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SCIENCE

X STANDARD

Untouchability
Inhuman - Crime

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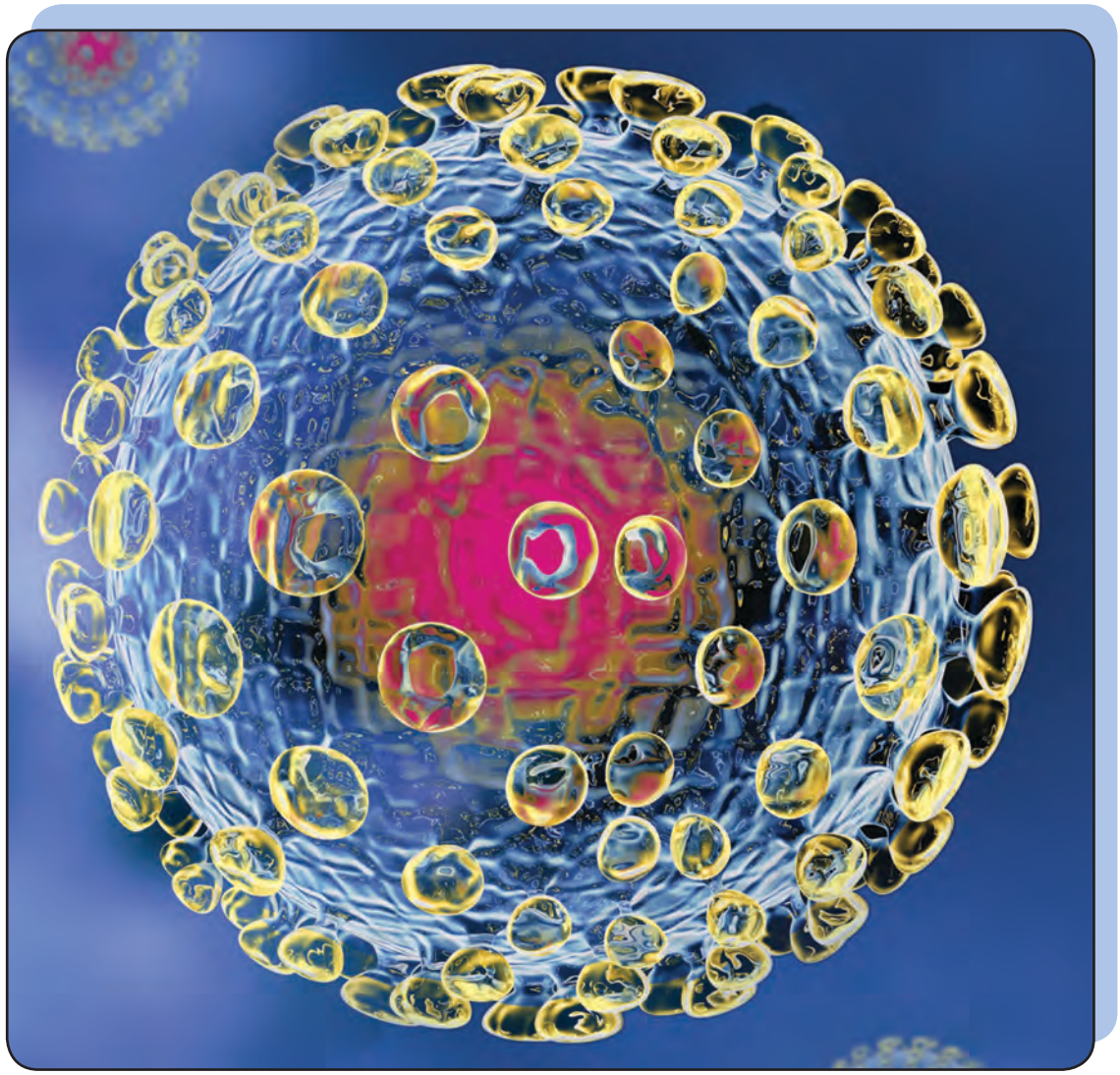
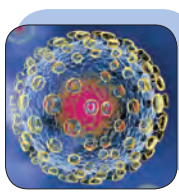
Chapter 1





HEREDITY AND EVOLUTION

1. HEREDITY AND EVOLUTION

HEREDITY AND VARIATION

A cow gives birth to a calf. Both the mother cow and calf share common characteristics like body design, physiological function etc, that are specific to their species. However on a very close observation of the mother cow and the calf and the bull which is the calf's other parent , we will come across a number of differences among them, like colour pattern in the skin. By virtue of being the progeny of the parent, the progeny individual, need not just be the replica of what its parents are. (Inheritance of characters from the parents to the progeny (i.e. , Heredity) ensures the passing of the parental characters to the progeny). The difference or change in the characteristics between the individuals is called Variation. Human population shows a great deal of variation.

ACTIVITY 1.1

- Ask your classmates to roll their tongues. Observe how many can and how many are not able to roll their tongues. Record your findings.
- Similarly record the variation in the eye colour noticed among your classmates.

1.1. HEREDITY

The progeny produced through the reproductive process is similar to its parents, in body design, function etc., The rules of heredity determine the process by which the traits and the characteristics are relatively inherited.

"The inheritance of characteristics through generation is called heredity"

The inheritable characteristics may be morphological/anatomical/physiological/ reproductive and are also known as traits.

If we take a very close look at the rules of inheritance, both father and mother contribute equal amount of genetic material to the child. This means that each trait can be influenced by both paternal and maternal genetic material – i.e, DNA.

Gregor Johann Mendel (1822-1884) worked out the first ever scientific experimental study on heredity and he is called the father of genetics.

Mendel, an Austrian Augustinian monk observed variations in the characteristics of garden pea plant (*Pisum sativum*) which he had cultivated in his monastery garden. Mendel was curious to find out the results of crossing of pea plants with the variation in traits. The visible contrasting characters that Mendel observed in the garden pea plants were

- Seed shape - Round/Wrinkled
- Seed colour - Yellow/Green
- Flower colour - Violet / White

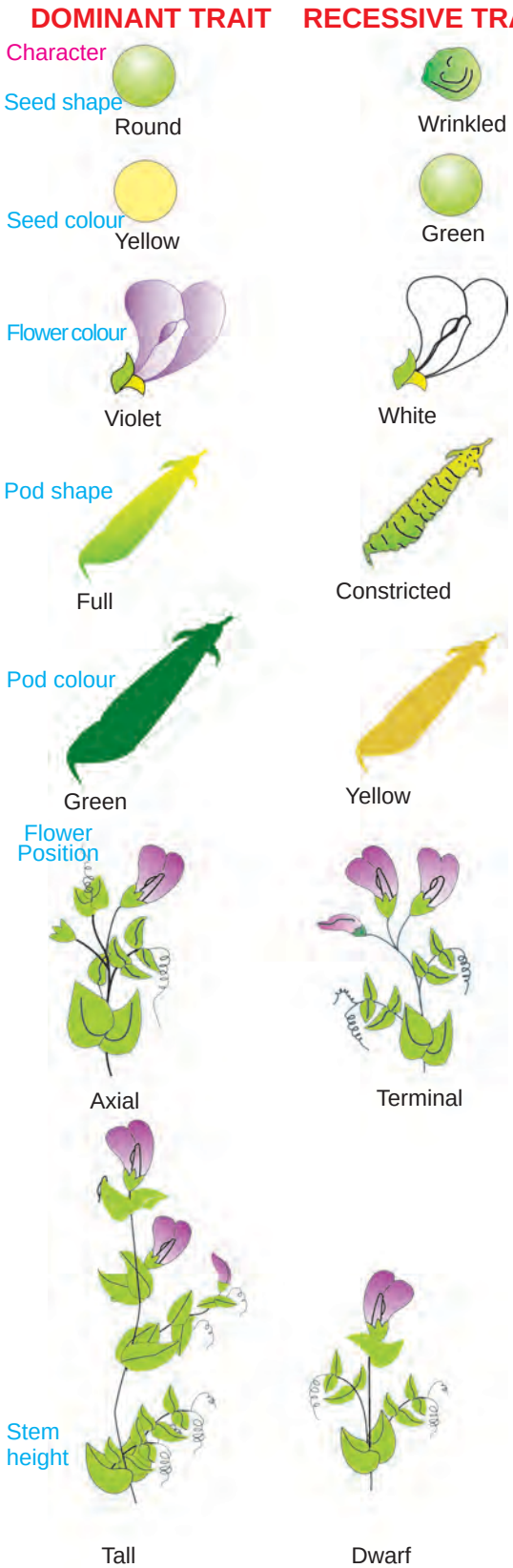


Fig. 1.1 Seven pairs of contrasting traits in Pea plant studied by Mendel.

- Pod shape - Full / Constricted
- Pod colour - Green / Yellow
- Flower position - Axillary / Terminal
- Stem height - Tall / Dwarf

1.1.1. Mendel's monohybrid cross

Mendel selected the garden pea plant, Pisum sativum for his experiments. He selected tall and dwarf plants and allowed them to grow naturally. As pea plants produce seeds only by self pollination, he observed that tall plants produced always

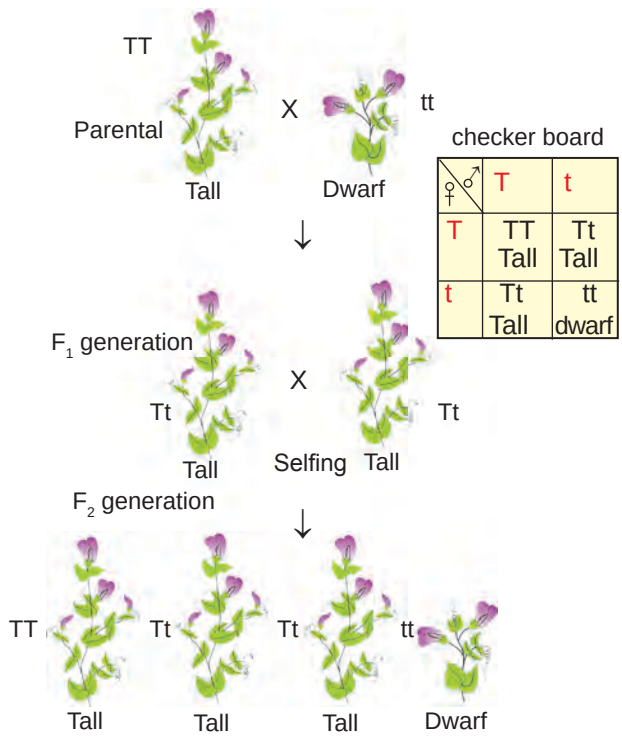


Fig. 1.2 Diagrammatic representation of Monohybrid cross

tall plants generation after generation under natural condition.Similarly, dwarf plants produced always dwarf plants generation after generation. Hence, he termed the tall and dwarf plants as wild types or pure breeding varieties.

Then he crossed a tall plant with a dwarf plant, produced progeny and calculated the percentage of tallness and dwarfness in subsequent generations.

When a pure breeding tall plant was crossed with a pure breeding dwarf plant, all plants were tall in the first filial generation (F1) i.e., there was not any medium height plants or dwarf plants. This means that only one of the parental traits were seen and not the mixture of the two. When such a F1 tall plant was allowed to have self pollination, both the tall and dwarf plants appeared in second filial generation (F2). in the ratio of 3:1. This indicates that both tallness and dwarfness were inherited in the F1 plants but only tallness trait was expressed.

The first experiment of Mendel considering the inheritance of a single trait (Height of the plant Tall/Dwarf) is called Monohybrid Cross.

Expression of morphological characters as tall or dwarf plant, violet or white flower is called Phenotype.

The expression of gene (or Chromosomal make up) of an individual for a particular trait is called Genotype.

Gregor Johann Mendel(1822-1884)

Mendel was educated in a monastery and went on to study science and mathematics at the university of Vienna. Failure in the examinations for a teaching certificate did not suppress his zeal for scientific quest. He went back to his monastery and started growing peas. Many others had studied the inheritance of traits in peas and other organisms earlier, but Mendel blended his knowledge of Science and Mathematics and was the first one to keep count of individuals exhibiting a particular trait in each generation. This helped him to arrive at the laws of inheritance that we have discussed in the main text.

ACTIVITY 1.2

Observe in your locality for plants which show different characters for the following traits. Count them and record your findings. Examples:

Coconut	Tall	Dwarf
Bean	Violet Flower	White Flower
Sugar Cane	White Stem	Purple Stem
Clitoria	Blue Flowers	White Flowers

1.1.2. Physical basis of heredity

The genotype of a character is influenced by factors, called Genes. The genes are the factors which form the physical basis for inheritance of Characters. The alternate expressions of the same gene are called alleles. The contrasting pair of alleles make up an allelomorph. Examples : Tall and

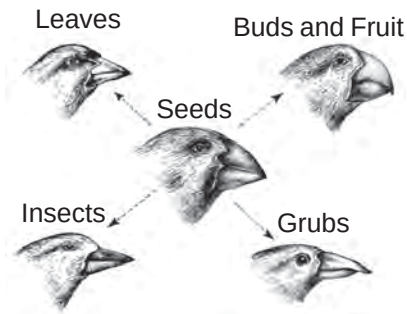


Fig. 1.3 Variations in the beaks of finches to suit their eating habits.

ACTIVITY 1.3

Find out identical / Non-identical twins in your school and locality. Find the minute variations between them.

dwarf plants, wrinkled and smooth seed coat, white and violet coloured flower. Organisms differ or vary in expressing phenotype which leads to variation.

1.2. VARIATION

All around us , we see different organisms belonging to different species, differing from one another. Variation may be defined as the differences in the characteristics among the individuals of the same species (intra specific variation) or among the different genera

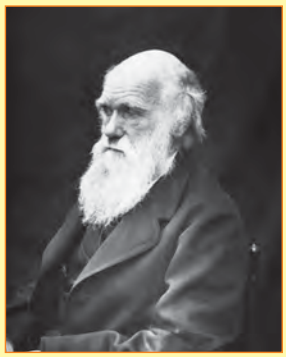
Fig. 1.4 Identical twins

(intergeneric variation) or different species (Inter specific Variation). No two individuals are identical to each other. Asexual reproduction produces, very closely resembling offsprings. Asexual reproduction thus results in offsprings with minor variations.Sexually reproducing organisms produce offsprings with marked,significant and visible variations.

1.2.1. Types of variations

a. ***Somatic Variation*** - It pertains to bodycells and it is not inherited.

Charles Darwin: *(1809-1882) Charles Darwin set out on a voyage when he was 22 years old. The 5 year voyage took him to South America and the islands, off its coast. Interestingly, after he got back to England, he never left to the shores again. He stayed at home and conducted various experiments that led him to formulate his hypothesis from which evolution took place due to natural selection. He did not know the mechanism from where the variations arose in the species. Had he been enlightened by Mendel's experiments, he would have contributed more. But these two great men did not know of each other or of their works!*



We often associate Darwin solely with the theory of evolution. But he was an accomplished naturalist, and one of the studies he conducted was, to do with the role of earthworms in soil fertility.

b. ***Germinal Variation*** - It pertains to germ cells or gametes and it is inheritable. It leads to speciation and evolution.

Significance of Variation

- It is the source of raw material for evolution.
- Animals are able to adapt themselves to the changing environment.

Lamarckian View on organic evolution:

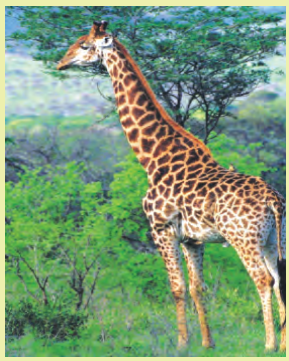


Fig. 1.5 Giraffe

Jean Baptiste Lamarck (1744-1829) postulated the Use and Disuse Theory. According to Lamarck, use of a part / organ efficiently by a species, for generations over a long period of time, results in that part / organ being well developed in the subsequent generations and disuse of part/organ for a long period would make that part / organ diminished or degenerated.

Lamarck quotes the example of development of long neck of Giraffe. Giraffes were forced to extend their neck and stretch their legs to reach the leaves of tall trees. Over a long period of time, this resulted in long neck and legs in giraffe. Lamarck remarks that the "will or want" for a character makes the organisms to posseses it at a later time.

- Organisms are better suited to face the struggle for existence
- Variations give the organisms an individuality of their own.
- Without variation, there would be no science of heredity as all individuals of a race, would be identical in all aspects.

1.2.2. Theory Of Natural Selection

Charles Darwin made a number of observations in many parts of the world and put forth the law of natural selection involving struggle for existence and survival of the fittest.

Variation leads to genetic diversity,which is the key for evolution.

1.3. EVOLUTION

Evolution may be defined as a gradual development of more complex species from pre-existing simpler forms.

It is an extremely slow process and has occurred over millions of years,as revealed by fossil evidences.

Evolution has thus resulted in the diversity of organisms, influenced by environmental selection.

1.4. SPECIATION

Mankind in India and all other parts of the world, form a single species called Homo sapiens. As in India, morphological features of people living in different geographical areas like South India, North India, North Eastern region, Kashmir and Andaman are not the same as the people living in different continents are different in morphological features.

Men, with these differences in their bodily features, differentiate more and more, if there is no chance of interbreeding among them.

Imagine a situation, where this would result in the impossibility of

breeding between two such individuals of geographically isolated populations. Then they would be ready to become two different species.

When two populations are isolated by geographical barriers, or reproductive barriers, there is a chance for a change to develop in their gene flow (Genetic drift), leading to formation of a new species. Genetic drift with changes in the gene flow imposed by isolation mechanism acts as an agent of speciation.

Thus speciation is arising of a new species from a sub-population of a species which is geographically or reproductively isolated over a long period of time from the other population of the same species.

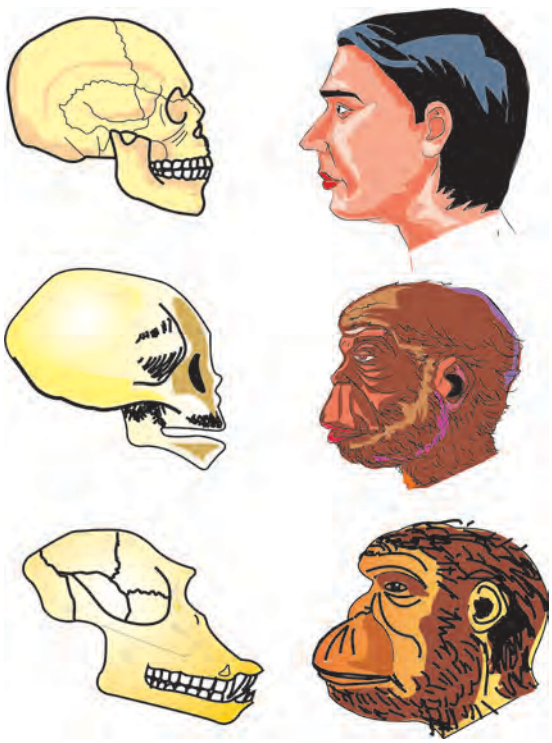


Fig. 1.6 A comparison of the skulls of adult modern human being, baby chimpanzee and adult chimpanzee. The skull of baby chimpanzee is more like adult human skull than adult chimpanzee skull.

1.5. HUMAN EVOLUTION

Fifteen million years ago, in Africa existed hairy bodied Gorilla and Chimpanzees like Hominids. After that 3-4 million years ago, men like hominids, walked into Eastern Africa. Evidence shows that they hunted with stone weapons but were mostly fruit eaters. They were probably not taller than four feet but, walked upright in the grass lands of East Africa. These creatures were called the First human like being – the hominid. The hominid was called *Homo habilis*.

The next stage of human evolution came into existence 1.5 million years ago with the rise of *Homo erectus* who were meat eaters

The Neanderthal man who lived in East and Central Asia 1 million years

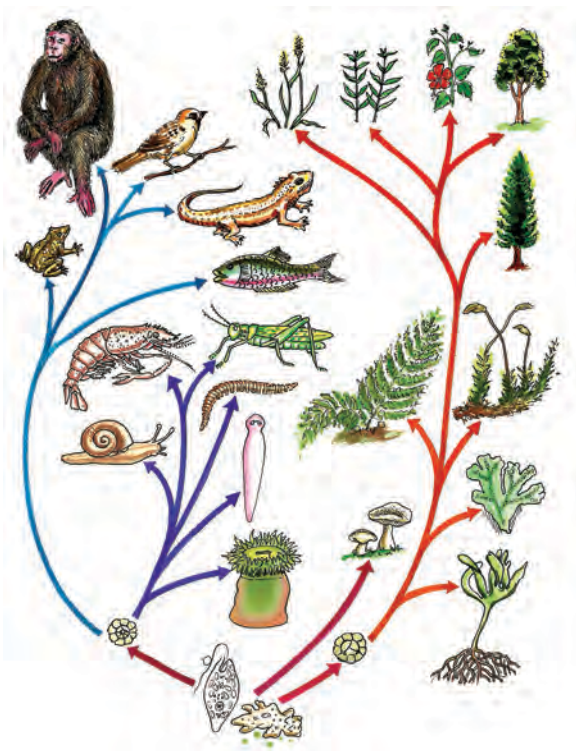


Fig. 1.7 Evolutionary tree

ago, used to hide to protect them and buried their dead.

Archaic Homo sapiens arose in South Africa and moved across continents and developed into distinct races during the ice age. Between 75,000 – 10,000 years, the modern Homo sapiens arose. Pre-historic caves were developed about 18,000 years ago, agriculture came around 10,000 years back and human settlements started.

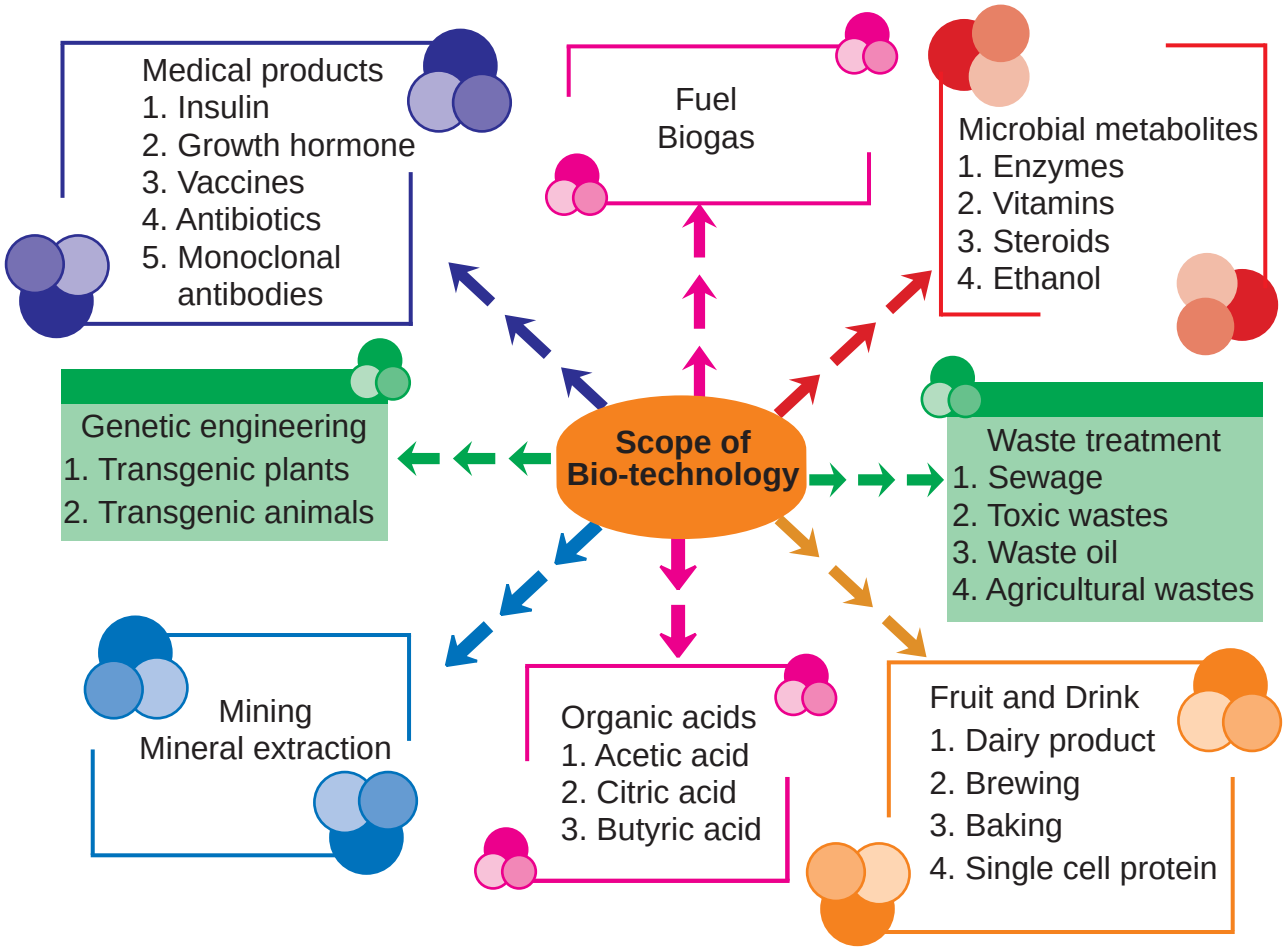
1.6. EVOLUTION TREE

To understand evolution, a branching diagram or "Tree" is used to show the inferred evolution, relationships, among various biological species or other entities based upon similarities and differences in their physical and genetic characters.

1.7. GENETIC ENGINEERING

Genetic engineering is the modification of the genetic information of living organisms by manipulation of DNA by adding, removing or repairing part of genetic material (DNA) and changing the phenotype of the organism. It is also known as gene manipulation or recombinant DNA Technology (r-DNA Technology)

Recent advances made in Genetics, Molecular Biology and Bio-Chemistry have resulted in the origin of this new branch of science. The benefits derived through the Genetic Engineering include:



- Understanding of the gene structure and function through basic research.
- Production of large quantities of insulin, interferon(Anti-Viral Protein produced by Virus infected cells) human growth hormones, proteins (Polypeptides) and vaccines for foot and mouth disease of cattle (komari – in Tamil) etc.,
- This technique is also employed in the transfer of genes involved in Nitrogen fixation(NiF–genes). This will help the cultivator to increase productivity.

1.7.1. Basic techniques in Genetic Engineering

Genetic Engineering has developed after the discovery of two enzymes. The enzymes which can cut DNA into fragments, and enzymes which can join such fragments.

Restriction enzymes or Restriction endonucleases are molecular scissors which cut DNA at specific sites. DNA ligases are the paste enzyme which helps to join the broken DNA fragments.

1.8. BIO-TECHNOLOGY AND CLONING

Bio-technology has contributed towards exploitation of biological organisms or biological processes through modern techniques which could be profitably used in medicine, agriculture, animal husbandary and environmental cleaning. There are several applications of Bio-technology such as brewing Industry, enzyme technology, manufacturing of anti-biotics, organic acids, vitamins, vaccines, steroids and monoclonal anti-bodies.

It was Edward Jenner (1749-1823) in 1791 who coined the term vaccine and the term vaccination for protective inoculation. Vaccines produced by Bio-technology differ from others. In that, they do not contain weakened or killed agents. Instead they are so refined as to consist only the reactive material ie., the antigen protein only. The first such vaccine was used against Hepatitis B Virus (HBV)

Edward Jenner

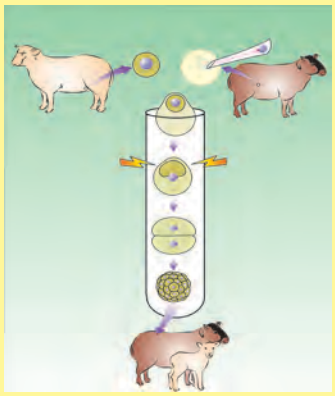
Brewing Industry: Fermentation in alcoholic beverages like beer, wine etc.,

Enzyme Technology : Enzymes are bio-catalysts that speed up reaction in cells. They can be used to catalyze the industrially important reactions and are more efficient than inorganic catalysts. Many enzymes are utilized in the pharmaceutical industry.

Anti-Biotics : These are substances produced by some microbes that help in increasing the immunity to human beings which are toxic to other micro-organisms.

Organic Acids: Acetic acid is used for the production of vinegar.

Development of Dolly



Cloning

Dolly was a cloned sheep, developed by Dr.Ian Wilmut and his colleagues in Roselind Institute in Scotland in July 1996.

The scientists used nucleus of udder cell (somatic cell taken from mammary gland) from a six year old Finn Dorset white sheep.

The nucleus of the udder cell contains, diploid number(2n) of chromosomes with all the genes. They preserved the diploid nucleus in a suitable preservative. Then they took an ovum from the ovary of another sheep. The haploid nucleus (n) in the ovum was removed.

The diploid nucleus of the udder cell was injected into the cytoplasm of the enucleated ovum. Then the ovum with the diploid nucleus, was implanted into the uterus of the surrogate mother sheep. Since the ovum had the diploid nucleus, it developed into a young clone. It was named "Dolly" by Dr.Ian Wilmut.

Vitamins: These are chemical compounds present in variable minute quantities in natural food stuffs. They do not furnish energy but are very essential for energy transformation and regulation of metabolism.

Fig. 1.10 Dr. Ian Wilmut with Dolly

Vaccines: Vaccines are substances that confer immunity against specific disease. They act as antigens and stimulate the body to manufacture antibody.

Steroids: They are a type of derived lipids Ex: Cholesterol, containing steroid drugs like prednisolone is produced from fungus Rhizopus.

Monoclonal anti-bodies : These are the anti bodies produced by cloned cells. Monoclonal anti -bodies, are now used for treatment of cancer.

Cloning: Cloning is an experimental technique wherein a group of morphologically and genetically identical organisms are produced. The "Clone" is an organism derived from a single parent by asexual method. A clone may be defined as an exact carbon copy or copies of a single parent.

The word clone refers only to living species.

If the cloning technique is to be applied to veterinary science, valuable

animals could be cloned from desirable adult cells.

1.8.1 Types of Clones

Natural clones: The natural clones include identical twins.

Induced clones: The induced (artificial) clones are developed by nuclear transfer into the host cell

1.9. STEM CELL (ORGAN) CULTURE:

One of the most fascinating branches in applied embryology is stem cell culture. The stem cells are the most unspecialized mass of cells. They are derived from animals and plants. They have two important characteristic features. They are:

1. Unspecialized cells which have the potentiality of growing and multiplying into enormous number of same type of cells by repeated mitosis.
2. They can be introduced to become any other type of tissues with specific functions i.e., they can be induced to become a cardiac muscle, beta cells of pancreas (which produce insulin), special neurons in brain etc.,

1.9.1. Types of Stem Cells

There are two kinds of stem cells

1. ***Embryonic Stem Cells:*** The embryonic stem cells can be derived from early embryo which is developed by "invitro fertilization" (fertilization made artificially in the laboratory).

After fertilization the zygote develops into a hollow blastula by cell division. The inner mass of undifferentiated cells are isolated and they are considered as embryonic stem cells.

2. ***Adult or Somatic Stem Cells***: The body of higher animals and human beings have many well differentiated tissues like epithelial, connective, muscular, vascular, supporting, nervous and reproductive tissues. In these tissues, there are some undifferentiated cells and are considered as the adult or somatic stem cells. They can grow, multiply and can be differentiated into same type of tissues into which they are implanted. The mechanism of adult or somatic stem cell culture is similar to that of embryonic stem cell culture. The somatic stem cells are derived from sources such as bone marrow, embryos, amniotic fluid and umbilical cord.

1.10. MICROBIAL PRODUCTION

As we discussed earlier, the field of Bio-technology is so vast and has great scope for different fields like agriculture, medicine, foodindustry etc.,

The microbial products of every day use are:

Vaccines : Killed or live germs suspension which is employed to induce the production of antibodies and bring forth immunity.

Antibiotics : Antibiotics are chemical substances derived from microbes like fungi, bacteria etc., employed to kill the infectious germs and cure a disease.

Vitamin B_{12} : Bio technologically synthesized vitamin B_{12} is used, to cure pernicious anaemia.

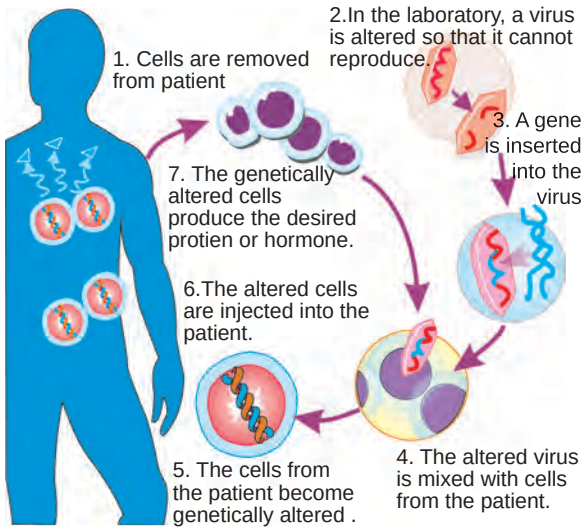


Fig 1.11 Gene therapy

Enzymes : Bio-Chemically significant enzymes are derived from microbes Ex. Amylase is derived from amyloproteins of bacteria.

Insulin : Diabetes is treated by the biotechnologically produced insulin.

1.11. BIO-SENSOR AND BIO-CHIPS

Bio sensor: It is a device consisting of immobilized layer of biological material such as enzyme, antibody, hormone, nucleic acids, organelles or whole cells and its contact with a sensor. The sensor converts biological signals into an electrical signal. It is used in medicines and industry.

1. Blood glucose level can be detected.
2. Production of any toxin in the body due to infection can be detected.
3. Pollution in drinking water can be monitored.
4. Odour, freshness and taste of food can be measured.

Bio-Chips

Bio-Chips are microchips which are developed by employing techniques of Bio-technology. In future, biological computers will be developed using bio-chips. Bio-Chips will be useful in defence, medicine etc.,

1.12 SCIENCE TODAY - GENE THERAPY

Insulin dependent diabetes is treated with insulin injection. Insulin dependent diabetes is caused by the degeneration of beta cells due to a defective gene. Applying the principle of Bio-technology, it is possible to correct the defective gene. When the defective gene is corrected with a new gene, the genetic defect developed is, rectified and cured.

Gene Therapy is the means to treat or even cure genetic and acquired diseases like cancer and AIDS by using normal gene to supplement or replace the defective gene.

It can be used to treat defects in Somatic i.e., (body) or Gametic (sperm or eggs) Cell.

Types of Gene Therapy

1. Somatic gene therapy:- The genome (gene set) of the recipient is changed. But this change is not passed along to the next generation.
2. Germ line gene therapy:- Egg and sperm of the parents are changed, for the purpose of passing the changes to the next generation.

EVALUATION

PART A

1. Mendel observed 7 pairs of contrasting characters in Pisum sativum. One of the following is not a part of that. Find out.

   - Tall and dwarf,
   - Yellow and green seed colour,
   - Terminal and axial Flower,
   - Smooth and rough stem

2. Primitive man evolved in - (Africa, America, Australia, India)

3. Which of the following is inheritable (an altered gene in sperm, analtered gene in testes, an altered gene in zygote ,an altered gene in udder cell)

4. Theory of natural selection was proposed by - (Charles Darwin, Hugo de Vries, Gregor Johann Mendel,Jean Baptise Lamarck)

5. Somatic gene therapy (affects sperm, affects egg, affects progeny ,affects body cell)

PART B

6. Mendel has observed Tallness as dominant character in Garden pea plant. Similarly tongue rolling is a dominant character in man. In a group of 60 students, 45 can roll their tongue and 15 are non rollers.

   a) In the above context, calculate the percentage of dominant and recessive characters.

   b) In Garden pea plant, draw the diagrammatic representation of mono hybrid cross as explained by Mendel.

7. The heritable characters are varying in different species and within the same species.

Name the variation in the following cases.

The eye colour among the human beings are varied as blue, black, brown, green, etc.,

a) This is called as _____variation. The dentition in rabbit and elephant are not the same.

b) This is called as _____ variation.

8. Sexually reproducing organisms produce offsprings with marked, significant and visible variation.

Asexually reproducing offsprings show minor variations.

a) Do you agree with the above statements?

b) Among the following organisms list out the asexually reproducing organisms

(Paramoecium, Euglena, Earthworm and Bird.)

9. Here is a certain important hereditary jargons, fix a suitable one from the list given below.

a) _____ are the factors which form the physical basis of inheritance.

b)_____ is alternate expression of same gene.

c)_____ are contrasting pairs of alleles.(alleles, variation, speciation, gene, allelomorph)

10. A change that affects the body cell is not inherited. However , a change in the gamete is inherited. Radiation effects of Hiroshima has been affecting generations. Analyzing the above statements, give your interpretation.

11. Sequentially arrange the different species of man from primitive to modern man. (Neanderthal man, Homo habilis, Homo erectus, Homo sapiens)

12. Bio-technology , the modern science in biology, has helped in producing different types of products.

    One of the following group does not have a product of bio-technology. Pick out and give reasons.

    a) Enzymes, Organic acids, Steroids, Vaccines

    b) Vaccines, Enzymes, Anti biotics, Inorganic acids

    c) Anti biotics, Hormones, Steroids, Vaccines

    d) Steroids, Enzymes, Anti bodies, Vaccines.

13. Identical twins are syngenic with similar chromosomal contents. Natural clones are those who possess identical chromosomes. Fill up with the suitable word given in the bracket.

    a) Identical twins are _____ (Natural clones / Induced clones)

    b) Identical twins are _____ (dissimilar to each other / similar to each other).

14. The ancestor of particular type of frog found in India and Srilanka were the same,

    a) With reference to the above map, identify the factor that has resulted in the formation of a new species.

    b) State a few other factors that help in the formation of new species.

PART C

15. Human evolution has a record of changes for the past of 15 milion years.

    a) Name the different species of mankind in chronological order from primitive to modern man.

    b)When were the primitive caves developed.?

    c) Narrate the life led by early man like hominids.

FURTHER REFERENCE

Books: 1. Biology - A Modern Introduction B.S.Beckett, Second Edition, Oxform University Press

Website: http://www.khanacademy.org

Chapter 2

IMMUNE SYSTEM

2. IMMUNE SYSTEM

IMMUNE SYSTEM

"Health is Wealth" is an apt proverb. There can be no wealth greater than the good health that a person enjoys. In a healthy state, a person keeps himself physically, mentally and socially, fit. Our body has a complex defense mechanism to keep itself fit and work against various agents which disturb our well being. Being exposed to diseases, we develop resistance towards diseases and gain immunity.

2.1. HEALTH AND ITS SIGNIFICANCE

"Health is a state of physical, mental and social well being of an individual and not merely absence of a disease or infirmity".

When a person is in good health, the different organ systems, not only function well discharging their duties, but the body as a whole is also able to adjust itself and strike a balance with the physical, mental and social environments.

The varying environmental factors such as temperature, humidity, wind, pressure, sun, rain, pollution caused by man, atomic radiation, malnutrition, the millions of microbes that surround our bodies, the inter-personal conflicts are all other factors affect our lives and are challenges to our health.

Dimensions of Health

1. **Physical dimension :** A person who is free from disease, is bright with his skin shining enjoying normal metabolism, has a good lustrous hair and has no black rings around his eyes.
2. **Mental dimension :** A mentally healthy person who knows his capacities, does not overestimate or underestimate himself and can judge his shortcomings and weaknesses.
3. **Social dimension :** A person adjusting himself in society, does not find fault with others. He maintains interpersonal relationships with his family members and colleagues at workspot and is free from interpersonal conflicts and will not quarrel.

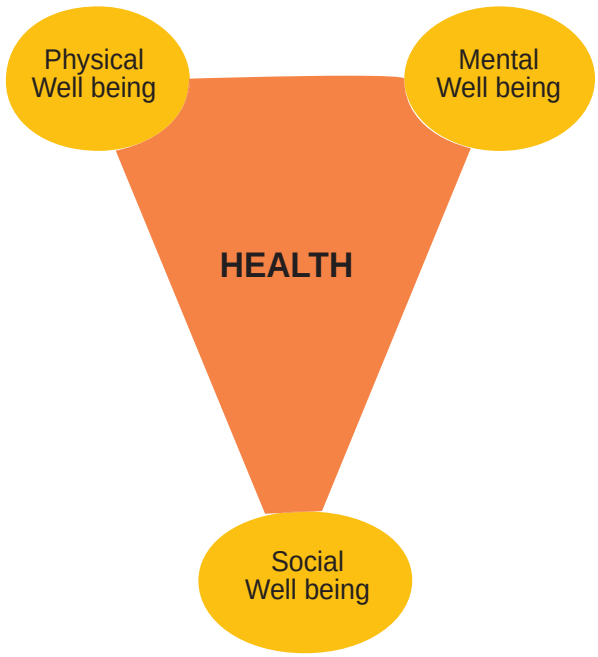


Fig. 2.1 Dimensions of health

ACTIVITY 2.1

Following the above criteria, make a survey of your classmates/people in your neighbourhood and record your finding

- No. of students/neighbours who are healthy.
- No. of students/neighbours who do not have good interpersonal relationship and do not enjoy social well being.
- No. of students/neighbours who have diseases affecting their metabolism.
- Listout positive qualities that you admire in your friend.

2.2. DISEASES AND CAUSES

The word disease means, "without ease or not at ease" and it is opposite to health. The condition of malfunctioning of the organ system or systems is called **disease.** There are numerous diseases that damage our health.

Causes of the diseases

Diseases are caused due to various factors such as pathogens, environmental factors, nutritional factors, genetic factors, metabolic factors, etc.

