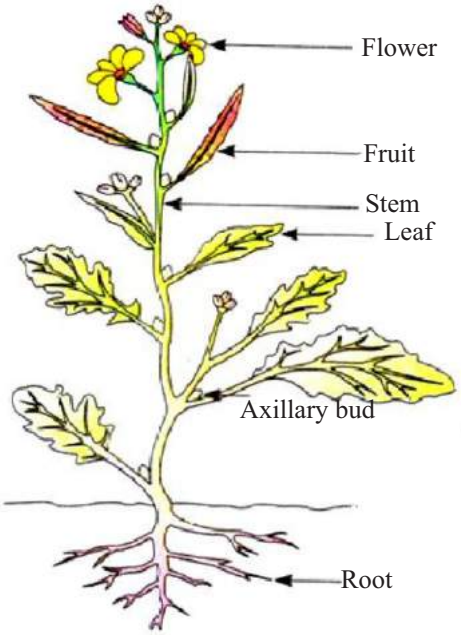


Fig. 7.8 Angiosperm (Mustard)

7.3.5 Animalia : The multicellular, eukaryotic and heterotrophic organisms are placed in this kingdom. Their cells lack the cell wall. Most of the animals exhibit locomotion. Animalia has been further subdivided into **non-chordata** and **chordata** on the basis of the presence of notochord.

(a) Non-chordata : The animals of this group lacks notochord. They have been sub divided into various phyla on the basis of their body structure and differentiation.

1. **Porifera :** Porifera means organisms having perforations or holes. These are the non-motile organisms which remain attached to some support. They have holes or pores all over their body, which are known as the **ostia** (ostium - singular).

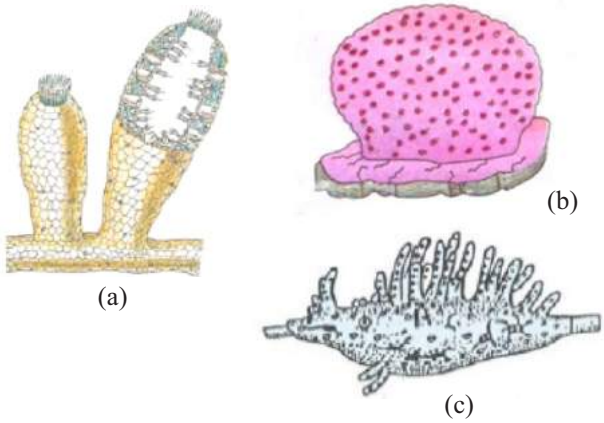


Fig. 7.9 Porifera
(a) Sycon (b) Euspongia (c) Spongilla

Water enters the body through these pores into a central body cavity and passes out through large pores, the **oscula** (osculum - singular). This water canal system is helpful in food intake, respiration and excretion. Their body is covered with external skeletal system, made up of spicules and spongin fibres. Their body organisation is of a cellular level. They are commoly known as the sponges. They are found in aquatic habitats. Examples : *Sycon, Spongilla, Euplectelia, Euspongia*.

2. **Cnidaria** : These are aquatic animals. Their body organisation is of the tissue level. The body of the organisms of this phylum has radial symmetry. These animals have tentacles and stinging cells (nematocysts) on their body this phylum was earlier known as *Coelentrata*. Examples : *Hydra, Sea-anemone*, Jelly fish.

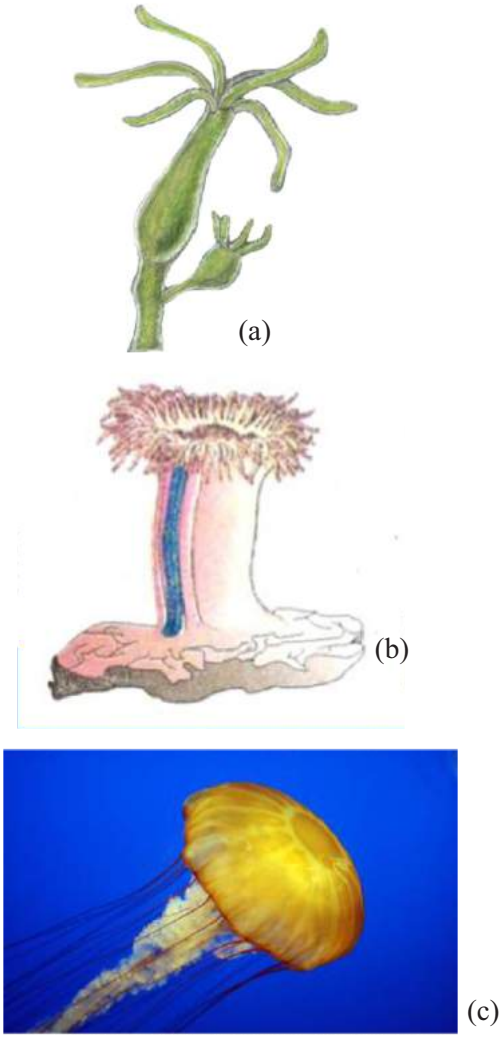


Fig. 7.10 Cnidaria
(a) Hydra (b) Sea-anemone (c) Jelly fish

3. **Platyhelminthes :** The animals of this phyla are dorsoventrally flattened. They are commonly known as the flat worms. Most of the animals of this phylum are present as parasites in human beings and other animals. Their body organisation is of the organ level. Their body is triploblastic (made up of three layers of cells) and have bilateral symmetry. They lack a true internal body cavity or coelom. Examples : *Taenia* (Tape-worm), *Liver fluke, Planareia.*

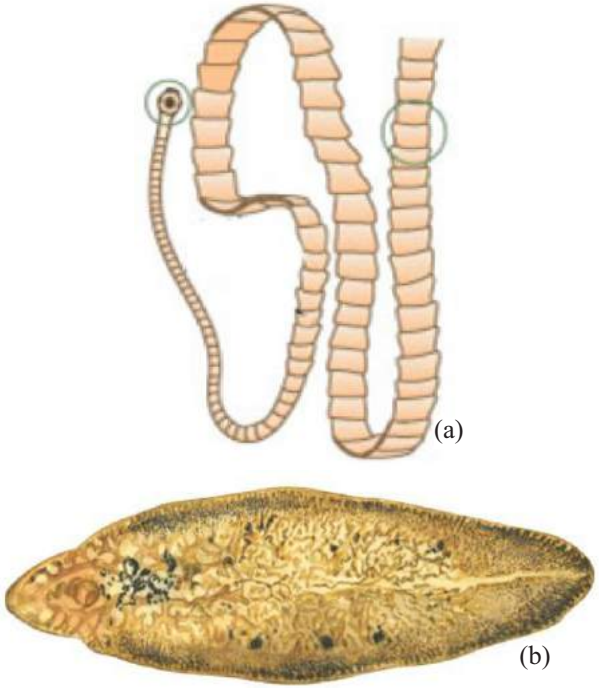


Fig 7.11. Platyhelminthes
(a) Tape worm (b) Liver fluke

4. **Aschelminthes :** The body of the animals of this phylum is cylindrical, hence they are also known as the round worms. They may be free living aquatic or parasitic. They are bilaterally symmetrial, triploblastic and have a pseudocoelom. Their body organisation is of the organ-system level. Example : *Ascaris, Wuchereria.*

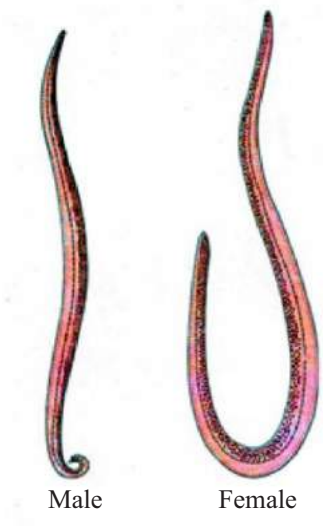
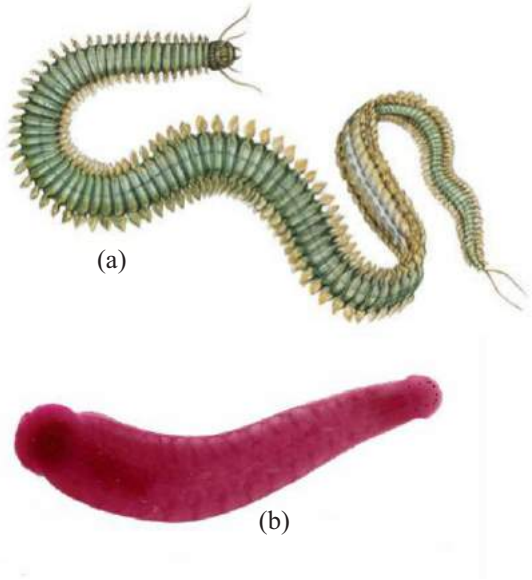


Fig. 7.12 Aschelminthes (Ascaris)

5. **Annelida :** The animals of this phyla are aquatic or terrestrial, free living and sometimes parasitic. These animals are bilateral, triploblastic and have a true coelom. Their body is segmented. They possess *nephridia* for excretion. Examples : *Leech, earthworm, Nereis*.

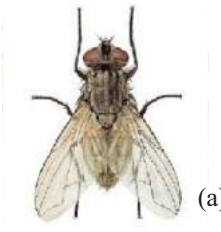


(a)

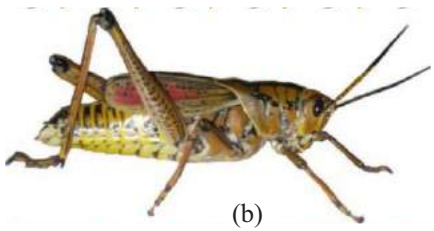
(b)

Fig. 7.13 Annelida
(a) Nereis (b) Leech

6. **Arthropoda :** The word arthropoda means arthro - jointed podas = appendages, i.e. these animals have jointed appendages. Maximum number of animals are present in this phylum. They are present at all the places on the earth. They are bilaterally symmetrical, triploblastic and coelomic animals. They have an open circulatory system. The body is segmented and is divisible into head, thorax and abdomen. Class insecta is important in this phylum. Most insects have wings. Excretion in this class is by Malpighian tubules. Their body is covered with chitin and external skeleton. Examples : House-fly, Shrimp, Cockroach, Butterfly, Grass-hopper, Scorpion.



(a)



(b)

(c)

(d)

Fig. 7.14 : Arthropoda
(a) House fly (b) Grasshopper (c) Crab (d) Scorpion

7. **Mollusca :** The animals of this phyla are terrestrial or aquatic. Body organisation is of the organ-system level. Their body is soft. In some organisms the body is covered with a shell made up of calcium. They are bilaterally symmetrical, triploblastic, coelomic animals. Their body is partially segmented and is differentiated into head, foot and visceral hump. Example : *Pila, Unio, Octopus*.

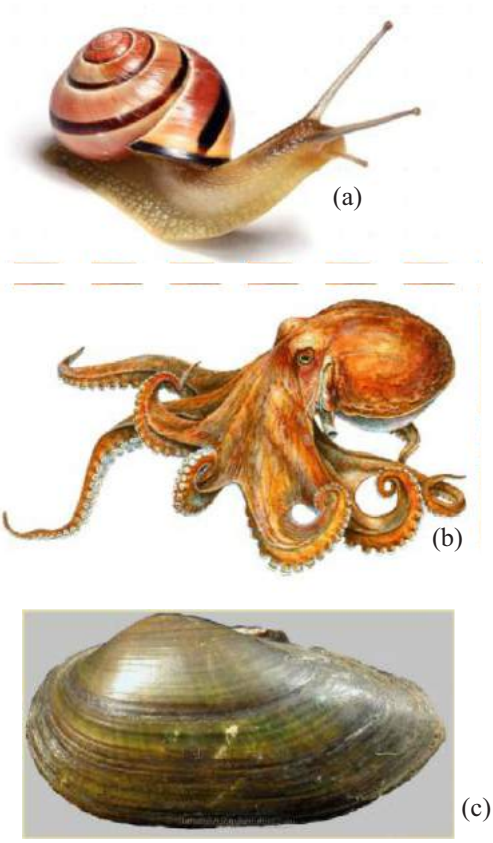


Fig. 7.15 Mollusca :
(a) Pila (b) Octopus (c) Unio

8. **Echinodermata :** The animals of this phylum has calcareous exoskeleton. Their skin is covered with spines. Hence they are known as echinodermata (spiny body). They are free living marine animals. These animals are radially symmetrical, triploblastic and coelomic. Their body organisation is of organ-system level. Water-vascular system is the characteristic feature of these animals, which help in locomotion, food intake and respiration. Example: Star-fish, sea-urchin, sea-cucumber, brittle star.

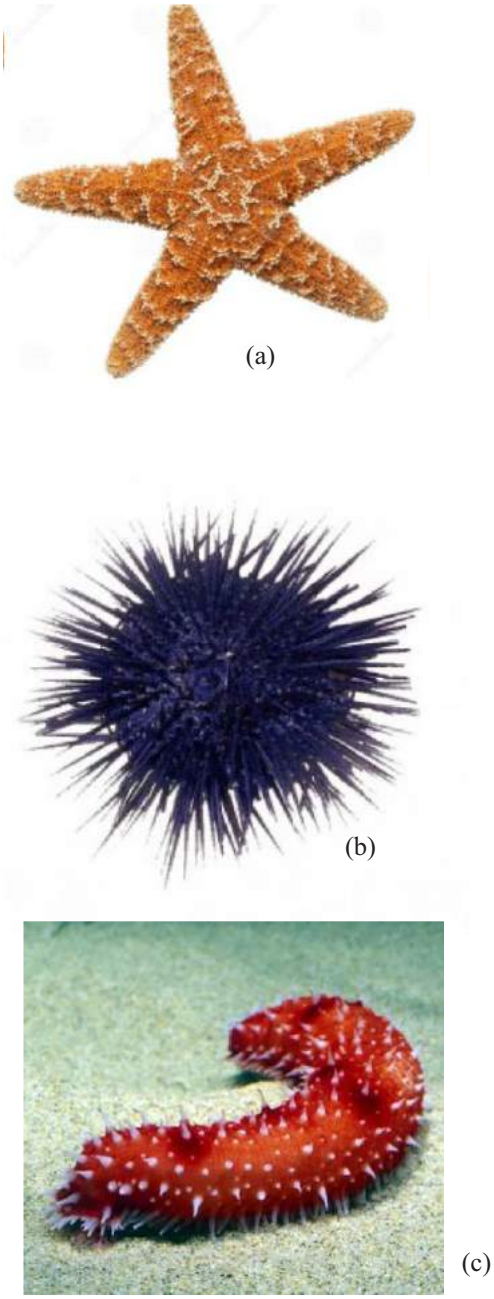


Fig. 7.16. Echinodermata
(a) Star-fish (b)Sea-urchin (c) Sea cucumber

B. Chordata : Notochord, true vertebral column, and endo-skeleton is present in the animals of this group. They are bilaterally symmetrical, triploblastic animals with a body cavity. There is complex differentiation of tissues and organs in them.

Chordates have been divided into five divisions :

1. **Pisces :** The animals of this division are found in both, marine and fresh water. Their skin is covered with scales. Body is stream-lined. Gills are present for respiration which use the oxygen dissolved in water. They are cold-blooded and lay eggs. Heart is two chambered. Skeleton is made up of bones and cartilage. Example : Rohu, Dog-fish, Electric-ray, Sting ray.

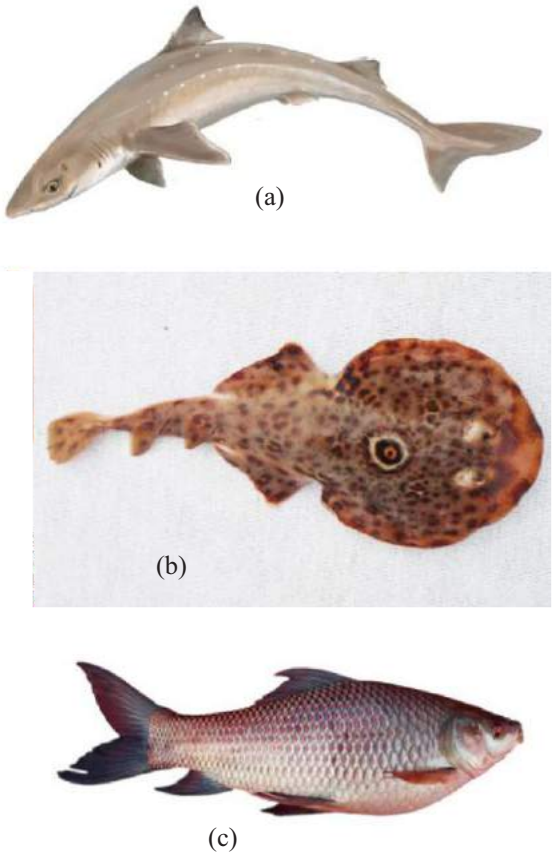


Fig. 7.17 Class Pisces
(a) Dog fish (b) Electric ray (c) Rohu

2. **Amphibia :** The animals of this class can live both on land and water. Their skin lacks scale, and have mucus glands. Respiration is through gills, lungs and skin. They are cold blooded animals that lay eggs. Heart is three chambered (Two atrium and one ventricle). Example : Frog, Salamander.

Fig. 7.18 : Amphibians
(a) Salamander (b) Frog

3. **Reptilia :** The animals of this class live mostly on land i.e. they are terrestrial. They are known as reptiles because they move by crawling. Their body is covered with scales. Respiration is through lungs. They are cold-blooded and mostly lay eggs. Eggs are covered with a hard shell. Usually, the heart is three chambered (two atrium and one ventricle). Example : Snake, lizard, crocodile, tortoise, tree-lizard.

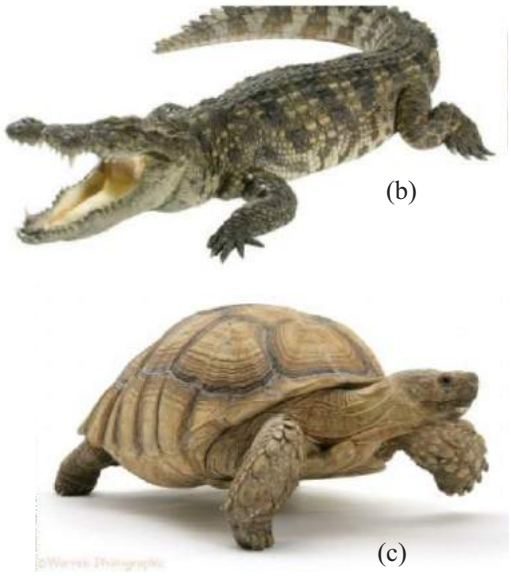


Fig. 7.19 Reptiles
(a) Snake (b) Crocodile (c) Tortoise

4. **Aves :** All the birds have been placed in this class. Their most characteristic feature is the presence of wings and the capacity to fly (exceptions include ostrich). They are warm blooded animals and lay eggs. Their heart is four chambered (Two atrium and two ventricles). The bones are light weighted, longer and hollow to assist in flight. Examples : Eagle, parrot, peacock, ostrich.

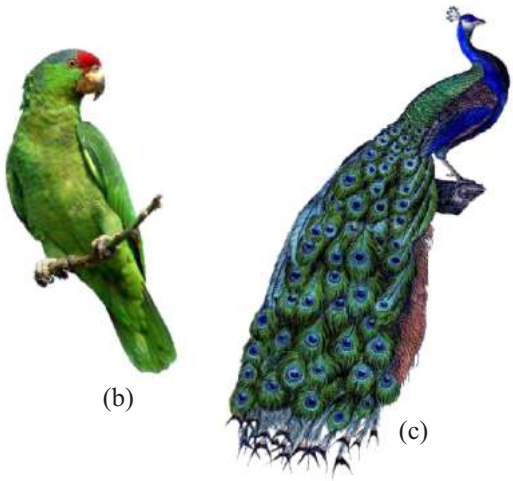
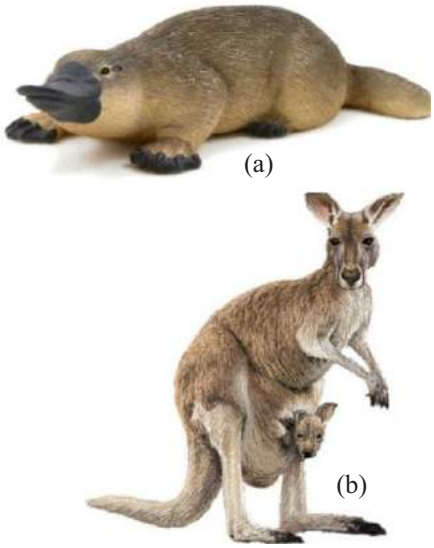


Fig. 7.20 Aves
(a) Ostrich (b) Parrot (c) Peacock

5. **Mammalia :** The animals of this class are found in all type of environments. They have mammary glands to nourish their young ones. Their heart is four chambered (two atrium and two ventricles).
The animals of this class are warm blooded and give birth to the young-ones. However, there are a few exceptions : Echidna lay eggs; kangaroos give birth to very poorly developed young ones, which remain in a sac named marsupium until they develop completely. Example : Human beings, Duck-billed platypus, Kangaroo, Bat.



(c)

Fig. 7.21 Mammals
(a) Duckbilled platypus (b) Kangaroo
(c) Bat

7.4 Adaptations of Animals according to their habitat :

Although animals and plants are present on all parts of the earth, but the environment of all the places is not the same. All the living beings (plants and animals) interact with their environment. Plants and animals are capable of surviving and reproducing in that environment because of their special type of organs, characteristics (anatomical, physiological, behavioural) and activities. This is known as **adaptation**. Adaptations in living beings are generated because of the environment and also depends on the genetic factors.

7.4.1. Habitat and adaptations of the plants : Based on the water present in their environment and their need for water, plants are of the following types :

1. Hydrophytes
2. Xerophytes
3. Mesophytes
4. Cryophytes
5. Halophytes

1. Hydrophytes : The plants which live in or on water or on water logged soil are known as **hydrophytes**. Examples : *Vallisneria*, *Eichchornia*, *Sagittaria*, *Ranunculus*, *Hydrilla*, Lotus, Water chestnut (singhara) etc.

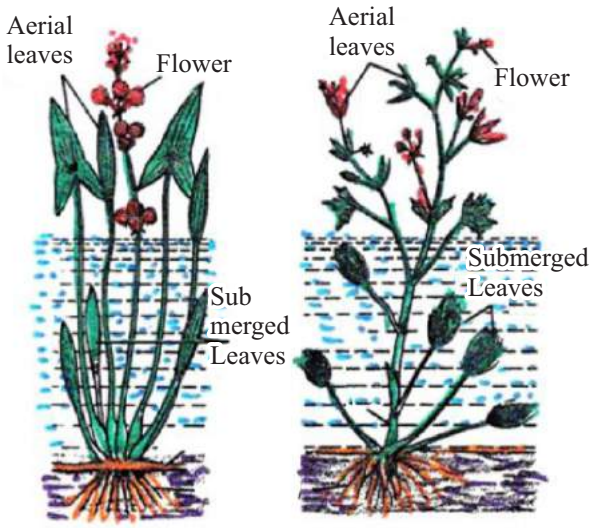


Fig. 7.22 : Hydrophytes
(a) *Sagittaria* (b) *Ranunculus*

Adaptations of hydrophytes :

1. The main function of the root system is to absorb water hence, because of abundant availability of water all around, the root system is less developed and water is absorbed from the plant surface.
2. In some plants like water- chestnut (Singhara or *Trapa*) the roots are green coloured for photosynthesis. They are known as the **assimilatory** roots.
3. Root hairs are absent. The **root pockets** replace the root hairs.
4. In some plants like *Lemna,* roots perform the act of balancing the plant body.
5. The stem is soft, thin and flexible in hydrophytes.
6. The leaves of the floating hydrophytes are broad while those of the submerged plants are dissected or ribbon shaped.
7. In hydrophytes pollination and dispersal of seeds and fruits is by means of water, hence their seeds and fruits are light in weight.
8. Air chambers are present in the internal structure of the leaves, stem and roots of the hydrophytes.
9. The osmotic concentration of the

cells of hydrophytes is less i.e. the concentration of salts in the cytoplasm is less.

10. Hydrophytes lack well developed mechanical tissue and vascular tissue.

2. Xerophytes : Xerophytes are the plants that are found in dry habitat having scarcity of water. Example : *Opuntia*, *Thor* (*Euphorbia*), Cactus etc.

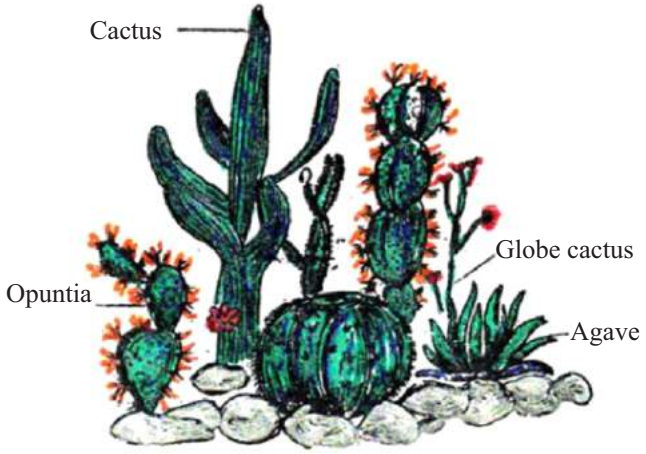


Fig. 7.23 : Xerophytes

Adaptations of Xerophytes : Xerophytes are recognised by their specific characteristics. These characteristics are as follows :

1. Xerophytes are present in habitats having scarcity of water, hence their roots are well developed and go deep down into the soil to absorb water.
2. Root hairs are present on roots for water absorption and root cap for protecting the growing root tip.
3. The stem of Xerophytic plants is woody and have multicellular hair on its surface. In some plants like *Calotropis* there is a layer of wax and silica present on the stem surface.
4. In some xerophytes the stem is green, succulent (stores water) and perform photosynthesis, as in *Aloe vera*.
5. To prevent water loss from its surface, the leaves of xerophytic plants fall off during summer season. In some plants like *Opuntia* the leaves are modified into spines.
6. In some other xerophytic plants, a waxy coating is present on the leaf surface and the sunken stomata are present on the lower surface of the leaf to reduce transpiration.
7. A hard cover is present around the fruits and seeds of the xerophytic plants.
8. The osmotic concentration of the cells of xerophytic plants is high.

3. Halophytes : Halophytes are the plants that grow in saline soils or marshes. In saline soil, soluble salts like sodium chloride, magnesium chloride and magnesium sulphate are present in abundance. The plants growing in marshy soils are known as **Mangrove vegetation**. Examples: *Rhizophora*, *Salsola* etc.

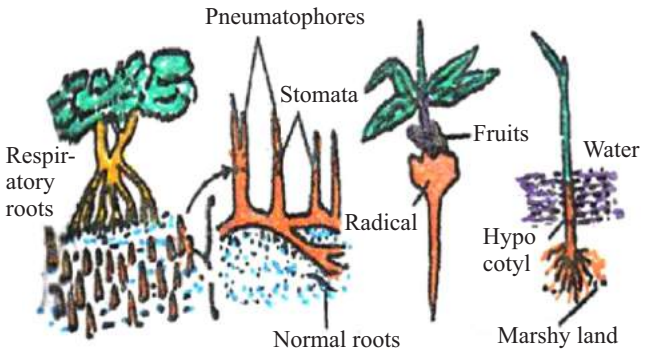


Fig. 7.24 : Halophytes

Adaptations of Mangrove Vegetation :

1. The roots of these plants do not go deep down into the soil therefore the 'stem-roots' develop and enter the marshy soil to provide extra support and stability.
2. Due to water-logging, marshy soils are deficient in oxygen and the normal regular roots do not get enough oxygen for respiration

Therefore in these plants some branches of the root become negatively geotropic and come out from the soil surface. Small pores are present on these aerial root which help the roots in oxygen uptake. These roots are known as **Respiratory roots** or **Pneumatophores.**

3. The stems of these trees are spongy because of storage of chloride ions.
4. The leaves are small, fleshy with a shining surface.
5. The seed in these plants start germinating while still within the fruit, attached to the parent plant. The embryo grows out from the fruit in the form of a seedling made up of the radical and the hypocotyl. The seedling falls down vertically on the ground and the radical directly enters the marshy soil. This type of germination is known as the **viviparous germination**.

4. **Cryophytes :** The vegetation growing in colder regions and ice-laden soil are known as cryophytes. Example : Moss, Lichens, Salmon-berry.

   Adaptations : In cold habitats, mostly the plants are herbs, mosses and lichens, which grow when the ice melts and complete their life cycle in very short duration i.e., these plants are short-lived.

   Salmon-berry is one of the many flowering plants which perennate under the snow and at the time of flowering when the snow melts by the respiratory - heat produced, only the flower emerges on the surface of the snow.

5. **Mesophytes :** The plants that grow in habitats having moderate amount of water, moisture and temperature are known as mesophytes. In such habitats all the conditions are ideal for the growth and reproduction of the plants.

   The root system is well developed in these plants and bear root hairs and root cap. The stem is aerial, branched, thick and hard. Leaves are broad with stomata on both surface. Plants are well developed, with normal physiology. Examples : Garden-plants and crops.

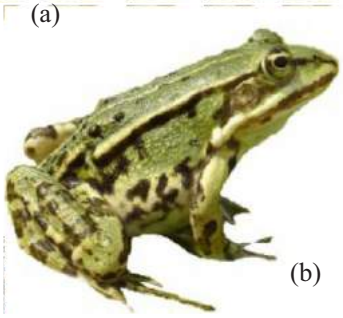
7.4.2 Habitat and Adaptation of the animals : In nature, animals are found in habitats like, water, land, air (sky) etc. The animals can be classified on the basis of their habitat as follows :

1. Aquatic animals 2. Terrestrial animals 3. Aerial

1. **Aquatic animals :** The animals which live in water i.e. aquatic habitat are known as aquatic animals. Some of these animals lie in marine water, some in fresh water and others are amphibious. These animals have characteristic features in order to adapt to their habitat. These features include :
   (a) The body of those animals is stream-lined so they can swim easily in water.
   (b) These animals have fins or feathers, which help them in swimming and balancing their body.
   (c) Aquatic animals have gills for respiration and use the oxygen dissolved in water.
   (d) The bones of these animals are light in weight and are spongy. The neck is absent or is less developed.
   (e) They have scales or mucus glands on their body.
   (f) Salt excreting glands are present in animals living in marine habitat to remove the excess of salt from their body.
   (g) In amphibians like Salamander, respiration is both, by gills and by lungs.

   Example : Fish, Frog, Sea-turtle etc.

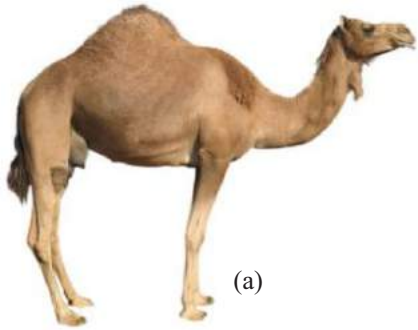
(a)



(b)

Fig. 7.25 Aquatic animals
(a) Fish (b) Frog

2. **Terrestrial Animals :** The animals which live on land are known as terrestrial animals. These animals have been subdivided on the basis of their surrounding environment on land.
   (i) Desert animals : The animals which live on dry lands, i.e. habitat with scarcity of water are known as desert animals. These animals have characteristic features which help them survive harsh conditions. These include :
   (a) The foot of these animals are adapted to walk, run and dig in the sandy deserts. For example, camels have cushioned feet.
   (b) The body-color of these animals is sandy i.e. brown like sand, so that they are protected against predators.



(a)

Camel's foot

(b)

Fig. 7.26 Desert animals
(a) Camel (b) Moloch

   (c) The faeces of these animals is solid and their urine is concentrated. Sweat glands are absent or less developed in their body.
   (d) On the body of some animals like Phrynosoma, scales are present to conserve water in the body.
   (e) The skin of some animals like moolak, is hygroscopic i.e. absorbs moisture from the surroundings.
   (f) There are water storing organs in these animals which perform the function of water storage, example - Camel.
   (g) The nasal apertures are small and are covered by valves to prevent the entry of sand particles, examples - Camel.
   Example : Camel, Phrynosoma,

Wild-rat, Moolak etc.

(ii) Cold Habitat Animals : The animals living in ice laden regions having low temperature are known as cold habitat animals. The cold habitats have very low temperature and the winds blowing in these regions are cold and dry. For most part of the year the land remains ice-laden. The skin of animals living in such habitats is covered with dense hair. Their colour is white, in order to protect them from predators.
Example : Polar - rabbit, Musk-ox

Fig. 7.27 Animals of cold habitat
(a) Musk - ox (b) Polar - rabbit

3. Avians : Animals that fly in air are known as avians or aerial animals. Following adaptations are found in these animals :

(a) The bones of these animals are hollow and light.
(b) Their forelimbs are modified into wings which help in flight.
(c) Their eye-sight is more sharp as compared to that of the terrestrial animals.
(d) Their body is covered with feathers which keep the body temperature constant.
(e) Their tail assists in maintaining the balance of their body.
(f) Body is cylindrical
Example : Sparrow, Vulture, Parrot, Crow, Peacock etc.

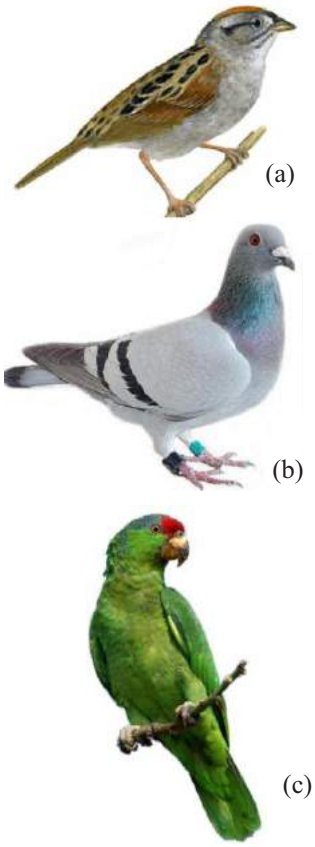


Fig. 7.28 Avian animals
(a) Sparrow (b) Pigeon (c) Parrot

Binomial Nomenclature : Lakhs of plants and animals live on the earth. They are known by local names at the places they are found. These local names are different in different regions of a country. Similarly, the name of these plants and animals are different in different languages. Therefore if

anyone is talking about an organism in local dialect, others not familiar with the local language are unable to understand. Scientists solved this problem by giving all the organisms (plants and animals) a scientific name. Each organism has a scientific name, by which it is known world wide. This process is known as **nomenclature**.

The universally valid rules for giving scientific names to plants have been laid forward by "International Code of Botanical Nomenclature" (ICBN) and those for animals in "International code of Zoological nomenclature" (ICZN).

The scientific method used for nomenclature is known as **binomial nomenclature**. Carolus Linnaeus proposed this method of nomenclature. This method is universally accepted worldwide for naming organisms. All the biologists use this method. According to this method of binomial nomenclature:

1. There are two parts in the scientific name of each organism - first is the name of the **genus** and the second is the **species** name.
2. Scientific names are usually of **latin origin**. They are written in **italics**. However, in case of hand-written names the two parts are underlined separately.
3. When writing in English the first alphabet of the genus name is capitalised while the name of species should start with small alphabet.
   Example : The scientific name of mango is *Mangifera indica*.

Important Points

1. In plants and animals the process of adapting (i.e. becoming better suited) to the environment by means of its special organs and special processes is known as adaptation.
2. The plant world has been classified into five divisions : Thallophyta, bryophyta, pteridophyta, gymnosperms and angiosperms.
3. Carolus Linnaeus is the "Father of binomial nomenclature". The first name of a binomial nomenclature denotes genus while the second name is that of the species.
4. Animal world has been classified into two groups invertebrata and vertebrata.
5. On the basis of their habitat, plants have been classified into hydrophytes, xerophytes, halophytes, cryophytes and mesophytes.
6. Whittaker gave the five kingdom hypothesis. According to this the organisms of earth can be grouped into five kingdoms : Monera, Protista, Fungi, Plantae and Animalia.
7. Animals can be classified as **aquatic, amphibian, terrestrial** and **avian**, on the basis of their habitat.
8. Halophytes are also known as the mangrove vegetation. They have pneumatophores or the respiratory roots.
9. In aquatic organisms, respiration is by means of gills while in terrestrial animals it is by lungs or the skin.
10. The osmotic concentration of aquatic plants is less while that of the xerophytic plants is more.

Questions

Objective questions

1. The most developed division of plants is :
   (a) Bryophyta (b) Angiosperm
   (c) Gymnosperm (d) Thallophyta
2. Viviparous germination of seeds take place in :
   (a) Hydrophytes (b) Mesophytes
   (c) Xerophytes (d) Halophytes
3. Presence of sunken stomata on leaves is an adaptation of :
   (a) Xerophytes (b) Halophytes
   (c) Hydrophytes (d) Mesophytes
4. Which plant group is known as vascular cryptogams :
   (a) Pteridophyta (b) Bryophyta
   (c) Gymnosperms (d) None of the above
5. An organisms of the class arthropoda is :
   (a) Leech (b) Tape worm
   (c) House fly (d) Star-fish

Very short answer questions :

6. Write the name of the Father of Binomial Nomenclature.
7. To which animal class does the frog belong to?
8. What is adaptation?

9. Who proposed the five kingdom classification?
10. The blue-green algae (cyanobacteria) is a member of which division.
11. What is a lichen?
12. Give two examples of gymnosperms.
13. Name the organism in which respiration is by means of gills, lungs and skin.
14. Name an egg-laying mammal.
15. In which habitat is the mangroove vegetation found?

Short answer type questions :

1. Name the two specialities found in halophytes.
2. Write the adaptations of aquatic animals.
3. What are the special features of cold habitat?
4. Write the characters of the animals of the class mammalia.
5. Write the characters of the animals of the class arthropoda.
6. What is the function of mycorrhizae and coralloid roots in gymnosperms?
7. Explain symbiosis in lichens.
8. Why pteridophytes are known as the vascular cryptogams?
9. Describe the adaptations of xerophytes.
10. What are saprophytes?
11. Write two similarities between bryophytes and pteridophytes.
12. What are monocots and dicots?
13. Write two differences between invertebrates and vertebrates.
14. What is the function of pneumatophores in halophytes?
15. What is the function of assimilatory roots in water chest-nut?
16. Write the adaptations of aves (aerial animals).

Essay type answer questions :

1. Classify the plants on the basis of their habitat and describe the adaptations of each type.
2. Write the rules of the nomenclature of organisms, according to the binomial nomenclature system.
3. Write the characteristic feature of the animals living in aquatic and desert habitats.
4. Describe the characteristic features of angiosperms and gymnosperms.
5. Write notes on the following :
   (a) Mangrove vegetation
   (b) Amphibians
   (c) Salt secreting glands
   (d) Lichens
   (e) Viviparous germination
   (f) Stem roots

Answer Key

1. (b) 2. (d) 3. (a) 4. (a) 5. (c)

Chapter-8

Major Activities of Living Organisms

8.1 Concept of Nutrition and its importance :

The process of food intake by animals is known as **Nutrition** . The nutritive elements present in food provide energy for various bio-chemical reactions and leads to physical growth of the body. This process of obtaining the food necessary for growth and healthy functioning of the body is known as **nutrition**. Nutrients are the food substances which provide energy to living beings and synthesize new cellular substances.

All living beings require food and the nutritive elements present therein, to perform various complex chemical reactions of the body. The nutritive elements present in the food make possible the growth of living organisms, repair of the damage, development, protection from various diseases, control of various activities reproduction etc. If food is not made available all the physical processes and functions of the body will cease.

Body of living beings is like an engine of a vehicle. Like the engine, even body needs fuel. Even the body requires continuous input of fuel to perform various activities. As soon as, sufficient fuel is not made available, even the body, like an engine will stop functioning. The reason behind it is the fact that the engine needs power to run, which is provided to it by the fuel. Similarly our body also needs energy which is provided by the food and nutritive substances. Food and nutritive substances are needed to maintain the body temperature and also to sustain the continuous growth taking place in the body.

8.2 Types of Nutrition :

On the basis of the mode of nutrition living beings can be divided into two main divisions

(a) Autotrophs

(b) Heterotrophs

(1) Autotrophs : Green plants contain a substance named chlorophyll. Hence, they prepare their own food using carbon-di-oxide, water and solar energy obtained from their environment. They are known as the **autotrophs**. Some bacteria like sulphur bacteria, nitrifying bacteria, iron bacteria are also autotrophs. They obtain the energy required to prepare their food by oxidising sulphur, nitrogen and iron compounds. They are known as the chemoautotrophic.

(2) Heterotrophs : Organism which a r e not able to synthesise their own food and depend on other living beings for their food, are known as the **heterotrophs**. Heterotrophic nutrition can be of the following types:

(a) Holozoic Nutrition : It is a type of nutrition in which the organism ingest other living beings or the carbonic substances made by them. Such type of organisms are known as holozoic living beings. They have been classified, on the basis of the source of their food, as under :

(i) Herbivores : Herbivors are the animals which depend on plants, directly, for their food. Examples: goat, cow, deer etc.

(ii) Carnivores : Animals which consume other animals, as their food are known as carnivores. Examples : Lion, tiger etc. Some plants are **insectivorous** for example : Pitcher plant, *Utricularia, Drosera* etc.

(iii) The Omnivores : The animals which consume both, plants and animals in the form of their food are known as omnivores. Examples : Rat, Pig, Human beings etc.

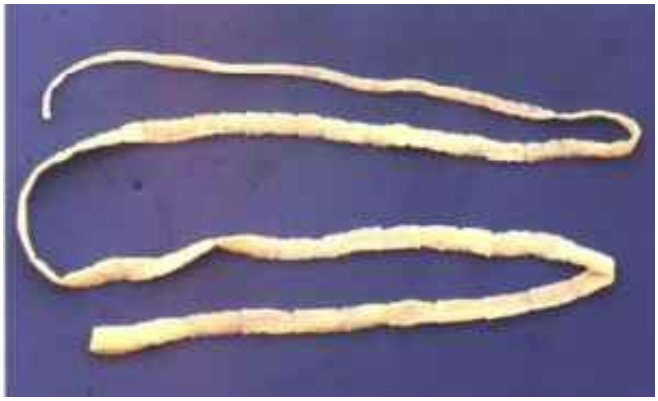
(b) Parasites : The organisms which reside inside or on the body of plants and

(a) Saprophyte (Mushroom)

(b) Symbotic organism (lichen)

(c) Nitrogen fixing bacteria

(d) Carnivorous plants (pitcher plant)



(e) endoparasits (Tape worm)

(f) ectoparasite (lice)

Fig. 8.1 Different types of nutrition in living beings

animals and obtain their food from these plants and animals are known as parasites. These parasites may be of two types :

* **Ectoparasite :** Parasites which obtain their nourishment by attaching themselves to the host skin/surface, are known as ectoparasites.

Example : Lice, Mosquito, Bedbug (animals); *Cuscuta* (plant).

* **Endoparasite :** Parasites which obtain their food by entering into the body-organs, like intestine, body cavity, liver, blood etc of their host are known as the endoparasites. Examples : Liver fluke, tape worm, plasmodium etc.

(c) Symbionts : The organisms which obtain their nourishment by living together are known as the **symbionts.** In **symbiosis** type of nourishment, different species live together and benefit each other. The two species living together does not cause any harm to each other.

Examples : Algae and fungi together form lichen. They spend their entire life with each other.

(d) Saprobic Nutrition : Some organisms obtain their nourishment from the dead and decaying organisms. They are known as **saprophytes** and their mode of nourishment is of saprobic type. Examples : Microbes, fungi, some protozoa etc.

8.3 Nutrition in Plants :

All living beings need food to remain alive. Energy is obtained from food. The body conducts various vital activities with this energy. If the body does not get food, all the activities and functions of our body will stop. In plants the prominent method of food formation is photosynthesis.

8.3.1 Photosynthesis : Photosynthesis in plants is an important activity from the perspective of environmental balance. During this activity the plant synthesize food in the presence of chlorophyll and sunlight using carbon-di-oxide and water present in the atmosphere and soil respectively and in return makes available the vital gas - oxygen. There is a vast difference in method of obtaining energy in plants and animals. Animals cannot synthesize their own food and obtain it from green plants. On the other hand, green plants use solar energy and converts it into chemical energy. The energy is stored in the form of Adenosine - tri-phosphate (ATP) and reduced Nicotinamide adenine-di-phosphate (NADPH). Plants use this energy for reduction of carbon-di-oxide. The entire process leads to the synthesis of carbohydrates, from which the animals obtain their food.

The process of absorption of solar energy by green plants and converting it into chemical energy is known as photosynthesis.

8.3.2 Photosynthetic Pigments : All photosynthetic organisms obtain light energy and converts it into chemical energy. This work is performed by the pigments. These pigments remain arranged in specific organelles which lie scattered in the cytoplasm. Haeckel coined the term 'plastid' for these organelles. They are present in all plants except the fungi and prokaryotes like bacteria and blue green algae.

Chloroplasts : These are green coloured plastids. Their green colour is because of the **chlorophyll pigment** present in them. The plants and leaves appear green because of their presence. Their function is to perform food by photosynthesis. There are two distinct regions in chloroplasts - Stroma and Grana.

(i) Stroma : It forms the matrix of chloroplasts. The ribosomes which synthesize proteins, remain scattered in it. The dark reaction of photosynthesis takes place in this part of the chloroplast.

(ii) Grana : The light reaction of photosynthesis occurs in this part of the chloroplast. There are 40-60 grana in each chloroplast. In the granum region are present numerous plate-like or disc like structures, arranged like a stack of coins. These structures are known as the thyllakoid. In higher plants four types of chloroplast pigments are present. The two green pigments are the chlorophyll a and b and the orange and yellow coloured pigments which are known as the carotene and xanthophyll respectively.

8.3.3 Mechanism of Photosynthesis : Carbon-di-oxide and water are the two major raw materials of photosynthesis. Chlorophyll and other

pigments absorb light energy and transform it into chemical energy. The entire process of photosynthesis can be represented by the following equation :

$$6CO_2+12H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6+6H_2O+6O_2\uparrow$$

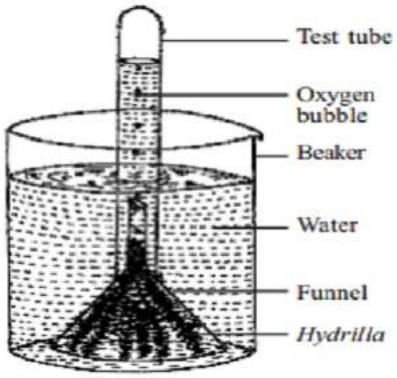


Fig. 8.2 : Oxygen is evolved during photosynthesis (Inverted funnel experiment)

The process of photosynthesis, basically, completes in two steps :

(i) Light reaction
(ii) Dark reaction

(i) Light Reaction : During this process the radiant energy of the sun is converted into chemical energy. Following are the main processes of this step of photosynthesis :

(1) Absorption of light of definite wavelength by chlorophyll
(2) Excitation of chlorophyll
(3) Photolysis of water takes place.
(4) Oxygen is evolved
(5) Conversion into chemical energy: The ATP formed stores the energy and the reducing power NADPH is synthesized.

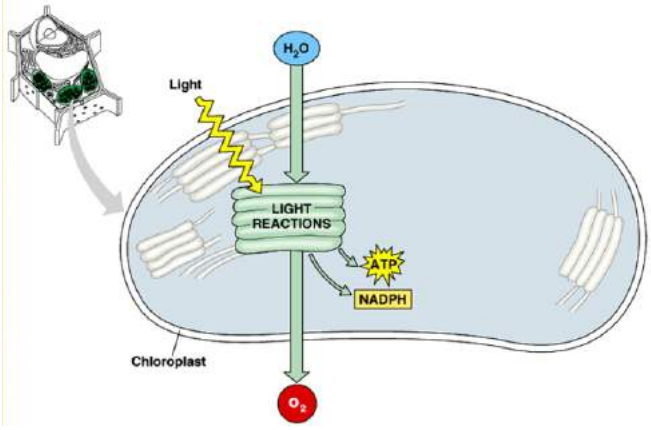


Fig. 8.3 Light reaction

This step is light-dependent, hence is known as the light reaction or the photo-chemical reaction. This process takes place in thyllakoid membrane present in the chloroplast.

(ii) Dark Reaction : During this step of photosynthesis 'synthesis' occurs. Here Carbohydrates are formed from carbon-di-oxide. This process does require light, hence is known as the dark reaction. It takes place in the stroma of the chloroplast.

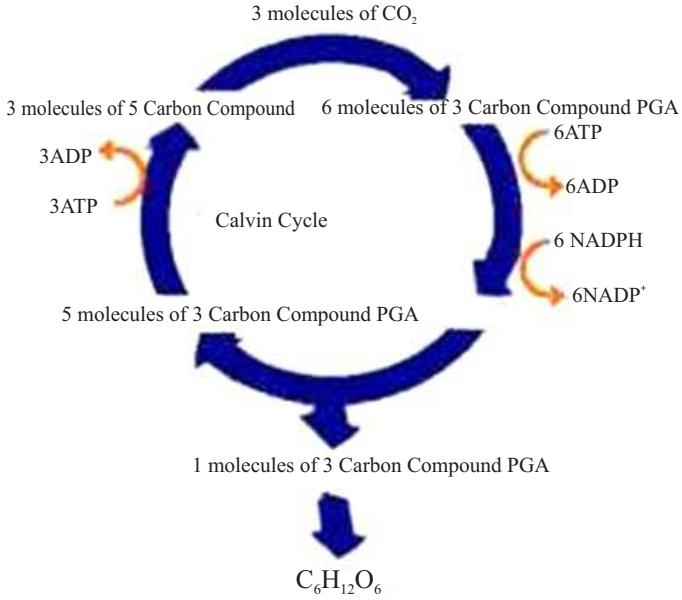


Fig. 8.4 Dark reaction

In this process, there is fixation and reduction of carbon-di-oxide. The first stable product of this reaction process is PGA (phosphoglyceric acid), which is a three carbon molecule. Hence this cycle is also known as the C_3 cycle or the

Calvin cycle.

8.3.4. Factors affecting photosynthesis: The factors affecting photosynthesis can be divided into two main types : External factors and Internal factors.

I. **External factors :** This involves sun-light, carbon-di-oxide concentration, oxygen, temperature and water.

II. **Internal factors :** Chlorophyll is a major factor under this category.

8.3.5. Bacterial photosynthesis : Bacterial photosynthesis is a special type of photosynthetic process which takes place in some major types of bacteria. During this process too carbon-di-oxide is reduced by using solar energy - example : Cyanobacteria, Purple bacteria.

8.4 Major Components of Food :

The complex chemical substances present in food, which are essential in proper amount, to accomplish different types of reactions in the body and to keep it healthy, are known as the **components of food** or **Nutrients**.

Nutrients have been classified into the following six types :

1. Carbohydrates
2. Fat
3. Protein
4. Mineral salts
5. Vitamin
6. Water

Although water does not provide for any nourishment as such, but since it is essential for different physical processes, it has also been included among the nutrients. There is one more substance which is not nutritive but must be a part of our food : Roughage or food fiber. In the animal food it is majorly the indigestable plant cell-wall part. It is helpful in removal of the residue, left after food digestion, from the body.

8.5 Nutrition in Animals :

The vegetation obtains carbon-di-oxide from the atmosphere and converts it into carbohydrates by the process of photosynthesis. Animals consume these vegetation or other animals which in turn eat plants to obtain their energy.

8.6 Digestion :

The food obtained by various animals, from the plants is in a non-diffusable state. They are converted into diffusable simple compounds with the help of digestion. There are specific organs for performing digestion. They are known as the digestive organs. These digestive organs form the digestive system.

8.6.1 Importance of Digestion : There are many types of nutritive elements and molecules present in the food stuff which are used in the formulation of new tissue and repair of the existing tissues. Since the animals cannot synthesize these nutritive elements, so these substances, synthesized by plants, are reduced by digestion and are then absorbed by the animals. Thus, digestion is the transformation of food into simple products.

8.6.2 Major parts of the Human Digestive system : The digestive system can be divided into two parts

1. Alimentary canal
2. Associated glands.

Alimentary canal starts with the mouth cavity continues into the pharynx, oesophagus,

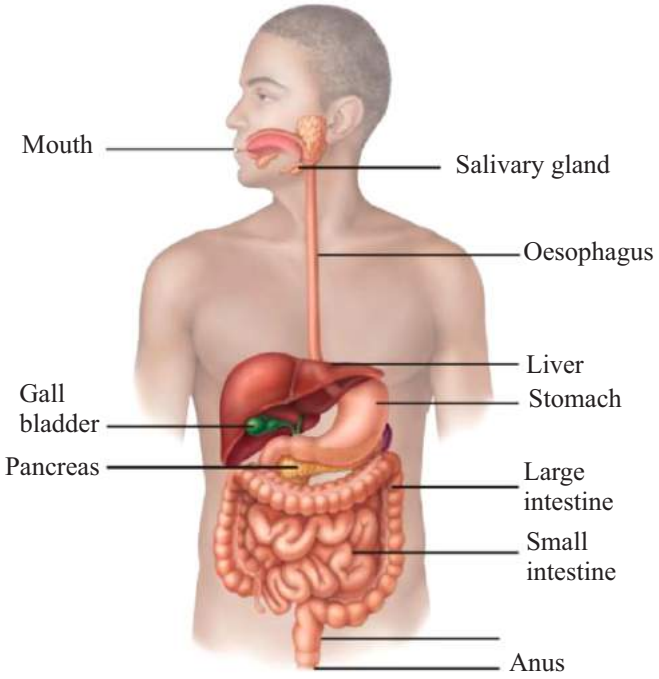


Fig. 8.5 Digestive System in humans

stomach, small intestine, large intestine, and ends at the anus. Salivary glands, pancreas and liver are the associated glands.

1. Alimentary Canal : The alimentary canal is made up of the following parts :

(i) Buccal cavity : This cavity present inside the mouth is guarded by the upper and lower lip. Jaws are present in the buccal cavity in which teeth are present. The teeth are present to cut, break, munch and chew the food.

A muscular tongue is present in the buccal cavity on which taste buds are present. These taste buds help in recognizing various taste. Salivary glands are also present in the buccal cavity which secretes saliva. The amylase enzyme present in the saliva (ptylin) converts starch into maltose. Along with this the saliva moistens and converts the food into a pulp. It functions like an antiseptic in the mouth.

(ii) Pharynx : The function of the pharynx, situated between the buccal cavity and the oesophagus, is to swallow the food.

(iii) Oesophagus : It is a small narrow tube which connects the pharynx with the stomach. No digestive enzyme is secreted by the oesophagus. It leads the food to the stomach.

(iv) Stomach : It is the most broad, sac like structure of the alimentary canal which appears like the alphabet 'J'. It is present towards left side in the abdominal cavity, below the diaphragm. When the food reaches the stomach, various gastric juices are secreted which are digestive in function.

Gastric Juice : It is secreted from the internal lining of the stomach wall. It is colourless, sour in taste, fluid, having 90% water and 0.5% hydrochloric acid, along with enzymes like pepsin, rennin and lipase. Its pH is 0.9 – 1.5.

Functions of the stomach :

1. It stores food.
2. The protein digestion initiates in this part of the alimentary canal.
3. The hydrochloric acid of the stomach makes the food acidic and kills the bacteria ingested along with the food. Pepsin in combination with HCl converts proteins into peptones and proteases. Rennin converts the protein caesinogen present in milk into casein which is then digested by pepsin.
4. Stomach absorbs glucose, water, alcohol and many type of medicines.

(v) Small Intestine : It is a very much curved and twisted tube lying between the stomach and the large intestine. Its length is approximately 22 feet. Although it is longer than the large intestine but since its diameter is smaller than the large intestine, it is known as the 'small intestine'. This tube like structure is divisible into three parts.

1. **Duodenum :** This is the first part of the small intestine, just beyond the stomach. It is a C-shaped tube that is 25 cm long. The bile and pancreatic ducts open into this part of the intestine.
2. **Jejunum :** It is the central coiled region. Its function is to digest food and absorb it. This part secretes the intestinal juices.
3. **Ileum :** The third portion of the small intestine is three meter long and ends near the caecum, where it connects to the large intestine. There are many digestive glands in it and it also performs the work of absorption.

Functions of the small intestine:

1. Pancreatic juice is secreted from the pancreas in the duodenum part of the small intestine. This makes the digestive media in the small intestine alkaline, with a pH 7.1 to 8.2. The chief enzymes present in the pancreatic juice includes amylase, maltase, sucrase, pancreatic lipase,

chymotrypsinogen, trypsinogen etc.

2. In the small intestine the carbohydrates, proteins and fats are digested completely. These compounds are reduced to their simplest components.
3. Small intestine absorbs the digested food with the help of microvilli present on its inner lining.

