GOVERNMENT OF TAMILNADU

SCIENCE

X STANDARD

NOT FOR SALE

Untouchability is Inhuman and a Crime

A Publication Under
Free Textbook Programme of
Government of Tamilnadu

Department of School Education

First Edition - 2011
Revised Edition - 2014, 2015, 2016
(Published under Uniform System of School Education Scheme)

Textbook Preparation

State Council of Educational Research and Training

College Road, Chennai - 600 006.

Textbook Printing

Tamil Nadu Textbook and Educational Services Corporation

College Road, Chennai - 600 006.

This book has been printed on 80 G.S.M Maplitho Paper

Price : Rs.

Printed by Web Offset at :

Textbook available at

www.textbooksonline.tn.nic.in

CONTENTS

Note to the teacher…

As we present this revised edition of the Science Textbook, we would like to express our deepest gratitude to the learners and the teaching community for their enthusiastic responses.

In science some concepts could be subject to change from time to time as new theories and principles are constantly being evolved.

We have tried to present facts and concepts of science (both concrete and abstract) in a visually appealing manner without detracting from the content.

Learning by experience and doing is now accepted as the basis of science education. These activities should be regarded as a means for open-ended investigation rather than for verification of principles/content given in the textbook are designed to facilitate low cost activities and experiments using locally available materials. With a view to streamlining the activities, we have now segregated them into three groups:

- I Do - activities to be done by an individual learner.
- We Do - activities to be done by a group of learners.
- We Observe - activities to be demonstrated by the teacher.

The third group of activities have a higher degree of difficulty or require careful handling as it may involve dealing with chemicals, electricity etc.,

The “More to know” snippets in the text represents some unusual and interesting facts or information in which the students need not be examined.

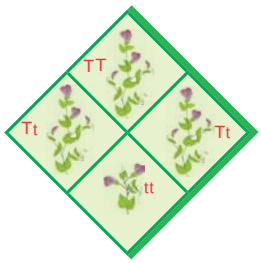
The evaluation section is nothing but another space for learning in a different manner. As the focus is on understanding, rote learning is to be discouraged thoroughly. Application of learnt ideas, problem solving skills and critical thinking is to be encouraged. There could be scope for more than one answer to a question, which should be acknowledged always.

To facilitate further reference, books and websites have been suggested at the end of each lesson. Suggestions and constructive criticism are most welcome. Valuable suggestions will be duly incorporated.

- Authors

sciencetextbook@gmail.com

Chapter 1



HEREDITY AND EVOLUTION

1.1.HEREDITY AND VARIATION

A cow gives birth to a calf, a cat to a kitten and so forth. However, on close observation of a cow and its calf or a cat and its kitten, we see a number of differences such as the colour of the skin, size etc. So the conclusion to be derived is that, the offspring, by virtue of being the progeny, need not be an exact replica of its parents.

Inheritable characteristics of the parents are passed on from one generation to the next through genes. No two individuals, even biologically related individuals, are alike in every way and the differences in their characteristics are defined as variation. Living organisms show a great deal of variation.

HEREDITY

The rules of heredity determine the process by which the traits and the characteristics are relatively inherited.

"The inheritance of characteristics from one generation to another generation is called heredity."

The inheritable characteristics (traits) may be morphological / anatomical / physiological / reproductive.

If we take a very close look at the rules of inheritance, both father and mother contribute an 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) conducted the first ever scientific experimental study on heredity.

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 variation in traits.