Based on the causative agent, diseases are classified into:

1. Diseases not caused by organisms
2. Diseases caused by organisms

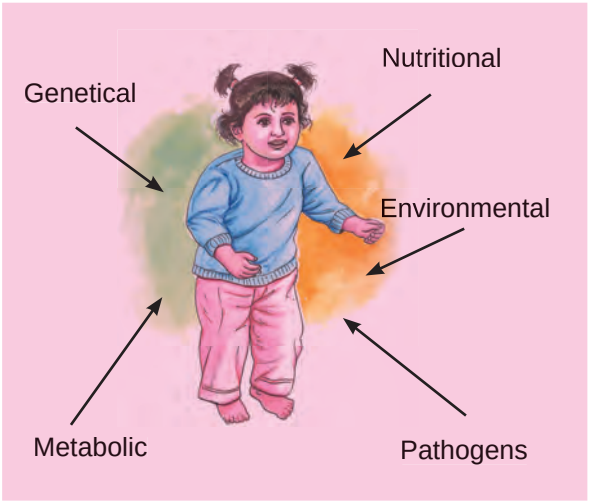


Fig. 2.2 Causes of diseases

Diseases not caused by organisms – Non communicable diseases

1. Organic diseases or Metabolic disorders: Healthy body maintains a constant blood sugar level which is normally 80-120 mg / 100 ml of blood under, fasting conditions. When large quantities of glucose enter the blood stream, as it happens after a meal, the excess glucose is converted into insoluble glycogen and stored in liver and muscles for future use. Later when required, glycogen is reconverted into glucose and reintroduced into blood stream. All these processes are controlled by the hormone, Insulin, secreted by beta cells of Islets of Langerhans of Pancreas. If Insulin is not produced in sufficient quantity, excess of sugar cannot be stored and utilized. As a result, sugar continues to get accumulated in the blood, till it is lost through urine. This leads to other complications and results in diabetes mellitus. Diabetes mellitus is a state of expulsion of excess unused glucose in the urine due to less production of insulin.

Similarly, Diabetes Insipidus, Coronary heart diseases, Renal failure, Hypertension,

Obesity, Alzheimer's disease, Stroke affecting the functions of the brain, etc, are all caused due to metabolic disorders.

2. Hereditary diseases or Genetic disorders: The genetic disorders are caused due to defective or mutated genes. Albinism is an inherited disorder of melanin metabolism, characterized by the absence of melanin in the skin , hairs and eyes. The recessive mutant genes cause this disorder. The clinical symptoms of Albinism are milky white coloured skin and marked photophobia (high sensitivity to light). Haemophilia, sickle cell anaemia, Thalassemia, Down's syndrome, Bubble boy syndrome, etc,. are a few other genetical disorders.

3. Nutritional Deficiency Diseases: A diet which contains all essential nutrients in correct proportion, is indispensable for maintaining good health. Deficiency in certain food constituents, causes various kinds of diseases. Protein deficiency causes Marasmus and Kwashiorkar. In Marasmus, the child loses weight and suffers severe diarrhoea and it will appear as though bones are covered by the skin. In Kwashiorkar the child develops an enlarged belly with swelling in the face and feet.

Fig. 2.3 An albino

4. Diseases caused by Organisms: Robert Koch and Louis Pasteur were the first to establish the Germ theory of diseases. A germ or microbe gains entry into the host, such as man, multiplies so fast that it can increase in large numbers, produce poisonous substance called Toxins and interfere with the host metabolism and produce a characteristic set of symptoms by which the disease can be diagnosed.

Fig. 2.4 Kwashiorkar

Fig. 2.5 Marasmus

SOME IMPORTANT VITAMIN DEFICIENCY DISEASES ARE TABULATED BELOW:

Vitamin	Deficiency disease	Symptoms
Vitamin A	Nyctalopia	Night blindness
Vitamin B_1	Beri-Beri	Nervous disorder
Vitamin B_5	Pellagra	Dementia, dermatitis, diarrhoea
Vitamin B_{12}	Pernicious anaemia	Destruction of RBC
Vitamin C	Scurvy	Bleeding gums and loosening of teeth
Vitamin D	Rickets	Defective calcification of bones
Vitamin E	Sterility	Inability to reproduce
Vitamin K	Haemorrhage	Profuse loss of blood

Disease producing organism

Parasitic Micro-organism: The causative organism of a large number of diseases in man, are micro-organisms belonging to different groups. They are viruses, bacteria, fungi and protozoans.

1. Viruses and viral diseases in man: Viruses are living substances inside the host cell and behave as dead particles outside the host cell. The Viral body consists of a nucleic acid, DNA or RNA and a protein cover. All the known viruses are parasitic and some of them cause deadly diseases such as. polio, rabies, hepatitis, meningitis, encephalitis (brain fever), etc.

2. Bacteria and Bacterial Diseases: Bacteria are unicellular prokaryotes and visible under Compound Microscope. Though many bacteria are harmless, some are parasitic and produce diseases. Bacteria can enter the host body through the mouth, nostrils or cuts and bruises on the skin. They multiply rapidly, producing toxins in high concentration to affect health. Some bacterial diseases in man are Tuberculosis, Leprosy, Cholera, Typhoid, Diphtheria, Tetanus, Plague, Pneumonia, Syphilis, Gonorrhoea, etc.

3. Fungi and Fungal Diseases: Fungi are non green saprophytic or parasitic plants living on dead and decaying organic matter or living organisms. Certain species

of fungi are parasitic on man and cause Ringworm attacking the keratinized layer of skin, destroying it in circular patches.

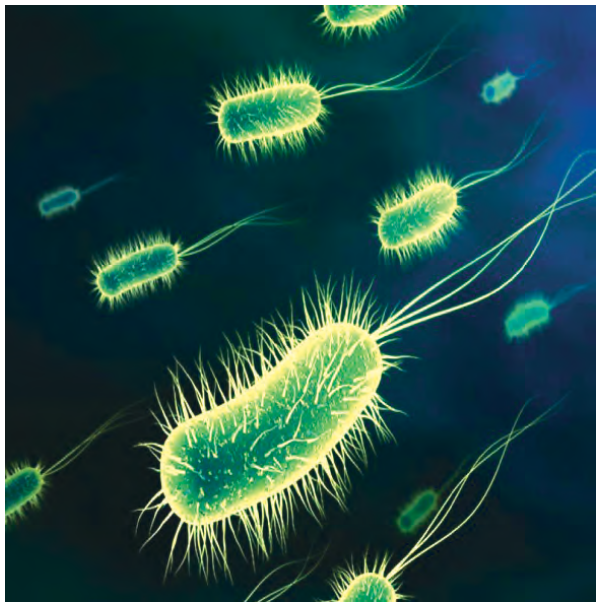


Fig. 2.6 Bacilli

Dandruff, Athletes' foot are some other fungal diseases in man.

Protozoan and Protozoan Diseases: Protozoans are unicellular animalcules, some parasitize man and cause diseases such as malaria, amoebic dysentery, sleeping sickness, etc.

Parasitic macro-organisms: Infestations of the body with tapeworm, liver fluke, round worm, filarial worm, etc,. cause diseases in man like Taeniasis, Ascariasis, Filariasis, etc,.

2.3. DISEASES CAUSED BY MICROBES AND PREVENTION

A disease caused by a parasitic organism and transmitted from one person to another by the transfer of the parasite is known as ***infectious disease***.

We shall study the cause, spread and prevention of a few selected infectious diseases prevalent in our country so that we will know how to guard ourselves against them and other similar diseases.

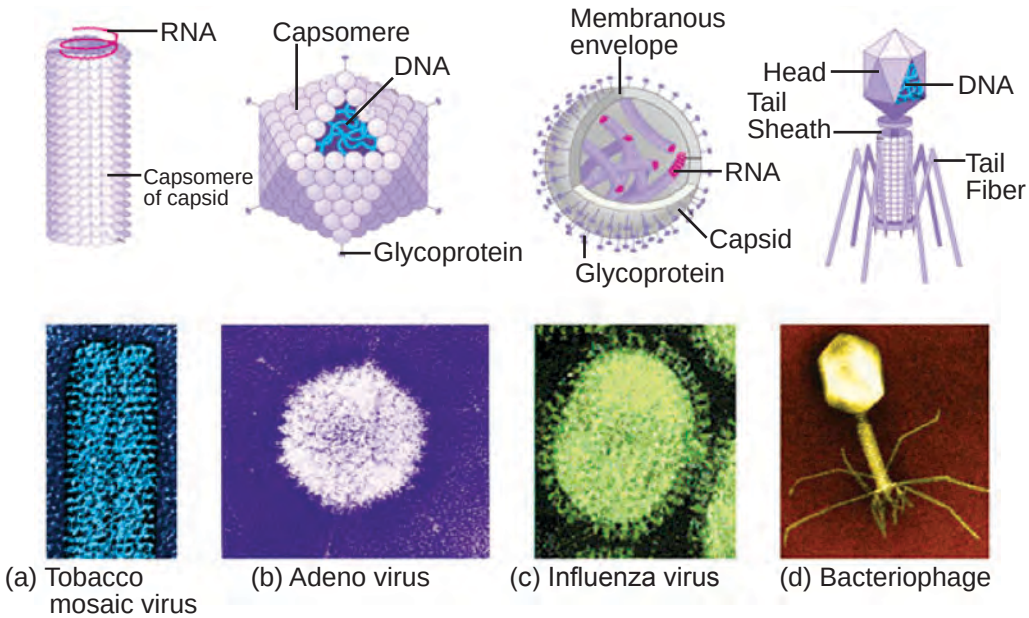


Fig. 2.7 Types of Viruses

2.3.1. Viral diseases

2.3.1.1. Common Cold

More than hundred strains of viruses are responsible, for causing common cold in man. Children are more susceptible to common cold than adults.

Symptoms

1. Inflammation of upper respiratory passage – nasal epithelium.
2. Flow of mucous.
3. Headache, slight rise in temperature, etc,.

It lowers the resistance of the body, leading to a number of secondary infections like pneumonia, bronchitis, etc,.

Transmission

i) It spreads mostly through the droplets discharged from the nose and the mouth of the patient in the process of talking, laughing, sneezing, etc,.

ii) It may also spread through close inanimate objects like handkerchief, bedding, clothes, utensils, toilet articles, etc,. (called ***fomites***)

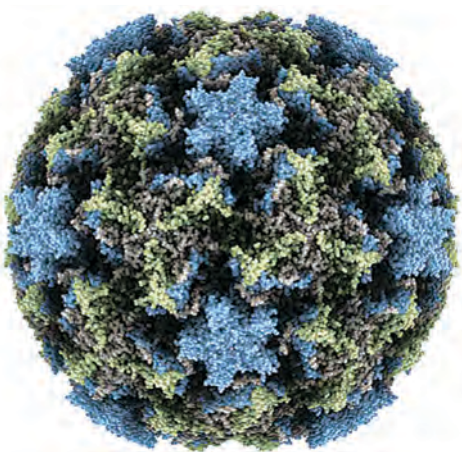


Fig. 2.8 Human rhino virus

Control and prevention: There are no effective measures to control common cold. However, a good nourishing food, avoiding contact with patients and wearing suitable clothing are suggested, to keep away from common cold.

2.3.1.2. Influenza

It was a dreadful disease once and worldwide in distribution (pandemic) in 1970s.

Causative agent : A(H_1N_1) Virus , is spherical in shape and highly contagious, causing influenza.

Fig. 2.9 H1N1 Virus

Symptoms

Sudden onset of fever accompanied by aches and pains in the back and limbs.

Transmission

It spreads through nasal and mouth droplets of patients and enters into the respiratory tract of normal man**.** It also spreads through fomites.

Prevention

i. Avoid contact with the patients.
ii. Avoid crowding.

2.3.2. Bacterial diseases

Bacteria are prokaryotic organisms. Some of the bacteria are parasitic in man, causing diseases like TB, Cholera, Typhoid, dysentry etc.,

2.3.2.1. Tuberculosis

It is an airborne disease affecting the lungs and also parts of our body such as bones, joints, lymph glands, alimentary tract, liver, kidney, etc,.

Causative agent: *Mycobacterium tuberculosis*, a rod shaped bacterium causes tuberculosis (TB).

Symptoms

i) The affected parts develop lesions in the form of small nodules called tubercles from which the disease gets its name.
ii) Persistant cough
iii) Loss of body weight

Transmission

Tuberculosis is transmitted through air. Large number of bacteria leave the patients through the droplets of sputum expelled by the patients while eating, sneezing, talking, laughing and so on by the patients. The droplets may remain suspended in the air for a long time. The dust arising from the sputum may also contain viable germs. The waxy cell wall of the tuberculosis bacillus prevents it from drying up and so it can remain viable outside the body for a long period. The germs suspended in the air may be inhaled by a healthy person.

Fig. 2.10 Tuberculosis bacteria

Prevention

i) Keeping oneself healthy and avoiding insanitary conditions, overcrowding and poor ventilation.
ii) Sunlight and fresh air are important agents, as they act as natural disinfectants readily destroying the germs.
iii) Isolation of the patients and frequent sterilization of articles used by them are also important.
iv) Incineration (burning) of the droplets, the sputum from the patients to prevent its occurrence in the air.
v) Immunization with BCG vaccine is an effective measure to prevent this disease.

ACTIVITY 2.2

Making a culture of live bacteria

Boil a few grams of chopped meat, carrot and potatoes in water for 15 minutes, then filter off the solid matter to obtain a fairly clear broth.

Leave the broth in open test tubes for a few hours. Plug the tubes with cotton wool and leave them in a warm palce (approximately 25^{o}C) until the broth has “gone bad” owing to the growth of bacteria.

What you have produced, is a bacteria culture.

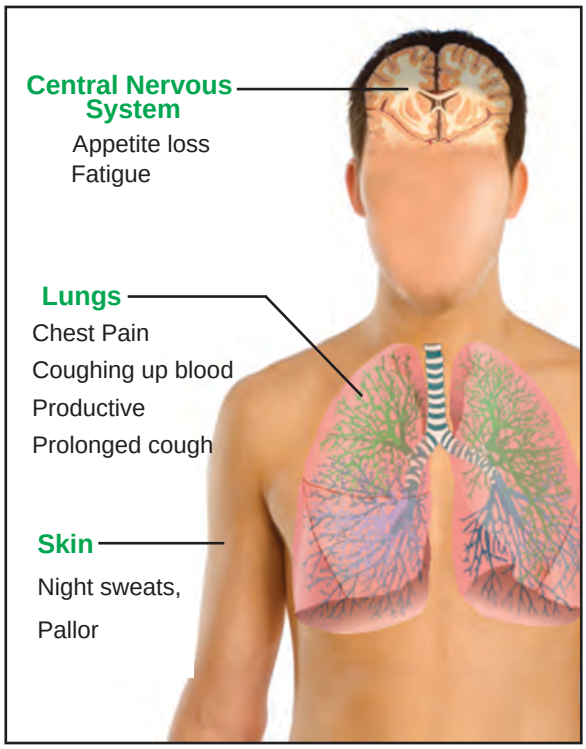


Fig. 2.11 Symptoms of tuberculosis

vi) The patient should cover his mouth and nose while coughing.

2.3.2.2. Typhoid

Causative agent: A short rod shaped bacterium with numerous flagella – ***Salmonella typhi*** causes typhoid.

Symptoms

i) Continuous fever.

ii) Inflammation and ulceration of intestine.

iii) Enlargement of spleen and a characteristic red spot eruption on the abdomen.

Transmission

Transmission of typhoid is through food and water contaminated with the germ, the personal contact with patients and carriers. Flies are also important transmitting agents of this disease.

Prevention and control: Isolation of the patient, control of flies, hygienic food habits, proper public sanitary measures are effective means of prevention of this disease. Artificial immunization with typhoid vaccine is advised. A recovery from typhoid usually confers a permanent immunity.

2.3.3 Protozoan diseases:

Some of the unicellular protozoans are parasitic pathogens and cause diseases in man.

2.3.3.1 Malaria

Causative agent: A tiny protozoan – Plasmodium is responsible for causing malaria. Four different species of Plasmodium namely, P.vivax, P.malariae, P.falciparum and P.ovale occur in India causing malaria. Of these, the malignant and fatal malaria, caused by Plasmodium falciparum is the most serious one.

Transmission

Through the vector - the female ***Anopheles*** mosquito.

Symptoms

i) Malaria is characterized by chillness and rise in temperature. This is followed by perspiration and lowered body temperature. The person feels normal for some time but the fever recurs at regular intervals.

ii) Successive attacks of malaria result in the distension of spleen and destruction of liver tissues.

Prevention and control:

i) Sanitary measures include ground fogging with disinfectants.

ii) Closure of stagnant pools of water and covering ditches is suggested.

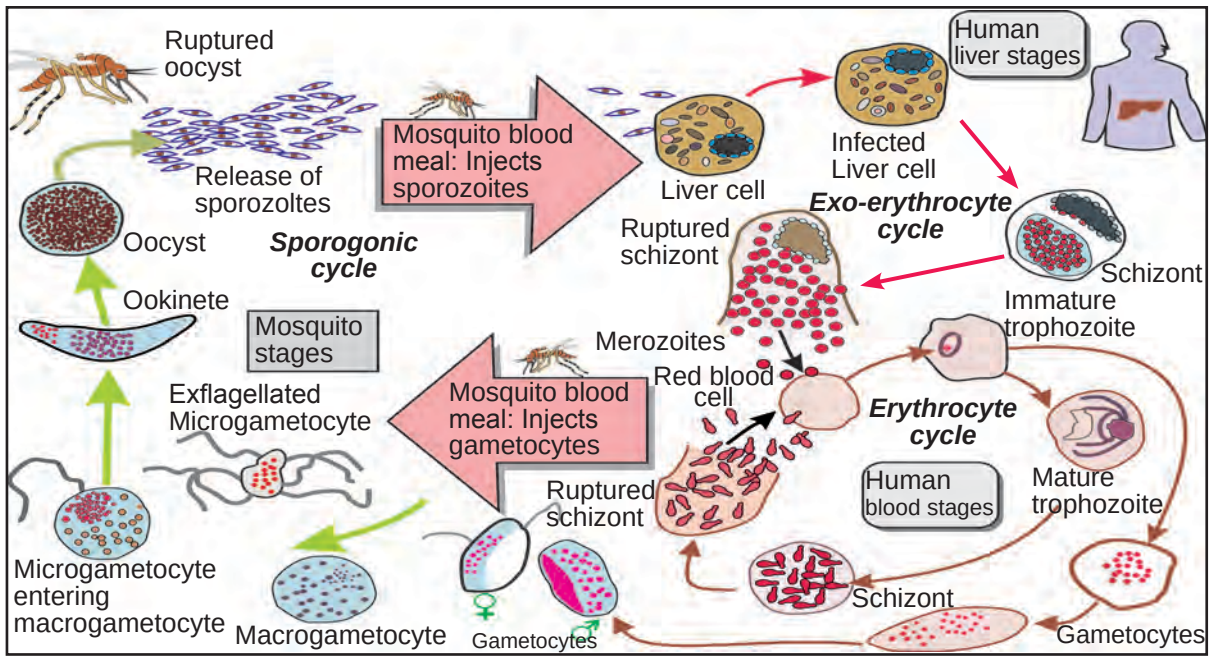


Fig. 2.12 Life cycle of malarial parasite

Life cycle of malarial parasite – Plasmodium: The sexual stage of Plasmodium takes place in female Anopheles mosquito whereas the vegetative stage occurs in man. When a female Anopheles mosquito bites an infected person, these parasites enter the mosquito and undergo further development in the mosquito body. The parasites multiply within the body of the mosquito to form sporozoites that are stored in the salivary glands of mosquito. When these mosquitoes bite a person, the sporozoites (the infectious stage) are introduced into his body; they multiply within the liver cells first and enter the RBC of man, resulting in the rupture of RBC. This results in the release of toxic substance called haemozoin which is responsible for the chill and high fever, recurring three to four days.

Sir. Ronald Ross

Sir. Ronald Ross (1857-1932), a British – Indian physician was born in Almora, India. He had his school education and higher studies in medicine in England. Later he was posted at the Presidency General Hospital, Calcutta. Ross studied about malaria between 1882 and 1899. As he was working in Bangalore, he noticed the connection between water as breeding ground of mosquitoes and the spread of malaria. He discovered the presence of malarial parasites in the female Anopheles mosquito when he was working on malaria at Secunderabad. He demonstrated that malaria is transmitted from infected individual to a healthy person by the bite of mosquito. In 1902, he was awarded the Nobel prize for his work on malaria.

iii) Using mosquito nets and repellants also, will grossly lower the chance for infection.

2.3.3.2. Amoebic dysentry (Amoebiasis)

Causative agent: ***Entamoeba histolytica*** – a protozoan parasite in the large intestine of man causes **Amoebiasis**.

Symptoms

i) Fever.

ii) Constipation and abdominal pain and cramps.

iii) Stools with excess mucous and blood clot.

Transmission

It is a water and food borne disease. House flies act as mechanical carrier and serve to transmit the parasite from the faeces of infected persons to the food – thereby contaminating the food and water.

Fig. 2.13 Clean habits

Prevention and control: Precaution may be taken by providing germ free clean water; clean food habits. Good sanitary facilities will control the flies.

2.3.4. Fungal diseases in man

Some of the fungi are parasitic on man and cause diseases

Fig. 2.14 Ringworm

2.3.4.1. Ringworm

Three different genera of fungi namely, Epidermophyton, Microsporum and Trichophyton cause ringworm.

Symptoms

The above fungi live on the dead cells of outer layer of skin in man and cause superficial infections in skin, hair, nail, etc; and form patches and Itching

Transmission

By direct contact or through fomites such as towels, combs, etc,.

Control and prevention: Avoid contact with infected person and articles used by them.

2.4. MODES OF TRANSMISSION OF INFECTIOUS GERMS

The transfer of a disease causing germ from an infected person to a normal healthy person through certain agents or direct contact is called transmission of the disease. The transmission can take place in one of the following ways;

Direct Transmission : By direct transfer of germs from the patient to normal healthy person through close contact, the diseases like diphtheria, pneumonia, cholera, typhoid, measles, mumps, etc,. are transmitted.

During sneezing, coughing and talking, the droplets from the patients are discharged from the mouth and the nose and enter the air. While a normal person is inhaling such air, laden with the droplets, he gets infected.

Fig. 2.15 Cover face while coughing and sneezing

Through the umblical cord, the germs are transferred from the infected mother to the child at the time of childbirth by the direct contact method.

Indirect transmission through fomites: Some germs may remain viable outside the body of the hosts and may be transferred indirectly through close inanimate objects used by the patients like clothing, bedding, handkerchief, toilet articles, utensils, drinking cups and glasses that are freshly soiled with the germs present in the discharges of the patients. Such contaminated objects are called **fomites**.

Transmission by animals: Various animals such as ticks, mites, birds, insects and mammals transmit diseases like cholera, malaria, rabies, etc;

2.5. IMMUNIZATION

Immunity: Immunity is part of a complex system of defence reaction in the body. It means the defence against or specific resistance exhibited towards the infectious organisms and their products.

The infectious organisms that invade the body and the toxins produced by them and any foreign protein entering the body are called **antigens**.

The immune system which includes blood plasma, lymph and lymphocytes analyze the chemical nature of the antigens and produce the suitable proteinaceous substances called **antibodies** to detoxify the antigens.

2.5.1. Types of Immunity

Natural or Innate Immunity: The **natural or innate immunity** that enables an individual to resist the disease, to which the particular species is immuned. E.g. Plant diseases do not affect animals.

Acquired or Specific Immunity: The resistance against some infectious diseases developed by an individual during lifetime on exposure to the infections is called **acquired or specific** immunity.

The acquired or specific immunity is of two kinds – active acquired immunity and passive acquired immunity.

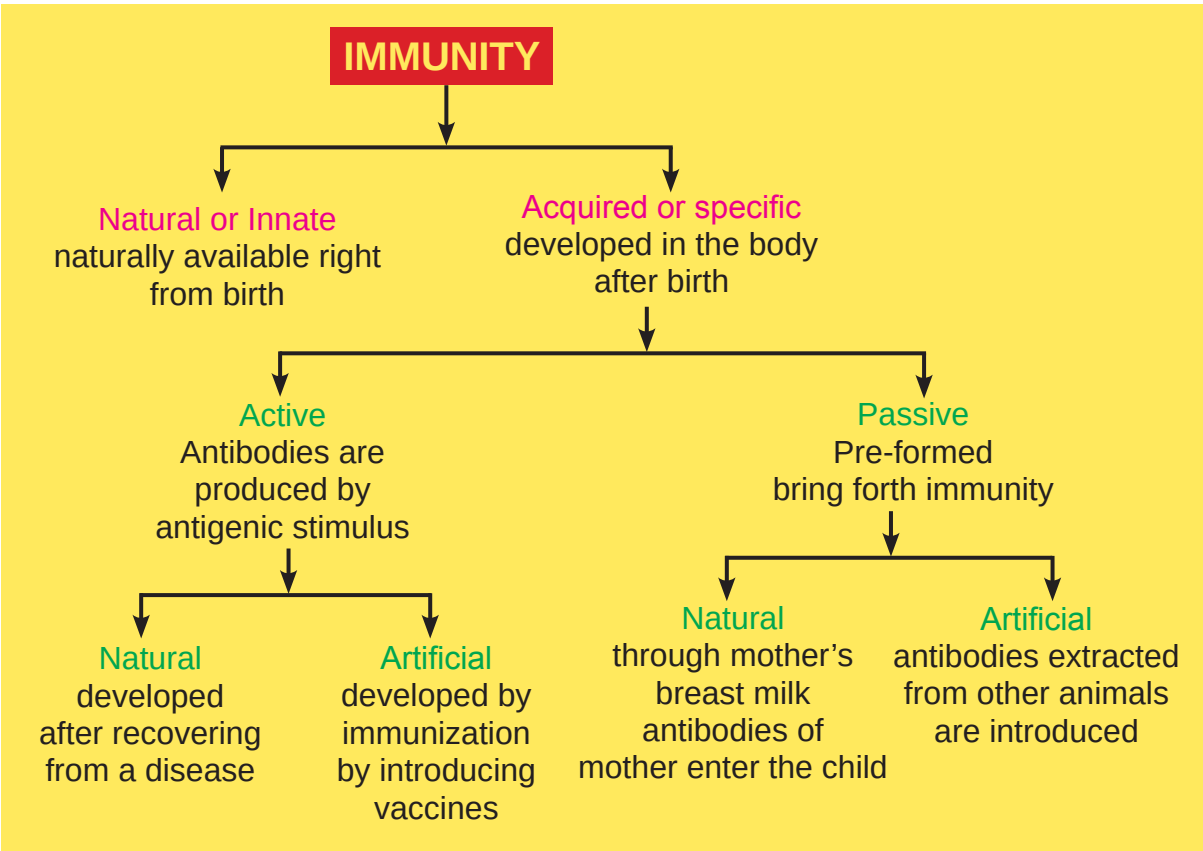
Active acquired immunity: This kind of immunity is developed by our body, during the first infection of any pathogen. The antibodies produced in the blood stays for a long period and kills the similar pathogens whenever they enter the body.

If the antibody production is stimulated naturally, after recovery from a disease, it is called Natural Active Acquired Immunity.

If the antibody synthesis is stimulated by application of vaccines or any other man made methods, the immunity gained is called Artificial Active Acquired Immunity. E.g. The polio drops and triple antigen injected into the child in the immunisation programme.

Passive Acquired Immunity: In this type of immunity, a readymade antibody is introduced from outside instead of

TYPES OF IMMUNITY



stimulating the body to produce antibody with antigenic stimulus.

If the readymade antibody is taken from the mother's blood into the foetus, it is called Natural Passive Acquired Immunity. If the readymade antibody is given to an individual artificially, (produced in some other animal and extracted) it is called Artificial Passive Acquired

MORE TO KNOW

What kind of Immunity does a child get when it is breast fed ?**BREAST FEED IS THE BEST FOOD.** Antibodies or Immunoglobins are found in breast milk. Through breast milk antibodies are passed on to the nursing baby. Bottle fed infants do not have the advantage of fighting the ingested pathogens on their own until the antibodies are produced in them. An infant should be breast fed for a minimum of six months.

Medical establishment knows that infants who are breastfed contract fewer infections than bottle fed infants. Breast milk protects the child, against bacteria like Escherichia coli, Salmonella, Shigella, Streptococci, Staphylococci, Pneumococci and viruses like Polioviruses and Rotaviruses.

IMMUNIZATION SCHEDULE

The immunization schedule indicates the stages at which the vaccinations and inoculations have to be given to safeguard children against different diseases. The table given below lists the names of vaccines, their dosages and the stage at which they have to be administered.

Immunization schedule followed in India

S.No	Age	Vaccine	Dosage
1	New born	BCG	Ist dose
2	15 days	Oral polio	1st dose
3	6th week	DPT & Polio	1st dose
4	10th week	DPT & Polio	2nd dose
5	14th week	DPT & Polio	3rd dose
6	9-12 months	Measles	1st dose
7	18-24 months	DPT & Polio	1st booster
8	15 months - 2 years	MMR vaccine	1st dose
9	2 – 3 years	Typhoid vaccine	2 doses at 1 month gap
10	4 – 6 years	DT & Polio	2nd booster
11	10th year	TT & Typhoid	1st dose
12	16th year	TT & Typhoid	2nd booster

Fig. 2.16 Oral Polio immunization

Immunity. This immunity is not permanent.

Immunization: Administering vaccines to prevent the disease is called immunization. This process of Immunisation develops Artificial Active Acquired Immunity.

Immunisation through inoculation is a mass means of protecting a greater number of people against the spread of diseases.

BCG Tuberculosis Vaccine

DPT Diphtheria, Pertussis, Tetanus Vaccine (Triple antigen)

MMR Mumps , Measles, Rubella

DT Diphtheria, Tetanus (Dual antigen)

TT Tetanus toxoid

2.6. TREATMENT AND PREVENTION OF THE DISEASES

Treatment means medical management of the symptom of the disease.

Medical management includes:

i) Treatment involving medicine.

ii) reatment not involving medicine.

Treatment involving medicine: Medicines are generally used to treat infectious diseases. These medicines either reduce the effect of the disease or kill the cause of the disease.The antibiotics are used as blocks to the pathways of the disease without affecting ourselves.

Treatment not involving medicine: As a person is recovering from the effect of fracture or neurotic problem, yoga and physiotherapy do a great deal of help to do normal activities. People addicted to

Fig. 2.17 Yoga practice

alcohol and drugs are given counselling to overcome the habit.

Prevention: Getting rid of a disease causing germs,is a means of prevention of the disease.

Prevention can be achieved in two ways:

i. General – preventing the infectious germs by keeping away from the exposure to the germs. Hygienic life style, avoiding overcrowding, fresh air, safe drinking water and good sanitary measures are all ways to prevent a disease causing germ, coming into contact with us.

ii. Specific – This relates to a peculiar property of the immune system that usually fights the microbial infections. e.g. Immunisation programme.

2.7. BIO-TECHNOLOGY IN MEDICINE

A detailed account of the role of Biotechnology in healthcare, has been dealt with in chapter 1.

Biotechnologically synthesized insulin has been effectively used replacing the defective insulin to treat diabetes mellitus in the field of medicine.

2.8. HIV AND PREVENTION

Acquired Immune Deficiency Syndrome (AIDS) is a dreadful disease transmitted through sexual contact or through blood and blood products. Robert Gallo at National Institute of Health, USA and Luc Montagnier at Pasteur Institute, Paris isolated the virus, Human Immuno Deficiency Virus (HIV) which causes AIDS.

HIV is a retro virus with glycoprotein envelope and the genetic material – RNA. HIV causes profound Immuno suppression in humans. It is due to the depletion of one type of WBC, which is involved in the formation of antibodies called CD4 plus T-helper cells (lymphocytes).

Symptoms: Significant weight loss, chronic diarrhoea, prolonged fever, opportunistic infections such as tuberculosis, candidiasis and recurrent herpes zoster (viral) infection.

Test for Virus:

1. Enzyme Linked Immuno Sorbent Assay (ELISA)
2. Western Blot – a confirmatory test.

Prevention:

1. Protected sexual behaviour.
2. Safe sex practices.
3. Screening the blood for HIV before blood transfusion.
4. Usage of disposable syringes in the hospitals.
5. Not sharing the razors / blades in the saloon.
6. Avoid tattooing using common needle.

EVALUATION

PART A

1. Pick out a case of healthy state of an individual.

   Mr. X is recovering from an infectious disease,

   Mr. Y is taking insulin injection everyday,

   Mrs. Z is very much depressed,

   Mr. K is attending to his duty and spends time joyfully,

2. Which one of the following is a state of a disease in which a person is not socially balanced.

   He enjoys a birthday party,

   He behaves rudely even for menial matters,

   He is adjusting to the surrounding situation,

   He is attending to his ailing mother at the hospital.

3. Pick out the bacterial disease.
(Meningitis,Rabies,Tetanus, Small pox)

4. One of the following is transmitted through air. Find out.

(Tuberculosis, Meningitis,Typhoid, Cholera)

5. The most serious form of malaria is caused by Plasmodium _____.

(P.ovale, P.malariae, P.falciparum, P.vivax)

6. An example for protozoan infecting our intestine is _____.

(Plasmodium vivax, Entamoeba histolytica,Trypanosoma gambiense, Taenia solium)

7. One of the means of indirect transmission of a disease is _____.

(Sneezing,Droplet from mouth,

Placenta,Utensils of patients)

8. When antibodies, extracted from some other animal is injected into your body, what kind of immunity do you gain?

Artificial active acquired immunity,

Artificial passive acquired immunity,

Natural active acquired immunity,

Natural passive acquired immunity.

9. The first vaccine injected into a just born baby is _____.

Oral polio, DPT,

DPT and Oral polio,BCG.

10. Pick out a non-antigen. Entry of _____.

(Germ,Toxins of germs,New forms of protein, Mother's Milk)

PART B

11. In order to lead a healthy life a person should enjoy physical, mental and social well being If a person lacks any one of them, then that person is suffering from _____.

12. Tamil selvan has inherited colour blindness from his father. Name the causative factor responsible for this defect _____.

13. Marasmus and Kwashiorkar are both protein deficiency defects. Marasmus differs from Kwashiorkar in enlarged belly and swelling in the face. Are these symptoms for the above diseases correct? If not, correct it.

14. A list of disorders are given below. Pick out the odd one out and give reasons. (colour blindness, haemophilia, night blindness, albinism, sickle cell anaemia)

15. Ramya is suffering from bleeding gum and loosening teeth. On a diagnosis, it was found to have been caused by vitamin deficiency.

Suggest Ramya the kind of vitamin that is lacking in her food and tell your friend the name of deficiency disease that he suffers from.

(A) Vitamins

(B) Deficiency diseases and

(C) Symptoms are given.

Match B, C with A.

A	B	C
Vitamins	**Deficiency diseases**	**Symptoms**
e.g. Vitamin A	Nyctalopia	Night Blindness
Vitamin B_1	Scurvy	Nerbvous disorder
Vitamin C	Rickets	Bleeding Gum
Vitamin D	Haemorrhage	Defective calcification of bones
Vitamin K	Beri-beri	Profuse loss of blood

16. Kavitha is suffering from common cold. What are the questions you will put forth to Kavitha to confirm the disease?

    a. _____

    b. _____

PART C

17. Kala has delivered a baby,

    a. Suggest the immunization schedule for the baby, in the first six months

    b. What are all the diseases that can be cured as per the schedule?

18. There is a widespread outbreak of malaria in your area.

    a. Suggest some controlling measures to the local authorities concerned.

    b. Pick out the right symptom for malaria. (chill and shiver and a rise in temperature / diarrhoea)

19. 15th October is observed as 'Handwashing Day'

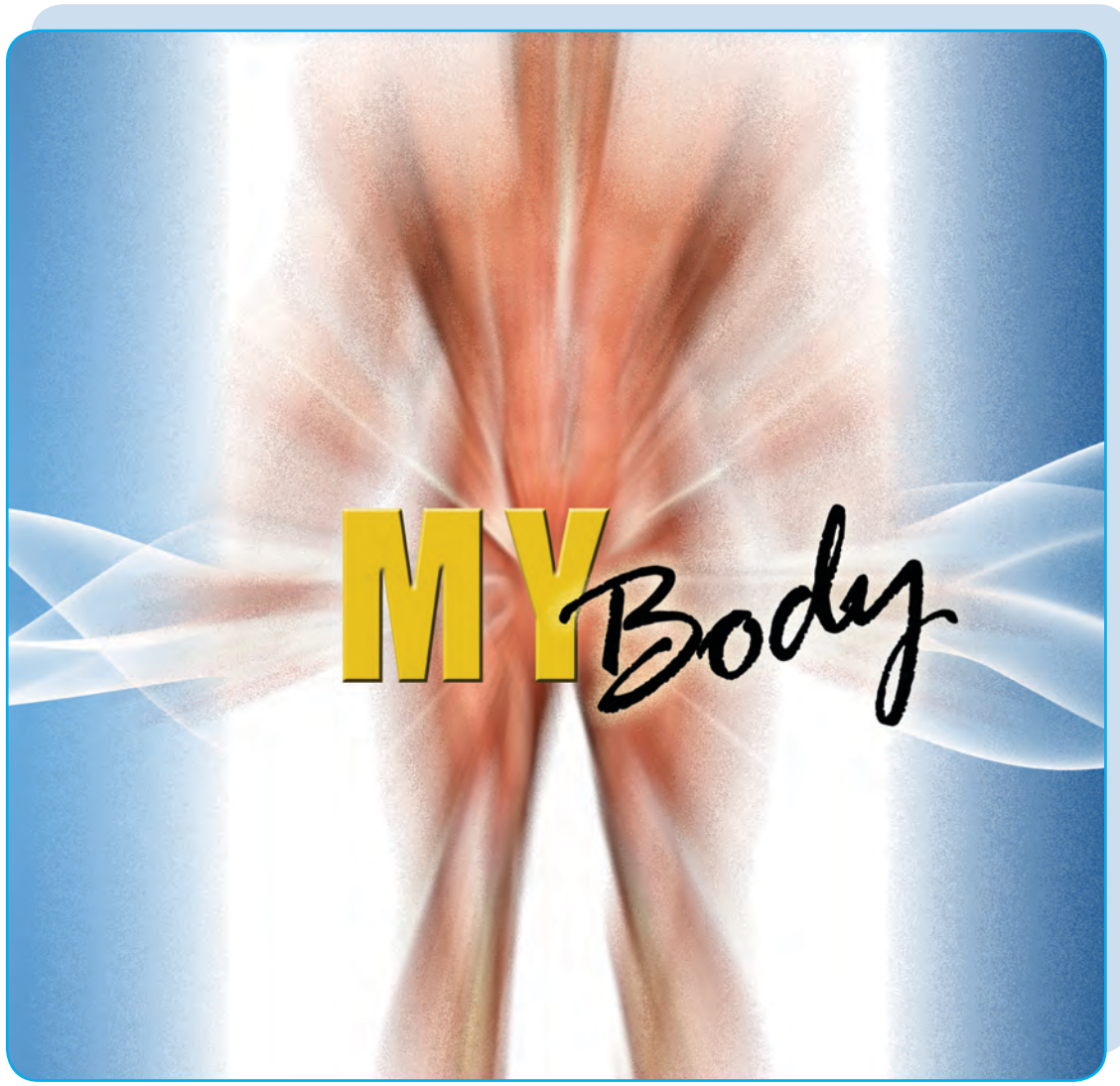
    a. Tell your friend the effects of hand washing.

    b. In a day what are the occasions in which you wash your hand?

FURTHER REFERANCE

Books: 1. Biology - RAVEN, Johnson WCB Mc Graw - Hill
2. Biology - A Modern Introduction, B.S. Beckett, Second Edition Oxford University Press.

Chapter 3



STRUCTURE AND FUNCTIONS OF HUMAN BODY-ORGAN SYSTEMS

3. STRUCTURE AND FUNCTIONS OF HUMAN BODY-ORGAN SYTEMS

NERVOUS SYSTEM – INTRODUCTION

Two or more people when gather together, each one is set with an interest and aptitude and performs his works in his own way. But when it is the question of maintenance of an order, a systematic working among them, there is a need for someone to control and co-ordinate them so that a harmony prevails. Similarly the functions of organs and organ system in our body cannot go on in their own way but must be coordinated to maintain the harmonius steady state of body functioning called Homeostasis. Coordination is the process through which two or more organs interact and compliment the functions of one or the other. In our body the neural or nervous system and the endocrine system do the function of coordinating and integrating all the activities of the organs so that the body works efficiently by synchronizing the functions.

The nervous system provides an organized network of point to point connections for a quicker coordination. The endocrine system provides chemical integration through hormones. In this chapter, we will learn the structure and functioning of the nervous system and the endocrine system in man.

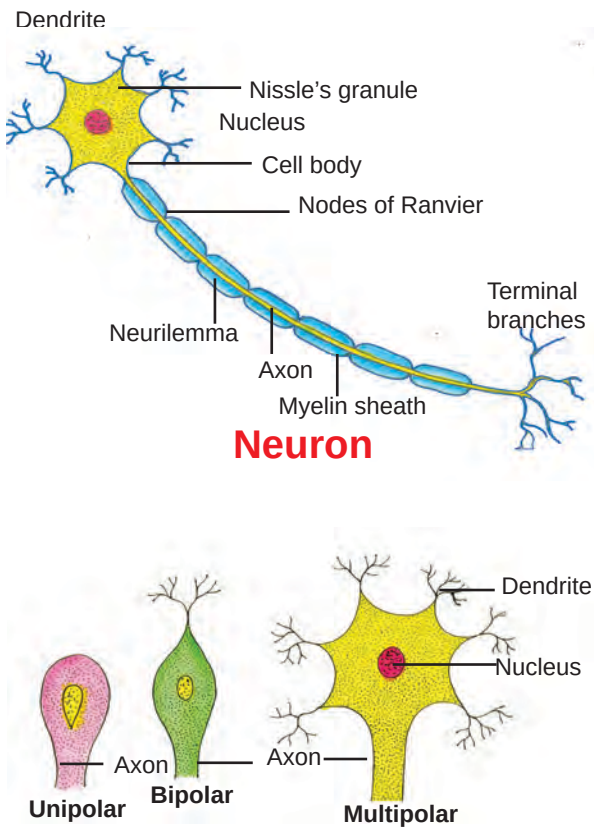


Fig. 3.1 structure of neuron and types

3.1 NERVOUS SYSTEM

The nervous system of an animal is composed of

i) Specialized cells called neurons or nerve cells which can detect, receive and transmit different kinds of stimuli.

ii) The nerve fibres are certain bundles of extended processes of nerve cells.

3.1.1 Nerve cells

Nerve cells or neurons are the structural and functional units of the nervous system.

Billions of nerve cells make up our brain. A nerve cell is a microscopic structure consisting of three major parts namely cell body, dendrites and axon.