Names and functions of the intestinal juices :

The juice secreted by the digestive glands present in the intestinal walls is known as the intestinal juice or Succuss entricus. Following enzymes are present in it :

1. **Peptidase :** It acts on the peptones of the protein and converts them into amino acids.
2. **Maltase :** Converts maltose into glucose.
3. **Sucrase :** Breaks down the sucrose sugar into glucose and fructose.
4. **Lactase :** It acts on the milk sugar lactose and converts it into glucose and galactose.
5. **Lipase :** Acts on lipids and breaks down the fatty substances into fatty acids and glycerol.
6. **Enterokinase :** It converts the inactive trypsinogen secreted by pancreas into active trypsin.

(vi) Large intestine : The illium part of the small intestine joins with the colon part of the large intestine. The large intestine is also divisible into three parts - colon, caecum and rectum.

1. This is the starting part of the large intestine. The internal lining of this region is devoid of microvilli and the goblet cells secrete mucus.
2. **Caecum :** It is a 10 cm long tube which is attached to the colon and have appendix at its end.
3. **Rectum :** It is the terminal end of the alimentary canal and is in the form of a long tube with a circular hole, the anus, at its open end.

Large intestine is not involved in any type of major digestive activity as such.

Functions of the large intestine:

1. It absorbs water, minerals and medicines.
2. Secretes mucus to smoothen the anus and facilitates the excretion of the undigested substances.

8.7 Major Information of digestion in animals:

1. **Digestion in amoeba :** This animal of phylum Protozoa is present in water. It is a unicellular organism and hence digestive organs are absent in amoeba. On coming in contact with food the pseudopodium of amoeba forms food vacuole all around the food particle. In the amoeba body, secretion of metabolic juices start in the food vacuole which digests the food material.

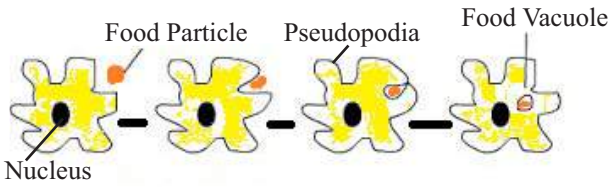


Fig. 8.6 Digestion in Amoeba

2. **Digestion in Euglena :** Euglena is autotrophic or phyto-holophytic as well as saprophytic or hetero-trophic. This dual type of nutrition is known as mixotropic nutrition.
3. **Digestion in Earthworm :** Earthworm feeds on dead organic matter. It ingests vegetation along with soil. The food intake is because of the pumping action of the pharynx. First it embeds the mouth in the soil and then by the contractile sucking action of the pharyngeal wall sucks the soil particle into the mouth cavity. This activity of pharynx is supported by muscular

fibers that are stretched from the pharynx to the body wall.

The alimentary canal of earthworm is a complete straight tube which extends the entire body length. Mouth and anus are the anterior and posterior openings respectively.

8.8 Respiration

8.8.1 Meaning and importance of respiration : Aerobic organisms need oxygen to remain alive because oxygen causes the oxidation or degradation of food substances and provide energy. This process of oxidation of nutritive substances is known as **cellular respiration**. In plant - respiration oxygen is inhaled by pores which is then used at cellular level for respiration; while in animals a complex system of respiratory organs function for the process.

Living cells need a continuous supply of oxygen. The organism performs respiration to fulfil this need. Removal of carbon-di-oxide formed, during the process, from the cells is essential. Respiration is a vital characteristic of all living cells. This process continues day and night, even when we are not engaged in any activity.

In this process there is oxidation of the sugar or glucose and energy is released. Energy is stored in the form of energy currency - the ATP. This energy in then used by the living being to carry-out various body functions smoothly. Respiration can take place in the presence as well as the absence of oxygen. Respiration can be compared with combustion as under :

(i) In both, organic compounds are degraded and energy is released.

(ii) Carbon-di-oxide and water are formed in both.

(iii) Oxygen is required for burning during both the processes.

However, there are differences between the two processes which are tabulated below :

	Respiration	**Combustion**
1.	It occurs at normal body temperature (37°C in humans)	High temperature is required for combustion
2.	It is a slow process.	If is a fast process.
3.	There are various stages of the oxidation of food.	Here the fuel forms carbon-di-oxide and water directly.
4.	It is controlled by various enzymes.	It is not regulated by enzymes.
5.	Here energy is stored in the form of ATP.	Here energy is released in the form of heat and at times even as light.

8.8.2 Plant respiration : In plants specific organs are not present for gaseous exchange, as are present in animals, rather they have pores and stomata for this purpose. Transportation of gases in plants is minimal hence demand for exchange is also very less. Moreover in plants, most of the cell-surface is in contact with air, hence availability of oxygen is not a problem.

Plant cells synthesize food in such a manner that the energy released by reduction of glucose is not released in the atmosphere in the form of heat. For this purpose, cellular respiration is a multistep process, so that maximum of the energy released is converted to ATP.

In animals two types of cellular respiration is present :

1. Anaerobic respiration
2. Aerobic respiration

1. Anaerobic respiration : This type of respiration does not require oxygen. It occurs in yeasts, bacteria, parasites and some lower animals which are unable to get free atmospheric oxygen. In deficiency or absence of oxygen, the glucose converts into ethyl alcohol or lactic acid and lesser amount of energy is produced. This process is also known as sugar **fermentation**.

(a) $C_6H_{12}O_6 \rightarrow 2\,C_3H_6O_3 + \text{energy}$

Glucose $\rightarrow$ Lactic acid (in muscles, by bacteria)

(b) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2 + \text{energy}$

Glucose Ethyl alcohol (by yeast)

2. Aerobic respiration : This type of respiration requires oxygen. Glucose is reduced in the presence of atmospheric oxygen to produce carbon-di-oxide, water and greater amount of energy.

This type of respiration occurs in

most of the animals and plants. In this respiration even plants take oxygen from the atmosphere and release carbon-di-oxide.

Respiration in animals : Different types of organs have evolved in animals to obtain oxygen and release carbon-di-oxide in the atmosphere. Terrestrial animals get their oxygen from the surrounding atmosphere (like in human beings lungs are used for the purpose); but the animals which live in water, like fishes, absorb the dissolved oxygen from water with the help of gills. Since the amount of dissolved oxygen is very less in water, than that present in the atmosphere, the rate of respiration of the aquatic animals is faster as compared to that in the terrestrial animals.

The unicellular organisms like Amoeba, Paramecium etc exchange gases by diffusion across their cell membrane. Similarly, in porifera, like-sponges; coelentrata, like hydra etc, the gaseous exchange is through their moistened body wall.

As the size of organisms increased, specifically made organs were required. In all such organs the common character is the presence of structures that increase the surface area. The respiratory system of earthworm is more complex than that of the amoeba and hydra. The mucus secreted from the skin keeps the external surface moistened in earthworm. The exchange of oxygen and carbon-di-oxide gases occurs through this moistened skin.

In insects, respiration takes place by special the absence of air in it.

Bronchi and Bronchioles : The trachea move down and divides into two parts, the bronchi, in the thoracic cavity. The bronchi further sub-divides into the bronchioles. The bronchioles branches into the lungs in the form of the alveolar ducts. These ducts open into small alveoli or the air sacs. Blood vessels are found on the alveoli which carry oxygen to the entire body. The area of the lungs increase many-fold due to presence of the air sacs.

Lungs : A pair of spongy, pink sac like lungs are present in the thoracic cavity of human beings. They are situated in the pleural cavity near the heart. There is a thin covering all around the pleural cavity, which is known as **pleura**. The right lung is longer than the left one. The volume of the thoracic cavity increases and decreases because of the contraction and relaxation of the ribs. This results in the entry and exit of the air from the lungs.

Diaphragm : The lower floor of the thoracic cavity is closed by a thin dome like plate which is known as the diaphragm. The diaphragm flattens at the time of exhalation.

Breathing mechanism in Human :

The breathing process is divisible into two :

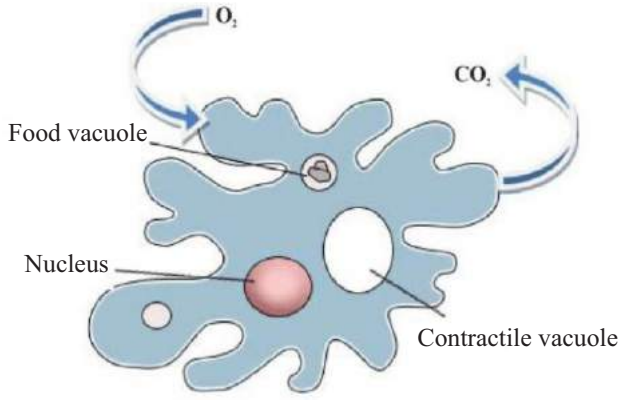


Fig. 8.7 Respiration in Amoeba

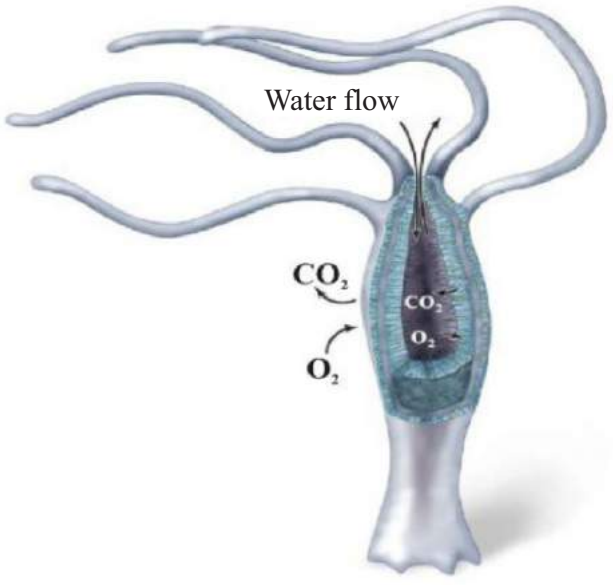


Fig. 8.8 Respiration in Hydra

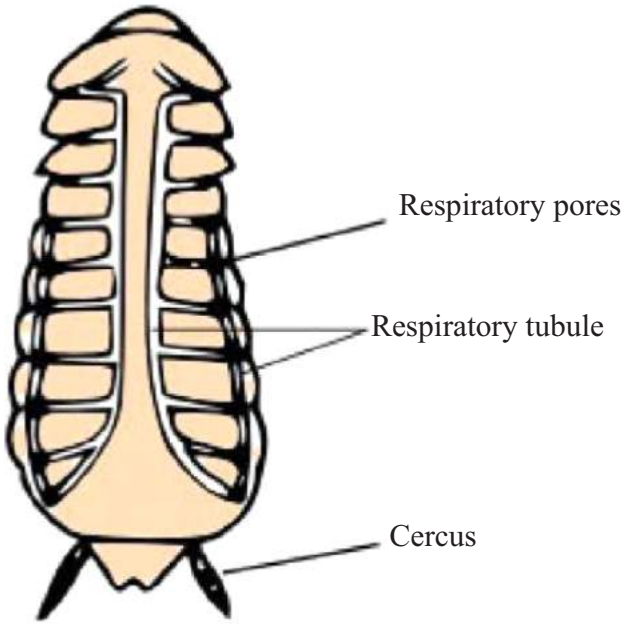


Fig. 8.9 Respiration in cockroach

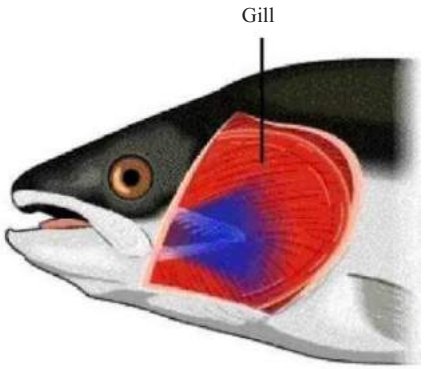


Fig. 8.10 In fishes respiration takes place with the help of gills.

(1) Inhalation
(2) Exhalation

Respiratory pigment : Haemoglobin is the respiratory pigment. It is present in the Red Blood Corpuscles (RBC). It binds the oxygen molecules and carry them to all the cells of the body.

8.9 Circulation :

8.9.1 Meaning and the need : Circulation is the process of carrying various substances, like the absorbed nutrients, water and waste products, from one part of the body to another in living beings. The

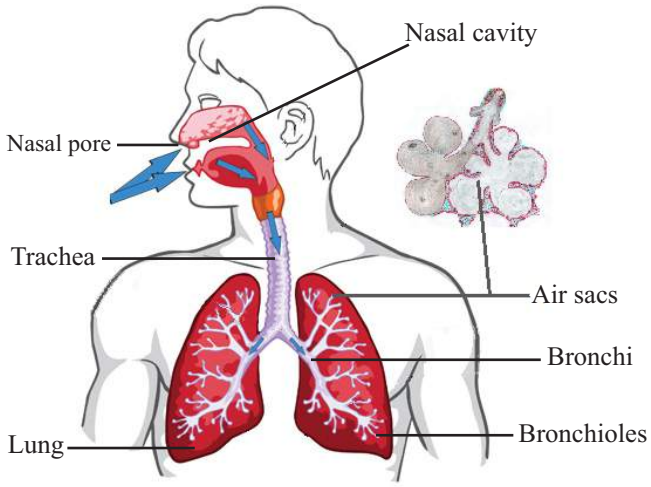


Fig. 8.11 Respiratory System in Humans

system related to this process is known as the circulatory system.

The circulatory system is made up of a few organs, vessels and capillaries, in which flows a fluid. The food substances, oxygen, water, excretory products and other essential substances move across the body through this fluid only. This fluid chiefly is the lymph, blood or water. Each body cell receives nutrients and energy through these substances. It is because of this energy and the nutrients that the cells perform their functions and the body runs smoothly.

8.9.2 Basic knowledge of circulation in animals : Two types of circulatory systems are present in animals :

1. **Open circulatory system :** In this type of circulatory system the blood flow in vessels, only partially i.e. only in some body parts. In the remaining parts it diffuses in the open spaces present between the various tissues and organs. In this system the cells and tissues of the animal, are in direct contact with the blood.
   Example : Cockroach, Shrimp, Snail, *Unio* etc.
2. **Closed Circulatory System :** In this type of circulatory system the blood circulates the vessels and capillaries. The nutrients are carried to various organs and the excretory products are collected from there by means of the circulating blood. Example : Earthworm, fish, frog,

birds, human etc.

8.9.3 Circulatory system in cockroach : The transportation of nutritive substances, excretory substances and hormones take place by the open circulatory system, in cockroach and other insects. However, gases cannot be transported by means of this system. There is a separate system of tracheal or respiratory vessels for the transportation of gases in these organisms. In cockroach, there is a cavity known as the **haemocoel**. It is divisible into three sinuses by two diaphragms. They are known as the pericardial haemocoel, the perivisceral haemocoel and the perineural haemocoel. In the pericardial haemocoel there is a thirteen chambered muscular, tubular and contractile heart in which the blood flows forward i.e. from back to front. The blood in cockroach is colourless because of the absence of any pigment in it. It is for this reason that it does not transport gases. The main function of this circulatory system is transportation of food and excretory substances.

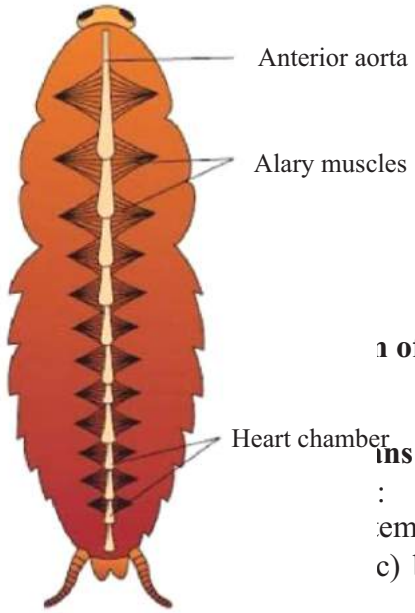


Fig.8.12 Open Circulatory system of cockroach

8.9.4 Circulatory system in Earthworm : The circulatory system in earthworm is of closed type i.e. blood circulation is confined to blood vessels. In earthworm, there are two main blood vessels - the dorsal blood vessel (towards upper side) and the ventral blood vessel (below the alimentary canal). In the dorsal blood vessel the blood is carried to the front of the earthworm's body while the ventral blood vessel carry the blood from the front to the back of the body. Near the anterior end these two blood vessels are connected to each other by means of five pairs of aortic arches which function like a heart and pumps the blood in both the major blood vessels. There are uni-directional valves in the heart and the dorsal vessel, which prevents the back flow of the blood. Thus the blood flows in the ventral vessel and returns to the heart via the dorsal vessel. In each segment there is a thin capillary that carries the blood from the ventral vessel to the dorsal vessel. It's cell wall is unicellular, therefore the nutrients and other substances diffuse and reach the cells through the tissue fluid, in each segment.

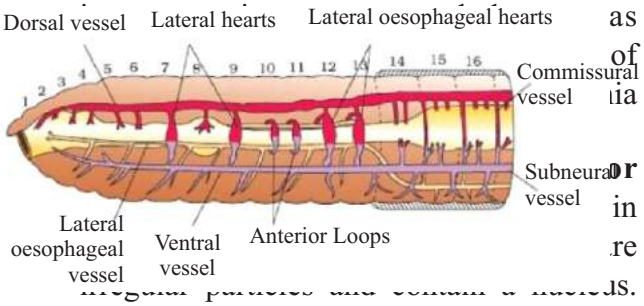
(A) The Circulatory System :

(a) Blood :

Blood is a fluid connective tissue having a fluid matter - **plasma** - in it. Plasma forms nearly 55% of the blood and is light yellow in color. 92% of the plasma is water and the remaining 8% are other substances. It contains many

organic substances like glucose, amino acid, fatty acid and oxygen and other dissolved gases. Apart from this the globulin antibody protein, fibrinogen and prothrombin which help in clotting etc. are also present in the plasma. Three types of blood cells are also present (i) Red Blood Corpuscles or RBC (ii) White Blood Corpuscles or WBC and (iii) Blood platelets or thrombocytes.

(i) Red Blood Corpuscles or RBC : These corpuscles are light yellow in color and are oval or round in shape. They appear red because they are present in large number and have oxyhaemoglobin. Their life span is about 120 days and they are enucleated i.e. they lack a nucleus. RBC contains an



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WBC do not contain haemoglobin therefore they are colorless. Many white blood corpuscles perform amoeboid movements along the walls of the blood vessel in a direction opposite to the blood flow. Whenever any bacteria or external toxic substance enters the body, these cells attack them and removes them after destroying. In this way they protect the body against various pathogens and develop our immunity system.

(iii) Blood platelets : These corpuscles are also known as the thrombocytes. They are smaller in shape, than the Red and the White Blood Corpuscles and their number is less than that of the red blood cells. Their main function is to form blood clot and block the route of bleeding. Nucleus is absent in these cells.

(c) Heart a muscular organ :

Human heart is an elongated, conical structure. It is located between the right and left lungs, slightly displaced towards the left, in the thoracic cavity. It is made up of four chambers. On the upper side are the left and the right atrium and towards lower side are the two ventricles: the left and the right ventricles. The oxygenated blood, from the lungs, enter the left atrium and the ventricle and the deoxygenated blood, from the body organs, is brought into the right hand chambers of the heart (right atrium and ventricle). As compared to the atrium the muscular wall of the ventricle is thicker. This is because it has to pump blood to the entire body. When the atrium or ventricle contracts, the valves ensure that the blood do not flow in the reverse direction. A septum is present between the two atria. It is known as the **inter auricular septum**. Similarly the **inter ventricular septum** is present between the two ventricles.

Fig. 8.14 Structure of the human heart

8.9.6 Mechanism of Heart Action : The function of the heart is to pump blood into various parts of the body. This is performed by the

contraction and relaxation of the heart. The oxygenated blood enters the left atrium from the lungs through the pulmonary veins. The deoxygenated blood from various parts of the body reaches the right atrium via the pulmonary artery. Now both the atria contract together so that the oxygenated blood is pumped into the left ventricle from the left atrium and the deoxygenated blood from the right atrium moves into the right ventricle. After this, the two ventricles contract together. Pressure is generated on the blood because of their contraction which results in the closing of the valves between the atrium and the ventricle and the blood cannot flow back into the atrium. The aortic valve of the aorta opens because of this pressure generated and the oxygenated blood is pushed into the aorta, from where it is distributed to various parts of the body by means of a network of arteries and capillaries. The blood flow to the lungs via pulmonary artery, on contraction of the right ventricle. In the lungs the carbon-di-oxide present in it is released and it gets oxygenated and then flows back to the left atrium. Thus the blood in human body circulates in two loops. This is known as **double circulation** or the double conduction.

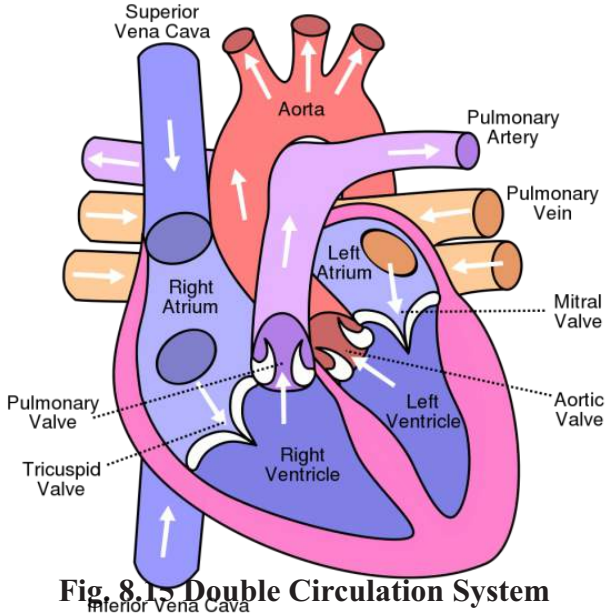
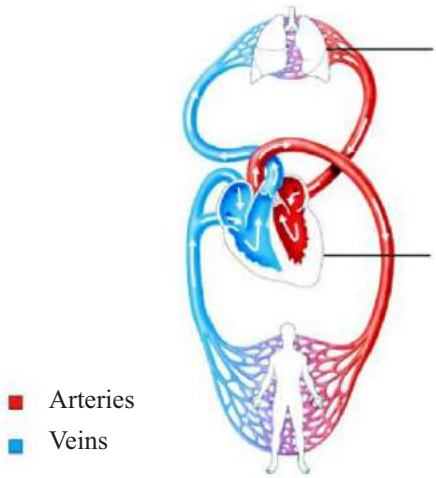


Fig. 8.15 Double Circulation System

(d) Blood vessels :

1. **Arteries :** The blood vessels which carry the blood from the heart to various body parts are known as the **arteries**. Their wall is thick and flexible because the blood flows in it under pressure. Normally, pure and oxygenated blood flows in the arteries. However, impure blood flows in the pulmonary artery.
2. **Veins :** The blood vessels which collect blood from various body parts and carry them back to heart are known as the **veins**. Their walls are thin and deflatable. The cavity of the vein is broad because the pressure of blood in it is less. Normally impure and deoxygenated blood flows in it. However, pure and oxygenated blood flows in the pulmonary vein.
3. **Capillaries :** These are the narrow blood vessels which connect the veins and the arteries.

Blood pressure : The pressure is more in arteries as compared to that in the veins. The heart is responsible for the flow of the blood into the arteries. The pressure of the blood in the arteries generated at the time of ventricle contraction is known as the **systolic pressure** and that generated



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immune system in human body. Lymph circulates in the interstices (i.e. the very small intervening spaces) of the body tissue and helps maintain fluid balance in the body. It is made up of lymph capillaries and the primary and secondary lymphoid organs.

8.10 Conduction in Plants :

Food substances are formed in green plants

by photosynthesis. For photosynthesis, the plants get energy from sun light, carbon-di-oxide from the atmosphere and water from soil by means of the roots. Let us study as to how the plants get all these substances? The major organ for photosynthesis is the leaf. So how these substances reach the leaves?

The plants present around us, whether herbs, shrubs or trees, may differ in their habit but their basic body plan is the same. All the flowering plants have root, stem, branches, leaves flowers, fruits and seed.

As compared to the animals, the number of organs in a plant are far less in number. The root, stem and leaves are the vegetative organs of the plant and perform the metabolic functions like photo-synthesis, conduction, food storage etc.

8.10.1 Leaf : The main functions of the leaf are photosynthesis and food storage. They are arranged on branches and stem in such a manner that they all are exposed to sun light. How the leaves perform photosynthesis can be better understood if we have an understanding of the internal structure of a leaf. Living parenchymatous cells are present below the upper epidermis of a leaf. These cells contain a pigment known as the chlorophyll. Intercellular spaces are present in between these cells which are interconnected with each other to facilitate the exchange of gases, like oxygen and carbon-di-oxide and the transpiration i.e. excretion of the water vapour and conduction of gases to all the cells of the leaves.

There is a network of veins in the leaves. The main tissue for conduction, are the xylem and phloem which are present in these veins. This tissue forms a web of tubules for the conduction of food material and water. The xylem and phloem present in the leaves is connected with the xylem and phloem of the stem. The main function of xylem is to carry water and minerals absorbed by the roots to every part of the plant. The phloem performs the function of carrying the organic food material formed in the leaves to all the plant parts including the roots.

Thus the conduction system, made up of xylem and phloem, extends in the entire plant body- from the root upto the leaves - in the form of tubules, which carry the water along with dissolved minerals and the prepared food, respectively.

Generally, minute pores called **stomata** are present on the lower epidermis. It is through these pores that the internal parenchymatous tissue remains in contact with the external environment. The pore is surrounded by two guard cells. These guard cells receive water from the neighbouring cells and become turgid, resulting in the opening of the stomatal pore. Air, carrying carbon-di-oixde, enters the leaf through these open pores. These guard cells lose water and become flaccid resulting in the closing of the stomatal pore.

Thus the main function of stomata is to exchange oxygen and carbon-di-oxide. The second important function performed by the leaf is to remove water from these pores in the form of water vapour.

Transpiration : Emission or removal of water, in the form of water vapour, through the pores present in the aerial green parts of a plant is known as transpiration.

Transpiration can be demonstrated by a simple experiment. We take a potted plant place it on a glass plate and cover it with a polythene. The set up is made air tight by applying vaseline on the tied end of the polythene. After some time water droplets are visible on the inner surface of the polythene. These droplets escape from the stomatal pores in the form of vapour and condense to form water droplets when they come in contact with the cool surface of the polythene.

In the absence of light, when the pores close, the rate of transpiration decreases. If the rate of transpiration increases in proportion to absorption of water from soil, the plant wilts.

The environment around the plant remains moist due to transpiration. it is because of this reason that during summer season we feel the coolness beneath a tree. Transportaion is helpful in the absorption of water from the soil.

8.10.2 Stem : Stem is the main route of conduction of water and mineral salts and the transpiration of food material to various parts of the plant body. Its conducting tissue are in continuity with the conduction tissue of the leaves.

Xylem : Xylem is a complex tissue. It has vessels and tracheid for the conduction of water and the dissoved salts. They are the long, dead cells with thickened cell walls. There are many pits on its cell wall through which water can move from one tracheidial element to another.

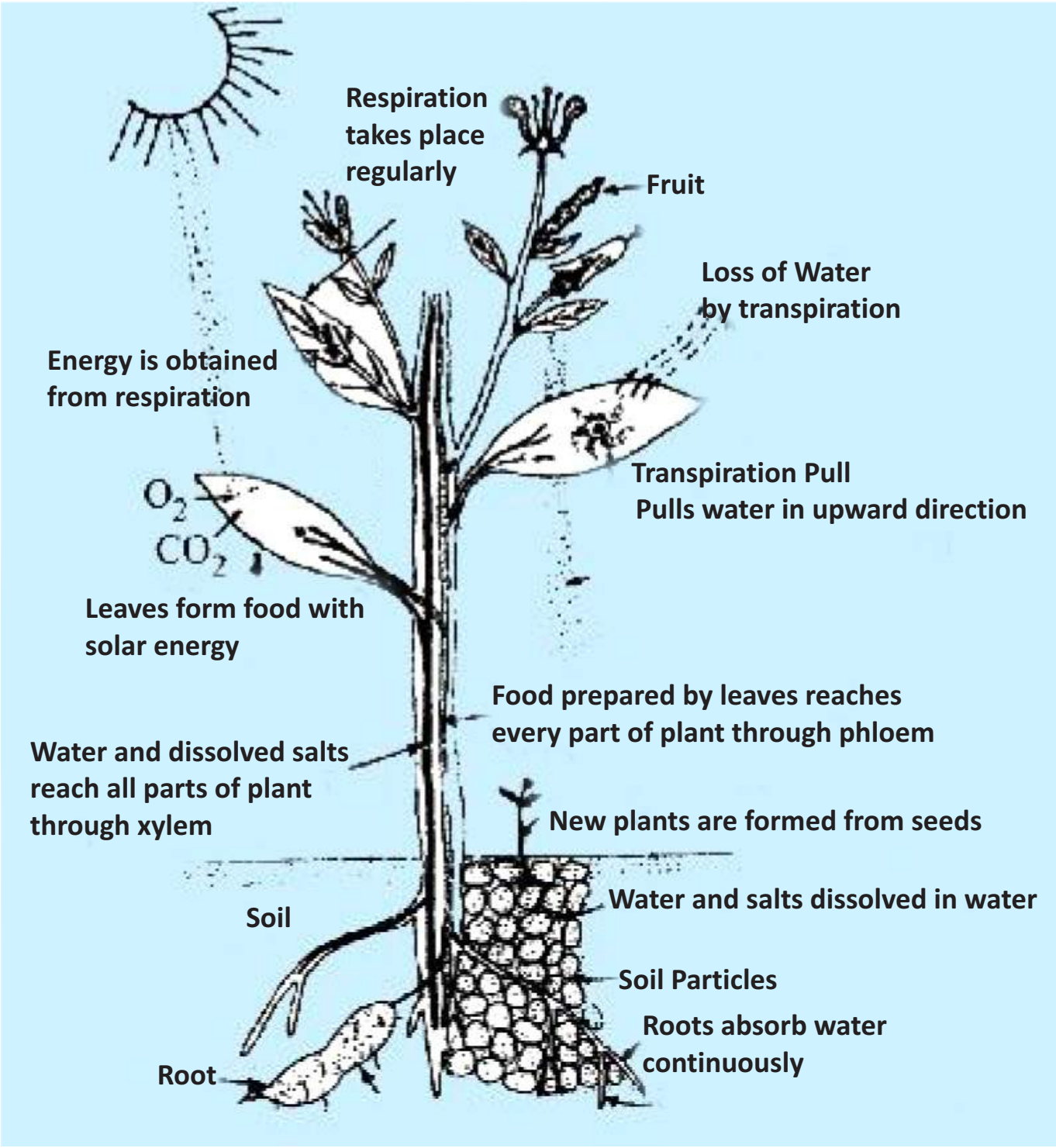


Fig. 8.16 Major organs of a plant and their functions

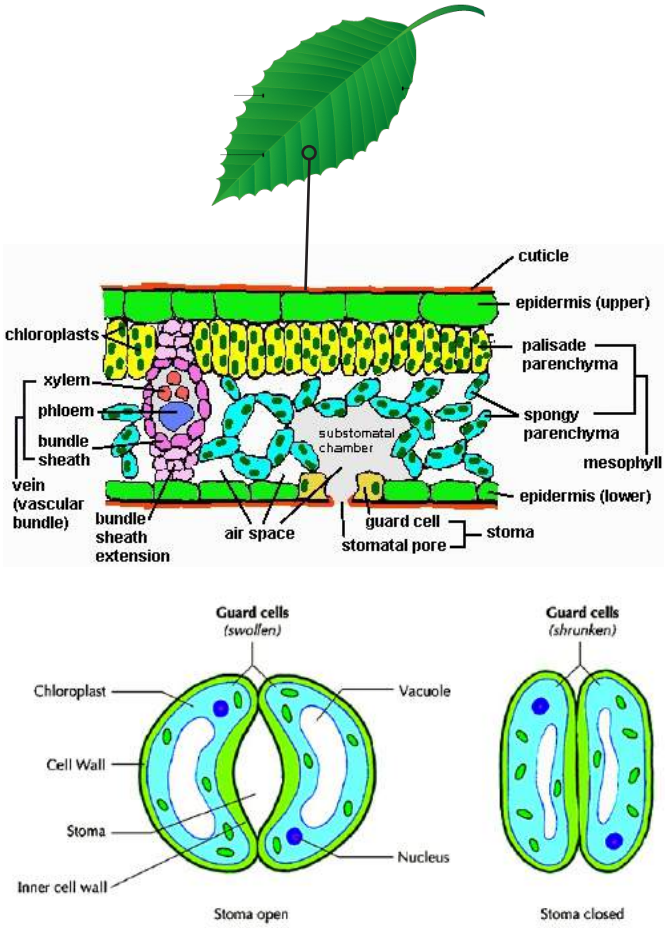


Fig. 8.17 (a) Internal structure of the leaf The green parenchyma perform photosynthesis. See the pores present on the epidermis (b) open pore (c) closed pore

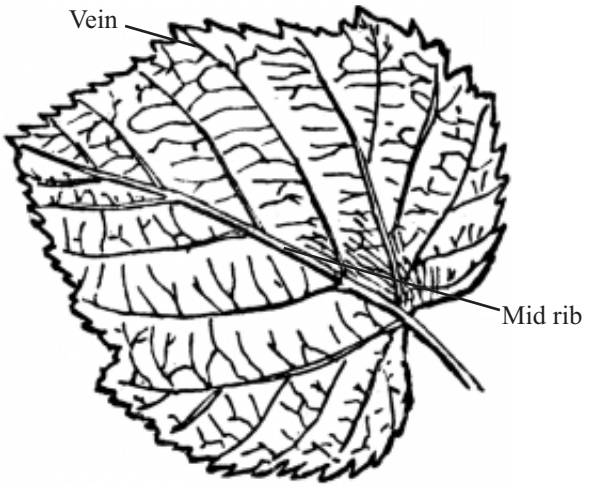


Fig. 8.18 Web of veins in a leaf (Reticulate venation)

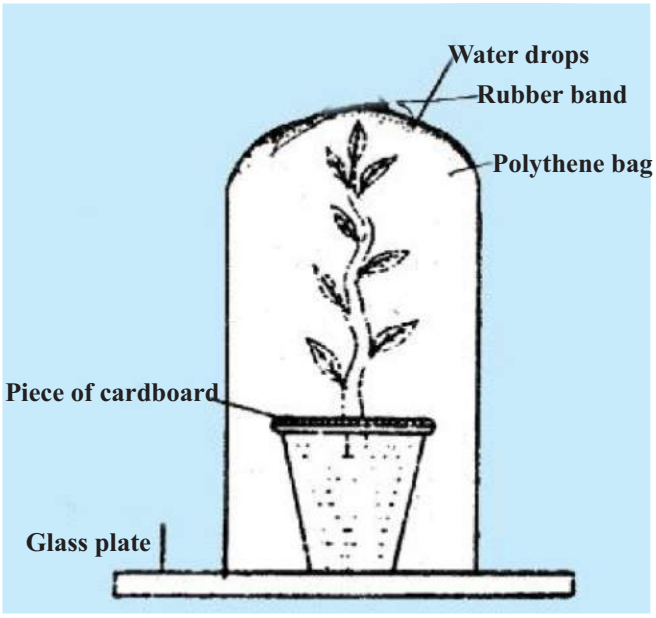


Fig. 8.19 Demonstration of Transpiration

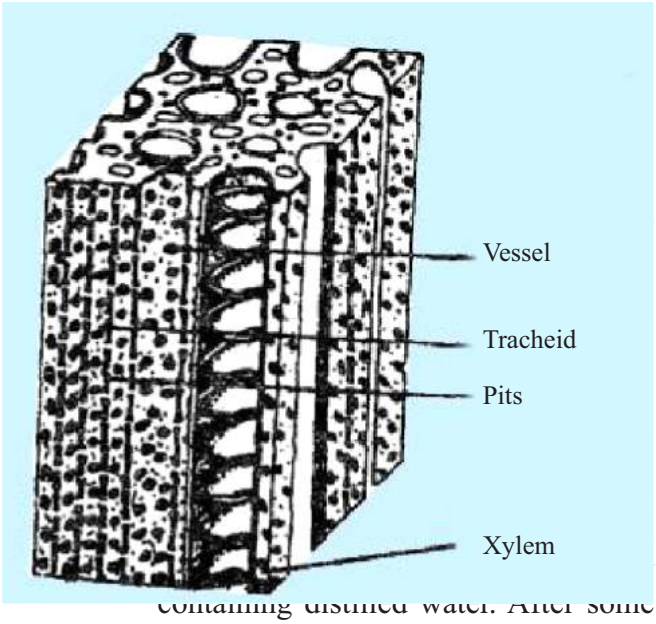
Fig. 8.20 Structure of Xylem

Phloem : The food synthesized during photosynthesis is conducted, in dissovled state, to various parts of the plant body through the phloem. There are specific sieve tubes for the purpose. The fluid food substances are transferred between the sieve elements by the minute pores present on their transverse walls. These cells lack a nucleus.

of water and dissolved minerals from the soil. Therefore the roots grow toward moisture and ground water in the soil.

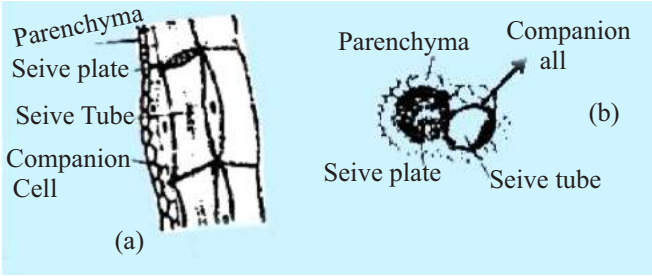
The absorbed water reaches the conducting tissue of the stem and the leaves through the conducting system present in the roots.

We have studied that the liquid food substance formed during photosynthesis reaches various parts of the plant through the phloem. This is possible only when the cell membrane is selectively semipermeable. Substances in the form of solution are absorbed and conducted through the membranes by two processes : (i) Passive absorption and (ii) Active absorption. Many physical processes like diffusion, osmosis, capillarity, imbibition etc. are helpful in passive absorption.



containing distilled water. After some time you will observe that the bag swells.

This happens because the concentration of the water in the beaker is 100% while in the bag the concentration of water is 98% (2% is the sugar and remaining 98% is water). The bag will swell because water from the beaker will diffuse into the bag i.e. from a region of its high concentration to its low concentration. The water fills in the bag as a result of a pressure - the **osmotic pressure**.



Similarly, if we place raisins in a bowl having water, the raisins will swell because of osmosis.

Cell, absorbs water by osmosis. If a plant or animal cell is placed in distilled water, water molecules will enter the cells because the concentration of water in the cell sap is less as compared to the distilled water (in other words, the concentration of cell sap is more than that of the distilled water). This will result in stretching of the cell membrane and at the same time cell wall will exert pressure towards the inner side, in order to regain the original state. This is the wall pressure. Water will move into the cell because of the high osmotic pressure and the cell will continue to swell and will become turgid. Movement of water inside the

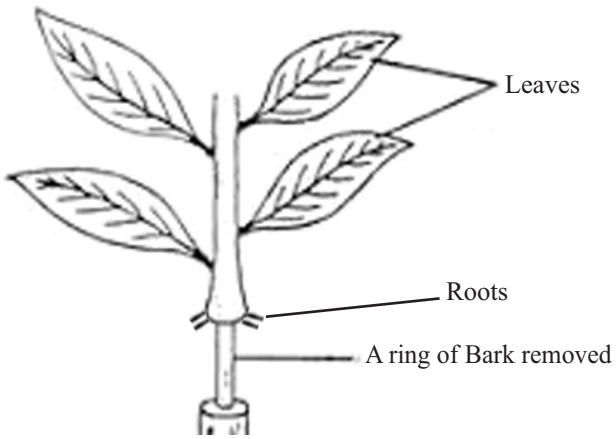
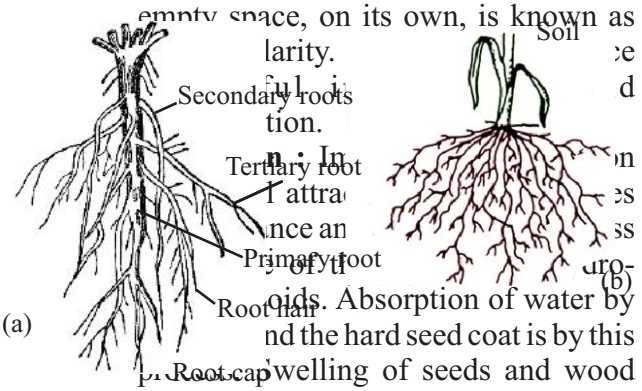


Fig. 8.22 The liquid food is conducted by the phloem

cell by osmosis is known as **endosmosis**.

The fully turgid state of the cell maintains the shape of the cell. The healthy nature of juicy fruits like mango and tomato and fleshy leaves is because of the turgidity of their cells.

(iii) Capillarity : If a thin glass tube is dipped in water from one of its end, water will rise in it for some distance. The tendency of a liquid to enter the empty space, on its own, is known as larity.



ful i tion.

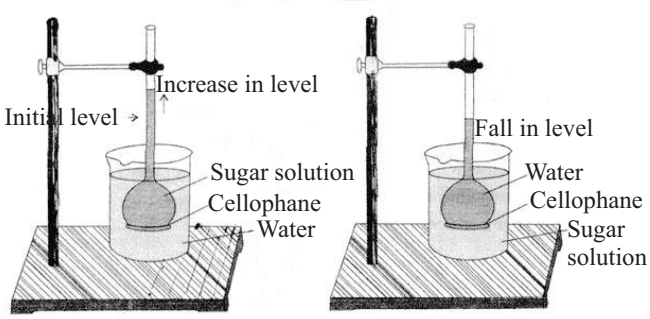
n : In attra nce an y of th oids. Absorption of water by nd the hard seed coat is by this welling of seeds and wood when placed in water are examples of imbibition.

Plasmolysis : Now let us consider a condition in which a cell is placed in a solution having concentration more than that of the cell sap - then what will happen? The water from the cell sap will move out into the external solution and the cell will shrink. The cell wall will shrink only to a particular limit; then after the protoplast will separate from the cell wall and will ultimately appear as a shrunked round or oval mass on one side of the cell. This process of shrinking of the protoplast because of exosmosis is known as **plasmolysis**. **Exosmosis** is the movement of water out of the cell, by osmosis.

Fig. 8.25 Plasmolysis in plant cell

Absorption of water from soil :

In the space (pores) present in between the soil particles, air and water are present. The water present in these spaces is known as the capillary water. The roots of the plants absorb this water. Water is absorbed primarily by the root hair region of the roots. Mineral salts remain dissolved in the



capillary- water of the soil. Hence, it is a dilute solution. The concentration of cell sap is more than the concentration of this solution. Therefore the water from the soil enters the root hair cells by osmosis. The cell sap thus gets diluted as compared to the sap in the nearby cells and water moves to the next cell by osmosis. In this manner a pressure gradient is created from the xylem vessels to the cortical cells and root hairs. The water with the dissolved salts move up regularly from the root hairs to the root xylem because of this gradient.

If the osmotic pressure of root hairs is less than the osmotic pressure of the soil solution, according to the principle of osmosis, exosmosis should occur. Under such circumstances too, the root hair can absorb water. Energy is required for such absorption which is provided by the ATP molecules present in the cell. This type of absorption is known as the **active absorption.**

Fig. 8.26 : Water path from the root hair to the xylem of the roots

Root Pressure : The water from the soil reaches the xylem of the roots due to active water absorption. The cells of the root become turgid because of this water absorption and the water reaching the xylem rises, in the xylem, for some height. This positive pressure that is present in the roots is the **root pressure**. It is an active pressure

which propels water in the xylem of some of the herbaceous plants. It is a vital process.

Fig. 8.27 Demonstration of root pressure

We will perform a simple experiment to understand root pressure. We will take a potted healthy plant and will cut the stem 7-8 cm above the soil, transversely. Now we will connect a glass tube to this cut end with the help of a rubber tube. Fill some water in the glass tube and mark the water level on it. The experimental set up is made air tight with the help of wax. We will observe that after some time the water level in the glass tube starts increasing. This is because of the root pressure.

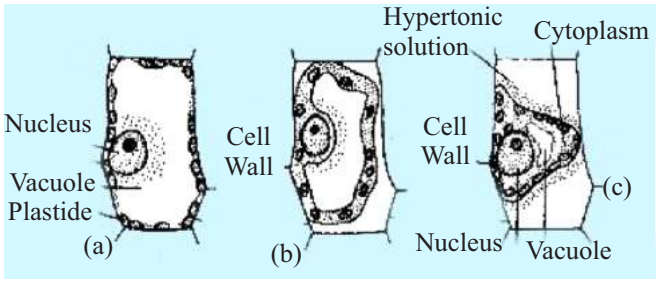
Root pressure is not enough to take up the water upto the leaves of 300 meter tall trees or trees taller than that. Now the question arises as to how the water reaches the leaves of these tall trees. This can be understood by the transpiration - cohesion tension theory.

Transpiration- Cohesion-Tension theory:

It is based on three main factors (1) Water is present in the xylem vessels in the form of a continuous regular column (2) The continuity of the column is maintained because of the strong force of attraction due to cohesion of the water molecules (3) the upper end of this water column is gradually removed to the atmosphere through leaves by transpiration. This exerts a pull or tension on the water column from the upper side and results in the upward movement of water molecules in this column.

8.11 Excretion :

The mechanism of eliminating waste and



toxic materials in living beings is known as excretion. The organs which participate in this excretory process are known as the excretory organs.

8.11.1 Need for excretion : Metabolic activity is observed in all the organisms. It may be catabolic or anabolic activity. Many waste products like urea, uric acid and ammonia are formed in the chemical reactions taking place during metabolism, which are harmful for the body. Excretion is essential for the removal of waste products formed during the protein metabolism in the body.

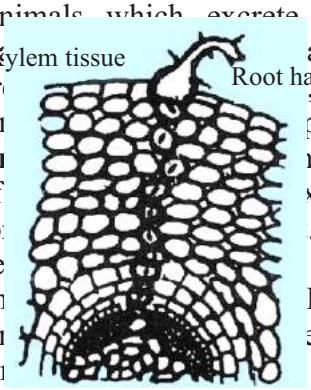
8.11.2 Excretion in animals :

On the basis of the nitrogenous excretory substance present in the urine, animals are of three types :

(1) Aminotelic : Some animals like *Unio*, Star-fish, *Pila* etc. excrete amino acid, directly.

(2) Ammonotelic : Ammonia is produced as a waste product during amino-acid metabolism. Ammonia is soluble and diffusable in water. The animals which secrete ammonia are known as Ammonotelic.

(3) Ureotelic : A waste product, urea, is formed in the liver by protein metabolism which dissolves in water. Animals which excrete nitrogenous w are known as ur , Fish, Snail, A otiles.



(4) U ed as a result of xcreted in the fo . Uric acid is ge animals are kn Examples : A environment, bi

Excretion in Amoeba :

Excretory organs are not present in amoeba

as it is a unicellular organism. Excretion of waste substances is by diffusion. Contractile vacuoles are present in amoeba, through which waste products are removed from the body.

Excretion in Hydra :

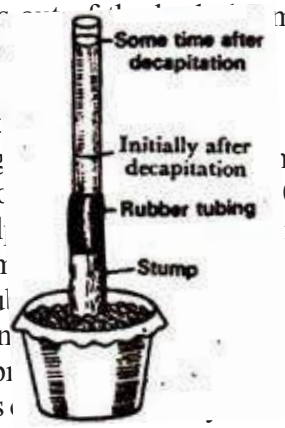
No excretory organ is present in Hydra. Ammonia and gases are excreted by diffusion.

Excretion in Earthworm :

In earthworm excretory process is carried by nephridia present in the body cavity. They excrete waste product[illegible] means of pores that open o[illegible] substance of earthworm is a[illegible]

Excret[illegible]

Malpig[illegible] nain excretory organs in cc[illegible] 0-90, yellow threadlike Mal[illegible] n the posterior part of the alin[illegible] ubules receive nitrogenous su[illegible] which reaches the proctodeun[illegible] these tubules. These waste pr[illegible])ved from the body by means [illegible]



Excretion in Humans :

The excretory organs in human are - skin, liver, spleen, intestine, lungs, kidney etc. Sweat glands are present in the skin which expel water and urea. Kidney is the main excretory organ.

Fig. 8.28 Excretory System in Human

The main organs of the excretory system in humans are : (1) Kidney (2) Ureter (3) Urinary bladder

(1) Kidney : A pair of kidney is present in mammals. They are red in color and their shape is like a bean seed. They are situated below the diaphragm on each side of the vertebral column. Each kidney is 4-5 inch long, 2 inch broad and weighs about 140-150 grams.

Fig. 8.29 Internal Structure of Kidney

It is protected by lipid layers on all sides. The outer part of the kidney is the cortex and the inner part is the medula. Numerous thin tubules are present in the kidney which are known as Uriniferous tubules or **nephrons**. The two main parts of a nephron are Bowman's Capsule and the secretory portion. The secretory portion starts from behind the Bowman's capsule and has three parts (1) proximal convoluted tubule (2) Henle's loop (3) distal convoluted tubule.

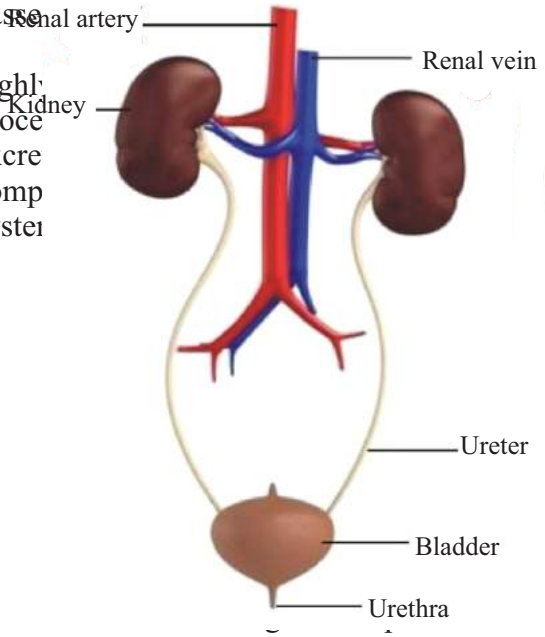
(2) Ureter : In each kidney a tube arises from the pelvis region and forms the ureter. It carries urine from the kidney to the urinary bladder.

(3) Urinary bladder : The sac like structure in the peritoneal cavity of human, present at the base of the pelvis

is the urinary bladder. Its outer covering is known as the peritoneum and it opens out by a tube called the urethra. Urethra opens out of the body by a pore or orfice.

Urine Excretion :

Urea is formed in liver. The impure blood from the liver reaches the kidney through the renal artery. The renal artery subdivides into numerous capillaries and provide blood to the glomerulus situated in the Bowman's capsule. The afferent arteriole supplies blood to the glomerulus while the efferent arteriole takes away the blood from glomerulus. The blood pressure in the glomerulus increases because the diameter of the afferent arteride is greater than that of the efferent arteriole. Because of this pressure generated, the water, glucose, urea, uric acid and some salts are released in the Bowman's capsule by Ultra filteration of blood from the afferent arterioles. Thus, fluid then enters the secretory substances. This fluid then enters the secretory portion of the nephron where, water, glucose and other useful salts are reabsorbed. The remaining fluid contains the waste products and is known as the **urine**. This urine ultimately enters the ureter which then opens into the urinary bladder. Urine collects in the urinary bladder which is then passe



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during protein metabolism in plants are used for the synthesis of novo-proteins.

4. The metabolism of plants mainly depends on the carbohydrates. The end products produced by carbohydrate metabolism are less toxic and harmful than the products of protein metabolism. Therefore the need of excretion in plants is very less than that in animals. Yet, excretion of certain metabolic waste products formed in plants or their storage, in a harmless form, is essential.
5. In aquatic plants some waste products diffuse out in the aquatic environment

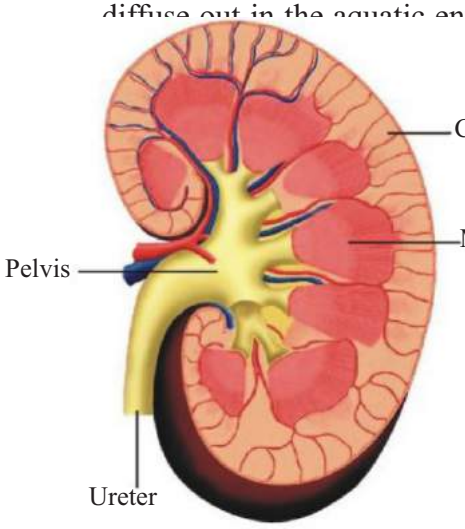

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Fig. 8.31 Structure of a lenticel

8. Many waste products are present in the vacuole in a dissolved form. These substances may be useless for the plants but they are very useful for us. They are used in many medicines. Even gum is a waste product.
9. Some of the useless substances are stored in the dead cells of the leaves or in the woody cells of the stem in the form of solid crystals. Mostly, these crystals are of calcium carbonate and calcium oxalate.

Guttation :

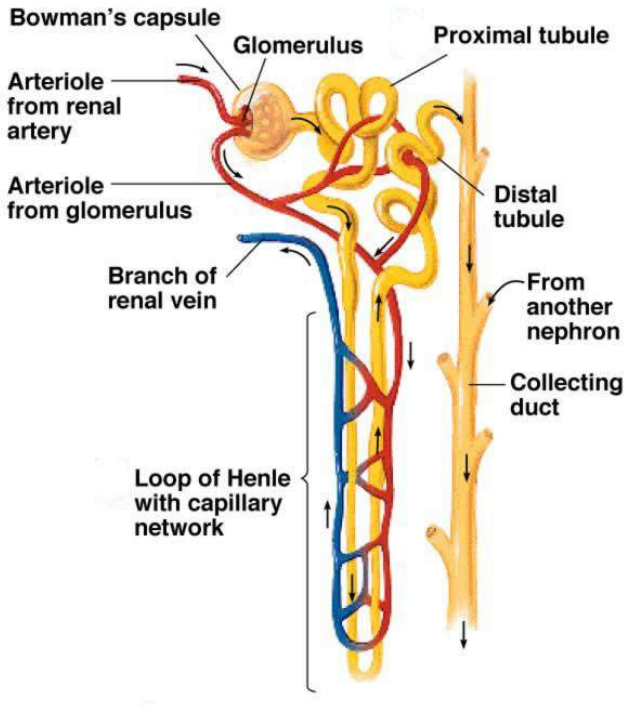


Fig. 8.30 Ultrafilteration in Kidney

If you stand beneath a peepal tree, early in the morning, you will feel minute water droplets falling on you. This is the water released by the leaves of this tree. Similar is the case with tomato, grass etc. where water oozes out at the margins or the apex of leaves, in the form of droplets. The exudation of water droplets, from leaves, is known as guttation. These plants have special pores, the **hydathodes**, for guttation. They are present at the end of veins of the leaves. Each minute pore opens in a small cavity which is lined by thin walled, soft parenchymatous cells.

Guttation is maximum in the state of more absorption and less transpiration. The water droplets contain some dissolved waste substances which deposit as a crust around the pores, on getting dry.

8.12 Reproduction :

8.12.1 Meaning and need : You must have seen numerous saplings beneath various trees and plants, like neem, babool etc., during rainy season. Similarly, you must also have observed babies of various birds like sparrow, pigeon, hen etc. which come out of the eggs. All these living beings gradually develop into adults. On attaining maturity, even they produce off-spring of their own type. Thus a continuity of the various species, is maintained in this universe.

The process of reproduction can be of two types :

(i) Asexual reproduction
(ii) Sexual reproduction

Asexual reproduction : Living beings originate from living beings. If the off-spring originate from one cell obtained from one parent only or from some specific vegetative structure, then this type of reproduction is known as the asexual reproduction.

Sexual reproduction : This process is accomplished by the male and female reproductive organs. Zygote is formed by the fusion of gametes produced by the male and female reproductive organs. The living being originates from the development of this zygote. This is known as the sexual reproduction.

The new organism formed by the fusion of two different gametes have variations which form the basis of evolution. From evolutionary point of view, sexual reproduction is more meaningful.

8.12.2 Reproduction in Animals : Reproduction is a natural characteristics of animals. All the living beings maintain their species in nature by means of this process. This production of off springs is known as **reproduction**. The number of animals increase by reproduction. In animals, reproduction is of two types :

(1) Asexual reproduction
(2) Sexual reproduction

1. **Asexual reproduction :** If the off-spring originates from cell obtained from done parent only or from any part of the biological body or from a vegetative organ, then this type of reproduction is called asexual reproduction. In this type of reproduction, male and female gametes are not formed. Asexual reproduction is of many types in invertebrate animals :
   (i) Binary fission : In unicellular organisms, similar organisms originate from cell division or fragmentation. In this, the animal divides into two similar types by

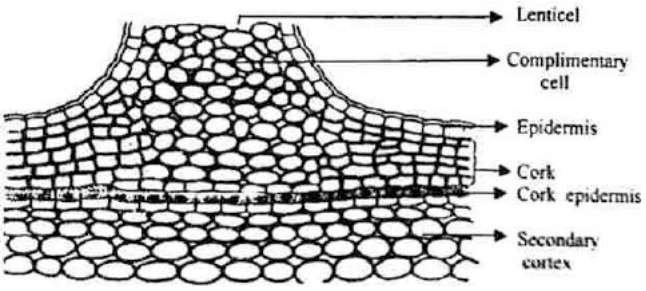


Fig. 8.32 Hydathodes

(Euglena) (c) lateral (Paramecium)

(ii) Multiple fission : Prior to this type of division, the nucleus of the individual divides many times resulting in the formation of many daughter nuclei. Later on the cytoplasm divides. New generation is obtained by the accumulation of cytoplasm around each individual nuclei. Thus the individuals of next generation are produced from the parent. Example : *Plasmodium* etc.