The visible contrasting characteristics that Mendel focussed on the garden pea plants were:

- Seed shape - Round / Wrinkled
- Seed colour - Yellow / Green
- Flower colour - Violet / White
- Pod shape - Full / Constricted
- Pod colour - Green / Yellow
- Flower position - Axillary / Terminal
- Stem height - Tall / Dwarf

ACTIVITY 1.1

- *Ask your classmates to roll their tongues. Observe how many are able to roll their tongues 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.*

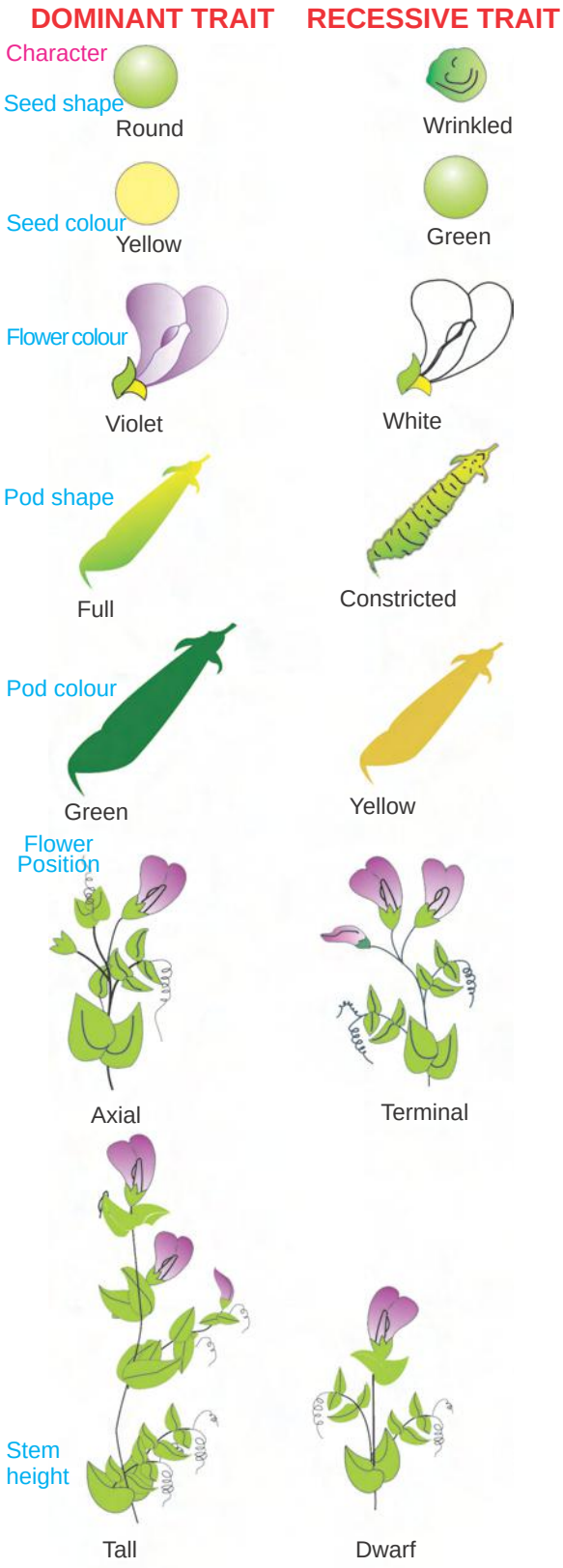


Fig. 1.1 Seven pairs of contrasting traits in Pea plant studied by Mendel.

1.1.1. Mendel's Monohybrid Cross

Mendel selected tall and dwarf garden pea plants, *Pisum sativum,* for his experiments. Mendel selected tall and dwarf pea plants for his experiments. He observed their growth for nearly two years and found that tall plants always produce tall plants and dwarf plants produce dwarf plants - generation after generation, on self pollination and under natural conditions. He termed those tall and dwarf plants as "wild types" or "pure breeding" varieties.