Cell body

It is the cell structure irregular in shape or polyhedral structure, it is also called as cyton. Cell body contains cytoplasm with typical cell organelles and certain granular bodies are called Nissle's granules .

Dendrites

Dendrites or Dendrons are shorter fibres which branch repeatedly and project out of the cell body. Dendrites transmit electrical impulses towards the cyton.

Axon

One of the fibres arising from the cell body is very long with a branched distal end and it is called as Axon.

The distal branches terminate as bulb like structures called synaptic knob filled with chemicals called neuro transmitters. Axon contains axoplasm inside and is covered by a membrane called neurilemma. Neurilemma encloses the axon except at the branched distal ends. In some neurons called myelinated neurons an additional white fatty fibre called myelin sheath covers the neurilemma. Myelin sheath is not continuous over the neurilemma. The gaps left by the myelin sheath on the axon are called Nodes of Ranvier. Over the myelin sheath are found certain cells called Schwann cells.

Types of nerve cells

a) Myelinated or Medullated or White neurons:

When the axon is enclosed by the white fatty myelin cover it is called Myelinated or Medullated or White neurons. This forms the white matter of our brain.

b) Non- Myelinated or Non-Medullated or Grey neurons:

This neuron is not enclosed by myelin sheath; so it appears greyish in colour. The axon is covered by only neurilemma and Schwann cells. This type of neuron is found in the grey matter of cerebrum.

c) Unipolar neurons:

The embryonic nervous tissue contains unipolar neurons. An unipolar neuron has a nerve cell body with a single process or fibre, which will act both as axon and Dendron.

d) Bipolar neurons:

The sensory hair cells of the sense organs like rods and cones of retina are made up of bipolar neurons. Each bipolar neuron has a cell body and two process at the ends, one acting as axon and the other acting as dendron.

e) Multipolar neuron:

The cerebral cortex contains the multipolar neurons; each multipolar neuron has a cell body with many dendrites and an axon.

Synapse: The dendrites and the synaptic knobs of the axons of neighbouring neurons are in physical contact with one another without fusing. This point of contact between the neighbouring nerve cells is called synapse.

ACTIVITY 3.1

Visit a hospital in your locality and study the principle behind the administration of anesthesia at the time of surgery. Find out if the fat soluble anesthetic substances like chloroform, ether etc., merge with medullary sheath and prevent conduction of nerve impulse.

3.1.2 Nerve impulse:

The conduction of stimuli by the nerve cells is called nerve impulse. The dendrites will receive the stimuli from the receptor (sense organ) and conduct the same as electrical impulse to the axon through the cyton. At the synapse, the synaptic knobs release out chemical substances called neuro transmitters which convert the electrical impulse into chemical impulse and pass it to the neighbouring neuron.

3.1.3 Human nervous system

The human nervous system is divided into

a) The Central Nervous System (CNS) and

b) The Peripheral Nervous System (PNS)

c) The Autonomic Nervous System (ANS)

The CNS includes the brain and spinal cord and it is the site of information processing and control.

The PNS comprises of the nerves of the body associated with the central nervous system.

3.1.3.1 Central Nervous System

It is organized of two organs namely the brain and the spinal cord. The CNS is accommodated in the protective bony structures namely skull and vertebral column.

MENINGES: The central nervous system is covered by three protective coverings or envelopes collectively called meninges. The outermost cover lying below the skull and vertebral column is doubly thick and is called ***Duramater***. The middle covering is thin and vascularised and is called ***Arachnoid membrane***. The innermost cover is a very thin delicate membrane and is closely applied on the outer surface of brain and spinal cord and it is called ***Piamater***.

3.1.3.1.1 The Brain

Man is a vertebrate and a mammal belonging to the animal kingdom. But, he stands unique and supreme and this supremacy in the living world is reflected in the organization of the brain. The brain is the central information processing organ and acts as the command and control system.

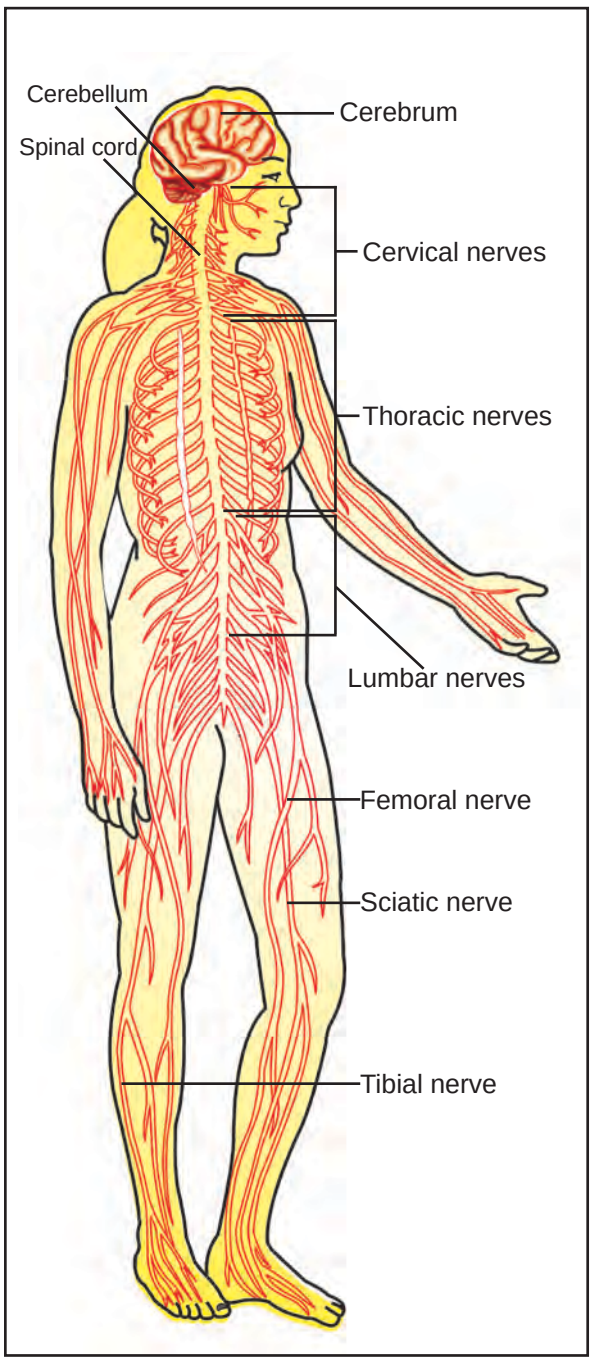


Fig. 3.2 Human Nervous System

The human brain as in the case of other vertebrates, is divided into three major parts:

a) Fore brain b) Mid brain
c) Hind brain

Fore brain

Fore brain consists of cerebrum, thalamus and hypothalamus.

Cerebrum

This forms the major part of the human brain (nearly two third of the brain is cerebrum). A deep cleft called **median cleft** divides the cerebrum longitudinally into two halves as right and left cerebral hemispheres, which are united at the base by a sheet of nervous tissue called **corpus callosum.** The outer region of the cerebrum is distinguished as, the grey matter or cerebral cortex and the inner region is called white matter.

Cerebral cortex

It consists of the nerve cell bodies of several layers of greyish nerve cells giving grey colour – so called as grey matter. The increased surface area of the cerebral cortex in man is folded and thrown into a pattern of convolutions consisting of ridges and furrows.

Cerebral cortex contains

a) motor areas
b) sensory areas and
c) association areas (a region that is neither sensory nor motor).

Motor areas

Motor areas are the sites of order or command of the cerebrum, from where the order arises to control the activities of the different organs of our body. Initiation of voluntary activities takes place here.

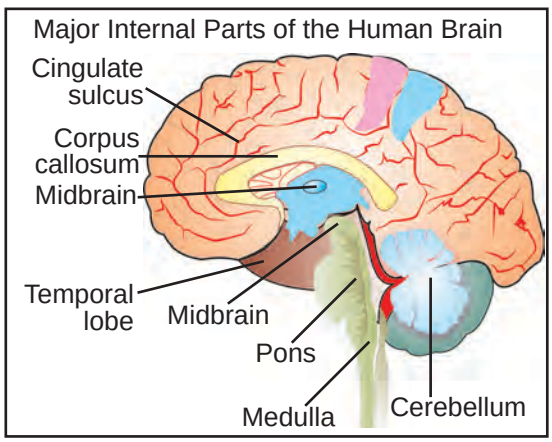


Fig. 3.3 Major internal parts of human brain.

Sensory areas

These are the sites where the sensory functions of the various sense organs are received through the sensory nerves.

Association areas

These are responsible for complex functions like intersensory associations, memory and communication.

White matter of cerebrum: The inner part of the cerebrum lying below the cerebral cortex is called white matter and it consists of bundles of nerve fibres with myelin sheath giving the white colour. Some of these bundles of nerve fibres connect the different parts of the cerebrum while others connect the cerebrum with the rest of the brain and spinal cord.

Within the cerebral hemispheres are present cavities called ventricles, filled with a nutritive fluid called cerebro spinal fluid.

Functions of cerebrum: Cerebrum is the seat of consciousness, intelligence, memory, imagination and reasoning. It receives impulses from different parts of the body and initiates voluntary activities. Specific areas of cerebrum are associated with specific functions. Thus there is a centre for hearing, another for seeing, another for tasting, another for smelling, another for speaking and so on. A damage in a specific centre of cerebrum will deprive the particular faculty from doing its functions.

Thalamus

Cerebrum wraps around a structure called thalamus – a major conducting centre for sensory and motor signalling.

Hypothalamus

It lies at the base of the thalamus. It controls body temperature, urge to

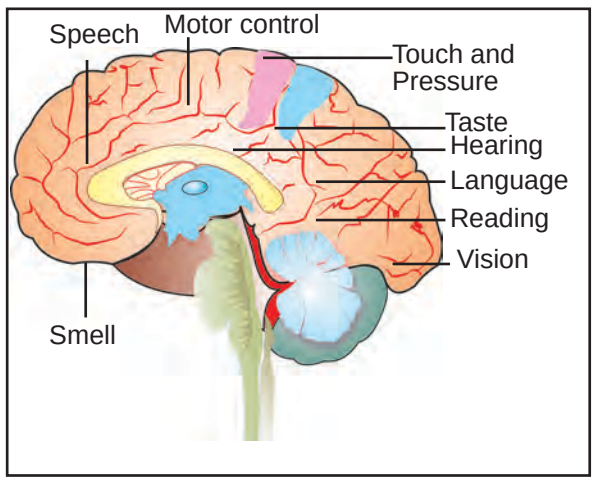


Fig. 3.4 Functional areas of human brain.

eat and drink, regulation of sexual behaviour, express emotional reactions like excitement, anger, fear, pleasure and motivation.

Mid brain

The mid brain is located between the thalamus and the hind brain. A canal called **cerebral aqueduct** passes through the mid brain. The dorsal portion of the mid brain consists of four hemispherical bodies called **corpora quadrigemina** which controls and regulates the various visual reflexes and optical orientation.

Mid brain with hind brain together form the brain stem.

Hind brain

Hind brain comprises of pons, cerebellum and medulla oblongata.

Cerebellum

It lies below the cerebrum and consists of a median portion and two lateral lobes. Cerebellum regulates and coordinates the group movements of voluntary muscles as in walking or running.

Pons

It is the bridge of nerve fibres that connects the lobes of cerebellum. It relays the information from the cerebrum to cerebellum. It also contains sleep centre and respiratory centre.

Medulla oblongata

Medulla is the posterior most part of the brain where it merges with the spinal cord. It acts as a coordination pathway for both ascending and descending nerve tracts. Medulla is the centre for several reflexes involved in the regulation of heartbeat, blood vessel contraction, breathing, etc,.

The ventricle of the medulla remains connected with the ventricles of the cerebral hemisphere.

3.1.3.1.2 The Spinal cord

This is a tubular structure, a continuation of the brain lying in the neural canal of the vertebral column. The three meninges – Piamater, Arachnoid membrane and the Duramater cover the spinal cord as in the case of brain.

The spinal cord has two enlargements – one in the neck region of the body called **cervical plexus** and another in the lumbar region of the vertebral column called ***lumbar plexus***.

The spinal nerves arise from these enlargements. The lower end of the spinal cord is filamentous and is called ***Filum terminale***. On the mid dorsal side of the spinal cord is found a narrow depression called ***dorsal fissure*** and on the mid ventral side of the spinal cord is found a deep depression called ***ventral fissure***. Running through the center of the spinal cord is the ***central canal***, an extension of the ventricle filled with **cerebro spinal fluid**. Outer region of the spinal cord contains medullated white neurons and the inner region contains non-medullated grey neurons. The spinal cord conducts impulses to and from the brain and acts as a reflex centre.

3.1.3.2 Peripheral nervous system (PNS)

The nerves arising from the brain and spinal cord constitute the PNS.

a) Cranial nerves:

Twelve pairs of cranial nerves arise from the brain. Some of the cranial nerves are sensory nerves (taking impulse from the sense organ to the brain e.g. optic nerves from the eyes). Some of the cranial nerves are the motor nerves taking impulse from the brain to the effector organ. e.g. vagus nerve innervating the heart and some are mixed nerves with both sensory and motor functions. e.g. facial nerve.

b) Spinal nerves:

Thirty one pairs of spinal nerves arise from the spinal cord. Each spinal nerve has a sensory root and a motor root. Thus, all spinal nerves are mixed nerves.

3.1.3.3 The Autonomic Nervous System (ANS)

It controls the functions of the vital organs of the body through its two antagonistic divisions namely, sympathetic nerves and parasympathetic nerves.

3.2. ENDOCRINE SYSTEM IN MAN

The chemical co-ordination of physiological processes to maintain the homeostasis is the work of endocrine system. Endocrine system control and coordinate the physical processes of growth, reproduction and sustenance of life.

Endocrine system consists of a number of endocrine glands and their hormones.

Endocrine glands are ductless glands (without ducts), secreting the chemical substances called hormones. The hormones are carried by the blood from the site of production to the site of action.

Endocrine glands in man are distributed in the different regions of the body without interconnections. The various endocrine glands found in different regions in man are as follows:

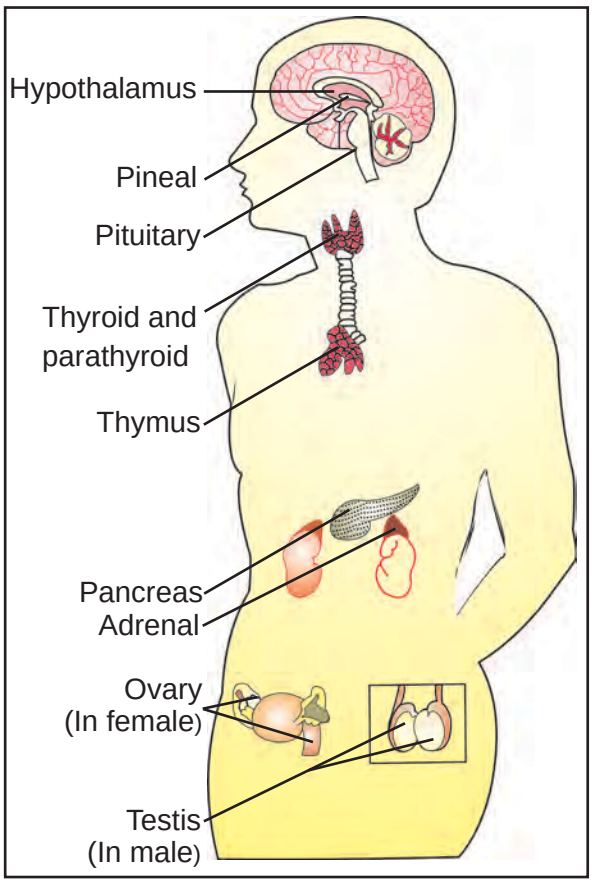


Fig. 3.5 Endocrine system in man

Head	–	a) pituitary gland
		b) pineal gland
Neck	–	a) thyroid gland
		b) parathyroid gland
Thorax	–	thymus gland
Abdomen	–	a) pancreas – Islets of Langerhans

b) adrenal glands – adrenal cortex and adrenal medulla

c) gonads – testes in man and ovaries in woman

Hormones

Chemically hormones are proteins or amino acids or steroids. Though the hormones are secreted in small quantities, their performance is profound in action.

Pituitary gland

It is a tiny gland of the size of a pea attached to the hypothalamus of the brain. Since some of the endocrine glands are regulated by the pituitary gland, it is called as the conductor of endocrine orchestra.

Divisions of pituitary : Pituitary gland is differentiated into an anterior lobe called ***adenohypophysis*** and a posterior lobe called ***neurohypophysis***.

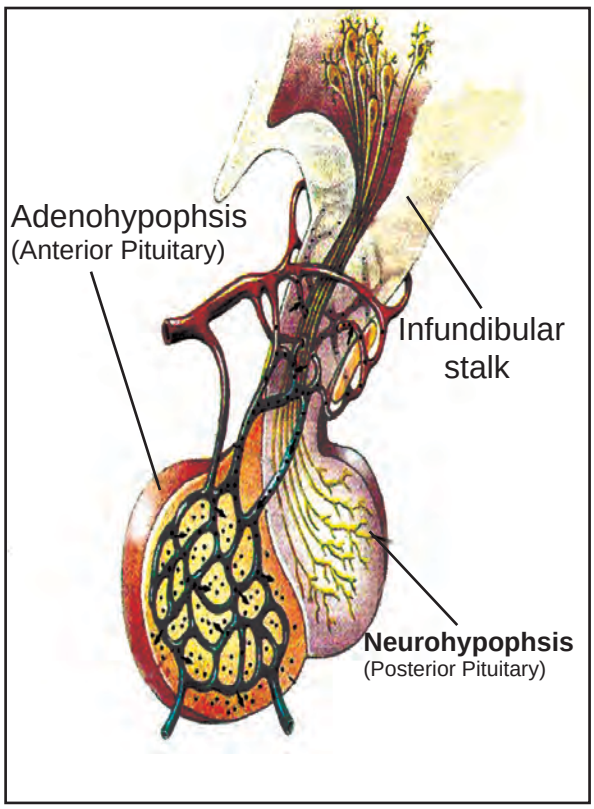


Fig. 3.6 Diagrammatic internal view of pituitary gland

Hormones of adenohypophysis	Functions and malfunctions
Somatotropic or Growth hormone (STH or GH)	• It brings forth growth in general • Less production in children – ***dwarfism*** with retarded growth • Excess production in children – ***gigantism*** with excess growth • Excess production in adolescents – ***acromegaly*** with large limbs and lower jaw
Thyrotropic or Thyroid stimulating hormone (TSH)	It stimulates the growth of thyroid gland and its production – the thyroxine
Adrenocorticotropic or Adrenal cortex stimulating hormone (ACTH)	It stimulates the adrenal cortex to produce the hormones aldosterone and cortisone

Follicle stimulating hormone (FSH)	It stimulates the maturation of graafian follicles (in the ovary) in the female, to produce the eggs and sperm formation in the males.
Lutenizing hormone (LH) in female or Interstitial cell stimulating hormone (ICSH) in male	LH in female causes discharge of egg from graffian follicle – a process, called ovulation and production of female sex hormone oestrogen and progesterone. ICSH in male, induces the interstitial cells to produce male sex hormone – testosterone
Lactogenic hormone	It stimulates the growth of mammary glands in female and milk production after child birth.

> The hormones of neuro hypophysis namely, oxytocin and vasopressin are secreted by hypothalamus and are released on specific stimuli. Thus the neurohypophysis hormones are secretions of a part of the nervous system and are chemically octapeptides and decapeptides

Hormones of Neuro hypophysis	Functions and malfunctions
Oxytocin	It speeds up the child birth process, by stimulating the contraction and relaxation of the uterus in the female.
Vasopressin or Antidiuretic hormone (ADH)	It helps in the reabsorption of water, producing concentrated urine in small quantity. It constricts the blood vessels and raises up the blood pressure Less production of ADH results in ***diabetes insipidus***, leading to production of excess of dilute urine.

Thyroid gland

The bilobed thyroid gland is located in the neck, one lobe on each side of

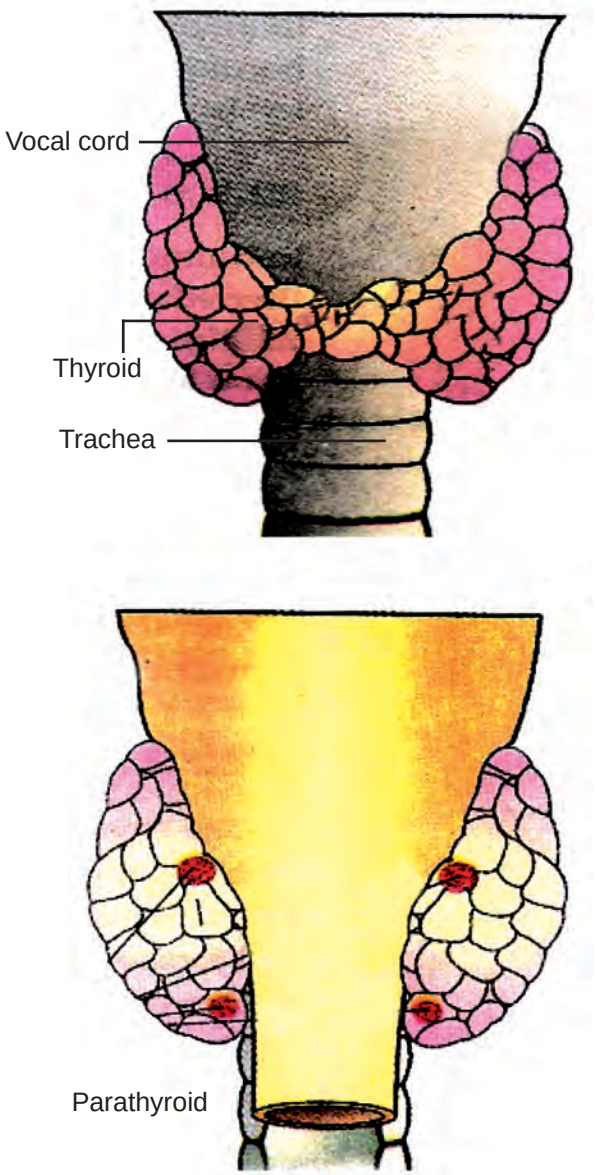


Fig. 3.7 Thyroid gland a) Dorsal view b) Ventral view

larynx, which secretes a hormone called ***thyroxine***. Thyroxine is an iodinated protein, composed of the amino acid, tyrosine and iodine.

Functions of thyroxine

- It increases the rate of metabolism.
- It stimulates a rise in the body temperature.
- It promotes growth and differentiation of tissues.
- Since it affects indirectly growth of the body, thyroxine is also called as **personality hormone**.
- It regulates iodine and sugar level in the blood.
- It controls working of kidneys and urine output.

Thyroid disorders

1) Hypothyroidism – less secretion of thyroxine causes many abnormalities like ***simple goitre***, ***myxoedema*** and ***cretinism.***

   a) Simple goitre – It is due to the deficiency of iodine in our diet. Thyroid gland bulges as a swelling in the neck and it is called as ***goitre***.

   b) Myxoedema – It is caused in the adults. The symptoms are, low

Fig. 3.8 a person with goitre

metabolic rate, loss of mental and physical vigour, increase in weight, thickening of skin, lowered heartbeat, mental dullness, etc.,

c) Cretinism – This is produced in children and the symptoms are stunted growth, retarded mental development, defective teeth, protrusion of tongue and loose skin.

2) Hyperthyroidism – The excess production of thyroxine causes exophthalmic goitre or Grave's disease. The symptoms are high metabolic rate, high blood pressure, high irritability, profuse sweating, loss of weight, fatigueness and protrusion of eyeballs.

The islets of Langerhans

Pancreas is a dual role playing endocrine gland. The exocrine parts produce pancreatic juice. The endocrine portion is called **islets of Langerhans**. It consists of two type of cells namely, alpha cells and beta cells. **Alpha cells** produce a hormone called glucagon and **Beta cells** produce insulin and amylin**.**

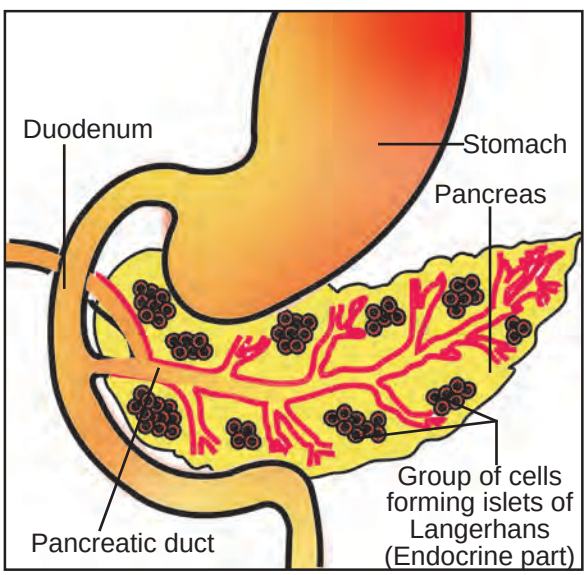


Fig. 3.9 Pancreas showing islets of Langerhans

Insulin

- It promotes the uptake of glucose by the cells for tissue oxidation.
- It favours conversion of glucose, into glycogen and its storage in the liver and the muscles.
- It prevents the formation of glucose from protein and fat.
- It maintains normal blood glucose level at 80 – 120 mg / 100 ml of blood.

Diabetes mellitus

Less production of insulin causes Diabetes mellitus, in which the excess unused glucose is excreted in the urine.

Glucagon

- It is secreted when glucose level in the blood is low.
- It influences conversion of glycogen into glucose, thus raising the blood glucose level.

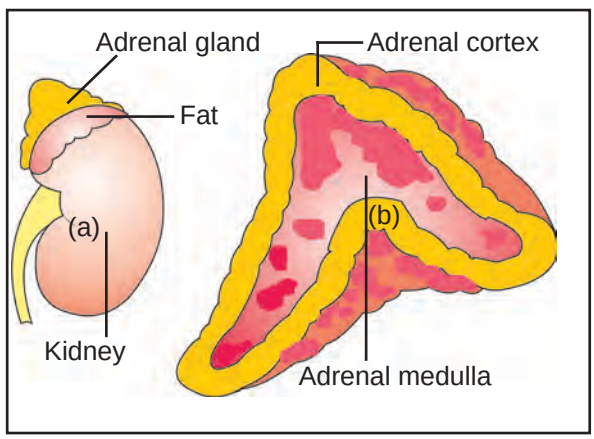


Fig. 3.10 a) Adrenal gland
b) L.S of Adrenal gland

Adrenal gland (Supra renal gland)

On each kidney is found an adrenal gland. It is composed of two portions, an outer adrenal cortex and an inner adrenal medulla.

Adrenal cortex

It secretes two hormones namely, Aldosterone and Cortisone.

Aldosterone (Mineralocorticoid)

It maintains mineral metabolism, by favouring reabsorption of sodium and water and excretion of potassium and phosphate ions.

It maintains electrolyte balance, body fluid volume, osmotic pressure and blood pressure.

Cortisone (glucocorticoid)

It stimulates the breakdown of glycogen into glucose raising the blood glucose level.

It also produces an anti-inflammatory reaction and suppresses the immune response.

Adrenal medulla

It is made up of modified neuroectodermal cells. It secretes two hormones, namely ***adrenaline (epinephrine)*** and ***noradrenaline (norepinephrine).*** They are together called **emergency hormones or hormones of flight and fight** as they rapidly mobilize the body to face a stress or emergency situation.

- They increase the heartbeat.
- They increase alertness.
- They increase the respiratory rate.
- They promote the conversion of glycogen into glucose.
- They cause dilation of pupil.
- They cause profuse sweating.
- They make the hair stand erect. (gooseflesh)
- In short noradrenaline and adrenaline mobilize the body, to face the emergency by fighting with it or running away from it.

Testes

They are both cytogenic (producing sex cells) and endocrine (producing male sex hormones) in functioning.

The endocrine part secretes male sex hormone called ***testosterone (androgen).***

Testosterone stimulates the growth of reproductive organs and the production of male sex cell, the sperm.

Testosterone determines the secondary sexual characters in male, such as growth of facial hairs, coarse voice, broadening of shoulder, etc.,

Ovaries

Ovaries are both cytogenic (producing egg cells) and endocrine (producing reproductive hormones, such as oestrogen, progesterone and relaxin) in functioning.

Oestrogen is responsible for growth of female reproductive organs and the appearance of secondary sexual characters in female, such as growth of pubic hairs, soft voice, feminine body, etc.,

Progesterone maintains pregnancy and regulates menstrual cycle.

Relaxin relaxes the muscles of the pelvic region at the time of child birth.

Parathyroid gland

These are found within thyroid and produce the hormones mainly ***Parathormone*** and ***Calcitonin*** which maintain the mineral metabolism.

Thymus gland

It's a lymphoid mass, present above the heart. It secretes ***thymosin*** which stimulates the differentiation of "T" lymphocytes to resist infection.

Pineal gland

It lies under the corpus callosum in the brain. It produces ***melatonin***, causing concentration of pigments in some specific areas like areola, scrotal sacs, etc.,

3.3. CELL DIVISION

A matured cell divides into two daughter cells. Unicellular animalcules like amoeba, undergo binary fission without any change in the chromatin reticulum by a type of cell division called Amitosis.

Body cells of all animals and plants undergo a cell division called ***Mitosis,*** involving changes in the structure of chromosomes, but without any change in the chromosomal number.

The germinal epithelial cells of animals undergo ***Meiosis*** cell division, involving changes in the structure and number of chromosomes.

You have studied the process of mitosis in the previous year. We will understand the various stages of meiosis and its significance in this unit.

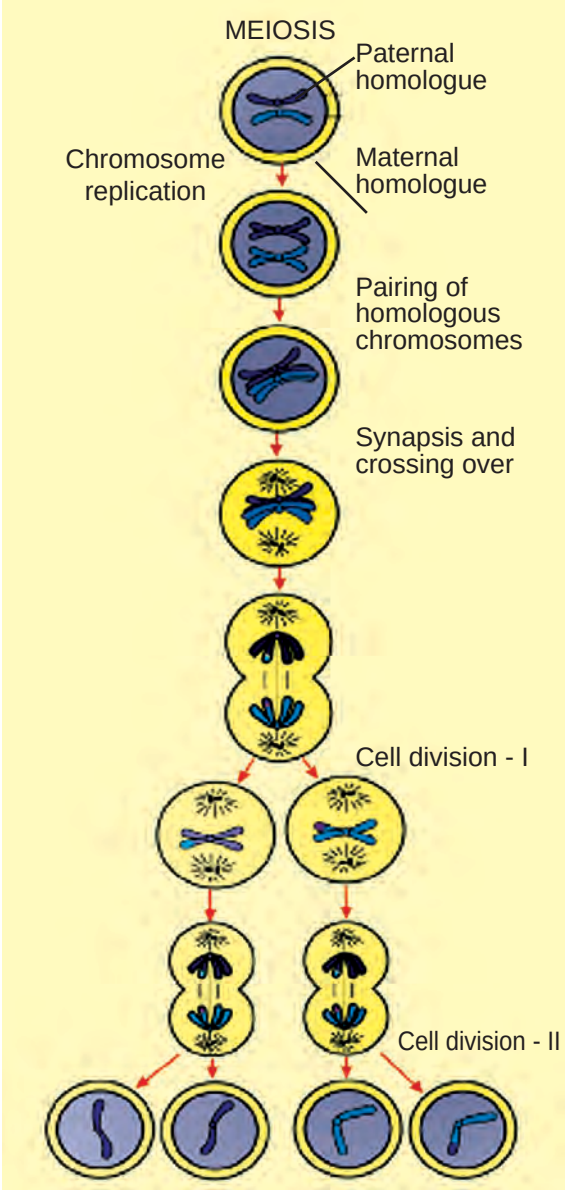


Fig. 3.11 Meiosis - stages

Meiosis

Meiosis is a kind of cell division, which occurs in the germinal epithelial cells of the gonads to form the gametes. Meiosis takes place in the specialized

diploid cells of gonads and produces four haploid gametes, each having half the number of chromosomes as compared to the parent cell. Meiosis is completed in two successive divisions – Meiosis-I and Meiosis-II. In Meiosis-I, as the chromosomal number is reduced to half, it is called Reduction division. Meiosis-II is similar to Mitosis.

Meiosis - I

The various events of Meiosis-I are studied under four substages namely Prophase-I, Metaphase-I, Anaphase-I and Telophase-I.

Prophase - I

The chromatin reticulum unwebs and individual chromosomes are liberated from one another. The nuclear membrane dissolves. The chromosomes undergo, marked differences in their shape and structure. Based on the shape of the chromosomes, this stage is studied under five sub-divisions as Leptotene, Zygotene, Pachytene, Diplotene and Diakinesis.

Leptotene

The chromosomes condense and appear like threads. Each chromosome splits up longitudinally, except at the centromere.

Zygotene

The homologous chromosomes come closer and start **pairing**. (a homologous pair of chromosomes consist of a paternal chromosome and maternal chromosome with similar genes). The pairing starts from the tip or from the middle and get attached laterally throughout the length. This pairing is called **Synapsis**, the paired chromosomes are called **Bivalents.**

Pachytene

The paired chromosomes become shorter and thicker. Each bivalent appears to have four strands called as, ***tetrads*** or ***quadrivalents*****.** The point of contact between the homologous pair of chromosomes are called, ***Chiasmata*****.** At the point of chiasmata, exchange of chromosomal segment takes place, between the chromatids of the homologous pairs. This exchange of segments of chromatids between homologous chromosomes, is called ***crossing over***.

Diplotene

After the crossing over is completed, the homologous chromosomes separate and this separation is called ***terminalization***. Terminalization may begin in chiasmata and move to the terminal end of the chromosomes.

Diakinesis

The nuclear membrane and the nucleolus disappear. The spindle apparatus is formed in the cytoplasm.

Metaphase - I

The chromosomes get condensed. Bivalents now appear on the equator of the spindle with their chromatids, pointing towards the equatorial plate and the centromere pointing towards the poles.

Anaphase - I

The spindle fibres contract pulling the chromosomes, towards the opposite poles. The entire chromosome, with the two chromatids move to the opposite poles. This involves, a reduction in the number

of chromosomes. Now two groups of chromosomes are produced, one at each pole with half the number of chromosomes.

Telophase - I

At the poles, around the group of chromosomes, a nuclear membrane develops. Thus two daughter nuclei each with half the number of chromosomes, are formed at the poles. The spindle fibres disappear.

At the end of Meiosis-I at right angle to the position of the nuclei, the cytoplasmic constriction takes place leading to the division of the cell. The cytoplasmic division is called Cytokinesis.

Meiosis - II

Meiosis-II is similar to Mitosis and so it is called Meiotic Mitosis. The events of Meiosis-II are studied in four sub-divisions as, Prophase-II, Metaphase-II, Anaphase-II and Telophase-II.

Prophase - II

The bivalent chromosomes gets shortened. The centrioles form asters and move to the poles. The nucleolus and nuclear membrane disappear.

Metaphase - II

Chromosomes, each consisting of two chromatids held together by a centromere are arranged at the equator of the spindle fibres. The centromeres are attached with the spindle fibres.

Anaphase - II

The centromere divides into two and the two chromatids separate and now they are called as daughter chromosomes or new chromosomes. The daughter chromosomes move towards the opposite poles.

Telophase - II

The haploid set at the two poles coil to form chromatin material. The nuclear membrane and nucleolus reappear. Thus two daughter nuclei are formed.

Cytokinesis

The cytoplasmic division takes place at right angles to the position of the nuclei resulting in the formation of four gametes.

Significance of Meiosis

1. Haploid sex cells are produced, in order to maintain the constancy in the number of chromosomes of a species.
2. Crossing over results in variation of genetic traits in the offspring.
3. Variations form the raw material for evolution.

3.4. HEREDITY

The resemblance of son or daughter with his or her father or mother, is an interesting feature in nature. Inheritance of characters from the parents to the progeny, (i.e. heredity) ensures the passing of the parental characters to the progeny.The inheritance of characteristics through generations is called heredity.

The inheritable characters may be morphological or physiological or anatomical or reproductive and are also known as traits. Both the mother and father contribute equal amount of genetic material to the child. This means, that each trait can be influenced, by both paternal and maternal genetic material i.e. DNA.

EVALUATION

Part A

1. Unipolar neurons are found in _____.

   (Brain, Spinal Chord, Embryonic nervous tissue, Adult nervous tissue.)

2. The sensory organs contain _____.

   (Unipolar neuron, Bipolar neuron, Multipolar neuron, Medullated neuron.)

3. The part of brain which controls emotional reactions in our body is ____.

   (Cerebellum, Cerebrum, Thalamus, Hypothalamus.)

4. One of the following is the part of the brain stem. Pick out.

   (Fore brain and mid brain, Mid brain and hind brain)

   (Fore brain and hind brain, Fore brain and spinal cord.)

5. Spinal nerves are _____.

   (Sensory nerves, Motor nerves, Mixed nerves, Innervating the brain.)

6. An endocrine gland found in neck is _____.

   (Adrenal gland, pituitary gland, thyroid gland, pancreas.)

7. An endocrine gland which is both exocrine and endocrine is _____.

   (Pancreas, pituitary, thyroid, adrenal.)

8. Normal blood glucose level in 100 ml of blood is _____.

9. The "T" lymphocytes are differentiated to resist infection in _____ (parathyroid gland, lymph gland,thymus gland, adrenal gland.)

10. In Meiosis-I, the pairing of homologous chromosomes take place during _____ stage.

    (leptotene, zygotene, pachytene, diplotene)

Part B

11. Copy the diagram and label any two parts in the group given.

(cyton, axon, dendron, endplate)

12. This diagram is human brain, and the functions of different parts are given below.

A. Seat of smell

B. Seat of vision

Mark A and B in the parts of the brain, corresponding with the function.

13. On the basis of the function performed, pick out the right statements.

    a. Pitutiary gland secretes hormones and enzymes

    b.Thyroid gland secretes thyroxine and insulin.

c. Testes produces sperms and the hormone androgen.

d. Pancreas produces enzymes and hormones.

14. Based on relationships fill in the blanks.

Thyroxine: personality hormone; adrenaline :_____.

15. Correct the statements if they are wrong.

a .alpha cells produce insulin and beta cells produce glucagon.

b. cortisone suppresses the immune response.

c. thymus gland is a lymphoid mass.

d. Ovary produces eggs and Androgen.

16. Reduction division is the process by which gametes are produced. The cells in which reduction division take place are

(germinal epithelial cells, the sensory epithelial cells, cuboidal epithelial cells, columnar epithelial cells).

17. In Amoeba, the cell division takes place ————————

(involving changes in the chromatinrticulum,

without involving changes in the chromatin reticulum,

leading to reduction in the number of chromosomes,without dividing the nucleus).

18. Pick out the item which has sequential arrangements

a. zygotene -> Leptotene -> Pachytene -> Diplotene -> Diakinesis

b. Diakinesis -> zygotene -> Leptotene -> Pachytene -> Diplotene

c. Leptotene -> zygotene -> Pachytene -> Diplotene -> Diakinesis

19. The important event of meiosis is the crossing over. It occurs during

(Leptotene,Pachytene,Diplotene, Zygotene).

FURTHER REFERENCE

Books: 1. Biology - **RAVEN, Johnson WCB** Mc Graw - Hill

2. Biology - A Modern Introduction, **B.S. Beckett,** Second Edition Oxford University Press.

Chapter 4

REPRODUCTION IN PLANTS

4. REPRODUCTION IN PLANTS

REPRODUCTION IN PLANTS

Do you know that all living organisms reproduce (both plants and animals)? Reproduction is a special biological process, by which new individuals of the same species are produced. It is one of the biological processes like nutrition, respiration and excretion etc.

What will happen if there is no reproduction?

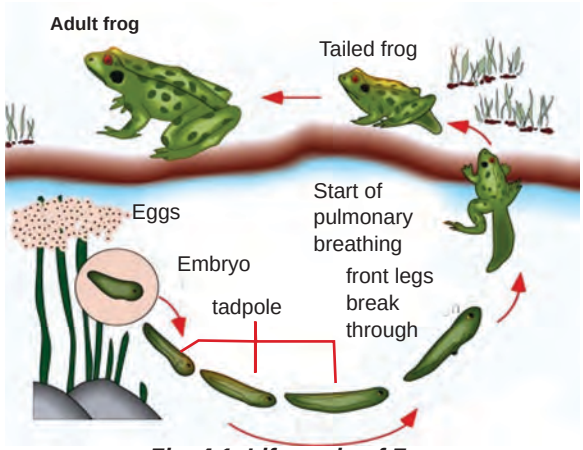


Fig. 4.1 Life cycle of Frog

Some of the methods of reproduction in organisms are:

Reproduction in animals	Reproduction in plants
Fission – Protozoan	Fission – Bacteria
Budding – Coelenterates	Budding - yeast
Fragmentation – Flatworms	Fragmentation – Algae
	Spores – Fungi
Sexual reproduction – Mammals	Pollination and Fertilization – Flowering plants

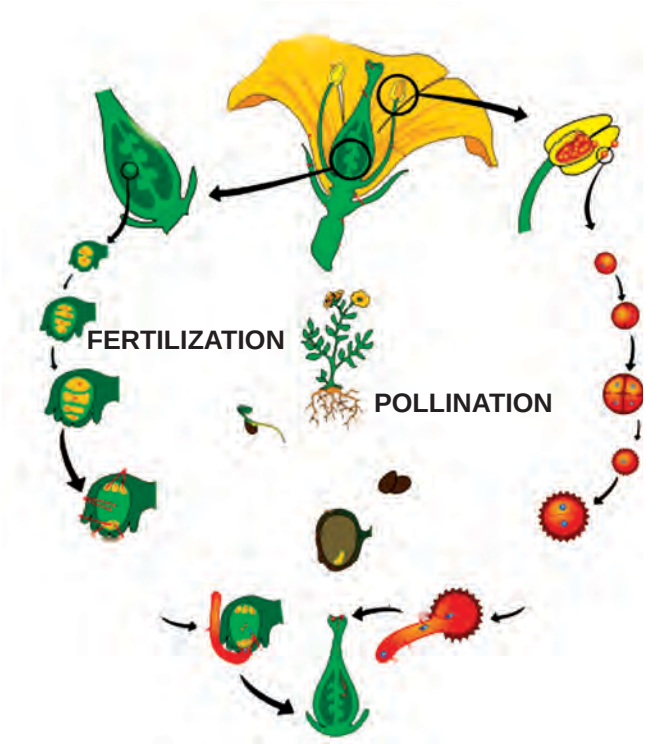


Fig. 4.2 Pollination and fertilization

Questions

1. What is meant by reproduction?
2. Mention a few methods of reproduction in plants and animals.

South African fossil records show that the first formed organism in the Earth is a Bacterium, i.e, Eobacterium which came into existence approximately four billion years ago. In the past two billion years, life got diversified into multitude of varieties of organisms that exist today or existed and became extinct in the past, whereas bacteria continues to live as bacteria without much change.