Fig. 8.33 : Different types of Binary fission in animals of the division protozoa - (a) Irregular (Amoeba) (b) longitudinal

Fig. 8.34 : Multiple fission in Plasmodium

(iii) Regeneration : In some animals, there exists a remarkable capability of forming new organisms, of their type, by division of their vegetative parts. The animal divides into some fragments and each fragment then gives rise to an individual. Process of reorganization of the organism is known as regeneration. Example : *Planeria*, *Hydra*, Star-fish etc.

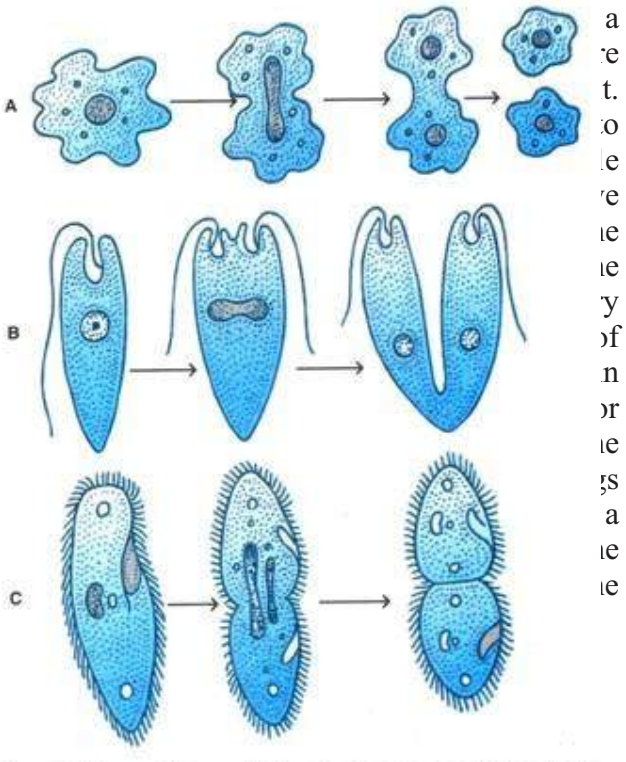
(iv) Budding : In some animals there exist cells having the capacity to reproduce a bud on the animal body i.e. an outgrowth, which develops into an individual. The new organism, thus formed, seperate from the parent organism only when mature. This method is known as budding. Example : Hydra

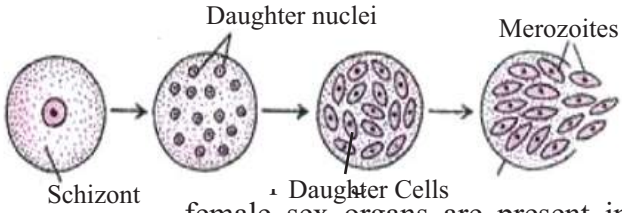
Fig. 8.36 : Budding in Hydra

2. **Sexual reproduction :** In this type of reproduction, there is participation of two individuals for the production of new generation. Production of a new organism, similar to the parents, by fusion of male and female gametes (sperm and egg) in known as sexual reproduction. Sexual reproduction takes place in higher invertebrates and vertebrates.

   (i) Sexual reproduction in Hydra : The male and female organs, testes and ovary respectively, are formed on the body of Hydra in the form of swellings. Zygote is produced by the fusion of male and female gametes. This zygote then develops to form hydra.

(ii) Sexual reproduction in





female sex organs are present in two separate individuals. The male reproductive cell is known as the male gamete or sperm, which is motile. The reproductive cell, present in female is known as the female gamete or the ovum, which is bigger than the male gamete and is non-motile.

The human reproductive system is more advanced than that of other evolved organisms. It is activated at a particular age, which is known as the puberty. In boys, puberty is at the age of 13-14 years while in girls it is at the age of 10-12 years. Human reproductive system can be studied in two parts :

(a) Male reproductive system : The organs that produce the

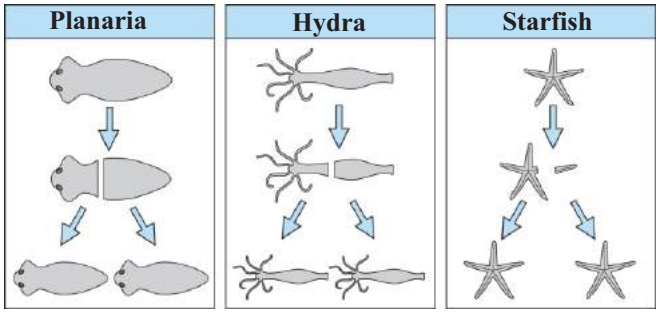
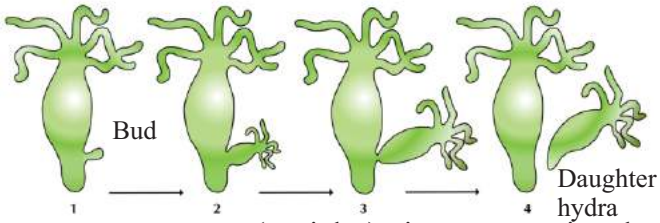


Fig. 8.35 Regeneration in various organisms

reproductive cells and the organs which carry them to the site of fertilization of the reproductive cells, together forms the male reproductive



(testicles) is present in the scrotum situated outside the abdominal cavity. This is because sperm-development requires a lower temperature than that of the body. Testes is made up of numerous seminiferous tubules. These coiled structures open into the epididymis. The distal end of the epididymis opens in the vas deferens which stores and nourishes mature sperms and move them to the ejaculatory duct. The ejaculatory duct connects the vas deferens to the urinary tract (urethra). The urethra is surrounded by a muscular organ, the penis and opens out by means of a pore. Both urine and the seminal fluid are passed out from this common opening. The prostate glands situated near vas deference secrete a milky fluid. Testosterone regulates the formation of sperms and the sexual characters visible during adulthood among boys. The motile sperms mainly comprise of the genetic material and a long tail which helps the sperm to swim upto the female gamete.

Fig. 8.38 : Male reproductive system in humans

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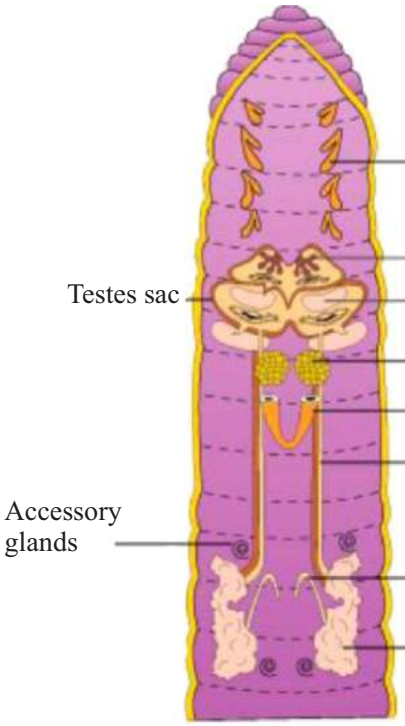


ovary is a funnel shaped structure which opens into the fallopian tube. The fallopian tubes of both sides join together to form a bag like structure the uterus. The uterus leads to the vagina via a cervix.

During mating sperms reach the fallopian tubes through the vagina and fertilizes the egg. The fertilized egg then establishes in the uterus and gradually develops into an embryo. A cord like structure, the placenta, is responsible for the nourishment of and excretion from the developing embryo. The female hormones, progesterone and oestrogen are responsible for the sexual symptoms of the female body.

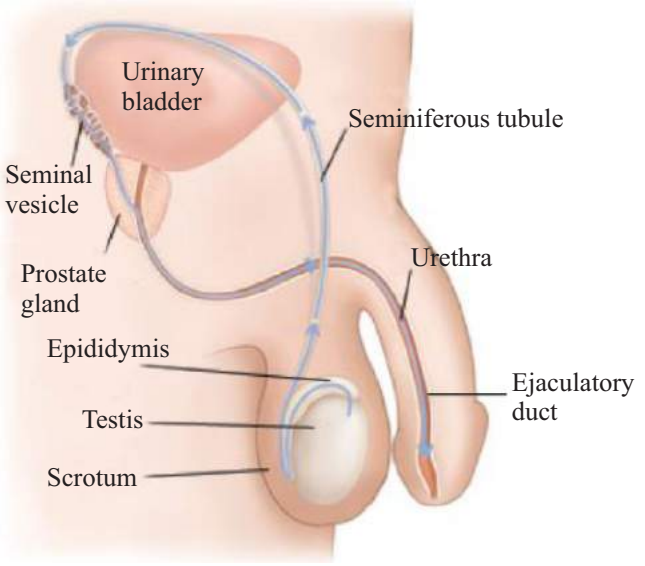


Fig. 8.39 Female reproductive system in Human beings

In the mammalian females there are two types of ovarian cycles :

(i) Menstrual cycle : If not fertilized, the egg cell remains alive only for a day, after ovulation. Then after, the internal wall of the uterus along with the blood vessels break down and passes out in the form of blood flow which is known as menstruation. It lasts for a duration of 4-7 days. In women, it is a regular process which occurs after a gap of 28-30 days. This is known as the menstrual cycle. The initialization of menstrual cycle at the time of puberty in females is known as menarche which indicates the beginning of the reproductive phase in women.

(ii) Estrous cycle : In most mammals, the reproductive period is in a particular season which is known as the estrous cycle or the reproductive phase. During the reproductive phase, after ovulation there is an intense desire for mating, in females and they reproduce , i.e. produce off-spring. This cycle occurs in all the female mammals like dogs, cat, cow etc.

8.12.3 Reproduction in plants : In plants, reproduction takes place by both asexual and sexual methods. Following are the major methods of reproduction in plants.

Asexual Reproduction in plants : In this method, a new plant develop from the cells obtained from only one parent or from some special vegetative structures. Following are the commonly occurring methods of asexual reproduction in plants:

(a) Budding : Asexual reproduction in yeast, which is used for bread formation, takes place by budding. In this method a small spherical outgrowth develops from the surface of the yeast cell. This is known as the bud. Now the nucleus present in the cell divides by mitosis to form two daughter nuclei. One of these nuclei moves to the bud while the other remains in the parent cell. After some time the bud takes the form of a mature cell and separates from the parent cell to form a new yeast.

Fig. 8.40 Budding in Yeast

Sometimes in a yeast cell many buds

develop one above the other forming a chain of buds. Thus, the asexual reproduction by budding occurs.

(b) Sporogenesis : This is the most common method of asexual reproduction in fungi. In this method a structure - the sporangium - develops in the mycelia. The nucleus of the sporangium divides many times resulting in the formation of numerous

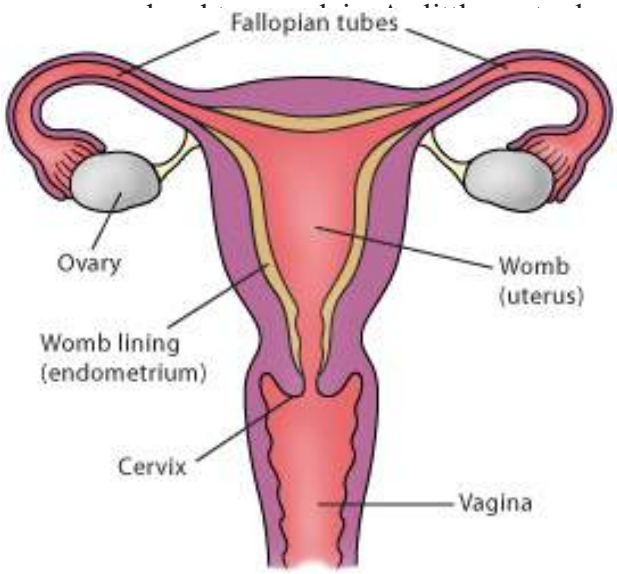


Fig. 8.41 Sporogenesis in Rhizopus

Vegetative Reproduction :

You must have observed plants like wheat jau, gram, bajra etc. developing from the germinating seeds. Have you observed seed production in plants like banana, rose, sugar-cane etc.? You will observe that seed production does not occur in them because of various reasons. However their vegetative parts have reproductive capability. New plants develop from the roots of banana; rose, mogra stem; and bryophyllum leaves. Dormant buds are present on the roots of sweet-potato and on potato tuber which develops into new plant by vegetative propagation. Thus development of new plants, from the vegetative organs of the plant, like - root stem or leaves, is known as vegetative propagation (The word 'asexual reproduction is not used in case of higher plants). In lower plants like *Spirogyra*, *Oscillatoria* etc. vegetative reproduction is by fragmentation.

Making use of the vegetatively reproducing capabilities of various plants, human beings have developed some methods of vegetative propagation for developing multiple plants at a fast rate, in lesser time, without any change in characteristics of plants of improved varieties having desired characters. Using these methods we can make our home, fields and gardens more ornamental and economically beneficial. These are the artificial vegetative propagation methods.

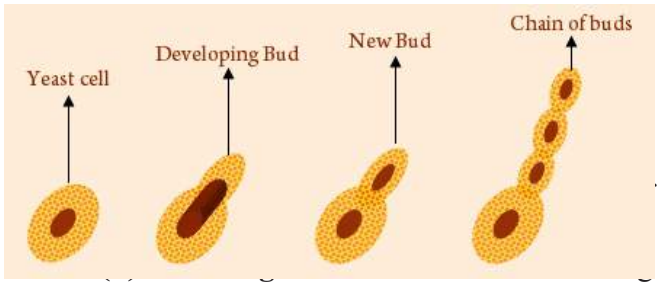


Fig. 8.42 : Vegetative reproduction by leaf

Artificial Vegetative reproduction : Following are the methods of vegetative reproduction developed by man :

(a) Cutting : A healthy, completely developed part of the root, stem or leaf

two plants together, is known as bud grafting or grafting. In this method the stem of two different plants is joined in

such a manner that they combine together in the form of a single plant.

Fig. 8.43 Method of Grafting

The plant with well developed root system is known as the stock and the plant stem having better quality characters which is to be established on this root system is known as the scion. A healthy branch of the stock and a scion of similar diameter is cut and the scion is tied to the stock in such a manner that their vascular region are in contact with each other. Within a few days the tissues of the stock and scion combine with each other and develop in the form of a single plant.

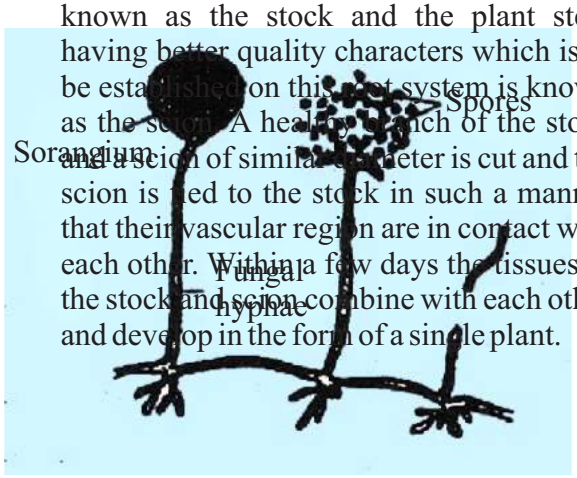


Fig. 8.44 Different stages of grafting : (a) prepared scion (b) rooted stock (c) Scion inserted in the stock (d) Graft showing growth.

Different varieties can be grafted on a single stock. This method is widely used to improve the varieties of various flowering and fruiting trees. Example : lemon, orange etc.

(c) Layering : This is the suitable method of vegetative reproduction in plants having long flexible branches, like mogra, litchi, pomegranate etc. In this method, rooting is done before separating the branch from the parent plant. In this method, rooting, on the branches, is done by two methods :

(1) Mound (stool) layering method : This is the simple method of layering in which branch is bent and buried or the soil is mounded over to the lower new branches on the stem. The soil is kept moist by watering at an interval of 2-4 days. In about 15-20 days, roots originate from the buried parts of the stem. Now, it is separated from the

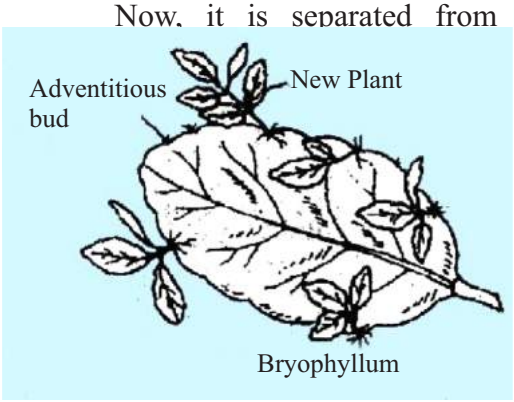
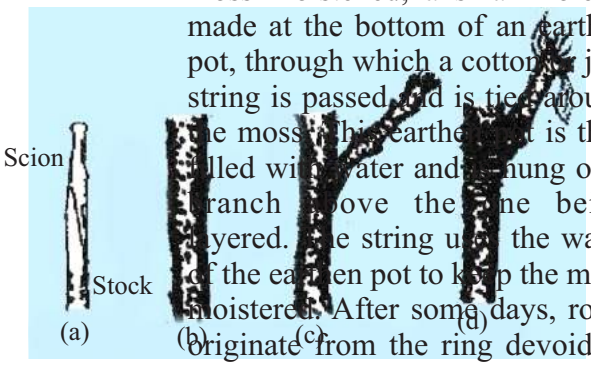


Fig. 8.45 : Technique of Layering

(2) Air layering of 'gutti-method' : The branches in woody trees like pomegranate, litchi etc. are very high from the soil. For layering in such plants, a groove is made by removing a ring of the bark of 1-2 year old branch, using a sharp knife. Moist moss is then tied around this groove using a piece of

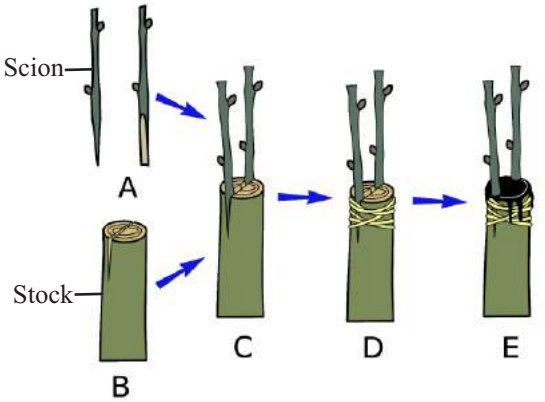
jute or a polythene. For keeping the moss moistened, a small hole is made at the bottom of an earthen pot, through which a cotton or jute string is passed and is tied around the moss. This earthen pot is then filled with water and hung on a branch above the one being layered. The string uses the water of the earthen pot to keep the moss moistened. After some days, roots originate from the ring devoid of the bark. This branch is then cut apart from the parent plant, below the gutti and thus a new plant is obtained. This method is known as air layering or gutti-method.



Significance of vegetative reproduction :

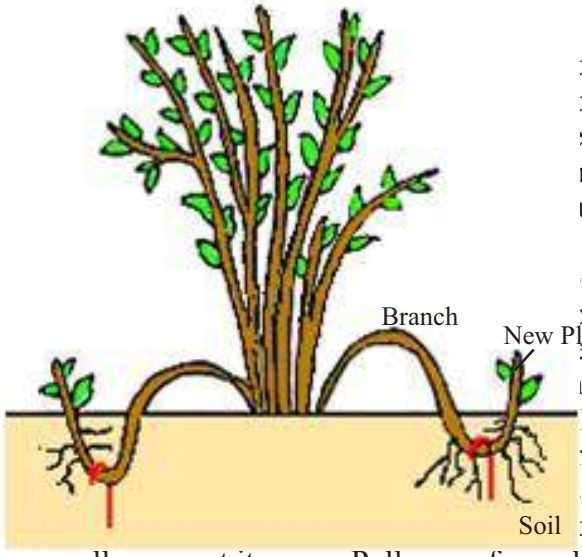
(1) Vegetative reproduction is the only method to maintain the variety of plants like banana, orange, grapes etc. in which either seeds are not formed naturally or the rate of germination is less and to ensure their availability at commercial level.

(2) In many plants which develop from seed, it takes a long time to obtain fruits



maintained from generation to generation whereas variations occur in plants that are developed from the seeds.

Sexual Reproduction in Plants : The flowering plants form the most highly evolved group in the plant world. Flowers bear the sex organs of the plant. In some plants both male and female reproductive parts are borne on the same plant. Such plants are known as bisexual. In others, the male and female reproductive parts are situated on separate plants. They are known as unisexual plants. We can understand sexual reproduction in plants using mustard or datura flowers.



pollen sac, at its apex. Pollen are formed in the pollen sac. Two male gametes are formed in each pollen grain. The carpel is divisible into three part - ovary, style and stigma. The swollen part at the base is the **ovary**, which contains the ovules. In each ovule there is a female gamete- the egg. A long tube-like structure develops from the upper part of the ovary. This is the **style** whose flattened apex is known as the stigma.

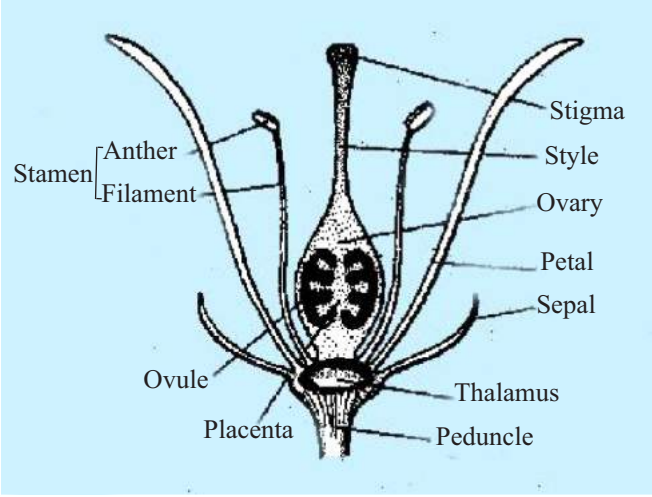
Pollination :

The transfer of pollen grains to the stigma of

the flower of the same species, is known as pollination. The female and the male gametes fuse after pollination. Pollination may take place by insects, air, water or by spontaneous dehiscence. The pollination of a flower by the pollen-grains from the same flower or from another flower situated on the same plant is known as **self-pollination**, while when the pollen-grains of a different flowering plant of the same species pollinate the stigma, it is known as cross pollination.

Fig. 8.47 Fertilisation in flowering plant

Fertilization and embryo development : The pollen grains reach the stigma of a flower by pollination. Here the pollen-grains germinate and forms a tube - **the pollen tube**. This tube enters the stigma and reaches the ovary. In the ovary, it enters the ovule through the micropyle. The two male gametes thus reach the embryo-sac situated in the ovule. Here, one of the male gamete fuses with the egg cell forming the zygote which develops into an embryo. This is true fertilization. The other male gamete fuses with the two polar nuclei, in the embryo sac. This is known as triple fusion. Thus during fertilization in angiosperms, there are two separate fusions within the embryosac - the fusion of the two gametes (egg and male gamete) and the fusion of the three nuclei (one male gamete and two polar nuclei). This is known as **Double fertilization**. After fertilization, ovule develops into the seed and the ovary into a fruit. Thus the sexual reproduction is accomplished in a flower.



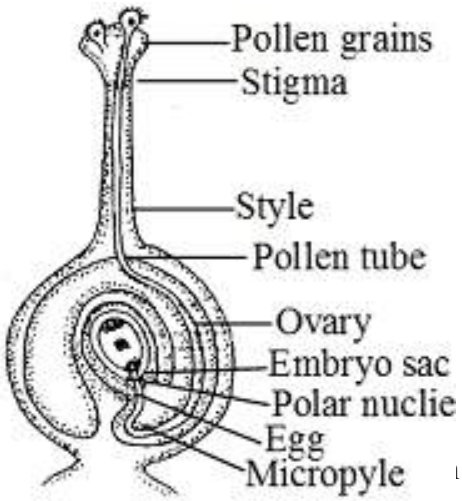
8.13 Regulation :

8.13.1 Sensitivity : Animals exhibit response to its environment and also to the changes in the environment. This process is known as sensitivity. All the living beings whether amoeba or human beings, exhibit sensitivity. In all of them the mode of responding may differ. If we prick a needle to the pseudopodia of amoeba, it retracts them and forms a ball-like structure. In higher animals the body is regulated by the nervous system and the endocrine system. In non-chordata and other less developed animals sensory cells are present instead of the complete nervous system which show sensitivity towards changes in their environment. The information received by the sensory organs reach the control center-brain, spinal cord, ganglions etc. through the nerves. This is known as the conduction of the impulse. These impulses are analyzed by the control centers and the reaction is carried to the affected organ or sense organ, accordingly. In animals the function of regulation is performed by the nerves at a fast pace.

8.13.2 Nervous system : The function of control and co-ordination of sensations in animals, is performed by the nerves and the muscle tissue. Every organism lives

normally in its environment and reacts to any sudden change in situations, like touching to a hot substance, pricking of a nail in the foot, touching of a person etc., by means of the nervous system.

The nervous system is made up of many nerve cells or neurons. There are three parts of a nerve cell - Cell body, axon and dendrite.

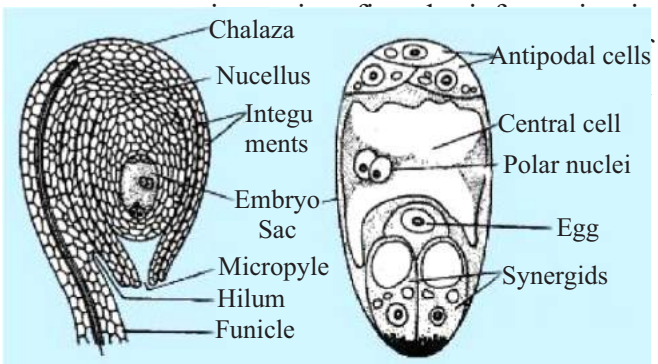


the nucleus, other organelles, Nissl body and neurofibrils are present in this part of the neuron.

(ii) Axon : A long cylindrical projection is present on one side of the cell body which is known as the axon. Cytoplasm is present in axon. It is covered with a layer of lipid which is known as the myelin sheath. It is an insulating sheath. There are many branches on the other end of the axon which terminates into button-shaped structures.

(iii) Dendrites : Many branched dendrite are present on the cell body which spread in all directions except in the direction of the axon.

An electric impulse is generated by a chemical reaction when information is received from the dendritic end of the neuron. This impulse is carried to the cell body by the dendrites and then it passes through the axon and reaches its other end. At the end of axon some chemicals are released by this electric impulse which travel across the void space or synapses and induces similar impulse in the dendrites of the adjoining neurons. This process



(1) Central Nervous System : In this system the brain and the spinal cord are the control centers.

(a) Brain : This is the most soft and a very important organ of the body. It is present in the cranium region of the skull which covers it and thus protects it from the external shocks. The brain has three main parts - Fore-brain, Mid-brain and Hind-brain. The weight of a normal human brain is 1350 gram and its volume is 1300 cc.

(i) **Fore brain :** This is the center of the main sensations in the brain. Different areas of this part of the brain has centers for hearing, smelling, viewing etc. Various sensory information are received at different points in the forebrain. This part of the brain controls voluntary actions like thought, recognition, memory, contemplation, will power etc. Various body processes like hunger, thirst etc. are also controlled and coordinated by the fore brain.

(ii) Mid brain : The centers of most of the involuntary actions are present in the mid-brain. For example : Watering of mouth on seeing food, contraction of the pupil in

bright light, reflex actions etc.

(iii) Hind-brain : It controls all the involuntary actions of the body like blood-pressure, vomiting, heart beat, digestion, excretion, circulation etc. The regulation of muscular movement of the hands and legs and other body parts is

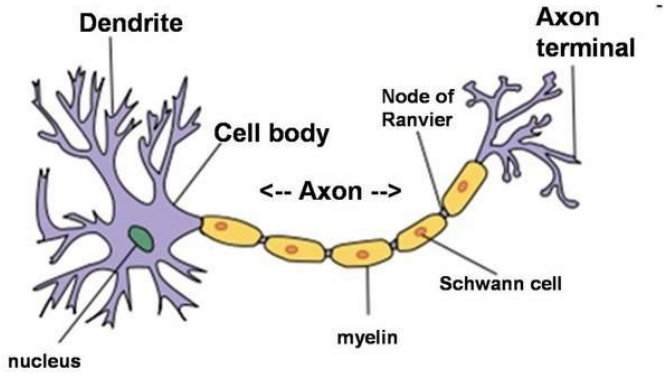


Fig. 8.50 Human Brain

(b) The spinal cord : It is long and cylindrical. It remains protected in our vertebral column. Its anterior end is connected to the medulla oblongata of the brain and the posterior end terminates in the form of a thin thread in the vertebral column. 31 pairs of nerves come out from the spinal cord which are known as the spinal nerves. Its main function is to regulate the reflex actions. In this process it carries the sensations to the brain and then sends back the communications and instructions received from the brain to the affected organs.

(2) Peripheral Nervous System : The various nerves coming out of the central nervous system comprises the peripheral nervous system. It connects the rest of the body with the central nervous system. In humans 12 pairs of cranial nerves come out from the brain which reaches to organs like eyes, nose, ear etc. and regulates them.

(3) Autonomic Nervous System : Various involuntary activities of our body, like the heart beat, peristalsis, digestion etc. are regulated by this nervous system. There are two parts of this system sympathetic nervous system and the parasympathetic nervous system.

Reflex action and reflex arch :

Reflex actions are involuntary i.e. they are not affected by our will power. They are controlled by the spinal cord. There are two roots of every spinal nerve - dorsal root and ventral root. The dorsal root is made up of the sensory nerve filaments. The ventral root is made up of the motor nerve filaments. The sensory cells present in the skin gets excited when a thorn is pricked in the leg. This stimulus from the sensory cells is carried to the dorsal root via the sensory nerves in the form of an impulse. In dorsal root this impulse reaches the gray-matter of the spinal cord. This information is analyzed in the spinal cord and the essential instructions are forwarded to the ventral root via the motor filaments. The motor nerves then carry these instructions to the affected organ, as a result of which we withdraw our leg immediately. The rate of reflex action is very high. In this process the entire path from the sense organ to the muscles of the affected organ is known as the reflex arch. Reflex actions occur very quickly thus protecting the organism from the harmful sensations instantly. The spinal cord controls the reflex action so the brain gets enough opportunity for other important body

functions.

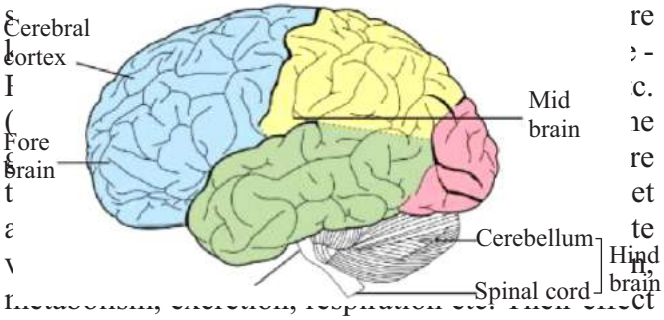


Fig. 8.51 : Diagram of the reflex arch.

8.13.3 Endocrine System : In human body there are ductless glands which directly release their s re l - I c. (ne re t et a te v n, metabolism, excretion, respiration etc. Their effect is very slow and they are secreted in very minute quantity.

Pitutary gland is situated in the fore brain and secretes growth hormones. Pitutary gland is also known as the 'master gland' because it regulates many other endocrine glands of the body. The Pitutary gland is controlled by the hypothalamus. Therefore it is also known as the 'master of master gland'. Imbalance in the growth hormone results in either very tall or a dwarf individual. **Thyroxine** hormone is secreted by the thyroid gland. This gland is present on either of the lateral side of the wind pipe near the voice box, in the anterior part of the lower neck. Unbalanced secretion of hormone (i.e. either too much thyroid hormone or not enough) causes enlargement of the thyroid gland. This is known as **goiter**. The goiter disease appears as a swelling in the neck. Thyroxine hormone is responsible for the proper metabolism of carbohydrates, proteins, fats etc. in our body which is essential for the proper functioning of our body. Iodine is very essential for thyroxine hormone. Iodine deficiency in the body disturbs the balance of thyroxine hormone in the body and this leads to the goiter.

Thymosin hormone is secreted by the thymus gland which is located in the chest. The main function of this hormone is to develop the immune system which enables our body to counter the pathogens. The overactivation of this gland results in enlargement of the tonsils and leads to the disease tonsillitis.

Pancreas are located near the duodenum. **Insulin** hormone is secreted by the pancreatic glands. This hormone regulates the blood sugar. If this hormone is not secreted in proper quantity the blood sugar level increases or decreases which results in a disease named diabetes.

Adrenal gland is located above the kidneys and secrete the hormone **adrenalin**. This hormone is secreted directly into the blood and is then carried by it to the target organs Adrenalin helps the body to face stressful situations. When under stress our heart beat increases which in turn increase the supply of oxygen in our muscles. This enhanced blood supply is managed by decreasing the amount of blood flow in some other organs. Even the rate of respiration increases.

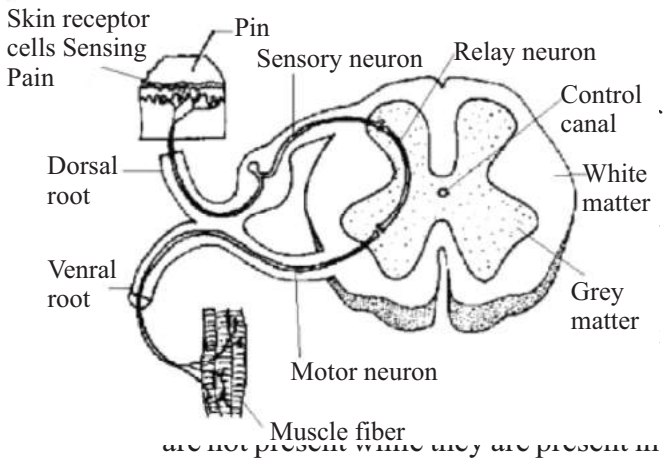
In males, the male reproductive glands are present which secretes **testosterone** at puberty. Testosterone is responsible for the development of the secondary sex characters during adolescence and development of male sex organs before birth.

Female reproductive glands are present in females, which secretes **estrogen**. Estrogen is responsible for the development of secondary sex characters in girls.

8.13.4 Regulation in Plants by Hormones: It is the general belief that the plant growth depends on the minerals present in the soil and the environmental factors. Now, it is a proven fact, that some chemical substances also influence the plant growth. These substances are generally produced in one part of the plant body and are then translocated to other parts where they influence the growth of that part. These chemicals which regulates and control the growth of various plant parts are known as the **plant hormones**.

Uses of plant hormones in agriculture :

Plant hormones are used in agriculture on a



are not present while they are present in animals.

2. In plants there are no specialized tissues for conduction of information but animals do have such tissues.
3. The process of change of shape of cells in plants is entirely different from that of animals.

Famous Indian Scientists :

Biography of Dr. Sir Jagdish Chandra Bose : Dr. Sir Jagdish Chandra Bose was born on 30th November 1858 at a place named Mymensingh in East Bengal (Now Bangladesh). His father, Bhagaban Chandra Bose was a leader of the Brahma-samaj and was the Deputy Magistrate at various places like Faridpur, Vardhaman etc. Sir J.C. Bose received his basic education in a school at his village, upto the age of 11 years. His father had a firm belief that a good knowledge of the mother tongue is essential prior to learning english, so his education started at a Bangla school. Dr. Bose in 1915 quoted at a conference at Vikrampur "In those days, educating children in an english medium school was a status symbol. In the Bangla school, I studied at, on my right hand side sat the son of one of my father's muslim servant while on the left hand side sat the son of a fisherman. They were my playmates. I used to listen to their stories about birds, animals and aquatic animals with interest. Probably these stories induced my interest in research on the composition of nature." After completing the primary education Bose was sent to Calcutta to learn English and got his further education at St. Xavier's school where he graduated in physical science. It was here that Prof. Father Lafont inspired him to study Physics. Jagdish Chandra Bose was very much interested in Biology. At the age of 22 years he went to London to study medical science but because of his bad health he abandoned the thought of becoming a doctor and got admission in the Christ College at Cambridge for his B.Sc. Degree.

He returned to his motherland in 1885 and taught physics at the Presidency College upto 1915. During those days Indian teachers were paid just one third the amount paid to the foreigners. As a protest Jagdish Chandra Bose continued teaching without drawing a single penny as salary for the initial three years. This resulted in the deterioration of his economic conditions, with debts piling high, he even had to sell out his ancetral land. In the fourth year, Jagdish Chandra was ultimately paid full salary from the date he joined the college. Bose was a famous teacher and in the class used scientific demonstrations on a large scale while teaching. Some of Bose's students like Satyendra Nath Bose became famous physicist.

Jagdish Chandra Bose was the first famous scientist of our country who had an indepth knowledge of physics, biology, botany and paleontology. He was a leading scientist who worked on the optics of radio and microwaves.

He conducted many important researches in Botany. It is worth mentioning that he was the first Bhartiya resercher and scientist to obtain an American patent. He is considered to be the 'father of radio science' He wrote science fictions also and is considered to be the 'father of the Bengali science fiction' also.

In November 1894, Bose used microwaves of one millimeter range to ignite dynamite placed at a distance and also to ring a bell, in a public display at Kolkata. In a Bengali essay "Invisible Light" (Adrashya Aalok) that "Invisible light can easily enter brick walls and buildings etc. and hence can be used to communicate messages without the use of wires."

Jagdish Chandra Bose made important contributions in the sphere of Biophysics also. By analyzing the changes in plant cells in different situations he concluded that plants are sensitive and have feelings. They can experience pain and love. Bose invented an instrument named 'Crescograph' and studied the response of plants towards various stimulants.

In 1917 the title of "Knight" was awarded to

Jagdish Chandra Bose and in 1920, Royal Society, London selected him as the Fellow of Royal Society (FRS) for his researches in Physics and Biology. The main point to be noted regarding his researches is that he accomplished everything without any costly apparatus and in a very simple laboratory. He was thinking about establishing a laboratory equipped with various advanced apparatus. The Bose Institute (Bose Science Temple) is the result of his aforesaid thinking. It is a famous center of research in science and is located at Calcutta.

Dr. Jagdish Chandra Bose died on 23 November in 1937 at Giridih (Bengal Presidency). His life and work is a source of inspiration for our youth. The lesson to be learnt from Dr. Bose's biography is that if there is talent and dedication in a person then high quality research can be conducted even in simple laboratory with limited means. The ideal personality and scientific attitude of Dr. Sir Jagdish Chandra Bose will remain a source of inspiration for the youth.

Important Points

1. Xylem and Phloem are found in the veins of leaves.
2. The main function of xylem is conduction of water to every part of the plant and the main function of phloem is to translocate the food material prepared in the leaves to all the parts of plant.
3. Stomata are present on the lower epidermis of a dorsi-ventral leaf. Gaseous exchange takes place through these stomata.
4. Conduction of water and minerals to various parts of a plant is through the stem.
5. Plasmolysis occurs in plant cells.
6. Water moves up in the plant due to transpiration- Cohesion - Tension.
7. The food consumed by animals is broken down into minute simple forms by specific organs, with the help of various digestive juices. The specific organs for the purpose are known as the digestive organs.
8. Stomach digests the food. The hydrochloric acid of the stomach makes the food acidic and kills the accompanying bacteria and other micro organisms.
9. Haemoglobin is the respiratory pigment present in the Red Blood Corpuscles (RBC).
10. The pressure applied against the walls of the blood vessels is known as the blood-pressure.
11. The process of translocating the absorbed nutritive substances, water and waste products from one part of the body to another, is known as circulation. The system related to it is the circulatory system.
12. Male reproductive cells i.e. sperms are produced in the testis. Female reproductive cell, the egg, is formed in the ovary.
13. Asexual reproduction in filamentous algae like *Spirogyra, Oscillatoria* etc. takes place by fragmentation.
14. Dormant buds are present on the roots of sweet potato and potato tuber which produce new plants by vegetative reproduction.
15. Man has developed some methods of vegetative reproduction by using the capability of reproducing vegetatively of various plants. Many plants can be produced by these methods in less time and at a faster rate.
16. The swollen part on the tip of a pedicle is known as the thallamus. The four whorls of a flower - Calyx, Corolla, Androecium and Gynoecium are situated on the thallamus. Androecium and gynoecium are the reproductive whorls and Calyx and Corolla are the accessory whorls of a flower.
17. Waste products are formed as a result of various metabolic processes and the process of removing them from the body is known as excretion.
18. No specific excretory organs are present in the plants because most of the waste products formed are used by the plant itself.
19. Guttation takes place by special pores, the hydathodes.

Questions

Objective type :

1. In plants water condition takes place through :
   (a) Phloem (b) Xylem
   (c) Seive tubes (d) Epidermis
2. The water available in soil for plant use is :
   (a) Hygroscopic water
   (b) Gravitational water

(c) Water obtained from guttation
(d) Capillary water

3. Exchange through stomata, takes place of :
(a) Water vapour and gases
(b) Oxygen and Hydrogen
(c) Oxygen and Carbohydrates
(d) Nitrogen and Water vapour

4. Food material is conducted through :
(a) Xylem (b) Phloem
(c) Stomata (d) Epidermis

5. Repiratory pigment is :
(a) Red Blood Corpuscles
(b) White Blood Corpuscles
(c) Haemoglobin
(d) None of the above

6. The systolic pressure of a normal body is :
(a) 120 nm (b) 90 nm
(c) 140 nm (d) 180 nm

7. Which of the following is not a function of the stomach :
(a) Storage of food
(b) Absorption
(c) Digestion
(d) Complete digestion of fats

8. Main example of fragmentation is :
(a) Spirogyna (b) Bryophyllum
(c) Yeast (d) Amoeba

9. The main method of reproduction in Rhizopus is :
(a) Binary fission (b) Budding
(c) Sporogenesis (d) Multiple fission

10. Ovules are located in :
(a) Ovary (b) Style
(c) Anther (d) Embryosac

11. In plant the metobolic process are mainly based on :
(a) Protein (b) Fats
(c) Carbohydrates (d) Vitamins

12. Hydathodes are present on :
(a) Roots (b) Stem
(c) Leaves (d) Flowers

13. Guttation can be observed when :
(a) Respiration is more
(b) More absorption and less transpiration
(c) Photosynthesis is more
(d) Diffusion is more

14. Ureotolic excretion occurs in :
(a) Amoeba and Frog
(b) Birds and fishes
(c) Fishes and snakes
(d) Man and frog

Very short answer type questions :

1. Excretion in aquatic plants occur by which method?
2. What is the function of the guard cells?
3. What is uricotelic excretion?
4. Name the two main parts of a plant.
5. Which conducting tissue is responsible for conduction of water from the roots to the leaves?
6. What is the function of Phloem?
7. Define plasmolysis.
8. What is respiration?
9. What is Binary fission?
10. What is a Thallamus?
11. Give examples of air-layering technique.
12. What is the need of reproduction in organism?

Short answer type questions :

13. Write the difference between the tap root and the adventitious roots.
14. Differentiate between the xylem and phloem tissue.
15. Define the following terms :
Diffusion, Osmosis, Plasmolysis, endosmosis
16. According to which theory does the water reach the leaves from the roots? Explain it.
17. Describe the functions of stomata.
18. How many types of circulatory systems are present in animals? Explain giving examples.
19. What are the anabolic and catabolic reactions?
20. Why special excretory organs are not present in plant? Explain.
21. What is budding?
22. Explain reflex action with example.

Essay type answer questions :

23. What is guttation? Explain with the help of example.
24. Explain the internal structure of a leaf?
25. Explain Root Pressure with the help of an experiment.
26. Give an illustrated account of the respiratory system in human.

27. Explain the method of grafting.
28. What is double fertilization? Elucidate.
29. Write a note on pollination.
30. Describe the reproductive system of human with the help of welllabelled diagrams.

Answer Keys

1. (b) 2. (d) 3. (a) 4. (b) 5. (c)
6. (a) 7. (d) 8. (a) 9. (c) 10. (a)
11. (c) 12. (c) 13. (b) 14. (d)

Chapter-9

Force and Motion

In this chapter we will study about force and motion. Before proceeding with the study of force and motion we will learn as to how are various physical quantities expressed.

Generally, the physical quantities are expressed by their unit and numeric value. While expressing some physical quantities even the direction is to be mentioned along with the unit and numeric value.

Physical quantities are classified into :

(a) Scalar quantities

(b) Vector quantities

9.1 Scalar and Vector Quantities :

(a) Scalar quantities : The physical quantities which can be expressed by only the magnitude are known as the scalar quantities. Scalar quantities do not specify direction. Mass, time, speed, density, energy, power etc. are the examples of scalar quantities. For example if the mass of a body is 5 kg, then no direction is required to be mentioned for expressing it.

(b) Vector quantities : There are many physical quantities whose magnitude, alone, cannot describe them completely. We can understand this with the help of the following examples.

(1) Fig. 9.1 (a) and (b) shows the distance travelled by a student. The distance AB = 4 meters and distance BC is 3 meters. The distance travelled by the student in both the journeys is 7 meters but the displacement between the starting point A and the end point C is different in the two cases. In the first situation the displacement is of 7 meters where the movement is in the same direction. However, in the second case the displacement is of 5 meters (AC) and its direction is at an angle of θº from AB.

Fig. 9.1 (a) Two displacements in the same direction

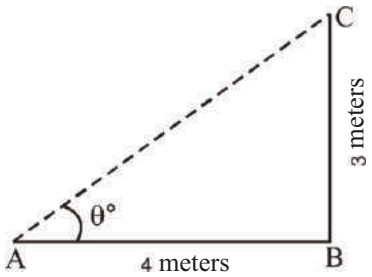


Fig. 9.1 (b) Two perpendicular displacements

(2) Two equal force F are working on a body having mass M, as shown in the fig. 9.2 [The direction of the force applied is shown by the arrows in the figure.

(a) (b)

Fig. 9.2 Forces applied on a body

We can say that the body in 9.2 (a) will remain static on appliccation of the force while in 9.2 (b) the body will move when force is applied.

Thus it is clear from the above examples that the physical quantities like force, displacement etc. are expressed in terms of their magnitude along with the directions.

This type of quantities are known as the vector quantities.

The physical quantities which require magnitude and a direction to be described completely are known as the vector quantities.

Presenting the vector quantities : Vectors are shown with an arrow like line. The length of the line fragment of the arrow is in proportion with the magnitude of the physical quantity while the arrow denotes the direction of the vector.

For example, if we have to depict the velocity of 30m/s in East direction, then we will take an appropriate scale (for example 10m/s=1cm) and will draw a line to the sacle (as shown in fig. 9.3) with the direction of the arrow towards East : Thus the vector QP will display the desired velocity in terms of the magnitude and the direction.

Point Q is the root point (or the tail point) of this vector and the point P is the apex. The vector line fragment from Q to P is denoted as $\overrightarrow{QP}$. [Here the direction of the arrow from Q to P is in the direction of the vector].

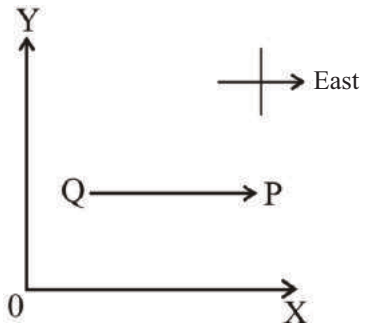


Fig. 9.3 Depiction of Vector

Representation of Vector : Following can be the methods of writing a vector :

(i) The alphabet of the tail is written first followed by that of the head and an arrow is marked on them. For example the above vector is depicted as $\overrightarrow{QP}$.

(ii) The vector can be symbolized by Bold alphabets or with an arrow above the alphabet For example : The vector $\overrightarrow{QP}$ can also be depicted as A or $\vec{A}$, where $\vec{A}=\overrightarrow{QP}$. In books both the methods are used but when writing it down it is always easy to draw an arrow above the alphabet the magnitude of the vector is expressed by the symbol or $|\vec{A}|$ or simple alphabet A. The magnitude of a vector is also known as intensity.

The magnitude of the vector $\vec{A}$ will be $|\vec{A}|$ or A.

Unit Vector :

The unit vector of a vector $\vec{A}$ is the vector whose magnitude is unit and the direction is same as that of the vector A. The unit vector of vector $\vec{A}$ is represented by $\hat{A}$ (Note - $\hat{A}$ s is pronounced as A cap)

It is expressed in the following manner :

$$\vec{A}=|\vec{A}|\hat{A}$$

i.e. $\hat{A}=\dfrac{\vec{A}}{|\vec{A}|}=\dfrac{\text{vector}}{\text{magnitude of the vector}}=\text{unit vector}$

Thus the unit vector can be obtained by dividing the vector with its magnitude.

9.2 Motion :

In our daily life we find some things static and others in a state of motion. The buildings, trees etc. around us are still while the cars on the road, the child walking down or running, the flowing water, flying bird etc. make us realize motion. Many times we are unable to perceive motion directly but it is inferred from the indirect evidence. For example the motion of air is inferred from the movement of leaves and branches.

Motion is a change in position of a body, particle or an object with respect to time. Similarly, no change in position of the object, with the passage of time expresses a static state of the object.

Same thing can be perceived by a person in a state of motion and by another it may be inferred to be static. For example the passengers of a train appears to be in motion to a person standing near the rail line while for a passenger in the train his co-passengers

are not in a state of motion because their relative distance does not change. It is clear from these observations that change in position is a comparative phenomenon. Therefore the state of motion and static state are always in relation to a reference point called the origin point.

Reference Point :

To have a complete knowledge of the position of an object one need to know the displacement of the object from the point of origin (i.e. reference point) and the angle of the reference axis with the line joining the point of origin and the present position of the object. This is known as the direction of motion.

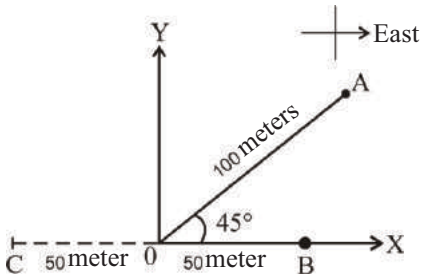


Fig. 9.4 Position in relation to the reference point

In fig. 9.4 the object A is situated at a distance of 10 meters from the reference point O. The angle between OA line and OX axis is of 45º and OX is in East direction. Here the line OA is forming an angle of 45º towards North. Therefore the object A is 100 meter away from the reference point O making an angle of 45º from East to North. Similarly the object B is 50 meters East from the point of reference; object C is 50 meters west of the point of reference. Therefore motion can be comprehensively defined as :

"Continuous change in the position of an object with time, relative to the point of reference is known as the motion of the object."

Motion of the object can be of many types. Some main types are :

(i) Simple linear motion : If the object moves along a simple straight line, it is known as simple linear or rectilinear motion. Example : Movement of a ball in a long straight pipe.

(ii) Circular motion : When a particle or an object moves on a circular path it is known as the circular motion. Example : Movement of a stone tied to a rope which is moved horizontally.

(iii) Oscillatory motion : To and fro motion of an object around a mean position that is repeated at a regular time interval is known as the oscillatory motion. Example : Motion of a pendulum in a clock having pendulum.

Block/Lump or Particle :

Usually while studying motion of objects we consider them to be a mass or a particle. If during movement the object do not break up into pieces it may be effectively visualized as a unit and is called a block or a lump. The entire mass of the block is supposed to be centralized at a point known as the center of mass. When the shape of the object is negligible as compared to the distance travelled by it, it is considered to be a particle. For example the size of a ball in comparison to the distance travelled by it in a field, is considered to be a particle.

9.3 Distance and Displacement :

The distance AB and BC in fig. 9.1 (a) and (b) are 3.0 meter and 4.0 meter respectively. But AC distance is different in both cases. The simple linear distance between the initial and the final position of the object is known as its **displacement**. It is a vector quantity. On the other hand, the distance travelled to reach the final position from the initial position is a scalar quantity. In displacement we mention the direction in which the distance is to be measured. Both distance and displacement are concerned with measure of length. Hence they are expressed in the unit of length. The SI unit (international unit) for both is meter. If the measurement of displacement is expressed without mentioning the direction then it is known as the magnitude of displacement.

In fig. 9.1. (a) the magnitude of the distance covered and the displacement is the same i.e. 7 meters. In fig. 9.1 (b) the distance AB+BC = 7.0

meters while the displacement will be 5 meter (i.e. AC) at an angle of θ^o from AB.

9.4 Speed :

The distance travelled by a moving body in unit time is known as its speed. Generally, objects are in a state of non-uniform motion, therefore, we express it in term of average speed. The average speed is determined by dividing the total distance travelled in a given time interval by the total time taken.

$$\text{Average Speed} = \frac{\text{Distance travelled by the object}}{\text{Time taken to cover the distance}}$$

$$v_{av} = \frac{d}{t}$$

here the object is covering a distance d in time t.

Speed is a scalar quantity. Its unit in SI system is meter/second [m/s]. The speed of vehicles used for travelling is generally expressed in terms of kilometer/hour (km/h).

Example 9.1 : A student covers a distance of 100 km in two hours by his vehicle. Determine the average speed of the student's vehicle.

Solution : $\text{Speed} = \frac{\text{Distance}}{\text{Time}}$

$$= \frac{100 \text{ km}}{2 \text{ h.}}$$

$$= 50 \text{ km/h.}$$

9.5 Velocity :

Along with the speed of a body, it is also essential to know the direction in which it is moving. The distance covered by a body in unit time in a particular direction, is known as its velocity. Velocity is a vector quantity. To determine the velocity the displacement of the body is divided by the time taken for the displacement. If displacement is denoted by s time by t and velocity by v then

$$\text{Velocity} = \frac{\text{Distance (in a particular direction)}}{\text{Time}}$$

$$= \frac{\text{Displacement}}{\text{Time}}$$

$$\vec{v} = \frac{\vec{s}}{t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (9.1)$$

Time t is always positive hence the direction of velocity is always the same as that of the displacement. If in a one dimensional motion the distance towards right hand side from the point of origin is taken as positive and that towards left hand side is taken as negative then if the displacement is positive even velocity will be positive while in case of negative displacement the velocity will be negative. The SI unit of velocity is meter /second (m/s).

If a body covers a distance s in a particular direction in time t with a uniform velocity, then the velocity of the body will be

$$\vec{v} = \frac{\vec{s}}{t}$$

or $\vec{s} = \vec{v} \times t$

If only the magnitude is considered then

$$s = v \times t \qquad \ldots\ldots (9.2)$$

Example 9.2 : A bus is moving in east direction. It covers a distance of 200 km in four hours. Determine the velocity of the bus.

Solution : $= \frac{200 \text{ Km}}{4 \text{ h}}$

Here Distance = 200 km (in east direction)

Time = 4 h

Therefore velocity $= \frac{200 \text{ Km}}{4 \text{ h}}$

= 50 km/h (in east direction)

Hence the velocity of the bus is 50km/h towards east.

9.6 Difference between Speed and Velocity :

Speed is the magnitude of motion. For example if two scooters are moving at a speed of 40km/h in opposite directions then their speed will be similar but their velocity will be different. Speed is a scalar quantity while velocity is a vector quantity.

9.7 Uniform motion :

If an object covers a uniform distance in a uniform time interval then the motion of that object is said to be a uniform motion. For example, suppose we are travelling in a car and we have a wrist watch which can show time to the accuracy of

second. Taking one of the mile-stone on the road as the point of origin, note the time at every consecutive mile-stone.

Suppose our observation comes out to be as under :

Number of milestone (distance in km.)	Time (in second)
Origin mile stone	Zero second
1 km mile stone	100 second
2 km mile stone	200 second
3 km mile stone	300 second
4 km mile stone	400 second
5 km mile stone	500 second

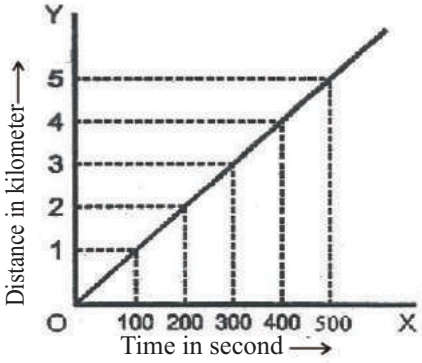


Fig. 9.5 The distance -time graph for a uniform motion

If we draw a graph between the distance travelled by the car and the time taken to cover that distance, for the observations recorded above, then the graph comes out to be a straight line as shown in fig. 9.5. This straight line denotes a uniform motion. The slope of the distance time graph denotes the speed of the body.

The distance - time graph of a journey provides us with some important information about the journey. The slope of the curve informs us about the low or high speed. Fig. 9.6 shows the journey-curve of another car. It is clear from the curve that the car moves with a uniform speed from the origin upto the time t_1 and covers a distance x. The car remains static at that point for the time interval t_1 to t_2 i.e. the car has stopped at point x for the given time interval (t_1 to t_2). Here the slope of the line AB is zero therefore the speed is zero. Then the car moves back from x to the point of origin during the time interval t_2 to t_3. The motion again is a uniform motion; but the slope of BC is more than that of OA- which means that the speed of the car during the return journey was more as compared to the speed while going to x.

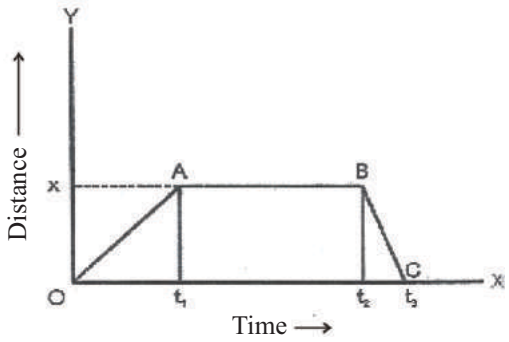


Fig. 9.6 Distance -time graph of the non-uniform velocity

9.8 Non-uniform Motion and Acceleration :

We know that the velocity of a moving car, scooter, cycle etc. does not remain uniform at the time of journey. Usually, the vehicles move with a non-uniform velocity. We all have experienced a journey by train. We know that the velocity of the train between two stations is not uniform. At a railway station, while starting, its velocity increases from zero and then at the next station its velocity again decreases down to zero.

We know that the velocity of a moving car, scooter, cycle etc. does not remain uniform at the time of journey. Usually, the vehicles move with a non-uniform velocity. We all have experienced a journey by train. We know that the velocity of the train between two stations is not uniform. At a railway station, while starting, its velocity increases from zero and then at the next station its velocity again decreases down to zero.

The change in velocity per second is known as acceleration. It is denoted by a. Thus the rate of change of velocity of an object is known as acceleration.

If the initial velocity of an object is u and after time t the velocity is v then the acceleration will be :

$$\text{acceleration} = \frac{\text{Change in velocity}}{\text{time taken for the change}}$$

$$\vec{a} = \frac{\vec{v} - \vec{u}}{t} \qquad \text{..... (9.3)}$$

In case of a motion with uniform acceleration the value of its acceleration and average acceleration will be the same at any given point of time.

The acceleration is positive when there is an increase in velocity and it is negative when the velocity decreases. In case of a simple linear motion the direction of the acceleration will either be in the direction of the velocity or in its opposite direction. Negative acceleration is also known as deceleration. It is clear from equation 9.3 that when a body moves with a uniform velocity, its acceleration will be zero. i.e. when $v = u$; $a = 0$

Unit : The unit of acceleration is obtained by dividing the unit of velocity with that of time.

$$\text{Unit of acceleration} = \frac{\text{Unit of velocity}}{\text{Unit of time}}$$

$$= \frac{\text{m/s}}{\text{s}}$$

$$= \text{m/s}^2$$

Thus the SI unit of acceleration is meter/second^2 (m/s^2).

9.9 Graphical Representation of Motion :

A line graph is used to study velocity. Line graph is used to demonstrate the inter-dependence of two physical quantities. For example for a body in motion a line graph may be used to show the dependence of a physical quantity, like the velocity, acceleration, distance etc. on time.

Velocity time graph :

(i) For a body moving with uniform velocity : The velocity-time graph of an object (cycle, scooter, train, bus etc.) moving with a uniform velocity v is shown in fig. 9.7. Since the velocity remains constant with time hence in the graph the curve appears parallel to the x axis in the form of a simple line.

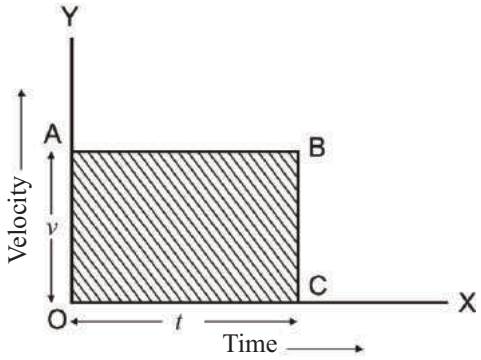


Fig. 9.7 Velocity-time graph

An object moving with constant velocity v covers distance s in time t, then the distance travelled by it can be calculated using formula 9.2

$s = v \times t$

In fig. 9.7 OC on the axis OX denotes time t and OA on axis OY is the velocity V. Therefore the area of the rectangle OABC

$= v \times t$

i.e. on a velocity time graph the value of the distance covered in time t is equal to the value of the area ABCO. In other words, the area between the curve of a velocity-time graph and the X axis denotes the distance travelled in time t.

(ii) For a body moving with uniform acceleration : Fig. 9.8 shows the velocity-time graph of a body moving with uniform acceleration. The equation for the velocity of a body moving with uniform acceleration can be obtained from this velocity-time graph.

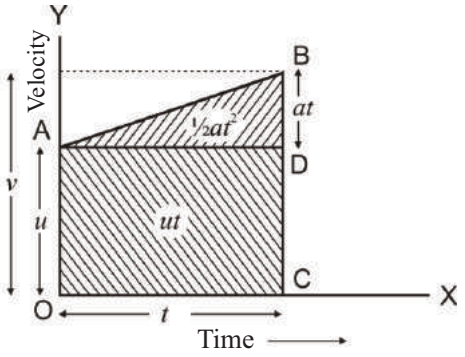


Fig. 9.8 Velocity-time graph of a body moving with uniform acceleration.

In this graph the initial velocity of the body is u which increases to v with time t. If the body would have been moving with a uniform velocity u then the distance travelled by it in time t would be equal to the area of the field AOCD of the graph. Here the velocity is changing because of the accelerated motion of the object. The distance s covered by it in the time interval t will be equal to the area of AOCDB in the graph. The shape AOCDB is a trapezium

Therefore Distance **s** = Area of AOCDB
= Area of the rectangle AOCD +
area of the triangle ADB.

$$= AO \times OC + \frac{1}{2} AD \times BD$$

Here OC and AD are parallel which are equal to u and BD = BC – CD = (v–u)

Therefore distance $s = ut + \frac{1}{2} t(v-u)$...(9.4)

If the uniform acceleration of the body is 'a'

then acceleration $a = \frac{v-u}{t}$

$\therefore \quad v - u = a \times t$

or $v = u + at$ 9.5

On placing the value of (v–u) from equation 9.5 in equation 9.4

$$s = ut + \frac{1}{2} t(at)$$

$$= ut + \frac{1}{2} at^2 \quad \text{..... 9.6}$$

Equation 9.6 shows the relation for determining the distance s covered in time t by a body moving with uniform acceleration.

From equation 9.5 $t = \frac{v-u}{a}$. On placing it in equation 9.6 we get

$$s = u\left[\frac{v-u}{a}\right] + \frac{1}{2} a \left[\frac{v-u}{a}\right]^2$$

On simplifying it

$$s = \frac{uv - u^2}{a} + \frac{v^2 - u^2 - 2uv}{2a}$$

or $2as = v^2 - u^2$

or $v^2 = u^2 - 2as$ 9.7

Equations 9.5, 9.6 and 9.7 are known as the equations for a uniform acceleration motion.

(iii) The velocity time graphs for non-uniform acceleration motion are shown in fig. 9.8 (a) and (b)

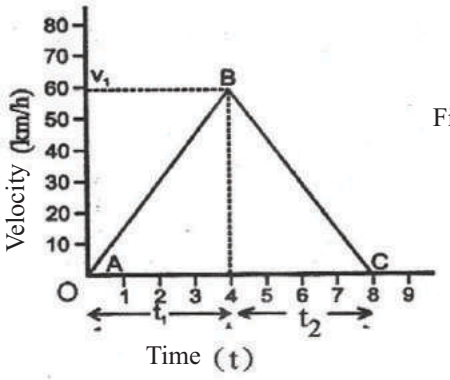


Fig. (a)

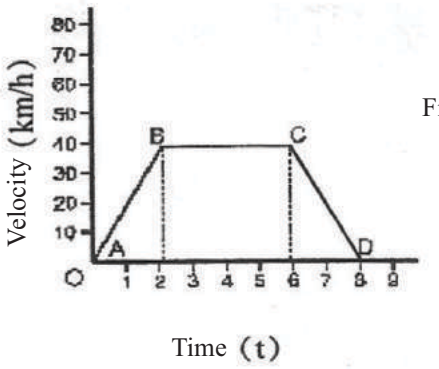


Fig. (b)

Fig. 9.9 Non-uniform acceleration motion (a) and (b)

In fig. 9.9 (a) the velocity increases from zero to v_1 in time t_1. From A to B the object is moving with a positive acceleration while during time t_2 the body shows negative acceleration from B to C.

In fig. 9.9 (b). The object is moving with positive acceleration for the first 2 seconds. The velocity then remains uniform from 2 to 6 seconds i.e. acceleration is zero. The acceleration then becomes negative between 6 to 8 second time interval and after 8 second the velocity becomes zero.

Example 9.4 : Starting from rest, a train attains a speed of 72 km/h in 10 minutes. If the acceleration of the train is uniform then determine (a) Acceleration of the train (b) The distance covered by the train while attaining this velocity.

Solution :

Given $u = 0$, $v = 72$ km/h $t = 10$ min

$$v = 72 \frac{km}{h}$$

$$= \frac{72 \times 1000 \text{ m}}{60 \times 60 \text{ s}}$$

$$= 20 \text{ m/s.}$$

Similarly $t = 10$ mins

$$= 10 \times 60 = 600 \text{ s}$$

(i) If the acceleration of the train is **a** then

$$a = \frac{v - u}{t}$$

$$= \frac{20 - 0}{600}$$

$$= \frac{1}{30} \text{ m/s}^2$$

(ii) We will use the formula $v^2 = u^2 + 2as$ to determine the distance

$2as = v^2 - u^2$

$$s = \frac{v^2 - u^2}{2a}$$

$$= \frac{(20)^2 - 0}{2 \times \frac{1}{30}}$$

$$= \frac{(20)^2 \times 30}{2}$$

$$= \frac{20 \times 20 \times 30}{2}$$

$= 6000$ m

$= 6.0$ km

Example 9.5 The initial velocity of an object is 4m/s. This object is moving with an acceleration of $2 m/s^2$. Find the velocity of the object after 5 seconds and the distance covered by it.

Solution :

Given $u = 4$ m/s $t = 5$ sec $a = 2 m/s^2$

Velocity $v = u + at$

$v = 4 + 2 \times 5$

$= 14$ m/s

Distance $s = ut + \frac{1}{2} at^2$

$$= 4 \times 5 + \frac{1}{2} \times 2(5)^2$$

$= 20 + 25$

$= 45$ m

9.10 Force :

In the previous section we have studied about the motion of an object. In day to day life we observe that some efforts are to be made to bring objects from a state of rest into a state of motion or to bring a moving body to a static condition. For example we have to push a static table to move it or brakes are applied to stop a moving vehicle. Thus the physical quantity to bring about a change in the static condition or in the moving condition or the effort to bring about a change is the force. It is not essential that the state of motion changes when force is applied to the object, for example the wall remains static even on application of force with the hands.

Force is the physical quantity which brings about a change in the state of motion or in the state of rest or even tries to bring about the change. It is a vector quantity.

We should know the following three things in order to get complete information regarding the force being applied on a body.

(i) The point of action of the force being applied i.e. the point at which the force is working.

(ii) Magnitude of the force.

(iii) Direction of the work done by the force.

Therefore force is a vector quantity which has a direction along with the magnitude.

9.11 Newton's Laws of Motion :

Sir Isaac Newton was the first one to establish the laws governing the motion of objects. We get the actual definition of force from these laws. The quantitative relation between the applied force and the state of motion of the object is also obtained from them. Scientist Galileo had performed some experiments in seventeenth century which later on laid the foundation of the Newton's laws.

On the basis of his experiments Galileo stated that if an object is moving in a simple linear manner then it will continue to move on that simple line with the same velocity unless some type of external force is not acting on it. This last clause is most important and essential. For example - When we roll a ball on the floor it stops after covering some distance. The velocity of a mass decreases as it moves up and ultimately becomes zero and it falls back on the ground. In these examples some external forces are acting on the moving objects because of which their movement changes.

In the first example the frictional force working between the ball and the floor hinders the motion of the ball because of which it slows down and ultimately becomes static. In the second example the gravitational force of the earth hinders motion. If these hindering forces are removed some how then the object, once in a state of motion will always continue to move with the same velocity.

9.12 Newton's First Law of Motion :

According to this law, an object in a state of rest tends to remain in the state of rest and a body moving in a direction with a particular velocity will continue to move with that velocity in that direction until and unless an external force is applied to it. The object opposes any change in its state of rest or of motion. This property of the object is known as **inertia**. The object remains in the state of the motion in which it is, unless some external force does not work on it. Therefore force is to be applied if the static condition of an object is to be changed. It is because of this, that Newton's first law is also known as the **Law of Inertia**. This law of motion can be divided into two parts.

1. Law of Inertia of Rest : According to this law a body in a state of rest will remain in the state of rest until some external force works on it.

Examples of the Inertia of Resting state :

Many examples of this law exist in our day to day life. We will describe some of them over here. For the purpose we will perform some activities.

Activity 9.1 : Take an empty glass. Cover it with a thick, smooth card board piece and place a five rupee coin on it. Now strike forcefully at the card board as shown in fig. 9.10 with your fingers. You will observe that cardboard moves away while the coin falls in the glass.

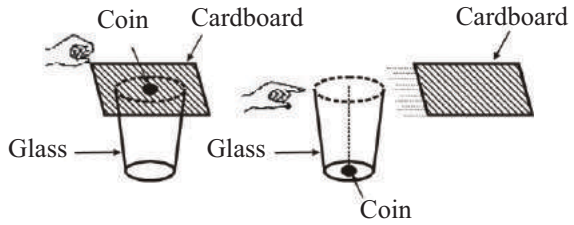


Fig. 9.10

Why the coin did not move away with the card board? It is because the inertia of the coin keeps it in the state of rest whereas the cardboard moves because of the sudden application of force on it.

Activity 9.2 : Stack 8-10 similar coins (i.e. all of rupees one or two or five etc.). Take another coin and strike it with your fingers in such a manner that it collides with the lower most coin of the stack. It will be seen that only the lowermost coin will be displaced from the stack and the others remain stacked together. This again is because the inertia of the remaining coins prevent them from moving.

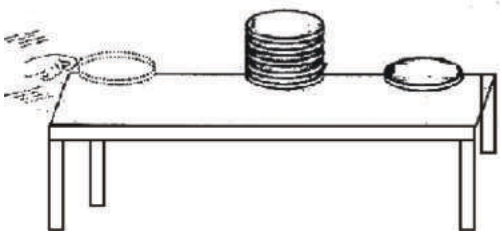


Fig. 9.11

Some other events of inertia of rest in daily life include :

(i) The passengers of a bus or a car experience a push towards back side if the vehicle is suddenly moved from a state of rest. This is because of the inertia of rest of the passenger.

(ii) The dust particles come out from dirty quilts, mats etc. if they are hung and then struck at with a stick because of this inertia.

(iii) If a horse starts running suddenly the rider falls back. The reason for this also is the inertia of rest.

(iv) Again it is because of the inertia of rest that fruits fall down when branches are shaken.

2. Law of Inertia of Motion :

According to this Law if an object is moving it will continue to move with uniform velocity in a straight line until some external force works on it.

Examples of Inertia of Motion :

(i) You must have seen the event of broad jump. In it the player, before leaping forward, comes running with a speed. At the time of jumping his inertia of motion is maintained and he is able to jump for a greater distance.

(ii) If brakes are applied to a speeding vehicle, the passengers bend forward. This is because of the inertia of motion. When the vehicle was moving the entire body was in a state of motion. However, when brakes are applied the lower half of the body which is in contact with the vehicle becomes static while the upper half remains in the state of motion because of inertia. As a result the passenger bends forward. Seat belt is tied by passengers in planes and vehicles when there are possibilities of sudden change in velocity.

(iii) When a person jumps off a moving bus or train he falls head on. This is because when in the vehicle, whole of his body was moving with the same velocity. When he jumps down his legs become static on coming in contact with the ground while the upper part of the body is in a state of motion with the speed of the vehicle. Therefore he falls head on. To avoid falling off, one should run for some distance in the direction of the motion of the vehicle after jumping off. Then after gradually the entire body balances itself and stops. However, it is better to board off the vehicle once it has stopped.

Inertia and Mass

The inertia of all objects is not equal. It is our daily experience that if we apply force to throw a rubber ball and an iron ball of the same radii it is always easier to throw the rubber ball. Similarly, it is easy to carry an empty bag as compared to one filled with books. It means all the objects do not resist the change in its state of motion equally. The resistance to the change in the state of motion of an object depends on its mass.

Greater the mass of an object, higher will be its inertia. Hence, the mass of an object is the measure of its inertia.

9.13 Newton's Second Law of Motion :

A cricket ball moving with a normal velocity is easily caught hold of by the fielder whereas it may be fatal for the person trying to stop a bullet fired from a gun, although it's mass is very less as compared to that of the ball. Therefore, the quantity obtained by multiplying the mass of the object with its velocity is highly meaningful i.e. is of great significance. Newton presented the concept of momentum by the statement of his Second Law of Motion.

The momentum of a moving body is defined by mass and velocity. If the mass of the moving body is depicted by m and its velocity by $\vec{v}$ then the momentum p of the body will be :

$$\vec{p} = m\vec{v} \qquad \text{..... (9.8)}$$

If we consider only the magnitude then

$$p = mv$$

Momentum also is a vector quantity. The SI unit of momentum is kg m/sec (kilogram meter per second).

The Newton's Second Law of Motion for a moving object is expressed as :

The rate of change of the momentum of an object is directly proportional to the force applied on it and its direction is the same as that of the force applied.

Suppose the velocity of a body of mass m is $\vec{u}$. The velocity changes from $\vec{u}$ to $\vec{v}$ after time t when a force $\vec{F}$ is applied on the body in the direction of its velocity, then :

Initial momentum $\vec{p}_1 = m\vec{u}$ .....(9.9)

Momentum after time t $\vec{p}_2 = m\vec{v}$ ..... (9.10)

Change in momentum in time t

$\Delta\vec{p} = \vec{p}_2 - \vec{p}_1 = m(\vec{v} - \vec{u})$

Therefore the rate of change of momentum

$$= \frac{m(\vec{v} - \vec{u})}{t}$$

From Newton's second law

$$F\alpha\frac{m(\vec{v} - \vec{u})}{t}$$

or $\vec{F} = K\frac{m(\vec{v} - \vec{u})}{t}$ where K is a constant

Here $\frac{(\vec{v} - \vec{u})}{t}$ is the rate of change of velocity i.e. acceleration a.

Therefore $\vec{F} = Km \times \vec{a}$ ..... (9.11)

We take the unit of force in a way so that the value of constant K remains one.

Placing the value of K as 1 in equation. 9.11 we get

$$\vec{F} = m\vec{a} \quad \text{..... (9.12)}$$

Now we can derive the unit of force from equation 9.12. By substituting the international unit for mass and acceleration in the equation we get

$$\text{Unit of force } F = \frac{\text{Kilogram} \times \text{meter}}{\text{second}^2}$$

$$= \frac{\text{Kilogram} \times \text{meter}}{\text{second}^2} = \text{Kg m/s}^2$$

This unit of force is named as Newton symbolized by N.

$$\left[N = \frac{Kg\ m}{s^2}\right]$$

We obtain a method of measuring force from the Newton's second law. If we know the mass of an object and the acceleration generated in that body on application of the force, then we can measure that force. Other units of force are dyne and poundal

1 Newton = 10^5 dyne and

1 Poundal = 13825.7 dyne

Example 9.6 : How much force is required to generate an acceleration of $10m/s^2$ in an object having mass of 5kg? If the force is doubled what

$a = \frac{F}{m}$

$= \frac{100\ N}{5\ kg}$

surface of the ground backwards and the earth, in turn, apply the same amount of force on our feet as a reaction, in the opposite direction, as a result we move forward. Now you must have understood why it is difficult to move on sand or smooth floor.

(ii) While swimming in water, the swimmer pushes the water backwards with his hands and feet (i.e. applies force). The reaction of this force pushes him forward.

(iii) The water is moved backwards with the help of oars while rowing a boat. The water applies a force on the boat, as a reaction, because of which the boat moves forward.

Fig. 9.12 Movement of Boat on water

(iv) The propeller blades of the aircraft throws the air backwards so the force applied by the displaced air moves the aircraft forward.

(v) When bullet is fired from a gun the force is applied on the bullet in the forward direction. An equal force is applied on the gun in the opposite direction. But the mass of gun is much greater than that of the bullet therefore the gun moves in the backward direction with very less velocity and the shoulder of the gun-man experiences a slight backward push.

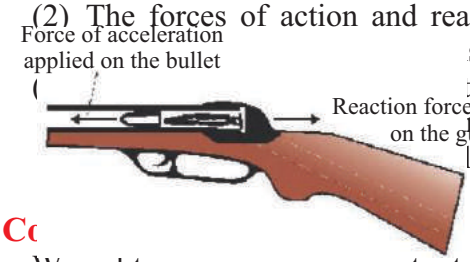
Fig. 9.13 The action and reaction forces, while firing a gun

(vi) When rockets are propelled gases escape from the tail end at a very high speed and as a reaction the rocket is propelled in the direction opposite to that of the escape of gases and it rises high up in the space.

We may get confused that if each force of action has an opposing force of reaction then how the objects move? From the above examples it is very clear that the forces of action and reaction although are equal and are applied in opposite directions, they cannot nullify each other because they work on two different objects. Equal forces applied in opposite directions can nullify each other only when they work on a single object and that too in the same simple line. On the basis of the above mentioned examples and experiments we get the following information regarding the Newton's Third Law of Motion.

(1) Every action has a reaction.

(2) The forces of action and reaction are



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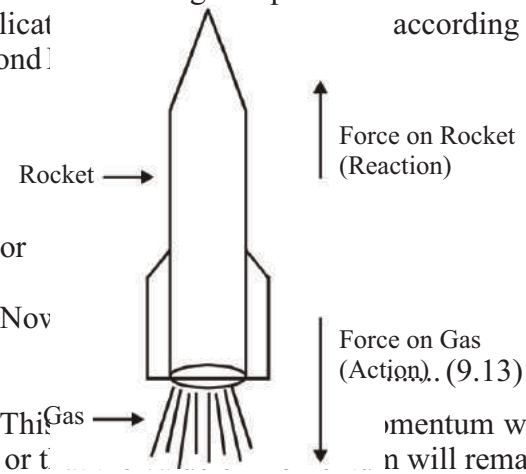
9.15 Cc

We obtain a very important law of conservation of momentum from Newton's Second Law of Motion. Suppose the initial momentum p_1 of a body of mass m changes to p_2 in time t because of the application of force F on it. Then according to the Second Law of Motion

We obtain a very important Law of Conservation of Momentum from Newton's Second Law of Motion. Suppose the initial momentum p1 of a body of mass m changes to p2 in time t because of the applicat according to the Second



or

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. (9.13)

Thi omentum will be zero or t n will remain constant. This is known as the Law or Theory of Conservation of Momentum. It can be expressed as under : "It the external force applied on a body or a system is zero then the entire momentum of that system remains conserved i.e. the value of momentum remains constant with time."

We will understand it by the following examples :

(1) To understand the Law of Conservation of Momentum we will consider a simple situation in which there are only two particles (Fig. 9.15), A and B which are glass balls whose mass is m_1 and m_2 respectively and initial velocity is u_1 and u_2. Suppose

Fig. 9.15 Collision of two balls

The momentum of ball A before and after the collision is m_1u_1 and m_1v_1 respectively. Therefore, the rate of change of momentum of ball A will be

Similarly, for ball B the rate of change in momentum will

$$\frac{m_2 (v_2 - u_2)}{t}$$

If the force applied by A on B is F_{12} and that applied by B on A if F_{21} then according to Newton's Second Law of Motion :

$$\rightarrow \quad \frac{(\vec{p}_2 - \vec{p}_1)}{t}$$

$$\rightarrow \quad \frac{\vec{p}_2 - \vec{p}_1}{t}$$

$$\rightarrow \quad \rightarrow$$

Now according to the Third Law of Motion the force exerted by A on B will be equal but opposite in direction to the force applied on A by B

Therefore $F_{12} = -F_{21}$

$$F_{12} = \frac{m_1 (v_1 - u_1)}{t}$$

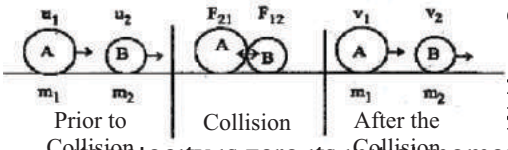
$$F_{21} = \frac{m_2 (v_2 - u_2)}{t}$$

or $m_1 (v_1 - u_1) = -m_2 (v_2 - u_2)$

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2 \ldots\ldots 9.14$$

This refers to that the total momentum before the collision is equal to the total momentum after the collision.

Thus we observe that the total momentum of the system before the collision is equal to the total momentum after the collision i.e. momentum is conserved when no external force is acting on the system. This result is in



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omb

Since its velocity is zero its initial momentum will be zero. Now if it explodes in two parts whose mass are in the ratio of 2:1, then after explosion their velocity will be in a linear manner but in opposite direction in such a manner that the entire momentum after explosion comes out to be zero.

Suppose the mass of the larger piece is 2m and velocity is v_1 and the mass of the smaller piece is m and its velocity is v_2, then after explosion

$$2mv_1 + mv_2 = 0$$

Fig. 9.16 Momentum in an explosive bomb

This means that the piece of mass m will move in opposite direction to the one having mass 2m with a velocity $2v_1$.

9.16 Friction :

We are well versed with friction. This force opposes the mutual motion between two objects. The frictional force is always applied opposite to the direction of motion.

It is a common observation that a ball covers greater distance on a surface as smooth as glass, as compared to that on a rough road. It is easy to cycle on an asphalt concrete road as compared to cycle on a rough road. The friction can be reduced by smoothing the surface but it cannot be eliminated completely. Friction even works on objects moving in air. Now we will consider the dependence of the frictional force that occurs between two surfaces.

Limiting Friction : Try to push a brick placed on a table with your finger. Initially when the value of the force being applied is less the brick will not move. At this time the force applied on the brick and its frictional force are in balance with each other and are acting in opposite directions. As we increase the force being applied even the frictional

force increases and at the point when the value of the force applied increases more than a limit, the brick moves. The magnitude of the force which is just enough to move the brick (i.e. neither more nor less than that required) is known as the limiting friction.

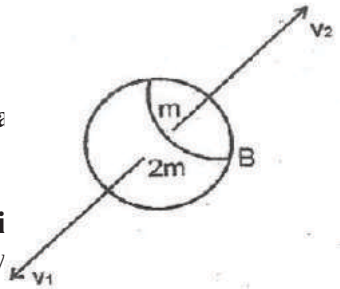


Fig. 9.17(a finger to

Slidi hat develops betw object slides on top of a surface is known as the sliding friction. The sliding friction acts to the point till there is relative movement of the two objects. Force of friction operates even when the external force being applied is removed, as a result the velocity of the body decreases and ultimately it comes to a halt.

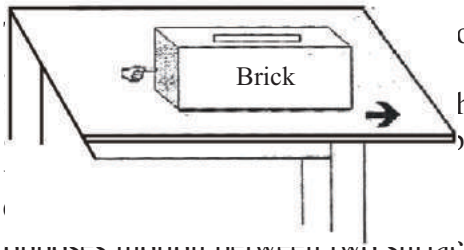
Rolling Friction : As shown in fig. 9.17, if a brick is placed on 3-4 cylindrical rollers like pencil or cylindrical pieces of iron and is pushed, it moves easily. The friction experienced by bodies moving on wheels or on rollers is known as the rolling friction.

Fig. 9.17(b) Rolling motion for moving a brick

The value of rolling friction between two similar surfaces is less than that of the sliding friction. Therefore tyres and rollers are used in various machines.

Friction on objects moving in air and fluid :

Force of friction acts on bodies moving in air or liquid too, however, this force is less as compared to that on solid surface. When meteors enter the earth's atmosphere they experience the air's force of friction because of their very high velocities, emit intense heat and start glowing. Most of them vaporises before reaching the earth's surface.



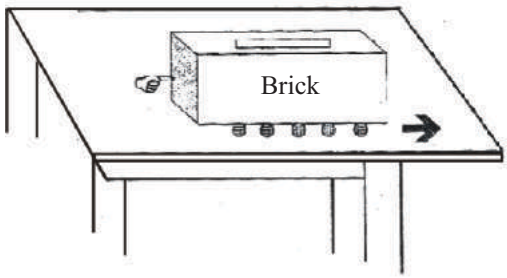
or-cars, special he force by them always opposes motion between two surfaces. The parts of a machine which are in a state of motion keep rubbing and become warm. This is because of friction and the wear off of parts. We have to apply the necessary force in order to keep the object moving with the uniform velocity, to refute the force of friction.

We can control friction but only upto a limit, by using the following methods :

(i) Friction is less on smooth surfaces, therefore the friction can be reduced by making the surface of the moving parts of the machine, smooth.

(ii) The vehicles, air-crafts and engines of the trains are made of a special shape in order to reduce friction.

(iii) Rolling friction is always very less as compared to the sliding friction. It is because of this reason that small steel balls, known as ball bearings are used



chine otion, s are e too. which e of substances known as lubricants, are used to reduce friction lubricants may be solid, liquid or gaseous. In light machines like cycle, watches etc. thin oil is used as a

lubricant where as in heavy machines thick oil or grease is used. When lubricant is applied between the two moving surfaces, its particles occupy the spaces between the irregular regions of the surface and forms a thin layer between them. Now the movement is in this layer thus reducing friction. Compressed air is also used as a lubricant. Air under high pressure is passed in between the moving components of some machines. This not only reduces the friction but also prevent dust particles from settling on the surface. Similarly, the powder used on a carom-board acts as a lubricant while playing.

Need of friction : Although the force of friction reduces the efficiency of machines by dissipating their energy but under many situations there is a need to increase friction. The match box and match sticks are made rough to increase friction so that the match sticks ignite easily. While walking when we lift the foot to place it forward, the other leg counters the reaction force generated because of the presence of friction. Similar is the case with the tyres of the vehicles. The tyre applies a backward force in order to move ahead. The reaction force generated due to friction prevents the tyre from skidding and the tyre rolls in the forward direction. If the force of friction is less, as is the case in sand and mud, the tyre will keep revolving at that point only when force is applied. The rough surface of vehicle tyres increases the force of friction while moving on the road. This increases their grip and prevents skidding. The vehicles are halted by using brakes, because of the force of friction.

Now you must have understood the reason of our slipping when we place our foot on the banana peel and why it is difficult to walk on a smooth floor. Again the reason is lack of friction in the two cases.

Advantages and Disadvantages of Friction :

Advantages of Friction :

1. Friction helps us to walk. On friction-less floor we will slip and fall.
2. Force of friction is helpful in the movement of tyres on the road. Without friction it will be difficult to move ahead or turn the vehicles around.
3. The vehicles come to a halt on applying brakes because of friction.
4. The transfer of rotation power from the motor to the machine through the belt or chain is possible because of the existence of the force of friction.
5. The wall and wood holds nail or screw because of friction.
6. Without friction we cannot hold a pen or pencil in our hand to write.
7. It will not be possible to tie a knot or weave a cloth without the availability of friction.

Disadvantages of Friction :

1. Energy is dissipated because of friction. This reduces the efficiency of machines.
2. In vehicles nearly 20% more fuel consumption is there because of friction.
3. The components of machine wear and tear because of friction.
4. It is due to friction that heat is generated in machines which hinders their smooth working and cause damage.

9.17 Thrust and Pressure :

Thrust : The vertical force applied to the surface of an object is known as thrust. Its SI unit is Newton.

Pressure : Force applied per unit area on an object is known as pressure. It is a scalar quantity.

Its SI unit is Newton per meter square (N/m^2) which is known as Pascal (Pa)

1 Pascal = 1 Newton per meter square

1 Pa = 1 N/m^2

Pressure depends on the following two factors :

1. The force applied
2. Area of the surface

If the area of two surfaces is equal, then,

more the force applied greater will be the pressure. If same force is applied than the object with greater surface area will experience less pressure.

9.18 Buoyancy :

The ship made up of iron and steel do not sink in sea water while a sheet of same weight of iron or steel will sink. Similarly, the iron nail sinks in water while the cork floats. To understand such phenomenon we will have to understand buoyancy.

"Buoyancy is the property of a fluid to exert an upward force, also known as upthrust, on a body that is submerged in it."

In a fluid the following two forces act upon an object :

First : The force of gravitation of earth on the object (weight of the object), in downward direction

Second : Force of buoyancy of water on the object, in upward direction.

The sinking or floating of the object in water depends on the relative values of the two forces.

1. If the weight of the object is more than the force of buoyancy, then the object will sink.
2. If the weight of the object is less than the force of buoyancy, then it will float in a partially submerged manner.
3. If the weight of the object is equal to the force of buoyancy then the body will be completely submerged but will float.

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

Fig. 9.18 On placing on water surface, the iron nail sinks while the cork floats

The knowledge of an object sinking or floating in water can be acquired by its density. If the density of the object is less than the density of the water, then the body will float in water. On the other hand, if the density of the object is more than the density of water, it will sink.

9.19 Archimedes' Principle :

A stone is tied to a spring balance and is weighed. Note its weight. Now note the weight when this stone is dipped in water filled in a vessel. A change in weight will be observed.

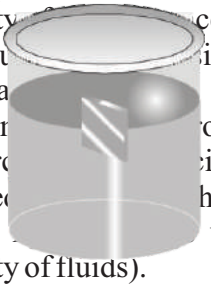
You will observe that there is decrease in the reading on submerging it in water. This decrease will be equal to the weight of the water displaced by the stone.

Fig 9.19 (1) Weight of the stone suspended in air (2) Weight of the stone on submerging it in water.

"When an object is partially or completely immersed in a fluid, it experiences a force in the upward direction which is equal to the weight of the fluid displaced by it. This force is known as the buoyancy force." This is known as the Archimedes' Principle.

Uses :

1. It is useful in determining the relative density[illegible]ce.
2. It is u[illegible]igning ships and subma[illegible]
3. Lactor[illegible]ometer are based on Arc[illegible]iple. (Lactometer is use[illegible]he purity of milk while [illegible] used to find the density of fluids).
4. This explains the floating of ice on water.



9.20 Density :

Mass of a unit volume of a substance is known as its density

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

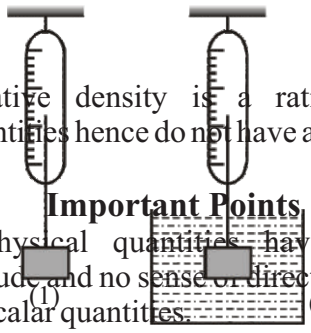
SI unit of density is Kg/m^3 or Kgm^{-3}.

9.21 Relative Density :

Generally the density of a substance is expressed in relation to the density of water. The ratio of the density of substance and that of water is known as the relative density of that substance.

$$\text{Relative Density} = \frac{\text{Density of a substance}}{\text{Density of water}}$$

Relative density is a ratio of similar quantities hence do not have any unit.



Important Points

1. The physical quantities having only the magnitude and no sense of direction are known as the scalar quantities.
2. The physical quantities which require a direction along with magnitude, for their expression, are known as vector quantities.
3. The vector obtained on dividing a vector A with its magnitude is known as the unit vector.

$$\hat{A} = \frac{\vec{A}}{|\vec{A}|}$$

4. Continuous change in the position of an object from the reference point is known as motion.
5. The motion of the body is known as the uniform motion if the body covers same distance in the same specific time interval.
6. If the body covers different distances in a specific time interval then the motion of the body is said to be non-uniform.
7. Distance travelled by an object in unit time is known as its speed. It is a scalar quantity. The distance travelled by an object, in a particular direction in unit time is known as velocity. It is a vector quantity. The unit for both, i.e. speed and velocity is m/s.
8. Acceleration is the rate of change of velocity. Its unit is m/s^2.
9. Uniformly accelerated motion of an object is expressed by the three equations :
   (i) $v = u + at$
   (ii) $v = ut + \frac{1}{2}at^2$
   (iii) $v^2 = u^2 + 2as$
10. Force is the physical quantity which brings about a change in the state of motion or the state of rest of a body.
11. Imbalanced force generates motion in an object.
12. A body remains in its state of rest or in a state of motion along a simple line, until and unless a non-balanced force acts upon it. The tendency of a body to resist a change in the state of rest or of motion is known as its inertia. This is Newton's First Law of Motion.
13. Newton's Second Law of Motion :- The rate of change of momentum is directly proportional to the force applied on the object. The direction of the change in momentum is always in the direction of the force applied.
14. Newton's Third Law of Motion :- For every action there is an equal and opposite reaction and these act on two different objects.
15. Force of friction always resist the motion of the body. Friction depends on the smoothness and roughness of the two surfaces which are in motion in contact with each other. Force of friction can be controlled to some limit. $\rightarrow$
16. The force applied on unit area of an object is known as Pressure. The unit of force is N/m^2 or Pascal (Pa).
17. When a solid is immersed in a fluid, an upward force equal to the weight of the fluid displaced by it, is applied on it. This is known as the Force of Buoyancy.
18. If the density of a solid is more than the density of the fluid, then it sinks. However, if the density of the solid is less than the density of the fluid then it will float.

Questions

Objective type questions :

1. Which of the following is a vector quantity :
   (a) Work (b) Time
   (c) Mass (d) Gravitational force
2. Two forces of 4N and 3N are working on the same body in opposite directions. Then the magnitude of the force on the particle will be :
   (a) 5 N (b) 7N
   (c) IN (d) Between IN and 7N
3. Rate of change of velocity is :
   (a) Force (b) Momentum
   (c) Acceleration (d) Displacement
4. Unit of momentum is :
   (a) Newton meter
   (b) Newton Kilogram/meter
   (c) Newton meter/second
   (d) Kilogram meter/second
5. The velocity time graph of an object moving with uniform velocity is

   (a) (b)

   (c) (d)

6. The momentum of an object depends upon :
   (a) Mass of the object
   (b) Displacement of the object
   (c) Time taken for displacement
   (d) All of the above
7. The equation relating the Force (F) mass (m) and acceleration (a) is :
   (a) F = ma (b) m = aF
   (c) a = mF (d) ma =
8. Unit of force is :
   (a) Kilogram – meter – second
   (b) Kilogram – meter – second^2
   (c) Kilogram – meter / second^2
   (d) Kilogram – meter / second
9. If a body moves in a straight line with a uniform velocity and no external force is applied to it, then
   (a) Its velocity will increase
   (b) Velocity will remain constant
   (c) The body will stop after sometime
   (d) Speed will increase
10. The inertia of an object depends upon :
    (a) Center of gravity of the object
    (b) Mass of the object
    (c) Gravitational acceleration
    (d) Shape of the object
11. An object of 5 Kg weight is moving in a simple line with an acceleration of 10m/s. The magnitude of the force working on the object will be :
    (a) 50 N (b) 0.5 N
    (c) Zero (d) 2 N
12. When a force is applied on an object :
    (a) Its motion may change
    (b) The direction of its motion may change
    (c) Its shape may change
    (d) All of the above
13. The weight of a body having mass 1 Kg will be:
    (a) 1 Newton (b) 9.08 Newton
    (c) 9.8 Newton (d) 8.9 Newton
14. If the mass of an object is m, velocity is v and acceleration is a, then its momentum p will be :
    (a) p = ma (b) p = mv
    (c) p = m/v (d) p = v/m
15. A body cannot change its state of rest or of motion because of its :
    (a) mass (b) weight
    (c) acceleration (d) inertia
16. If the force applied on the surface of an object is doubled, then the pressure will :
    (a) reduce to half (b) not change
    (c) double itself (d) become four times

Very short answers type question :

1. What will be the acceleration of a body moving with a uniform velocity of 40m/s after 10s?
2. A moving body of mass m and having a velocity u collides with the wall and rebounds with the velocity u. What will be the change in its momentum?
3. What will be the distance covered in 30 mins by a train moving with a velocity of 20km/h.
4. The area between the velocity time graph of a

moving object and its time axis is equal to what?
5. The principle of rocket is based on which one of the Newton's laws.
6. What is the direction of the force of friction of a moving bicycle?
7. Why a cricket player pulls his hands gradually with the moving ball while holding a catch?
8. Why a player runs for some distance prior to jumping in a high jump /broad jump event.
9. Why a person standing in a moving bus falls in the forward direction if the bus halts suddenly?
10. What will be the magnitude of the force on a body moving with constant velocity?
11. What efforts should be made by a person standing in the middle of a frozen lake to reach the shore?
12. What is 1 Newton force?
13. What is Inertia?
14. On applying brakes the vehicle stops. What will be the momentum of the vehicle in the process?
15. What is the momentum of the gun and its bullet before it is fired?
16. What is Thrust?
17. What is the unit of Relative Density?

Short answer type questions :

1. Define :
   (i) Displacement (b) Velocity
   (iii) Acceleration
2. What is meant by Uniform Motion? Give an example?
3. If action is always equal to reaction, then explain how the horse cart pulled by a horse, moves forward?
4. The fruits fall down when branches are shaken forcefully. Give reason.
5. Explain the reason why some space is left empty in the tanker while filling water in it?
6. Explain why the boat moves in the opposite direction when the passenger jumps out of it?
7. Comment on the following statement - "On any object two forces work in a pair, only one force is not possible on it at a given time.
8. Differentiate between the dynamic friction and the rolling friction
9. What is the Law of Conservation of Momentum? Explain with the help of an example?
10. Suggest method to reduce friction.
11. The linear momentum of a car and a truck are equal. Whose velocity will be more?
12. Explain the advantages and disadvantages of friction.
13. What happens when we shake a wet cloth? Explain your observation.
14. Why a person pulling out water from a well falls backward if the rope breaks off suddenly.
15. Explain why a person getting off from a moving bus falls in the forward direction.
16. The ship made of iron floats on the surface while a sheet made up of iron sinks. Explain.
17. Differentiate between Density and Relative Density.
18. Write the Archimedes' Principle.

Essay type answer questions :

1. Explain scalar and vector quantities. What is the way of writing a vector quantity? Define unit vector.
2. Explain Uniform and Non-uniform Motion. Find the equation of motion with the help of velocity time graph.
3. Define the Equations of Balanced and Unbalanced forces. Explain with the help of suitable diagram that only unbalanced force can generate motion in an object.
4. Explain the Newton's Laws of motion taking examples from the day to day life. Establish the relation between force, mass and acceleration on the basis of the Second Law.
5. What is meant by Inertia? Explain taking two example.
6. Define Momentum. With the help of diagram show that the Momentum is conserved during the direct collision of two moving objects.

Numerical Questions :

1. A ship having a mass of 3×10^7 Kg is in a state of rest. It is pulled to a distance of 3m by applying a force of 5×10^4 N. If the friction of water is negligible then find the speed of the ship.
2. The speed of a bus increases from 25km/h to 70 km/h in 5s. Determine the mean acceleration of the bus.
3. The momentum of a child riding a bicycle is 400 kg m/s. The cycle is moving with a velocity of 5 m/s. Find the mass of the child along with

the bicycle.

4. A child throws a ball in the upward direction and then catches it after 8 sec. Then determine
   (a) the velocity with which the ball was thrown up
   (b) At what height will the velocity of the ball will become zero?
   ($g = 9.8\ m/s^2$)

Answer Key

1. (d) 2. (c) 3. (c) 4. (d) 5. (c)
6. (d) 7. (a) 8. (c) 9. (c) 10. (b)
11. (a) 12. (d) 13. (c) 14. (b) 15. (d)
16. (c)

Numerical formula

1. 0.1 m/s 2. $2.5 m/s^2$ 3. 80 Kg.
5. (a) 39.2 m/s 6. 78.4 m

Chapter-10

Gravitation

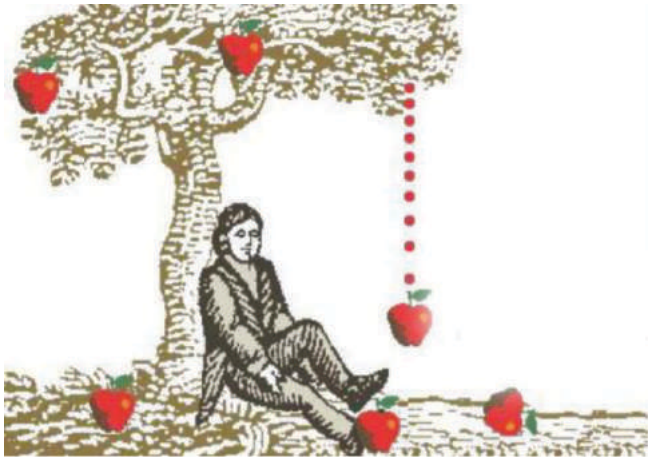
Activity 10.1

- On leaving a stone from hand it automatically falls down on the earth surface.
- Some force is to be applied if we want to throw up the same stone in the upward direction.

In the last chapter we have studied that force is required to change the movement or direction of motion of an object or body. On considering the force required in the above activities we understand that on leaving any object freely it moves towards the surface of the earth. This means, that the earth exerts some invisible force on the object, which is known as the Gravitational Force. When the object is thrown up an external force is applied by the person throwing it up. At that time also earth's gravitational force is working on it and hence its velocity gradually decreases down to zero. Then after it again starts falling down towards the earth surface. This also is an example of earth's gravitational force. Another example of this force is the movement of water drops from the clouds to the earth surface.

10.1 Gravitation :

It is said that once Newton was sitting beneath an apple tree and an apple fell on him. Newton was inspired to find the reason underlying this episode. He thought as to why the apple fell towards earth? Why was it not attracted towards the moon. Thus on the daily life observations Newton proposed the theory of Gravitation.



In this chapter we will study about the Gravitation and the Universal Laws of Gravitation. We will also consider the movement of object under the influence of the gravitational force, the change in weight of objects and why do objects fly in the space.

Let us see as to how circular motion takes place.

Activity 10.2 :

- Tie a small stone to a piece of a thread.
- Move the stone on a circular path by catching hold of the other end of the thread, as shown in fig.
- Observe the direction of the movement of the stone.
- Now leave the thread and observe the direction of movement of the stone.

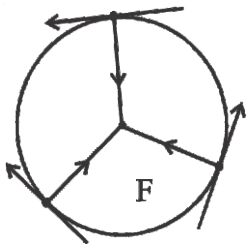


Fig. 10.1

Before we left the thread the stone was moving in a circular path. At that time it experienced a force towards its center which is known as the Centripetal Force. This force is responsible for the circular motion of the objects.

On leaving the thread the stone proceeds in a simple line and then moves in a free manner i.e. the circular motion ends on removing the Centripetal Force.

The movement of moon around the earth is due to the presence of centripetal force. This

centripetal force is derived from the earth's gravitational force.

Gravitational Force occurs naturally between all the objects of the world, but we are unable to experience the gravitational force working between the normal objects. Since the mass of celestial bodies is more this force becomes effective and controls their motion.

It was in fifth century that the Bhartiya astronomer Aryabhatt propounded the geocentric model to understand the movement of planets. Nearly 500 years before Newton and Kepler, Bhaskaracharya in the grah-ganit section of his famous work Siddhantsiromani had discussed the gravitational power of earth and the planetary movements, in detail. Bhaskaracharya calculated the radius (R) and circumference ($2\pi r$) of the earth. The western scientist Copernicus (1473-1543) propounded the model of the movement of celestial bodies on the basis of Aryabhatt's vision. Even Kepler and Galileo also worked out some laws to clarify the understanding about the movement of the planets.

The famous seventeenth century scientist Isaac Newton (1642-1727) gave the Laws of Motion and the Universal Law of Gravitation. These were based on substantial scientific logic and were proved mathematically. The contributions of these scientists in the sphere of physics were very important.

10.2 Universal Law of Gravitation :

Each particle (body) of the universe exerts a force of attraction towards itself on every other particle (body) which is known as the Gravitational Force.

According to the Law of Gravitation "the force of attraction between two particles of matter or bodies is directly proportional to the product of their masses and is inversely proportional to the square of the distance between them. The direction of this force is the same as the direction of the line joining the two particles".

Suppose two bodies of mass M and m are placed at a distance d from each other. Then the gravitational force F working between will be

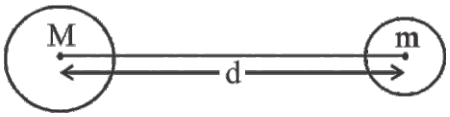


Fig. 10. 2

(1) $F \alpha Mm$ ..... (i)

(2) $F \alpha \frac{1}{d^2}$ ..... (ii)

From equation (i) and (ii) we get

$$F \alpha \frac{mM}{d^2}$$

or $$F = \frac{GMm}{d^2}$$ ..... (10.1)

Here G is the proportional constant known as the Universal Gravitational constant.

The value of G has been worked out to be 6.67×10^{-11} Newton–meter^2–Kilogram^2, from various experiments. Its value does not depend on the nature of the particles, medium, time, temperature etc., i.e. it remains the same at every place. Hence it is known as the Universal Constant. The earth also attracts things towards itself. This, earth's force of attraction is known as the Force of Gravitation.

Derivation of the unit of G :

From equation 10.1 : $Fd^2 = GMm$

or $$G = \frac{Fd^2}{Mm}$$ ..... (10.2)

When we place the units of F, d and Mm in equation (10.2), the SI unit of G obtained will be

$$\frac{Nm^2}{Kg^2}$$

Many phenomenon can be easily interpreted by the Law of Gravitation. Some of the important ones includes :

(1) The force that binds us to the earth
(2) Movement of planets around the sun
(3) Movement of the moon around the earth
(4) Occurrence of tides in the sea.

Example 10.1 : The mass of the earth is approximately 6×10^{24} Kg and that of the moon is approx. 7.4×10^{22} Kg. If the distance between the

earth and the moon is 3.84×10^5 Km, then calculate the force exerted by the earth on the moon

Here $G = 6.7\times10^{-11}\ \frac{Nm^2}{Kg^2}$

Solution :

Mass of the earth $M = 6\times10^{24}$ Kg

Mass of the moon $m = 7.4\times10^{22}$ Kg

Distance between the two $d = 3.84\times10^5$ Km

$G = 6.7\times10^{-11}\ \frac{Nm^2}{Kg^2}$

$d = 3.84\times10^5$ Km $= 3.84\times10^5\times1000$ m

$= 3.84\times10^8$ m

The force applied by the earth on the moon

$$F = \frac{GMm}{d^2} = \frac{6.7\times10^{-11}\times6\times10^{24}\times7.4\times10^{22}}{3.84\times10^8\times3.84\times10^8}$$

$= 20.17\times10^{19}$ N

$= 2.02\times10^{20}$ N

Example 10.2 : A ball of 40 Kg mass experiences a gravitational force of 0.25×10^{-6} Kg weight by another ball of 80 Kg mass. The distance between the centers of the two balls is 30 cm. If the gravitational acceleration $g = 9.8 m/s^2$ then calculate the gravitational constant.

Solution :

Here $m_1 = 40$ Kg

$m_2 = 80$ Kg

$W = F = mg = 0.25\times10^{-6}\times9.8$ Newton

$r = 30$ cm $= 0.3$ meter

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

$$G = \frac{Fr^2}{m_1 m_2}$$

$$= \frac{0.25\times10^{-6}\times9.8\times0.3\times0.3}{40\times80}$$

$$= \frac{225\times98\times10^{-11}}{32\times100}$$

$= 6.89\text{x}10^{-11}\ Nm^2/Kg^2$

Activity 10.3

(i) When a stone is thrown up it moves up to a certain height and then starts falling down.

(ii) A stone when left from some height automatically falls downwards.

You have seen that in the first case the stone moves up for some distance. This distance depends upon the force applied by you. In this situation the direction of the movement of the stone is opposite to the direction of the earth's gravitational force. Therefore, after attaining a certain height the stone starts falling down.

In the other situation the stone automatically falls down from some height when left. This is known as the free fall. In this case the direction of the movement of the stone and that of the force of gravitation, both are the same.

In both the above cases the velocity of the body changes thus its movement is under the influence of the gravitational acceleration.

10.3 Gravitational Acceleration :

When the change in an object's velocity i.e. acceleration, is due to the earth's force of gravitation, it is known as the Gravitational Acceleration. It is denoted by g and its unit is ms^{-2}.

From the second law of motion

Force = mass × acceleration

or $F = mg$ ..... (10.3)

On equating equation (10.1) and (10.3) we get

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

$$g = \frac{GM}{d^2} \quad \text{..... (10.4)}$$

Here M is the mass of earth and d is the distance of the object from the center of the earth. The value of g decreases with the increase in value of d.

If the radius of earth is R then the gravitational acceleration on the earth's surface g^s will be :

$$g_s = \frac{GM}{R^2} \quad \text{.....(10.5)}$$

It is clear from fig. 10.3 that the radius of the

earth is more at the equator as compared to that at the poles. Therefore, the value of g will be more at the poles as compared to that at the equator.

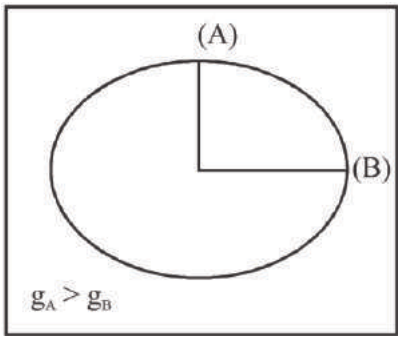


Fig. 10.3

As we move to height h the value of g decreases.

Calculation of the value of gravitational acceleration at the earth surface :

Mass of earth M $= 6\times10^{24}$ Kg

Radius of earth R $= 6400$ Km

$= 6400\times1000$ m

$= 6.4\times10^{6}$ m

From equation 10.5

$$g_s = \frac{GM}{R^2}$$

$$= \frac{6.7\times10^{-11}\times6\times10^{24}}{6.4\times10^{6}\times6.4\times10^{6}}$$

$$= 9.8 m/s^2 \text{ or } ms^{-2}$$

Therefore the value of earth's gravitational acceleration $= 9.8\ ms^{-2}$.

10.3.1 Gravitational acceleration of different planets :

The gravitational acceleration of any planet depends upon its mass and radius. In other words, heavier a planet comparatively more will be its gravitational acceleration.

Activity 10.4

- In the table given below, the mass, radius and gravitational acceleration of various planets have been tabulated.
- Keeping in mind the dependencies of g study the given table and try to answer the questions given below :

Table 10.1

Name of Planets	Mass $X10^{24}$ (Kg)	Radius (Km)	gravitational acceleration (m/s^2)
Mercury	0.33	4879	3.7
Venus	4.87	12104	8.9
Earth	5.97	12756	9.8
Mars	0.642	6792	3.7
Jupiter	1898	142984	23.1
Saturn	568	120536	9.0
Uranus	86.8	51118	8.7
Neptune	102	495.28	11
Pluto	0.014	2370	0.7

[Pluto has been removed from the category of planets in 2006].

Question 1. Which Planet has the maximum value of 'g' and why?

Question 2. What is the value of 'g' on mercury?

Make questions on your own based of this table and discuss with your friends.

> The gravitational acceleration on moon is 1.61 m/s^2 which is about 1/6 of the earth's gravitational acceleration .

10.4 Movement of objects under the influence of the earth's force of gravitation :

It is clear from the equations 10.4 and 10.5 that the Gravitational Acceleration experienced by various objects does not depend upon the mass and shape of the objects. This means that different objects should fall down with the same rate when dropped from the same height. But is it so? Again we will perform an activity to get an answer.

Activity 10.5

- Take some stones, coins, feathers and papers. Throw them down from the terrace of your house and observe. Do all of them reach the earth simultaneously?

> The initial velocity of the free falling objects is zero.

The value of gravitational acceleration 'g' remains constant for a height of some kilometers from the earth's surface. Therefore to study the

motion of objects near the earth's surface, the equation for uniform acceleration motion described in the last chapter is made use of.

Here the acceleration a is replaced by the gravitational acceleration g. If the resistance due to air is considered to be negligible, then :

(i) The equations of motion on throwing an object in the upward direction

$$\left.\begin{aligned} v &= u - gt \\ h &= ut - \frac{1}{2}gt^2 \\ v^2 &= u^2 - 2gh \end{aligned}\right\} \quad \ldots\ldots (10.6)$$

here h is the height of the object from the surface at the given moment of time.

(ii) The equations of motion for a free falling object :

$$\left.\begin{aligned} v &= gt \\ s &= \frac{1}{2}gt^2 \\ v^2 &= 2gs \end{aligned}\right\} \quad \ldots\ldots (10.7)$$

Example 10.3 : A bread from the beak of a crow sitting on the neem tree reaches the earth's surface in 2 seconds. Taking the value of g as $10 m/s^2$, Calculate the following :

(i) What will be the velocity of bread on reaching the earth's surface?

(ii) What will be the average velocity of the bread during these two seconds.