4.1. MODES OF REPRODUCTION

4.1.1. Modes of reproduction in single cell organism

Let us examine how different organisms actually reproduce. The methods by which organisms reproduce depend upon the body shape and structure of organisms.

Unicellular organisms, like amoeba and bacteria, split into two equal halves and produce new ones which is called binary fission.

Some Bacteria, like Lactobacilli, Salmonella multiply rapidly, others like Myco bacterium tuberculosis, multiply slowly.

ACTIVITY 4.1

- Wet a slice of bread and keep it in a cool, moist and dark place.
- Observe the surface of the slice with a magnifying glass.
- Observe for a week and record.

Beneficial activity to humans :

Conversion of milk into curd by Lactobacilli

Harmful activity to humans :

Bacteria like Mycobacterium tuberculosis cause tuberculosis.

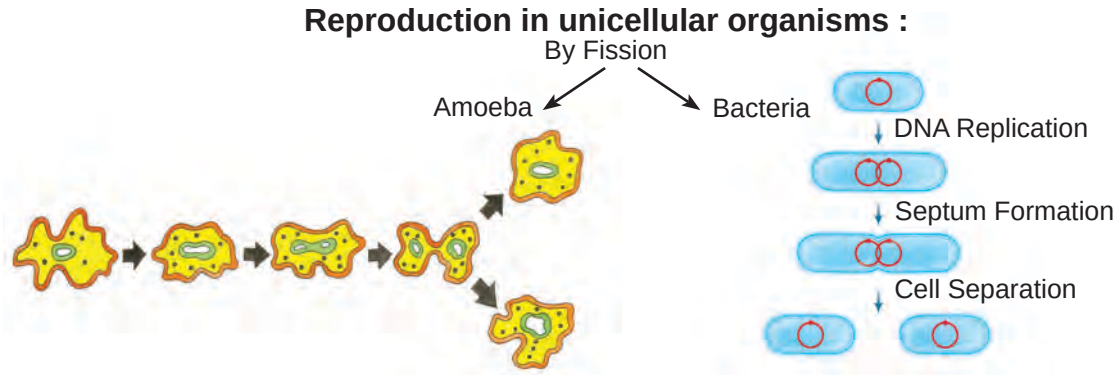


Fig. 4.3 Reproduction in unicellular organisms

Think, read and analyse,

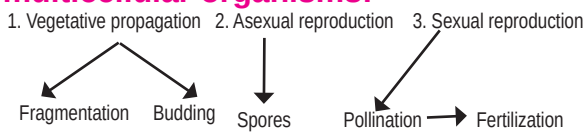
why there are so many methods of reproduction?

Evolution may be defined as a gradual development of more complex species from pre-existing forms. On this basis, the reproduction in simpler forms, like Amoeba and Bacteria, is very primitive by means of Binary Fission, Fragmentation, etc., If, the complexity of the body design of organisms increases, the method of reproduction also gets complicated involving two organisms (male and female).

ACTIVITY 4.2

- Observe a permanent slide of bacteria under a microscope.
- Similarly, observe another permanent slide of bacteria showing Binary Fission.
- Now compare the observations of both the slides.

4.1.2. Modes of reproduction in multicellular organisms:



Depending upon the body organization of multicellular organisms, there are various methods of reproduction.

Vegetative propagation: is the ability of plants to reproduce by bringing forth new plants from existing vegetative structures without sexual rproduction.

Fragmentation

In multicellular organisms with simple body organization, simple reproductive methods have been noticed.

In Spirogyra algae, the plant body breaks up into smaller fragments. Each fragment grows into a new individual.

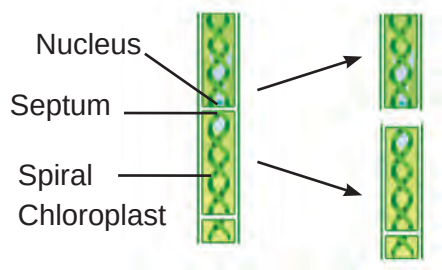


Fig. 4.4 Fragmentation in spirogyra

ACTIVITY 4.3

- Collect water from a lake or pond that appears dark green and contains filamentous structures.
- Put one or two filaments on a slide.
- Put a drop of glycerin on these filaments and cover it with a cover slip.
- Observe the slide under a microscope.

Budding

In Hydra, a bud develops as an outgrowth due to repeated cell division at one specific site. These buds develop into tiny individuals and, when fully mature, get detached from the parent body to become new independent individuals.

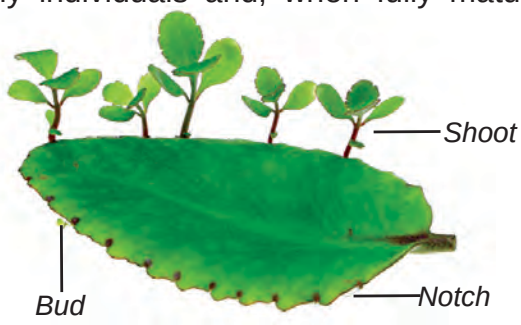
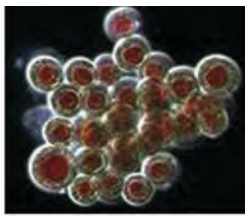


Fig. 4.5 Bryophyllum

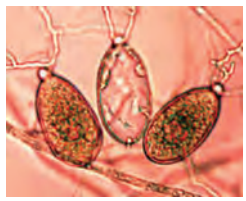
Similarly, buds produced in the notches along the leaf margin of Bryophyllum fall on the soil and develop into new plants (in Tamil katti pottal kutti podum).

4.1.3. Asexual reproduction

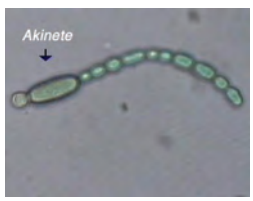
In lower group of plants, reproduction takes place by means of spores. The spores are covered by thick walls that protect them until they come into contact with another moist surface and can begin to grow.



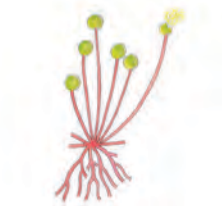
Aplanospores



Zoospores



Akinetes



Conidia

Fig. 4.6 Different kinds of spores

Some of the spores in different algae and fungi are

APLANOSPORES	ZOOSPORES	AKINETES	CONIDIA
In algae, the protoplast of the vegetative cells contract and produce ovoid bodies surrounded by a thin wall. These thin walled non-motile spores are called Aplanospores. New filaments are formed by the germination of these spores.	A zoospore is a motile asexual spore that uses a flagellum for locomotion. These spores are created by some algae, bacteria and fungi to propagate themselves.	In algae, the vegetative cells secrete thick additional wall layers. During adverse conditions, food materials are filled up in cells. These structures are called akinetes. During favourable conditions they develop into new filaments.	Conidia are uninucleate, non-motile, asexual spores produced by the fungus like penicillium, etc.

Questions

1. *Differentiate vegetative propagation and sexual reproduction.*
2. *Mention some of the spores of asexual reproduction.*

4.1.4. Sexual reproduction in plants

What is sexual reproduction?

Sexual reproduction is the process in which two components (male and female) are involved to produce offsprings of their own kind.

A bull alone cannot produce new calves.

It needs a cow. Female sheep alone cannot produce new ones. It needs a male sheep.

Both the sexes, male and female, are needed to produce new offspring.

As you have already studied in your earlier classes, the flower is a reproductive organ of a flowering plant. To understand this we need to look first at the structure of a flower.

Parts of a typical flower

A flower is a modified shoot with a limited growth. Flowers vary in size, shape,structure and colour.

The main parts of a flower are,

1. *Calyx*
2. *Corolla*
3. *Androecium and*
4. *Gynoecium.*

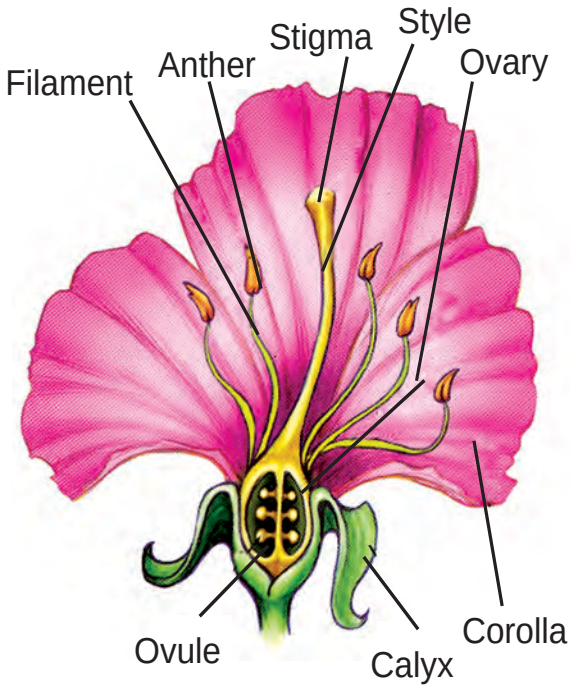
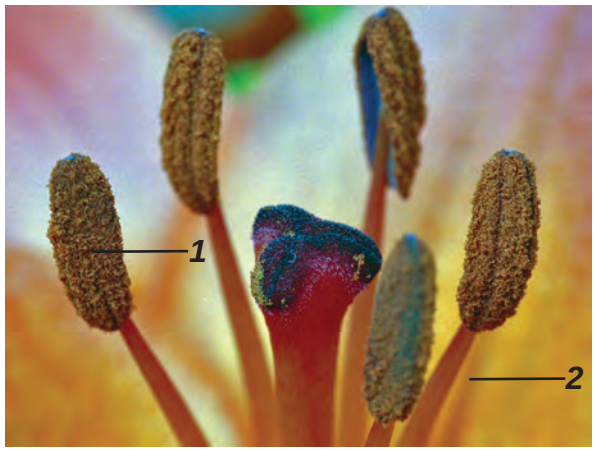


Fig. 4.7 Parts of a flower



1. Anther,

2. Filament

Fig 4.8 Androecium

Androecium is the male part of a flower,and Gynoecium is the female part.

Androecium is a group of stamens. Each Stamen consists of a stalk called the filament and a small bag like structure called the anther at the tip. The pollen grains are contained in the anther within the pollen sacs.

Gynoecium

Gynoecium is the female part of the flower and consists of the carpels or ovary. Gynoceium has three parts 1) Stigma 2) Style and 3) Ovary.

The ovary contains the ovules and each ovule carries within it an embryo sac, within which lies the egg cell or the female gamete.

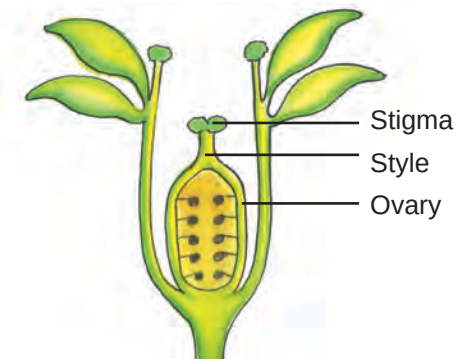


Fig. 4.9 Gynoecium

ACTIVITY 4.4

- Take a shoe flower from a growing plant.
- Observe the floral parts Calyx, Corolla, Androecium and Gynoecium.
- Separate the stamens and carpels and observe the parts.
- Dust the pollen grains on a slide and observe under the microscope.

4.2. POLLINATION

How does sexual reproduction take place in flowering plants?

The sexual reproduction in flowering plants involves

1. Pollination
2. Fertilization

1. Pollination

Transfer of pollen grains from the anther to the stigma is called pollination. Pollen grains are transferred mainly by wind, water and insects. They are called as pollinating agents.

Pollination is the first and important event in the development of the fruit and seed. Pollination is followed by fertilization.

Types of Pollination

Pollination is of two types. They are

1. *Self pollination*
2. *Cross pollination*

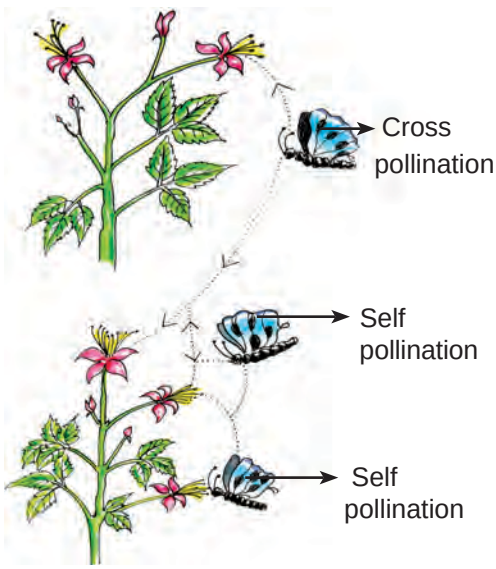


Fig. 4.10 Pollination

4.2.1. Self Pollination (Autogamy)

Self pollination is also known as autogamy. The transfer of pollen grains from the anther of a flower to the stigma of the same flower or another flower of the same plant is known as self pollination.

Advantages of self pollination

1. Self pollination is certain in bisexual flowers.
2. Flowers need not depend on agents of pollination.
3. There is no wastage of pollen grains.

Disadvantages of self pollination

1. The seeds are less in number.
2. Endosperm is minute. Therefore, the seeds produce weak plants.
3. New varieties of plants cannot be produced resulting in the degradation of the plant.

4.2.2. Cross Pollination (Allogamy)

The transfer of pollen grains of a flower to the stigma of another flower of a different plant of the same species is called cross pollination or allogamy.

Advantages of cross pollination

1. The seeds produced as a result of cross pollination develop, germinate properly and grow into better plants, i.e., cross pollination leads to the production of new varieties.
2. More viable seeds are produced.

4.2.3. Agents of cross pollination

How is it possible for the transfer of pollen grains from one flower to another?

In order to bring about cross pollination, it is necessary that the pollen should be carried from one flower to another of a different plant. This takes place through agency of animals, insects, wind and water.

Pollination by birds (Ornithophily)

Pollination by insects (Entamophily)

Pollination by animals (zoophily)

ACTIVITY 4.5

Observe the flowers in a garden near to you.Identify the insects, and birds,that act as pollinating agents. Maintain a record detailing the pollinating agents and the plants they pollinate.

Zoophily

Animals and insects – Birds, squirrels and insects are attracted to the bright petals of the flowers. These flowers are also large in size and have a sweet smell. Some of these flowers have nectar and a sweet scent. This is the most common of all methods of pollination. This kind of pollination is called Zoophily. (Pollination by animals and birds).

Fig. 4.11 Zoophily

Anemophily (Pollination by wind)

The flowers pollinated by air are mostly small in size and without any attractive colour, smell and nectar. They produce a large number of pollen grains to make up for the wastage of pollen in times of transit.

Fig. 4.12 Anemophily

The pollen grains are dry and powdery, and hence are easily carried by the wind.

Some pollen grains even have wings. Stigmas are large and protruding, even branched and feathery. e.g.Maize.

Flowers pollinated by wind are called Anemophilous, e.g. Grass and pine.

ACTIVITY 4.6

- Collect some of the zoophilous, anemophilous,hydrophilous flowers.
- Prepare a chart and make a note of their adaptations to suit the corresponding pollination.

Pollination by Water (Hydrophily)

This pollination takes place in water plants or plants that are adapted to water habitat. e.g. Vallisneria. This pollination is known as hydrophily. The flowers are small and inconspicuous.

Fig. 4.13 Hydrophily

4.3. FERTILIZATION

Recall what you have studied about pollination.

Pollination is the transfer of pollen grains from the anther to the stigma. Each pollen grain has protective walls called exine and intine. The outer wall exine is thick and it has small pores called germination pores. The inner wall is thin and elastic.

Germination of pollen grain

If pollen grain falls on a suitable stigma, it starts germinating. A mature pollen consists of two cells. The larger one is vegetative cell and the smaller one is generative cell. The vegetative cell starts growing and emerges through the germination pore. It develops through the style as a long tube known as pollen tube. The generative cell gets into the tube and divides into two male gametes (sperms).

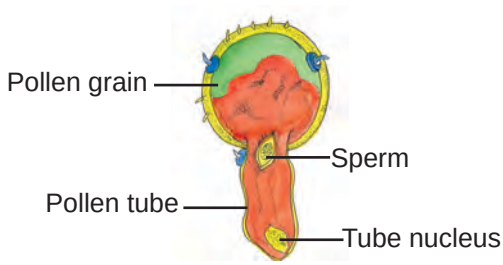


Fig. 4.14 Germination of pollen grain

4.3.1. Process of fertilization

The pollen tube enters into the embryo sac through micropyle. At this time, the pollen tube bursts open, gametes released from the pollen tube and enter into the embryosac. One of the gametes fuses with the egg, and the other fuses with the secondary nucleus. The fusion of a male gamete with egg is known as fertilization. The fertilized egg is known as zygote which develops into embryo.

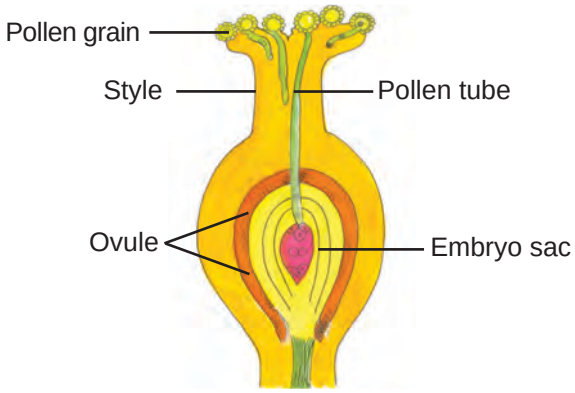


Fig. 4.15 Process of fertilization

4.3.2. Double fertilization

The other male gamete fuses with the secondary nucleus. The secondary nucleus is diploid in nature.

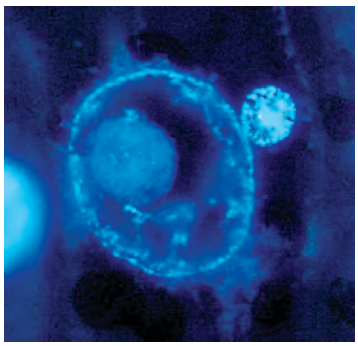


Fig. 4.16 Double fertilization

The fusion of this nucleus with the second male gamete is known as triple fusion. The triple fusion nucleus is called endosperm nucleus because it develops into endosperm.

Endosperm is a nutritive tissue meant for the development of the embryo. The process of fusion of a male gamete with egg and the other gamete with secondary nucleus is known as double fertilization.

4.3.3. Post fertilization changes :

i. The ovule develops into seed.
ii. The integuments of the ovule develop into seed coats.
iii. The ovary enlarges and develops into fruit.

4.4. FRUIT FORMATION

You are all very familiar with fruits. They are inseparable with us in our day-to-day life. Fruits are rich in vitamin and give energy to us. Now let us discuss about the development of fruits and their types.

As we discussed earlier, fruits are the product of fertilization. The ovary will become fruit after fertilization. It has two parts namely pericarp (fruit wall) and seeds.

Some fruits develop without the act of fertilization. Such fruits are called Parthenocarpic fruits. e.g. seedless grapes, guava, mango etc.

4.4.1. Classification of fruits

The fruits are classified as follows:

Simple fleshy fruits

In simple fleshy fruits, the pericarp is succulent and juicy when fully ripe. The fleshy fruits are indehiscent in nature. The pericarp is distinguished into three parts, namely epicarp, mesocarp and endocarp. There are mainly two types of fleshy fruits – Baccate and Drupaceous. Baccate is further classified into berry, hesperidium, pome and pepo.

Simple dry fruits

These fruits have a dry pericarp. They are classified based on mode of dehiscense as dry dehiscent, dry indehiscent and schizocarpic fruits.

4.4.2. Dry dehiscent fruit

These fruits split open at maturity to liberate the seeds.

4.4.3. Dry indehiscent fruit

These fruits do not split open at maturity and the seeds are liberated by the decay of pericarp

4.4.4. Schizocarpic fruits

At maturity, these fruits break into many one seeded parts called mericarps. The mericarps containing the seeds remain indehiscent. Thus the schizocarpic fruits show characters of dehiscent and indehiscent fruits.

4.4.5. Aggregate Fruit

It is developed from a single flower with multicarpellary, apocarpous, superior ovary.Each free carpel develops into a fruitlet. Hence, the aggregate fruit has a cluster of fruitlets attached to a common stalk (e.g) Polyalthia

In Annona squamosa (custard apple), the margin of the carpels are united and appears like a single fruit.

Fig. 4.17 Polyalthia

Fig. 4.18 Custard apple

4.4.6. Composite or Multiple fruit

Multiple or composite fruit is formed by all the flowers of whole inflorescence and give a single fruit. There are two types of multiple fruits namely sorosis and syconus.

ACTIVITY 4.7

Collect a variety of fruits. Identify what type of fruit they belong to and make a note on them.

Think, read and find out :

Why are there so many varieties of fruits?

4.4.7. Seed Formation

Seed is a fertilized ovule. It possesses embryo, food materials and are protected by the seed coat. During favourable condition, the seed germinates and gives rise to a new seedling.

Seeds have great variations in the size, shape, colour and surface. In orchids, there are many seeds which are tiny dust like particles. In coconut, there is a large sized seed. The seed grows into a full plant.

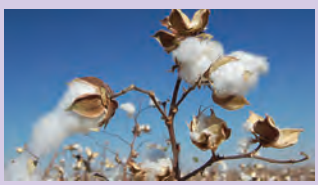
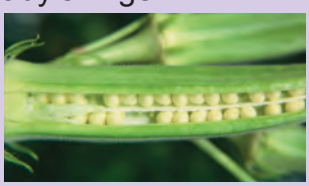
On the basis of the number of cotyledons in the embryo (seed), the angiosperms have been divided into two groups.

Simple fleshy fruits

Sl.No	Type	Diagram	Description
1.	B a c c a t e - Berry	Tomato 	It is one or many seeded fruit. Epicarp is thin and the mesocarp is fleshy. They form a pulp which is edible and the seeds are embedded in it.
2.	Hesperidium	Orange 	It develops from multicarpellary, superior ovary with axile placentation. The epicarp is thick, leathery and contain oil glands. The whitish spongy layer lining the epicarp is called mesocarp. The endocarp forms distinct chambers. Juicy hairs produced from the endocarp is the edible part.
3.	Pome	Apple 	The fruit develops from pentacarpellary syncarpous inferior ovary with many seeds. The thalamus becomes fleshy and develops into a fruit which is edible. The true fruit containing seeds remain inside.
4.	Pepo	Cucumber 	It develops from a tricarpellary, syncarpous inferior ovary with parietal placentation.The pulp contains many seeds.
5.	Drupaceous Drupe	Mango 	It is a one seeded fleshy fruit and develops from monocarpellary, syncarpous ovary. The pericarp is differentiated into outer skinny epicarp,fleshy middle mesocarp and stony inner endocarp. Because of the presence of stony endocarp, the fruit is also known as stone fruit.

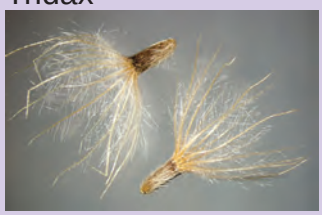
Simple dry fruits

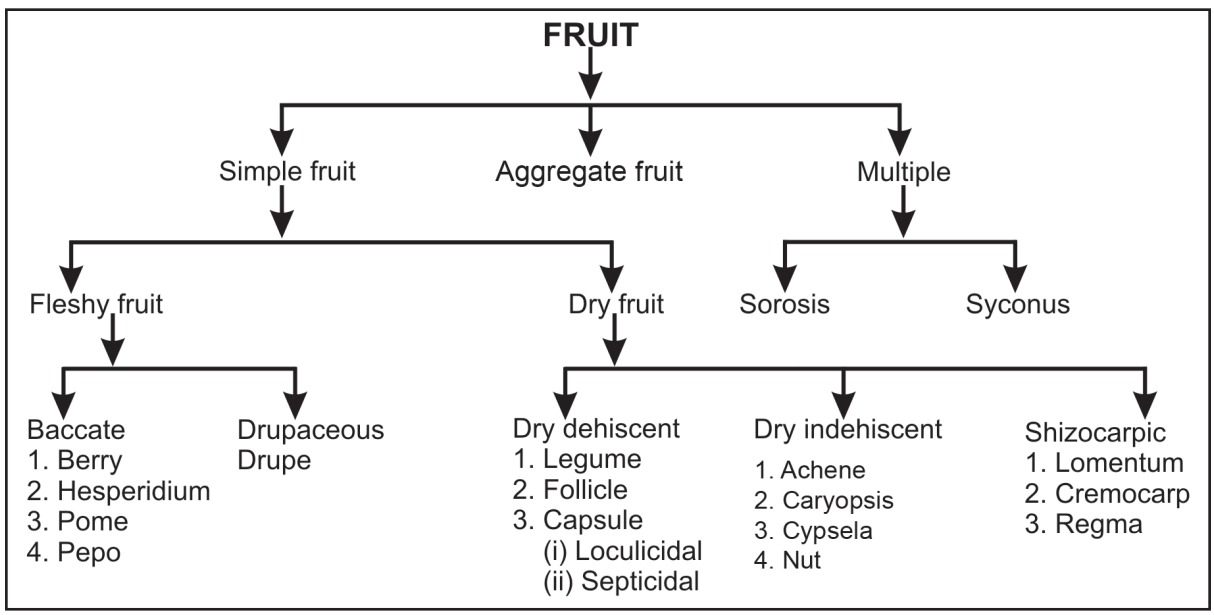
Dry dehiscent fruits

Sl.No	Type	Diagram	Description
1.	Legume	Beans 	It develops from monocarpellary, unilocular, superior ovary with marginal placentation. Pericarp dehisces along both dorsal and ventral sutures (e.g.) pea, bean, etc.
2.	Follicle	Calotropis 	It is like a legume fruit, but the pericarp dehisces along one suture only. (e.g.) Calotropis.
3.	Capsule (a) Loculicidal capsule (b) Septicidal capsule	Cotton  Lady's finger 	This is a many seeded fruit developing from superior or inferior, syncarpous multicarpellary ovary. Capsules dehisce by various methods.

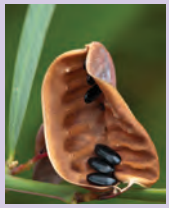
Dry indehiscent fruits

Sl.No	Type	Diagram	Description
1	Achene	Clematis,Mirabilis 	This is a single seeded fruit which develops from monocarpellary, unilocular ovary. Pericarp is hard and leathery, remains free from the seed coat

2.	Caryopsis	Paddy 	It is a one seeded fruit which develops from superior mono-carpellary ovary. Pericarp is fused with the seed coat (e.g paddy, wheat, maize).
3.	Cypsela	Tridax 	This fruit develops from inferior, bicarpellary syncarpous ovary. The pericarp and the seed coat remains free (e.gTridax).
4.	Nut	Cashew nut 	It is a dry indehiscent, one seeded fruit with hard and woody pericarp. Nut is developed from superior, bi or multi-carpellary ovary (e.g. Cashew nut, Walnut etc).



Schizocarpic Fruits

Sl.No	Type	Diagram	Description
1.	Lomentum	Acacia 	It resembles a legume and breaks transversely at constrictions between the seeds (e.g Acacia).
2.	Cremocarp	Coriandrum 	It is a two seeded fruit which develops from bicarpellary syncarpous, bilocular and inferior ovary. It dehisces longitudinally into two indehiscent mericarps (e.g) Coriandrum.
3.	Regma	Castor 	It develops from tricarpellary syncarpous superior ovary and breaks up into three one seeded cocci (e.g Castor).

Composite Fruits

Sl.No	Type	Diagram	Description
1.	Sorosis	Jack fruit 	In jack fruit, the rachis (inflorescence axis) and other floral parts of the female inflorescence fuse together forming a composite fruit. It consists of a fleshy central axis. The edible part represents the perianth which is bag like and one seeded. There are numerous, elongated, whitish flat structures in between the edible flakes. They represent the sterile or unfertilized flowers. The pines on the tough rind represent the stigma of the carpels.

Sl.No	Type	Diagram	Description
2.	Syconus	Fig 	It is derived from a special type of inflorescence known as hypanthodium which has a fleshy receptacle. It has large number of minute unisexual flowers. On ripening, the receptacle becomes fleshy and juicy and forms the edible portion (e.g.) banyan, peepal , fig, etc.

1. Dicotyledons: Seeds with two cotyledons (e.g) pea, bean, gram and castor.

2. Monocotyledons: Embryo with one cotyledon (e.g) maize, rice, wheat and onion.

1. Structure of a dicot seed (bean)

The seed is bulky, oval and slightly indented on one side. On this side there is a short longitudinal, whitish ridge called the raphae. At one end of the raphae there is a minute opening known as germ pore or micropyle.

If a water soaked seed is pressed gently a small drop of water along with air bubbles will be found coming out though the micropyle.

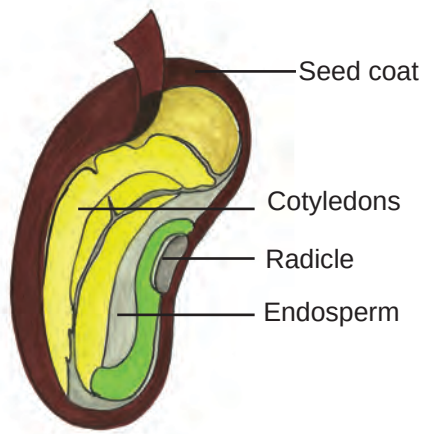


Fig. 4.19 Dicot Seed (Bean)

The embryo is enclosed by the seed coat. It consists of cotyledons attached to the primary axis which has rudimentary root portion called the radicle and a rudimentary stem portion known as plumule.

The tip of the radicle projects outside ,and is nearer to the micropyle. The plumule is placed between the two cotyledons and consists of a shoot axis, and a small bud having two tiny little folded leaves.

2. Structure of monocot seed (paddy)

In paddy, the so called seed is actually a fruit. It is a simple indehiscent one seeded fruit known as caryopsis, (you have already studied about this in the lesson of fruits.).The seed coat is very thin. The fruit wall (pericarp) is thin and fused with the seed coat. The fruit is covered by generally yellowish bract and bracteoles which are commonly known as chaff. The embryo consists of single cotyledon called scutellum and a shoot axis. The lower part of the axis is the radicle, covered by a sheath called coleorrhiza (root sheath). The upper part is known as plumule which is covered by a sheath called coleoptile. In a day or two, after the seed is placed in a moist soil, the coleorrhiza pierces the base of the seed. The radicle comes out next after splitting the coleorhiza.

The radicle does not form the root system. Meanwhile, roots are formed from the lower most nodes of the stem. These roots are called adventitious roots. These adventitious roots form fibrous root system of matured plant.

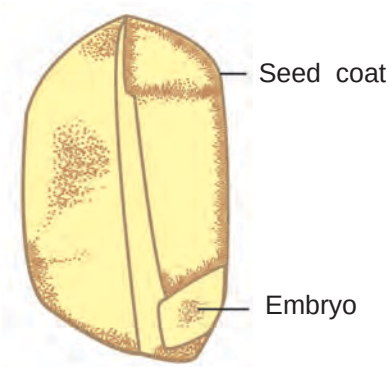


Fig. 4.20 Monocot seed (Paddy)

MORE TO KNOW

Darwin used seeds of cress, cabbages, lettuces and onions. Darwin also studied longer periods in sea water, the effect of water temperature on germination and floating of seeds. His experiments overturned the idea that sea water kills seeds. Of the 87 species he used, Darwin found almost three-quarters of the seeds studied could tolerate salt water at least 28 days in salt water.

ACTIVITY 4.8

Label jars, filled with sea water and seeds. After 7 days put the seeds in a sieve, rinse under a tap, and plant out in labeled pots.

ACTIVITY 4.9

- Soak a few seeds of bengal gram (Channa) and keep them over night in a wet cloth.
- Take care that the bengal gram is not swollen absorbing exess of water. (The bengal gram should not be decayed with excess water.
- Drain the excess water and cover the seeds with the wet cloth and leave them for a day. Make sure that the seeds do not become dry.
- Cut and open the seed carefully and observe the different parts.
- Compare your observations with the diagram and see if you can identity all the parts.

4.5. Dispersal of seeds :

The seeds fall off far away from the mother plant. Why?

The reproductive capacity of plants is so tremendous that a very large number of seeds is produced by a single plant. If all these seeds fall directly below the parent plant, the seedlings would have to compete for space, water, oxygen, minerals and sunlight, leading to competition. When the seedlings are grouped together at one place, they could easily be destroyed by grazing animals. Such a situation would be detrimental to the species.

The fruits and seeds of plants have evolved various devices by which they can be distributed far and wide through various agencies.

This not only eliminates the unhealthy competitive struggle that would arise from over crowding, but also ensures the successful spreading and establishment of a species on the earth. Most fruits and seeds have evolved adaptations for dispersal.

Agents for the dispersal of fruits and seeds:

Based on the agents involved in dispersal, there are various types of dispersal mechanisms of fruits and seeds in plants.

Autochory: Autochory is an active mechanism of self dispersal of fruits and seeds. Fruits like balsam burst with a sudden jerk and disperse the seeds by an explosive mechanism.

Anemochory is the wind dispersal of fruits and seeds. Alternatively, the wind may blow them away, for which they have to be light, so that their buoyancy may enable them to float on air over long distances. Some of them are provided with hairs and membranous wing-like structures which enable them to be carried away easily (e.g. Seeds dispersed by the wind are Calotropis (Erukkum), Moringa (drum sticks) etc.,

Fruits of Tridax carry a persistent calyx modified into a pappus (a ring of fine, feathery hairs) which act like a parachute and aids in the dispersal by wind.

Hydrochory: Hydrochory is a mechanism in which dispersal of fruits and seeds is by water. Fruits which are dispersed by water have outer coats that are modified to enable them to float. The mesocarp of coconut is fibrous, which is easily carried away by water currents.

The spongy thalamus with air chamber of Lotus floats in water streams and after some time the fruits get separated, and the seeds germinate.

Zoochory: Zoochory is a mechanism in which dispersal of fruits and seeds is by animals. Some fruits are provided with hooks, spines, bristles, stiff hairs, etc., on their outer coat. With the aid of these out growths, these fruits stick to the furry coats of skins of some animals and get carried away from one place to another.

The fruits of Xanthium have sharp-pointed stiff hooks and the Achyranthus the perianth and bracts are pointed. Many fleshy fruits are eaten by animals and human beings and the seeds are thrown away.

Fig. 4.21 Autochory (Balsam)

Fig. 4.22 Anemochory (Tridax)

Fig. 4.23 Hydrochory(Lotus)

Fig. 4.24 Zoochory(Xanthium)

Fig. 4.25 Zoochory(Achyranthus)

In fruits like tomato and guava, the seeds are eaten along with the edible portion and later passed out by excreta. These types of seeds are protected from the digestive juices by their seed coat.

Man is responsible for the dispersal of many fruits and seeds. In the pursuit of more economy, useful plants like Cinchona, Rubber and Eucalyptus have been successfully introduced by man and they have acclamatised well to the new surroundings far away from their original mother land.

ACTIVITY 4.10

- Collect a few fruit or seeds which have wings.
- Observe the fruit of Tridax and draw. Look at the pappus calyx.
- Why is the mesocarp of coconut fibrous?

Collect some of the plants around you. What are their local names?

Can you find out their botanical names?

EVALUATION

PART A

1. This is the one of the methods of reproduction in unicellular organisms like amoeba and bacteria in which they split into two equal halves and produce new ones is called.
   (fragmentation, binary fission, budding, spore formation)

2. In sexual reproduction of flowering plants, the first event involved in this is.
   (fertilization, germination, regeneration, pollination)

3. Which of the following statement is true.
   (Thin walled non mobile spores are called zoospores,
   A motile asexual spore produced by some algae bacteria and fungi are Akinetes,

Uninucleate non-motile asexual spores are produced by the fungus are called conidia,
Thick walled vegetative cells produced by the algae during adverse conditions are called aplanospores.)

4. The fertilized ovary is a fruit. The fruit develops from a single flower with multi carpellary, apocarpous superior ovary is

   (Aggregate fruit, Composite fruit, Simple fruit, Multiple fruit)

5. If a water soaked seed is pressed, a small drop of water comes out through.
   (stomata, lenticel, micropyle, radicle)

6. The mango fruit is called as stone fruit. because it has.

   (skinny epicarp, stony mesocarp, fleshy endocarp, hard endocarp)

7. Pick out the wrong statement.
   (In a dicot seed there is a short longitudinal whitish ridge is called the raphae.
   There is a minute opening in dicot seed is known as micropyle.
   The rudimentary stem portion known as radicle.
   The rudimentary root portion is called radicle)

8. Consider the following statement regarding the dispersal of fruit by wind and select the correct answer.
   (Fruits and seeds dispersed with a sudden jerk by an explosive mechanism.
   Fruits of tridax are carry a persistent calyx modified into pappus.
   The fruits of xanthium have sharp pointed stiff hooks.
   The mesocarp of coconut is fibres)

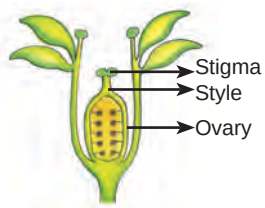
9. The product of triple fusion which acts as nutritive tissue for the development of embryo is
   (zygote, placenta, scutellum, endosperm)

10. The disadvantage of self pollination is
    (There is no wasteage of pollen grains,
    The seeds are less in number
    Self pollination is sure in bisexual flowers
    Flowers need not depend on agents of pollination)

PART B

11. a. Identify the given fig. A and B.

    b. Which part of the A is modified in to B.



A

B

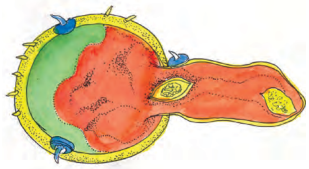
12. The methods of reproduction and the organisms are given below. Match the type of reproduction to the suitable organisms.

Fission	Spirogyra	Yeast
Budding	Protozoans	Flatworms
Fragmentation	Bryophyllum	Bacteria

13. In balsam plant the seeds fall off far away from the mother plant.
    a) Is this statement correct or incorrect?
    b) Give reason.

14. Composite fruits is formed by all the flowers of ----------, ---------- fruit is developed from a single flower with multicarpellary apocarpous superior ovary.

15. Redraw the diagram and label the following parts.
    a) Exine b) Tube nucleus.



PART C

16. a) Name the process by which the fruit is developed.
    b) Give the development process in brief.
    c) Draw a neat diagram of that process and label.

17. a) Write the two events involved in the sexual reproduction of flowering plant.
    b) Discuss the first event and write the types
    c) Give advantages and dis-advantages of that event.

18. a) Fruit is the product of fertilization. Is there any fruit is formed with out the act of fertilization?
    b) Represent the classification of fruits in a diagrammatic sketch

19. Compare aggregate fruit with multiple fruit with suitable examples.

20. Describe the structure of dicot seed.

FURTHER REFERENCE

Books:

1. Plant Reproduction - **S.R.Mishra** - Discovery Publishing House Pvt. Ltd.

NAME OF THE PLANTS IN ENGLISH AND TAMIL

S.No	Botanical Name	Common Name in English	Tamil Name	How it is called locally
1	Abelmoscus *esculentus*	Lady's finger	வெண்டை	
2	Acacia *coccina*	Soap acacia	சிகைக்காய்	
3	Achyranthes *aspera*		நாயுருவி	
4	Anacardium *occidentale*	Cashew nut	முந்திரி	
5	Anona *squamosa*	Custard apple	சீதாப்பழம்	
6	Artocarpus *integrifolia*	Jack fruit	பலா	
7	Bryophyllum		கட்டிப் போட்டால் குட்டிப்போடும்	
8	Calotropis *gigantea*	Madar plant	எருக்கு	
9	Citrus *sinensis*	Sweet orange	சாத்துக்குடி	
10	Cocus *nucifera*	Coconut	தென்னை	
11	Coriandrum *sativum*	Coriandar	கொத்துமல்லி, தனியா	
12	Gossypium *arboreum*	Cotton	பருத்தி	
13	Cucumis *sativus*	Cucumber	வெள்ளரிக்காய், தோசைக்காய்	
14	Cucurbita *maxima*	Pumpkin	பூசணிக்காய்/ பரங்கிக்காய்/ அரசாணைக்காய்	
15	Cuscuta *reflexa*		அம்மையார் கூந்தல்/ சடதாரி/ தங்கக்கொடி	
16	Ficus *glomerata*	Fig	அத்தி	
17	Impatiens *balsamia*	Balsam	பால்சம்/ பால்செண்டு	
18	Lablab *purpurreus*	Been	அவரை	
19	Lycopersicon *esculentum*	Tomato	தக்காளி	
20	Mangifera *indica*	Mango	மா	
21	Mimosa *pudica*	Touch me not plant	தொட்டால் வாடி/ தொட்டல் சுருங்கி / தொட்டால் சிணுங்கி	
22	Mirabilis *jalapa*	Four 'o' clock plant	அந்திமந்தாரை / அந்தி மல்லிகை	
23	Nelumbo *nucifera*	Indian lotus	தாமரை	
24	Oyza *sativa*	Paddy/ rice	நெல்	
25	Pisum *sativum*	Pea	பட்டாணி	
26	Polyalthia *longifolia*	Mast tree	நெட்டிலிங்கம்	
27	Pyrus *malus*	Apple	ஆப்பிள்	
28	Ricinus *communis*	Castor	ஆமணக்கு/முத்துக் கொட்டை	
28	Tridax *procumbens*		வெட்டுக்காயப் பூண்டுச் செடி	

Chapter 5

A REPRESENTATIVE STUDY OF MAMMALS

5. A REPRESENTATIVE STUDY OF MAMMALS

Mammals are the diverged group of animals, occupying different biomes of the environment ,successfully fitting in their habitats. Mammals are found almost in all habitats like oceans , freshwater, hilly regions , forests, deserts, polar regions and swamps.