(iii) How high is the crow's beak from the earth?

Solution :

(i) The final velocity [as from equation 10.7]

$$\vec{v} = gt$$

$$\therefore \vec{v} = 10 \times 2 = 20 m/s$$

(ii) Average velocity :

$$\vec{v} = \frac{u + v}{2} = \frac{0+20}{2} = 10 \text{ m/s}$$

(iii) The height of the beak will be the distance travelled, hence

$$s = \tfrac{1}{2}\, gt^2$$

$$= \tfrac{1}{2} \times 10 \times 4$$

$$= 20 m$$

Example 10.4 : An object is thrown up vertically if it reaches to a height of 10m then calculate :

(1) The velocity with which the object was thrown up.

(2) Time taken by the object to reach the highest point.

Solution : Here the maximum height reached

$h = 10 m$

final velocity $v = 0$

gravitational acceleration $g = 9.8 m/s^2$.

(1) $v^2 = u^2 + 2gh$

$O = u^2 - 2gh$

$u^2 = 2gh$

$u^2 = 2 \times 9.8 \times 10 = 196$

$u = \sqrt{196}$

$= 14 m s^{-1}$.

(2) $v = u - gt$

$O = u - gt$

$u = gt$

$$t = \frac{u}{g} = \frac{10}{9.8} = 1.43 \text{ s}$$

10.5 Mass :

In the last chapter you have studied that Mass is the measure of the inertia of an object. In other words, greater the mass of a body more will be its inertia. The mass of a body remains the same every where; whether it is on earth or in space.

10.6 Weight :

On earth the weight of an object is a type of a force that takes it towards the earth. As per definition the weight of a substance is the force by which it is attracted towards the earth.

Mathematically $F = mg$

$\therefore$ the weight of the body $w = mg$.

> Think what is the unit of weight and why

Since the value of g at a given point is constant, therefore, the weight of an object is proportional to it's mass. The mass remains the same with the change in the value of g but the weight changes .

10.7 Weight of an object on the Moon :

Weight of a body on Moon is the force with which the moon attracts it towards itself. The mass of moon is less as compared to that of the earth therefore even the force of attraction will be less. We can say that the weight of an object on moon is relatively less than that on earth.

Since we have seen that the gravitational acceleration on moon is 1.61 m/s^2 which is 1/6 of that present on the earth's surface, whose gravitational acceleration is 9.8 m/s^2, therefore the weight of the object on moon will be 1/6 of its weight on earth.

Weightlessness :

If you have sat in the swings put up in fairs, you must have experienced that when the swing comes down from up we experience reduction in weight.

Basically, the notion of weight is because of the reaction force being applied on the object. If the cable of a lift coming in downward direction beaks, there will be free fall of the lift and we will experience weightlessness, i.e. zero weight.

In case of weightlessness the reaction force. (R) = 0 Thus, artificial satellite continuously falls freely toward the center of the earth and all the things present in it including the organisms, are in a state of weightlessness. In such a condition some very interesting results have been observed. For example :

(1) The water filled in the glass will not fall even if the glass is inverted. This is because on tilting the glass, the water of the glass being heavy will float in the form of drops. Therefore an astronaut cannot drink the water of the glass.

(2) Even the food is to be ingested in the form of a paste directly from the tube by squeezing it.

(3) All the things inside the space craft are afloat.

(4) If the astronaut measures himself with a spring balance, in the space craft, his weight will be zero.

(5) If an object is tied and hung with a string on the space craft, the tension in the string will be zero.

Here the point to be noted is that in an artificial satellite everything experiences weightlessness while the case is not so on a natural satellite. This is because the natural satellite exerts gravitational force because of its mass, which is more. The mass of an artificial satellite however, is less and hence it applies negligible gravitational force and the object is in a state of weightlessness in its environment.

Important Points

1. Some or the other type of force is responsible for the motion of an object. The centripetal force is responsible for the circular motion.
2. Every object of this universe applies a force of attraction, naturally, on every other object, which is known as the force gravitation. All the stars, planets galaxies and small atomic particles are included in the term 'object'.
3. The gravitational force acting between two objects is mathematically represented as under. It is also referred to as the Universal Law of Gravitation

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

where M and m are the masses of the objects concerned and d is the distance between them. G is the constant of proportion whose numeric value is 6.67×10^{-11} $\frac{Nm^2}{Kg^2}$

4. If there is a change in the velocity of an object under the influence of the gravitational force, then it is known as the gravitational acceleration.
5. The equation for the value of gravitational

acceleration on the earth's surface is

$$g = \frac{GM}{R^2}$$ where M and R are mass and radii of the earth respectively. The numeric value of the gravitational acceleration on earth surface is 9.8 m/s^2.

6. The value of gravitational acceleration decreases as we move up from the surface or move down to some depth from the surface.
7. The value of gravitational acceleration decreases as we move from the poles to the equator.
8. The value of gravitational acceleration on the surface of any planet depends upon its mass and radius.
9. The largest planet of our solar system is Jupiter and hence its gravitational acceleration also is the maximum.
10. The initial velocity of the freely falling body is zero whereas the final velocity of an object thrown in the upward direction is zero.
11. Every particle, body or object has a mass which is not dependent on the gravitational force while the weight of the object depends on the gravitational force.
12. The relation between the weight and mass of an object is W = F = mg. Here F, the weight of the object is expressed in unit of Newton, m is the mass of the object and g is the gravitational acceleration whose unit is m/s^2.
13. The weight of an object on a planet or satellite depends on the value of its gravitational acceleration. For example the gravitational acceleration on moon is $1/6^{th}$ of that on earth and hence the weight of an object on moon will also be $1/6^{th}$ of its weight on earth.
14. A free falling body is in a state of weightlessness because the reaction force on it is zero.
15. All the things in an artificial satellite are afloat because they are in a state of weightlessness.
16. The understanding about the astronomical objects and their movements has become easy because of the calculation of their gravitational force.
17. The important names of Bhartiya scientist who made contribution in the field of astronomical bodies, gravitational force and planetary movements includes Aryabhatt, Varahmihir and Bhaskaracharya. Western scientists who have made valuable contributions in the field includes : Copernicus, Galileo, Kepler and Newton.

Important Questions

Objective type :

1. The Newton's Law of Gravitation is universal because :
   (a) It is always of attraction
   (b) It is applicable on all the members and particles of the solar-system.
   (c) It is applicable on all the masses, at all the distances and is not influenced by the medium.
   (d) None of the above.
2. Which is the force responsible for the circular motion of object :
   (a) Gravitational force
   (b) Frictional force
   (c) Centripetal force
   (d) None of the above
3. The value of the Universal Constant G depends upon :
   (a) Nature of the particles
   (b) Medium present between the particles
   (c) Time
   (d) Does not depend on anything
4. The weight of a person on earth surface is 60 N then his weight on moon will be :
   (a) 60 N (b) 30 N
   (c) 20 N (d) 10 N
5. An object of mass m is taken into a very deep mine then :
   (a) Its mass increases
   (b) Its mass decreases
   (c) Its weight decreases
   (d) Its weight increases
6. On doubling the distance between two masses, the gravitational force between them :
   (a) Remains unchanged
   (b) will become one fourth
   (c) will be reduced to half
   (d) will double itself

Very short answer type questions :

1. From where do the satellite derives the

centripetal force required by it to revolve round the planets?

2. Can the gravitational mass of a body be measured in an artificial satellite?
3. What will be the change in the gravitational force between two masses if the distance between them is doubled?
4. If the mass of a body is 10 Kg then what will be its weight on the earth surface?
5. Write the formula of the gravitational force between two bodies.
6. On which principle does a ball pen work?
7. A person can jump on the Moon for a greater height. Why?
8. Two bodies of 1 Kg each are at a distance of 1 meter from each other. Write the value of gravitational force between them.
9. Why does the moon not fall down on experiencing the earth's gravitational force?
10. What is the main reason for oceanic tides?

Short answer type questions :

1. Write the Universal Law of Gravitation.
2. On the earth's surface the value of g is maximum at what point and why?
3. Write the value of the universal constant of gravitation along with its unit.
4. What is Gravitational Acceleration? Write its formula.
5. Clarify the difference between the mass and weight of an object.
6. What is meant by Free Fall? Give examples of free fall.
7. What will be the change in weight of a person moving from the poles of the earth to its equator and why?
8. What is weightlessness? Give two interesting examples of weightlessness.
9. Write the three equations of motion for a freely falling body. Also write the meaning of the symbols.
10. An object is thrown in the upward direction with a velocity u so that it attains a height of h. Write the three equations for the movement of the object.
11. What are the difficulties faced by an astronaut due to weightlessness.
12. Who were the ancient Bhartiya astronomy scientist prior to Kepler and Newton? Write their contributions in the field of gravitation.
13. The objects in an artificial satellite are in a condition of weightlessness while it is not so on a natural satellite. Why?

Essay type questions :

1. Find the value of gravitational force between two balls each having a weight of 10 Kg placed at a distance of 50 cm from each other.
2. Calculate the gravitational force on a 40 Kg object placed on the earth's surface. The radius of the earth R is 6400 Km and its mass is 6×10^{24} Kg.
3. A stone is thrown up in the air with an initial velocity of 20m/s. Taking g = 10m/s^2 calculate the following :
   (i) time taken by the stone to attain the maximum height
   (ii) distance travelled by the stone.
4. Find the Gravitational Acceleration on the moon surface if the mass of the moon is 0.073×10^{24} Kg and its radius is 1738 Km.
5. A stone is thrown from a 125 m high tower. Calculate (i)time taken to reach down
   (ii) final velocity of the stone
6. If the radius of the earth becomes half of the present radius then the mass will become 1/8th. What will be the g of this earth of half the shape?

Answer Key

1. (c) 2. (a) 3. (d) 4. (d) 5. (c) 6. (b)

Chapter-11

Sound

There are different forms of energy like mechanical energy, electric energy, heat, light energy, nuclear energy etc. One more form of energy is the sound energy. We hear sound from different sources in our day-to-day life. The sensation generated in our ears by the sound vibrations help us to hear voices.

Activity 11.1 : Can you hear sound on striking the prong of a tuning fork on a rubber pad? We will observe that on striking on a rubber pad the prong of the tuning fork starts vibrating. If this vibrating fork is brought near a ball suspended with a thread even the ball starts vibrating as shown in fig. 11.1.

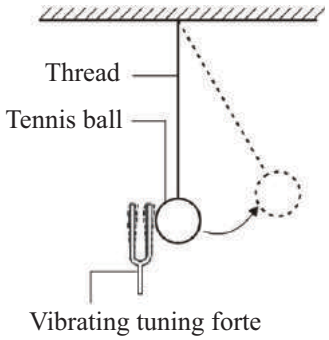


Fig. 11.1 :
The vibrating tuning fork touching a suspended ball

Activity 11.2 : Various musical instruments and their part which vibrate to produce sound

Musical Instrument	**Part that vibrates**
Gitar, Sitar	Wire
Flute	The air inside the flute
Drum	Screen
Hormonium	Reeds activated by air

Similarly the school bell rings when we strike it with a hammar which generates vibrations and hence sound. The above observations make it clear that sound is produced by the vibrations generated.

11.1 Propagation of sound :

The substance through which the vibrations of objects pass is known as the medium. Sound can propagate in all three medium solid liquid and gas. When something vibrates the particles of the medium transfer their energy to the nearby particles of the medium by vibrating. As a result the neighbouring particles start vibrating and similarly pass on their energy to their neighbouring particles. Thus the sound (energy) reachs our ears passing in the form of vibrations from particle to particle. In the ear these vibrations or disturbances generate stimuli because of which we are able to hear the sound. In sound propagation, only the vibrations are propagated. The total displacement of the particles of the medium remains zero.

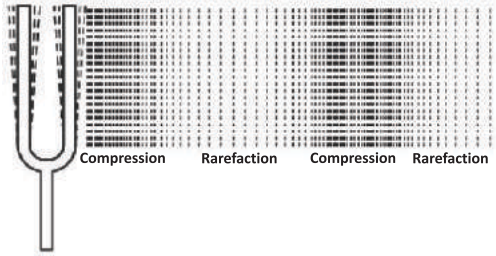


Fig. 11.2 :
Series of compression and rarefaction in sound propagation

Air is the most normal medium for sound propagation. As shown in fig. 11.2 the vibrating body pushes air to cause compression. When the vibrating body moves back rarefaction is generated. These compressions and rarefactions form the sound waves which propagate in the medium. Compression is an area of high pressure and rarefaction is the area of low pressure.

Sound needs medium to travel :

Sound is a mechanical wave and a medium like- air, water, iron etc. is required for its propagation. It cannot move in vacuum. This can be observed by a simple experiment.

Activity 11.3 : An electric bell is suspended in a bell jar and its sound is heard when we press the switch from outside. Now, vacuum is created in the jar with the help of a suction pump. As the amount of air in the bell jar decreases, the sound of the bell also reduces. When there is the condition nearing vacuum the sound of the bell stops being heard.

From this activity it is clear that a medium is required for the propagation of sound. This is the reason why we will not hear what our friend speak on the moon because there is no atmosphere on moon.

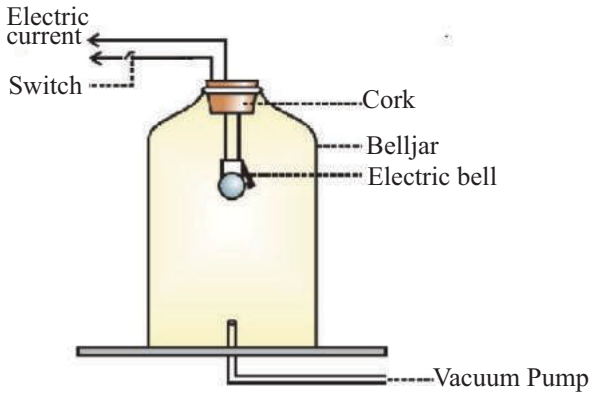


Fig. 11.3 The bell jar experiment

Nature of sound waves :

Waves can be of two types depending upon the direction of vibration and propagation :

(i) Transverse waves : The waves in which the vibrations are vertical to the direction of propagation are known as transverse waves. Examples - light waves, energy transmitted in a stretched rope etc.

(ii) Longitudinal waves : The waves in which the vibrations are in the direction of the propagation are known as longitudinal waves examples : waves generated in a spring, sound waves etc.

Sound waves are the longitudinal waves. We can understand the propagation of longitudinal waves by the following activity.

Activity 11.4 : A spring (slinky) is held in the two hands as shown in the fig. 11.4. Now stretch one of its end and then give it a sharp push towards the other end. If a dot is marked on this it is observed that the dot moves in the parallel direction i.e. to and fro of the direction of the disturbances i.e. vibrations.

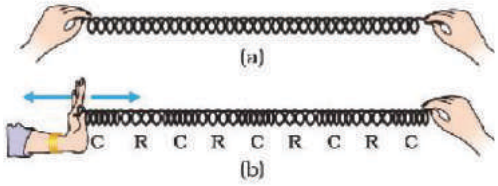


Fig. 11. 4
Longitudinal wave in a slinky
(pre compressed helical spring)

The regions where the coils come close to each other are known as compressions (c) while the regions where the coils are away from each other are known as rarefactions (R). The waves of the propagation of disturbances in the slinky are known as longitudinal waves. In these waves the displacement of the particles of the medium is in the direction of the propagation of disturbances i.e. parallel.

11.2 Characteristics of a sound wave :

There are three characteristics features of a sound wave :

(i) Frequency
(ii) Amplitude
(iii) Speed

The sound wave has been graphically represented in fig. 11.5. Here the distance of propagation has been shown along x-axis and the average value of the pressure of the medium at the given point of the time is shown along the y-axis.

On studying the various points on the graph we observe that points 1, 5, 9, etc. are the regions of maximum pressure while at the points 3, 7, 11 the pressure is the least. The points of high pressure are the regions of compression of sound propagation while the points of low pressure are the rarefaction regions. The distance between two consecutive compressions or two consecutive rarefactions is known as the wave length. It is generally denoted by λ.

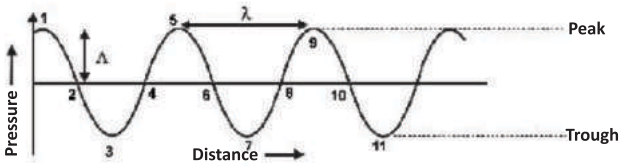


Fig. 11.5 : Graphical representation of the sound wave

Frequency : "The number of vibrations or oscillations occurring in unit time is known as the frequency of the sound wave". It is denoted by υ and it's SI unit is Hertz (Hz).

Time period : "The time taken by two consecutive compressions or rarefactions to pass a particular point is known as the time period of the wave." In other words the time taken by the particles of the medium to complete one oscillation is known as the time period. It is represented by T and its SI unit is second (s).

The relation between the frequency and the time period is

$$\text{frequency} = \frac{1}{\text{Time period (T)}} \quad .....(11.1)$$

Amplitude : The maximum displacement of the disturbance of the medium from the equilibrium position is known as the amplitude. It is represented by A.

Velocity and Wave Equation : In a wave, the distance travelled in one second by a point (like compression or rarefaction) is known as the wave velocity.

$$\text{We know that velocity} = \frac{\text{Distance}}{\text{Time}}$$

$$\text{Therefore } V = \frac{r}{T} = \lambda\upsilon \quad .....(11.2)$$

This equation is known as the wave equation and it is true for all types of waves. The velocity of the wave depends on the medium and remains constant in a medium. When the frequency of a wave in any medium increases, the wave length will decrease.

Intensity :

1. The sound energy passing a unit area in one second is known as the intensity of the sound.
2. The sound intensity can be measured.
3. Sound intensity is related to its energy.

Loudness :

1. The measure of the sensitivity of ears is known as the loudness of the sound.
2. Loudness of the sound cannot be measured.
3. Loudness of sound depends more on the sensitivity of our ears as compared to the wave energy.

Some facts regarding the characteristics of sound are as under :

1. Pitch is the property of sound because of which it is shrill or heavy. Pitch cannot be measured but can be experienced.
2. Pitch depends on the frequency of the sound. The pitch of the high frequency sound is high. This sound is shrill to hear. On the other hand the pitch of low frequency sound is low and is the heavy sound.
3. The pitch of buzzing mosquito is high while that of the roar of a lion is low.
4. Loudness is the property of sound on the basis of which it is loud or soft to listen. The loudness of soft or quiet sound is less while that of the loud sound is more.
5. The loudness of sound depends on the medium of sound propagation as well as the sensitivity of the ears. The same sound can be loud for one person while for the other it may be soft.
6. Quality or timbre is characteristic of sound on the basis of which two sounds having the same pitch and loudness can be distinguished from each other.

Example 11.1 : The frequency of a sound is 4 KHz and its wavelength is 17.5 cm. What will be the time taken by it to move by a distance of 3.5 km?

Solution : Frequency $\upsilon = 4\text{ KHz} = 4000\text{ Hz}$

$$v = \lambda\upsilon = 0.175\text{ m} \times 4000\text{ Hz}$$

$$700\text{ m/s.}$$

The wave has to cover a distance of 3.5 km, so the time taken by it will be

$$t = \frac{d}{v} = \frac{3.5\times1000\text{ m}}{700\text{ ms}^{-1}} = \frac{35}{7} = 5\text{s}$$

Thus, the sound will take 5 seconds to cover the distance of 3.5 km.

Example 11.2 : In a given medium the

frequency of the sound wave is 220 Hz and its velocity is 440m/s.Calculate the wave length of this wave.

Solution :

Frequency of the wave $\upsilon = 220$ Hz

Wave velocity = 440 m/s

Formula :

$V = \lambda\upsilon$

$$\lambda = \frac{V}{\upsilon} = \frac{440}{220} = 2\text{m}$$

11.3 Speed of sound in different media :

Speed of sound depends upon the properties of the media including its temperature. The speed of sound is more in solid and less in gaseous media. The speed of sound increases with the increase in temperature. Normally, the speed of sound at 0°C is 330 m/s. Table 11.1 shows the speed of sound in different media.

Table 11.1

Speed of sound in different media at 25°C

State	Substance	Speed (m/s)
Solid	Aluminium	6420
	Nickel	6040
	Steel	5960
	Iron	5950
	Brass	4700
Liquid	Water (Marine)	1531
	Water (distilled)	1498
	Ethanol	1207
	Methanol	1103
Gas	Hydrogen	1284
	Helium	965
	Air	346
	Oxygen	316
	Sulphur-di-oxide	213

11.4 Reflection of sound :

Like light, sound is also reflected by the surface of a solid or liquid and follows the same laws of reflection as the light does. These laws are :

(1) The angle between the direction of the incidence of the sound and the perpendicular drawn on the point of incidence of the sound on the reflecting surface is the same as the angle of the direction of reflection and the perpendicular i.e. angle of incidence is equal to the angle of reflection.

(2) Incidence sound, reflected round and the perpendicular lie on the same plane.

Activity 11.5 : Two similar pipes are arranged near a wall, on a table, as shown in fig. 11.6 place a clock or some other source of sound at the open end of one of the pipes. Try to listen to this sound by placing your ear at the open end of the other pipe. Adjust the angle of the second pipe to hear the sound clearly. Now measure the angles of these pipes with the perpendicular drawn.

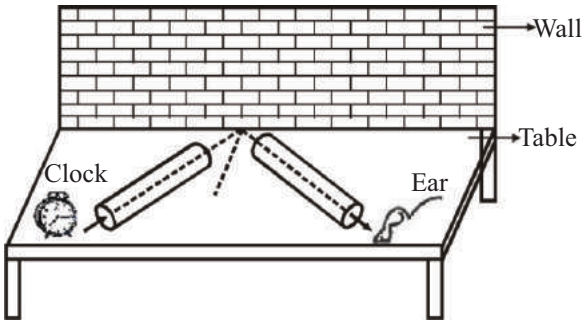


Fig. 11.6 Reflection of Sound

We find that

(1) The sound is heard with utmost clarity when the angles made by the two with the perpendicular are equal i.e. $\angle i = \angle r$.

Echo : If we shout loudly in front of any proper reflecting object - like a building, well, hill etc. we will hear our own voice after some time. This is known as the echo. To hear a clear echo there should be a time interval of atleast 0.1 sec between the original sound and the reflected sound. If the speed of sound at room temperature is 350m/s then to listen to a clear echo the distance of the barrier should be half of the total distance i.e. $\frac{1}{2}$ of $(350 \times 0.1) = \frac{1}{2} \times 35 = 17.5$ m. More than one echos can be heard because of repeated reflections of the sound

11.5 Reverberation :

The sound produced in an auditorium or a large hall is repeatedly reflected by its walls causing persistence of the sound after its source has stopped. This repeated or multiple reflection, which results in

the persistence of the sound, is known as reverberation.

11.6 Uses of Multiple Reflection of Sound:

(1) Loudspeaker, horns and musical instruments like shahnai are designed in a manner that the sound spreads in all the directions. The sound waves produced by them are reflected many times and then are send towards the listener.

(2) Stethoscope is an important instrument in medical research which is used by the doctors to listen to the sound of heart and lungs. In it the sound reaches to the doctor's ears by multiple reflections.

(3) The roof of the concert halls, seminar rooms and cinema halls is curved so that the sound reaches to all parts of the hall after reflection.

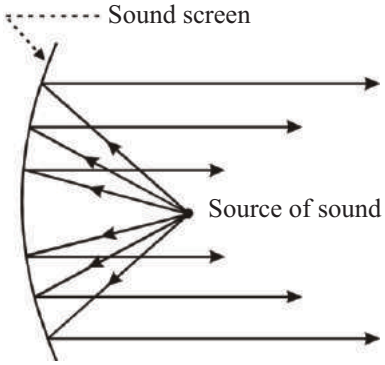


Fig. 11.7 Sound screen used in large halls.

Range of Hearing :

Sound waves on the basis of the range of their frequency can be of the following types :

(1) Audible sound waves : The sound waves which can be heard by our ears are known as audible sound. The frequency of these waves lies between 20 Hz and 20 KHz. These are known as the lowest and highest limits of the audibile frequency. These waves are produced by the resonance air column, tuning fork, violin etc.

(2) Infra sound waves : The sound waves of frequency less than 20Hz are known as the infra sound waves. These waves cannot be heard. They are produced at the time of earth quake, volcanic erruptions and in animals like whale, elephant etc.

(3) Ultra sound : The sound whose frequency is more than 20,000 Hz (20KHz) are known as the ultra sound waves. They can be produced by the vibrations of the quartz crystal. Animals like bat, cat, dog etc. and some birds and insects use ultra sound waves for signaling. They are used to measure the depth of the oceans, in medical science and to remove fog at Airports. In air the wave length of these waves is less than 1.6 cm.

Applications of Ultrasound :

Ultra sound are high frequency waves. Ultra sound is extensively used in the field of medical science and in industries. Some of its uses are as follows:

(i) Ultra sound is used to find out the cracks and other defects in metallic blocks. Ultra sounds are passed through the metallic blocks and indicators are used to detect the transmitted waves. If there is any defect the ultrasound waves are reflected which indicates defect in the block.

(ii) Ultrasound are used to clean the objects which are not reachable. The objects to be cleaned are placed in the cleansing solution and ultrasound waves are passed. The particles of dust, grease and dirt separate and fall apart due to the high frequency.

(iii) Ultrasound waves are reflected from various parts of the heart and an image is formed. This is known as the electrocardiogram (ECG).

(iv) Ultrasound is also used in the ultrasound sonography. In it images of various organs like liver, gall bladder, uterus, kidney etc. are obtained using ultrasound waves. Ultrasonography is made use of to examine the embryo during pregnancy and to detect any irregularities. This technique is used to detect tumours.

(v) Ultrasound is also used to break the kidney stone into minute pieces so that they come out along with the urine.

Bats emit ultrasound waves while flying at night and to find food and then detects the reflected waves. Bats cannot see so they generate high pitch ultra sound vibrations which are reflected on striking the barriers or insects other prey. These are then detected by bat's ears and it comes to know about their position.

11.7 : Sonar

This is a device in which ultrasound is made use of to determine the distance, direction and speed of objects present in the water. The English synonym of the word SONAR is Sound Navigation and Ranging.

Mechanism : In sonar, there is a transmitter and a detector and it is put on the boat or ship as shown in fig. 11.8. The ultrasound waves generated by the transmitter travels in water and after colliding with the object or sea floor are reflected. These reflected rays are detected by the detector which converts them into electric signals. The distance of the object from which the sound waves are reflected can be calculated by knowing the speed of sound (in water) and the time interval between transmission and detection of the ultrasound.

Suppose the time interval between transmission and detection of ultrasound signals is t and the speed of sound in marine water is v and if the object is at a depth d then the distance travelled from the ship to the object and back to the ship will be 2d.

Then $2d = v \times t$.

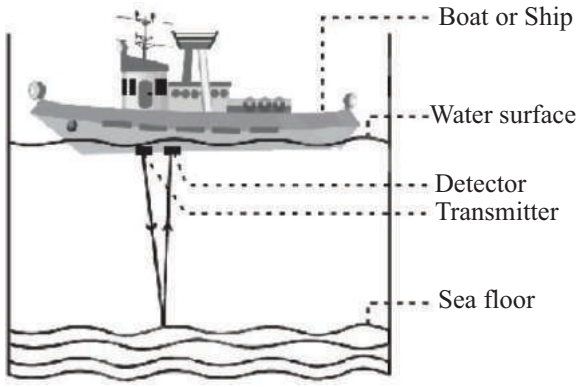


Fig. 11.8 Sonar

11.8 Structure of Human Ear :

We listen with our ears. Ear converts the variations of the pressure in air due to audible frequencies, into signals that reach the brain via the auditory nerves.

The structure of ear is shown in fig. 11.9. The outer ear is known as the 'pinna'. It collects the sound from the surroundings and send them to the auditory canal. On the end of the auditory canal there is a thin membrane called the ear drum. When the compression due to sound reaches the membrane the pressure on the outside of the membrane increases and pushes the ear drum inwards and at the time of rarefaction the membrane moves toward outside. Thus vibrations are generated on the ear drum.

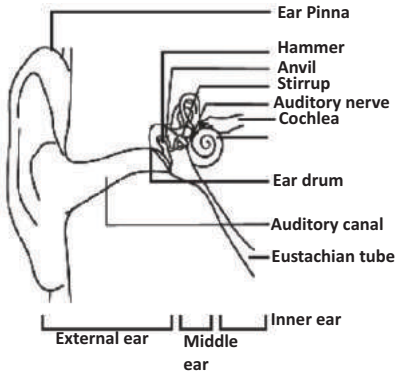


Fig. 11.9 Structure of ear

Three bones - the hammer, anvil and stirrup magnifies these vibrations manifold. The middle ear conducts these changes in pressure to the inner ears. The cochlea in the inner ear converts these pressure variations into electric signals and send them to the brain. The brain then interprets them in the form of sound.

11.9 Radar [Radio Aim Detecting and Ranging]:

Radar is a scientific equipment. It was invented by Taylor and Leo C Young in 1922. This instrument is used in detection of air crafts moving in space and to determine their position. It makes use of radio waves to find out distant objects, their location i.e. direction and distance. Radar can locate things situated at distances much more than can be perceived by our eyes and can identify their exact location. Nothing like fog, smog, rains, snowfall,

smoke or darkness can hinder its functioning. However, radar cannot compete with our eye, as it cannot know the colour and minute details of the object. There is only a sense of presence of the object. Objects that are odd from the background and large objects like ships on the sea surface, high flying air-crafts, islands, sea shore etc. can be detected easily by the Radar. In 1886 Heinrich Hertz, the inventor of radio waves, had proved that radio waves could be reflected from the solid objects. In 1925 the reflection of radio pulse had been made use of to detect the distances and by 1939 many instruments working on the principle of Radar had been formed. But radar was used on large scale from Second World War onwards.

Fig. 11.10 Radar

Method for Position Location :

Radio waves are transmitted from radar and the time taken by them to return , on being reflected from the distant object is measured. The velocity of radio waves is 1,86,999 miles per second. Therefore the distance of the object can be easily calculated on knowing the time taken. The exact location of the reflector, that is, the target object is known by the high direction sensing antenna on the Radar. The actual position of the object becomes known by knowing the distance and direction. The transmitter of the radar emits momentary but intense pulses of radio waves at regular intervals. The receiver receives the reflected waves from outer objects, if present, in the time interval between the two pulses. The exact timing of reception of reflected waves is known by the electric circuits and the distance is then known instantly by the indicators marked in proportion to time. One microsecond (10 lakh part of a second) refers to 164 yards and 19.75 microsecond means a distance of 1 mile. Some radars can sense the presence of objects upto the distance of 199 miles. Good instruments measure the distances with an accuracy of 15 yards and the variation in distance does not influence the measurement much. The angle of the height or the direction of the target object can be measured to an accuracy of 9.96 part of a degree. The position is clearly observed in the Cathode-ray-tube of Radar.

Knowledge of direction :

The antenna is rotated or is moved to and fro to know the target. When the antenna is in the direction of the target the image of the target is seen on the cathode ray tube screen. This image is known as the pip. Pip is most clear when the antenna is in its direction. The antenna of the radar are highly direction oriented. They concentrate the radio waves into screwed beams and special type of reflectors in the instrument condense these beams. Waves with very small wave length i.e. those having high frequency are used for the functioning of the radar. An instrument known as the multi cavity magneton is required for the production of these beams. Functioning of modern radars is not possible without this multi cavity magneton.

Components of a Radar :

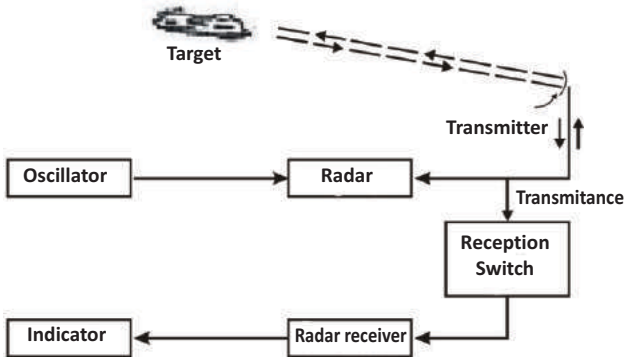


Fig. 11.11 : Components of a Radar and its functioning

Modulator : The essential impulse of high electric power provided to the Radio frequency Oscillator is obtained from the modulator.

Radio frequency Oscillator generates the high frequency power impulses from which the radar signals are formed. Antenna transmits these impulses to the sky and receives them back.

Receiver detects the radio waves that returns .

Indicator provides information gathered by the antenna to the radar operator.

Synchronisation and **measurement of range** is done by the modulator and the indicator.

These are just the basic components of the radar, the details however are modified and fine tuned according to the purpose for which the radar has to be used.

Use of Radar :

The sudden attacks during wars has become nearly impossible because of radar. It pre informs the arrival of ships, aircrafts and rockets. The presence of radar on aircraft informs of the other arriving aircrafts. Because of this instrument the fighter planes successfully reach their target and return. With the help of radar it is possible to know what is happening in all the directions, in the sky, on the ground in a radius of 299 miles, from the central controlling point. We can come to know of the presence of boats on the sea and other ships, whether it is day or night. They also help in shooting missles on enemy ships.

During times of peace also the radar have many uses. They have made boat, ship or air craft monitoring more safe because the drivers are able to view the hills, glaciers and other hurdles from a distance. Radar helps the airplanes to know their exact height from the earth surface and facilitates landing at airports during night. On 19th January 1946 the United States of America's troop first established contact with the moon by means of radar. The radio signals had to cover a distance of 4,59,999 miles to contact moon and it took a time of 2.4 seconds.

Important points

1. The motion of a particle which is repeated continuously after a definite time is known as recurrent motion.
2. The recurrent motion of a particle to and fro from a point in a simple line is known as the vibrational motion or oscillatory motion.
3. On the basis of the type of vibrations of the particles of the medium, waves can be of two types :
   (i) Transverse waves (ii) Longitudinal waves
4. Sound is produced because of vibration of different objects. Sound waves are longitudinal waves.
5. Sound travels in a medium in the form of consecutive compression and rarefaction.
6. The distance between two consecutive compressions or two consecutive rarefactions is known as wave length. It is represented by λ.
7. Time period (T) is the time taken by a wave for a complete oscillation of the disturbance of the medium.
8. Frequency (υ) is the total number of oscillations in a unit time. $\upsilon = 1/T$
9. The speed of a wave is equal to the product of its frequency and wave length i.e. $v = \upsilon\lambda$.
10. Intensity of the sound is 'amount of sound energy passing a unit area in one second.'
11. The speed of sound basically depends upon the nature of the medium of propagation and its temperature.
12. The direction of incidence of sound on a reflector (wall etc.) makes an angle with the perpendicular drawn at the point of incidence, which is always equal to the angle made by the perpendicular with the direction of the transmitted sound wave. The direction of incidence of the wave, that of transmitted wave and the perpendicular all three lie in the same plane.
13. A minimum time interval of 0.1 second between the original sound and the reflected sound, is essential, for hearing the echo, clearly.
14. Sound has three properties :
    (i) Pitch (b) Loudness
    (iii) Quality
15. The range of sound audible to human ears it 20 Hz to 20KHz.
16. The sounds of frequency less than 20 Hertz are known as infra sound while those having frequency more that 20 KHz are known as ultra sonic.
17. Ultra sonic sound has many uses in medicine and industries.
18. Sonar is a device used to measure the depth of sea or to detect some visible object under water.

19. Ultra sonic waves are used in Sonar.
20. Tone is the sound generated by the mixture of many frequencies.
21. Radar is used to detect the air-crafts moving in the space and to determine their position.

Important Questions

Objective type :

1. The wave having compression and rarefaction is known as :
   (a) Transverse wave
   (b) Longitudinal wave
   (c) Light wave
   (d) Ultra violet waves
2. The relation between velocity v, wavelength λ and frequency υ is :
   (a) $v = \upsilon\lambda$ (b) $\lambda = v\upsilon$
   (c) $\upsilon = v\lambda$ (d) $v = \lambda/\upsilon$
3. Longitudinal waves can be generated in :
   (a) solid and gas
   (b) solid and liquid
   (c) gas and liquid
   (d) solid, liquid and gas
4. The vibration of the particles of the medium in longitudinal waves is :
   (a) In the direction of the wave
   (b) Vertical to the direction of the wave
   (c)The particles do not vibrate
   (d) at an angle of 60^o to the direction of waves
5. The speed of sound is maximum in :
   (a) air (b) solid
   (c) water (d) Both water and solid
6. The time period of the hour-hand of a clock is :
   (a)1 hour (b) 24 hours
   (c) 12 hours (d) None of the above
7. If the speed of a wave is 350 m/s and its wave-length is 50 cm then the frequency of the wave will be :
   (a) 13500 Hz (b) 700 Hz
   (c) 400 Hz (d) 300 Hz
8. The number of complete oscillations made in one second is known as :
   (a) Amplitude (b) Speed
   (c) Time period (d) Frequency
9. The time period of a vibrating body is 0.02 s. The frequency of vibrations will be :
   (a) 100 Hz (b) 20 Hz
   (c) 50 Hz (d) 1 Hz
10. The time period of the seconds-hand of a watch is :
    (a) 1 minute (b) 1 hour
    (c) 12 hours (d) 24 hours
11. The limit of audibility is :
    (a) 200 Hz to 20,000 Hz
    (b) 20 Hz to 20,000 Hz
    (c) 2 Hz to 20 Hz
    (d) more than 20,000 Hz
12. To listen to the echo the sound should reach our ears at least after :
    (a) 0.1 s (b) 0.5 s
    (c) 1 s (d) 2 s
13. The frequency of the waves used for ultrasonography is :
    (a) 20 Hz
    (b) Less than 20 Hz
    (c) From 20 Hz to 20,000 Hz
    (d) More than 20,000 Hz
14. Unit of amplitude is :
    (a) m (b) m/s
    (c) Hz (d) None of the above
15. The velocity of sound in vacuum is :
    (a) 3×10^8 m/s
    (b) 330 m/s
    (c) Sound cannot move in vacuum
    (d) None of the above

Very short answer type :

1. Longitudinal waves can be generated in which type of medium?
2. The sound waves produced in iron are of which type?
3. The sound waves produced in air are of which type?
4. If a wire tied between two pegs is stretched vertically to its length and is left, then which type of wave will be produced in the wire.
5. What is the SI unit of wave length?
6. What is the SI unit of frequency?
7. Which type of waves will be generated if a freely hanging slinky is stretched and is left?
8. What is the type of movement of the hands of a clock?
9. Define wave length.
10. Define frequency.
11. What is a Radar?

Short answer type questions :

1. What is essential for production of sound?
2. What do you understand by motion of a wave?
3. What are longitudinal waves?
4. What is required for the propagation of waves?
5. What is transferred during wave propagation from one point to another? Energy or some physical mass?
6. Give two examples of longitudinal waves.
7. Are waves generated by a bullet fired from a gun or a stone hurled from a catapult?
8. Write the method of 'position location' by a radar and the uses of radar.
9. What is the difference between the longitudinal and the transverse waves?

Essay type Questions :

1. Define the following :
   (i) Amplitude (ii) Frequency
   (ii) Time period (iv) Wave-length
2. Write the relation between :
   (i) Time period and frequency
   (ii) Frequency, wavelength and velocity
3. Answer the following :
   (i) What is the distance travelled by the wave when the particle of medium completes one oscillation?
   (ii) The sound waves in air are transverse or longitudinal?
   (iii) Write the names of the wave/waves which can be generated in a long slinky.
   (iv) Give two examples of each : the longitudinal waves and the transverse waves.
   (v) Name the physical quantity whose unit is Hz.
4. Write the uses of ultrasound.
5. Write the extended form of SONAR. How will you determine the depth of sea by using reverberation range?
6. Explain, with the help of a suitable diagram, the working of the human ear.
7. Write the laws of reflection of sound. Describe an activity to verify them.
8. What is ultrasound? How can it be used to detect the defects in metallic blocks?
9. Elucidate the components of a radar and their functions.

Numerical Questions :

1. An object is vibrating 6600 vibrations per minute. If the velocity of sound in air is 330 m/s then find :
   (i) Time period (ii) Frequency
   (iii) Wave length
2. The time period of a body is 0.004 s. Find its frequency.
3. The distance between two adjacent crests of a wave is 30 cm and its frequency is 450 Hz. Then determine the velocity of the wave.
4. A wave of frequency 256 Hz is propagating at a speed of 330m/s. What will be the speed of a wave having frequency of 512 Hz, in the same medium?

Answer Key

1. (b) 2. (a) 3. (b) 4. (a) 5. (b)
6. (c) 7. (b) 8. (d) 9. (c) 10. (a)
11. (b) 12. (a) 13. (d) 14. (a) 15. (c)

Answer for the numeric questions

1. (i) 1/110 seconds
   (ii) 110 Hz
   (iii) 3m

2. 250 Hz

3. 135 m/s

4. 330 m/s

Chapter-12

Celestial bodies and Indian Calendar

12.1 Celestial Bodies :

In your earlier classes you have studied that riddles and puzzles, have witnessed the beautiful scenes of the moons and the stars. Even you can see this mesmersing view at night. You can see numerous stars - some very bright and others not so. A few of them twinkle while others do not. Some stars appear near to each

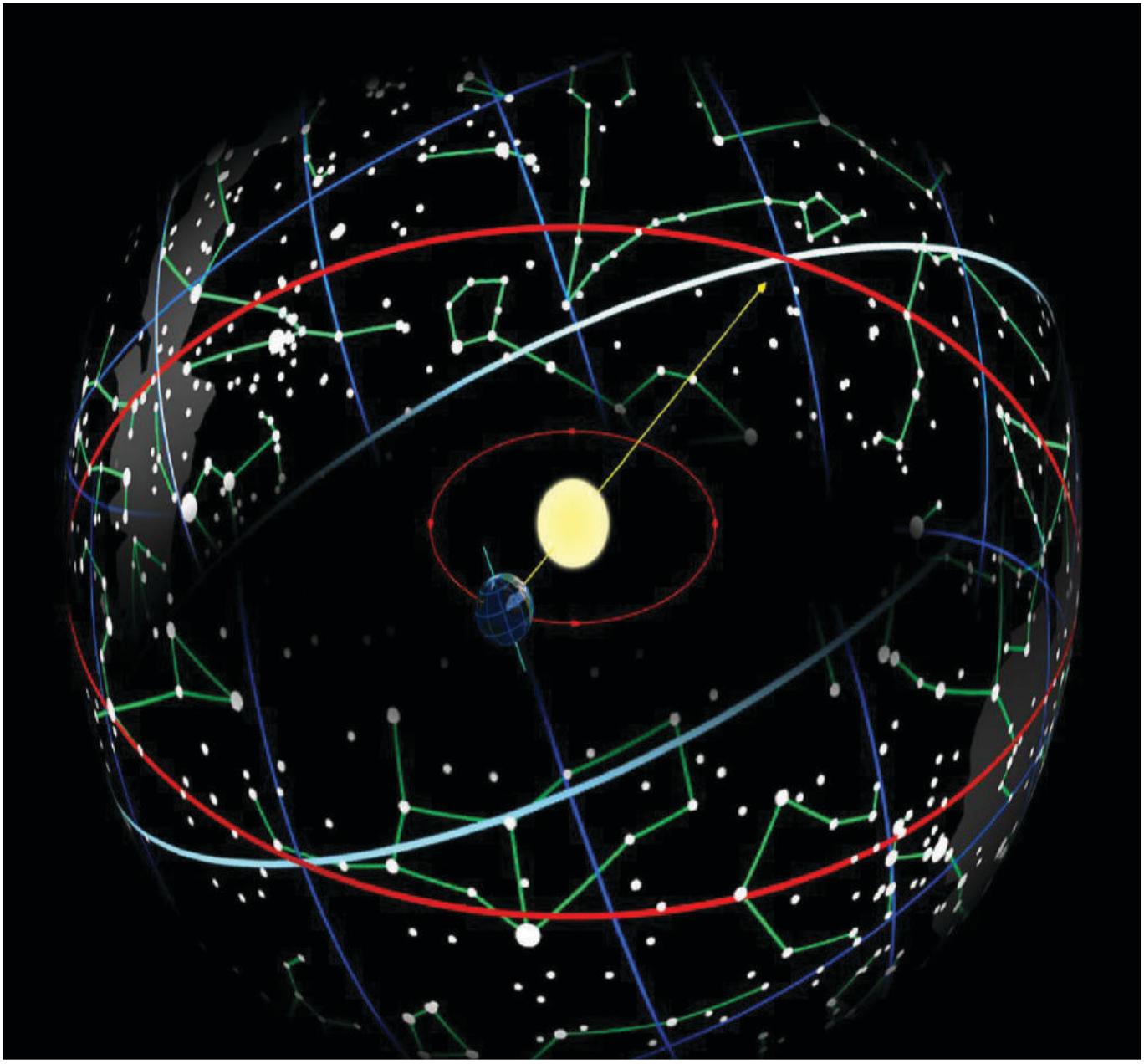


Fig. 12.1

other in the form of groups. Some group of stars form special shapes in the sky, by their arrangement. So this is how our universe appears to some extent. Many other celestial bodies can be observed using astronomical telescope, which are invisible to our naked eyes. On observing minutely these views change because all celestial bodies are in a state of continuous motion.

Activity 12.1

- Divide all students in groups of five each.
- Teacher should write the following lines on the black board : "Enlist the celestial bodies that you have seen, heard of or have read about.
- Compile all the names that turn up in various groups on the black board.

There are many small, big and very big bodies in the universe. These are known as the celestial bodies. Sun, stars, planets, asteroids, meteorites, comets, galaxies, moon - all are celestial bodies. You must have heard about polar-star, sapt-rishi mandal etc. from your elders - they also are celestial bodies which have their own light and are therefore known as the stars.

One such star is our Sun. There are many stars farther away from the Sun, hence they appear small and appear to shine to a lesser extent. Many of the stars are much larger than our Sun. The extent of the universe is beyond our imagination. It has been described, though in another form, even in our Vedas.

Indian calendar (almanac) is an astronomical book based on mathematical calculations in which are mentioned the names of various celestial bodies and their movements. Millions of years ago when there were no watches or other type of time measuring devices, our ancestors determined time, date, month etc. by observing the position of these celestial bodies. The Indian almanac was prepared on this basis.

Activity 12.2

The teacher discuss the following questions with the students :

- When is full moon seen in the sky?
- When is there no moon in the sky?
- When and on which day the lunar eclipse occurs?
- The workers involved in construction work keep a holiday on which day?
- From where do we get the knowledge of all such things in our day to day life?

Teachers express answers given by the students in a comprehensive manner and make it clear that all these information have been mentioned in our Bhartiya calendar since time immemorial. Various astronomical event can be predicted on the basis of mathematical calculations provided in the almanac.

Bhartiya Almanac (Calendar) :

There are five main parts of the Bhartiya calendar, hence it is known as the 'Panchang'. They are :

1. **Tithi (Date) :** This is similar to the **date** of the english months, but it is related to the lunar month. There are two phases in a lunar month which are known as the 'Shukl paksha' and the 'Krishan Paksha'. There are 15 'tithis' in each 'Paksha', two of them are the Full Moon (Poornima) and the New Moon (Amawasya).
2. **Vaar (days) :** It is the same as the **days** of the week and are seven in number.
3. **Nakshtra (Constellations/asterisms) :** The path of revolution of moon about the earth has been divided into 27 sectors. A nakshtra is a sector along the lunar ecliptic.
4. **Yog (Combination) :** It refers to the difference at a given time in the movement of sun and moon. There are 27 Yog. It is an auspicious moment.
5. **Karan :** Half of the part of a tithi is called a karan. Thus there are two karans in a tithi, to calculate the micro-effects of a tithi.

Apart from these the 'panchaang' presents many other information in a very accurate manner. Some of them have been enumerated as under :

- The daily sun-rise and sun-set time for various cities.
- Time of appearance of moon.
- Movements of sun, moon and various planets.
- Revolution of various planets in Nakshatra and Rashis i.e. in asterisms and constelations.
- Daily tithi, increase and decay in them.
- Rashi, description of the twelve months.

The Bhartiya pachang shows the daily calculations of the time and moment and the position of celestial bodies at each given moment. Of the five parts of a 'panchang', information regarding nakshatra and tithi is being presented in this chapter.

The current prevalent panchang is based on the Bhartiya Panchang. In it, along with the various astronomical events, the festivals and specific events of all religions have been mentioned. It is available in the language of the specific community.

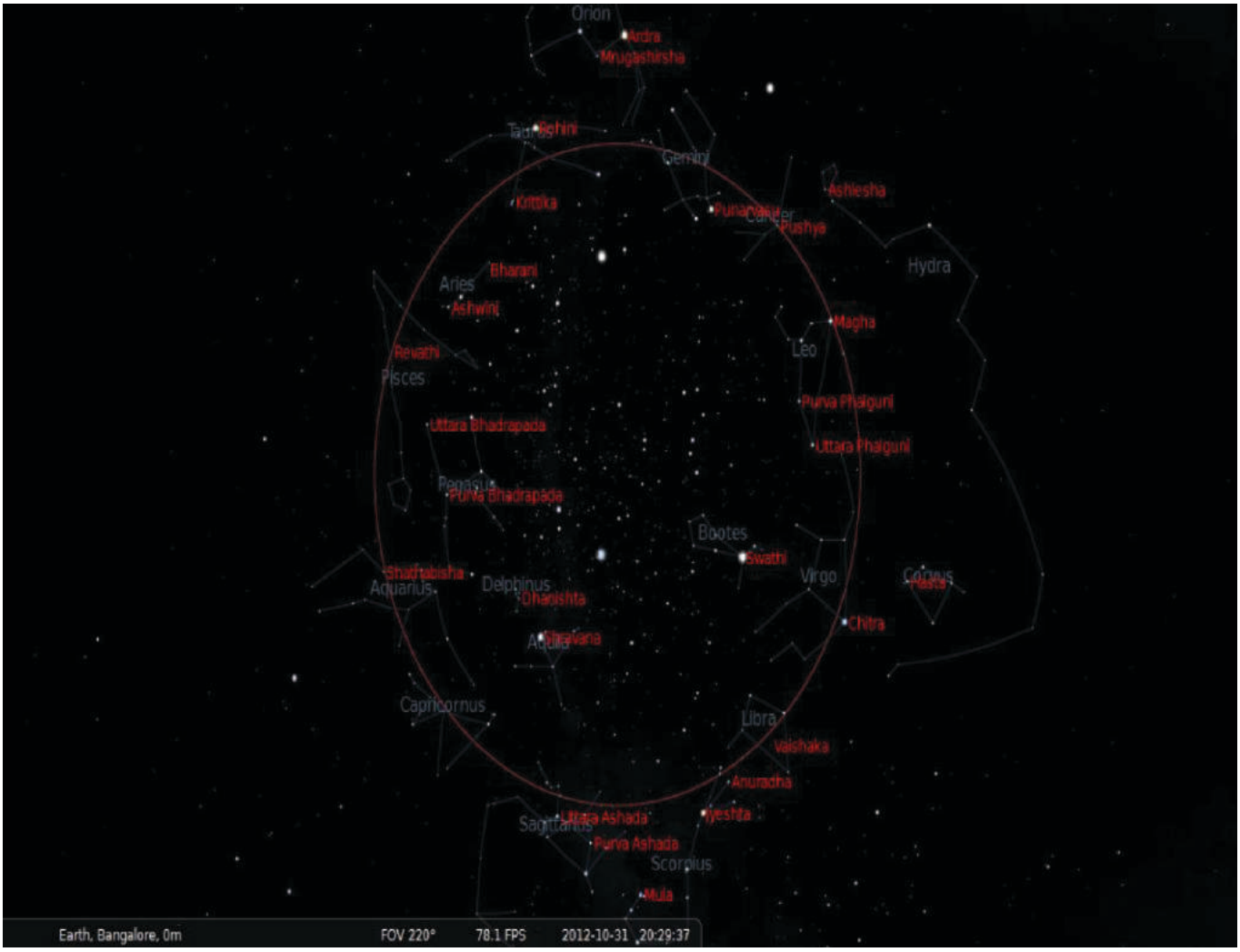


Fig. 12.2

12.3 Nakshatra :

The group of stars in the sky is known as the constellation. In it stars are observed in a recognizable pattern. They are very far from the sun and appear to be static because they do not revolve around the sun. These groups of stars have been named for identification purpose. These names are on the basis of their apparent form or are identified with some mythological figures.

The moon completes its revolution about the earth in about 27 days. The constellations present along the lunar ecliptic are known as nakshatra. The ecliptic of moon has been divided into 27 sectors and these nakshatras present there in, are named. The table below enumerates the detailed description of these 27 nakshatra (Table 12.1).

S. No.	Name of Nakshatra	No. of stars	Shape or Identity
1.	Ashwini	3	Horse
2.	Bharni	3	Triangle
3.	Krtika	6	Agnishikha
4.	Rohini	5	Cart
5.	Mrigashira	3	Head of a dear
6.	Ardra	1	Bright
7.	Punarvasu	5 or 6	bow & quiver
8.	Pushya	1 or 3	Ruby Colour
9.	Ashlesha	5	The tail of a dog
10.	Mgha	5	Plough
11.	Purvafalguni	2	bed (the front leg)
12.	Uttarafalguni	2	bed (4 legs)
13.	Hast	5	hand palm
14.	Chitra	1	bright jewel, pearl
15.	Swati	1	Kumum
16.	Vishakha	5 and 6	triumphal arch
17.	Anuradha	7	winnowing basket
18.	Jyeshtha	3	Snake
19.	Mool	9 or 11	Shankh
20.	Purvashad	4	Elephant tusk
21.	Uttarashad	4	winnowing basket
22.	Shravan	3	Arrow or Trident
23.	Dhanishtha	5	Drum
24.	Shatbhisha	100	empty circle
25.	Poorv bhadrapda	2	Bell shaped
26.	Uttara bhadrapda	2	Twins
27.	Rewati	32	Fish

The name of the 28th nakshatra is Abhijeet which has been considered with Purvaashad.

12.4 Solar system and its planets :

You have already studied about our solar system in your previous classes. Here we are again going to get the detailed information about our solar system in brief :

- The solar family is made up of the celestial bodies that are revolving in elliptical paths around the sun.
- In the solar family there are planets, satellites, meteorites, comets, asteroids and many unknown bodies which are revolving around the sun.
- They revolve around the sun because of its gravitational force.
- The bodies revolving around the sun are known as planets and those revolving around the planets are known as the satellites. All these planets and satellites are the members of our solar family. Among the celestial bodies our earth comes under the category of planets.
- The planets do not have their light and heat. They only reflect the light of the sun and other planets.
- Sun is the biggest body of our solar system. Its mass makes up more than 99 percent of the mass of our solar system. It is nearly ten lakh times bigger than our earth and is a large ball mainly made up of gases like hydrogen and helium. It is a powerful source of energy. Only a small part of the energy emitted by sun reachs the earth surface. Sun is the reason for rains on the earth, occurrence of day and night and change of seasons. This solar energy affects the life cycle of all the planets and animals.

In the modern era eight celestial bodies have been categorized as the planets, but according to the "Bhartiya Panchang" there are nine planets. In the given chapter we will study about these planets from both point of view.

Planets and their movements according to the modern science :

Table 12.2

Name of Planet	Mass ($x10^{24}$ Kg)	Radius (Km)	Distance From Sun ($x\ 10^{6}$ Km)	Time for Revolution (days)	Time for for Rotation (hours)
Mercury	0.33	4879	57.9	88	1407.6
Venus	4.87	12104	108.2	224.7	–5832.5
Earth	5.97	12756	109.6	365.2	approx 24
Mars	0.642	6792	227.9	687	24.6
Jupiter	1898	142984	778.6	4331	9.9
Saturn	568	120536	1433.3	10747	10.7
Uranus	86.8	51118	2872.5	30589	–17.2
Neptune	102	49528	4495.1	59800	16.1

The celestial bodies present in the solar system have been categorized into three categories according to the approval of International astronomical union conference, Prague (24 August

2006), the celestial bodies present in the solar system have been categorized into three categories

(1) **Planets :** The above mentioned eight planets have been recognized in this category. The first four i.e. Mercury, Venus, Earth and Mars have been termed as the terrestrial planets because they have a ground while the next four i.e. Jupiter, Saturn, Uranus and Neptune are heavy planets made up of gases.

(2) **Dwarf planets :** Pluto, Aries, Ceres etc.

(3) **Smaller solar system bodies :** It comprises of 166 known satellites and other small astronomical bodies including asteroid belt, comets meteorites and the dust present in between the planets.

The dust and gaseous bodies revolving in the space are attracted towards the earth because of its gravitational force. When they enter the earth's atmosphere they shine bright because of their friction in the atmosphere and most of them are burnt down to ash before reaching the earth's surface. They are known as meteor. Those bodies which do not burn away completely and fall on the earth in the form of rocks, are termed as meteorite.

There is no atmosphere at **Mercury**. This is nearest to the sun. Here the nights are very cold and the days are very hot. There are clouds of sulphuric acid in the atmosphere of **Venus**. The ground surface is laden with rocks and volcanoes. It is the brightest planet and in common parlance is known as the evening star and morning star. It is also known as earth's sister because its size and mass are equal to that of earth.

The **Earth** rotates from west to east therefore we can see the sunrise in the east and the sun-set in the west. Venus and Uranus rotates from east to west.

Mars is also known as the 'Red Planet'. Its highest mountain is "Nix Olympia" which is three times higher than Mount Everest. Recent discoveries have indicated the presence of life on this planet. Mars has two satellites : Phobos and Deimos.

Jupiter is the largest planet of our solar family. Its famous red spot is actually a large hurricane situated in the disturbed clouds. Of the 16 satellites of this planet the important ones are - Ganymede, Io, Europa, Callisto etc.

The famous ring around **Saturn** actually consist of thousands of spiral belts of waves. All around it there is a ring of gas and minute rock debris. Its famous satellites are Phoebe, Tethys Mimas etc.

It is clear from the table 12.2 that more is the distance of the planet from the sun greater is its time of revolution in its orbit.

Do you know, on 24 September 2014 the Bhartiya scientists were successful in establishing our space shuttle in the orbit of Mars. This Mars space ship was completely indegenous and was launched from Sri Harikota Andhra Pradesh. It took eleven months to reach the orbit of Mars. It is the first example in the entire world that our country successfully established it in its maiden attempt at a very low cost.

According to Bhartiya Panchang the celestial bodies which affect our earth are considered to be the planets. The nature and movement of these planets are very much similar to the ones obtained by modern science after calculations.

Planets and their movement according to Bhartiya Panchang

S. No.	Name of Planets	The planetary movement time (to travel in a rashi)
1.	Sun	One month in one rashi
2.	Moon	2.25 days in a rashi
3.	Mars	1.5 months in a rashi
4.	Mercury	0.75 month in a rashi
5.	Venus	0.75 month in a rashi
6.	Jupiter	13 months in a rashi
7.	Saturn	2.5 years in a rashi
8.	Rahu	1.5 years in a rashi
9.	Ketu	1.5 years in a rashi

Rahu and Ketu both come under the category of shadow planets. They are the points of intersection of the apparent path of the sun with the moon. They are in exact opposition to each other. They are the positions of the moon in which eclipse occurs. In Bhartiya Panchang other planetary movements have also been described which will be

studied in higher classes.

> The light of the sun takes approximately eight minutes to reach earth. The light reflected from the moon takes about 1¼ seconds to reach the earth, when the velocity of light is 3×10^8 m/s.

12.5 Rashi (Signs) :

Like nakshtra's have been named on the basis of the path of moon, similarly rashi are related with earth's movements. The earth's orbit has been divided into twelve sectors, each sector is considered to be a rashi.

According to the Bhartiya Panchang the

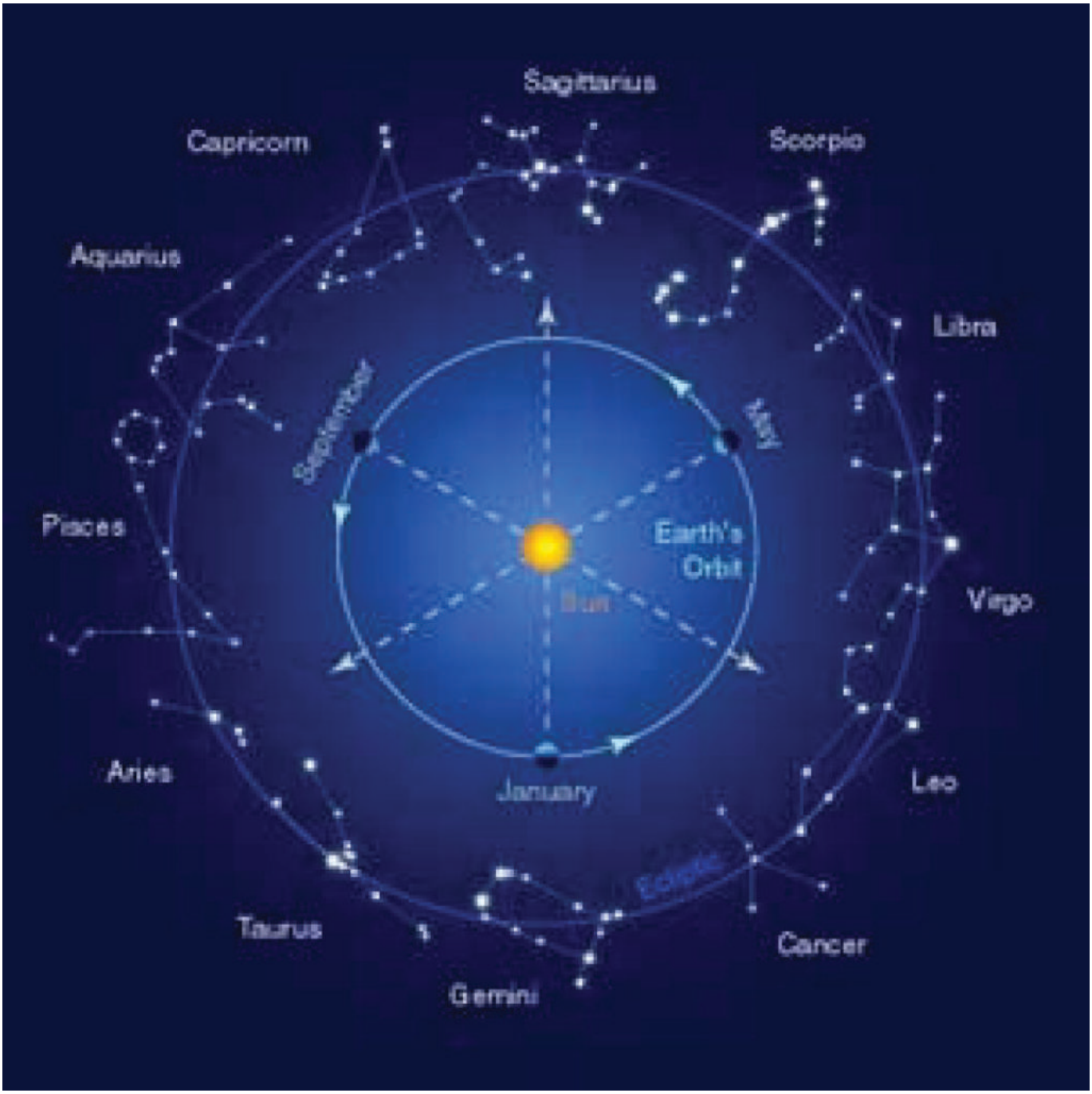


Fig. 12.3

names of these rashis and their shape are on the basis of various constellations present in the sky. The sectors of the rashi-chakra are bigger as compared those of the nakshtra-chakras. Therefore in each to there may be 2 or 3 nakshatras. Each nakshatra has been divided into four steps. Therefore there are 9 charans in a rashi.

In other words we may say that since earth takes nearly one year to move around the sun, therefore the sun will remain in each rashi for about one month. The position of these rashis is known as the twelve solar months. Peruse the different shapes of the various rashis in the table given below (table 12.3).

When the earth moves from one rashi to another it is known as the sakranti i.e the sun's transition. When sun transits in Capricorn it is known as Makar sakranti. Mostly it is on 14 January.

Table 12.3

S.No.	Rashi/sign	Shape
1.	Aries	Ram
2.	Taurus	Bull
3.	Gemini	Pair of male and female
4.	Cancer	Crab
5.	Leo	Lion
6.	Virgo	Girl
7.	Libra	Balance
8.	Scorpio	Scorpion
9.	Sagittarius	Bow
10.	Capricorn	crocodile
11.	Aquarius	pot
12.	Pisces	fish

12.6 Northern Movement and Southern Movement :

You must have heard that during Mahabharat Bhishm "Pitamah" slept on a bed of arrows, before his death, waiting for the sun to start the northern movement. In this chapter we will understand what is the meaning of northern movement.

You know that our earth revolves around the sun. This is known as Earth's orbit. If we divide the earth's orbit into two halves, then the position of sun for 6 months is daily from east to south-west. This is known as "Northern Movement" i.e. in the Northern Hemisphere. For next six months the daily position of sun is east to north-west. This is known as Southern Movement.

During Northern Movement the position of earth is such that the sun's light remain on the earth for more time therefore the days are long and nights are short in the Northern Hemisphere. The tilt of the northern hemisphere towards sun i.e. the northern movement starts from "Makarsakranti". Thus makarsakranti signifies the progress from darkness towards light. The six signs that fall in the path of the earth during northern movement are Capricorn, Aquarius, Pisces, Aries, Taurus and Gemini. Similarly, the Southern Movement i.e. tilt of the northern hemisphere away from the sun and Southern Hemisphere towards the sun, begins from the "Karka sakranti". During this time sun rays fall directly on the Southern Hemisphere and hence the days in the northern hemisphere are short while the nights are long. The remaining six rashis which fall in the path of earth during this time i.e. southern movement are Cancer, Leo, Virgo, Libra, Scorpio and Sagittarius .

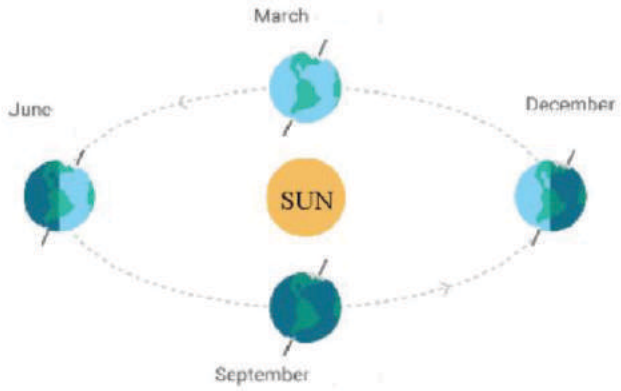


Fig. 12.4 Revolution of the Earth

On 21st June and 22nd December the Tropic of Cancer and the Tropic of Capricorn receives direct rays of the sun, respectively. (21st June - Summer solstice and 22nd December - Winter solstice.)

When the Equator receives direct rays of the sun i.e. neither of the two poles is tilted towards the sun, the length of the day and night is equal i.e. 12 hours each. This happens twice a year - on 21st March (Spring Equinox) and 22nd September (Autumn Equinox).

Activity 12.3 :

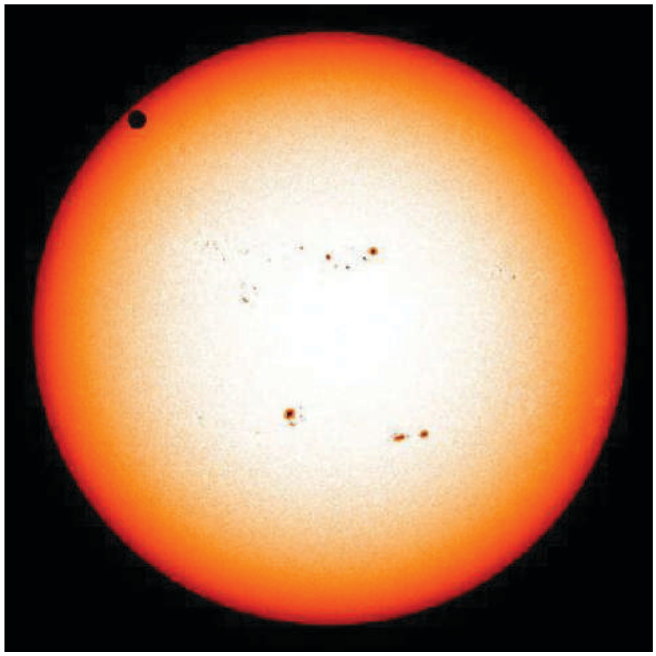
- Ask the students what all is done on the day of Makar Sakranti.
- Discuss the scientific and moral basis of the activities done on Makar Sakranti.

The sun is considered the stationary member of our solar family, hence by movement of sun, we mean change in position of sun due to earth, movement. It is similar to the case when we see a tree from the window of a moving train.

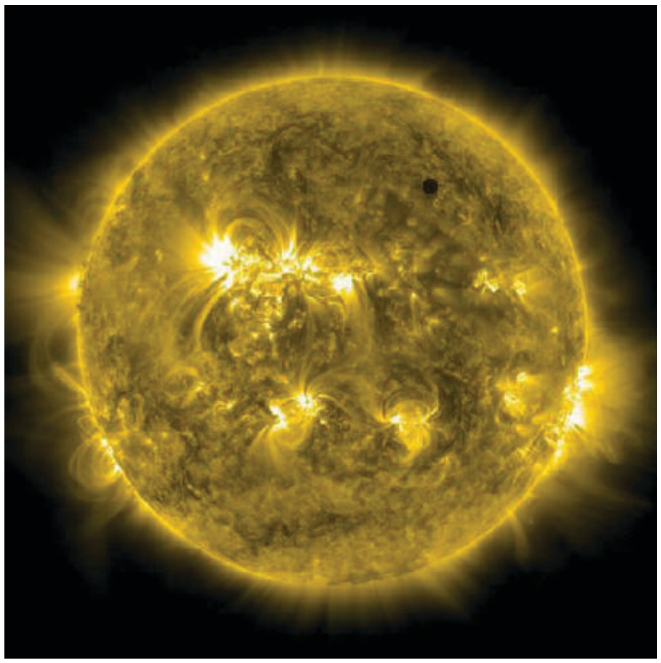
12.7 Transition of Mercury and Venus :

Many predictable celestial events take place in our sky. Some of them are repeated after years. These events appear differently in different parts of the earth. Two such events are the Mercury transit and the Venus transit which are being described here:

Venus Transit : Transit of Venus occurs when the Venus comes in between the earth (or any



S. No.	Longitudinal difference between the sun & moon	Tithi
1.	0-12	Pratipada or Ekam
2.	12-24	Dwitya
3.	24-36	Tritiya
4.	36-48	Chaturthi
5.	48-60	Panchmi
6.	60-72	Shashthi
7.	72-84	Saptmi
8.	84-96	Ashtmi
9.	96-108	Navmi
10.	108-120	Dashmi



11.	120-132	Ekadashi
12.	132-144	Dwadashi
13.	144-156	Tryodashi
14.	156-168	Chaturdashi
15.	168-180	Poornima

This duration of fifteen days is the brighter phase or Shukla paksha. Similarly, for the next fifteen days the longitudinal angle decreases i.e. 180-168 degree is the pratipada of the darker phase

or Krishan paksha and so on till it is Amavasya with the longitudinal difference between the moon and the sun being 12-0 degree.

In this way both Krishan paksha and Shukla paksha last for a duration of 15 tithis each; each tithi beginning at a different time of the day and vary in duration i.e. the duration of all thithis is not the same.

12.9 Celestial relation of the names of the Bhartiya months :

In the previous section you came to know about the twelve solar months which are related to the movement of the earth in relation to the sun. Similarly the lunar months are governed by the movement of the moon. There are 12 lunar months which have been named according to the constellations and rashis in the path of the moon's orbit.

For example after amavasya, when the moon appears in Aries rashi and Ashwini Nakshtra and gradually increasing phase by phase becomes the full moon in Chitra Nakshtra, then this month becomes the "Chaitra" (because of Chitra Nakshtra). In other words, the month is named on the basis of the location of the moon, on Full Moon day, in a particular nakshtra. Like the full moon will be in Kritika Nakshtra during the Kartik month. The table below enlists the nakshtras with their respective months.

Table 12.5

S. No.	Nakshtra	Rashi	Name of the month
1.	Chitra	Aries	Chaitra
2.	Vishakha	Taurus	Vaisakha
3.	Jaishtha	Gemini	Jyaishtha
4.	Poorvashada Uttarashada	Cancer	Asadha
5.	Shrvan	Leo	Sharavana
6.	Poorvabhadrapada Uttarabhadrapada	Virgo	Bhadrapada or Bhadra
7.	Ashwini	Libra	Ashwin
8.	Kritika	Scorpio	Kartik
9.	Mrgshira	Sagittarius	Margshirsh
10.	Punarvasu/Pushya	Capricorn	Paush
11.	Magh	Aquarius	Magh
12.	Poorafalgun Uttarafalgun	Pisces	Falgun

There is a difference in the duration of the lunar year and the solar year because of the difference in the rate of revolution of the moon and the earth. To co-ordinate between the lunar and solar months there is an increase in lunar month, every three year, which is known as the 'adhik maas'. One month is decreased in every 150 to 200 years.

12.10 Knowledge About Bhartiya Scientists

You have learnt about so many things about this universe in this chapter, have you ever thought of who provided all these informations and calculations?

This is the result of the continuous efforts of numerous astronomers, mathematicians and scientists over the years. The results and inferences of one scientists are carried by another and in this manner theforward knowledge expands. It is on the basis of the concepts and principles presented

by our ancient philosophers and scientists that many of our modern equipments, gadgets, machines etc. are invented.

The contribution of Bhartiya scientists in various spheres has been immense and have astonished the world by the depth and understanding of the subject concerned. You will feel proud to study about the brief biography and the contributions made by them, that have been presented in the following section.

Aryabhatt :

Aryabhatt was a great astronomer and mathematician of ancient Bharat. He was born in 476 BC. He studied at Nalanda and later on taught at this institute as he was a knowledgeable person. He brought into existence, great texts like Aryabhatiya in a very short time. It is a purely mathematical and astronomical scientific text.

The direct description of Aryabhatt's work has been known from the Aryabhatiya text only. The entire work consists of 108 verses and 13 extra in the form of introduction. It has been divided into four chapters :

1. **Geetikpaad** (13 verses) describes the bigger units of time like - Kalp, Manvantar, Yug etc.
2. **Ganitpaad** (33 verses) is a compilation of geometric progression and simple, quadratic, simultaneous and indeterminate equations.
3. **In Kaal Kriyapaad (25 verses)** these are the different units of time and the method of determining the position of planets at a particular day. It also includes the calculation of "adhika mass" (i.e. the extra lunar month) and "Kshya mass' (i.e. the decay month or the decrease in lunar month) and the names of the various days of a week.
4. **Golapada** (50 verses) includes the geometric and trignometric aspects, orbits, shape of the earth, reasons of day and night etc.

Aryabhata had initiated the discoveries a thousand years ago for which Copernicus became famous (1473-1543 AD). The main discoveries by Aryabhata include :

1. Represented the value of pie (π) accurately.
2. Earth rotates on its own axis.
3. Relation between the circumference and radius of a circle.
4. Area of a triangle.
5. Presented hypothesis regarding the geocentric model of the solar system and analyzed the reasons for the solar and lunar eclipse.
6. The time taken by earth to rotate around fixed stars was calculated to be 365 days 6 hours 12 minutes 30 seconds - which by the present day calculations have an error of just 3 minutes 20 seconds.
7. Calculated the perimeter of the earth which was just 0.2% less than the actual value.
8. Aryabhata was the first person who created the sine tables from 0 to 90º.

The methods of astronomical calculations presented by him were very spectacular which

remained useful as the micro-calendar in Europe for centuries. The calculation of dates done by Aryabhata and his followers have been of practical importance in Bharat.

The various discoveries made by Aryabhata without the availability of advanced means are of great significance. To commemorate his work, the first Bhartiya satellite was named as "Aryabhata".

He was a revolutionary thinker. He presented his correct opinion, although against the prevailing traditions, and paved the path of healthy traditions of scientific research in Bharat.

Varahmihir :

Varahmihir was a Bhartiya mathematician and astronomer of the 5^{th}-6^{th} century. He was born in a Brahmin family at Ujjain in 499 AD. He learnt the traditional mathematics and astronomy from his father Adityadas and carried extensive research in the field. He invented the time measuring device. The iron-pillar at Indraprastha was constructed by him and established the observatory at Jundishahpur on the invitation of the emperor of Iran. All these present a glimpse of his contributions. The center of advanced mathematical science developed by him at Patthak (Ujjain) remained unique for seven hundred years.

On his visit to Kusumpur (Patna) Varahmihir met the great mathematician Aryabhatta. Young Varahmihir was so much impressed by him that he made astrology as his aim of life. Chandragupt II on coming to know about his extent and depth of knowledge, included him in his nine gems. Varahmihir gave important formulae in the field of trignometry, optics and astronomy. Morever he worked on the accuracy of the sine tables prepared by Aryabhatt I. He died in 587 AD.

Panchsiddhantika summarises five earlier astronomical texts - Surya Siddhanta, Romak Sidhhanta, Paulisa Siddhanta, Vasishtha Siddhanta and Paitama Siddhanta. Varahmihir was the first person in the history who said that there exists a force which attracts things to the earth. Today that force is known as the gravitational force.

Varahmihir's main aim was to connect mathematics and science to public interest. In fact, this has been the tradition in Bharat from Vedic times. Varahmihir totally followed it.

Bhaskaracharya or Bhaskar II :

Bhaskar II, who is also known as Bhaskaracharya was born in 1114 AD at Bijapur, Karnataka. He was the famous mathematician and astronomer of twelfth century in Bharat. He wrote the first text with full and systematic use of the decimal number system. Bhaskaracharya wrote simple commentaries on the work of Aryabhata for the common man to understand. He also wrote his own texts based on these works. He wrote a book Siddhant Shiromani in Sanskrit at the age of 36 years. It has four parts - Lilawati, Bijaganitadhyay, Grahganitadhyay and Goladhyay which are the detailed descriptions of arithmatic, algebra, Planetary mathematics and sphere. He was the chief of the Ujjain's Astronomical observatories. Much before Newon, Bhaskaracharya had mentioned, in one of his texts that the earth pulls celestial bodies towards itself by virtue of a special force. 'Karan Kautuhal' is another composition by Bhaskar II, in which he has done various astronomical calculations. It is referred to while preparing the almanac (panchang). In another text, Suryasiddanta, Bhaskaracharya had made it clear that earth is round and moves around the Sun continuously in a defined orbit.

Bhaskara II also completed the incomplete works of the famous mathematician Bhramgupta (598-665 AD) whom he considered to be his Guru. Bhaskaracharya was the first mathematician who stated that the answer of any number divided by zero, is infinity. During the era when Bhaskaracharya was born and remained active in the field of science, was the time when many superstitions prevailed in our society. At such a time a rumour was spread by staunch and traditional superstitious people that earth was baseless and was sinking. They did it by misinterpreting the Puranic texts for selfish ends to keep their control over the society on the whole. At such a time, Bhaskar II, the great astronomer, fulfilled his duty as a scientist, by stating that although Earth is baseless but various planets & nakshtras present around it kept it in a balanced position by exerting gravitational force on it. The earth will remain as such and will never sink.

These facts are all the more important because the Bhartiya astronomers declared these facts years before the western astronomers and scientists did, which is a substantial proof of Bharat

being the forerunner in the field of science.

Bhaskara's astronomical views have been translated in various languages, over the years. Thus the important Bhartiya information regarding mathematics and astronomy were accepted on a global level. The great scholar Faizi, of Samrat Akbar's court, translated Bhaskaracharya's work 'Lilawati' in Persian. This text was translated into English by an english scholar Colebrooke in 1710. As a tribute to the works of this great astronomer - mathematician, the Government of India named its second artificial satellite 'Bhaskara'.

The term II is connected to his name to distinguish him from Bhaskara I who was born in approx 6th century. He also, was a famous mathematician.

Other Bhartiya mathematicians who have done commendable work includes Brahmguta (628 AD), Jain mathematician Mahaveeracharya (80 AD), Shri Bhaskaracharya (991 AD) Ramanujan (1887) Subhramanyan Chandrashekhar (1936). Sawai Jai Singh II (1686-1743 AD) of the Jaipur Royal family who built observatories at Jaipur, Delhi, Mathura, Varanasi and Ujjain. These are known as the Jantar-Mantar.

Important Points

1. Stars, sun, planets, asteroids, meteorites, comets, galaxies, moon etc. are the celestial bodies of our universe.
2. The Bhartiya almanac (panchang) is the book based on various calculations and provides information regarding the position and movement of various celestial bodies.
3. There are five main parts of the panchang - Tithi, Vaar, Nakshatra, Yog and Karan.
4. The constellations of specific shape lying in the moon's orbit are known as the nakshatras. There are 27 nakshatras recognizable during the movement of the earth and moon.
5. Our solar family is made up of various celestial bodies orbiting around the sun in different paths. These include planets, asteroids, comets, satellites etc.
6. The number of planets recognized by the international astronomical union is 8 which, in order of there distance from the sun are - Mercury, Venus, Earth, Mars. Jupiter, Saturn, Uranus and Neptune.
7. Jupiter is the biggest planet of our Solar System. Moon is a natural satellite of Earth.
8. According to the Bhartiya Panchang the celestial bodies, whose gravitational force affects the earth, are known as the 'grah' or planet. They are 9 in number viz. Sun, Moon, Mercury, Venus, Jupiter, Mars, Saturn and two shadow planets named Rahu and Ketu.
9. All the planets orbit around the sun and at the same time rotate on their axis. The time of revolution and rotation is different for each planet.
10. The earth completes its one revolution around the sun in 12 months. The earth's orbit has been divided into 12 parts. The constellation (nakshtra) present in each part of the orbit are known as the Rashi. They are - Aries, Tauras, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricorn, Aquarius and Pisces.
11. If the earth's orbit is divided into two parts of six months each, during six months the northern hemisphere is tilted towards the sun and receives the direct sun rays. This is the northern movement (Uttarayan). During next six months the tilt of northern hemisphere is away from sun. The sun's position being east - south west. This is the Dakshirayan or the southern movement.
12. When during its revolution around the sun, Mercury comes in between the Sun and the Earth, it appears as a dark spot on the sun's face which gradually moves ahead. This is known as the Mercury Transit. Similarly Venus transit also takes place. These events have been observed by scientists and will happen in future too.
13. At the end of Amavasya the longitudinal angle between the sun and the moon is more or less the same in the same rashi. Gradually during moon's movement there is a change in this angle. The tithis pratipada occurs when the angle is 0-12º. Thus other thiti also occur for each consecutive 12º longitude.
14. There are two phases in each month (Maas) Shukla paksha (increasing phase) and Krishan paksha (decreasing phase). Each paksh has 15 tithis. The last tithi of sukla paksha is Poornima

while that of krishan paksha is Amavasya.

15. The Lumar Month is named according to the position of the moon on full moon day in a given nakshatra. The twelve lunar months - Chaitra, Vaishakha, Jaishtha, Aashad, Shravan, Bhadrapada, Ashwini, Kartika, Margshirsh, Paush, Magh, Phalgun, are all named on this basis.
16. The analysis and forecast of various celestial events is possible by having the knowledge of the nature, movement and mutual relation of the celestial bodies. In ancient Bharat, many renowned astronomers and mathematicians like Aryabhata, Varahmihir, Bhaskaracharya etc. worked on various formula, theory and new information in the field and have astonished the world.

Questions

Objective Type :

1. The celestial bodies having their own light and heat are known as :
   (a) Stars (b) Planets
   (c) Satellites (d) Meteor
2. In which category has moon been placed in the solar system ?
   (a) Star (b) Planet
   (c) Satellite (d) Asteroid
3. The number of nakshatra according to panchang is :
   (a) 15 (b) 27
   (c) 12 (d) 07
4. What is the number of rashis according to the Panchang :
   (a) 15 (b) 27
   (c) 12 (d) 07
5. Which is the largest body of our solar system
   (a) Jupiter (b) Sun
   (c) Earth (d) Saturn
6. Which is the largest planet of our solar-system :
   (a) Jupiter (b) Saturn
   (c) Uranus (d) Neptune
7. The "adik mass" (extra month) appears in the lunar calender at an interval of :
   (a) 1 year (b) 2 years
   (c) 3 years (d) 4 years
8. At the initiation of the southern movement the earth is in which rashi :
   (a) Cancer (b) Leo
   (c) Capricorn (d) Aquarius

Very short answer type questions :

1. Who was the author of the book Lilawati based on arithematic?
2. The first Bhartiya satellite has been named after which great scientist?
3. Which tithi falls after Chaturdashi of the brighter phase (Shukl paksha)?
4. What will be the name of the lunar month if the moon on Purnima is in Mrigshira Nakshtra?
5. Which planet has the smallest period of revolution?
6. Write the name of the planets according to their increasing distance from the sun.
7. Name the terrestrial planets.
8. Apart from earth, which planet has the possibility of existence of life?
9. According to the Bhartiya Panchang which 'grah' belong to the category of shadow planets?
10. Two planets A and B are at a distance of X and Y, from the sun, respectively. If the value of Y is more than X, then which planet will have a longer revolutionary period.

Short Answer Type Questions :

1. Write the names of planets with increasing distance from the earth?
2. Write the name of the five parts of the Bhartiya Panchang.
3. What is meant by Nakshtra? How many nakshtras are there? Name any five nakshtra.
4. How is a tithi determined according to the Bhartiya Panchang? Explain in brief.
5. Write the names of the planets according to their increasing size.
6. What is meant by northern and southern movement?
7. Explain the various motions of the earth.
8. According to the Bhartiya Panchang, rashi are related to whose movement? How are the rashis determined?
9. What is the meaning of Makar-Sakranti?
10. What do you understand by "adhik maas"?
11. Explain mercury transit. Compare it with the Venus transit.
12. Write the names of lunar months according to the Bhartiya Panchang.

Essay type answer questions :

1. Write the main points of the biography of Aryabhata and explain his contributions in detail.
2. Outline the biography of Bhaskaracharya and describe in detail the work accomplished by him.
3. What is the basis of the nomenclature of the Bhartiya months (maas)? Write the names of the Bhartiya months (lunar months) and explain in detail the celestial position formed at that time in the sky.
4. Write in detail about our solar system.

Answer Key

1. (a) 2. (c) 3. (b) 4. (c) 5. (b)
6. (a) 7. (b) 8. (a)

Chapter-13

Environment

13.1 Meaning of Environment :

The etymological meaning of environment is surround (French 'Environment' = to surround). In Webster dictionary environment h as been defined as the group of all the conditions which affects the existence, growth and progress of an organism or a group of organism. Thus it includes all the components and conditions of the surrounding that affects the existence growth and progress of organisms. It can also be said that environment is a "Life Support System" because the existence and perpetuation of all the constituent organisms of the biosphere depends on it. The science related to the study of the mutual activities of environment and the organisms living there in is known as **Ecology**. Living beings remain embedded in their environment which (i.e. the environment) provides all the resources for its protection and perpetuation. The requirements for the support and continuity of living beings does not remain constant for the various phases of their life cycle-from birth to death, i.e. they are variable. Environmental factors are changeable with space and time. Hence at a given time and space, the existence and perpetuation of a living being depends on the integration of its ever changing needs and environmental rate of keeping up with them.

The physical, chemical, biological, scientific and technological components of the environment surrounding the living beings have been broadly categorized in the following three sub complexes :

(a) Abiotic sub complex

(b) Biotic sub complex and

(c) Scientific and technological sub complex

There are many factors in each sub complex which affect each other at the complex level and thus all the three sub-complexes form the total environmental complex by interacting with each other. The living beings are supposed to be lodged in this complex. In his epic-Ramcharitmanas, Tulsidas has considered the five abiotic components, i.e. earth, water, energy, space and air, to be the resource for the composition of living beings (Ramcharitmanas 4). The abiotic and biotic components of environment are being transformed at a large scale because of the changes brought about by the scientific and technological revolutions during the last century. It is because of this reason that the third subcomplex has been included. In it an artificial environment has been created for the living organisms. Haber termed it as the Tech-ecosystem in 1989.

This environment of the living beings can be in the form of natural, physical, chemical and biological form. The environment includes the fauna, flora and their related factors like - light, air, water, soil, sound, humidity etc. Earth's environment is also known as Biosphere. It includes Hydrosphere, Atmosphere and Lithosphere. Environment includes all the things that surround the living world and influence their life in different ways.

In Bharat, from vedic period only, there has been a tendency of exploration, testing and analysis of the environment. Its knowledge has also been described in the Purans, Veds and Upnishads. It has been mentioned in these scriptures that origin of human is from the five elements : earth, water, fire, space and air. Environment has been described in Vishnu Puran, Vrahat Samhita, Charak Samhita and Sushrut Samhita. Examples of environmental awareness have been mentioned at many points in the epics like the Ramayan andthe Mahabharat.

Biotic and abiotic components are included in the environment. Biotic factors include animals, plants, micro-organisms and humans while abiotic factors include air, water, soil, temperature, moisture, topography etc. These components of the environment function together and keep coordination with each other and also transform each other's effects. Environmental studies include the study of its various components, including their

promotion, conservation and management.

13.2 Environmental Pollution :

The meaning of the words pollution and pollute as given in Oxford dictionary are as under :

Pollute : Contaminate (or make air, water etc. impure) with harmful or poisonous substances.

Pollution : The presence in or introduction into the environment of a substance which has harmful or poisonous effect.

Thus it is clear that pollution cannot be defined in exact words, however the word can be analyzed in order to form a concept of environment. Pollution is the unwanted change in the air, water, soil, biological creatures etc. which degrades the basic composition of these resources. It can have adverse impact on the biotic components, specially man, by bringing about direct or indirect changes in one or more abiotic components of the environment. Some pollutants like bad-odour, noise etc. can have psychological consequences. At times they become risky and hazardous for human heath.

Pollution can be categorized into two types

(1) Those which result in harmful changes, in the physical and chemical components of the environment, for man.

(2) Those in which some new substances are incorporated in the environment by the modern industrial and technological activities of man. As compared to the first category of pollutants these new substances are negligible.

Increase in population is a direct attack on natural resources. Modern man believes that earth is made for man. He is authorized for the exploitation of resources. Our Father of Nation had said that "Earth provides enough to satisfy every man's needs but not every man's greed." Thus the prime reason for the exploitation of nature and the danger of pollution is the greed and ignorance of man.

If evaluated judiciously, it will be obvious that the fast growing population, unplanned destruction of forests, urbanization, industrialization, the blind-pace of development etc are the actual reasons of the ever growing pollution.

In Bharat, the awareness about nature has been there since Vedic times. Environmental conservation had been an integral part of life-practices in the entire Vedic and Post-vedic era. Upanishads presents policies to conserve resources for our future generations. Samrat Ashok's inscriptions perhaps is the first record of wild life conservation. They reveal that Ashok had made hospitals and reserved areas for protection wild life and birds. The moghul attacks on our country were quite unfortunate, in the sense that it destroyed our social system to an extent that our ancestor's knowledge of times immemorial was concealed.

The so called development related to the technological revolution and blind-pace for technological development has set the concern for nature at backfoot. Neglect of long term benefits for humanity and the desire to obtain instant benefits have generated conditions which are having harmful effects on plants, animals and human-life.

13.2.1 Air pollution

The air that forms the atmosphere is actually a mixture of various gases. It includes oxygen the life-giving, indispensable gas for respiration and other metabolic processes of living beings.

Table 13.1
Composition of Air on the basis of volume

S.No.	Component	Percentage
1.	Nitrogen	78.09
2.	Oxygen	20.95
3.	Carbon-di-oxide	0.03

Other components include Argon, Krypton, Helium, Ozone, Carbon-mono-oxide, water vapour, Ammonia, Methane etc.

13.2.2 Causes of Air Pollution :

Air pollution may be caused naturally or may have anthropogenic (caused by man) origin. Following are the natural causes of air pollution :

1. **Volcanic eruption :** In this gaseous pollutants such as Sulphur-di-oxide (SO_2), Hydrogen sulphide (H_2S), Carbon-mono-oxide (CO) etc. are evolved.
2. Forest fires.
3. Marsh gases (like methane - CH_4).
4. Products of natural decomposition of various organic and inorganic substances.

5. Suspended particulate matter.
6. Extra-terrestrial substances.
7. Cosmic-dust.
8. Allergens and irritants like pollens, spores etc.

Following are the examples of pollutants of anthropogenic origin :

1. Industrial effluents (discharge)
2. Vehicular effluents
3. Domestic effluents
4. Substances produced by burning of fossils
5. Explosives and other chemicals used in wars etc.
6. Various substances used in agriculture and agricultural practices.

Effect of Air Pollution :

These pollutants have adverse effects on human health. Given below are a few pollutants and their effects.

1. **Sulphur-di-oxide :** Chest congestion, headache, vomiting etc. Disorders caused by it may become fatal.
2. **Oxides of nitrogen :** They cease the activity of cilia. This is the reason why carbon and dust particles may reach the lungs causing various respiratory disorders.
3. **Hydrogen sulphide :** Causes irritation in throat and eyes and nausea.
4. **Carbon-mono-oxide :** It reduces the oxygen carrying capacity of blood and causes fatigue.
5. **Hydrogen cyanide :** If affects the nerve cells and results in dry throat, vague vision, headache etc.
6. **Ammonia :** It causes swelling in upper respiratory tract.

13.2.4 Control of Air Pollution :

Judicious and limited use of resources can control air pollution. A few strategies of controlling it, include :

1. **Adsorption :** It is a physical process that depends upon the surface properties of some substances. In it the flow of liquid and gas is coupled with a solid, so that the solid holds a thin film of the liquid or gas on the outside surface - thus entrapping it. Activated charcoal, silica gel. Resin etc. are used as adsorbents. In this process the adsorbents may be reused hence it is an economic (thrift) process.
2. **Absorption :** This also is a physical process. In it the gases are allowed to dissolve in fluids. Water is the best solvent or medium for absorption.
3. **Condensation :** The gaseous vapours are controlled by condensation. It is the best method for removing the hydrocarbons having very low vapour pressure at ambient temperature, (i.e. air temperature of the surroundings). Air pollution can be satisfactorily controlled by using water or air cooled condensers.
4. **By chemical reactions :** Pollutants can be removed from the air by various chemical reactions.

13.2.5 Water Pollution :

Water is the most valuable resource of the planet earth, on which the life of all organisms depend. It is the main component of all living beings. In some organisms it forms upto 90% of the body weight. History reveals that all the great civilizations prospered on the banks of various rivers. Non-judicious use and wastage of water converted these civilizations into graveyards. Water provides natural beauty to landscapes and generates aesthetic beauty in them. It is the basis of entertainment and water sports. It is an important component for human health. Its pollution gives rise to many epidemics and water-borne diseases.

13.2.6 Causes of water pollution :

As in case of air pollution, even water-pollution has two reasons (1) Natural and (2) Anthropogenic. In the natural process of water pollution fusion of natural substances like salts, chemicals, minerals and products of the decomposition of the water soluble plant and animal products are involved. All of them are washed off to water bodies like ponds, lakes, puddles, rives etc. by the rain water and ultimately they may reach the oceans or ground water. The oceanic water is saline because accumulation of various salts which are

brought down to it, over centuries, by the ever flowing rivers.

The present day problem of water-pollution is the result of the modern industrial activities. Dirty domestic water, sewage water, sewage, urban wastes, industrial effluents, agricultural wash-out, oil-grease, decomposition products of the solid waste etc. when immersed in natural water bodies result in water pollution. The water soluble pollutants from air and land ultimately reach water bodies thus polluting them. The soluble effluents then may reach down to the ground water sources.

Various substances which pollute water by dissolving in it include : (1) Acids (2) Base (3) Coal (4) Dyes (5) Fats, Soap and waxes (6) Gaseous adjunct (dissolved gases) (7) Fertilizers (8) Insecticides (9) Weedicides (10) Farm products (11) Poisonous metals like mercury and its compounds (12) Synthetic detergents (13) Oil (14) Proteins and carbohydrates (15) Dissolved solids (16) Other organic pollutants (1) Poly chlorinated biphenyls (PCBs) (b) Phenol and phenolic compounds (c) Polynuclear aromatic hydrocarbons (d) Aldehydes (17) Radioactive substances (18) Thermal pollutants which include heated industrial waste water or water from the cooling towers of the nuclear power plants (19) Colours (20) Biological pollutants - Virus, Algae, Fungi etc. (21) Odour and (22) Turbidity etc.

All the fourteen big rivers of Bharat, including Ganga, Yamuna, Godavari, Gomti, Kosi, Kauvery, Ravi, Son, Chinaab, Jhelum, Narmada, Mahi, Tapti and Krishna are the victims of intense water pollution.

13.2.7 Effects of water pollution :

If the pollutants accumulating in the oceanic waters cross the threshold, then the planktons which release nearly 60% of the photosynthesis oxygen of earth, will land into a condition of mismanagement and disaster. It will be very difficult even to estimate the harm caused by decrease in dissolved oxygen level to levels less than the biological oxygen demand.

13.2.8 Control of water pollution :

Integrated water and waste management programs are required to get rid of the menace of water pollution. This approach comprises : (1) Water treatment (2) Waste water treatment, (3) Waste water recycling (4) Product recovery. The following techniques of waste water treatment can be made use of :

(1) Oxidation and stabilization ponds - The effluent water is stablized in these ponds which gets oxidised in sufficient sun-light and hot-climate.
(2) Treatment of sewage effluent water and reuse it for agricultural purpose.
(3) Remove the pollutants :
  (a) separation of salts by reverse osmosis
  (b) removal of metals by electrolysis, ion dispersion resins etc.
  (c) Controlled culture of water hyacinth (though it is very harmful for the existence of water bodies)
  (d) Root zone treatment technique.

There is a need to have a water management policy, on a local level, with the aim of making available water for human consumption. Following measures may be taken for ensuring water availability :

1. Take proper measures to control pollution of puddles, rivers, rivulets, lakes etc.
2. Conservation of natural vegetation.
3. Improvement in the catchment area of rivers, rivulets, lakes, ponds etc.
4. Proper sewage treatment before immersing it in water bodies.
5. Construction of water reservoirs.
6. Development of underground water reservoirs on large scale.
7. Rain water harvesting.
8. Recharging the ground water and aquifers.

13.2.9 Soil pollution :

Soil is the part of lithosphere which interacts with atmosphere, hydrosphere and biosphere. Thus it fulfils the fundamental requirements of terrestrial living beings. Soil provides the essential elements to planets which then produce organic substances from which the basic needs of human - food, cloth and shelter - are fulfilled.

In soil, different types of particles are present in different combinations and proportions. It

has inter-particulate spaces that are filled with air and water. If the soil is not well aerated, the spaces between soil particles get water logged and prevents the growth of the root system. This happens in soil which lack proper drainage and the soil becomes water logged.

13.2.10 Causes of Soil Pollution :

Soil pollution has resulted from the modern life style, and the human activities related to industries and agriculture. A few important sources of soil pollution includes :

1. **Industrial wastes/effluent :** The solid and liquid effluent from industries are spread on the soil without any type of pre-treatment. The fly-ash which spreads for miles harm the soil to a great extent. The minerals, chemicals, toxins etc. of the effluents pollute the soil and make it barren.
2. **Urban effluents :** Paper, glass, metallic boxes, plastic, fibres, food-waste, rubber, dyes, paint etc. are the solid urban wastes which pollute the soil to a large extent. The liquid urban wastes include the organic and inorganic chemicals, oil, grease, toxic substance etc. which spread on the soil and pollutes it. These effluents have pathogens which cause various diseases.
3. **Agricultural activities :** In-judicious, unforeseen use of chemical fertilizers in excess and excessive irrigation makes the soil water logged and devoids the soil of the essential nutrients. This makes the soil barren.

The concentration of soluble salts increases in the soil due to excessive use of chemical fertilizers every year. Such soils are known as the saline soil. If the sodium content of such soils increases they become alkaline and are known as the alkaline or sodic soil. Both the types of soils - alkaline and saline - are known as 'usar' in Bharat. They are the most unsuitable soil for agriculture.

In modern-agricultural practices, various chemicals like- pesticides (like DDT), fungicides bactericides and herbicides are used on large scale to protect plants from pathogens, diseases, weeds etc. These chemicals do not decompose, in general and remain in the soil. Plants, at times, absorb them and they reach the higher trophic levels by means of the food chain. In this process, there is biomagnification of these substances and they become toxic for human consumption.

13.2.11 Noise pollution :

The sound energy, which flows in unit area of the medium in unit time, is measured in watt/meter square. The sound pressure can also be measured in Newton/meter square (N/m^2). The loudness of sound is expressed in terms of a unit 'sone'. 1 Sone = 40 dB sound amplitude. 1 dB (decible) = 0.002 microbar sound pressure ($dynes/cm^2$) - approx. 10^{-16} watt energy. The range of human hearing may vary from 0 to more than 120 dB. Generally a sound of 80 dB is considered to be critical level to damage the ears. Therefore this and higher amplitude sounds are considered to be pollutant.

WHO (World Health Organization) has fixed 45dB as the safe noise level for any city. A sound level of more than 90dB for more than 10 milliseconds leads to aural reflex action and contracts the tympanic membrane. Sound of more than 140dB changes the direction of movement of ear ossicle, because of which the intensity of sound received by internal ear decreases. This protective reflex action can protect us from the danger of loud noise only for some time. On the basis of these facts 65dB has been accepted to be the limit to tolerance, in hospital areas, according to international standards.

Noise pollution affects human health, ease and efficiency. It may contract blood vessels and may increase the secretion of a hormone - adrenalin which generates blood pressure. This results in strained muscles which may lead to psychological tension, nervous disorder and madness. high level of noise pollution may lead to mental fatigue, high cholesterol level, heart attack and may damage brain, kidney, liver etc. and may cause long-lasting damage to the ciliated cells on the inner lining layers which may lead to deafness.

Thermal Pollution :

The temperature of a natural water body increases if hot effluents are added to it, causing thermal pollution. This reduces the water quality

and harms aquatic and terrestrial organisms. The sources of thermal pollution include :

1. **Coolants of nuclear power plants :** The temperature of the effluent coolants of these power plants is on an average 10ºC higher than the water entering the system. This affects the aquatic life adversely.
2. **Effluents of the thermal power plants:** These power plants use coal for generating electricity. For the purpose, water from nearest water body is made use of and then the effluent having a temperature of at least 15ºC more is again sent to the water body. This warm effluent reduces the amount of dissolved oxygen which results in the death of fishes and other aquatic living beings.
3. **Effluents from the hydro electric power plants :** This is perhaps the only process of power generation in which there is negative thermal loading of a water system.
4. **Industrial effluents :** The cloth, paper, sugar etc. industries produce heated effluents which have a temperature that is approximately 8 to 10ºC high. The effect caused by the temperature of these effluents depends on the original temperature and size of the water body.
5. **Domestic sewage:** The domestic sewage is immersed in water bodies without pre-treatment. Normally, the temperature of the domestic waste is higher and hence may increase the water temperature. This leads to reduction of the number of aquatic organisms. This may also lead to anaerobic conditions because of which fishes may die. Some of the physical and chemical changes and the adverse effect of thermal pollution on the biology of living beings and biological communities, includes :

(a) **Physical conditions :**
   1. Increase in temperature
   2. Increase in vapour pressure
   3. Increase in the silting-rate of suspended particles etc.
   4. Decrease in density
   5. Decrease in viscosity

(b) **Chemical conditions :**
   6. Increase in chemical oxygen demand (COD)
   7. Increase in biological oxygen demand (BOD)
   8. Increase in toxicity

(c) **Biological effects :**
   9. Changes in physiological activities
   10. Change in Metabolic rates
   11. Change in biochemical parameters
   12. Interference in reproduction
   13. Variation in the rate of reproduction
   14. Increase in direct mortality of aquatic organisms.

(d) Effect on Biological communities:
   15. The distribution patterns of living organisms change.
   16. Unwanted changes in algal population.
   17. Formation of water blooms by cyanobacteria.
   18. Attack of destructive organisms.

In order to reduce thermal pollution the plant design should be altered to reduce the temperature of the effluents. The effluents produced may be cooled off to normal temperature before immersing them in water bodies. For the purpose special cooling tanks or towers can be constructed.

13.3 Ecology :

Environmental study is a part of ecology. The word ecology has originated from a greek word 'Oikos' which means 'a place to live' and 'logos' means 'to study' i.e. to study about the habitat of living organism. According to Ernst Haeckel (1868) "ecology is the mutual interaction of living organisms with its biotic and abiotic environment."

Each organism obtains different substances from the environment to survive. For example - oxygen is essential for respiration; similarly plants need carbon-di-oxide, water and sun-light for photosynthesis. The minerals required for plant growth are obtained from soil. Animals obtain their

food from plants and micro-organisms and human being obtain food from plants and animals.

Metals like copper, aluminium, iron etc. are used to make machines, utensils, ship, aircrafts etc. These metals are obtained from minerals. Coal, petroleum and natural gas are used as domestic and industrial fuel. In this way the living beings use various substances found on earth.

The substances required by living beings for sustenance of life are known as Resources. All the substances that are present in nature and are essential for the flow of life of living beings are known as **Natural Resources**. Air, wind, soil, vegetation, animals, minerals, sun-light, fossil fuel etc. are natural resources.

13.4 Ecosystem :

It is the structural and functional unit of biosphere and is characterized by self sustenance. i.e. ability to continue a healthy state without outside assistance. It is an open system and depends on sun-energy. Ecosystems may be small or big. There is a continuous exchange of minerals and energy between neighbouring ecosystems. Hence, all the ecosystems are interlinked and inter related. The web of inter-linked ecosystems is known as the **biosphere**. The term 'ecosystem' was first of all used by a British Ecologist Arthur Tansley in 1935. It is made up of biotic and abiotic components. According to Eugene P. Odum (1963) ecosystem is the basic unit of ecology in which the biotic and abiotic components interact with each other and both components are important for the continuum (uninterrupted existence) of life. Animals are holozoic and do not prepare their own food; they depend - directly or indirectly - upon plants for their food requirements. Although plants synthesize their own food yet they depend on various abiotic factors. From a broader perspective, the earth we live upon is itself a giant ecosystem whose various biotic and abiotic components interact with each other. It is because of this reason that structural and functional changes occur continuously in the ecosystem. Although it appears to be impossible to control the entire Bioshpere but to facilitate its study it can be subdivided into various ecosystems.

13.5 Structure of Ecosystem :

Ecosystem is made up of two main components biotic and abiotic.

(1) Abiotic components : It includes inorganic, organic and climatic factors like - air, water, soil, sun light etc.

- **(i) Inorganic substances :** It includes nutritive elements and components like - carbon, nitrogen, sulphur, phosphorus, carbon-di-oxide, water etc. They are cycled in the ecosystem.
- **(ii) Organic compounds :** It includes proteins, fats, carbohydrates, humic substances etc. They are basically related to the living body and connect the abiotic and biotic components.
- **(iii) Climatic factors :** They are of two types -
  - (a) Environmental factors like sun-light, temperature, humidity, precipitation etc.
  - (b) Edaphic factors like topography, soil texture etc.

(2) Biotic components : The living components of the environment are known as the biotic components. They can be further categorized as producers, consumers and decomposers.

- **(i) Producers :** These are the chlorophyll containing plants which include algae, grass, trees etc. They convert solar energy into chemical energy during photosynthesis. They are the source of food for majority of animals. They are also termed as **autotrophs** as they synthesize their own food.
- **(ii) Consumers :** These are the organisms which cannot synthesize their own food and depend on other organisms for their nourishment. They are known as the **consumers** and are **heterotrophs**. Mostly they are animals. Animals which directly depend upon plants for their food are known as **herbivorous**. For example - grass hopper, goat, sheep, rabbit etc. The

animals which depend upon herbivorous animals for their food requirement are known as **carnivorous**. For example snake, lion, frog etc. They may be **predators** or **parasites**. The animals which can derive their food from both plants and animals are known as **omnivorous**. For example - cockroach, man etc.

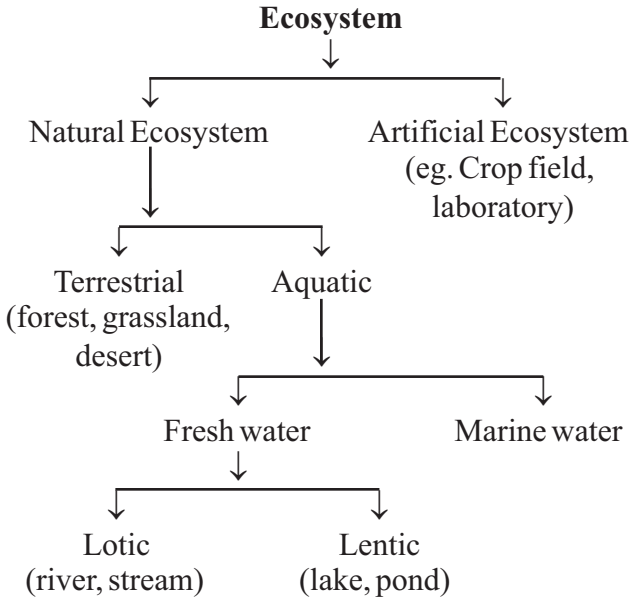
(iii) Decomposers : This category mainly includes bacteria and fungi. In an ecosystem bacteria generally work upon the animal tissue while fungi on plant tissue. They digest dead organic matter with the help of enzymes and in this way the basic elements of the cell components are released into the atmosphere, which are then reused by producers.

13.5.1 Types of ecosystems :

Ecosystem are of two types :

1. **Natural ecosystem :** They are naturally under their own control and are self sustained with the human interference of the least order.
   - **(a) Terrestrial ecosystem :** Example- Forest, grassland, desert etc.
   - **(b) Aquatic ecosystem :** They are of two types (i) Fresh water and (ii) marine water. The fresh water ecosystem again may be of two types lotic (example - river, streams etc.) and lentic (example - pond, lake etc.).
2. **Artificial ecosystem :** These ecosystems are man-made and are under their control. Example crop-land which includes fields of wheat, bajra, rice etc. Here man tries to control the biotic community and physico-chemical factors.

Apart from the above systems, even the space eco-system has been recognized.



13.6 Biogeochemical cycle :

The harmony between the biotic and abiotic components of the biosphere keeps it dynamic and stable. There is transfer of substance and energy between the various components of biosphere due to this co-ordination. Let us consider the various processes that keep this balance.

13.6.1 Water-cycle

You have seen how it rains following vapourisation of water from water bodies and then there condensation. But we have never seen the seas and oceans drying. Then how is water replenished in these reservoirs.

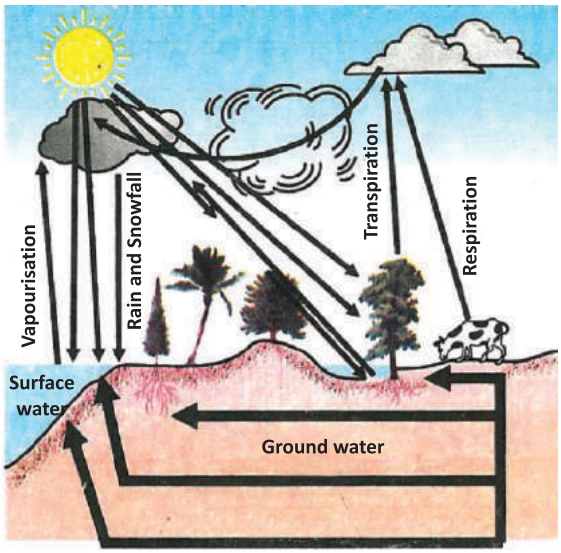


Fig 13.1 Water cycle in nature

The entire process by which water forms water vapour, forms clouds and then comes back to the earth surface in the form of rains and then flows into the oceans is known as the water cycle.

This cycle is not so easy and simple as it appears to be by the statement given. All the water that comes down to earth does not directly flow into the oceans. Some of it percolates into the soil and forms part of the water table. Some of this ground water flows out in the form of streams on the earth surface or we bring it to the surface through wells and tube wells. For the various life processes the terrestrial living beings use this surface water. (fig. 13.5.1)

As is a well known fact, water dissolves many substances. When water flows through soluble minerals some of them dissolve in it. These are then carried over to oceans by water flowing in the rivers and rivulets and they are then used by the aquatic flora and fauna.

13.6.2 Oxygen cycle :

Oxygen is one of the most abundant element on earth. Its quantity is nearly 21% of the atmospheric gases. It is also present on a large scale, on the earth surface, in the form of water and other compounds and in air in the form of carbon-di-oxide also. It is present in the form of metal and silicon oxides in the earth's crust. It is also present in the form of carbonate, sulphate, nitrate and oxides of minerals. It is an essential component of biomolecules like - carbohydrates, proteins, nucleic acid and fats or lipids.

But when we talk about oxygen cycle, we are basically concerned with cycle that keeps the oxygen levels in nature balanced. Oxygen from atmosphere is used in three processes - Respiration, combustion and formation of oxides of nitrogen. Oxygen returns to the atmosphere by only one process i.e. photosynthesis. This forms the outline of oxygen cycle in nature.

Although we consider oxygen to be of importance in the respiratory process but for some organisms, mainly bacteria elemental oxygen is toxic. Actually nitrogen fixation does not take place in the presence of oxygen.