5.1. MORPHOLOGY

Mammalian morphology is so divergent, as they occupy different habitats . The sea living dolphins, whales etc., look like fish, by form and structure. A nocturnal bat gliding in the sky, looks like a bird. All the large land animals are mammals. The size of mammals sets them apart from all other kinds of land animals.

Mammals are distinguished from other vertebrates by two fundamental characteristics that all mammals possess and no other living vertebrate possess. They are

1. Epidermal Hairs
2. Milk producing glands.

Epidermal Hairs

All mammals have hairs, even apparently naked whales and dolphins grow sensitive bristles on their snouts. Mammalian hair is a new form of skin structure a derivative from the skin; the hair is an insulator against heat loss. The colouration and pattern of mammal's skin usually matches its background. Hairs also are sensory structure, as the whiskers of cats and dogs are sensitive to touch. Hair is also defensive for porcupine and hedgehogs with long, sharp, stiff hairs called ***quills*** to protect them from predators.

ACTIVITY 5.1

Observe the hair of dog, cat, cattles, man, horse and donkey. Look for the structural details like shape, texture and curly or straight condition and record your findings.

Milk producing glands

All female mammals possess mammary glands that secrete milk. New born mammals, born without teeth suckled by the mother. Milk producing glands are modified sweat glands.

5.2. HABITAT

The place of living of an organism is its habitat. Mammals exhibit a great degree of functional adaptation to fit in the habitats in which they live. We find mammals living in high mountains, plains and forests, tundra, grassland, deserts, fresh water and marine habitats. Some important mammals in their different habitats are listed below;

High mountains	- mountain goats, big horned sheep, grizzly bears, etc.,
Plains and forests	- porcupine, giant squirrel, deers,

	elephants, tiger, leopard, rhinoceros, Hippopotamus, etc.,
Tundra	- reindeer, muskdeer ox, rodents, etc.,

Desert	- black buck, Indian wild ass etc.,
Fresh water	- beavers, platypus, otters, etc.,
Marine	- whales, dolphins, dugong, porpoise, seal, walrus, etc.,

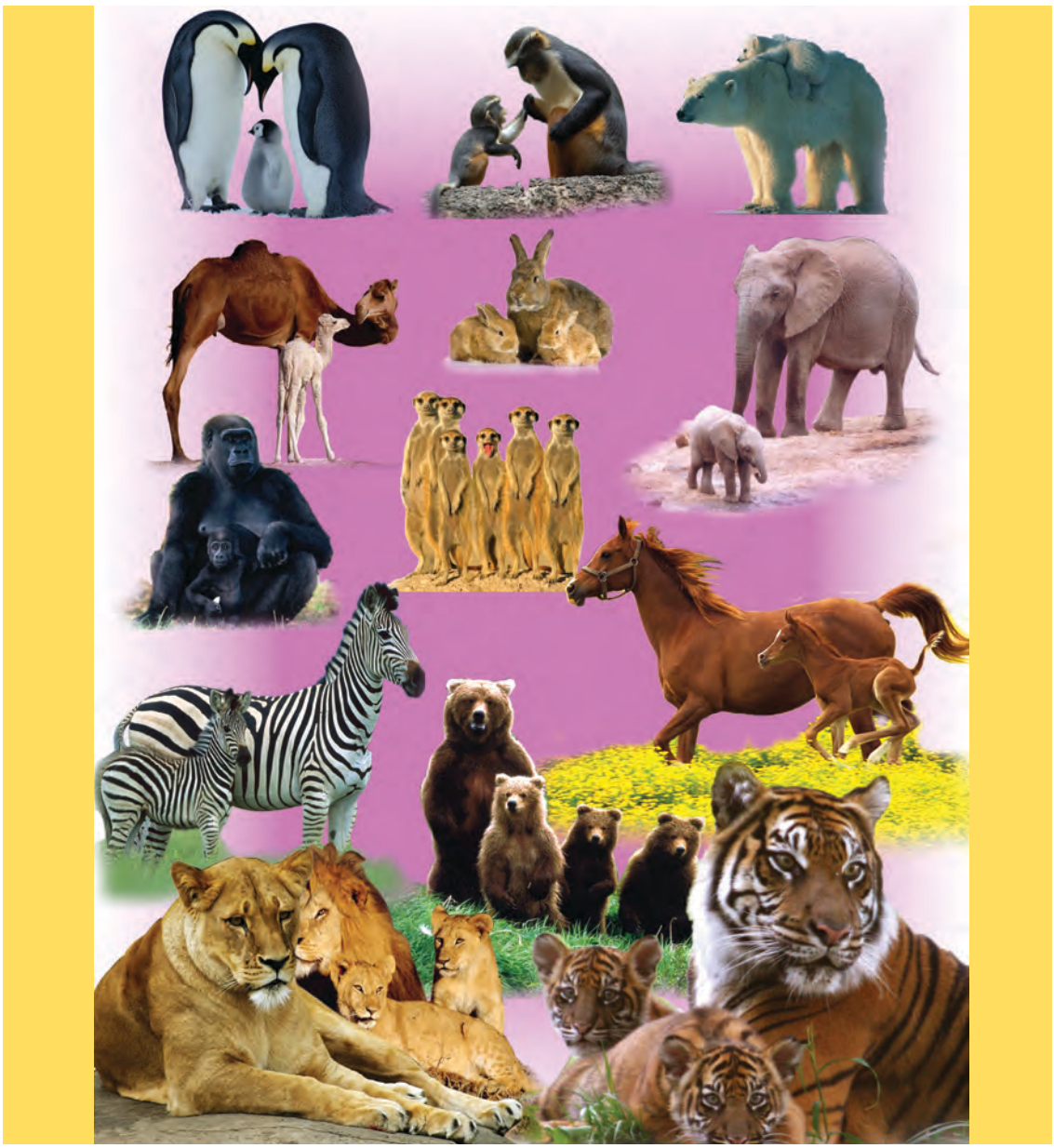


Fig. 5.1 Diverged group of Animals with their young ones

5.3. MAMMALIAN ADAPTATIONS

Mammalian group is the most successful animals adapted to different conditions of life.

i) In the marine whales, dolphins, etc,. the limbs are modified into flippers which are used as oars to swim in water. They also posseses huge subcutaneous fat deposits to conserve heat. The jaws of the whales are modified into baleen plates to sieve the water and trap the minute planktonic organisms as their food called krill.

ii) The skin of camels is doubly thick and contains water storing osmotic cells to conserve water, as they live in deserts. They have thick bunchy eyebrows covering the eyes to protect the eyes from sandy wind. Their nasal hole can be closed during desert storms to prevent the entry of sand particles.

iii) Most mammals are herbivores, eating mostly or only plants. To digest the cellulose rich food, they have developed a mutual partnership with bacteria that have cellulose splitting enzymes.

iv) Mammals such as cows, buffaloes, antelopes, goats, deers, etc,. have huge four chambered stomach that function as storage and fermentation vats. The stomach of cattles also helps them to ruminate or cud the food.

v) Mammals have heterodont dentition with different types of teeth that are highly specialized to match particular eating habits. For example, the carnivorous animals have tearing teeth - the canine. In elephant the incisors are modified into tusks as a specialized weapon.

vi) Bats are the only mammals capable of powered flight. The forelimbs of bats are modified into wing like structure. The bat's wing is a leathery membrane of skin and the muscle is stretched over the bones of the four fingers. Bats prefer to hang upside down from their legs while resting. The nocturnal bats can fly without crashing into things and still capture insects by echo location. As a bat flies, it emits very rapid series of extremely high pitched clicking sounds. The sound waves bounce off objects or flying insects and the bat hears the echo.

vi) The marsupials, kangaroo have developed abdominal pouches to bear the tender young ones.

vii) The polar bears have thick skin coats and woolly fur to bear the biting cold of the polar regions.

viii) The supreme mammal – man is highly adapted as an intellectual social animal. The fingers and toes are adapted for handling extremely fine movements in holding of fine objects, in writing and using very delicate instruments.

Fig. 5.2 Bat

5.4. BASIC PHYSIOLOGICAL FUNCTIONS

Mammals perform the physiological functions more efficiently compared to other vertebrates.

Mammals are warm blooded or homeotherms, maintaining a constant body temperature, irrespective of the temperature in the surroundings. The body temperature in man is maintained at 98.4^{o} F to 98.6^{o} F. The temperature regulation is done as a team work, by the sweat glands of skin, kidneys, lungs and blood.

In summer, we sweat more as a cooling up mechanism, to conduct the heat out in the sweating process. This is possible with increased blood supply to the sweat glands. The kidneys expel less urine since much of water is lost in the sweat.

In winter, we produce little sweat as a warming up mechanism to conserve heat. The sweat glands are supplied with less amount of blood, so that the amount of heat lost is lowered. Now the kidneys excrete out more urine.

Mammalian respiration is more efficient in comparison to other vertebrates. Red blood cells of mammals are fully packed with the respiratory red blood pigment haemoglobin, to carry the maximum amount of oxygen. The mammalian RBCs are without nucleus, as the space occupied by the nucleus is taken up by the haemoglobin molecules.

ACTIVITY 5.2

Note the body temperature of some of your classmates at 10 a.m, 1 p.m and 4 p.m. Record the same. Do you find any change in the temperature at different timings?

5.5. CIRCULATORY SYSTEM OF MAN

In order to transport substances from one part of the body to the other, the circulatory system has evolved. In man, the circulatory system is composed of

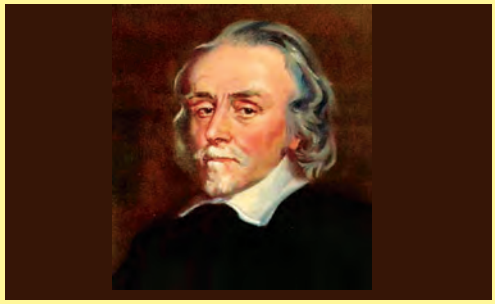
i) the heart

ii) the blood vessels namely arteries, veins and capillaries

iii) the blood and

iv) the lymph.

William Harvey in 1628 discovered the circulation of blood in man, until then it was thought that the body is a blood filled entity, and the blood is stagnant in it.



William Harvey 1578-1657 was an English physician. He was the first to give the details of blood circulation, the properties of blood and the pumping of blood by the heart.

The heart

The human heart is a hallo fibro muscular organ. It is conical in shape. the heart is covered by a protective double walled sac called ***pericardium*** filled with ***pericardial fluid***. The heart is made up of special type of muscles, called cardiac muscles. The partitions within the heart divide the heart into four chambers as auricles and ventricles. The right half of the heart receives and pumps off deoxygenated blood and the left half of the heart receives and pumps out oxygenated blood.

Auricles

These are thin walled upper chambers. The auricles are divided into a right auricle and a left auricle, by a partition called inter auricular septum. Auricles are the receiving chambers of blood. Into the right auricle open the superior venacava and inferior venacava emptying the deoxygenated blood brought from different parts of the body. Into the left auricle open the four pulmonary veins emptying the oxygenated blood brought from the two lungs.

Ventricles

These are thick walled lower chambers of the heart. A partition called inter ventricular septum divides the ventricle into right and left ventricle. The ventricles pump the blood out from the heart. From the right ventricle the deoxygenated blood is pumped into pulmonary artery to supply the two lungs. From the left ventricle oxygenated blood is pumped into the aorta to supply the oxygenated blood to the different parts of the body through its branches.

Apertures of the heart

Between the right auricle and right ventricle is found the right auriculo ventricular aperture and between the left auricle and left ventricle is found the left auriculo ventricular aperture.

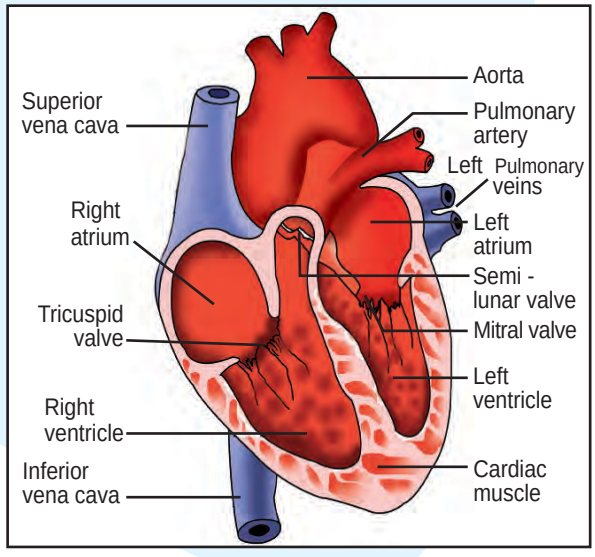


Fig. 5.3 Human heart

Valves of the heart

A tricuspid valve with three flaps is found in the right auriculo ventricular aperture to regulate the flow of blood, from right auricle to right ventricle and not backwards.

A bicuspid valve or mitral valve with two flaps in the left auriculo ventricular aperture regulates the flow of blood, from left auricle to left ventricle and not backwards.

At the base of the pulmonary artery is present the semi-lunar valve, which regulate the blood to flow from the right ventricle to the pulmonary artery.

At the base of the aorta is present the aortic valve, to regulate the flow of blood from left ventricle into aorta.

Working of heart

Human heart works by contraction and relaxation of the cardiac muscles. The contraction phase is called systole and relaxation phase is called diastole.

When the auricles are filled with blood they are in relaxation phase (auricular diastole). By now ventricles will push the blood into aorta and pulmonary artery by their contraction (ventricular systole).

When the auricles contract (auricular systole) the blood is pushed into the ventricles through the bicuspid and tricuspid valves, leading to ventricular relaxation (ventricular diastole).

Heartbeat

The closure of the valves of the heart produce two different cardiac sounds as ***"lubb"*** and ***"dubb".*** The human heart beats 72 times in a minute at rest. Heartbeat is an inherent capacity of the heart, begun and conducted by the specialized muscle bundle in the heart.

Blood vessels

There are three distinct types of blood vessels, namely, arteries, veins and capillaries.

Arteries

Arteries carry the blood from the heart to different parts of the body. They are the branches of aorta, supplying oxygenated blood to the different regions of the body (except pulmonary artery which carries deoxygenated blood). The aorta branches into arteries. Arteries branch into arterioles. Arterioles branch into fine tubes called meta arterioles. The meta arterioles end up in the tiny blood vessels called capillaries.

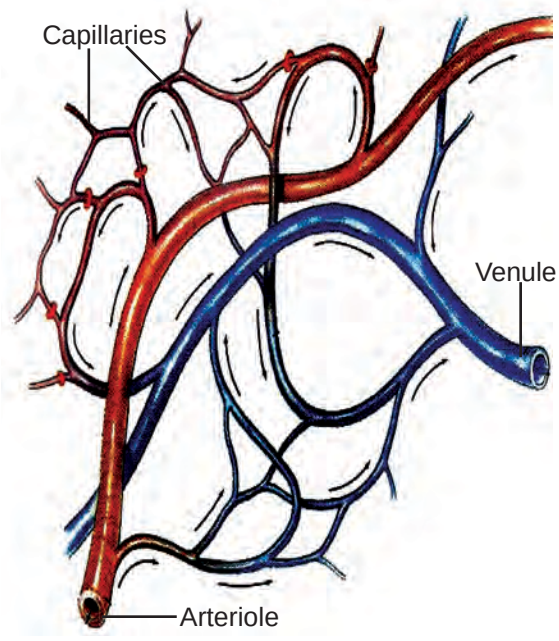


Fig. 5.4 Arteries, capillaries and veins

Capillaries

These tiny blood vessels form a network, called capillary network around the tissues to enable the passage of substances from the blood into the tissues.

Veins

The veins drain the blood from different parts of the body to the heart. The capillaries reunite to form venules, which drain the deoxygenated blood from the tissues. The small venules united with the big veins open into superior venacava and inferior venacava. Except the pulmonary veins all other veins carry deoxygenated blood.

The blood

Blood is the river of life – providing the internal environment to the body. Blood is the connective tissue, consisting of the fluid part, the plasma and the solid components, the blood cells.

Plasma

The liquid component of blood, the plasma is composed of water, organic substances, inorganics substances, etc,. The important organic substances of plasma are the plasmaproteins namely globulin (for immunity), fibrinogen (for blood clotting) and albumin (for water balance).

Blood cells

There are three types of blood cells namely Red Blood Cells, White Blood Cells and Blood Platelets freely floating in the plasma.

Red Blood Cells –Erythrocytes

RBCs are circular, biconcave and disc shaped. While the young RBCs have nuclei, the matured ones are without nuclei. The red blood pigment haemoglobin is fully packed in the RBCs. They are concerned with carriage of respiratory gases.

White Blood Cells – Leucocytes

WBCs are amoeboid in shape with prominent nuclei. WBCs are concerned with phagocytosis of engulfing the germs and producing antibodies to resist the germs entering the body.

Blood Platelets – Thrombocytes

Platelets are irregular broken up pieces of certain giant cells. They are concerned with blood clotting to prevent the loss of blood.

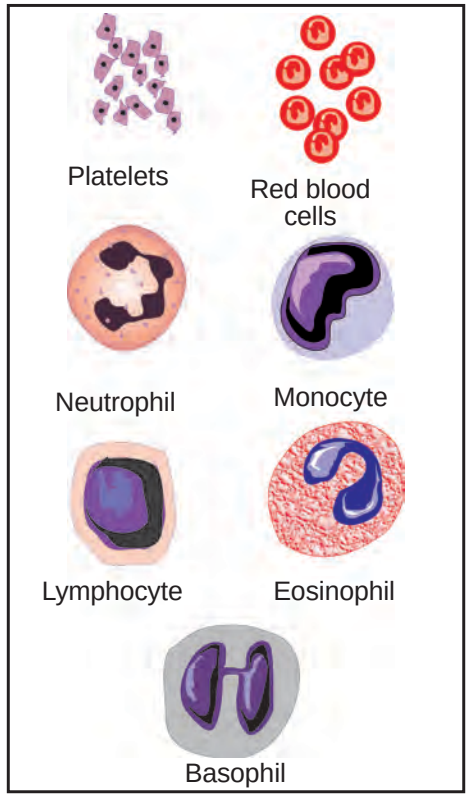


Fig. 5.5 Blood Cells

5.6. EXCRETORY SYSTEM IN MAN

Excretory organ	Excretory products	Sent out as
Kidneys	Nitrogenous waste products – urea, uric acid, creatinine, etc,.	Urine
Lungs	Carbondioxide and water vapour	Expired air
Skin	Excess water and salt	Sweat

Excretion is the removal of metabolic waste products called excreta. The important excreta and the excretory organs which remove them are shown in the above table.

The principal excretory organs of our body are the kidneys, which maintain the chemical composition of the blood and so are called as master chemist of our body.

External structure of kidney

A pair of kidneys are present in the upper abdominal region, one on either side of the vertebral column attached to the dorsal body wall. A thin transparent membrane called capsule covers the kidney. The kidneys are bean shaped with outer convex surface and inner concavity. The depression in the concavity is called renal hilus, from which arises the muscular tube called ureter. The two ureters open into the distensible muscular sacs called the urinary bladder which is the store house of urine. From the urinary bladder arises the urethra which delivers the urine out of the body.

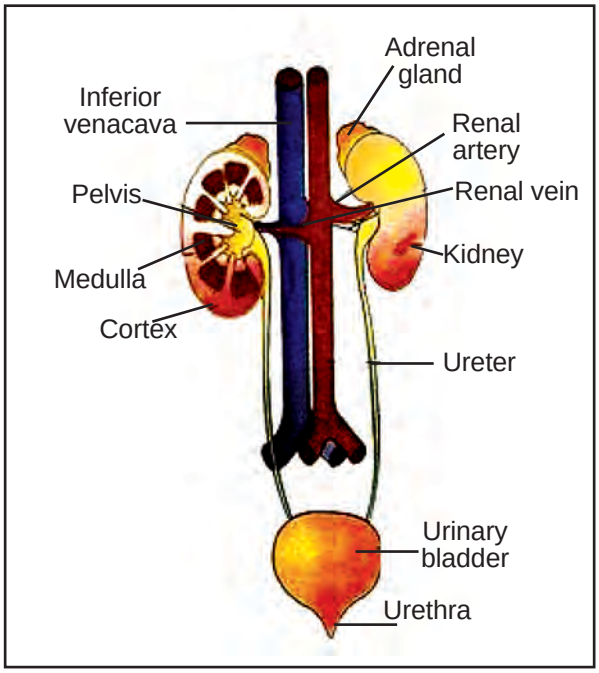


Fig. 5.6 Excretory system of man

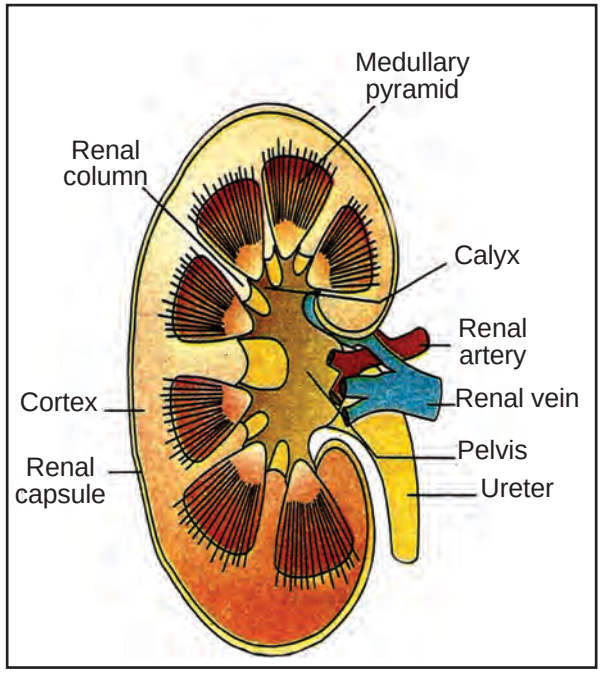


Fig. 5.7 LS of Kidney

Internal structure of kidney

The outer portion of the kidney is dark in colour and is called renal cortex and inner pale region of the kidney is called renal medulla. Renal medulla contains conical masses called renal pyramids. On the renal pyramids are found the openings called renal papillae, which open into the inner space of the kidney called renal pelvis. From the renal pelvis arises the ureter.

The kidneys are composed of millions of units called nephrons.

Structure of a nephron

Nephrons are the structural and functional units of the kidney, each kidney is composed of millions of nephrons. A nephron has two structural components namely, Malpighian capsule and the uriniferous tubules.

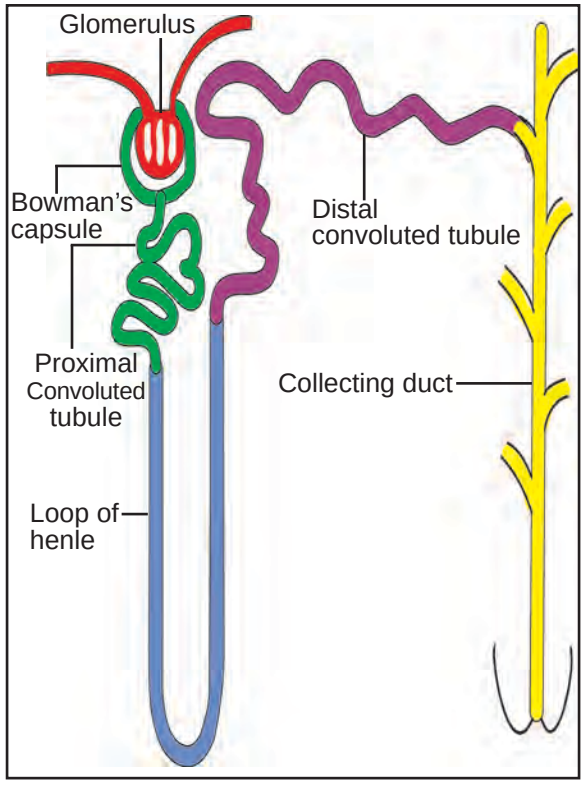


Fig. 5.8 Nephron

Malpighian capsule

This consists of a network of blood capillaries called glomerulus and a double walled cup called Bowman's cup. The glomerulus is a network of blood capillaries, formed by the branches of the wider afferent renal arteriole. From the glomerulus arises the narrow efferent renal arteriole, which branches over the rest of the nephron as network of capillaries. The Bowman's capsule accommodates the glomerulus.

Uriniferous tubules

From the Bowman's capsule arises the Uriniferous tubules. It is divided into three portions as the initial coiled proximal convoluted tubule, the middle U-shaped Henle's loop and the later coiled distal convoluted tubule. The distal convoluted tubule straightens as the collecting ducts. The collecting ducts open on the renal pyramids as renal papillae. The nephrons filter the blood and form the urine.

5.7. RELATIONSHIP OF STRUCTURE AND FUNCTION

Based on the functional need a particular organ or part gets a suitable modification in its structure. Thus a structure is so adapted to perform a specific function. So structure and function go hand in hand. The fore limbs of different mammals are suitably modified to do different functions according to their environment. For example, all the vertebrate animals in general, and all mammals in particular, have their fore limbs sharing a common basic pattern of construction. The fore limbs of mammals consist of five parts namely upper arm, fore arm, wrist, palm

and phalanges, but they are differently used in different animals like

i) Man uses his fore limb to hold an object, write, operate very fine musical instruments and delicate digital devices. The thumb is deviant from other four fingers, to enable man to do the above jobs.

ii) A horse uses it's fore limb to gallop.

iii) A rat or bandicoot uses it's fore limb to make holes in the ground to live.

iv) A giraffe uses its pretty long and stout fore limbs to reach up the vegetations, at the height of the plants.

v) A monkey leaps from one branch of the tree to another using it's fore limb to swing and leap.

vi) A whale uses its fore-limbs as oars to swim.

Fig. 5.9 Basic pattern of forelimbs of vertebrates

5.8. ANIMAL BEHAVIOR

Behaviour can be defined as an organism's adaptive response to stimuli in its environment. The stimuli may be as simple as the odour of the food. Nervous system perceives and passes the information concerning the environmental stimuli and trigger adaptive motor response which we see as the patterns of behaviour.

5.8.1. Social behavior

Behaviour is both an instinctive process (influenced by genes) and learned experience (gained by experience).

Social attachments between animals is called imprinting. The binding or attachment between the parents and the offspring is called filial imprinting. At times, we find an individual of a species is raised by a parent of another species (e.g the chick of cuckoo bird is fed by crow in its nest). This behavioural pattern is called cross fostering.

Many insects, fish, birds and mammals live in social groups in which information is communicated between group members. For example some individuals in mammalian societies serve as guards.

Fig. 5.10 Honey Bee

In an elephant herd, it is always the oldest she elephant that leads the herd,

while the strong males will form the periphery of the herd and the young calves and other she elephants will be in the centre.

Sexual behavior

The Opposite sexes coming closer to each other is both by instinctive process and sexual attraction exhibited by one or both the partners. The secondary sexual characters developed during the breeding season bring the two sexes together for sexual reproduction. For example , the bright and colourful plumage of male peacock is to draw the attention of the female.

Sexual imprinting

Is a process in which an individual learns to direct its sexual behaviour at a member of its own species. During the courtship, animals produce signals to communicate with potential mates and with other members of their own sex. A character exhibited by one sex to attract the other sex is called courtship signalling. Many courtship signals are species, specific to help animals avoid making errors in mating.

Parental care

Any investment or effort by the parent to take care of the young ones in order to increase the chance of survival of the offspring and hence increase the reproductive success is called parental care. The parents care for the young ones and provide high nutrition, protect the young ones from predators and enable the young ones to lead a successful life.

Providing the young one with the milk from its mammary gland and aggression exhibited against the predator are the best means of taking care of the young one. Even after the nutritional independency is

Fig. 5.11 Parental care in elephants

obtained by the young one i.e it takes care of its nutrition by itself, the parental care is extended in some species beyond this level.

5.9. A CASE STUDY BY A RESEARCHER

The behavioural patterns in different situations are investigated in the research projects taken up by leading universities in Tamilnadu.

The abstract of case study by Arun Venkatraman, Asian Elephant Conservation Centre, Centre for Ecological Science, Indian Institute of Science – Bangalore on Dholes is given below.

Courtesy to the researcher – Mr.Arun Venkatraman)

Asiatic wild dog (Chen Nai – in Tamil), commonly called Dholes – ***Cuon***

alpines is an endangered species living in Mudumalai Wildlife Sanctuary at Nilgiris, Tamilnadu.

The Dholes live in packs which consist of old females, males, females and pups. The pack members co-ordinate while pulling down and killing large prey such as adult Sambar Deer. There is a tendency to share the meat among the members of the pack. However there prevails a squabbling among them to get the choicest meat. The young pups are allowed to take the meat first. The old males follow them. The other young ones and old females usually lag behind.

The Dholes also exhibit a high degree of parental care by changing

Fig. 5.12 Dholes

the den frequently so that the pups are safe from predators such as leopards and hyenas.

- functions efficiently.
- Behaviour is the adaptive response of an organism to the stimuli in the environment.
- Social behaviour is both instinctive and learned experience.
- Sexual behaviour involves courtship signalling which is species specific.
- The investment or effort by the parent on their offsprings to provide nutritive food and safeguard them from predators is called parental care.

ACTIVITY 5.3

CASE STUDY

- Conduct a case study on the behavioural aspects of your pet dogs in reference to their territorial dominance when strangers or other dogs try to enter into your locality.

ACTIVITY

- Follow an ant line and try to break its route by drawing a line with your finger without killing any ant.
- Observe the behaviour of the ants as to whether they change the route or go in disarray.
- Try to observe for a few minutes for any change they resort in their route. Make a report of their behaviour and submit.

EVALUATION

PART A

1. Sensitive whiskers are found in _____.

   (Bat, Elephant, Deer, Cat)

2. The tusks of elephants are modified _____.

3. Pick out an animal which has four chambered stomach _____.

   (Elephant, Dolphin, Deer, Kangaroo)

4. Normal body temperature of man is _____.

   (98.4 – 98.6^{o}F, 96.6 – 96.8^{o}F,
   94.4 – 98.6^{o}F, 98.4 – 99.6^{o}F)

5. Mitral valve is found between _____.

   Right auricle and right ventricle, Left auricle and left ventricle,

   Right ventricle and pulmonary artery, Left ventricle and aorta.

PART B

6. One of the following groups contains a non mammalian animal. Pick up the group.

   a. dolphin, walrus, porcupine, rabbit, bat
   b. elephant, pig, horse, donkey, monkey
   c. antelope, deer, cow, buffalo, black buck
   d. dog, cat, crocodile, lion, tiger

7. The epidermis of mammals contains

   a. hair, bristle, quills
   b. hair, nail, claw
   c. hair, bristle, horn
   d. hair, nail, scale

8. Based on relationship, fill up:

   Whale: Baleen plates; Bat : _____

9. Fill in the blanks.

   Plasma : Fibrinogen ; RBC: Carriage of oxygen; WBC: ————————

10. Master chemists of our body are kidneys. Justify.

    a. kidneys acquire all chemicals taken in the body
    b. maintain the chemical composition of blood
    c. kidneys send out all chemicals taken in the body
    d. kidneys store the various chemicals taken in the body

11. Based on modifications make the pairs:

    incisor: tusk of elephant;

    _____ : quills of porcupine.

FURTHER REFERENCE :

Books:

1. Biology - **RAVEN, Johnson** WCB Mc Graw - Hill
2. Biology - A Modern Introduction, B.S. Beckett, Second Edition Oxform University Press.

Website:

http://www.khanacademy.org

6. LIFE PROCESSES

How do you differentiate the living things and non-living things?

If we see a dog running

(or)

a cow chewing cud

(or)

a man shouting loudly on the street,

We know that these are living beings.

What if the dog or the cow or the man were asleep?

We would still think that they were alive, but how did we know that? We see them breathing and we know that they are alive.

What about plants?

How do we know that they are alive?

We see their green leaves and some kind of movements like the folding and unfolding of leaves, stages of growth as common evidences for being alive.

6.1. WHAT ARE LIFE PROCESSES?

The maintenance of living organisms must go on even at the conditions, when they are not physically active. Even when we sit idle and during sleeping, this maintenance job through cells functioning has to go on. The life process includes the activities performed by the different organs to maintain the body.

Some of the life processes in the living beings are described below:

Nutrition

The process of obtaining energy through consumption of food.

Respiration

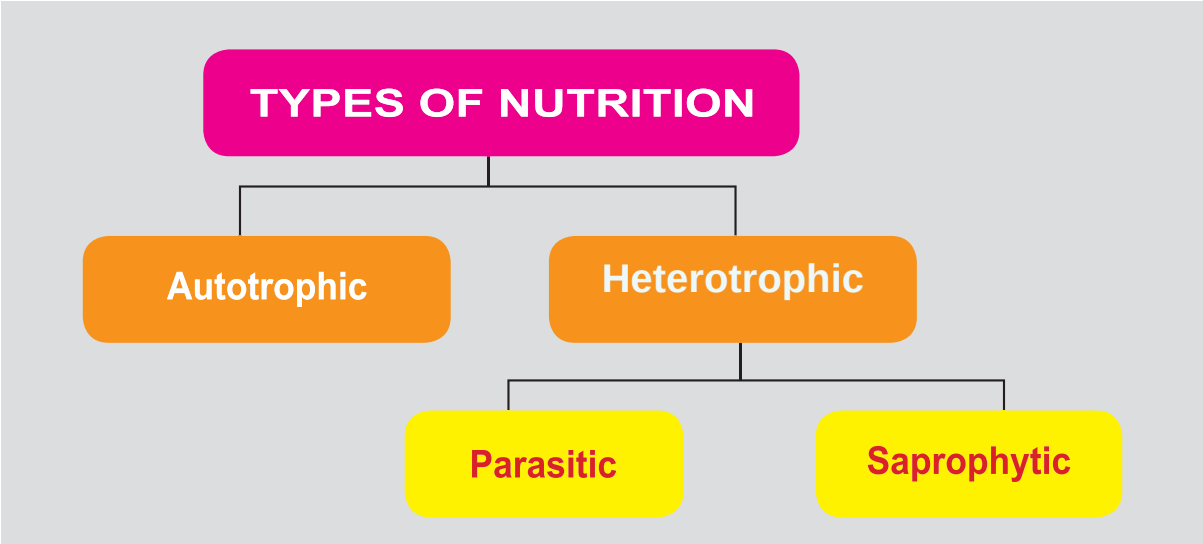
The process of acquiring oxygen through breathing and making it available to cells for the process of breaking down of organic substances into simpler compounds is called as respiration.

Transportation

Transportation is the process by which the food and oxygen is carried from one organ to other organs in the body.

Excretion

It is the process by which the metabolic waste by-products are removed from the different organs and released out from the body.



Questions

1. How do we understand the living nature of organisms?
2. What are the materials available from external sources for the organism's consumption?
3. What processes are essential to maintain our body?

6.2. NUTRITION IN PLANTS

Do you know that we need energy for all activities?

where do we get that energy?

The source of energy is the food we eat.

Types of Nutrition

Autotrophic Nutrition

Most of the green plants are self-dependent, because they synthesize their own food materials by photosynthesis. Such mode of nutrition is described as autotrophic nutrition.

It is the process by which autotrophic plants consume substances from the external sources and convert them into stored form of energy. The materials are taken in the form of carbon dioxide and water which are converted into carbohydrates in the presence of light and chlorophyll. Carbohydrates are utilized as energy rich sources to the plant., for their entire activity.

The process of photosynthesis is explained in the form of bio-chemical reaction shown below:

$$6CO_2 + 12\ H_2O \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$
(Glucose)

The raw materials and other necessary items required for photosynthesis are Sunlight, Water, CO_2 and Chlorophyll.

Sunlight - energy from the sun

Water - plant absorbs water from the soil through roots.

CO_2 - assimilated from the atmosphere through leaves containing small pores called stomata.

Chlorophyll - the green pigments in the chloroplasts, an organelle of the cells of leaf.

Let us do an activity which demonstrates that chlorophyll is essential for photosynthesis

ACTIVITY 6.1

1. Take a potted plant with variegated leaves – for example, money plant or crotons.
2. Keep the plant in a dark room for three days so that all the starch gets used up.
3. Now keep the plant in sunlight for about six hours.
4. Pluck a leaf from the plant. Mark the green areas in it and trace them on a sheet of paper.
5. Dip the leaf in boiling water for a few minutes.
6. After this, immerse it in a beaker containing alcohol.
7. Carefully place the beaker in a water-bath till the alcohol begins to boil.
8. What happens to the colour of the leaf? What is the colour of the solution?
9. Now dip the leaf in a dilute solution of iodine for few minutes.
10. Take out the leaf and rinse off the iodine solution.
11. Observe the colour of the leaf and compare this with the tracing of the leaf done in the beginning.
12. What can you conclude about the presence of starch in various spots of the leaf?

Heterotrophic nutrition

Fungal cells do not contain chloroplasts and they formed into saprophytes and parasites. Likewise all organisms, except the green plants do not possess chloroplasts as they do not carry out photosynthesis. They depend upon plants or other organisms for their nutrition.

Parasites

Some organisms live on other organisms for nourishment. They are called Parasites. The plants or animals in which the parasites live for nourishment are called hosts. Parasitic plants have some special roots, which penetrate the host plants and absorb food from the phloem, water and minerals from xylem. These roots are called haustoria. (e.g.: Cuscutta and Viscum).

Saprophytes

Some plants obtain nutrients from non-living organic matter. They are called saprophytes. Many fungi and bacteria are

saprophytes. Certain angiosperms like Monotropa lack chlorophyll and have mycorrhizal roots.The plant absorbs nourishments from the humus through their mycorrhizal roots.

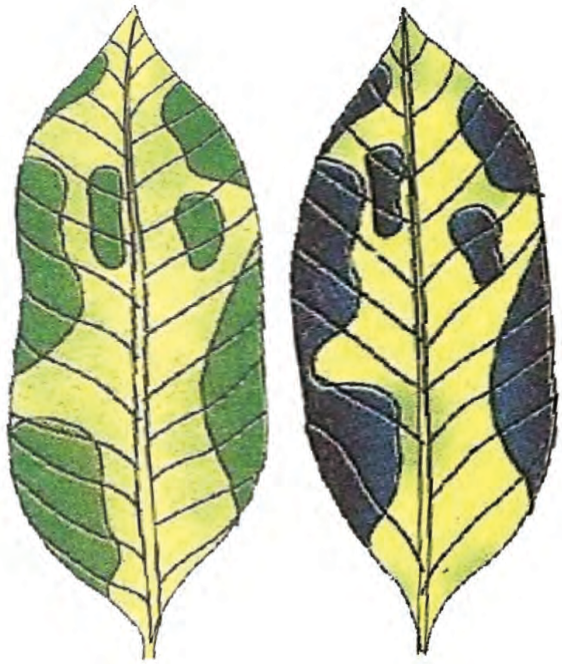


Fig. 6.1 Variegated Leaf

(a). Before starch test *(b). After starch test*

Fig. 6.2 Cuscutta - a parasitic plant

Fig. 6.3 Viscum - a parasitic plant

Questions

1. What are the differences between autotrophic nutrition and heterotrophic nutrition?
2. What are the sources of materials required by plants for photosynthesis?

6.2. HUMAN DIGESTIVE SYSTEM

Intracellular digestion

White blood cells (leucocytes) in vertebrate animals are defensive in functioning and get rid of germs in the body of the animals. WBCs engulf the invading germs by producing pseudopodia around the germs and digest the germs inside them by phagocytosis.

The unicellular animalcules like Amoeba also produce pseudopodia to engulf the diatoms and other minute organisms and digest them within the cell. Paramoecium, an another protozoan has a cytopharynx, a cytoplasmic depression to swallow the food (i.e microorganisms

in water) and digest the food within the cells. In the above mentioned examples the food is directly taken into the cells and is digested within the cell. This sort of digestion is called intracellular digestion. Intracellular digestion is a very primitive form of digestion and does not require an organized digestive system. Even in animals like sponges and coelenterates, the digestion is intracellular, though an alimentary canal like structure has developed in them.

Extracellular digestion

As animal body becomes more complex, digestive system has evolved to digest the food taken into the body. The digestive system in higher animal and man consists of alimentary canal and digestive glands that are specialized to produce digestive juices. Food is taken into alimentary canal and in the regions of digestion like mouth, stomach and duodenum, digestive juice is secreted by the digestive glands and the complex food swallowed is broken down to simpler food molecules by the action of enzymes of the digestive juices. Since digestion takes place in the space or lumen of alimentary canal i.e outside the cell it is called as extracellular digestion – an advanced form of digestion.

Digestion in human beings

Food contains a number of nutrient molecules needed for building up of new body tissues, repairing damaged tissues and sustained chemical reactions.

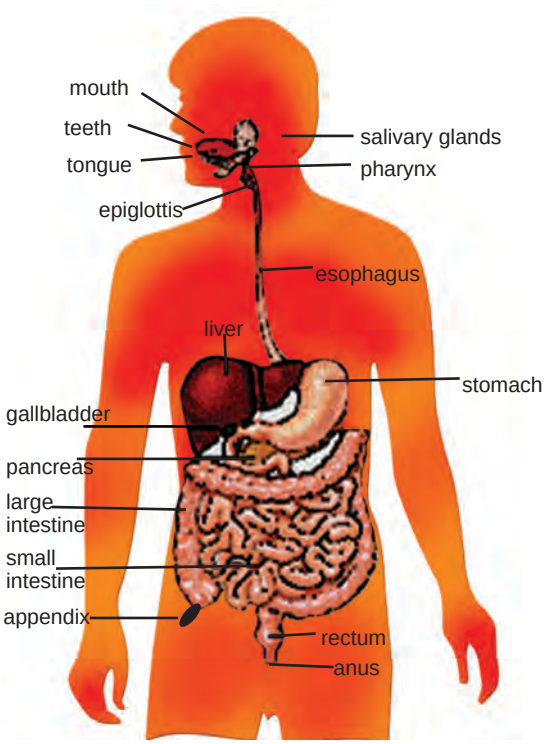


Fig. 6.4 Human Digestive System

ACTIVITY 6.2

- Take I ml of starch solution (1%) into test tubes (A and B)
- Add I ml of saliva to test tube A and leave both the test tubes undisturbed for 20-30 minutes
- Now add a few drops of dilute iodine to the test tubes
- In which test tube do you observe a colour change?
- What does this indicate about the presence or absence of starch in the two test tubes?
- What does this tell us about the action of saliva on starch?
- Is there a difference? If yes, in which case more energy from external sources is consumed.

Food must be broken down to be used as a source of energy. The process of converting the complex food into a simple chemical substance, that can be absorbed and assimilated by the body is called digestion. The medical speciality that deals with the structure, function, diagnosis and treatment of diseases of stomach and intestine is called gastroenterology.

The digestive system is composed of two groups of organs. They are

1) The gastro intestinal tract
2) Accessory digestive glands

Digestion is brought about in a stepwise manner with the help of enzymes which are otherwise called bio-catalysts.

The gastro intestinal tract (alimentary canal) is a long muscular tube, about 9 mtrs in length and it commences from the mouth and ends in the anus. The mouth, buccal cavity, pharynx, oesophagus, stomach, small intestine, large intestine, rectum and anus are the parts of the alimentary canal.

6.3. RESPIRATION IN PLANTS

Why should we eat?

Why should plants synthesize food?

For the simple reason that all living organisms ranging from minute bacteria to large elephants, plants and humans, require energy for growth, movement and reproduction.

Where does this energy come from?

Food that we eat is the starch that is synthesized by plants and it is the source of energy.

In fact, energy is locked up in food materials. During respiration, the food materials are oxidized (degraded). During this reaction, energy is released from the food and it is stored in a special chemical (or) biological substance called ATP (Adenosine triphosphate).

The energy of ATP is utilized in various activities of cells.

Apart from ATP, two other substances are also formed during respiration. They are CO_2 and H_2O.

$$\underset{\text{(Glucose)}}{C_6H_2O_6} + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \underset{\text{(ATP)}}{2900KJ\ \text{energy}}$$

Substance that is used in respiration is known as respiratory substrate. Respiratory substrates are of three kinds viz., carbohydrates, fats and proteins.

Types of Respiration

Depending on whether oxygen is used or not, respiration is of two types:

1. Aerobic respiration.
2. Anaerobic respiration.

1. Aerobic respiration

In majority of living organisms, oxygen is utilized during respiration. Respiration that uses oxygen is known as aerobic respiration.

Aerobic respiration takes place in four stages:

1. Glycolysis
2. Oxidative decarboxylation of pyruvic acid
3. Kreb's cycle
4. Electron transport chain.

In Glycolysis, glucose (a simple carbohydrate) is split into two molecules of pyruvic acid. This takes place in the cytoplasm, in a series of reactions and a number of enzymes are involved. With the formation of pyruvic acid, glycolysis comes to an end.

Further oxidation of pyruvic acid takes place in the second and third stages occurring in the mitochondria.

During the last stage i.e. electron transport chain, the energy associated with the liberated electrons is used to synthesize the ATP energy molecules at certain stages. Finally the hydrogen, an electron joins with oxygen to produce water as a by-product.

Complete oxidation of a glucose molecule in aerobic respiration produces 38 ATP molecules.

2. Anaerobic respiration

In some organisms, oxygen is not utilized for respiration. This type of respiration is known as anaerobic respiration. It is also known as fermentation.

[E.g. Conversion of milk into curd.]

6.3. RESPIRATION IN ANIMALS

Amoeba, Hydra, Sponge, etc,. live in water. In these organisms, respiration takes place through their body surface. Dissolved oxygen in water diffuses through the cell membrane or body surface into

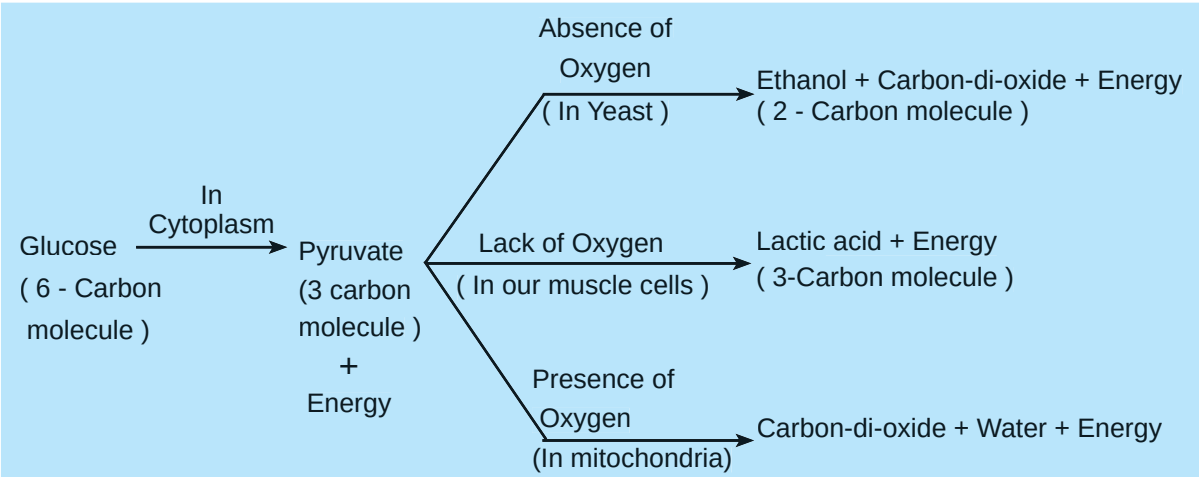


Fig. 6.5 Break down of glucose by various pathways

ACTIVITY 6.3

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

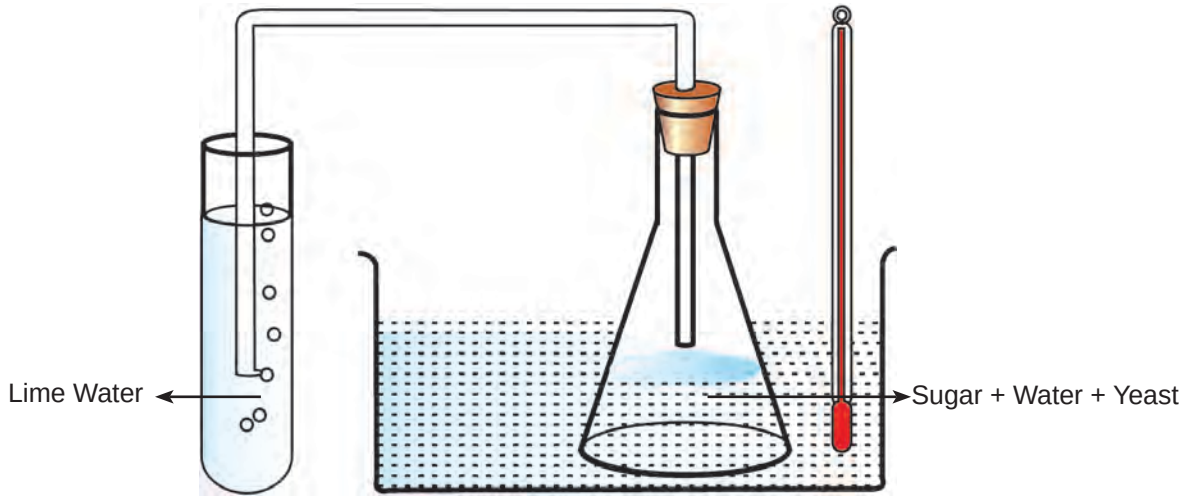


Fig 6.6 Anaerobic respiration apparatus

ATP

- ATP is the energy currency for the most cellular processes. The energy released during the process of respiration is used to make an ATP molecule from ADP and inorganic phosphate.
- ADP + Pi $\xrightarrow{\text{Energy}}$ ATP
- Think of how a battery can provide energy for many different kinds of uses. It can be used to obtain mechanical energy, light energy, electrical energy and so on. Similarly, ATP can be used in the cells for the contraction of muscles, protein synthesis, conduction of nervous impulses and many other activities.

the cell and after its usage, the carbon-di-oxide produced is passively diffused out into water.

Repiratory surface for a fish is gill; for a frog it is lungs and skin the lungs for land vertebrates.

Since the amount of dissolved oxygen is fairly low, compared to the amount of oxygen in the air, the rate of breathing in aquatic organisms is much faster than that seen in terrestrial organisms. Fishes take in water through their mouth and force it pass the gills where the dissolved oxygen is taken up by the blood.

Terrestrial organisms use the oxygen in the atmosphere for respiration, Oxygen is absorbed by different respiratory organs in different animals. All these organs have a structure that has bigger surface area, which is in contact with the oxygen-rich atmosphere. The exchange of oxygen and carbon-di-oxide has to take place across this surface. But it is usually placed within the body. So there are air passages present, that will take atmospheric air to this area. In addition, there is a mechanism for blowing the air in and out of this area where oxygen is absorbed.

In human beings, air is taken into the body through the nostrils. The air passing through the nostrils is filtered by fine hairs that line the passage. This passage is also lined with mucous which helps in this process. From here, the air passes through the throat into the lungs. Rings of cartilage are present in the throat which keep the air passage open and prevent it from collapsing.

Within the lungs, the air passage branches repeatedly into smaller tubules which finally terminate in balloon like structure called alveoli. The alveoli surrounded by blood capillaries provide a surface, where the exchange of gases takes place.

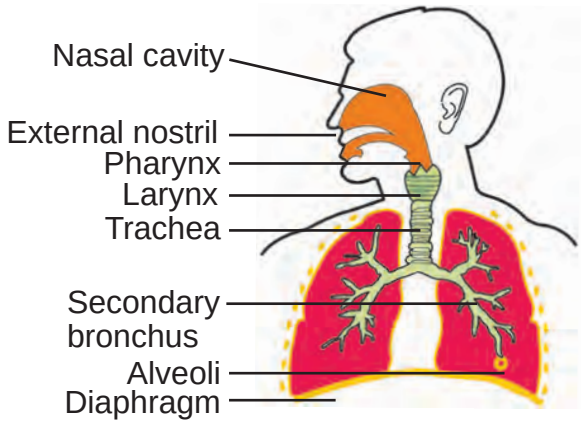


Fig. 6.7 Human respiratory system

ACTIVITY 6.4

- Observe fishes in an aquarium, and their opening and closing of mouth and the gill slits (or the operculum which covers the gill slits) found behind their eyes also open and close. Is not the timing of the openings and closings of the mouth and gill slits co-ordinated?
- Count the number of times the fish opens and closes its mouth in a minute.
- Compare this into the number of times you breathe in and out in a minute.

6.4. TRANSPORTATION IN PLANTS

We have discussed earlier, how the plants prepare food by the process of photosynthesis using various raw materials, like water, CO_2, sunlight and chlorophyll.

We already know that the chlorophyll pigments are in the leaf. So the leaf is the site for photosynthesis. The food prepared from the leaf should be transported to all other parts.

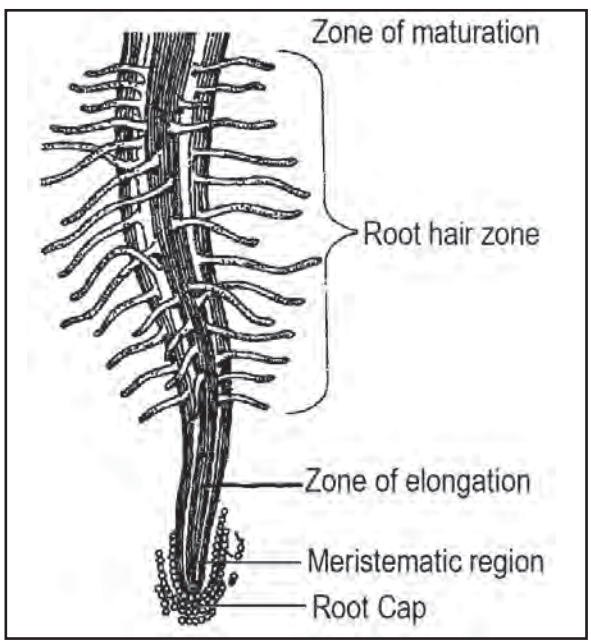


Fig. 6.8 Root hair region

In the same manner, water is essential for photosynthesis and all other biological activities in the plants. For plants, soil is the nearest and richest source of water and other raw materials like nitrogen, phosphorus and other minerals.

How do the absorbed water and minerals get transported from one place to all other parts of the plant body?

Which part of the plant is in contact with the soil?

For the above questions, you were getting answers already in your lower classes.

The roots are the absorbing organs of the plant.

Thus, plant transport systems will mobilize energy stores, (food) from leaves, and raw materials from roots. These two pathways are constructed as independently organized conducting tubes.

i) Xylem transports water with dissolved minerals absorbed from the soil.

ii) Phloem transports products of photosynthesis (food) from the leaves to the parts of the plant.

Transport of water

In xylem, vessels and tracheids are the conducting elements of the roots, stems and leaves. They are inter-connected to form a continuous system of water conducting channels, reaching all parts of the plant. In roots, the root hair cells in contact with the soil, actively take up ions.

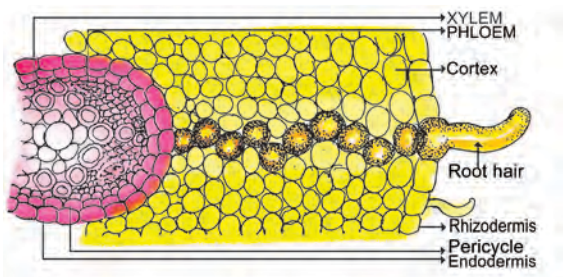


Fig. 6.9 Path of water across the root

This creates a difference in the concentration of these ions between the root and the soil. Water, therefore enters into the root from the soil to eliminate this difference.

This means that there is a steady movement of water into root xylem, creating a column of water that is steadily pushed upwards.

Is this pressure enough to conduct water over the heights in tall and huge trees?

Plants use another strategy to move water in the xylem upwards to the highest points of the plant body. This can be achieved by the process of transpiration, in which when the plant has an adequate supply of water. The water which is lost

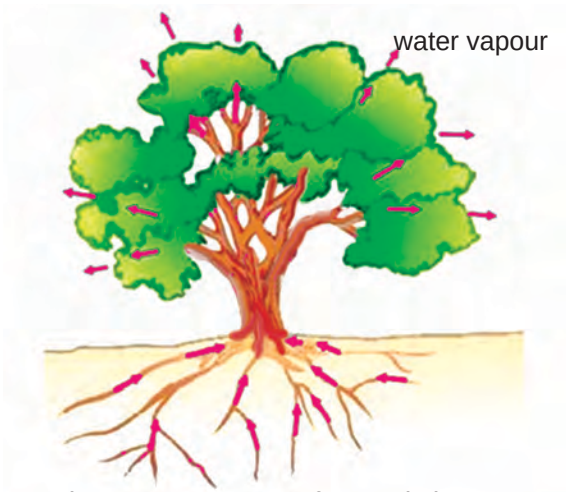


Fig. 6.10 Movement of water during transpiration in a tree

through the stomata is replaced by water from the xylem vessels in the leaf.

In fact, evaporation of water molecules from the cells of a leaf creates a suction which pulls water from the xylem cells of roots.

ACTIVITY 6.5

- Place a potted plant into a clear glass bell jar. The pot is covered with plastic to prevent water evaporating from the soil.
- Set up a second bell jar with a potted plant with leaves removed.
- Keep the bell jars in bright light at room temperature (20^{o}C) for 6 hours.
- No liquid condenses in the bell jar without leaves.
- The bell jar containing the leafy plant has much more condensed liquid.
- Test the liquid it turns dry blue cobalt chloride paper to pink colour. Therefore the liquid is water.
- Discuss with your classmates, and find the reason why water droplets are formed in the potted plants containing leaves.

The loss of water in the form of vapour from the aerial parts of the plant is known as transpiration.

Thus, transpiration helps in the absorption and upward movement of water and mineral dissolved in it from roots to the leaves. It also helps in temperature regulation. The effect of root pressure in transport of water is more important at night. During the day when the stomata are open, the transpiration pull becomes the major driving force in the movement of water in the xylem.

Transport of food and other substances

How are the products of photosynthesis transported from leaves to other parts of the plant?

The transport of soluble products of photosynthesis is called translocation and it occurs in the part of the vascular tissue known as phloem. Besides the products of photosynthesis, the phloem transports amino acids and other substances. These substances are especially delivered to the storage organs of roots, fruits, seeds and to growing organs.The translocation of food and other substances takes place in the sieve tubes (sieve tubes are one of the constituents of the phloem which act as pipe line from leaves to the other parts of the plant) with the help of companion cells both in upward and downward directions.The translocation by phloem is achieved by utilizing energy. Materials like sucrose is transferred into phloem tissue using energy from ATP. This increases the osmotic pressure in the tissue causing water movement. This pressure moves the material in the phloem to tissues which have less pressure. This allows the phloem to move material according to the plant's needs. For example, in the spring, sugar stored in root or stem tissue would be transported to the buds, which need energy to grow.

Questions

1. What are the components of the transport system in highly organized plants?
2. How are water and minerals get transported in plants?
3. How is food transported in plants?

Transportation in animals

In microscopic organisms such as Amoeba and Paramecium, the volume of body is so small that useful substances can be distributed by a process called diffusion. Oxygen for example, enters an amoeba through the cell membrane and spreads out i.e diffuses, in all directions at the rate approximately equal to the rate at which oxygen is consumed in respiration. Similarly, carbon-di-oxide diffuses out of an Amoeba with sufficient speed to prevent it accumulating to harmful levels within the cell.

In large multi-cellular organisms, however, the body volume is so great that diffusion alone is far too slow a process for adequate distribution of oxygen and food, and removal of waste.

The cells in the multi-cellular organisms relying on diffusion alone would be a tightly packed crowd. Those in the middle region would not get enough oxygen. Hence, most large organisms do not rely on diffusion for their supply of food and oxygen. They have a transport system of some kind to carry these substances to all the cells in the body.

In human body, for example the transport system consists of a pump called heart which propels the fluid called blood around a complex system of tubes called blood vessels. As it passes through these blood vessels, the blood picks up oxygen from the lungs and transport it to every cell in the body. Blood also picks up waste product such as carbon-dioxide and many other substances like salts from the cells and excrete out from the body.

Lymph

There is another type of fluid which is also involved in transportation. This is called lymph or tissue fluid. It is similar to the plasma of blood but it is colourless and contains less protein. Lymph drains into lymphatic capillaries from the intercellular spaces, which join to form large lymph vessels that finally open into veins. Lymph carries digested and absorbed fat, from intestine and drains excess fluid from extra cellular space back into the blood.

ACTIVITY 6.6

1. Visit a health centre in your locality and find out what is the normal range of haemoglobin content in human beings.
2. Is the same for children, women and men? Discuss why does the difference exist?

6.5. EXCRETION IN PLANTS

What is excretion?

How does the excretion take place in plants?

Excretion is the process by which the metabolic waste products are removed from the plant body.

In plants there are different ways for excretion.

1. Plant waste products are stored in cellular vacuoles.
2. Waste products may be stored in leaves that fall off.
3. Other waste products are stored as resins and gums, especially in old xylem tissues.
4. Plants also excrete some waste substances into the soil around them.

Excretion in animals

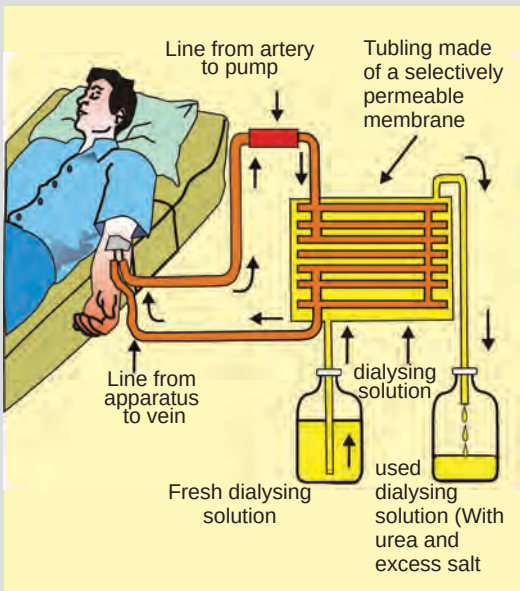
In unicellular protozoans, the excreta are discharged out through the contractile-vacuoles, which are formed by the absorption of water and other excreta.

In coelenterates and sponges, the excreta diffuse out through the cell membrane.

In flat worms and round worms, the excretory tubes develop for transporting

Artificial kidney (Haemodialysis)

Kidneys are vital organs for survival. Several factors like infections, injury or restricted blood flow to kidneys reduce the activity of kidneys, This leads to accumulation of poisonous wastes in the body, which can even lead to death. In case of kidney failure, an artificial kidney can be used. An artificial kidney is a device to remove nitrogenous waste products from the blood through dialysis.



Artificial kidneys contain a number of tubes with a semi-permeabe lining, suspended in a tank filled with dialysing fluid. This fluid has the same osmotic pressure as blood, except that it is devoid of nitrogenous wastes. The patient's blood is passed through these tubes. During this passage, the waste products from the blood pass into dialysing fiuid by diffusion. The purified blood is pumped back in to the patient. This is similar to the function of the kidney, but it is different since there is no re- absorption involved. Normally, in a healthy adult, the initial filtrate in the kidneys is about 180 L daily. However, the volume actually excreted is only a litre or two a day, because the renmaining filtrate is re- absorbed in the kidney tubules.

the excreta to exterior. In annelids special kidneys called nephridia are evolved to collect excreta from the coelomic cavity.

In vertebrates, an elaborate well-defined excretory system has developed with kidneys and excretory tubes. The kidney of vertebrates consists of nephrons which filter the blood and form the urine and large amount of ammonia is found in fish excreta. They are called ammoniatelic animals. The birds are called uricotelic animals as their excretory substance is composed mostly of uric acids.In mammals urea is the main excretory products so they are called ureotelic animals.

Nephron

Each Nephron consists of a filtering apparatus called glomerulus and uriniferous tubules.The glomerulus filters the plasma part of the blood to form urine. The uriniferous tubules reabsorb the substances required in the body from that filterate and the final urine product contains mostly water and nitrogenous waste products.

6.6. NERVOUS SYSTEM

The millions of cells and the scores of different tissues and organs in the body of an animal do not work independently of each other. Their activities are co-ordinated. This means that they work together, performing the various functions at certain times and at certain rates according to the needs of the body as a whole.

One of the most familiar examples of co-ordination is the way in which muscles works together during movement. When a boy runs to catch a ball, for example, he uses hundreds of muscles to move the joints in his arms, legs and back using information from his sense organs. The boy's nervous system co-ordinates these muscles so that they contract in correct sequence with the correct degree of power, and for precisely the correct length of time needed to get him to the spot where he can catch the ball. Muscular activities like running to catch a ball, involves many other forms of co-ordination, such as those which increase the rate of breathing and heart beat to adjust blood pressure, remove extra heat from body and maintaining sugar and salt levels in the blood. Furthermore, all these co-ordinations occur as an unconscious process.

Worms have the simplest form of coordinating system where an earthworm has dual nerve cords. Two ganglia acts as brain and eye spots act as photo receptors.

In insects, ganglia are connected by a ventral nerve cord function as brain. Well-developed sensory organ for vision and antennae for olfactory function are present.

In mammals and other well-developed vertebrates this co-ordination is achieved by nervous system and endocrine system.

In simple, the nervous system consists of tissues which conducts "messages" called nerve impulses, at a high speed to and from all parts of the body.

6.7. CO-ORDINATION IN PLANTS

How do plants co-ordinate?

Unlike animals, plants have neither nervous systems nor muscles.

Fig. 6.11 Sensitive Plant (Touch-me-not plant)

So, how do they respond to stimuli?

When we touch the leaves of Touch–me–not plant, they begin to fold up and droop.

When a seed germinates, the roots go down , the stem comes up above the soil.

What happens during the above actions?

In the first instance, the leaves of sensitive plants show two different types of movements.

1. Movement independent of growth
2. Movement dependent growth

Movement- Independent of growth

Immediate response to stimulus

This movement is sensitive to plant. Here, no growth is involved but, the plant actually moves its leaves in response to touch. But there is neither nervous tissue nor muscle tissue.

How does the plant detect the touch and how do the leaves move in response?

In touch-me-not plant, if we touch at one point, all the leaflets show the folding movements. This indicates that the stimulus at one point is communicated. But unlike in animal, there is no specialized tissue in plants for transmitting the information. Plant cells change the shape by changing the amount of water in them resulting in swelling or shrinking and therefore the leaves in touch-me-not plant shrinks.

Movement dependent on growth:

More commonly, the plants respond to stimuli slowly by growing in a particular direction. Because this growth is directional, it appears as if the plant is moving.

Let us understand this type of movement with the help of some examples.

1. Response of the plant to the direction of light (Phototropism)
2. Response of the plant to the direction of gravitational force (Geotropism)

ACTIVITY 6.7

1. Go to the field and find the touch-me-not plant.
2. Touch the plant at one point.
3. Observe what happens.

3. Response to the direction of water (Hydrotropism)
4. Response to the direction of chemicals (Chemotropism)

Phototropism

It is the growth of the stem towards the direction of sunlight.

Fig. 6.12 Phototropism

Geotropism

It is the growth of roots towards the direction of gravitational force.

Roots cannot grow towards sunlight and stem cannot grow towards gravitational force.

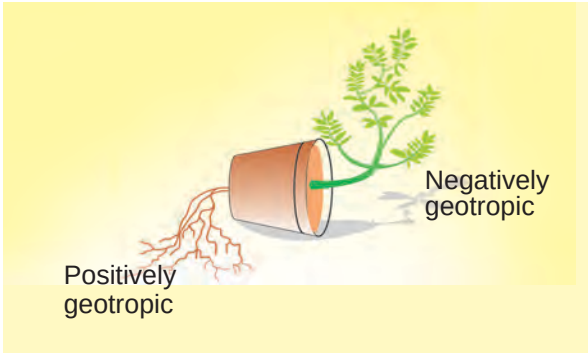


Fig 6.13 Geotropism

Hydrotropism

The roots of very huge trees grow towards the availability of water source

(e.g) The roots of coconut tree are seen away from the plant for the want of water.

Chemotropism

This is the movement of plant parts towards the direction of chemicals. (e.g) The pollen tubes grow towards ovule.

ACTIVITY 6.8

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

6.9. HORMONES IN ANIMALS

The endocrine system consists of ductless glands and their secretions called hormones. Hormones are bio - chemical substances which act as bio catalysts speeding up the chemical reactions. These are released into the blood stream and transported around the body. Hormones co-ordinate the physiological activities in our body. A detailed account on hormones is dealt in chapter 3.

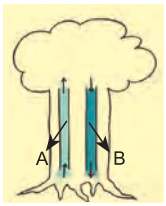
EVALUATION

PART A

1. In monotropa the special type of root which absorbs nourishment is (Haustoria, Mycorrhizal root, Clinging root, Adventitious root)
2. The product obtained in the Anaerobic respiration of yeast is (Lactic acid, Pyruvic acid, Ethanol, Acetic acid)
3. The roots of coconut tree are seen away from the plant. Such kind of movement of root for want of water is (Phototropism,Geotropism,Chemo-tropism, Hydrotropism)
4. The xylem in the plants are responsible for (transport of water, transport of food, transport of amino acids, transport of oxygen)
5. The autotrophic nutrition requires (CO_2 and water, chlorophyll, sunlight, all the above)

PART B

6. Name the types of vascular tissues in the plant stem which are labelled as A and B

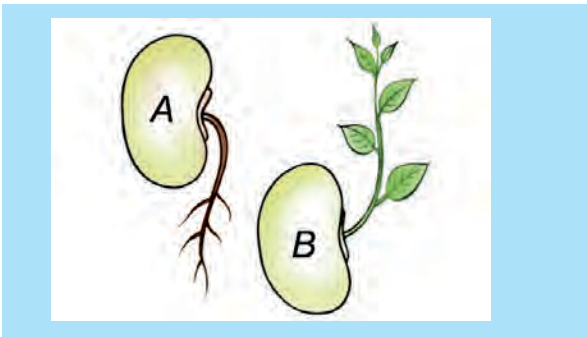


a) Name A and B

b) What are the materials transported through A?

c) What are the materials transported through B?

d) How do the materials in A move upwards to leaves?



7. Observe the diagram

a) Mention the type of movements shown in fig, A and B.

b) How does the movement differ from the movement of mimosa

8. Match the methods of nutrition of special organs with suitable examples.

Autotrophs	Mycorrhiza	Cuscuta
Parasites	chlorophyll	Monotropa
Saprophytes	Haustoria	Hibiscus

9. In the process of respiration_____ is carbon compound, the lactic is _____ carbon compound.

10. Sugar is converted into alcohol. From the above statement what kind of process takes place? Which micro organism is involved?

11. Pick out the odd one : The parts of the alimentary canal are (Pharynx, mouth, buccal cavity, pancreas)

12. In human beings air enters into the body through _____ and moves into _____ In fishes water enters into the body through _____ and the dissolved oxygen of water diffuses into _____.

PART C

13. Compare the respiration in higher plants with the respiration in lower plants

14. Is the pressure created in xylem enough to conduct water in tall trees. Give reasons.

15. In touch - me - not plant the leaves show movements. What type of movement have you observed. Discuss.

NAME OF THE PLANTS IN ENGLISH & TAMIL

SL. NO.	BOTANICAL NAME	NAME IN ENGLISH	TAMIL NAME	HOW IT IS CALLED LOCALLY
1	Monotropa uniflora	Indian pipe	மானோடிரோபா	
2	Viscum	Parasitic plant	புல்லுருவி	
3	Cuscuta reflexa	Podderplant	அம்மையார் கூந்தல் / சடதாரி	

FURTHER REFERENCE

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Publisher : 2. Fundamentals of plant physiology **Jain .V.K.**

Chapter 7

CONSERVATION OF ENVIRONMENT

7. Conservation of Environment

Living organisms live in different surroundings. Some plants and animals completely live in water and some others live on land.

Man also leads life in different surroundings. Some live in cities, some in towns and some in villages. How do they adapt themselves to the place they live in?

Plants, animals, human beings survive with the interaction between them and the non-living things like air, water and land. Human beings depend on the resources of nature. These resources include soil, water, coal, electricity, oil, gas, etc. These resources improve the life style of human beings.

Environmental science can be defined as the study of organisms in relation to their surrounding.

In the course of development, unplanned and vast misuse of natural resources like water, forest produce, land and mineral resources have occurred. This has led to an imbalance in nature and release of many harmful substances in the atmosphere.

Mankind is greatly influenced by the surrounding in view of the problem of over Population, environmental pollution, human survival, pest control and conservation of natural resources.

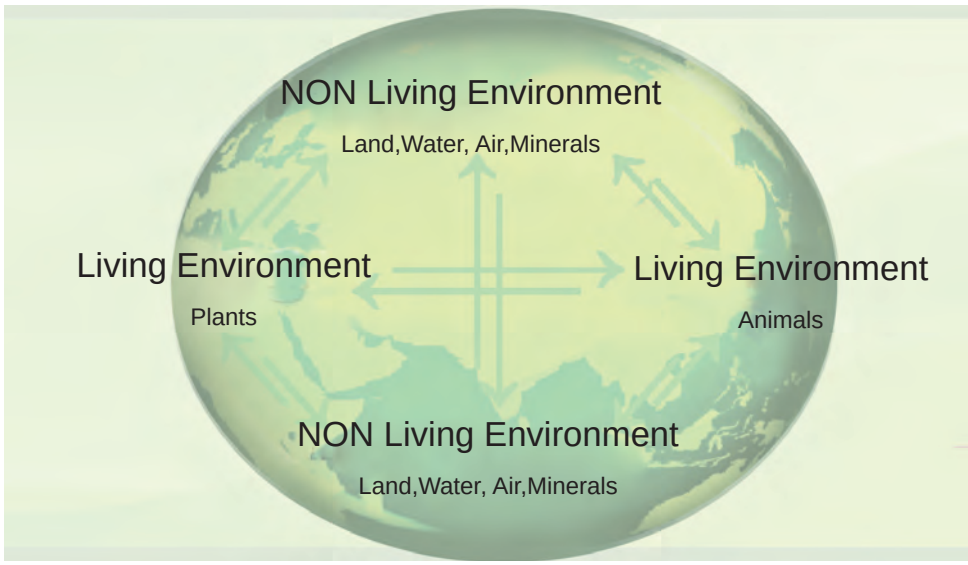


Fig. 7.1 Interaction between non-living and living components in the biosphere

In our daily activities, we generate a lot of materials that we throw away.

- What are some of these waste materials?
- What happens after we throw them away?

Human activities related to livelihood and welfare generate waste. All wastes are pollutants and they create pollution in one way or another. Air, land and water surroundings are affected due to improper disposal of wastes which create an imbalance in the environment.

- What is Pollution?
- What are Pollutants?

Pollution: Any undesirable change in the physical, chemical or biological characteristics of air, land and water that affect human life adversely is called pollution.

Pollutant: A substance released into the environment due to natural or human activity which affects adversely the environment is called pollutant. e.g. Sulphur-di-oxide, carbon-monoxide, lead, mercury, etc.

7.1.CLASSIFICATION OF WASTES

1. Bio–degradable wastes
2. Non–bio-degradable wastes

Substances that are broken down by biological process of biological or microbial action are called bio-degradable waste. e.g. wood, paper and leather.

Substances that are not broken down by biological or microbial action are called non-bio-degradable wastes. e.g. Plastic substances and mineral wastes.

How to protect us from these hazardous wastes ?

Why do the government and so many organizations conduct awareness

ACTIVITY 7.1

- Find out what happens to the waste generated at home. Is there a system in place to collect this waste?
- Find out how the local body (panchayat, municipal corporation or resident welfare association) deals with the waste. Are there mechanisms in place to treat the bio-degradable and non-bio-degradable wastes separately? Calculate how much waste is generated at home in a day.
- How much of this waste is bio-degradable?
- Calculate how much waste is generated in the classroom in a day.
- How much of this waste is non bio-degradable?
- Suggest ways of dealing with this waste

THINK IT OVER

Disposable cups in trains

If you ask your parents, they will probably remember a time when tea in trains was served in plastic tumblers which had to be returned to the vendor. The introduction of disposable cups was hailed as a step forward for reasons of hygiene. No one at that time probably thought about the impact caused by the disposal of millions of these cups on a daily basis. Some time back, Kulhads, that is, disposable cups made of clay, were suggested as an alternative. But a little thought showed that making these Kulhads on a large scale would result in the loss of the fertile top-soil. Now disposable paper-cups are being used. What do you think are the advantages of disposable paper-cups over disposable plastic cups?

Programmes against using plastics ?

The following methods are adopted for the disposal of harmful waste materials.

1. Land Fills

There are permanent storage facilities in secured lands for military related liquid and radioactive waste materials. High level radioactive wastes are stored in deep underground storage.

2. Deep well injection

It involves drilling a well into dry porous material below ground water. Hazardous waste liquids are pumped into the well. They are soaked into the porous material and made to remain isolated indefinitely.

3. Incineration

The burning of materials is called incineration.

Hazardous bio-medical wastes are usually disposed off by means of incineration. Human anatomical wastes, discarded medicines, toxic drugs, blood, pus, animal wastes, microbiological and bio-technological wastes etc., are called bio-medical wastes.

Management of non-hazardous wastes – solid waste management

Reuse and recycling technique

The separating out of materials such as rubber, glass, paper and scrap metal from refuse and reprocessing them for reuse is named as reclamation of waste or recycling.

Paper

(54% recovery) Can be repulped and reprocessed into recycled paper, cardboard and other products.

Glass

(20% recovery) Can be crushed, re-melted and made into new containers or crushes used as a substitute for gravel or sand in construction materials such as concrete and asphalt, Food waste and yard wastes (leaves, grass etc.,) can be composted to produce humus soil conditioner.

7.2. WATER MANAGEMENT

Due to increasing demands for water and reduced availability of fresh ground water resources, urgent measures have to be taken to conserve each and every drop of water that is available.

Clean and fresh water is essential for nearly every human activity. Perhaps more than any other environmental factors, the availability of water determines the location and activities of human beings.

Can you list out the reasons for increasing demand of water?

7.2.1. Sources of water

Water is a basic natural resource and valuable asset to all nations. Human beings depend on water for all their needs such as bathing, washing, cooking, transportation and power. Water in India is of two kinds. Salt water and fresh water. Fresh water is obtained from rain water, surface water and ground water.

The main sources of water are rain and snow which form a part of the hydrological cycle.

Surface water

India is blessed with a number of rivers, lakes, streams and ponds.

Ground water

Aquifers are under ground reserves of fresh water.

In the water table, water that percolates into the ground through porous rocks is ground water. These porous rocks are saturated with water to a certain level. The upper layer of waterlevel is the watertable. The ground water is important for plant growth, man also taps this water through tube wells and bore wells. Scanty rainfall and unnecessary felling of trees affect the ground water level.

7.2.2. Fresh water management

To meet out the water scarcity we need several ways to increase the water supply.

i) Seeding clouds

Seeding clouds with dry ice or potassium iodide particles sometimes can initiate rain if water laden clouds and conditions that favour precipitation are present.

ii) Desalination: (Reverse osmosis)

Desalination of ocean water is a technology that has great potential for increasing fresh water. Desalination is more expensive than most other sources of fresh water. In desalination, the common methods of evaporation and re-condensation are involved.

iii) Dams, reservoirs and canals

Dams and storage reservoirs tap run-off water in them and transfer the water from of excess to areas of deficit using canals and underground pipes.

iv) Water shed management

The management of rainfall and resultant run-off is called water shed management. Water shed is an area characterized by construction of small dams to hold back water which will provide useful wildlife habitat and stock watering facilities.

v) Rain water harvesting

Rain water harvesting essentially means collecting rain water from the roof of building or courtyards and storing it under ground for later use. The main idea in harvesting rain water is to check the run-off water. The rain water that falls on the roofs of buildings or in courtyards is collected through pipes and stored in under ground tanks of the buildings fitted with motor for lifting water for use. The process of rain water harvesting is not only simple but also economically beneficial. It helps in meeting the increased demand for water, particularly in urban areas and prevent flooding of living areas.

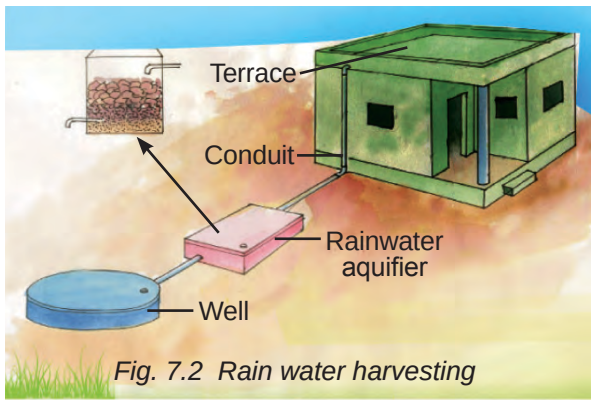


Fig. 7.2 Rain water harvesting

vi) Wetland conservation

It preserves natural water storage and acts as aquifer recharge zones.

vii) Domestic conservation

As an individual, every one can reduce the water loss by taking shower, using low-flow taps, using recycled water for lawns, home gardens, vehicle washing and using water conserving appliances.

viii) Industrial conservation

Cooling water can be recharged and waste water can be treated and reused.

Fig. 7.3 Domestic conservation method of water

7.3. WILDLIFE SANCTUARIES

Wildlife

All non-domesticated and non-cultivated biota found in natural habitat are termed 'wildlife'. It includes all the natural flora and fauna of a geographic region. Wildlife is an asset to be protected and preserved to our own advantage and to the benefit of future generations.

There are approximately 400 varieties of reptiles, 200 varieties of amphibians, 3000 varieties of fishes, 3000 species of birds 20,000 species of flowering plants and 4100 species of mammals found in our country according to the latest census estimate.

It is essential to protect and conserve wildlife because they have aesthetic, ecological, educational, historical and scientific values, a good biotic diversity is essential for ecological balance. Large scale destruction of wildlife could lead to ecological imbalance. Wildlife also adds aesthetic value and from this, eco-tourism is being promoted in a big way by several countries. Wildlife and their products could be of great economic value if utilized properly. The invulnerable plants could yield products of immense medicinal value in future. Wildlife also forms as store of vast genetic diversity which could be properly used with advances in genetic engineering. Thus wildlife has been of great value in the past and will continue to be so in the future. Protection and conservation of wildlife, therefore gains importance.

SANCTUARIES

Wildlife sanctuary is an area constituted by competent authority in which hunting or capturing of animals is prohibited except by or under control of the highest authority responsible for management of the area.

Wildlife sanctuaries were established in India in the pursuit of conserving wildlife which was suffering due to ecological imbalance caused by human activities. There are 89 National parks, 500 wildlife sanctuaries, 27 Tiger reserves, 200 Zoos and 13 Biosphere reserves in the country covering an area of 1.6 lakh sq.km.

7.4. BALANCE IN ECOSYSTEM

What is Ecosystem?

- Fish lives in Water.
- Tiger lives in Forest.

Important sanctuaries in Tamilnadu

Name	Location	Animals
Indira Gandhi Wildlife, Sanctuary	Western Ghats.	Tiger, leopard, porcupine, nilgiris thar, civet cat, elephant, gaur, pangolin.
Kalakkadu Wildlife Sanctuary.	Tirunelveli district	Lion tailed macaque, sambhar, sloth bear, gaur, flying squirrel.
Srivilliputhur Grizzled squirrel wildlife Sanctuary	Virudhunagar district	Grizzled squirrels, mouse deer, barking deer, tree shrew.
Vedanthangal Bird's sanctuaries	Kancheepuram district	Cormorants, egrets, grey heron, open-billed stork, white bears, shovellers, pintails, stets, sandpipers.
Mudumalai wildlife Sanctuary	The Nilgiris	Elephants, gaur, langur, tigers, leopards, sloth bear, sambhar, wildbear, jackal, porcupine, mangoose.
Viralimalai	Trichy district	Wild peacocks
Gulf of Mannar marine National Park.	Coast of Rammad and Tuticorin district.	Coral reefs, dugong, turtles, dolphins, balanoglossus,
Mundhanthurai wildlife Sanctuary.	Tirunelvelli district	Tiger, bonnet macaque, langurs, sloth bear, wild dog.
Vallanadu Blackbuck Sanctuary.	Tuticorin district	Blackbuck, jungle cat, hare, mongoose.
Arignar Anna Zoological Park	Vandalur	Lion, elephant, tiger, monkeys.
Mukkurthi National Park	The Nilgiris	Tigers.
Point calimere wildlife Sanctuary	Nagapattinam district	Chital, wild bear, plovers, stilts, bonnet macaque.
Anamalai wildlife sanctuary	Slopes of western ghats.	Civet cat, porcupine, gaur, tiger leopard, nilgiri tahr.