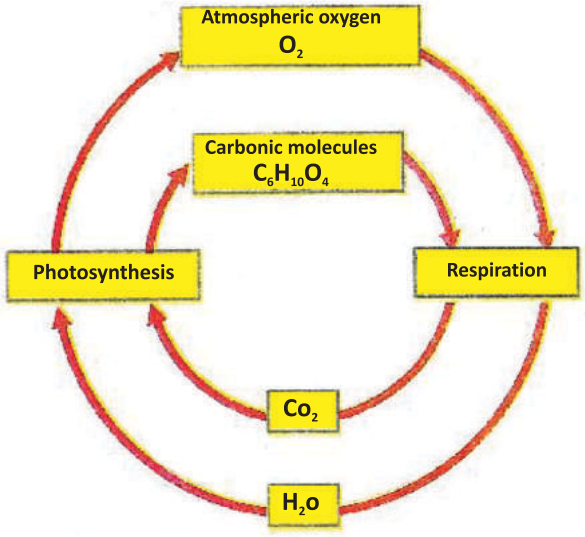


Fig. 13.2 Oxygen cycle in nature

13.6.3 Carbon cycle :

Carbon is present on earth in various states. It is present in the form of diamond and graphite in its original form. In atmosphere it is present in the form of a compound - carbon-di-oxide; carbonates of various minerals and hydrogen carbonate. Furthermore, all the life forms are based on carbon-based molecules like - proteins, carbohydrates, fat, nucleic acid and vitamins. The exo and endo

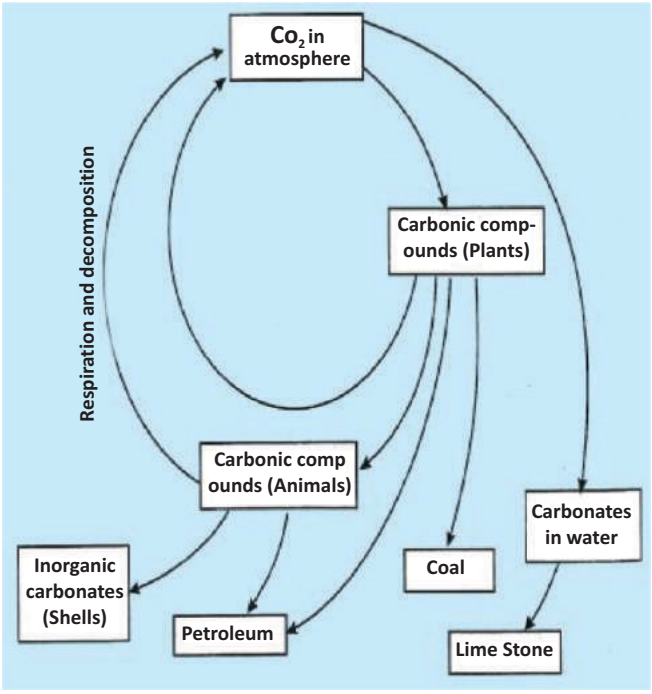


Fig. 13.3 Carbon cycle

skeleton of many organisms is made up of carbonate salts. Carbon is incorporated in various forms of life through the process of photosynthesis which takes place in the presence of sunlight in the chlorophyll containing plants. The carbon-di-oxide present in the atmosphere or in dissolved form in water is converted to glucose by the process of photosynthesis. These molecules of glucose either convert into other molecules or provide energy for the synthesis of other important molecules.

Glucose is used in the process that provides energy to living beings. Glucose is oxidized to carbon-di-oxide, with or without oxygen, by the process of respiration. The carbon-di-oxide thus formed goes back into the atmosphere. Carbon-di-oxide also enters the atmosphere through the process of combustion where fuel is used to cook food, warm it, or in transportation and various industries. Actually after industrial revolution man started using fossil fuels on a large scale, to the extent that the amount of carbon-di-oxide in atmosphere has nearly doubled. Like water even carbon is recycled by various physical and chemical processes.

13.6.4 Nitrogen cycle :

Nearly 78% of our atmosphere is made up of nitrogen gas. This gas is the component of many molecules essential for life. For example : proteins, nucleic acid - DNA and RNA and some vitamins.

Nitrogen is found in other bio molecules also like alkaloids and urea. Thus nitrogen is an essential nutrient for all organisms. The life would be simple if all the organisms use nitrogen present in the atmosphere, directly. But this does not happen in nature. Apart from some bacteria, most of the other organisms are unable to convert the inactive nitrogen into nitrates, nitrites etc. "Nitrogen fixing" bacteria are found either as free living forms or in symbiotic association with some types of dicots. Generally, these nitrogen fixing bacteria are present in special root nodules of pod bearing plants. Apart from these bacteria, the nitrogen atoms also form nitrates and nitrites by various physical reactions. The high temperature and pressure generated in the atmosphere at the time of lightening, converts nitrogen to oxides of nitrogen. These oxides dissolve in rain water and form acid which fall on earth surface; then after it is used by various life forms.

What happens to nitrogen after it forms various nitrogenous molecules. The plants, generally, absorb nitrates and nitrites and convert them into amino-acids which are used in protein synthesis. There are some other bio-chemical options which are used for synthesis of other nitrogen containing complex molecules. These proteins and other complex compounds are then used by the animals. When the plant or animal die, various bacteria present in the soil converts the nitrogenous compounds into nitrates and nitrites and other type of bacteria break down these nitrate and nitrite molecule into nitrogen element.

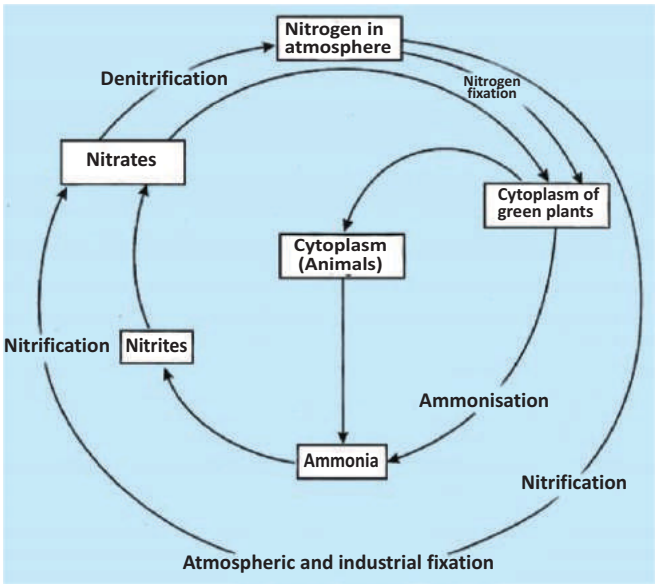


Fig. 13.4 Nitrogen-cycle in nature

Thus in nature there operates a nitrogen cycle in which nitrogen, passing from its basic form in atmosphere converts into simple molecules in the soil and water and then in living beings it forms very complex compounds. Later-on they break down, releasing the nitrogen atoms back into the nature.

13.7 Green House Effect :

In a glass house, the internal temperature is very high as compared to the external temperature because the glass does not allow the heat waves to transmit back in the atmosphere. This concept is made use of in maintaining, warm tropical plants in the cold climate. This type of cover is known as a green house.

Similar, phenomenon occurs in the

atmosphere too. Some gases prevent the escape of heat into the outer atmosphere. Increase in the amount of such gases in the atmosphere may rise the average temperature of the earth's atmosphere. This type of effect is known as the **green house effect**. Carbon-di-oxide is a green house gas. Increase in the amount of carbon-di-oxide in the atmosphere will increase the heat content of the atmosphere. These activities lead to global warming.

13.8 Ozone layer :

The elemental oxygen is generaly present in the form of bi-atomic molecule. However, in the upper layer of atmosphere tri-atomic molecules are also present. Its formula is O_3 and is known as ozone. In contrast to the biatomic oxygen molecules, the ozone is toxic. We are lucky that ozone is unable to remain near the surface layers of earth. It absorbs the harmful radiations of the sun. Thus it prevents those radiations from reaching the earth surface which may harm various life forms.

Recently, it has been detected that the ozone layer present in upper atmosphere is degrading. Different types of compounds, made by man, for example the chloro-fluoro-carbons (CFCs) are present in the atmosphere in a stable state. CFCs are chlorine and fluorine containing organic molecules. They are very stable and do not degrade even by biological processes. Once they reach near the ozone molecules, they react with them. This results in decrease in the amount of ozone and this leads to thinning of the ozone layer. Recently ozone hole has been observed above Antarctica. It is very difficult even to think about the hazardous effects the life on earth will be subjected to, in the absence of this ozone layer, which is thinning rapidly. Serious efforts are required to be undertaken to protect it.

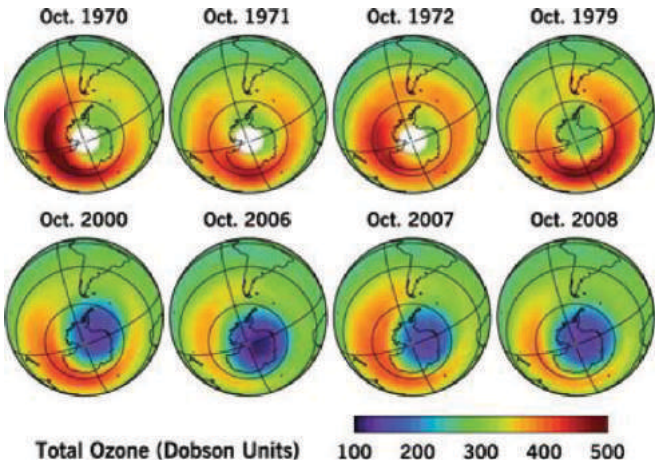


Fig. 13.5 Satellite pictures showing ozone hole above Antarctica.

Important points

1. Environment is a "Life Support System" because the existance and perpetuation of all the components of the Biosphere depends on it.
2. The existence and perpetuation of a living being at a given place and time depends on the harmony between the speed of the ever changing needs of the living being and that of the environment.
3. The biotic and abiotic components of environment are being transformed on a large scale because of the changes brought about by the scientific and technological revolutions of the past century.
4. Environment is also known as the Biosphere. It includes Hydrosphere, Atmosphere and Lithosphere.
5. Environment includes the (i) biotic and (ii) abiotic components.
6. Pollution is the undesired change in the physical, chemical and /or biological characteristics of air, water, soil, living beings etc. which degrades the raw nature of the resources.
7. Man-made pollutants includes :
   Industrial effluents, vehicular effluents, domestic effluents, substances produced by burning fossil fuels Explosives and other chemicals etc. used in battle field, substances used in agriculture and other agricultural activities.
8. The modern day problem of water pollution is the result of activities of modern industrial civilization.
9. Integrated water and waste management programs are required to combat the problem of water pollution.
10. In soil there are different types of particles which are connected to each other in different proportions. There exist spaces between these particles which are filled with air and water.

11. World Health Organization has decided that the limit of upto 45dB is the safe limit of noise for a city.
12. Thermal pollution results from increase in water temperature due to addition of hot effluents in a natural water reservoir. This reduces water quality and harms the aquatic as well as the nearby terrestrial life forms.
13. According to Ernst Haeckel (1868) Ecology is the mutual relation of living beings with their biotic and abiotic environment.
14. The substances required by living beings for remaining alive are known as the resources. All the substances which are present in the environment and are essential for the flow of life are known as natural resources.
15. Ecosystem is the basic unit of ecology. The biotic and abiotic components present therein interact with each other and both are important for the perpetuation of life.
16. **Decomposers :** They mainly include the bacteria and the fungi. In an ecosystem bacteria usually degrade the dead animal matter while the fungi are responsible for the degradation of plant material.
17. **Artificial ecosystem :** These systems are controlled by man; for example cropland which includes wheat, bajra, rice fields etc.
18. Oxygen is used in the atmosphere during the three basic processes of respiration, combustion and formation of oxides of nitrogen.
19. Nitrogen fixing bacteria are either present free in nature or in symbiotic association with some species of dicotyledonous plants. Generally, these nitrogen fixing bacteria are present in special root nodules of pod bearing plants.
20. Some gases prevent the escape of heat from the earth's atmosphere. Increase in the quantity of such gases can increase the average temperature of the atmosphere. This effect is known as the Green House Effect. Carbon-di-oxide is an example of green house gas present in the atmosphere.
21. Various compounds like chloro-fluoro-carbons (CFCs) which are produced by human being, remain stable in the atmosphere. CFCs are organic compounds containing chlorine and fluorine. They are very stable and are not degraded naturally. They harm the ozone layer, which forms a protective cover around earth.

Questions

Objective type :

1. Which of the following is not an air pollutant :
   (a) Marsh gases (b) SO_2
   (c) CO_2 (d) DDT
2. Who coined the term ecosystem?
   (a) Odum (b) Tansley
   (c) Haeckel (d) Haber
3. The main gas responsible for the Green House effect is :
   (a) CO_2 (b) SO_2
   (c) NO_2 (d) CO
4. Which of the following is an artificial ecosystem :
   (a) Forest (b) Grassland
   (c) Desert (d) Cropland
5. Adsorption, absorption, condensation etc. are useful for the control of which type of pollution:
   (a) Air (b) Water
   (c) Thermal (d) Soil

Very short answer type questions :

6. Define the term 'ecology'.
7. Write the names of two main air pollutants.
8. What are decomposers?
9. Define noise pollution.
10. Write the chemical conditions produced by thermal pollution.

Short answer type questions :

11. Write the names and examples of the abiotic components of the ecosystem.
12. What is Global Warming?
13. What is artificial ecosystem ? Give example.

Essay type questions :

14. Explain the causes and effects of air pollution.
15. Give a schematic description of the nitrogen cycle.

Answer Key

1. (d) 2. (b) 3. (a) 4. (d) 5. (a)

Chapter-14

Health, Disease and Yoga

14.1 Meaning of Health :

"Healthy body is the first happiness" and "Healthy mind resides in a healthy body" are the quotes which are very old and prevailing ones and are absolutely correct. Health is essential, rather mandatory, for everyone. Only a healthy person can accomplish any work smoothly and efficiently.

14.2 Significance of Health :

To remain healthy is essential to lead a happy life. If we are healthy we will be able to use our potential to the maximum: physically, mentally and socially. We can lead a happy life by remaining healthy.

Being in good physical condition is the main characteristic of our being healthy. Only a healthy person can build a healthy and strong nation. Much emphasis is being given in our country on remaining healthy.

Generally a healthy person means the one who is physically fit, whose head and heart are healthy, family is healthy and who lives in a healthy environment.

It is essential to remain healthy in order to be able to perform our tasks in a smooth and efficient manner. Only a happy, disease free and healthy person can have the potential to accomplish the work efficiently therefore to improve the quality of life it is essential to focus on the complete state; particularly efficiency, being energetic, satisfaction and peace levels.

14.3 Balanced Diet and its Components :

A balanced diet is one which has all the nutrients (carbohydrates, proteins, fats, vitamins, water and minerals) in proper quantity (Table 1). Carbohydrate and fat provide energy to the body. Protein is essential for growth and formation of cellular components. Minerals and vitamins are required for the biological reactions taking place in cells and tissues. Water plays an important role in various cellular and biological functions like digestion, excretion, translocation etc. Along with these, some roughage is also essential for proper digestion. Roughage chiefly comprises indigestible cellulose, which absorbs water and increases the quantity of food so that constipation does not occur. (fig. 14.1)

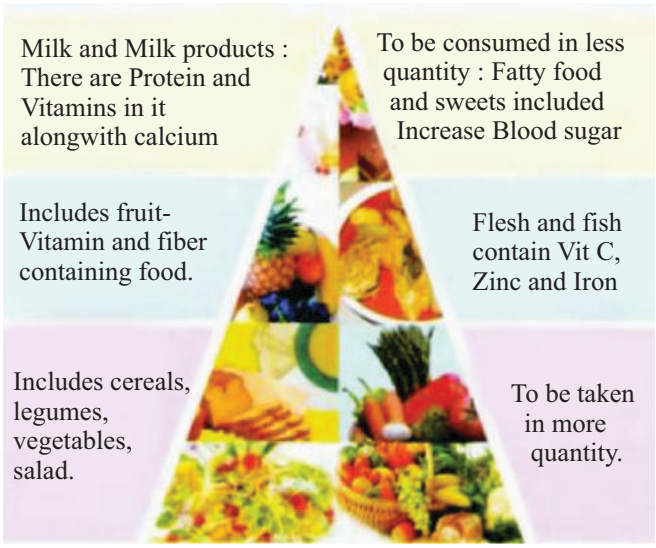


Fig. 14.1 Balanced Diet

Components of a Balanced diet :

The main components of a balanced diet are as under :

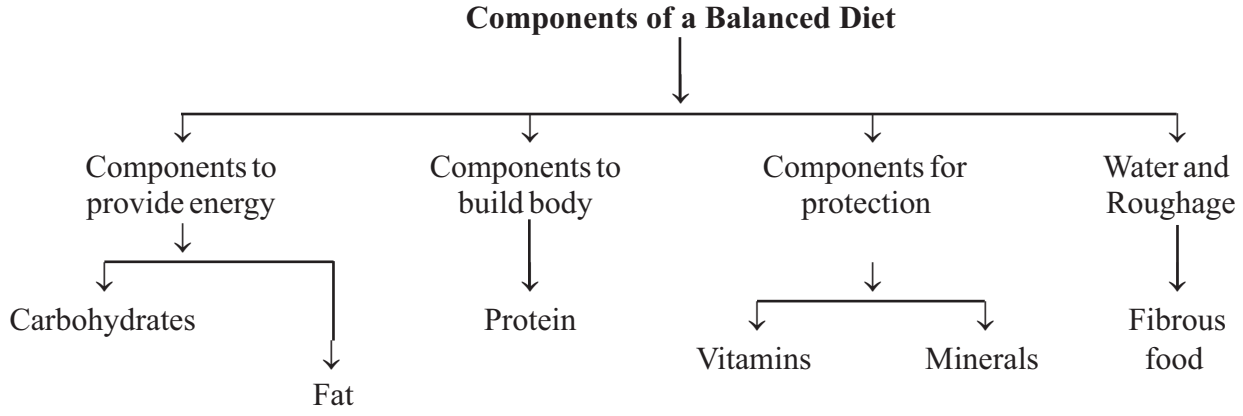
(1) Carbohydrates :

Carbohydrates (starch and sugar) are the main source of energy for our body. Although they are not very rich source, but are the most cheap ones. Generally, carbohydrates provide for 60% to 80% of the total food energy of our diet.

When we consume fruits, vegetables and other vegetable products, we receive large quantities of plant cells whose cell wall is made up of cellulose - a carbohydrate. Our body does not have enzymes to work upon cellulose hence they act as roughage.

(2) Fats :

On being oxidised, fats provide double the



amount of energy as provided by carbohydrate. It is because oxygen is less in fat molecules. Apart from providing energy they also help in formation of structural components of cells and tissue; for example cell membrane and other organelle. Fat is also stored by the body for future usage. If we consume food in such large quantities that the body is unable to utilize all the energy produced from it then the extra energy is deposited below our skin, in the form of hypodermal adipose. We obtain fat from butter, ghee, paneer milk, yolk, nuts, flesh and all edible oils.

(3) Protein :

Protein is the member of the nutrient group of which our body is majorly made up of. In cytoplasm apart from water, remaining part is mostly protein. Our body selects the amino acids as per its requirement, re-organizes them and makes the specific proteins. Proteins are digested in the small intestine and the amino acids formed in the process are absorbed by the intestine. Then after, they bind in new groups forming special proteins in the body cells from which the cells and tissue develop - for example the skin, muscles, blood and bones. Like carbohydrates and fats, even protein is a compound made up of carbon, hydrogen and oxygen but it also incorporates some other elements like nitrogen and sulphur which play very significant role in biological processes. There are some proteins which are derived directly from our food. All plants contain some amount of protein, but groundnut, beans, cereals (Maize and Wheat) and lentils are the best vegetarian sources. Meat, Fish, Egg, Milk and Cheese are the source of animal proteins.

(4) Water and Roughage :

Water and roughage are of equal importance in a balanced diet. Water is present in the cytoplasm, blood-plasma and the interstitial fluid of the tissue. It is present in many processes in the form of a solution. Water regulates our body temperature by sweating and evaporation and in this way plays an important role in the excretion of waste substances from the body. The water required by our body is majorly obtained from the water we drink and other liquid substances like tea, coffee, fruit juices, milk etc. Some water is also produced as a by-product in oxidation and other reactions.

The salad, vegetables and fruits having more of fibres and rind provide roughage in our diet. They are good for digestion and help in the movement of the excreta. Porridge and maize have good roughage along with the nutrients.

(5) Minerals :

We need many metals and salts, like iron (Fe), zinc (Zn), iodine (I), salt (NaCl), calcium phosphate [$Ca_3(PO_4)_2$] etc. for the different reactions of our body. Together they are known as the minerals. You must have observed that during summer months very often there are white stains on our cloths due to sweat. It is mainly sodium chloride i.e. common salt (NaCl). Even calcium salts are important to provide strength to our bones and teeth and is also essential for clotting. Sodium (Na) and Potassium(K) salts are required to maintain osmotic concentration of cells and tissues. Iodine, in very small quantity is essential for the formation of thyroid hormone. Iron is required for the formation of haemoglobin protein. This haemoglobin is responsible for the transportation of oxygen to various parts of our body. Many compounds of phosphorus, chlorine, copper, magnesium and zinc are also important to control many important reactions of our body and for general health and growth.

(6) Vitamin :

Vitamins play an important role in our nourishment. They have a major contribution in body metabolism. This component of our diet is helpful in the growth and development of our body. They are present in very minute quantities in the food substances but their presence is essential (Table 2).

Table 1 :
Important nutrients in some common food substance

Carbohydrates	Fat	Protein	Minerals
Rice, Idli, Bread (Roti : wheat, jowar bajra) Casava, normal sugar, honey jaggery, underground tubers like potato, colocasia, sweet potato, sweet juicy fruits	Butter, groundnut Ghee, Refined vegetable oil (mustard, ground net, sunflower) nuts, animal fat obtained from meat	Egg, Meat fish, milk cheese, ground nut, lentils Pea, Soyabean	***Calcium*** **:** milk curd, green vegetable, Ragi. ***Iron*** **:** liver, egg, meat, Pea, dry fruits, Green leafy vegetables Jaggery. ***Phosphorus*** **:** Milk curd, green leafy vegetables ***Sulphur*** **:** egg, yolk ***Iodine*** **:** Sea food

Table - 2
Description of Vitamins Important for Man Vitamins Source Main disease Effect

1. Vitamin A (Retinol) Soluble in fat	Green leafy vegetables, carrot, fish, liver oil	Night blindness	Lack of night vision
2. Vitamin B Soluble in water	Milk, sea food, soya bean, whole grain, green vegetables, germinated lentils meat, potato	Beri-Beri	Decrease in hunger, weakness, in active -ness of muscles headache, paralysis
3. Vitamin C (Ascorbic acid) Soluble in water	Juicy fruits especially Amla, Lime, Orange, guava	Scurvy	Bleeding gums, Red spots on skin
4. Vitamin D (Calciferol) Soluble in fat	Milk, Fish liver oil, egg, produced by the body itself in the presence of sunlight	Rickets	In children the bones become abnormal and soft, interruptions in the growth of teeth.
5. Vitamin E (Tocopherol) Soluble in fat	Green leafy vegetables, milk, butter, tomato liver, soyabean	Sterlity and Paralysis	the repreoductive epithelium gets damaged and leads to sterlity Paralysis due to neuro muscular dystrophy
6. Vitamin K (Phylloquinone) Soluble in fat	Milk product, almonds spinach, sunflower seeds, soyabean, tomato green vegetables	Haemmorrhage	Continuous blood flow, Absence of clot foramtion

14.4 Fast food :

In the present day physical world, fast food has become a popular alternative for our food. But it does not provide the required nourishment to our body. It does not also fulfil the need for various nutrients for our body to remain healthy. The person in turn remains tired and is not capable of doing the daily chores. In our country we have many better, nutritive food products like - poha, pakore, idli, dosa germinated grains, fruits, egg, upma, gajak, tilpatti, gur, sangri, mathri etc., which do not harm our body. Regular use of fast food leads to various diseases/disorders like fatness, hypertension etc. Healthy mind and healthy psyche results from healthy body. But fast food like pizza, burger, noodles etc. do not provide a healthy body because they do not have enough of proteins and good carbohydrates and have large quantity of fats which deposit in body and lead to various diseases like heart attack, blood pressure, kidney dysfunctioning, arthrites, diabetes etc. Thus because of fast food, neither we have a healthy body nor a healthy psyche. Obsessed mentality is responsible for many crimes.

Among humans, to remain healthy, a young person needs about 1800-2600 calories, an adult female 2200 and an adult male about 2000-3200 calories. The diet required to obtain these calories must have less quantity of saturated fats, trans-fats, cholestrol salt, sugars etc. But fast foods have an excess of all these which is harmful for our body and results in the development of serious health problems. This is one of the main reason for obesity among school children, weak and distorted mentality and hence they are involved in crimes of various nature and also suffer from serious health problems.

Fast food is very high in calory content and low in nutrition. Because of its easy availability and varied taste all the age-groups are attracted towards it as a result the society on the whole is struggling against various types of health concerns. We are witnessing a range of fatal effects of all this.

14.5 Effects of Synthetic Food Beverages :

In today's era the trend of synthetic beverages has increased. These beverages are contributing towards a range of diseases. They have been found to have high phosphate content, thus disturbing our bodies calcium and phosphate balance. This leads to various health problems. In young age body needs more of calcium that we obtain from food products like egg milk etc. But the increasing trend of synthetic beverages is retarding healthy growth of our younger generation.

These drinks are rich in sugar content. Body has to secrete excess of insulin to control the blood sugar level, which over a period of time may lead to diabetes. The high level of cholestrol in them is responsible for increasing risk of heart problems (fig. 14.2).

The synthetic drinks do not let the various metabolic activities of our body to occur smoothly. This leads to tensed state in the body and results in various problems like brain cancer, mental and

Fig. 14.2
Effect of synthetic beverages and fast food on the body

emotional defects etc. These drinks increase the acid level of our body which gradually deforms our digestive system. Synthetic beverages are unnatural substances which do not provide any nourishment instead the present generation is struggling with its negative impact. There is high concentration of sugar, sodium and caffeine in these drinks which results in dehydration of the body and also leads to obesity and the various diseases that follow there-from. The mental deformities being induced in the youth of our generation by their fallacious eating habits is resulting in an increase in the crime rate in

the present day society. To avoid these and various other negative impacts natural drinks such as coconut-water, lime-water, fruit juices, shakes etc. should be used instead of the synthetic beverages.

14.6 Malnutrition :

Malnutrition refers to a lack of balanced diet. The diseases due to malnutrition i.e. lack of one or more nutrients in our diet are known as malnutrition diseases or deficiency diseases. For a balanced growth there should be a balanced quantity of various nutrients like - proteins, carbohydrates, fats, vitamins, minerals and various micro-nutrients, in our food.

In our country and in other developing countries people are malnourished in large number, because they do not take a balanced diet.

14.6.1 Causes of Malnutrition :

1. Poverty and ignorance
2. Unemployment and increasing population.
3. Lack of food grains and food adulteration.
4. Our food habits.
5. Mental agony and tension
6. False notions

14.6.2 Symptoms and Causes of the Malnutrition diseases :

(A) Disease due to protein deficiency :

Protein is essential for physical development of humans. In children maximum malnutrition is reported due to protein deficiency. This leads to two main diseases (fig. 14.3) :

1. **Kwashiorkor :** It is a disease due to protein deficiency. The main symptoms include - loss of appetite, swelling in body, change in skin colour to yellow, dryness and irritability.
2. **Marasmus :** It is due to lack of calories and protein deficiency. In this disease the body starts drying, patient becomes feeble with weak face, lustre-less, sinking eyes and chronic diarrhoea.

Fig. 14.3
Diseases due to protein deficiency
(a) Kwashiorkor (b) Marasmus

(B) Diseases due to carbohydrate deficiency :

Carbohydrates is the main source of energy in a balanced diet; therefore its deficiency leads to serious diseases :

Hypoglycemia : There is reduction in level of blood sugar because of unavailability of glucose in the body due to carbohydrate deficiency in the diet. The symptoms includes shakiness, fatigue, lack of energy etc.

(C) Diseases due to deficiency of minerals:

Minerals are the substances which strengthen bones, tissues and teeth and forms a healthy body. Many diseases develop in body due to deficiency of various minerals (fig. 14.4) :

1. **Calcium and Vitamin D :** These are important for maintaining bone density. Calcium deficiency leads to pain and twitching in bones and muscles which results in repeated fractures. In an adult body the magnesium level is to be maintained to maintain the energy level because its deficiency leads to the deficiency of other minerals like potassium, sodium and calcium. The symptoms of such a condition includes - jerking, twitching and nausea etc. Potassium helps in smooth functioning of the muscles. Iron

deficiency in the body results in reduction of haemoglobin in the body which is the symptom of a disease-anemia. Zinc is responsible for mental growth and strengthening of the immune system.

2. **Goiter :** Iodine is an important requirement of our body. It is required in very less quantity. It helps in the secretion of thyroxine hormone from the thyroid gland, which controls various metabolic processes of the body. Many defects occur due to iodine deficiency including various mental and physical growth defects. The size of thyroid gland increases and results in the symptom known as goiter.

(D) Diseases due to Vitamin deficiency :

(a) Goiter due to iodine deficiency

(b) Yellowing of teeth

(c) Spots on the body

(d) Defective broken and damaged nails

Fig. 14.4 Diseases due to deficiency of minerals

Vitamins are not synthesized in the body hence they are supplied in the diet.

1. **Night blindness :** It results from the deficiency of vitamin A. The patient lacks night vision.
2. **Beri-beri :** This disease is due to deficiency of vitamin B_1 which directly affects the nervous system. The symptoms are - loss of appetite, weakness in body, inactive muscles etc.
3. **Scurvy :** This disease develops due to deficiency of vitamin C. It results in symptoms like formation of skin-spots, bleeding gums etc. This also weakens the body immunity system.
4. **Rickets :** Rickets disease develop in children due to deficiency of vitamin D; in adults it is known as osteoporosis. Bone disability develops from this disease which lead to bow-shaped legs, pigeon like chest and decay of teeth enamel.
5. **Sterlity :** Deficiency of vitamin E leads to sterlity.
6. **Haemorrhage :** This disease develops due to deficiency of vitamin K. It prevents formation of blood clots and leads to excessive bleeding. In extreme condition it leads to the death of the patient due to excessive blood loss.

14.7 Diseases :

Various pathogens present in the environment enter the body and make it diseased. White blood cells (WBC) kill the pathogens that enter the body. In many circumstances if WBC are unable to kill the pathogens they destroy various organs in the body and as a result a healthy person becomes diseased.

Development of abnormality in the general processes of body or any part thereof is known as a disease.

14.7.1 Causes of Disease :

1. **Biological agents :** The organisms which become the reason for disease development are known as **pathogens**. For example - virus, bacteria, mycoplasma fungi, protozoans, helminthes etc.
2. **Chemical agents :** The chemical substances which cause disease in the body are the chemical agents. For example - pollutants, spores, pollen grains, the urea and uric acid being produced in the body etc.
3. **Nutritional agents :** Excess or deficiency of various nutritional substances also act as agents of disease development : For example - carbohydrates, minerals, fats, proteins, vitamins etc.
4. **Mechanical agents :** Disease causing agents which cause diseases because of mechanical injury. Examples - friction, injury, wound, bone fracture, muscle sprain or strain etc.
5. **Physical agents :** Factors like heat, cold, humidity, electric shock, sound or radiations which cause diseases.
6. **Deficiency or excess of substances :** Substances like hormones, enzymes etc. cause physical disorders and diseases if deficient or present in excess.

14.8 Communicable and Non communicable diseases :

Diseases have been categorized into two types on the basis of their nature and causal agents (A) Communicable and (B) Non-communicable diseases.

(A) Communicable diseases : Diseases caused by various living factors like - bacteria, virus, protozoa etc. can be transmitted from person to person and are hence known as communicable diseases.

14.8.1 Viral diseases :

(i) Chicken pox :

It is commonly known as "choti mata".

Pathogen : *Varicella* virus

Symptoms : Fever, coughing, intense pain in back and neck, itchy blister like rashes on the skin. (Fig. 14.5)

Treatment : The things used by infected patients should be disinfected and the patient should be taken to health center, well in time. Antibiotics should be used for its cure and prevention.

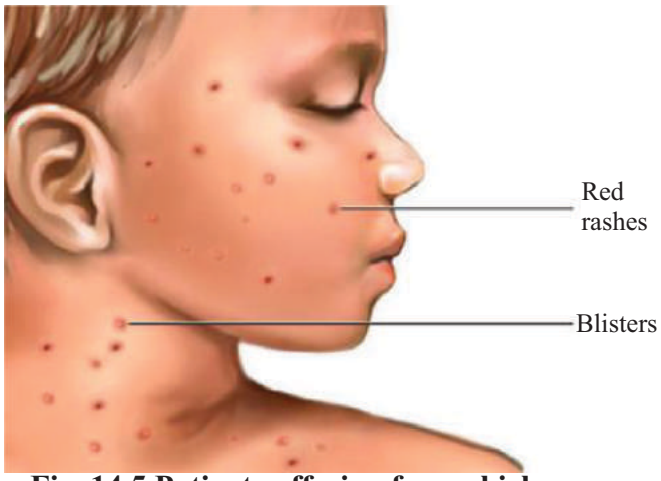


Fig. 14.5 Patient suffering from chicken pox

(ii) Poliomyelitis :

Pathogen : *Entero virus* - It is the smallest known virus.

Symptoms : Stiffness in neck, lying down of the patient without movement, weakness in limbs, nervous system and muscles are also influenced. In case of intense infection, physical disability is caused.

Treatment : Proper and regular vaccination of children as scheduled by the pulse polio campaign.

(iii) Aids (AIDS- Acquired Immuno Deficiency Syndrome)

Pathogen : HIV virus (Human Immuno - Deficiency Virus). (Fig. 14.6)

Symptoms : Loss in body weight, persistent fever, diarrhoea, ulcers in the throat, loss in general body immunity, swelling and irritation on skin, lymph glands are affected.

Transmission of disease : Sexual contact with infected person, on coming in contact with the blood of the infected person, on being born of an infected mother, by using infected needle etc.

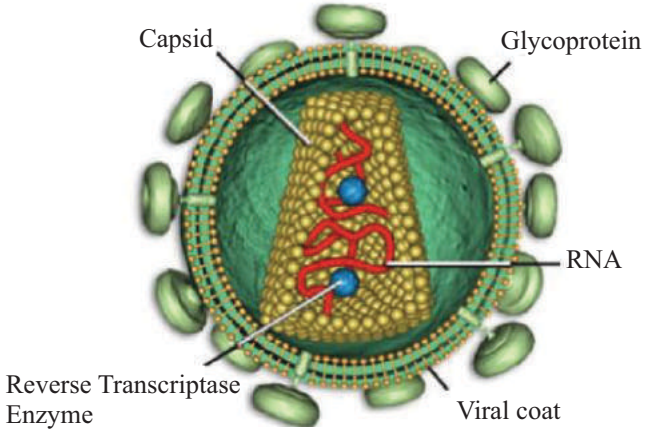


Fig. 14.6 : HIV virus

Prevention : Using sterlised needle, by not marrying an infected person, infected mother should not get pregnant, by having safe sex.

Treatment : HIV cannot be cured but can be controlled by using ART (Anti retroviral therapy). A combination of HIV drugs are used for treatment of HIV.

(iv) Dengue : It is also known as the bone breaking fever or dandy fever. It is a viral disease that is transmitted by female *Aedes aegypti* mosquito bite.

Symptoms : Fever, feeling cold, intense pain in muscles and joints, weakness, loss of appetite, dizziness, decrease in the number of blood platelets, fall in pulse rate, possibility of death etc.

Treatment : Mycophenolic acid and ribavirin are used to control the growth of dengue virus controlling the mosquito population by various means like adding gambusia fish in lakes and water tanks. There is no specific medicine or vaccine to cure dengue.

14.8.2 Bacterial Diseases :

The diseases that develop due to bacterial infection are known as bacterial diseases. A few important ones include :

(i) Tuberculosis or TB :

Pathogen : *Mycobacterium tuberculosis.*

Symptoms : Fatigue, loss in weight, blood tinged cough, fever, cold, chest pain, heaviness of voice etc.

Transmission of the disease : Living in

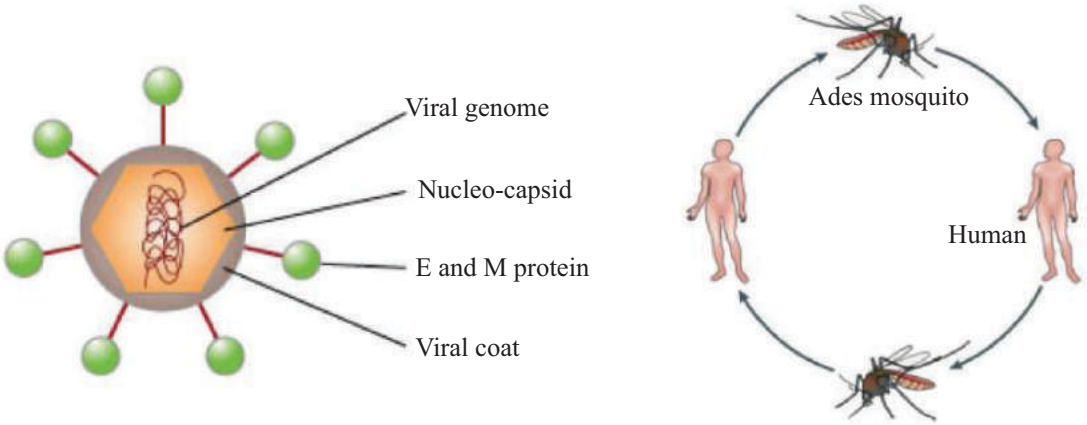


Fig. 14.7 : (a) Dengue Virus (b) Transmission of Dengue Virus

contact with a TB patient (i.e. sleeping, sitting, eating moving etc. with TB patient), due to malnourishment, consuming milk of an infected cattle, using things used by infected person, smoking, drinking hukka and chewing tobacco etc.

Treatment : Medicines like streptomycin, vitamin B-complex and isoniazid are important for its treatment. BCG (Bacillus Calmette Guerin) vaccine is used against tuberculosis and is administered to newly born child.

(ii) Diptheria : It is a serious bacterial infection generally of children but even adults are infected.

Pathogen : *Corynebacterium diphtheriae*.

Symptoms : It affects the mucous membrane of the throat and nose, with laziness and lethargy, loss in appetite, fever, headache, dizziness and in extreme cases the nervous system, heart and lungs are also affected. Bleeding with nasal mucous, congestion which at times may lead to death.

Transmission of disease : Generally is spread by direct contact with the patient. The bacteria spreads in the atmosphere by flies, sneezing, coughing, spitting in environment etc. The disease is transmitted by direct contact with the patient i.e. living, eating, moving around, kissing etc.

Treatment : Primary immunization of children is done using DPT vaccine (Diptheria, Pertussis and Tetanus). It is done as prevention against diphtheria, whooping cough and tetanus. Various antibiotics like-penicillin, erythromycin etc. are also administered.

(iii) Jaundice : This disease leads to liver cirrhosis. It is also known as icterus. Jaundice is a sign of diseases like hepatitis. The patient becomes yellow due to increased level of bilirubin.

Symptoms : Inactive liver, increase in level of bilirubin, body weakness, yellowing of skin, liver cirrhosis etc.

Transmission of disease : It develops due to use of contaminated water.

Treatment : New Livfit medicine is prescribed to keep the liver healthy. Hepatitis vaccination should be done.

(iv) Leprosy :

Pathogen : *Mycobacterium leprae*.

Symptoms : Loss in skin sensitivity, appearance of colourless spots on the skin, thickening of skin in the infected area, dissolving of the skin etc. It also affects nerves, skin, fingers and toes.

Transmission of disease : By living in contact with infected person for long.

Treatment : It is diagnosed by the lepromin test and is treated at the leprosy prevention centers.

14.8.3 Protozoan Diseases :

(i) ***Amoebiosis*** **:**

Pathogen : *Entamoeba histolytica*

Symptoms : Mucous and blood are excreted along with the stool of the infected person. There is twitching of the intestines. Ulcers develop in the colon (large intestine). If it infects the liver it leads to anaemic hepatitis.

Prevention : Wash vegetables thoroughly before use, Amoebic vesicles should be completely destroyed using chlorine, phenol, cresol etc. Antibiotics like Tetracycline teramycin etc. are used for treatment.

(ii) Malaria :

Malaria in humans is transmitted by the bite of the female *Anopheles* mosquito. The pathogen plasmodium is present in the saliva of this insect.

Pathogen : The four species of plasmodium are as under

1. *Plasmodium vivax*
2. *Plasmodium ovale*
3. *Plasmodium malariae*
4. *Plasmodium falciparum*

Symptoms : Body ache, twitching of limbs, headache, chills, shivering, loss of appetite, anemia, weakness, lethargy, short tempered.

Treatment : Spray of insecticides to kill mosquitoes. Clean the water filled ditches, use mosquito nets. Use of medicines like quinine, chloroquinine etc.

B. Non-Communicable Diseases :

Disease which are not transmitted from person to person are known as non-communicable diseases.

(i) Diabetes : It is also known as the sugar disease. It result from insufficient secretion of insulin from the pancreas. There is increased level of blood sugar or blood glucose along with high sugar level in urine too. Fatigue persists and the patient feels weak. External dose of insulin is injected in the blood to control the sugar level.

(ii) Cancer : Cancer may occur in any body part. It may be caused by many factors like-smoking, chemicals, carcinogenic factors (like X-rays, UV radiations etc.) In it there is irregular cell growth and division which leads to formation of ever growing tumors. This condition is known as cancer.

Symptoms : Reduction in body weight, formation of tumors, persistent wounds, headache, stomach ache, change in shape of testicular chamber/mammary glands, bleeding while urinating etc.

Treatment : The diseased part is removed by surgery. The cancerous cells are destroyed with the help of radiations and medicines, use of antibiotics, alkaloids etc., surgery by radio therapy or Bone-marrow transplantation etc. Medicines - Vincristine, Vinblastin.

14.9 Patanjali :

In yoga traditions, Maharshi Patanjali is a revered person. He is known as the 'father of yoga'. The 'ashtang yog' propounded by Maharshi Patanjali is not a notion, religion, caste or creed. Rather it is a complete method of leading life. The tradition of yog dates back at least to the Mahabharat era. Yog provides focus to the deviated and distracted mind and end conflict of thoughts i.e. mental deviations. Yog helps us to inculcate many qualities in our life, like - abstinence, truth, non-violence, self-contemplation, contentment, discipline, focus, concentration, self-control, dedication etc. which leads to the transmission of positive energy and thoughts in the human body and this is very essential for todays' generation. Today's generation lacks these qualities. Patanjali decided to provide all these benefits to the humanity. Now-a-days we have conquered many of the irretrievable diseases by yog. (fig. 14.8)

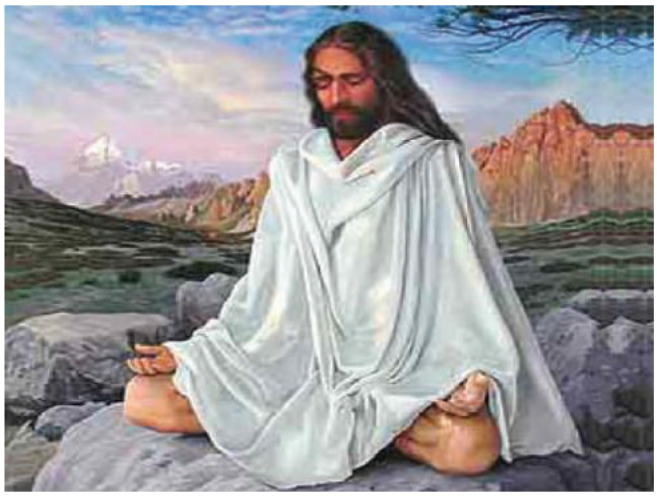


Fig. 14.8 Maharshi Patanjali

14.10 Effects of Yog on Health :

Yog has surfaced as a 'life giving elixir' in the present day, tensed life. There are two faces of yog - physical yog and the spiritual, philosophical, emotional side. From physical health to the attainment of trance (samadhi), the journey of yog is very easy, simple, scientific, certified, practical and universal. Life is supposed to have three basic elements - thoughts, feelings and actions. On doing yog these basic elements of life and many other fundamental transformations which are essential, occur. The person who performs yog is pious and non-violent, i.e. does not believe in rajsik, tamsik and violent tendencies. Yog maintains a balance between the individual and the masses. Yog induces a flow of spiritual and prudential idealogy in a person's life.

Yog is a very transcendental, useful and practical subject, it is a science of transformation. Yog is not just for the sages, monks, saints etc. but every individual, whether he be a businessman, farmer, serviceman, worker or students, they can be benefited from it.

Yog is a very ancient bhartiya lifestyle. The body becomes disease-free and graceful (agile). Yog leads to overall development of an individual. 21st June 2015 was celebrated as the international Yog Day. Most of the countries of the world have understood the utility of yog.

Ashtang Yog :

Maharshi Patanjali outlined the eight-steps for attainment of union between body, mind and spirit which leads to everlasting peace. These steps are known by the term - **Ashtang Yoga**. These eight

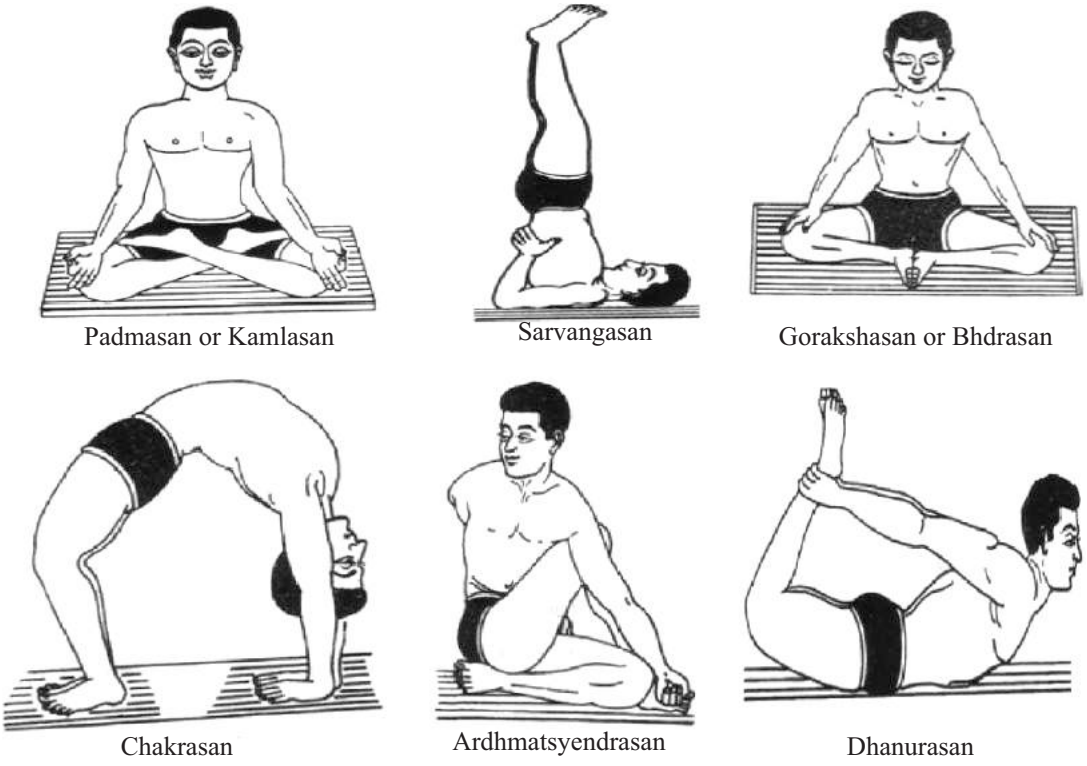


Fig. 14.9 Different types of Yogasans

steps are as following :

(1) Yam : (Social discipline) : This is the first element of Ashtang Yog. By adopting it the mind is diverted from violence etc. and is self-focused. It is the universal morality.

(2) Niyam : (Personal discipline) : By niyam, individual learns the compliance of the laws, customs, commands or rules for a disciplined life. On adopting it the person develops a good character.

(3) Asanas : Body postures which result in stability and happiness. (fig. 14.9)

(4) Pranayam (Control and regulation of the breathing process) : Its purpose is to receive, regulate and balance the vital energy that resides in our body.

(5) Pratyahara : (Control of the senses) : Divert the mind and senses from the external environment and make them introvert. Pratyahara leads to complete control of senses i.e. the senses follow the mind instead of the mind following the senses.

(6) Dharana (Concentration) : It means the immovable concentration of the mind on any one of the body areas like navalpoint, heart-lotus, bhumadya, Baharandh, nose etc.

Due to pratyahar, when the mind and senses are diverted from the external sensations and they become introvert, at that time focusing them at a particular point is known as dharna.

(7) Dhyaan : (Sadhna or Meditation) : When an individual frees himself from the time and space shackles and concentrate, then the stage is that of dhyaan, i.e. perfect contemplation.

(8) Samadhi (Self realization) : In it the individuality of a person is lost internally and externally in meditation. The individual goes beyond consciousness. It is the stage of perfect bliss - the height of meditation.

Effect of Yog on Health :

1. Yog improves the flow of oxygenated blood which help to cure problems like arthritis, swelling, reduction in number of platelets etc.
2. With yog there is improvement in the physical and mental health of the individual.
3. Yog brings out a person from a state of internal depression. Thus reducing the intensity of the criminal and violence mentallity.
4. By following yog on a regular basis the physical balance of the body is maintained even in the old age.
5. Yog leads to qualities like self contemplation, spontaneity, practicality, emotionality, concentration and firm determination.
6. Yog and pranayam subdues the excitation of the nervous system which delivers us from the tensed life.
7. Yog enhances the action-potential of our immunity system so that we can defend ourselves against various disease.
8. Yog guides an individual to perform the right deed which enhances the positive health and well being.
9. Yog and meditation induces enlightenment in the person so that in the present day culture, of competition, the anger and other destructive emotions are subdued and a positive approach is inculcated.
10. The healthy body achieved by yog leads to a better work-culture and the person serves others and the nation, on the whole, in a better way.
11. The internal body organs are activated by yog postures which leads to happy and healthy long life.
12. Immunity of the body increases.
13. Body becomes flexible.
14. Yog develops the mental and physical power to keep the mind peaceful and the senses under control.
15. Yogie postures purify blood.
16. Yog is a non-violent activity by which moral values are inculcated.
17. Yog excels various body glands. Thus assisting in balanced development of

the body.

To summarize, we may say that yog leads to comprehensive development of an individual and a disease free long life.

14.11 Life of Nagarjuna :

Nagarjuna was a renowned metallurgist and alchemist of ancient bharat. He was born near Somnath in Gujrat at Daihak district. His period is of about 7th and 8th century - the period of ayurveda metallurgy. Nagarjuna was an alchemist.

His treatise "Ras-ratnakar" and "Rasendra-mangal" are well known.

In 'Ras-ratnakar' there is depiction of metal-purification and the representation of their properties. The most famous being the reference of mercury (use of mercury). The chemical actions mentioned therein, still astonish the scientists. Various experiments to prepare mercury compounds have been described in it. It also presents a survey of the standard of metallurgy and alchemy in the country. The methods of purifying silver, gold, tin, etc. have been described in it.

To prepare life saving drugs and other substances from mercury, Nagarjuna made use of animal and plant elements, acid, minerals etc. He suggested various acids prepared from vegetation to dissolve many metals. Many scientists have obtained their in-depth knowledge of chemistry by studying the treatise written by Nagarjuna. Nagarjuna has described many important chemical processes, like distillation, sublimation liquidification etc., in his books. All these processes play a pivotal role in chemistry till date. Nagarjuna had also described the process of forming gold or the metals with the gold-like yellow lustre, in his book.

All these facts make it clear that Nagarjuna had deep and intense knowledge about the chemical properties of various substances. Modern chemistry has developed from alchemistry. Hence in Bharat, Nagarjuna is considered to be the promoter of metallurgy. Nagarjuna had described the method of preparing mercury ash and then its use to keep the body healthy, for long.

Nagarjuna edited a book named 'Sushrut Samhita' and added a new chapter 'uttar tantra'. This chapter describes method to prepare medicines.

Nagarjuna also composed many texts on Ayurveda, including - 'Aarogya manjiri', 'Yogsaar', 'yogashtak' etc. Many chemists used his knowledge for furthering their research.

Important points

1. A balanced diet is one which incorporates all the nutrients (carbohydrates, proteins, fats, vitamins minerals and water) in proper quantity.
2. Fast food and synthetic beverages are harmful for our body and gradually develop many serious diseases.
3. Malnutrition means unavailability of balanced diet for the body. The diseases which develop due to deficiency of one or more nutrients, in the diet, are known as malnutrition or deficiency diseases.
4. Protein deficiency leads to the Kwashiorkor and Marasmus diseases.
5. Deficiency of calcium leads to symptoms like pain in muscles and bones and twitching. It also results in repeated fractures.
6. Goiter develops because of iodine deficiency.
7. Beri-beri disease develop due to deficiency of vitamin B_1 and deficiency of vitamin C results in scurvy.
8. The diseases caused by various living factors like - bacteria, virus, protozoa etc., which are transmitted from person to person are known as communicable diseases. Examples - AIDS, Jaundice, Tuberculosis etc.
9. AIDS is transmitted by HIV.
10. Diseases which are not transmitted from person to person are known as non-communicable diseases. It is limited to the patient suffering from it. Examples - diabetes, cancer etc.
11. Yog assists in the development of the physical and mental health of a person.
12. Maharshi Patanjali is known as the 'father of yog'.
13. Nagarjuna was a renowned scholar of chemistry of the ancient period.
14. Nagarjuna edited a book named "Sushruta Samhita" and added a new chapter named "Uttar tantra".

Important Questions

Multiple Choice Questions :

1. Kwashiorkor disease develops due to deficiency of which nutrient in the diet :
   (a) Carbohydrate (b) Protein
   (c) Fats (d) Minerals
2. Which of the following disease is not by-birth -
   (a) Leprosy (b) Titanus
   (c) Malaria (d) Chicken pox
   (e) None of the above
3. The food component, considered to be the chief source of energy is :
   (a) fat (b) carbohydrate
   (c) protein (d) Water
4. Disease due to Vitamin D deficiency is :
   (a) Leprosy (b) Titanus
   (c) Malaria (d) Chicken pox
   (e) None of the above
5. AIDS is not transmitted by :
   (a) Blood (b) From mother to children
   (c) Touch (d) Sexual relations
6. Which of the following characters develops in a person, by Yog :
   (a) Self contemplation
   (b) Optimism
   (c) Discipline
   (d) All of the above

Very short answer type questions :

7. What are the main components of a balanced diet and their main sources.
8. Name the vitamins essential for our body.
9. Name the deficiency disease of Iodine.
10. Name the diseases caused by virus.
11. Write the symptoms and treatment of Dengue.

Short answer type questions :

12. Explain the effects of fast food on our body.
13. What is malnourishment? What are its reasons? Name two diseases that are caused due to malnourishment.
14. What is a balanced diet? What is the role of minerals in the balanced diet? Describe the diseases due to mineral deficiency.

Essay type answer questions :

15. How many types of diseases are there? Explain the difference between communicable and non-communicable diseases with examples. Also explain the factors responsible for development of a disease.
16. What is Yog? Name some of the important yoga. Elucidate the effect of yog on health.
17. Explain the life-history of Nagarjuna and Patanjali.

Answer Key

1. (b) 2. (e) 3. (b) 4. (e) 5. (c) 6. (d)

Chapter-15

Natural Resources and Agriculture

We know that earth is the only planet where life exists. Temperature, water and food are required for life. To fulfil the basic needs of all living forms on the earth, energy from the sun and the resources available on earth are required. We fulfil our needs from air, water, soil, plants, animals etc. present in the nature. Man uses these gifts of nature in the form of resources. Actually, even man is a resource because develops other resources using his knowledge. Any physical substance becomes a resource when man considers it to be of some importance and some value is added to it. The value may be economic, moral or aesthetic. All the substances obtained from nature which used by other organisms, along with humans, are known as natural resources. They include air, water, soil, minerals, fossil fuel, plants and animals.

15.1 Significance of Air, Water and Soil :

There is a thick cover of atmosphere all around the earth. It stretches for a height of 300km from the earth's surface. 92% of its air, however, is present upto the height of 20 km.

Various gases are present in it in different proportions. 78.09% of the atmosphere by volume consists of Nitrogen, 20.95% of oxygen, 0.03% of carbon-di-oxide and 0.00006% of Hydrogen. Apart from these gases Argon, Neon,Helium etc. are the other gases present in the atmosphere.

The gases present in the atmosphere are very essential for plants and animals. In nature cycles of oxygen, nitrogen, carbon-di-oxide etc. operate between the atmosphere, soil and living beings and maintains a balance. Evay living organism uses oxygen. Plants use the carbon-di-oxide from atmosphere in the process of photosynthesis to prepare food. Similarly even nitrogen is essential for photosynthesis. The bacteria and blue-green algae present in soil and plant tissue fix the atmospheric nitrogen and increases the fertility of the soil. Atmosphere is a bad conductor of heat and covers the earth like a blanket. Thus keeping the earth's average temperature constant.

Of all the substances present on the earth's surface water is most abundant. More than 70% of the earth's surface is submerged with water. Most of the water of the earth's surface is present in the oceans and seas. This water is saline. Non-saline, i.e. fresh water is present on the poles, as underground water, in the rivers, lakes, ponds etc. Water is an essential component of the protoplasm of the living cells. Water is a universal solvent in which various nutrients dissolve and enter the plant body. All the metabolic reactions occurring in the cell take place in the aqueous media. Thus all the life-processes of organisms depend on water. Apart from this growth, types of plant communities and their distribution are also controlled, to a large extent, by water.