Important National Parks, wildlife sanctuaries and reserves.

Bandhipur National Park (It is a tiger reserve)	Karnataka	Indian bison, chital, sloth bear, elephants.
Corbett National Park (India's first national park) (Tiger reserve)	Uttaranchal	Tigers, chital, elephants, leopard, Jungle cat and sloth bear.
Gir National Park	Gujarat	Aslatic Lion
Kanha National Park (Tiger reserve)	Madhyapradesh	Deer Tiger, Wilddog, chital.
Bharathpur Bird sanctuary	Rajasthan	374 special of bird, e.g. Indian darters, spoonbills, painted stock, open billed stork, black necked stork etc,.
Manas wildlife sanctuary (Tiger reserve)	Assam	Hispid hare (rere), pygmy hog, golden langue
Sunderbans National Park (Tiger reserve)	West Bengal	Unique royal Bengal Tigers.

How can they lead their life in the above habitats?

A community of organisms that interact with one another and with the environment is called an ecosystem.

The Ecosystem is of two types, namely aquatic and terrestrial.

What are the major components in Ecosystem?

There are four major components, namely:

1. Abiotic factors
2. Producers
3. Consumers
4. Decomposers.

Producers, consumers and decomposers are biotic factors.

Pond Ecosystem

An example for aquatic ecosystem is a pond.

Abiotic factors

It includes light, temperature, hydrogen ion concentration, inorganic substances like CO_2, H_2, O_2, N, PO_4, CO_3 and S and organic substances like carbohydrates, proteins and lipids.

Biotic factors

It includes producers and consumers. Producers are the water living plants like *Hydrilla, Vallisneria* etc., and *phytoplankton* like *Chlamydomonas, Volvox* and *Spirogyra.*

Primary consumers or herbivores

Zooplanktons like insects, larvae of Dragon-fly consume the phytoplanktons.

Secondary Consumers

These are certain fishes, frogs, water beetles etc., which feed on the primary consumers in the pond.

Tertiary Consumers

These are big fishes and kingfisher that feed on small fishes.

Decomposers

Several bacteria and fungi form the decomposers in the pond.

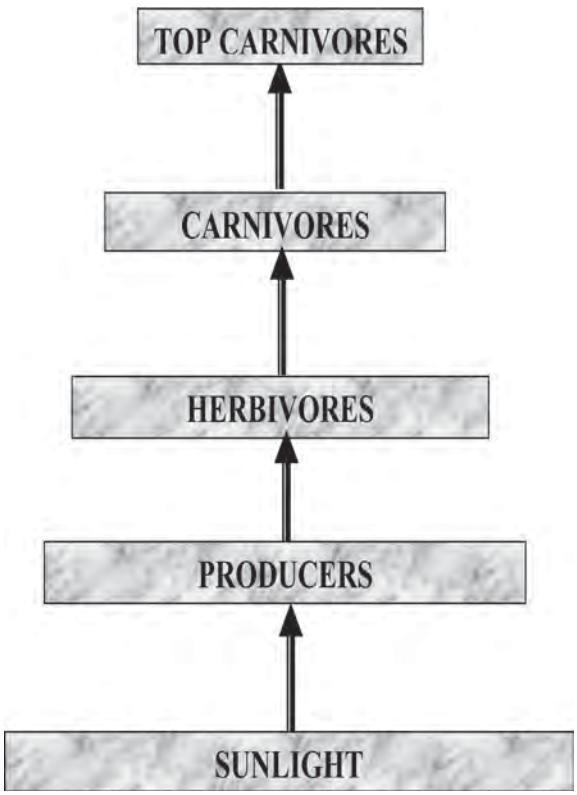


Fig. 7.4 Flow of energy in an ecosystem

BALANCE IN ECO-SYSTEM

A balanced ecosystem is an ecological community together with its environment and functioning as a complex unit.

ACTIVITY 7.2

- While creating an aquarium did you take care not to put an aquatic animal which would eat others? What would happen otherwise?
- Make groups and discuss how each of the above groups of organisms are dependent on each other.
- Write the aquatic organisms in order of who eats whom and form a chain of at least three steps.
- Would you consider any one group of organisms to be of primary importance? Why or why not?

An ecosystem is maintained by the balance in nature such as the balance between hawks and mice, if hawk population is larger than the mice population, then it is not balanced.

There is a balance between resources like a banana tree and monkeys. If the banana trees stop growing, the monkeys won't get bananas.

An ecosystem maintains the balance between the number of resources and the number of users or the balance between prey and predators.

What is food chain and food web?

Various organisms are linked by food chains in which the food energy is passed from one organism to another in a linear fashion.

e.g. Food chain of a grassland ecosystem.

Grass → Grass hopper → Frog → Snake→Eagle

(Producers) (Herbivores) (Primary consumer) (Secondar consumer) (Teritary consumer)

Fig. 7.5 Grassland ecosystem

ACTIVITY 7.3

- Go to a pond and observe the organisms that lives in the pond.
- List out the organisms.
- Prepare a chart of food chains

Food Web

The food chains are interlinked to form food webs, So every component of the ecosystem is connected to one another.

How is the ecosystem maintained?

There are many factors which maintain the harmony in an ecosystem naturally. Disturbing any one factor could have a drastic impact upon the living conditions of other organisms that will result in an imbalance. For example, removal of trees and vegetation would affect both land and water ecosystems as there will be no food for organisms. Killing animals and polluting land, air and water also disturb the balance in nature.

Inorder to maintain the eco-balance in an ecosystem, there should be recycling of nutrients, minerals, and water. Careful use of natural resources will maintain the eco-balance. Thus eco-balance or ecological balance is the maintenance of

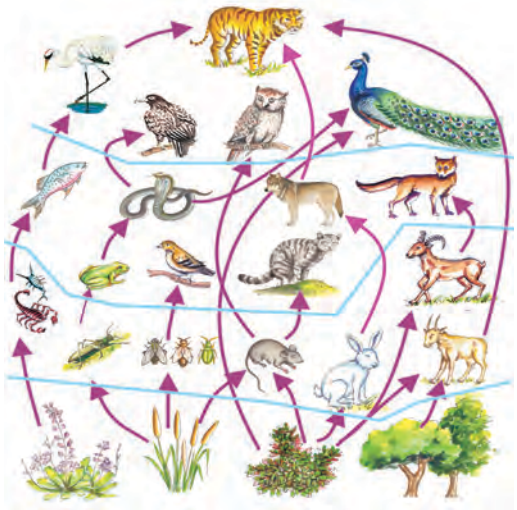


Fig. 7.6 Food web

balance between living components and its resources of an ecosystem, so that it remains a stable environment community for the better functioning of the organisms.

Bio - Geo chemical cycles

In an ecosystem, the energy from the sun is fixed by the plants. Then it is transferred to herbivores and carnivores. i.e. the energy flows in one direction only. But the minerals required in the ecosystem are continuously absorbed by the plants and transferred to animals. As the minerals are removed from the soil, they have to be replaced or cycled. These minerals are returned to the soil by the decomposition of dead and decaying materials by saprophytic organisms such as bacteria and fungi (You have studied the cycles in earlier classes in detail.)

7.5. COAL AND PETROLEUM

7.5.1 Coal

Coal is a compost primarily of carbon along with variable quantities of other elements chiefly sulphur, hydrogen, oxygen and nitrogen.

Coal is a fossil fuel and is the largest source of energy for the generation of electricity world wide, as well as one of the largest worldwide sources of CO_2 emissions. Gross CO_2 emission from coal usage is high and more than those from petroleum and about double the amount from natural gas.

Fig. 7.7 Coal

Coal is obtained through mining or in open pits. Coal is primarily used as a solid fuel to produce electricity and heat through combustion. When coal is heated in air, coal burns and produces mainly carbon-di-oxide gas. Coal is processed in industry to get some useful products such as coke, coal tar and coal gas.

Environmental effects of coal burning

1. Generation of waste products which contain mercury, uranium, thorium, arsenic and other heavy metals, which are harmful to human health and environment.
2. Sulphur particles present in the coal will cause acid rain..
3. Interference with ground water and water table levels.
4. Contamination of land and water ways.
5. Dust nuisance.
6. Release of CO_2, a green house gas, which causes climate change and global warming.
7. Coal is the largest contributor to the man-made increase of CO_2 in the air.

ACTIVITY 7.4

- Visit Neyveli lignite corporation.
- See how the coal is mined.
- Discuss with your classmates about the uses of coal.

7.5.2 Petroleum

In modern life today, we are inseparable from petrol and petroleum products.Petroleum or crude oil is a naturally occurring, toxic, flammable liquid consisting of a complex mixture of hydrocarbons and other organic compounds that are found beneath the earth's surface.

Do you know how was petroleum formed?

Petroleum was formed from organisms living in the sea. After the death of those organisms, their bodies settled at the bottom of the sea and were covered with layers of sand and clay. Over millions of

years, absence of air, high temperature and high pressure transformed the dead organisms into petroleum and natural gas.

Many useful substances are obtained from petroleum and natural gas. These are used in the manufacture of detergents, fibers (polyester, nylon, acrylic etc.), polythene and other plastic substances. Hydrogen gas, obtained from natural gas, is used in the production of fertilizers (urea). Due to its great commercial importance, petroleum is also called 'Black Gold'.

Environmental effects

Oil Spills

1. Crude oil (refined fuel) spills from tanker ship and accidents have damaged natural ecosystem.
2. Oil Spills at sea are generally causing more damage than those on land. This can kill sea birds, mammals, shellfish and other organisms, because of their lateral spreading on water surface.

Tar Balls

A tar ball is a blob of oil which has been weathered after floating on the ocean. Tar balls are aquatic pollutants in most of the seas.

Fig 7.8 Petroleum Industry

Alternatives to petroleum – based vehicle fuels

1. Internal combustion engines (Biofuel or combustion hydrogen)
2. Electricity (for e.g. all electric (or) hybrid vehicles), Compressed air or fuel cells (hydrogen fuel cells).
3. Compressed natural gas used by natural gas vehicles.

7.6 GREEN CHEMISTRY

Green chemistry is the design of chemical products and processes to reduce or eliminate the use and generation of hazardous substances.

The concept of green chemistry was introduced in 1995. The Green Chemistry Institute was recently created and the Presidential Green Chemistry challenge awards were established in 1999.

MORE TO KNOW

Many countries are making commitments to lower green house gas emissions according to the Kyoto protocol.

ACTIVITY 7.5

Coal is used in thermal power stations and petroleum products like petrol and diesel are used in means of transport like motor vehicles, ships and aeroplanes. We cannot really imagine life without a number of electrical appliances and constant use of transportation. So, can you think of ways in which consumption of coal and petroleum products can be reduced?

- Greener reaction conditions for an old synthesis e.g. replacement of an organic solvent with water or the use of no solvent at all)
- A greener synthesis for an old chemical (e.g. a synthesis which uses biomass rather than petrochemical feed stock or the use of catalytic rather than stoichiometric reagents).
- The synthesis of a new compound that is less toxic but has the same desirable properties as an existing compound. (e.g. a new pesticide that is toxic only to target organisms and bio-degrades to environmentally benign substances)

Green chemistry / technology has been developed in almost all branches of chemistry including organic, bio-chemistry, inorganic, polymer, toxicology, environmental, physical, industrial etc.

The Principles of Green Chemistry

- It is better to prevent waste generation than to treat or clean up waste after it is generated.
- Wherever practicable, synthetic methodologies should be designed to use and generate substances that posses little or no toxicity to human health and the environment.
- Chemical products should be designed to preserve efficacy of function while reducing toxicity.

Fig. 7.9 Green chemistry

List of some of the products produced by the process of green chemistry

- Lead free solders and other product alternatives to lead additives in paints and the development of cleaner batteries.
- **Bio-plastics:** Plastics made from plants including corn, potatoes or other agricultural products.
- Flame resistant materials.
- Halogen free flame retardants.

e.g. silicon based materials can be used.

Future products

- A raw material feedstock should be renewable rather than depleting whenever technically and economically practical.
- Catalytic reagents are superior to stoichiometric reagents.
- Green Chemistry is applicable to all aspects of the product life cycle as well. Finally, the definition of green chemistry includes 'The term "hazardous". It is important to note that green chemistry is a way of dealing with risk reduction and pollution prevention.

PVC and Lead

New lead free solders with lower heat requirements are being developed.

Beware of Green washing

Green chemistry is not a panacea. We must be vigilant in making sure that what is called "Green Chemistry really pushes towards a more sustainable world and not simply green washing".

7.7. SCIENCE TODAY – TOWARDS A GLOBAL VILLAGE

Global village

Global village is the term used to mean that world had shrunk into a village by means of different types of media especially the world wide web, making It is easy to pass across messages (like news) thereby making the world become a single village where people can easily contact each other quicker.

What is global village?

A term that compares the world to a small village, where fast and modern communication allows news to reach quickly. The use of electronics for faster communication is a global village concept.

What is the global electronic village?

Global electronic village (GEV) is a term used to refer to a village without borders; it refers to connecting people around the world technologically through Information Communication Technologies (ICTS).

Fig. 7.10 Global village

Global Village (GV) is located at a distance of 12 kms from Bangalore on the Bangalore - Mysore Expressway and easily accessible by road. Spread over 110 acres of greenery, the project will house a cluster of technology companies in a campus type setting. The Buildings nestle among the lush green of manicured lawns, coconut palms and an eclectic mix of old trees in a serene and dust free environment. The Technology Campus has been conceptualized and designed by a team of reputed Indian and international architects and landscape designers.Ample residential facilities are in close proximity to the campus. The estimated driving time to GV from the heart of Bangalore city is approximately 20 minutes.

Kshema Technologies have the distinction of being the first of GTV's companies to move into the campus with an 80,000 sq ft facility to house 600 employees.

The term global village was coined by Marshall McLuhan. He emphasized that "this forces us to become more involved with one another from countries around the world and be more aware of our global responsibilities". Similarly, web-connected computers enable people to link their web sites together. This new reality has implications for forming new sociological structures within the context of culture.

EVALUATION

PART A

Multiple choice questions

1. Which of the following groups contain only bio degradable items?

   (Grass, flowers and leather ; Grass, wood and plastic ; Fruit peels, cake and plastic ; Cake, wood and grass)

2. Which of the following constitute a food chain?

   (Grass, wheat and mango ; Grass, goat and human ; Goat, cow and elephant ; Grass, fish and goat)

3. Which of the following are environmental friendly practices?

   (carrying cloth bags to carry the purchase items during shopping, switching off light and fans when not in use, use the public transport, all the above)

4. what is called as 'black gold'?

   (hydrocarbons, coal, petroleum, ether)

5. odd one out.

   (Plants, grasshopper, frog, tiger, snake)

6. Example for product of green chemistry is

   (plastic, paper, bio plastics, halogen flame retardants)

7. _____ green house gas which causes climate change and global warming.

   (hydrogen, oxygen, nitrogen carbondioxide)

8. The _____ forms decomposers in the pond ecosystem (plants, bacteria, frog, phlytoplanktons)

9. _____ chemical is used in seeding clouds (potassium iodide, calcium carbonate, sulphurdioxide, ammonium phosphate)

10. Example for fossil fuel is (copper, iron, magnesium, coal)

PART B

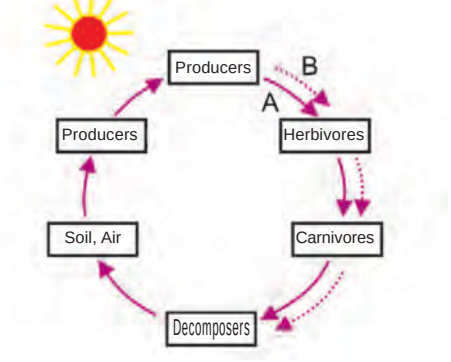
11. Study the food chain below, correct it and convert into a pyramid of energy.

    Mulberry -> Sparrow -> Caterpillar -> Kite

12. Study the illustration and answer the question.

    a. which line (A or B) represent the flow of energy? Why do you say so?

    b. Give an example of a decomposer.



13. Study the food chain.

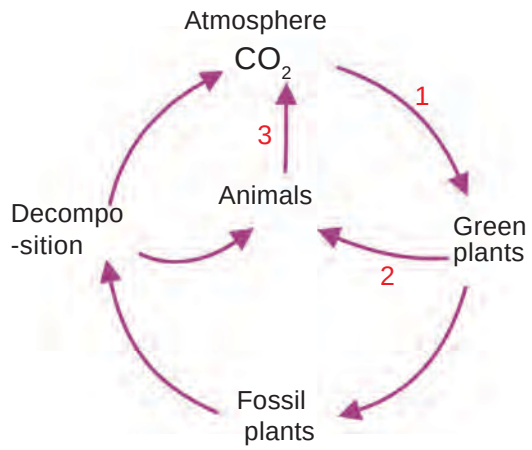
Paddy -> Mouse -> Snake -> Kite

If the producer has a Stored up Energy of 500 k Cal. How much of it goes to the organism at the third trophic level get from it?

14.

a. Name the processes noted as no. 1 and 3

b. Define the process 1



PART C

15. a) Classify the following substances – wood, paper, plastic and grasses.

b) Give detailed account on your classification.

16. In your area there is scarcity of water due to this the people are affected. So what are the measures to be taken by you to meet out the scarcity of water.

17. Smoke, smoke everywhere smoke. Do you agree this situation is good for health. List out the harmful effects of coal burning.

Sholas and grasslands of western ghats are the sources of all our South Indian rivers. All the hillocks in the upper mountains have this unique ecosystem, which we cannot create.

FURTHER REFERENCE

Books: 1. Plant Ecology **Sheela.R.S** and **Chandel .P.S**

2. New development in green chemistry **V.K. Atlerwalia, M. Kidwai**

Website: www.enviroliteracy.org/article.php/600 html

8. Waste water management

Human beings have been abusing the water-bodies around the world by disposing into them all kinds of wastes. We tend to believe that water can wash away everything not taking cognizance of the fact that the water bodies are our life line as well as that of all other living organisms.

Can you list out the things we tend to try and wash away through our rivers and drains?

Due to such activities of human being, the ponds, lakes, streams, rivers, estuaries and oceans are becoming polluted in several parts of the world. So we should manage the waste water in order to prevent the water pollution and its effects on our life.

8.1. JOURNEY OF WATER

Water, a precious physical substance, is essential to all living organisms. All biological functions and cell metabolism require water. Because of this feature, without water, life cannot be expected on the earth.

Water cycle

Large quantity of water is present to an area of about 1400 million km^3 in the entire globe. This water evaporates from moist surfaces, falls as rain or snow, passes through lake, rivers, entered into the ground water table and to the ocean, also fixed in glaciers and deposited over mountains. Plants absorb water from the soil, utilized for its metabolic activities and release it into the atmosphere mainly through transpiration and all living organisms utilize water.

Sources of water

Water is widely distributed in nature and occurs in number of forms viz., solid, liquid and vapour. Rainfall brings the available primary source of water over the earth surface. Ocean water is the largest among all the water resources. A little quantity of water i.e., 2.4 percent, water is fresh and most of this water is in glaciers or in ground water. Geologic layers containing water is known as aquifers of underground water. On some areas of the earth's

crust, fresh water flows freely which is called as an artesian well or spring. Rivers carry huge volume of water for discharge into the lakes and ponds. Wetlands, swamps and marshes play a vital role in this journey of water.

8.2. SEWAGE

Sewage is formed from residential, institutional, commercial and industrial establishments and includes household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers.

8.3. TREATMENT

Sewage can be treated close to where it is created (in septic tanks, biofilters or aerobic treatment systems), or collected and transported via a network of pipes and pump stations to a municipal treatment plant (see sewage and pipes and infrastructure). Sewage collection and treatment is typically subject to local, state and central regulations and standards. Industrial sources of waste water often require specialized treatment process.

Conventional sewage treatment may involve three stages called primary, secondary and tertiary treatment.

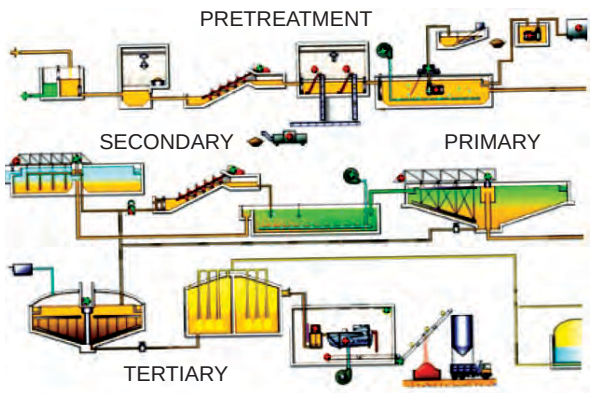


Fig. 8.1 Sewage water treatment

Primary treatment

Primary treatment consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float over the surface. The settled and floating materials are removed and remaining liquid may be discharged or subjected to secondary treatment.

Secondary treatment

Secondary treatment is used to remove dissolved and suspended biological matter. Secondary treatment is typically performed by indigenous, water – borne micro organisms in a managed habitat. Secondary treatment may require a separation process to remove the micro organisms from the treated water prior to discharge or tertiary treatment.

Tertiary treatment

Tertiary treatment is defined as either chemical or treatment of filteration done after primary and secondary treatment. Treated water is sometimes disinfected chemically or physically (for example by lagoons and micro filtration.). Before discharging into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

Bioremediation in sewage treatment

Bioremediation can be defined as any process that is done by the use of microorganisms, fungi or their enzymes to treat the contaminants. Nitrosomonas europaea can be used

ACTIVITY 8.1

- Find out how the sewage in your locality is treated. Are there mechanisms to ensure that local water bodies are not polluted by untreated sewage.
- Find out how the local industries in your locality treat their wastes. Are there mechanisms in place to ensure that the soil and water are not polluted by the waste?

to treat sewage, freshwater, walls of buildings and on the surface of monuments especially in polluted areas where there is high levels of nitrogen compounds.

8.4. DOMESTIC PRACTICES:

Sewage is created by residential house hold waste liquid from toilets, bathroom, showers, kitchens, and so forth then is dispersed of via sewers.

The separation of draining of household waste into grey water and black water is becoming more common in the developed world, with grey water being permitted to be used for watering plants or recyling for flushing toilets.

Waste water

Waste water is often referred to as grey water. Any water that has been used in the home, with the exception of water in the toilet can be referred to as waste water.

This water could be reused for a multitude of purposes, including,

1. watering yard and gardens,
2. Filtering septic systems,
3. Irrigating fields,

Benefits of house hold waste water recycling systems,

1. Less fresh water usage,
2. Reduce strain in septic tanks,
3. Recharge ground water,
4. Encourage plant growth.

8.5. SANITATION AND DISEASES :

Water supply, sanitation and health are closely interrelated. Poor hygiene, inadequate quantities and quality of drinking water and lack of sanitation facilities cause millions of the world's poorest people to die from preventable diseases each year. Water contaminated by human, chemical or industrial wastes can cause a variety of communicable diseases through ingestion or physical contact.

Water-borne diseases

Water - borne diseases are caused by the ingestion of water communicated by human or animal faeces or urine containing pathogenic bacteria or viruses; include cholera, typhoid, amoebic and bacillary dysentery and other diarrhoeal diseases.

Water-washed diseases are caused by poor personal hygiene and skin or eye

ACTIVITY 8.2

- Practice regularly to wash your hands thoroughly before and after using the toilets.
- Food and water containers should be cleaned and has to be closed when they are in use.
- During flood and other natural calamities, water should be used only after boiling.
- People live near hazardous industrial waste accumulating or water pollution areas should be very careful in using the ground water.

contact with contaminated water; include scabies, trachoma and flea, lice and tick-borne diseases.

Water-based diseases are caused by parasites found in intermediate organisms living in water; include dracunculiasis, schistosomiasis and other helminthes.

Water-related diseases are caused by insect vectors which breed in water; include dengue, filariasis, malaria, onchocerciasis, trypanosomiasis and yellow fever.

- Contaminated water that is consumed may result in water-borne diseases including viral hepatitis, typhoid, cholera, dysentry and other diseases that cause diarrhoea.
- Without adequate quantities of water for personal hygiene, skin and eye infections spread easily.
- Water - based diseases and water-related vector-borne diseases can result from water supply projects. They inadvertently provide habitats for mosquitoes and snails. They are intermediate hosts for parasites that cause malaria, Schistosomiasis, lymphatic filariasis and Japanese encephalitis.
- Drinking water supplies that contain high amounts of certain chemicals (like arsenic and nitrates) can cause serious diseases.
- Inadequate water, sanitation and hygiene, account for a large part of the burden of illness and death in developing countries.
- Lack of clean water and sanitation is the second most important risk factor in terms of the global burden of diseases, after malnutrition.
- Approximately 4 billion cases of diarrhoea per year cause 1.5 million deaths, mostly among children under five.
- Intestinal worms infect about 10 percent of the population of the developing world, and can lead to malnutrition, anaemia and retarded growth.
- 300 million people suffer from malaria.

8.6. ALTERNATIVE ARRANGEMENT FOR SEWAGE DISPOSAL

Wherever crops are grown, they always need nutrients and water. Wastewater is often used in agriculture as it contains water, minerals, nutrients and its disposal is often expensive. Where effluent is used for irrigation, good quality water can be reserved exclusively for drinking water. Wastewater can also be used as a fertilizer, thus minimizing the need for chemical fertilizers. This reduces costs, energy, expenditure and industrial pollution. Waste water is also commonly used in aquaculture or fish farming.

8.7. SANITATION IN PUBLIC PLACES

Wherever population density is high such as bus station or school, especially when they are eating food from the same source, there is a greater risk of the spread of diseases such as, cholera, hepatitis A,- typhoid and other diarrhoeal diseases.

These places vary in the number of people using them, the amount of time that people spend there and the type of activity that occurs in the area, but all public places need to have adequate sanitation and hygiene facilities.

Basic rules for sanitation in public places

1. There should be sufficient toilet facilities.
2. The toilet facilities should be arranged in separate blocks for men and women.
3. The men's toilet block should have urinals and toilet compartments, the women's block have toilet compartments only.
4. There must be a hand washing basin with clean water.
5. There must be a clean and reliable water supply for hand washing, personal hygiene and flushing of the toilet facilities.

8.8. ENERGY MANAGEMENT

What is Energy Management?

"Energy management" is a term that has a number of meanings, but we are mainly concerned with the one that relates to saving energy in business, public-sector / government organizations and homes.

Energy saving measures

Energy management is the process of monitoring controlling and conserving energy in a living home or in any organization.

8.8.1. Energy Audit

An energy audit is an inspection, survey and analysis on energy flows for energy conservation in a building, process or system. It is done to reduce the amount of energy input into the system without negatively affecting the output(s).

Home energy audit

A home energy audit is a service where the energy efficiency of a house is evaluated by a person using professional

equipment (such as blower doors and infra-red cameras), with the aim to suggest the best ways to improve energy efficiency in heating and cooling the house.

An energy audit of a home may involve recording various characteristics of the building envelope including the walls, ceilings, floors, doors, windows and skylights. The goal of this exercise is to quantify the building's overall thermal performance. The audit may also assess the efficiency, physical condition at programming of mechanical systems such as the heating, ventilation, air conditioning equipment and thermostat.

A home energy audit may include a written report estimating energy use given local climate criteria, thermostat settings, roof overhang, and solar orientation. This could show energy use for a given time period, say a year, and the impact of any suggested improvements per year. The accuracy of energy estimates are greatly improved when the homeowner's billing history is available showing the quantities of electricity, natural gas, fuel oil, or other energy sources consumed over a one or two-year period.

A home energy audit is often used to identify cost effective ways to improve the comfort and efficiency of buildings. In addition, homes may qualify for energy efficiency grants from central government.

Energy audit in schools

The function of an energy audit is to expose different ways to affect energy consumption and identify numerous options for reducing energy consumption.

ACTIVITY 8.3

- Using a thermometer, observe the room temperature of your class room and the temperature under a Neem tree on an hot day.
- Burn the tungsten lamp and compressed fluorescent lamps and compare the energy consumption.

The money your school saves will be available to fund important school projects, but just as important, energy savings help the Earth by reducing resource use and environmental pollution. By improving efficiency in places like our schools, we can get the same benefits while using less energy. For example, substituting energy efficient, compact fluorescent light bulbs (CFL) for standard incandescent bulbs will save on average up to 6,000 megawatts of electricity each year.

There are many ways you can help your school save money on water usage, such as checking for leaks in the system, reducing water usage (especially hot water), and improving the efficiency of water delivery.

Another important way to save energy at your school is through recycling. This can be done all over the school. For example, you can save by recycling paper, milk cartons from the lunch room or printer cartridges in the copy room. By recycling paper, milk cartons and other

materials, schools are able to reduce the amount of waste they produce. This can garner significant savings as well as benefit the environment.

8.8.2. Renewable sources

A natural resource is a renewable resource, if it is replaced by natural processes at a rate comparable or faster than its rate of consumption by humans. Solar radiation, Hydrogen, Wind and hydroelectricity are in no danger of a lack of long term availability.

Solar Energy

Solar energy is the energy derived directly from the sun. Along with nuclear energy, it is the most abundant source of energy on earth. The fastest growing type of alternative energy increasing at 50 percent a year ,is the photovoltaic cell, which converts sunlight directly into electricity. The sun yearly delivers more than 10000 times the energy that humans currently use.

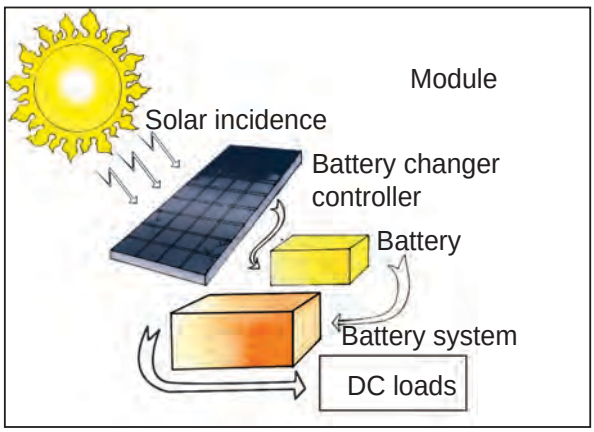


Fig. 8.2 Solar Energy

Hydrogen

The Hydrogen has been found to be a good choice among all the alternative fuel options . It can be produced in virtually unlimited quantities with on hand production technologies. It has been established that hydrogen can meet all the energy needs of human society, including power generation more efficiently and more economically than petro fuels, and with total compatibility with the environment. In addition, hydrogen is non-toxic, reasonably safe to handle, distribute and to be used as a fuel. Hydrogen has the highest mass energy content – its heat of combustion per unit weight is about 2.5 times that of hydro carbon fuel, 4.5 times that of ethanol and 6.0 times that of methanol. Its thermodynamic energy conversion efficiency of 30-35 % is greater than that of gasoline (20-25%).

ACTIVITY 8.4

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

Wind Power

Wind power is derived from uneven heating of the Earth's surface from the sun and the warm core. Most modern wind power is generated in the form of electricity by converting the rotation of turbine blades into electrical current by means of an electrical generator. In wind mills (a much older technology) wind energy

MORE TO KNOW

Denmark is called the country of “winds”. More than 25% of their electricity needs are generated through a vast network of windmills. In terms of total output, Germany is the leader, while India is ranked 5th in harnessing wind energy for the production of electricity. It is estimated that nearly 45000MW of electrical power can be generated if India’s wind potential is fully exploited. The largest wind energy farm has been established near Kanyakumari in Tamilnadu and it generates 380MW of electricity.

is used to turn mechanical machinery to do physical work, like crushing grain or pumping water.

Fig. 8.3 Windmills

8.8.3. Non-renewable sources

A non-renewable resource is a natural resource which cannot be produced, grown, generated or used on a scale which can sustain its consumption rate. These resources often exist in a fixed amount, or are consumed much faster than nature can create them. Fossil fuels (such as coal, petroleum and natural gas) and nuclear power (uranium) are examples.

Fossil Fuels

Fossil fuels are energy rich, combustible forms of carbon or compounds of carbon formed by the decomposition of biomass buried under the earth over million of years.

Fig. 8.4 Coal mining

Fossil Fuel – Coal

It is a black mineral of plant origin which is chemically, a complex mixture of elemental carbon, compounds of carbon containing hydrogen, oxygen, nitrogen and sulphur.

Petroleum

Petroleum is a dark, viscous, foul smelling liquid, a mixture of solid, liquid and gaseous hydro carbons with traces of salt, rock particles and water.

ACTIVITY 8.5

- Debate the following two issues in class.
- The estimated coal reserves are said to be enough to last us for another 200 years. Do you think we need to worry about coal getting depleted in this case? Why or why not?
- It is estimated that the sun will last for another 5 billion years. Do we have to worry about solar energy getting exhausted? Why or why not?
- On the basis of the debate, decide which energy sources can be considered i) exhaustible ii) inexhaustible iii) renewable iv) non-renewable. Give your reasons for each choice.

Natural Gas

The composition of natural gas is chiefly methane (> 90%) with traces of ethane and propane. It is found associated with other fossil fuels, in coal beds, as methane clathrates and it is created by methanogenic organisms in marshes, bogs, and land fills. It is an important fuel source, a major feedstock for fertilizers and a potent green house gas.

Before natural gas can be used as a fuel, it must undergo extensive processing to remove almost all materials other than methane. These by-products of that processing include ethane, propane, butane, pentane and higher molecular weight hydrocarbons, elemental sulphur, carbon-di-oxide, water vapour and sometimes helium and nitrogen.

Natural gas is often informally referred to as simply gas, especially when compared to other energy sources such as oil or coal.

USES

Power Generation: Natural Gas is a major source of electricity generation through the use of gas turbines and steam turbines. Most grid peaking power plants and some off – grid engine – generators use natural gas.

Domestic use: Natural gas is supplied to homes where it is used for such purposes as cooking in natural gas – power rangers and oven, natural gas heater clothes dryers, heating or cooling and central heating. Home or other building heating may include boilers, furnaces and water heaters.

Natural gas is a major feedstock for the production of ammonia, for use in fertilizer production.

Other: Natural gas is also used in the manufacture of fabrics, glass, steel, plastics, paint and other products. With man's ever increasing need for energy , he has been using fossil fuels indiscriminately. In the process, harmful materials contributing to air pollution are being produced.

8.8.4. Bio-fuels – Generation and use

Biofuels are a wide range of fuels which are in some way derived from biomass. The term covers solid biomass, liquid fuels and various biogases. Bio fuels are gaining increased public and scientific attention driven by factors such as oil price hikes, the need for increased energy security and concern over green house gas emissions from fossil fuels.

The various liquid bio fuels for transportation are

1. Bio alcohol
2. Green diesel
3. Bio diesel
4. Vegetable oil
5. Bio ethers
6. Bio gas

Bioalcohol (Bioethanol)

Bioethanol is an alcohol made by fermenting the sugar components of plant materials and it is made mostly from sugar and starch crops. With advanced technology being developed, cellulosic biomass, such as trees and grasses are also used as feed stocks for ethanol production. Ethanol can be used as a fuel for vehicles in its pure form. Bioethanol is widely used in the USA and Brazil.

Biodiesel: Biodiesel is made from vegetable oil and animal fats. It is used as a fuel for vehicles in its pure form.

Biogas: Biogas is produced by the process of anaerobic digestion of organic material by anaerobes. It can be produced either from bio degradable waste material or by the use of energy crops fed into anaerobic digesters to supplement gas yields. The solid by product, digestable can be used as biofuel or fertilizer.

8.8.5 ENERGY CONSERVATION & HOW WE CAN HELP

Energy conservation

Energy conservation refers to efforts made to reduce energy consumption in order to preserve resources for the future and reduce environmental pollution. It can be achieved through efficient energy use or by reduced consumption of energy services. Energy conservation may result in increase of financial capital, environmental value, national security, personal security and human comfort. Individuals and organizations that are direct consumers of energy may want to conserve energy in order to reduce energy costs and promote economic security. Industrial and commercial users may want to increase efficiency and thus maximize profit. Electrical energy conservations are the important element of energy policy.

Lighting

1. Turn off the lights when not in use.
2. De-dust lighting fixtures to maintain illumination.
3. Focus the light where you need.
4. Use fluorescent bulbs.
5. Use electronic chokes in place of conventional copper chokes.

Fans

1. Replace conventional regulators with electronic regulators for ceiling fans.
2. Install exhaust fans at a higher elevation than ceiling fans.

Electric Iron

1. Select iron boxes with automatic temperature cut off.
2. Use appropriate regulator position for ironing.

3. Do not put more water on clothes while ironing.
4. Do not iron wet clothes.

Gas Stove

1. When cooking on a gas burner, use moderate flame settings to conserve LPG.
2. Remember that a blue flame means your gas stove is operating efficiently.
3. If there is yellowish flame, this indicates that the burner needs cleaning.
4. Use pressure cooker as much as possible.
5. Use lids to cover the pans while cooking.
6. Use solar water heater – a good replacement for a electric water heater.

Electronic Devices

1. Do not switch on the power when TV and Audio systems are not in use. i.e., idle operation leads to an energy loss of 10 watts / device.
2. Battery chargers such as those for laptops, cell phones and digital cameras, draw power whenever they are plugged in and are very inefficient. Pull the plug and save.

Washing Machine

1. Always wash only with full loads.
2. Use optimal quantity of water.
3. Use timer facility to save energy.
4. Use the correct amount of detergent.
5. Use hot water only for very dirty clothes.
6. Always use cold water in the rinse cycle.

EVALUATION

PART A

1. Example for water-borne disease is

   (scabies, dracunculiasis, trachoma, typhoid)

2. The settled and floating materials are removed by this treatment method.

   (primary treatment, secondary treatment, tertiary treatment, peripheral treatment)

3. Which is a non-renewable resource?

   (coal, petroleum, natural gas, all the above)

4. ---------- is the chief component of natural gas.

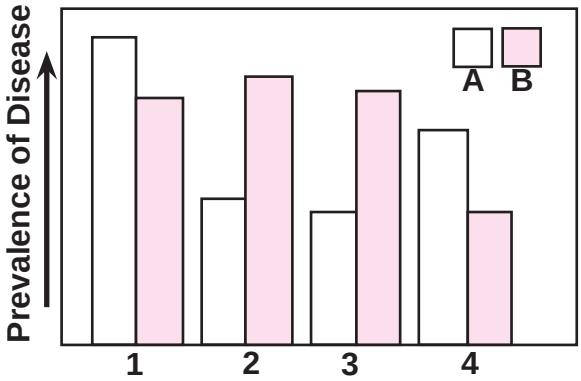
   (ethane, methane, propane, butane)

PART B

5. The bar graph indicates the presence of the infectious diseases in two cities A and B. Observe it and answer the questions given below.

   1. Dengue fever 2. Rat fever
   3. Cholera 4. Chikungunya

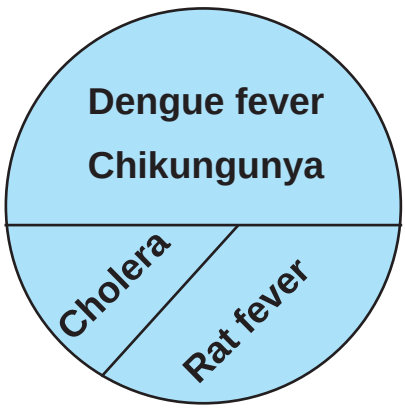
   a. What may be the reason for the disease in the city A?



b. Which city needs more careful waste disposal and cleaning?

c. How can the disease be controlled in city A?

6. The pie diagram represents a survey result of infectious diseases of a village during 2008 – 2009. Analyse it and answer the following chart



Which diseases affect the majority of the population?

a. How are these diseases transmitted?

b. Write any three measures to control the other two diseases.

7. Match the suitable renewable and non-renewable sources.

Sources	A	B	C
Renewable	Coal	Wind	Petroleum
Non-Renewable	Hydrogen	Natural gas	Solar energy

8. Odd one out

a. bio alcohol, green diesel, bio ethers, petroleum

b. cholera, typhoid, scabies, dysentry

9. A non renewable resource is a natural resource if it is replaced by natural process at a rate comparable or faster than its rate of consumption by humans. Read this statement and confirm whether it is correct or incorrect. If it is incorrect give correct statement.

10. Pick out the suitable appliances to conserve the electric energy.

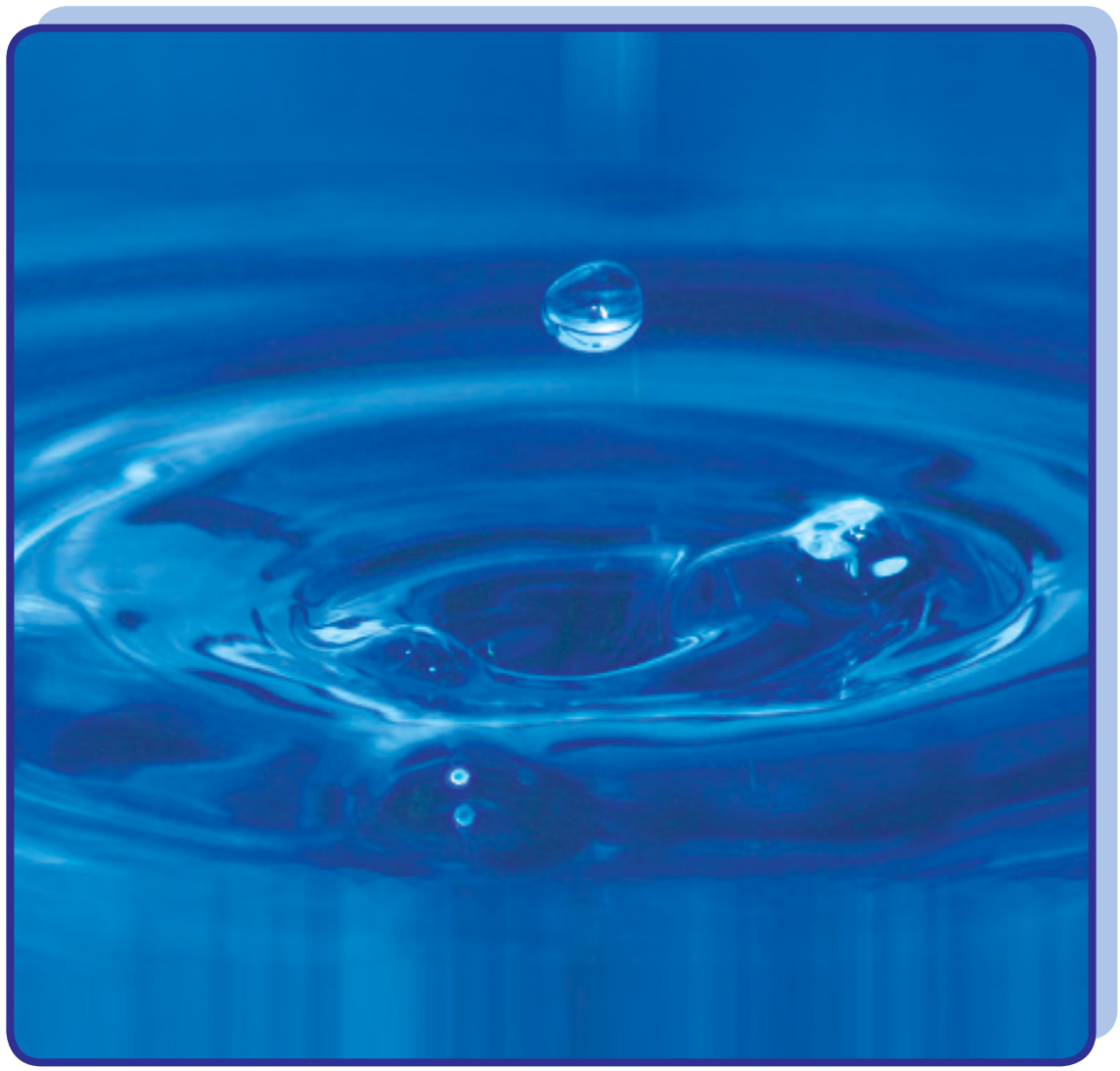
Florescent bulbs, copper choke, solar water heater, electric water heater, tungsten bulbs, electronic choke.

FURTHER REFERENCE

Books: 1. Land treatment of waste water M.B. Gohil Publisher : New Age International (p) Ltd.

Website: 2. Sewage, en.wikipedia-org/wiki/sewage -treatment.

Chapter 9



SOLUTIONS

9. Solutions

Result of health drink

Health drink

Anu has got back home from playfield after winning a match. She is received by her mother cheerfully with a glass of health drink.

Anu: Mother! What is this?

Mother: This is your health drink – a solution of fruit juice and sugar for your revitalisation.

Solutions are of great importance in **everyday** life. The process of food assimilation by man is in the form of solution. Blood and lymph are in the form of solution to decide the physiological activity of human beings.

A solution is a homogeneous mixture of two (or) more substances.

All solutions exist in homogeneous form. **Homogeneous** refers to the state in which two (or) more substances, that are uniformly present in a given mixture. If a solution contains two components, then it is called as a **Binary Solution**.

Salt solution containing common salt in water is a suitable example for binary solution.

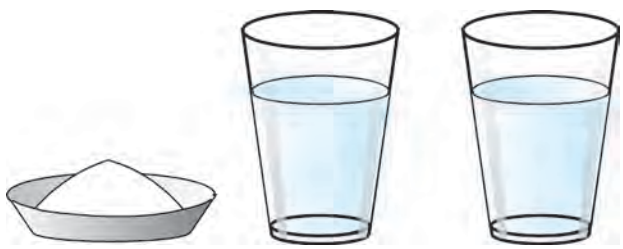


Fig. 9.1 A solution is a homogenous mixture of solute and solvent

9.1. SOLUTE AND SOLVENT

In a solution, the component present in lesser amount by weight is called **solute** and the component present in a larger amount by weight is called **solvent.** Generally a solvent is a dissolving medium. It surrounds the particles of solute to form solution.

In short, a solution can be represented, as follows

(Solute + Solvent → Solution)

9.2. TYPES OF SOLUTIONS

9.2.1. Based on the particle size

Based on the particle size of the substance, the solutions are divided into three types.

1. **True solutions:** It is a homogeneous mixture that contains small solute particles that are dissolved throughout the solvent eg. Sugar in water.

2. **Colloidal solutions:** It is a heterogeneous mixture made up of two phases namely, dispersed phase and dispersion medium. The substance distributed as particles is called **dispersed phase.** The continuous phase in which the colloidal particles are dispersed is called **dispersion medium.**

(Dispersed phase + Dispersion medium → Colloidal solution)

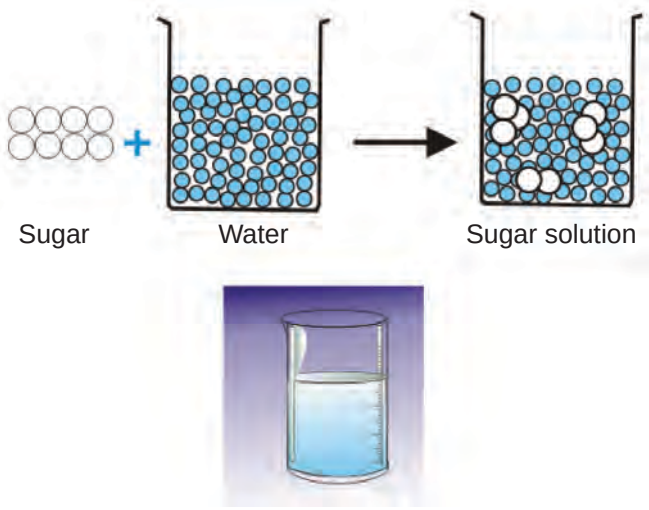


Fig. 9.2 Mixture of sugar and water forming true solution

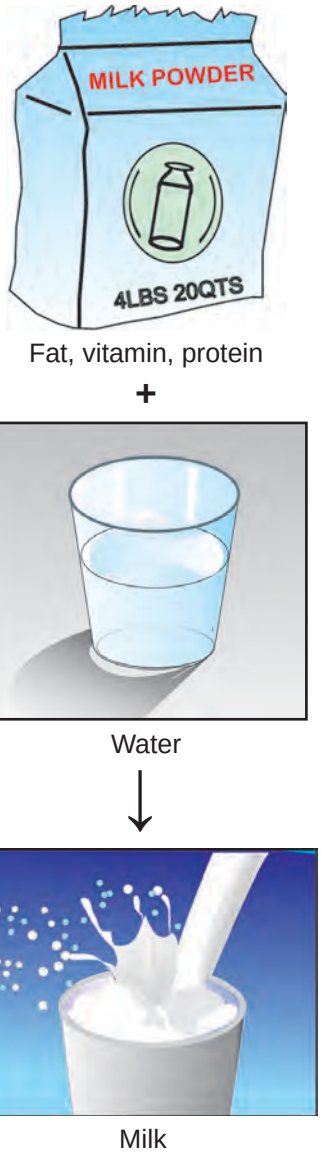


Fig. 9.3 A mixture of milk powder and water forming colloid

3. Suspensions: It is a heterogeneous mixture of small insoluble particles in a solvent. In a suspension, the particles of solid stay in clusters that are large enough to be seen (e.g. Chalk powder in water).

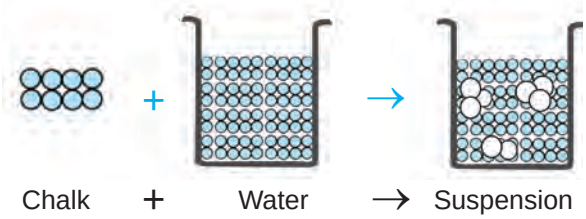


Fig. 9.4 A mixture of chalk and water forming suspension

MORE TO KNOW

Tyndall effect, The phenomenon by which colloidal particles scatter light is called **Tyndall effect**. If a beam of light is allowed to pass through a true solution, some of the light will be absorbed and some will be transmitted. The particles in true solution are not large enough to scatter the light. However if light is passed through a colloid, the light is scattered by the larger colloidal particles and the beam becomes visible. This effect is called TYNDALL EFFECT

ACTIVITY 9.1

Students may be asked to observe the scattering of light (Tyndall effect) when sunlight passes through the window of the class rooms. The dust particles scatter the light making the path of the light visible.

Fig. 9.5 Tyndall effect in nature

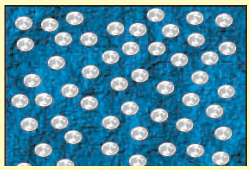
MORE TO KNOW

Brownian movement: The phenomenon by which the colloidal particles are in continuous random motion is called **Brownian movement.**

Brownian motion is named in honour of ROBERT BROWN a biologist.He observed the motion of the particles in suspension of pollen grains in water.

Fig. 9.6 Brownian movement

Comparing the properties of true solution,colloidal solution and suspension

Property	True Solution	Colloidal Solution	Suspension
Particle size in A^O ($1A^O = 10^{-10}m$)	 $1A^O$ to $10\ A^O$	 $10A^O$ to $2000\ A^O$	 More than $2000\ A^O$
Appearance	Transparent	Translucent	Opaque
Visibility of particles	Not visible even under ultra microscope	Visible under ultra microscope	Visible to the naked eye
Nature	Homogeneous	Heterogeneous	Heterogeneous
Diffusion of particles	diffuses rapidly	diffuses slowly	diffusion does not occur
Scattering effect	Does not scatter light	It scatters light	It does not scatter light

9.2.2. Based on the type of solvent.

Based on the type of solvent solutions are classified into two types

1. **Aqueous solution:** The solution in which water acts as a solvent, is called **aqueous solution**. For e.g., sugar solution.
2. **Non-aqueous solution:** The solution in which any liquid other than water acts as a solvent is called **non-aqueous solution**. Solution of sulphur in carbon disulphide is a suitable example for non-aqueous solution. (Benzene, ether, CS_2, are some of the examples for non aqueous solvents.)

9.2.3. Based on the amount of solute in the given solution

Based on the amount of solute in the given amount of solvent, solutions are classified into the following types.

1. Unsaturated solution
2. Saturated solution
3. Super saturated solution

1. **Unsaturated solution:** A solution in which the solute is in lesser amount in comparison with the solvent is called unsaturated solution. In this, addition of solute is possible till the solution reaches the point of saturation.

   e.g., 5g or 10g or 20g of NaCl in 100g water

2. **Saturated solution:** A solution in which no more solute can be dissolved in a definite amount of solvent at a given temperature is called a saturated solution e.g.,

i) A saturated solution of CO_2 in H_2O

ii) 36g of NaCl in 100g of water at room temperature forms saturated solution

3. **Super saturated solution:** A solution which has more of solute at a given temperature than that of saturated solution is called **super saturated solution**.

MORE TO KNOW

Nitrogen in earth soil is an example for saturated solution in nature. (Earth soil cannot store more N_2 than it can hold)

ACTIVITY 9.2

Test whether a solution is saturated, unsaturated or super-saturated with respect to the addition of salt at a particular temperature to the solution.

Take a glass containing 100ml of water, three packets of salts each weighing 20g, 16g, and 1g and a table spoon (see fig 9.7).

Record your observations after the addition of each packet in the given order followed by stirring at each stage.

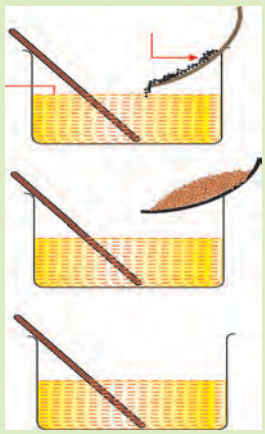


Fig. 9.7 To test Unsaturation, Saturation and Super Saturation in a given solution

9.2.4 Based on the physical state of the solute and the solvent the solutions are of 9 types.

Solute	Solvent	Examples
Solid	Solid	Alloys
Solid	Liquid	Sugar solution
Solid	Gas	smoke
Liquid	Solid	cheese
Liquid	Liquid	Milk
Liquid	Gas	Cloud
Gas	Solid	Cork
Gas	Liquid	Soda water
Gas	Gas	Helium-oxygen mixture (for deep sea diving)

9.3. SOLUBILITY

Solubility of a solute in a given solvent at a particular temperature is defined as the number of grams of solute necessary to saturate 100g of the solvent at that temperature. For example

Solubility of $CuSO_4$ in H_2O is 20.7g at 20°C

MORE TO KNOW

Dilute and concentrated solutions: Concentration of a solution is the amount of solute dissolved in a given amount of solvent. A solution containing less amount of solute is known as dilute solution whereas a solution containing large amount of solute is known as concentrated solution. It may be noted that dilute and concentrated are the relative terms and they have only quantitative meaning.

ACTIVITY 9.3

Determine the solubility of a solid (say KCl) in water at room temperature.

- Prepare saturated solution of KCl in about 30 ml of water at room temperature. Add more of KCl ensuring that solution is saturated and some KCl is left undissolved.
- Filter the solution to remove solid KCl.
- Find temperature of the solution by dipping a thermometer in it.
- Evaporate the solution to dryness by using a low flame to avoid bumping.
- Allow the dish and solid to cool to room temperature. Place the dish and solid in a dessicator containing anhydrous calcium chloride (calcium chloride is dehydrating agent, it absorbs moisture).

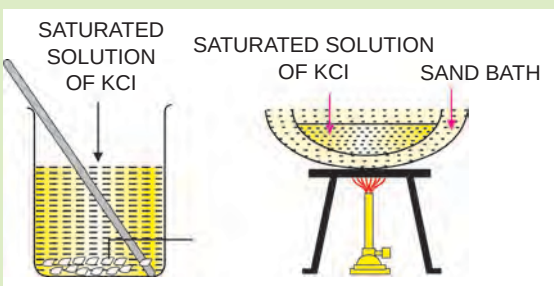


Fig. 9.8 Determination of solubility

- Take out the evaporating dish and again weigh it.
- The observation and calculation are given as follows.

Observation

Weight of the dish = W g

Weight of dish + saturated solution of KCl = W_1 g

Weight of dish + dry KCl = W_2 g

Calculation

Weight of saturated solution = $(W_1 - W)$ g

Weight of KCl = $(W_2 - W)$ g

Weight of water present in saturated solution

$= [(W_1 - W) - (W_2 - W)]$ g

$= [(W_1 - W_2)$ g

$$\text{Solubility of KCl} = \frac{\text{Weight of KCl}}{\text{Weight of solvent}} \times 100$$

$$= \frac{(W_2 - W)}{(W_1 - W_2)} \times 100$$

Tit Bit

100ml of water can dissolve 36g of NaCl at 25^{0}C to attain saturation.

Solubility of some ionic compounds at 25°c

Substance	Solubility (g per 100g water)
NaCl	36 g
NaBr	95 g
NaI	184 g
$NaNO_3$	92 g

9.4. FACTORS AFFECTING SOLUBILITY

1. Temperature
2. Nature of solute (or) solvent
3. Pressure

1. Effect of Temperature

In endothermic process, solubility increases with increase in temperature.

e.g., Solubility of KNO_3 increases with the increase in temperature.

In exothermic process, solubility decreases with increase in temperature.

e.g., Solubility of CaO decreases with increase in temperature.

2. Nature of solute and solvent

Solubility of a solute in a solvent depends on the nature of both solute and solvent. A polar compound dissolves in a polar solvent.

e.g., Common salt dissolves in water. A polar compound is less soluble (or) insoluble in a non polar solvent.

3. Effect of pressure

Effect of pressure is observed only in the case of gases. An increase in pressure increases the solubility of a gas in a liquid. For eg. CO_2 gas is filled in soft drinks using the effect of pressure.

Fig. 9.9 CO_2 filled in soft drinks

MORE TO KNOW

Increase in pressure increases the solubility of gases. At a given temperature, the mass of gas dissolved in a fixed volume of liquid is directly proportional to the pressure of the gas on the surface of the liquid. This is called **Henry's Law.**

PROBLEM 1

Take 10g of common salt and dissolve it in 40g of water. Find the concentration of solution in terms of weight percent.

Weight percent

$$= \frac{\text{Weight of the solute}}{\text{Weight of solute + Weight of solvent}} \times 100$$

$$= \frac{10}{10 + 40} \times 100 = 20\%$$

PROBLEM 2

2g of potassium sulphate was dissolved in 12.5 ml of water. On cooling, the first crystals appeared at 60°C. What is the solubility of potassium sulphate in water at 60°C?

SOLUTION

12.5 ml of water weighs 12.5g.

In 12.5g of water, amount of potassium sulphate dissolved, is 2g

In 1g of water, amount of potassium sulphate dissolved, is 2/12.5 g

Hence in 100g of water, amount of potassium sulphate dissolved, is (2 x 100)/12.5=16g.

The solubility of potassium sulphate in water at 60ºC is 16g.

PROBLEM 3

50g of saturated solution of NaCl at 30°C is evaporated to dryness when 13.2g of dry NaCl was obtained. Find the solubility of NaCl at 30°C in water.

Mass of water in solution = 50-13.2 = 36.8g

Solubility of NaCl =

$$\frac{\text{Mass of NaCl}}{\text{Mass of water}} \times 100 = \frac{13.2}{36.8} \times 100 = 36g$$

Solubility of NaCl = 36g (appx.)

PROBLEM 4

An empty evaporating dish weighs 20.0g On the addition of saturated solution of $NaNO_3$, the dish weighs 66.0g. When evaporated to dryness, the dish with crystals weighs 41.5g. Find the solubility of $NaNO_3$ at 20°C.

SOLUTION

Weight of saturated solution of $NaNO_3$ = (66.0 – 20.0) g = 46.0g

Weight of crystals of $NaNO_3$ = (41.5-20.0) g = 21.5g

Weight of water in saturated solution = (46.0-21.5) g = 24.5g

Solubility of $NaNO_3$ =

$$\frac{\text{Weight of } NaNO_3 \text{ Crystals}}{\text{Weight of water}} \times 100$$

$$= \frac{21.5}{24.5} \times 100 = 87.7g$$

Solubility of $NaNO_3$ at 20°C is = 87.7g in 100g H_2O

EVALUATION

PART - A

1. A true solution is a homogeneous mixture of solute and solvent. Chalk powder in water is a heterogenous mixture. Is it a true solution?
2. Solution that contains water as the solvent is called aqueous solution. If carbon disulphide is a solvent in a given solution, then the solution is called _____.
3. Solubility of common salt in 100g water is 36g. If 20g of salt is dissolved in it how much more is required to attain saturation.
4. If two liquids are mutually soluble, they are called _____ liquids. (miscible, immiscible)
5. When sunlight passes through window of the classrooms its path is visible. This is due to _____of light. (reflection, scattering)
6. The particles in various forms are visible only under ultramicroscope. A solution containing such particles is called _____. (True solution, colloidal solution)
7. The mixture of gases used by deep sea divers is _____(Helium-oxygen, oxygen-nitrogen)
8. Earth soil cannot store more nitrogen than it can hold. Hence earth soil is referred to be in a state of _____. (saturation, unsaturation)
9. In an endothermic process, solubility increases with _____ in temperature. (increase, decrease)

PART - B

10. From the table given below , furnish your points of inferences.

Substance	Solubility at 25°C
NaCl	36g
NaBr	95g
NaI	184g

11. Distinguish between the saturated and unsaturated solution using the data given below at a temperature of 25°C

    A. 16g NaCl in 100g water
    B. 36g NaCl in 100g water

Note : Solubility of NaCl is 36g

12. You have prepared a saturated solution of sugar. Is it possible to dissolve some more grams of sugar to this solution? Justify your stand.
13. Find the concentration of solution in terms of weight percent if 20 gram of common salt is dissolved in 50 gram of water.

FURTHER REFERENCE :

BOOKS: 1. Physical Chemistry by : **Puri & Sharma** - Vishal Publication
2. Advanced Chemistry by: **Bahl & Arun Bahl** - S.Chand publishers

WEBSITE: www.chemistry explained.com www.sparknotes.com

10. Atoms & molecules

ATOMS AND MOLECULES

Rani shows a piece of chalk to Vani & asks her to break it into minute particles. The breaking spree, goes on and on endlessly and finally they come to conclude that the minute particle is a group of invisible atoms. They get set to probe further.

EXPLORING THE ATOM

The word atom is derived from the Greek word **"Atomos"** which means indivisible. John Dalton modelled atoms as hard indivisible spheres.

His theory remained undisputed for about a century without any changes. However towards the end of 19th and in the beginning of 20th centuries, the introduction of matter wave concept by de Broglie, the principle of uncertainty by Heisenberg etc., paved the way for **modern atomic theory or modified atomic theory.**

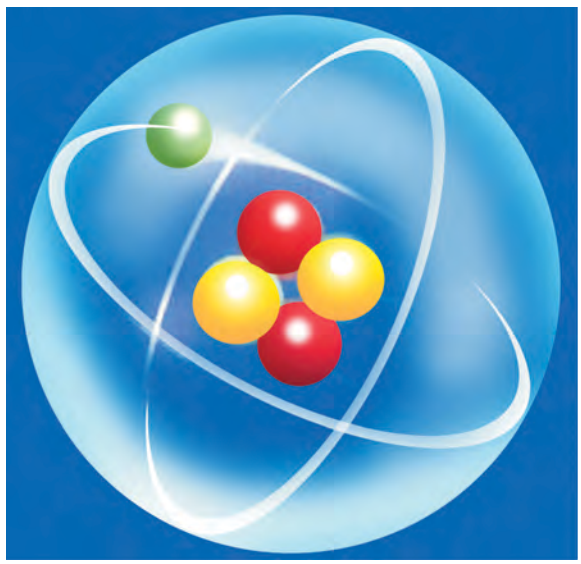


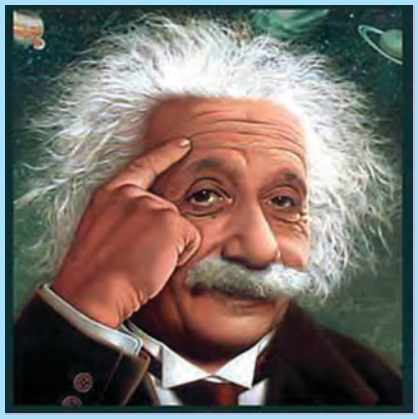
Fig. 10.1 Inner View of an atom

10.1. MODERN ATOMIC THEORY

The findings of **modern atomic theory** are given as follows.

- Atom is considered to be a divisible particle.
- Atoms of the same element may not be similar in all respects.
  eg: Isotopes ($_{17}Cl^{35}$, $_{17}Cl^{37}$)
- Atoms of different elements may be similar in some respects
  eg. Isobars ($_{18}Ar^{40}$; $_{20}Ca^{40}$)
- Atom is the smallest particle which takes part in chemical reactions.
- The ratio of atoms in a molecule may be fixed and integral but may not be simple
  e.g., $C_{12}H_{22}O_{11}$ is not a simple ratio (Sucrose)

ALBERT EINSTEIN



When a nuclear reaction occurs the mass of the product is found to be less than the mass of the reactants. The difference in mass is converted into energy in accordance with the equation $E = mc^2$, where E = energy liberated, m = disappeared mass and c = speed of light. This famous equation of Einstein, made revolution in nuclear science.

- Atoms of one element can be changed into atoms of other element by transmutation.
- The mass of an atom can be converted into energy. This is in accordance with Einstein's equation $E = mc^2$

10.2. AVOGADRO'S HYPOTHESIS

Amedeo Avogadro put forward hypothesis and is based on the relation between number of molecules and volume of gases.

Avogadro's Law: Equal volumes of all gases under the same conditions of temperature and pressure. contain the equal number of molecules.

10.2.1. Atomicity

The number of atoms present in one molecule of an element is called the atomicity of an element.

Depending upon the number of atoms in one molecule of an element, molecules are classified into monoatomic, diatomic, triatomic, and poly atomic molecules.

For any homo atomic molecule atomicity can be deduced using the formula

$$\text{Atomicity} = \frac{\text{Molecular Mass}}{\text{Atomic mass}}$$

Avogadro's Law enables us to change over directly from a statement about volume of gases to a statement about molecules of gases and vice-versa.

MORE TO KNOW

Isotopes ⇒ These are the atoms of same element with same atomic number (Z) but different mass number (A). example ($_{17}Cl^{35}$, $_{17}Cl^{37}$)

Isobars ⇒ These are the Atoms of the different element with same mass number but different atomic number. example ($_{18}Ar^{40}$, $_{20}Ca^{40}$)

Isotones ⇒ These are the atoms of different elements with same number of neutrons Example : ($_{6}C^{13}$, $_{7}N^{14}$)

Atomicity	No. of atoms per molecule	Eg
Monoatomic	1	Helium (He) Neon (Ne) Metals
Diatomic	2	Hydrogen H_2 Chlorine Cl_2
Triatomic	3	Ozone (O_3)
Polyatomic	>3	phosphorous P_4 Sulphur S_8

e.g.,

N_2 + O_2 → 2 NO

Nitrogen (1 Vol) Oxygen (1 Vol) Nitric oxide (2 Vols)

After applying Avogadro's Law, the equation,becomes

N_2 + O_2 → 2 NO

1 Molecule 1 Molecule 2 Molecules

MORE TO KNOW

Avogadro an Italian Scientist (1766 – 1856) He was the One to propose that volume of a gas at a given temperature and pressure is proportional to the number of particles.

TEST YOUR UNDERSTANDING SKILL

1. Find the atomicity of chlorine if its atomic mass is 35.5 and its molecular mass is 71
2. Find the atomicity of ozone if its atomic mass is 16 and its molecular mass is 48

It is found that two molecules of nitric oxide contains 2 atoms of nitrogen and 2 atoms of oxygen.

These two atoms of nitrogen and the two atoms of oxygen should have come from 1 molecule of nitrogen and 1 molecule of oxygen, respectively.

Hence, nitrogen and oxygen are called **diatomic molecules** and are written as N_2 and O_2.

This proves that, atomicity of Nitrogen is 2 and the atomicity of oxygen is 2

Thus Avogadro's hypothesis is used in the deduction of atomicity of elementary gases.

10.2.2. To establish the relationship between vapour density and relative molecular mass of a gas

i. **Relative Molecular Mass:** It is defined as the ratio of the mass of 1 molecule of the gas or vapour to the mass of 1 atom of hydrogen.

$$\text{Relative molecular mass of a gas} = \frac{\text{Mass of 1molecule of the gas or vapour}}{\text{Mass of 1 atom of hydrogen}}$$

ii. **Vapour Density (V.D):** It is defined as the ratio of the mass of a certain volume of the gas or vapour to the mass of the same volume of hydrogen at the same temperature and pressure.

$$\text{V.D} = \frac{\text{Mass of 1 volume of gas or vapour}}{\text{Mass of 1 volume of hydrogen}}$$

Applying Avogadro's Law,

$$\text{V.D} = \frac{\text{Mass of 1 molecule of gas or vapour}}{\text{Mass of 1 molecule of hydrogen}}$$

Since hydrogen is diatomic,

$$\text{V.D} = \frac{\text{Mass of 1 molecule of gas or vapour}}{2 \times \text{Mass of 1 atom of hydrogen}}$$

Multiplying both sides by 2, we get

$$2 \times \text{V.D} = \frac{\text{Mass of 1 molecule of gas or vapour}}{\text{Mass of 1 atom of hydrogen}}$$

2 x V.D = relative molecular mass of a gas or vapour

2 x Vapour density = Relative molecular mass

How to arrive at the value of *GRAM MOLAR VOLUME (GMV)*

$$GMV = \frac{GRAM\ MOLAR\ MASS}{DENSITY\ OF\ GAS\ AT\ STP}$$

To find the value of

$$\text{GMV OF OXYGEN} = \frac{\text{GMM of } O_2}{\text{DENSITY OF } O_2}$$

$$= 32/1.429$$

$$= 22.4 \text{ lit}$$

Therefore GMV = 22.4 litre at STP

MORE TO KNOW

Gay-Lussac's law of Combining volumes of gases

Whenever gases react, they do so in volumes which bear a simple ratio to one another, and to the volumes of the gaseous products, provided all the volumes are measured under the same conditions of temperature and pressure.

10.2.3. Applications of Avogadro's law

1. It is used to determine the atomicity of gases.

2. It is helpful in determining the molecular formula of gaseous compound.
3. It establishes the relationship between the vapour density and molecular mass of a gas.
4. It gives the value of molar volume of gases at STP. Molar Volume of a gas at STP=22.4 lit (or) 22400 cm^3.
5. It explains Gay Lussac's law effectively.

10.3. ATOMS AND MOLECULES

Atoms and molecules are the building blocks of the matter.

10.3.1. Atom: It is the ultimate particle of an element which may or may not have independent existence. The atoms of certain elements such as hydrogen, oxygen, nitrogen, etc.do not have independent existence whereas atoms of helium,neon,argon,etc. do have independent existence. All elements are composed of atoms.

10.3.2. Molecule: A molecule is the simplest structural unit of an element (or) a compound which contains one (or) more atoms. It retains the characteristics of an element.

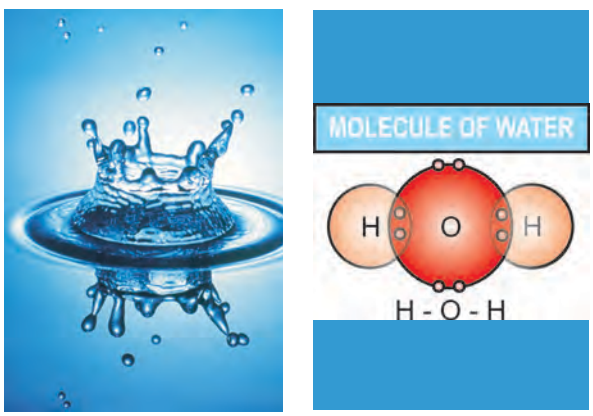


Fig 10.2 Molecule of water

POINT TO EXPLORE

Name the elements and find their number of atoms in one molecule of a) Nitrogen b) Water c) Ammonia d) Sulphuric acid.

A molecule can exist freely and it is a combined form of bonded units whereas an atom is a singular smallest form of non bonded unit.

10.3.3. Differences between atom and molecule:

Atom	Molecule
The smallest particle of an element that can take part in a chemical reaction.	The smallest particle of an element or a compound that can exist freely.
An atom is a non bonded entity	A molecule is a bonded entity
An atom may or may not exist freely	A molecule can exist freely

Molecules are of two types, namely homo atomic molecules and hetero atomic molecules.

1. Homo atomic molecules

These are the molecules which are made up of atoms of the same element.

Most of the elementary gases consist of homo atomic molecules. For example hydrogen gas consists of two atoms of hydrogen (H_2).Similarly oxygen gas consists of two atoms of oxygen (O_2). In accordance with the number of atoms present in these molecules they are classified as monoatomic, diatomic, triatomic or poly atomic molecules showing that they contain one, two, three, or more than three atoms respectively.

2. HETERO ATOMIC MOLECULES

The hetero atomic molecules are made up of atoms of different elements. They are also classified as diatomic, triatomic, or polyatomic molecules depending upon the number of atoms present. H_2O, NH_3, CH_4, etc., are the examples for hetero atomic molecules.

10.4. RELATIVE ATOMIC MASS (RAM)

10.4.1. Definition (based on hydrogen scale)

$$\text{RAM} = \frac{\text{Mass of 1 atom of an element}}{\text{Mass of 1 atom of hydrogen}}$$

The relative atomic mass of an element is the ratio of mass of one atom of the element to the mass of one atom of hydrogen taken as standard.

10.4.2. Definition (based on carbon scale)

$$\text{RAM} = \frac{\text{Mass of 1 atom of an element}}{\frac{1}{12}\text{ th part of the mass of one atom of carbon}}$$

Relative atomic mass of an element is the ratio of mass of one atom of element to the **1/12**th part of mass of one atom of carbon.

Relative atomic mass is a pure ratio and has no unit. If the atomic mass of an element is expressed in grams, it is known as **gram atomic mass.**

e.g.,

Gram atomic mass of hydrogen = 1g

Gram atomic mass of carbon = 12g

Gram atomic mass of nitrogen = 14g

Gram atomic mass of oxygen = 16g

Gram atomic mass of sodium = 23g

Atomic mass is expressed in atomic mass unit (**amu**). **One atomic mass unit is defined as 1/12th part of the mass of one atom of carbon.**

10.5. RELATIVE MOLECULAR MASS(RMM)

10.5.1. Definition (based on hydrogen scale)

$$\text{RMM} = \frac{\text{Mass of 1 molecule of an element / compound}}{\text{Mass of 1 atom of hydrogen}}$$

The relative molecular mass of an element or a compound is the ratio of mass of one molecule of the element or a compound to the mass of one atom of hydrogen.

10.5.2. Definition (based on carbon scale)

$$\text{RMM} = \frac{\text{Mass of 1 molecule of an element / compound}}{\frac{1}{12}\text{ th part of the mass of one atom of carbon}}$$

The relative molecular mass of an element or a compound is the ratio of mass of one molecule of the element or a compound to the mass of 1/12 th part of mass of one atom of carbon.

Relative Molecular mass is a pure ratio and has no unit. If the molecular mass of a given substance is expressed in gram, it is known as **gram molecular mass** of that substance.

Molecular mass is the sum of the masses of all the atoms present in one molecule of the compound or an element.

Gram molecular mass calculations to test your numerical skill

1. Find the gram molecular mass of water (H_2O)

calculation

$2(H) = 2 \times 1 = 2$

$1(O) = 1 \times 16 = 16$

18

∴ **Gram molecular mass of H_2O = 18g**

2. Find the gram molecular mass of carbon dioxide (CO_2)

$1(C) = 1 \times 12 = 12$

$2(O) = 2 \times 16 = 32$

44

Gram molecular mass of CO_2 = 44 g

10.6. MOLE CONCEPT

While performing a reaction, to know the number. of atoms (or) molecules involved, the **concept of mole** was introduced. The quantity of a substance is expressed in terms of mole.

Shown here in Fig.10.3 are one mole quantities of each of the following materials: (clockwise from top left) 180g of acetylsalicylic acid (aspirin), 18.0g of water, 342g of sucrose (table sugar), 201g

Fig. 10.3 Mole in various forms

of mercury, 55.9g of iron, 58.5g of sodium chloride (table salt), and 254g of iodine.

10.6.1. Definition of mole

Mole is defined as the amount of substance that contains as many specified elementary particles as the number of atoms in 12g of carbon-12 isotope.

One mole is also defined as the amount of substance which contains Avogadro number (6.023×10^{23}) of particles.

Avogadro number: Number of atoms or molecules or ions present in one mole of a substance is called Avogadro number. Its value is 6.023×10^{23}.

Therefore, one mole of any substance contains Avogadro number of particles. The particles may be atoms, molecules, ions etc.,

For eg. one mole of oxygen atoms represents 6.023×10^{23} atoms of oxygen and 5 moles of oxygen atoms contain $5 \times 6.023 \times 10^{23}$ atoms of oxygen.

To find the number of moles, the following formulae are useful

$$\text{Number of moles} = \frac{\text{Mass}}{\text{atomic mass}}$$

$$\text{Number of moles} = \frac{\text{Mass}}{\text{molecular mass}}$$

$$\text{Number of moles} = \frac{\text{No. of atoms}}{6.023 \times 10^{23}}$$

$$\text{Number of moles} = \frac{\text{No. of molecules}}{6.023 \times 10^{23}}$$

WATCH OUT !

It may be noted that while using the term mole it is essential to specify the kind of particles involved.

10.6.2. Problems (based on mole concept)

1. *When the mass of the substance is given:*

$$\text{Number of moles} = \frac{\text{given mass}}{\text{atomic mass}}$$

a. Calculate the number of moles in

i) 81g of aluminium ii) 4.6g sodium iii) 5.1g of Ammonia iv) 90g of water v) 2g of NaOH

$$\text{Number of moles} = \frac{\text{given mass}}{\text{atomic mass}} = \frac{81}{27}$$

= 3 moles of aluminium

FOLLOW UP: Find the number of moles for remaining problems given above.

b. Calculate the mass of 0.5 mole of iron

Solution: mass = atomic mass x number of moles

= 55.9 x 0.5 = 27.95 g

FOLLOW UP: Find the mass of 2.5 mole of oxygen atoms

Mass = molecular mass x number of moles

2. *Calculation of number of particles when the mass of the substance is given:*

$$\text{Number of particles} = \frac{\text{Avogadro number} \times \text{given mass}}{\text{gram molecular mass}}$$

a. Calculate the number. of molecules in 11g of CO_2

Solution: gram molecular mass of CO_2 = 44g

$$\text{Number. of molecules} = \frac{6.023 \times 10^{23} \times 11}{44}$$

= **1.51×10^{23} molecules**

FOLLOW UP: Calculate the number of molecules in 360g of glucose.

3. *Calculation of mass when number of particles of a substance is given:*

$$\text{Mass of a substance} = \frac{\text{gram molecular mass} \times \text{number of particles}}{6.023 \times 10^{23}}$$

a. Calculate the mass of 18.069×10^{23} molecules of SO_2

Sol: Gram molecular mass SO_2 = 64g

Mass of SO_2

$$= \frac{64 \times 18.069 \times 10^{23}}{6.023 \times 10^{23}} = 192 \text{ g}$$

b. Calculate the mass of glucose in 2×10^{24} molecules

Gram molecular mass of glucose = 180g

Mass of glucose

$$= \frac{180 \times 2 \times 10^{24}}{6.023 \times 10^{23}} = 597.7\text{g}$$

FOLLOW UP: Calculate the mass of 12.046×10^{23} molecules in CaO.

4. *Calculation of number of moles when you are given number of molecules:*

a. Calculate the number moles for a substance containing 3.0115×10^{23} molecules in it.

$$\text{Number of moles} = \frac{\text{Number of molecules}}{\text{Avogadro Number}}$$

$$= \frac{3.0115 \times 10^{23}}{6.023 \times 10^{23}} = 0.5 \text{ moles}$$

b. Calculate number of moles in 12.046×10^{22} atoms of copper

Number of moles of atoms

$$= \frac{\text{Number of atoms}}{\text{Avogadro Number}}$$

$$= \frac{12.046 \times 10^{22}}{6.023 \times 10^{23}} = 0.2 \text{ moles}$$

FOLLOW UP: Calculate the number of moles in 24.092×10^{22} molecules of water.

MORE TO KNOW

Molar volume: Volume occupied by one mole of any gas at STP is called molar volume. Its value is 22.4 litres

22.4 litres of any gas contains 6.023×10^{23} molecules.

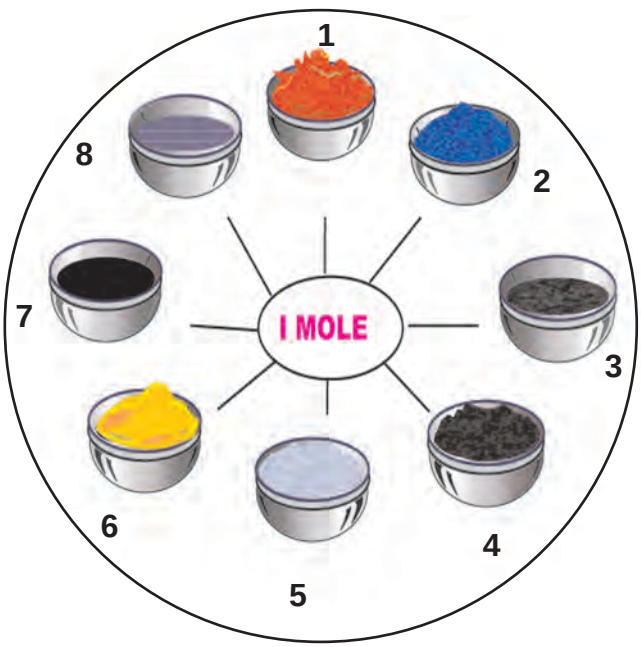


Fig. 10.4 More illustrations for mole in various forms

1. 162.4 g of FeCl3

2. 159.6g of CuSO4

3. 27g of Al

4. 56g of Fe

5. 58.5 g of NaCl

6. 32g of S

7. 12g of C

8. 200.6g of Hg

EVALUATION

PART A

1. From the given examples, form the pair of isotopes and the pair of isobars

   $_{18}Ar^{40}$, $_{17}Cl^{35}$, $_{20}Ca^{40}$, $_{17}Cl^{37}$

2. Molecular mass of nitrogen is 28. Its atomic mass is 14. Find the atomicity of nitrogen.
3. Gram molecular mass of oxygen is 32g. Density of oxygen is 1.429g/cc. Find the gram molecular volume of oxygen.
4. 'Cl' represents chlorine atom, 'Cl_2' represents chlorine molecule.

   List out any two differences between atoms and molecules.
5. Calculate the gram molecular mass of water from the values of gram atomic mass of hydrogen and of oxygen.

   Gram atomic mass of hydrogen = 1g

   Gram atomic mass of oxygen = 16g
6. One mole of any substance contains 6.023×10^{23} particles.

   If 3.0115×10^{23} particles are present in CO_2. Find the number of moles.

PART B

1. Modern atomic theory takes up the wave concept, principle of uncertainty and other latest discoveries to give a clear cut picture about an atom. State the findings of modern atomic theory.
2. You are given the values of mass of one volume of oxygen gas and the mass of one volume of hydrogen. By applying Avagadro's law how will you establish the relation between vapour density and molecular mass of a gas?
3. Calculate the number of moles in

   a. 12.046×10^{23} atoms of copper

   b. 27.95g of iron

   c. 1.51×10^{23} molecules of CO_2

FURTHER REFERENCE :

BOOKS: 1. Physical Chemistry : **Puri and sharma - Vishal publications**

2. Inorganic Chemistry : **P.L. Soni - S.Chand publication**

WEBSITE : www.ehow.com/atomsandmolecules

www.chem4kids.com/tag/atomsandmolecules

http://www.khanacademy.org