Soil is the upper fertile layer of land. It is formed by the weathering of rocks. The organic substances formed by the decay of remains of plants and animals by microorganisms mix with these particles of rocks and form the actual soil. The black coloured organic substances produced by the decay of dead parts of plants and animals by the microorganisms are termed as **Humus**. Humus is the store-house of the plant nutrients. Plants obtain nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and other minerals and salts from the soil.

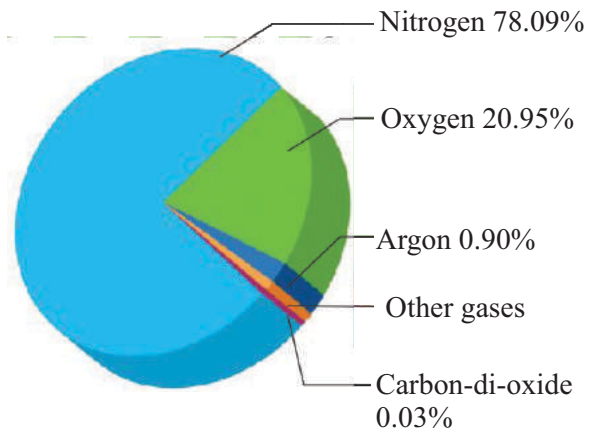


Fig. 15.1 Composition of Air

15.2 Movement of Air :

Of the various atmospheric factors, wind is an important factor which affects organisms, especially in the plains, sea-shores and high-mountains. Due to difference in air pressure on the earth surface movement is produced in the air which is termed as the **wind**. The reason for difference in air pressure is unequal heating. Equatorial regions produce more heat as compared to the northern and southern regions. This results in low air pressure in the Equatorial Regions, and the wind blows from the poles to the equator. According to the location the movement of air depends on various factors like geographical position, topography, height and distance from the sea, density of vegetation etc. Wind affects the plant life directly and indirectly.

The branches of trees fall off due to the fast blowing winds. Flow of winds in the same direction for long durations brings about permanent changes in the basic shape of the plants. Fast blowing winds blow away the top soil from the ground and make it barren. **Anemometer** is used to measure the velocity of wind.

15.3 Pollution :

Environmental pollution is a much talked about topic on social media like television, newspaper and seminars, science magazines, other magazines and periodicals etc. In the contemporary era it is a very serious and alarming problem created by modern civilization. It has turned out to be a global problem.

The dictionary meaning of pollution is "to make impure or dirty" "desecrate (i.e. spoil something that is valued or respected)" "to pollute" etc. According to a simple definition, "pollution is the unwanted-for or undesired change in the chemical or biological properties of air, water and soil, which is very harmful for the human life, ecology and natural resources.

Substances made by humans and thrown away after use, in nature, are the pollutants. Card-boards, metal, polythene bags, stones, pebbles, lime etc. left after construction of buildings, the fibers, wood shavings, iron-fitings, various herbicides and pesticides, exhaust of automated vehicles, industrial wastes etc. - all are the by-products of anthropogenic activities and are the pollutants.

Pollution are of the following types :

15.3.1 Air Pollution :

Sufficient amount of oxygen in the air is the result of photosynthetic activity of the nature. In dry air there is approximately 79% nitrogen, 20.9% oxygen, 0.03% carbon-di-oxide and rest part is of gases like neon, helium, krypton etc. The main source of oxygen required for respiration and the carbon-di-oxide for photosynthesis, is the atmosphere. Man is the main cause of atmospheric pollution. The chief air pollutants include carbon-mono-oxide, sulphur-di-oxide, hydrocarbon mixture, the suspended particulate matter present in the air, smoke and dust particles. The source of all these pollutants are coal burnt in industries and household, petrol, gas ovens, automated vehicles etc.

Fig. 15.2 Air Pollution

(a) Smoke : The smoke released on burning of coal and other natural fuels contain many oxides of sulphur. Sulphur-di-oxide is a harmful pollutant. It affects the mucous membrane of eyes, lungs and throat and causes many diseases. SO_2 enter the plants through stomata and forms sulphuric acid (H_2SO_4). This acid degrades chlorophyll. Lichens and Bryophytes are more affected by sulpher-di-oxide pollution. This gas kills them. Lichens are considered to be the **indicator** of this pollutant.

Smoke combines with fog and forms **smog**. In it the sulphur-di-oxide reacts with oxygen and forms higher oxides of sulphur which form sulphuric acid with

water. This acid corrodes the stones and walls of buildings. The acid formed by the pollutants released from the petroleum refinery at Mathura has increased the fear of corrosion of the marble of Taj Mahal.

Nitrogen-di-oxide (NO_2) released from the burning of fossil fuels oxidises to form Nitrate (NO_3) which forms nitric acid with water (HNO_3). The nitric acid thus formed comes down to the earth along with rain water. The rain containing nitric and sulphuric acids dissolved in its water is known as the **Acid Rain**. Acid rain increases the acidity of soil and thus destroy its fertility. It harms buildings, rail-roads, monuments, statues etc. by corroding them. Carbon-mono-oxide (CO) is formed by incomplete combustion of fuel. Approximately 50% of the total air pollutants is the carbon-mono-oxide. This gas enters the human body and combines with the haemoglobin in the blood. The rate of this combination is 210 times faster than the combination of oxygen with haemoglobin, therefore there is lack of oxygen in human body in the presence of carbon-mono-oxide. Other particulate contents of smoke like soot, tar, dust particles etc. reduces light. They gradually deposit on the earth, enters the animal body during respiration causing various diseases of respiratory tract including lungs. They also harm metal, painted surfaces, clothes, paper, leather etc.

(b) Automobile exhaust : Automobile exhaust consists of all the air pollutants about which we have studied in the preceeding paragraph i.e. smoke. This exhaust is responsible for 60% of the air pollution in today's world. On burning of 1000 gallon petrol approximately 3200 pound CO, 200-400 pound carbonic vapour, 20.75 pound oxides of nitrogen, 2 pound carbonic acids 2 pound ammonia and 0.3 pound solid carbon particles are released. 3-4, benzepyrene formed by incomplete combustion of hydrocarbons cause cancer. Oxides of nitrogen causes irritation in nose and the respiratory tract.

15.3.2 Water Pollution :

Water reservoirs, large fresh water lakes, ponds and rivers are the main sources of drinking water for man and animals. Most of the towns, big cities, and industrial townships are also settled near these water sources. The domestic and industrial affluents are released directly in these water bodies. Now water pollution is a big problem in developing and developed nations. These sources of water are polluted by various pollutants like sewage, detergents, herbicides and insecticides dissolved in water, industrial affluents containing dissolved organic and inorganic chemicals, harmful micro-organisms, soil sediments of rivers and rivulets deposited on the banks etc.

(a) Sewage : Mostly it contains the organic substances which are oxidized to carbon-di-oxide and water by micro-organisms. So if the quantity of sewage released in water bodies is not much, it will not get polluted. Most of the wastes are oxidized by bio-degradation. But if the quantity of sewage released is more, the population of micro-organisms will increase and the dissolved oxygen present in the water will not be enough for their respiration. Moreover the amount of dissolved carbon-di-oxide

Fig. 15.3 Water pollution

will increase. Fishes and other aquatic plants and animals will die because of lack of oxygen and the river or lake will gradually convert into a stinking pond or puddle.

By calculating the amount of oxygen used in unit volume of water in the given time, the quantity of organic pollutants can be inferred upon. This measurement is known as the **Biological Oxygen Demand (BOD)**.

The sewage released from leather industries, animal slaughter-houses, passenger-ships and boats etc. contains many infections micro-organisms which results in various diseases among human population like - Cholera, typhoid, jaundice etc. Sewage is a good source of nutrients for the aquatic organisms and make the water bodies eutrophic. This results in the rapid increase in the population of algae and the water reservoir, lake, river etc. get filled with the dense growth of these algae. This is known as the **algal-bloom**. As these algae die the bacteria decomposes them so that there is lack of dissolved oxygen in the water-body. This also increases the pollution. Many aquatic fishes and other animals and plants die under these anaerobic conditions.

(b) Release of liquid affluents by various industries : The liquid affluents of various industries like petro-chemical, fertilizers, oil-refinery, medicines, fibers, rubber, plastic etc. are hazardous pollutants. The affluents from these sources contain many toxic chemicals and acids in dissolved conditions. They pollute water and also pollute the ground water by perecolating down through the soil. The lake water gets polluted by these liquid affluents and the animals and plants present in such water bodies are also killed. Many severe diseases occur in animals and man consuming this polluted water. Many of these toxic substances are deposited in the body and are then passed on from one trophic level to the next in the food chain. Mercury and other toxic metals from chemical industries and the mining activities reach the rivers and then the oceans. Corrosion of automated boats also leads to the dissolution of mercury and lead in the water-body. It forms the toxic methyl-mercury which affects the nervous system of aquatic animals. The other metal-pollutant of water is lead (Pb). It reaches the water bodies by lead mining and corrosion of automated water boats and exhibits toxic effects by percolating down the food chain.

(c) Chemical fertilizers in the form of pollutants : Chemical fertilizers like urea, potash, diammonium phosphate etc. are used to increase the agricultural production. These fertilizers flow down to the water bodies and results in the formation of Algal blooms.

(d) Insecticides and fungicides : To destroy the insects and pathogens that harm the crop, various insecticides and fungicides are used on a large scale. DDT, an insecticide, is widely used in agriculture to destroy the harmful insects etc. Its excessive use over the years has proved to be a hazardous water and soil pollutant.

All these are non-degradable organic compounds. Their continuous use over the passage of time increases their concentration in soil and water. These chemicals also exhibit **bio-magnification**. Their concentration gradually increases in the organisms of higher trophic levels. When the concentration of DDT increases in the plant body their consumption by herbivorous organisms like insects, fishes etc. introduces them into the food chain. The more the consumption of these infested plants the higher will be the deposition of the chemicals in the herbivores from where they will be passed on to the next trophic level on

being consumed. This how is the concentration of these chemicals like DDT reaches toxic levels and becomes lethal. If these top carnivores, like the big fishes in an aquatic food chain, are consumed by humans they show harmful effects on the health. The polluted water is non-consumable and have a bad-smell. It at times, is not even fit for washing clothes or having bath etc. It has the pathogens of may diseases like typhoid, cholera, jaundice etc. These diseases are transmitted by polluted water.

15.3.3 Noise Pollution :

Sound is produced in many of the works performed by us. Conversation and music are good to listen to and we enjoy them. When the sound is undesirable and annoying it is termed as noise. When the sound intensity reaches levels that irritates us, we call it noise pollution. It is the intensity that differs between a whisper and the loud sound produced by the engines of an air craft. The intensity of sound is measured in terms of a unit called **Decibel**. This unit was proposed by the famous scientist Graham Bell. It is expressed by db. Sound at quiet places like libraries, radio-sound, recording room etc. ranges from 0 to 30 db. In the quiet study rooms and in our homes this sound is upto 50 db. In normal conversation also it is 50 db. The sound produced by trucks, buses etc. is of the range of 90 db. Machines at the industries produce 100 db sound while that produced by jet planes is 180 db.

The sound of intensity more than 80 db is a pollutant which is harmful for our hearing. We feel restless and disturbed by sound of 100 db intensity and that of 120 db or more produces severe headache. Intense sound destroy our physical environment. The supersonic jet which moves at a speed faster than sound leaves a trial of sound waves as it moves ahead. This is known as the **Sonic boom**. Sonic boom when collides with the earth surface weakend the buildings.

Noise hinders with the smooth conversation. It reduces our hearing power and disturbs our mental peace. The citizens, residing in over populated cities and industrial townships,

Fig. 15.4 Noise Pollution

where noise pollution is intense, loose their ability to listen at a very young age. Noise increases mental tension and the heart beat. Excessive noise is bad for liver and brain functioning. The sudden loud noise is all the more harmful for our health. It hampers the hearing ability and at times the person may even faint.

Noise is the cause of many harmful physiological effects to our body. The pupil expands by intense noise, the yellowing of skin may be observed, voluntary muscles may contract, secretion of digestive enzymes may be hampered, blood pressure increases, the quantity of adrenalin in the blood increases which results in increased tension in nerves and increases restlessness.

15.3.4 Soil Pollution :

The upper layer of land which is known as soil is affected by soil pollution. Mineral substances, organic substances, soil water and micro-organisms together make the soil. The ratio of these components is different in different types of soils. The physical, chemical and biological characters of each type of soil are definite. Hence unwanted change in the properties of soil is known as soil pollution.

Sources of Soil Pollution :

1. **Industry :** Various industries like the paper and pulp industry, oil refinery, industries preparing various chemicals, vanaspati ghee, sugar, liquor various power plants etc., are the main sources of soil pollution. Most of the industrial furnaces produce ash which pollutes the soil.

2. **Mining :** During various mining processes the topsoil and subsoil are removed forming deep pits. This is also accompanied by surface pollution of the nearby land.
3. **Agriculture :** Agriculture is directly influenced by the revolution in the field of chemistry. To increase the agricultural production the use of advanced seeds and better irrigation facilities is accompanied with use of fertilizers, insecticides, pesticides, weedicides etc. These chemicals pollute the soil to a large extent.
4. **Garbage :** Garbage includes domestic wastes such as paper, glass, cloth, iron and aluminium containers, plastic containers, polythene bags, pieces of rubber, leather, animal compost, wastes of building material etc. The garbage disposal is a big source of soil pollution.
5. **Radioactive substance :** Alpha and gamma radiations are emitted from the degradation of radioactive substances. The radioactive elements released during atomic tests enter the soil and pollute it.
6. **Dead organisms :** Soil is also polluted by the carpses of birds and other organisms thrown out in the open.

Effects of Soil Pollution :

1. To meet the ever growing demand of food of the ever growing population more production from crop-lands is required. To achieve this chemical fertilizers along with various fungicides, insecticides, weedicides etc. are used. These toxic chemicals kill even the beneficial microorganisms, as a result the process of natural soil formation (pedogenesis) stops.
2. The rate of photosynthesis slows down because of the insecticides, weedicides, fungicides etc. sprayed on the plants.
3. Regular irrigation and use of fertilizers increase the soil salinity and some of the unwanted elements increase in the soil. This disturbs the balance of various nutrients in the soil and reduces its fertility. In other words the land becomes barren.
4. Chlorine containing hydrocarbons like DDT; 2, 4-D; 2, 4, 5-T etc. are not degraded and hence accumulates in the soil. Along with water and minerals even these pollutants are absorbed by the plants and thus enter the food chain where they make various trophic levels poisonous.
5. Garbage not only reduces the aesthetic sense of the landscape but also results in pollution of the soil as well as atmosphere.
6. Explosions carried out during mining processes reduces the agricultural productivity of the adjoining areas.
7. Radioactive elements accumulate in the upper layer of atmosphere after the conduction of nuclear test. These come down to earth with rain water and pollute the soil and water bodies.

Management of Pollution :

Pollution is undoubtedly increasing in the atmosphere day by day. Following measures can be taken to reduce and regulate the atmospheric pollution :

1. The masses at different levels of the society will have to be made vigilant towards this problem by educating and making them aware of the methods of conservation using interesting media, picture books, posters, movies, videos, articles, T.V. programmes, dance-drama depicting environmental pollution and conservation strategies etc. For the purpose various seminars and functions should be organized. The youth of the country should come forward for the purpose and make important contributions in the direction.
2. Various pollution regulation systems and curriculum based on conservation of natural resources should be made compulsory for all the classes at school and college level.
3. Every country should take controlled care of various aspects of atmosphere so that even the new pollutants can be

known, timely, and controlled immediately.

4. The inflammable solid wastes should be burnt in large furnaces made for the purpose. The gases released on burning them should be well treated to reduce their polluting effect before letting them escape in the environment.
5. Solid pollutants like sewage, dung, remains of plants and animals etc. should be buried deep under soil in large pits, away from the residential areas. After some time they will degrade and will convert into humus which can be used for agricultural purpose.
6. Non-flamable solid wastes like ash, glass, PVC metal etc. should be broken down into pieces and should be used to fill pits in barran lands.
7. Automated vehicles which are not based on fossil fuels should be encouraged. Catalytic converters should be used in vehicles using fossil fuels like petrol, diesel etc. Special devices should be used in the fire-place and chimneys of industries to purify the escaping gases to some extent for example - scruber, cyclone separators, electro-static precipitators etc.
8. Unmindful use of fertilizers, insecticides, weedicides etc. should be banned.
9. Use of wood as a fuel should be completely banned. Heavy penalties should be imposed against cutting of trees.
10. Use of paper disposables and card board cartons should be banned.
11. Use of detergents should be discouraged and use of soap for cleaning clothes should be promoted.
12. Use of plastic disposables and polythene bags should be banned and the plastic containers, bottles etc. should be recycled and reused.
13. The affluents from cities and industries should not be released in water bodies.
14. Unnecessary use of horns in vehicles should be avoided. The devices used to amplify sound intensity and to transmit it to distances should be banned. Sound absorbers should be used in auditoriums and use of ear-plugs should be compulsory for workers in the industries.

15.4 Light and Radiation :

Light is essential for living organisms. It affects many physiological processes in the plants, directly (for example transpiration, photosynthesis, plant movements etc.) and indirectly (respiration, absorption, growth, plant hormones etc.). Light plays an important role in development and expansion of vegetation and controlling the species composition. Sun light is the main source of energy in nature. Green plants synthesize food with the help of light by the process of photosynthesis. This food is the basis of bio-energy in the bio-sphere.

The part of radiant energy or electromagnetic rays of the sun which forms the visible spectrum is known as the visible light. The radiations reaching the earth from the sun are of the wavelength range 300nm to 1000 nm. Of these only the radiations in the ranging from of 390 nm to 760 nm are visible to eyes i.e. the radiations of wavelength 390 nm to 760 nm are known as the visible light. On passing through a prism the visible light scatters into light of different wavelengths for example violet (390 nm-430 nm) indigo (430nm-470 nm) blue (470 nm- 500 nm), green (500 nm- 580 nm) yellow (580 nm- 600 nm), orange (600 nm- 650 nm) and red (650 nm- 760 nm). The radiations of wavelength less than violet color are known as the **ultra-voilet** rays while those having wavelength more than red are the **infra-red** radiations. The light radiations having lower wave length have more quantum energy while those with bigger

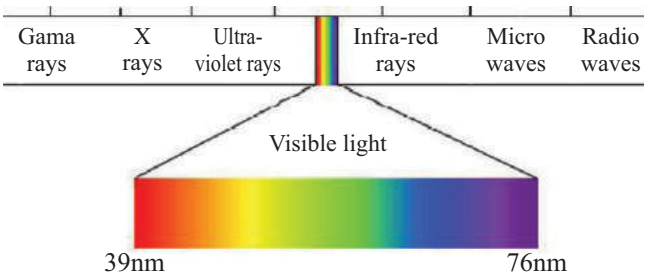


Fig. 15.5 Light Radiations

wavelengths have lesser energy.

15.5 Manure and Fertilizer

Like food is essential for the development, growth and health of human being, so are the nutrient substances essential for the growth of plants. Plants obtain their nutritive substances from the air, water and soil. 16 nutritive elements are essential for plants. Carbon and oxygen are obtained from the atmosphere, water provides for the hydrogen and oxygen and the remaining 13 elements are obtained from the soil. Out of these 13 elements, 6 nutrients are required in greater quantity and are known as the **macro nutrients** while the remaining seven are required in very small amount and are known as the **micro nutrients**. Deficiency of these elements affects various physical processes of the plant including reproduction, growth and resistance towards various diseases. To increase production these elements are to be added to the soil in the form of manure and fertilizers. Various elements obtained from air, water and soil are as under :

Air - Carbon and oxygen

Water - Hydrogen and oxygen

Soil- (i) **Macro nutrients** : Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur

Micro nutrients : Iron, Manganese, Boron, Zinc, Copper, Molybdenum, Chlorine.

15.5.1 Manure :

The amount of organic substances is more in manure. It is prepared by the decomposition of dead plant parts and animal wastes. Manure replenish the soil with organic substances and nutrients and increases its fertility. More quantity of organic substances in manure improves the structure of soil. We use bio-waste to produce manure. Use of manure reduces the need of fertilizers and thus helps in environmental conservation. Manure may be of the following types on the basis of use of various bio-materials and the process of preparing it :

(i) **Compost and vermi-compost :** For composting, the agricultural wastes like the feaces of animals, dung etc., vegetable rind and trash, weeds etc. are filled in pits. These animal and agricultural wastes are decomposed using micro-organisms. This decomposed material is then used as manure. Compost is rich in organic matter as well as various nutrients. Vermi-compost is prepared from the plant and animal wastes by rapid degradation using earthworms.

(ii) **Green manure :** Pod bearing, leguminous plants like- sunhemp, moong, gwar etc. are grown in the fields before growing crops. After they attain sufficient height they are mixed with the soil by ploughing them down. These plants convert into green manure and replenish the nitrogen and phosphorus content of the soil.

15.5.2 Fertilizer :

Fertilizers are the plant nutrient prepared commercially. They provide nitrogen, phosphorus and potassium. They results in good vegetative growth of plants and keep them healthy. Fertilizers are used to increase the production. Fertilizer should be used carefully. Many-a-time the fertilizers are washed away due to over irrigation and plants are not able to absorb them properly. Use of excess of fertilizers leads to soil and water pollution continuous use of fertilizers reduces the soil fertility. It adversely affects the life cycle of various subterranean organisms and microorganisms. We can increase the agricultural production by using fertilizers in lesser time but after some time the soil fertility reduces rapidly. However the benefits of using manure persists over long period of time. **Organic farming** is the technique of farming in which chemical fertilizers, insecticides, weedicides etc. are not used at all or in case of intense need they are used only is very small quantities. In this technique organic manure recycled agricultural wastes and cattle wastes, biological agents like blue-green algal cultures, bio-fertilizers etc. are made use of. Neem leaves and turmeric powder are used as bio-insecticides during storage.

15.6 Crop :

Carbohydrate as source of energy is obtained from cereals like wheat, rice, maize, bajra and jowar, protein is obtained from pulses like pea, gram, black lentil, urd, moong, arhar etc. and the oil-seeds like soyabean, groundnut, til (sesamum), castor, mustard, alsi (flex) and sunflower provide us with the essential fats. Vegetables, spices and

condiments and fruits provide various vitamins and minerals along with some amount of proteins, fat and carbohydrates. Fodder crops like berseem, oat, grass etc. are cultivated to provide for the cattle feed. Hence, their regular production, proper management and distribution is essential to provide for the needs of the large population.

Bharat is a big country. Here climate conditions like temperature, humidity and rains vary from region to region. Hence different types of crops are cultivated in different parts of the country. Crops can be broadly categorized into two on the basis of season :

(i) Kharif crops : These are the crops which are sown during rainy season. In Bharat the rainy season is from June to September. It includes paddy, maize, soyabean, groundnut, moong etc.

(ii) Rabi crops : Crops grown in winter season are the rabi crops. Wheat, gram, pea, mustard and flex are some of the major rabi crops.

15.7 Varieties of Crops :

Good production of crops depend upon the selection of varieties for cultivation. Various useful qualities (like disease resistance, compatibility with fertilizers, quality of the produce and high production) of the crop varieties can be chosen by breeding. Desired traits can be introduced in the varieties by hybridizations. In the hybridization technique plants with different genetic properties are hybridized. Another method of crop improvement is introduction of the desired genes. This results in the production of genetically altered varieties. Before adopting any new variety it is essential to ensure that the variety can give sufficient produce in various environments at various places. Good quality seeds should be made available to the farmers. In other words the seeds should be of the quality which germinate properly in favourable conditions.

Crop production depends upon the weather, quality of soil and availability of water. Since weather prediction like drought, floods etc. is difficult, so crops which can grow under varied environmental conditions are more useful. Similarly varieties which can grow in saline soil have also been developed for some crops. The objective of improving crop varieties includes :

(1) High production : Increasing the production per hectare.

(2) Improved varieties : The quality of the crop produce is different for every crop. For example the quality of protein in pulses, quality of oil in oil crops, high quantity of vitamins and minerals in fruits and vegetables etc.

(3) Biotic and Abiotic resistance : The crop production may decrease due to various biotic (diseases, insects etc.) and abiotic (drought, salinity, water logging, heat, cold, frost etc.) factors. The varieties tolerant to these factors can increase the production under adverse conditions.

(4) Change in maturation period : Economically it is beneficial to use varieties with reduced duration, from sowing to reaping. The farmers, hence, may obtain more than one crop produce in his field per year. Reduction in time reduces the expenses of crop production. The loss of produce is reduced if the crop maturation is simultaneous.

(5) Broad compatibility : Production of varieties having broad compatibility will be helpful in stabilizing the produce in different environmental conditions. Some varietes may then be used for cultivation under varied environmental conditions.

(6) Optional qualities of the crop : Long and dense branching is the desired quality for fodder crops, so that there will be more production using less of is nutrients. In this way various improved varieties may be used to enhance production.

15.8 Crop Pattern :

The land becomes barren by continuous use of chemical fertilizers, insecticides and pesticides etc., therefore need was felt of techniques which could be used for crop cultivation, on a continuous basis, without harming natural resources. This is known as the **long term agriculture.**

Methods such as mixed farming, mixed

cropping and crop-rotations are used for long-term agriculture.

(a) Mixed farming : The needs of the farmer cannot be fulfilled by the produce of small patches of land. So the farmer adopts other methods to increase productivity. These include - animal husbandry, fisheries, horticulture and agriculture. This practice not only increases the farmer's income but also utilizes the land available to the maximum. **Mixed farming**, thus, is a system of farming which involves the growing of crops along with raising the livestock.

(b) Mixed cropping : When only one type of crop is grown in a field, the requirements of all the crop plants are alike. It will use some of the nutrients which will reduce in quantity over time while others will not be used at all. To avoid the imbalance of nutrients now-a-days two or more than two type of crops are grown together in the field. This type of cropping pattern is known as **mixed cropping**. For example, Wheat and gram; wheat and mustard; groundnut and sunflower etc. If due to adverse weather conditions or due to other reasons, one of the crop fails, at least the produce of the other will be available.

The following things should be kept in mind while selecting crops for mixed cropping.

1. One crop should be of long period while other of short period.
2. One crop should be long and other should be dwarf.
3. One crop should have deep root system while the other must have surface roots.

(c) Crop Rotation : The fertility of land reduces due to continuous cropping of the same crop over the years. The production of that crop reduces due to deficiency of certain nutrients in the crop land since they are the ones being used continuously. So to replenish the soil and maintain nutrient balance, crop rotation is adopted. **Crop rotation** is growing of different crops in succession in the field in a planned manner.

In crop rotation cultivation of cereals should be altered with the cultivation of pod-bearing leguminous plants so as to replenish the soil nitrogen.

15.9 Crop Protection :

In the fields crop is affected by weeds, insects, pests and various diseases. If the pests and weeds are not controlled in time, they can cause immense harm to the crop.

Weeds are the unnecessary plants that grow along with the crop plants. For example : Vilayati Gokhru (*Xanthium*), Carrot-grass (*Parthenium*), Motha (*Cyperus rotundus*). These weeds compete for food space and light and use various nutrients of the soil thus reducing the production. Therefore, for healthy growth of crop plants, the weeds should be removed from the fields right from the beginning.

Usually, insect-pests attack the plants in three ways (1) they cut the roots, stem and leaves of the plants i.e. they chew them (2) they suck the cellular juices from various parts of the plant (3) they bear the fruits and stem and enter it, i.e. they perforate it. Thus they damage the crop and reduces production.

In plants diseases are caused by casual organisms like bacteria, fungi, virus etc. They are present in soil, water and air and are transmitted to the plants through them. The weeds, insects and diseases can be controlled by various methods. The most common of all is use of chemical pesticides. Various insecticides, fungicides and weedicides belong to this category. These chemicals are sprayed on the crop and are used for seed and soil treatment. But their excessive use leads to many problems. These chemicals may be toxic for plants and animals and may cause environmental pollution. Mechanically removing the weeds is another method. Preventive measures include sowing the crop on time, preparing proper beds, inter cropping and crop rotation, for controlling the growth of weeds. The pests can be controlled by using resistant varieties and ploughing the land during summer months. Deep ploughing during summer months kill the pests and uproots the weeds

and exposes the seed of weeds to the heat, thus destroying them.

15.10 Methods of Irrigation :

All organisms needs water to remain alive. Water is of great importance for the growth and development of flowers, fruits and seeds. Water is absorbed, along with the dissolved minerals and fertilizers from the soil, by the roots. In plants there is approximately 90% water. Water is important because seeds cannot germinate in dry conditions. The nutrients dissolved in water are translocated to all parts of the plant. It protects the plant from frost and hot air. For healthy growth of crop plants, watering the fields on a regular basis is essential. Watering the fields at different time intervals is known as **irrigation**. The time and frequency of irrigation differs with the crop, soil type, season etc. The frequency of irrigating will be comparatively more during summer months.

Sources of Irrigation : Well, tube-well, lakes, ponds, rivers, dams and canals are the various sources of water. The methods of taking water to the fields from the sources differ from region to region.

In traditional methods cattle or workers are used. They are cheap but less efficient. They include (i) Pulley (ii) Chain pump (iii) Dhekli and (iv) Rahat (water lifting).

Water is lifted either manually or by using pumps. Diesel, biogas, electricity or solar energy is made use of to drive the pump.

Modern Methods of Irrigation : We can use water economically by using modern methods of irrigation. These methods include :

(i) Sprinkler System : This method is used for uneven land where water availability is less. Rotating nozzles are attached to the upper ends of vertical pipes, these pipes are at a definite distance from each other and are connected to the main pipe. When water is sent to the nozzles via the vertical pipes they rotate, sprinkling water over the crop plants in a manner similar to the rains irrigating the crop.

Fig. 15.6 Sprinkler Irrigation System

(ii) Drip System : In this method water reaches down directly to the roots, drop by drop. Therefore it is known as the drip system. This is the best method of irrigating the fruit trees, gardens and other plantations. Water is not wasted in this method and the plant receives continuous supply of water, drop-by-drop. This system is a boon for areas having scarcity of water.

Fig. 15.7 Drip System

15.11 Agriculture :

Contemporary agriculture is the combined effort of arts, science and technology. In it crops with desired characteristics can be obtained using principles of science and genetic engineering. Hence the basic need of food and cloth of the fast growing human population can be met .

Various stages of advanced agriculture

includes :

(1) **Improved seeds :** The quality of seed is improved for more production, disease resistance, uniformity in time of maturity, adaptation for various environmental conditions.

(2) **Mineral nutrition of the crops :** Crop plants need various nutrients for preparing food and for growth. Plants obtain their nutrients from air, water and soil. Different types of manure and fertilizers are used to supply nutritive elements to the soil. Dung manure, compost, vermi-compost and green manure are used as manure - Urea, di-ammonium phosphate, super phosphate, ammonium sulfate and calcium ammonium nitrate are used as fertilizers.

(3) **Weeds :** Farmer sow the seeds of the crop plant but many other seeds present in the soil germinate along with the crop seeds and produce plants. The undesired plants that grow along with crop plants in the field are known as **weeds**.

There is competition for water, mineral salts etc. between the crop plants and the weeds. This results in lack of availability of sufficient water and nutrients for the crop plants. The weed plants grow fast and cover the crop plant thus hindrance is generated for the sun light to reach the crop plants. Some weeds produce special chemicals from their root system and have adverse effect on the crop plants. Weeds are the shelter for various pests and pathogens and hence increases the chance of disease development. The cost of crop increases because of the cost of weeding. Weeds can be controlled physically i.e. uprooting them manually or by chemical and biological methods.

(4) **Plant diseases :** Dys-functioning of the plant or any part thereof is known as the plant disease. Disease develop in plants by virus, bacteria and fungi. To control disease in crop plants, disease resistant varieties are used and pesticides are sprayed.

15.12 Animal Husbandry :

Animal husbandry is the supplementary occupation of agriculture. From ancient times man has domesticated animals and have used them. In modern times due to mechanization, the dependence of man on animals has decreased, yet animal husbandry is generating employment for a large section of our population. As compared to other countries there are maximum number of domesticated animals in Bharat and it is number one in milk production. Animal husbandry includes caring and domesticating animals such as cows, buffaloes, camels, sheep, goats, horses etc. and obtaining milk, flesh, leather, dung etc. from them and using them for agriculture.

15.12.1 Milk production :

Milk production is an important part of the business of food products. Man has been using the milk produced by other mammals for their young ones, for his own use, since ancient times. The milk obtained from mammals, immediately after the birth of young ones is known as colostrum. In an average milk there is 87.3% water, 4.5% fat, 4.6% carbohydrate, 3.5% protein 0.75% minerals, 0.85% fat-less solid substances. The maximum protein (6.25%) is present in sheep milk and cows' milk has about 3.21% proteins. Various products like curd, cream, butter, mawa, ghee, milk powder etc. are obtained from milk.

Because of high nutritive value bacteria grow very rapidly in milk and spoils it. Milk can be stored for many days after pasteurization and cooling.

15.2.2 Cattle breed :

Cow, buffalo, goat etc. are domesticated for milk production. From milk production point of view the deshi varieties of cow includes Sahiwaal, Sindh, Gir, Devli, Hariyanawi etc. while the foreign breeds include Redden, Holstein, Jerry etc. The murrah, jafarabaadi, surti etc. are the varieties of buffalo preferred for more milk production. Similarly the breeds of goat are Jamanapaari, Barbery, Sirohi etc.

15.12.3 Animal feed :

Extra animal feed should be given to bovines and pregnant cattles along with the regular feed. Animals should be fed upon 2/3 part of hay and 1/3rd green fodder. Animal feed should consist of 40% grains, 40% pomace (Khali) and 20% left over of wheat flour straining (chokar). Apart from this 50 gm of salt and 30 gms mineral powder should also be given to the cattle.

15.12.4 Animal health :

The animal should remain healthy. Production reduces in sick and unhealthy animals. For prevention of diseases animals should be vaccinated from time to time and animal shelters should be kept neat and clean. Animals may suffer from diseases caused by virus, bacteria, fungi and worms. The main diseases of animals along with their vaccines and vaccination are listed in the table given below :

S.No.	Disease	Vaccine	Time
1.	Khurpka (paw festering) and Muhpka (festering of mouth)	Poly vaccine	Every year
2.	Diphtheria	H. S oil, Adjuvant vaccine	Every year
3.	Glandular disease (Gilte-rog)	Anthrax spore vaccine	Every year
4.	Tuberculosis	BCG vaccine	After every three years
5.	Small pox	RP Tissue vaccine	After every three years

15.13 Poultry Farming :

The main aim of poultry farming is to obtain eggs and meat. Apart from this, by products like feathers, manure blood etc. are also obtained. The poultry industry fulfils a major part of the demand of proteins in the country, in the form of eggs and meat.

15.13.1 : Poultry Breed :

The poultry breed of Bhartiya origin includes Red jungle fowl, Aseel, Chatgoan, Bustra etc. They are reared chiefly to obtain meat. Foreign breeds (Exotic strains) includes Rhode Island Red, Plymouth Rock chicken, Leghorn, white Leghorn etc. White Leghorn is the breed with maximum egg production.

15.13.2 : Dwelling and food :

Arrangement for safe dwelling and nutritive food is essential for good growth and healthy fowls. The dwelling should be at some height. No water should be puddled near the dwelling and it should be well aerated and ventilated.

Yellow maize, groundnut pomace, small wheat particles, meshed rice grains, jowar, fish powder, pebbles containing lime, salt etc. are used as food.

15.13.3 : Health :

Infectious bronchitis, Marek's disease, Ranikhet, Plague, Small pox etc. are the main viral diseases in poultry. Proper vaccination should be done to prevent these diseases.

15.14 Apiculture :

Man has been using honey obtained from honey-bee since ancient times. Honey is a high energy food stuff. It contains glucose, fructose, sucrose, minerals etc. It is used as a medicine and as a preservative. The wax obtained from bee hive is known as the bee-wax. It is used in cream, floor polish, shoe polish and sculpturing. Now-a-days, honey bee are reared to obtain honey.

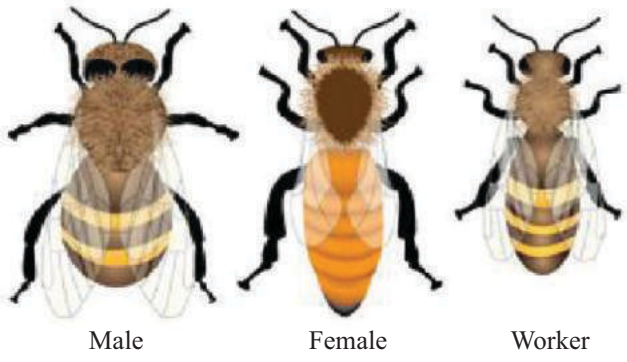


Fig. 15.7 Honey bees

15.14.1 Honeybee - a social insect :

The form and function of honey bee varies. There are three types of honey bee in a hive. Queen, Male and worker. Queen bee can be recognized by its elongated abdomen while males have very big

prominent eyes. The Queen bee dominates the hive, and controls it by secreting a substance with typical smell. The queen bee lives in the hive only. The male in their single coitus flight with the queen deposit sperms with the queen for the life-time. After this the male bees die spontaneously or they are expelled from the hive.

Queen bee lays two type of eggs. The generation of worker or queen from the fertilized eggs depends on their nourishment. The larvae which are fed upon the royal jelly develop into queen bee. The first formed queen bee kills the other developing queen bees. Thus there is a single queen bee in a hive. Males develop from the unfertilized eggs.

15.14.2 Artificial Apiculture :

The main species of honey-bee includes *Apis mellifera*, *Apis dorsata*, *Apis florea* and *Apis indica*. Of these, *Apis mellifera* is used for Apiculture. The hives of this species are large with more accumulation of honey and the number of honey-bee is also greater. *Apis dorsata* is the species with sting.

For artificial Apiculture, artificial hives of the shape of closed boxes are prepared. In the artificial hives there are larger egg chambers and plates of metal or plastic. There is a coating of wax on these plates and they form the support for the formation of hives. There are many perforations in the closed box, through which the honey bee can enter the hives.

The artificial hives are placed in gardens or near the fields from where they may get the nectar. The worker bees collect the nectar and converts it into honey. Honey is collected in the cells of the artificial hive and is obtained by removing the plates from the hive.

15.15 Fishery :

Fishery has been established as a profession because fishes are a good source of human nourishment. Fishes are used as a major food material. The by products of this industry includes oil rich in vitamins, protein, fins, skin scales etc. Fishery is a combined form of agriculture and animal husbandry because fishery is a type of animal husbandry while producing food from fishes in the water reservoir is agriculture.

Steps of Fish-culture :

15.15.1 Dwelling :

Fishes are cultured in natural water sources like sea, lakes, ponds and river but artificial water reservoirs are also used for the purpose. Places with clay-rich soil are considered good for constructing water reservoir.

15.15.2 Various species of fish :

Fishes are produced more in fresh water as compared to that in saline water. Rohu, Mrigla, katla etc. are the indegenous fishes cultured in fisheries and common carp, silver carp etc. are the exotic species of fishes which are also cultured.

15.15.3 Food for fishes :

In natural water bodies minute aquatic plants and micro-organisms are the food for fishes. In artificial water bodies rice husk, particles of cereals, wheat pieces, almond pomace, soyabean etc. are provided to the fishes as food.

15.15.4 Fish production :

The seeds of fish (i.e. spawn) are collected with the help of nets from the breeding places of the rivers. Fertilized eggs are obtained from these seeds. The small fishes which emerge from the eggs are known as the fry. After some time fry transform into fingerlings or parr. The fingerlings are then taken to the fish cultivation tanks. Fingerlings are treated with bactericidal substances like copper sulphate, formalin, Potassium permanganate or salt to kill the infectious bacteria present there.

15.15.5 Fish storage :

When sufficiently big, the fishes are caught using nets in the water reservoirs or by passing current in the water body.

15.15.6 Fish shielding :

To prevent rotting of the fish they are preserved by burying them in ice.

Important Questions

1. The substances which are obtained from nature and are used by man and other organisms are known as **natural resources**.
2. Living beings use oxygen for respiration and

carbon-di-oxide is used by plants for photosynthesis.

3. 70% of the earth is submerged under water.
4. The upper fertile layer of earth surface is known as the soil.
5. N, P, K are the important nutrients for the plants.
6. Movement in air is generated by the difference in air pressure on the surface of the earth.
7. Anemometer is used to measure the wind velocity.
8. Undesirable changes in the physical, chemical and biological characters of air, water and soil are known as pollution.
9. Carbon-mono-oxide, sulphur-di-oxide, hydro-carbons, smoke and dust are the main air pollutants.
10. The nitric acid and sulphuric acid formed in the atmosphere is washed down to earth surface with the rain water resulting in acid rain.
11. The rate of combining of carbon-mono-oxide with haemoglobin is far more as compared to that of oxygen.
12. Sewage, detergents, pesticides, insecticides, industrial affluents etc. are the main water pollutants.
13. Excessive growth of algae in water bodies is known as algal blooms.
14. Decibel is the unit of measuring sound.
15. The wavelength of visible light is 390 nm to 760 nm.
16. Cultivating same type of plants at a place on large scale is known as a crop.
17. The crops sown in rainy season are known as kharif crops while those sown in those sown in winters are the rabi crop.
18. Growing different crops in the field according to a planned programme is known as the crop-cycle.
19. Unwanted plants growing along with crop plants are known as weeds.
20. Maximum protein (6.25%) is present in the sheep milk (among the milk producing animals)
21. White leghorn breed of fowl produce maximum number of eggs.
22. Honey bee is a social insect.

Questions

Objective type Questions :

1. Growing different crops in a field in a planned manner is known as :
   (a) Mixed cropping (b) Mixed farming
   (c) Crop cycle (d) Intra cropping
2. According to the volume, the amount of carbon-di-oxide present in the atmosphere is :
   (a) 0.03% (b) 0.003%
   (c) 0.0003% (d) 0.3%
3. Acid rain results from :
   (a) Air pollution (b) Water pollution
   (c) Soil pollution (d) Sound pollution
4. Of the following which nutrient is obtained by the plants from the soil :
   (a) Carbon (b) Hydrogen
   (c) Oxygen (d) Nitrogen
5. Which of the following is a Kharif crop :
   (a) Soyabean (b) Wheat
   (c) Gram (d) Pea

Very short answer type questions :

6. Name the device used to measure the speed of wind.
7. What is pollution?
8. What are the natural resources?
9. What are algal blooms?
10. What is sonic boom?
11. What is mixed farming?
12. What is the name of the gas present in maximum amount in the atmosphere?
13. Which gas is used by plants during respiration?
14. What is the reason for wind movement?
15. Write the name of fowl with maximum production.

Short answer type questions :

1. What is humus? What are its benefits?
2. How does acid rain occurs? Write the side effects of acid rain.
3. What is Biological Oxygen Demand (BOD)?
4. Describe the negative effects of air pollution.
5. What is bio magnification? Explain.
6. What is noise pollution? Explain the negative effects of noise pollution.
7. Write four reasons of soil pollution.
8. Write four methods to control air pollution.

9. What is the difference between manure and fertilizer.
10. How is vermi-compost prepared?
11. What is Organic Farming? Explain.
12. How is artificial apiculture done?
13. Write the name of the breeds of cow and buffalo. Which produce more milk?
14. Write the names of a few cattle diseases.
15. What is Mixed Cropping? What are its benefits?

Essay type answer question :

1. What is long term cultivation? Explain the various methods of long term cultivation.
2. Write the name of the products of fisheries and explain the various steps of culturing fishes.
3. What is irrigation? Explain the modern methods of irrigation.
4. Describe the aims of improvement in varieties of crop plants.
5. What is water pollution? Describe the causes and negative impacts of water pollution.

Answer Key

1. (c) 2. (a) 3. (a) 4. (d) 5. (a)

शब्दावली (Glossary)

अभिकेन्द्र बल	–	Centrifugal force	वाहित मल	–	Sewage
अनुसंधान	–	Research	विकिरण	–	Radiation
औसत वेग	–	Average Velocity	वर्णीलवक	–	Chromoplast
आकाश गंगा	–	Galaxy	विदलन	–	Cleavage
अपवर्तन	–	Refraction	विषाणु	–	Virus
अंश	–	Degree	विभज्योतक	–	Meristematic
अदिश	–	Scalar	वाहिनिका	–	Tracheid
अभिलक्षण	–	Characteristics	वाहिका	–	Vessel
आवृत्ति	–	Frequency	वैज्ञानिक	–	Scientist
आवर्तकाल	–	Time Period	वायुमण्डल	–	Atmosphere
आयाम	–	Amplitude	वैद्युत अपघटन	–	Electrolysis
अनुरणन	–	Reverberation	विषाक्त	–	Toxic
अपश्रव्य	–	Infra	क्रांति पथ	–	Revolution Path
अम्लीय वर्षा	–	Acid Rain	कक्षा	–	Orbit
अपमार्जक	–	Detergent	कृत्रिम उपग्रह	–	Artificial Satellite
अवरक्त	–	Infra-red	क्वथनांक	–	Boiling Point
आधात्री	–	Matrix	कक्ष	–	Orbit
आत्मघाती थैलिया	–	Suicidal bags	कोश	–	Shell
अन्तर्द्रव्यी जालिका	–	Endoplasmic reticulum	कीटनाशी	–	Insecticide
अन्तरावस्था	–	Interphase	कवकनाशी	–	Fungicide
अन्त्यावस्था	–	Telophase	कोशिका	–	Cell
आवृतबीजी	–	Angiosperm	कोशिका विज्ञान	–	Cytology
अनुकूलन	–	Adaptation	कोशिका कला	–	Cell Memberane
अजैविक	–	Abiotic	कोशिका द्रव्य	–	Cytoplasm
आर्द्रता	–	Humidity	केन्द्रक	–	Nucleus
अधिशोषण	–	Adsorption	कोशिका भित्ति	–	Cell Wall
अवशोषण	–	Absorption	कशाभिका	–	Flagella
अपघटक	–	Decomposer	कोशिकारस	–	Cell Sap
आपेक्षिक	–	Relative	केन्द्रकद्रव्य	–	Nucleoplasm
वृत्ताकार गति	–	Circular Motion	केन्द्रिक	–	Nucleolus
विषुवत रेखा	–	The global line	कोशिका चक्र	–	Cell Cycle
वायु प्रतिरोध	–	Air Resistance	केन्द्रक विभाजन	–	Karyokinesis
विस्थापन	–	Displacement	कोशिका द्रव्य विभाजन	–	Cyto Kinesis
वेग	–	Velocity	क्लोम	–	Gill
विरलन	–	Rarefaction	खगोलविद्	–	Astronomer
विदलन	–	Cleavage	खगोल भौतिकी	–	Astrophysics
विज्ञान	–	Science	खरपतवार	–	Weed
वैज्ञानिक विधि	–	Scientific Method	गति के नियम	–	Law of Motion
वर्णक्रम	–	Spectrum	गुरूत्व	–	Gravity
विद्युत विसर्जन नलिका	–	Electric Discharge Tube	गुरूत्वीय बल	–	Gravitational Force

ग्रह – Planets
गतिविधि – Activity
गति – Motion
गुणसूत्र – Chromosome
ज्वारभाटा – Tides
जड़त्व – Inertia
जैविक आवर्धन – Biological Magnification
जीवाणु – Bacteria
जल अपघटनी एन्जाइम – Hydrolytic Enzyme
जन्तु कोशिका – Animal Cell
जनन – Reproduction
जरायुज – Vivipary
जीवन चक्र – Life Cycle
जीवाणुभोजी – Bacteriophage
जीन विनिमय – Crossing Over
जैवविविधता – Biodiversity
जलोद्भिद – Hydrophyte
जैविक – Biotic
जीवाश्म – Fossil
जल मण्डल – Hydrosphere
जीव मण्डल – Biosphere
घर्षण बल – Friction Force
घर्षण – Friction
घरेलू कचरा – Garbage
घनत्व – Density
घटक – Component
द्रव्यमान – Mass
दूरी – Distance
दोलित्र – Oscillator
दाब – Pressure
द्वि बीजपत्री – Dicot
दृढ़ोतक – Sclerenchyma
भार – Weight
मात्रक – Unit
मृदूतक – Parenchyma
भारहीनता – Weight lessness
प्रतिक्रिया – Reaction
पाठ्यांक – Reading
पोष स्तर – Tropic level
प्राकृतिक विज्ञान – Natural Science
परावर्तन – Reflection
परावर्तित किरण – Reflected Rays
पादप कोशिका – Plant Cell
प्रकाश वर्ष – Light Year
पराबैंगनी – Ultraviolet
प्राकृतिक उपग्रह – Natural Satellite
प्रबलता – Loudness
परावर्तन कोण – Angle of Reflection
प्रतिध्वनि – Echo
पराश्रृव्य – Ultra
पक्ष्माभ – Cilia
पृष्ठवंशी – Chordata
पूर्णिमा – Full moon day
प्रणोद – Thrust
परमाणु सिद्धान्त – Atomic Theory
पुरावनस्पति शास्त्री – Paliobotanist
परखनली शिशु – Testtube Baby
परमाणुकता – Atomicity
परमाणु भार – Atomic weight
पर्यावरण – Environment
प्रदूषण – Pollution
प्रदूषक – Pollutant
पारिस्थितिक तंत्र – Ecosystem
परिस्थितिकी – Ecology
प्रक्षेपण – Launching
पीठिका – Stroma
पूर्व केन्द्रकीय कोशिका – Prokaryotic Cell
पश्चावस्था – Anaphase
तनाव – Tension
तारामण्डल – Constellations
तुल्यकालन – Synchronisation
तारे – Stars
त्वरण – Acceleration
तरंगदैर्ध्य – Wavelength
तारककाय – Centrosome
तारक केन्द्र – Centriole
तीव्रता – Intersity
तंत्रिका ऊतक – Nervous Tissue
मुक्त पतन – Free Fall
मधुमक्खी पालन – Apiculture
उल्काश्म – Bolide
उल्का – Meteors
ऊतक – Tissue
उल्कापिण्ड – Meteorites
उर्वरक – Fertilizer
उत्प्लावकता – Buoyancy

ऊष्मागतिकी	–	Thermodynamics
उत्परिवर्तन	–	Mutation
उभयचर	–	Gill
उपापचयी	–	Metabolic
उत्पादक	–	Producer
उपभोक्ता	–	Consumer
राशिचक्र	–	Zodiac
राशि	–	Sign of Zodiac
चन्द्रमा की कलाएँ	–	Phases of moon
चालनी पट्टिका	–	Sieve plate
धूमकेतु	–	Comets
धातु कर्म	–	Metallurgy
ध्रुवतारा	–	Pole Star
धुआँ	–	Smoke
धूम–कुहरा	–	Smog
ध्वनि	–	Sound
ध्वनि बूम	–	Sonic boom
धात्विक त्रिज्या	–	Metallic radius
समस्थानिक	–	Isotope
सममारिक	–	Isobar
सप्तर्षि	–	Ursa Major
सौर परिवार	–	Solar System
सुपाषी	–	Eutrophic
सरीसृप	–	Reptile
सार्वत्रिक नियम	–	Univershal Law
सदिश	–	Vector
सम्पीड्यता	–	Compressibility
सापेक्षतावाद	–	Relativity
संवहन ऊतक	–	Vascular Tissue
सहजीविता	–	Symbiosis
सूचक	–	Indicator
संचरण	–	Propagation
सुकेन्द्रकीय कोशिका	–	Eukaryotic Cell
सहकोशिका	–	Comapanion Cell
संपीड़न	–	Compression
संवेग	–	Momentum
स्नेहक	–	Lubricant
स्थूलकोण ऊतक	–	Collenchyma
स्थल मण्डल	–	Lithosphere
स्थनधारी	–	Mammalia
स्फीत	–	Turgid
सूक्ष्मकाय	–	Microbody
सहसंयोजक त्रिज्या	–	Covalent Radius
सर्पी	–	Sliding
संसाधन	–	Resource
क्षुद्र ग्रह	–	Asteroids
बल	–	Force
बहुकोशिक जीव	–	Multi Cellular Ogranism
लोटनी	–	Rolling
लवक	–	Plastid
लवणमदोद्भिद	–	Halophyte
श्रव्य	–	Audible
राडार	–	Radar
रासायनिक संयोग	–	Chemical Combination
रिक्तिका	–	Vacuole
मांडुलटेर	–	Modulator
मण्ड	–	Starch
मातृ कोशिका	–	Mother Cell
मूलगोप	–	Root Cap
मूल रोम	–	Root hair
मृतजीवी	–	Saprophyte
मूलाभास	–	Rhizoido
मत्स्य	–	Pisces
निर्वात	–	Vaccum
शैवाल ब्लूम	–	Algal bloom
शीतोद्भिद	–	Cryophyte
शाकनाशी	–	Herbicide
श्वसन	–	Respiration
शक्ति गृह	–	Power House
एककोशिक जीव	–	Unicellular Organism
एक बीजी पत्री	–	Monocot
नीले–हरे शैवाल	–	Blue Green Algae
हरित लवक	–	Choroplast
युग्मनज	–	Zygote
युग्मक	–	Gamete
यांत्रिक ऊतक	–	Mechanical Tissue
जीव–विकास	–	Evolution
जीव–जनन वाद	–	Theory of Biogenesis
स्वतः जनन वाद	–	Theory of spontaneous generation
ब्रह्माण्ड	–	Universe
आकाशगंगाएं	–	Milky ways
ग्रह	–	Planet
बुध ग्रह	–	Mercury
शुक्र ग्रह	–	Venus
मंगल ग्रह	–	Mars

पोषण	–	Nutrition
पाचन	–	Digestion
कार्बोहाइड्रेट	–	Carbohydrate
वसा	–	Fat
प्रोटीन	–	Protein
खनिज लवण	–	Mineral
विटामिन	–	Vitamin
जल	–	Water
रूक्षांश	–	Roughage
मांसाहारी	–	Carnivores
मुखगुहा	–	Buccal cavity
स्वपोषी	–	Autotrophs
परपोषी	–	Heterotrophs
सर्वाहारी	–	Omnivorous
परजीवी	–	Parasites
अवायवीय श्वसन या अनॉक्सीश्वसन	–	Anaerobic respiration
अंतःपरजीवी	–	Endoparasite
आमाशय	–	Stomach
आहारनाल	–	Alimentary canal
जठर रस	–	Gastric juice
आंशिक परजीवी	–	Partial parasites
ऑक्सीश्वसन	–	Aerobic respiration
स्थायी परजीवी	–	Permanant parasite
बाह्य परजीवी	–	Ectoparasite
रसायन–संश्लेषी	–	Chemoautotrophs
प्राणीसमभोजीपोषी जन्तु	–	Holozoic organism
शाकाहारी	–	Herbivores
ग्रसनी	–	Oesophagus
मलाशय	–	Rectum
खमीरीकरण	–	Fermentation
समपोषी	–	Halophytic
नासाछिद्र	–	Nostril
नासामार्ग	–	Nasal passage
नासागुहा	–	Nasal chamber
श्वासनली	–	Trachea
स्वरयंत्र	–	Larynx
श्वसनी	–	Bronchi
श्वसनीकाएं	–	Bronchioles
परिसंचरण	–	Circulation
वायुकोष	–	Airsac or Alveoli
उच्छवास	–	Exhalation
फेफड़े	–	Lungs
लाल रूधिर कणिका	–	Red Blood Corpuscles or RBC
श्वेत रक्त कणिका	–	White Blood Corpuscles or WBC
रक्त क्षीणता	–	Anemia
आलिन्द	–	Auricle
धमनी	–	Arteries
शिराएं	–	Veins
रूधिर दाब	–	Blood Pressure
दोहरा परिसंचरण तंत्र	–	Double circulation system
हृदय	–	Heart
अर्न्तआलिन्दीय पट	–	Inter auricular septum
अन्तर्निलयी पट	–	Inter ventricular septum
अपघटनी या अपचयी	–	Catabolic
उपचयी या संश्लेषी	–	Anabolic
मूत्राशय	–	Urinary bladder
वृक्क	–	Kidney
मूत्रवाहिनियां	–	Ureter
परानिस्यंदन	–	Ultrafiltration
मूत्र नलिकायें	–	Uriferous tubules or Nephrons
जनन	–	Reproduction
पुनरुद्भवन	–	Regeneration
अलैंगिक जनन	–	Asexual reproduction
लैंगिक जनन	–	Sexual reproduction
द्विविखण्डन	–	Binary fission
तंत्रिका तंत्र	–	Nervous System
प्रतिवर्ती क्रिया	–	Reflex action
प्रतिवर्ती चाप	–	Reflex arch
नियमन	–	Regulation
तंत्रिकाक्ष	–	Axon
द्रुमाश्म	–	Dendrite
अन्तःस्त्रावी तंत्र	–	Endocrine System
अन्तःस्त्रावी ग्रंथियों	–	Endocrine glands
गलगण्ड	–	Goiter
स्वास्थ्य	–	Health
रोग	–	Disease
योग	–	Yoga
जैविक कारक	–	Biological agent
रोगजनक	–	Pathogen
हृदय रोग	–	Heart disease

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