He crossed a tall plant with a dwarf plant, and observed how the traits are transmitted the progeny and calculated the

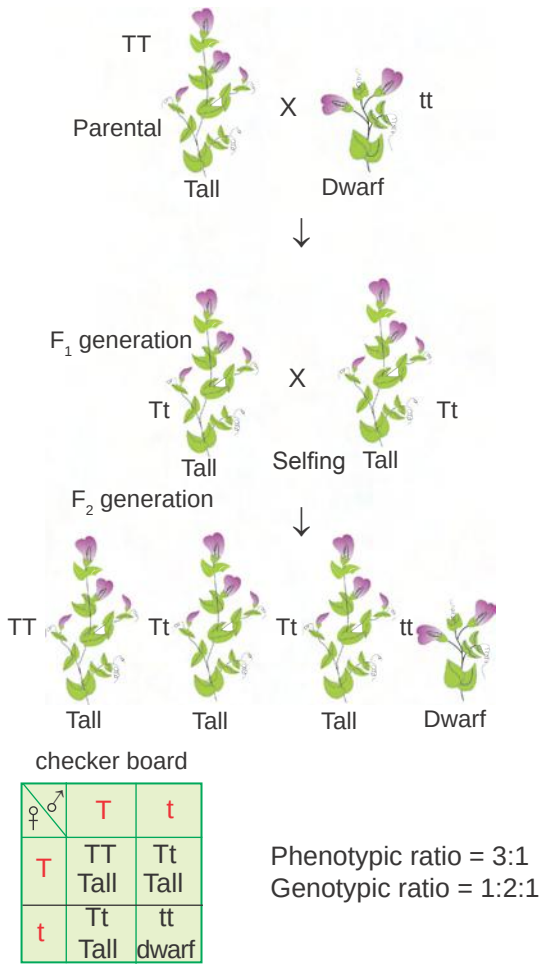


Fig. 1.2 Diagrammatic representation of Monohybrid cross

percentage of tallness and dwarfness in subsequent generations.

When a pure breeding tall plant (TT) was crossed with a pure breeding dwarf plant(tt), all plants were tall in the first filial generation(F_1) i.e. there was not any medium height plants or dwarf plants. This means that only one of the parental traits was seen and not a mixture of the two. When such an F_1 tall plant(Tt) was allowed to self-pollination, both the tall and dwarf plants appeared in second filial generation (F_2) in the ratio of 3:1. This indicates that both tallness and dwarfness were inherited in the F_1 plants but only one trait was expressed, i.e. tallness. The trait which is expressed is called dominant. The hidden trait is called the recessive trait.

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. Genetic make up of an individual for a particular trait is called Genotype. The genotype of a character is influenced by certain factors.

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 set out experimenting on pea plants. 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 the plants in your locality which show different characters for the following traits. Count them and record your findings. Examples:

Coconut	*Tall*	*Dwarf*
Bean	*Violet Flower*	*White Flower*
Sugarcane	*White Stem*	*Purple Stem*
Clitoria	*Blue Flower*	*White Flower*

PHYSICAL BASIS OF HEREDITY

The unit of inheritance or the determinant of a trait(character) is called gene.The genes are the factors which form the physical basis for inheritance of Characters. The alternate forms of the same gene are called alleles. The expression of contrasting pair of alleles(Tt) makes up an allelomorph. Examples : Height of plant

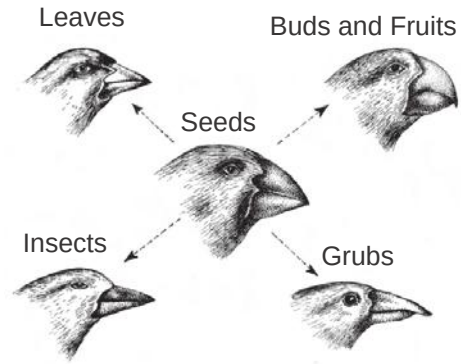


Fig. 1.3 Variations in the beaks of finches to suit their eating habits.

(Tt), shape of seed (Rr). Recombination in expressing phenotype 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 differences in the characteristics among the individuals of the same species, (A) Intra specific variation or among the different genera (B) Intergeneric variation or among different species (C) Inter specific variation. No two individuals are identical. Asexual reproduction produces very closely resembling offspring. Asexual reproduction thus results in offspring with minor variations. Sexually reproducing organisms produce offspring with marked, significant and visible variations.

Fig. 1.4 Identical twins

1.2.1. Types of Variations

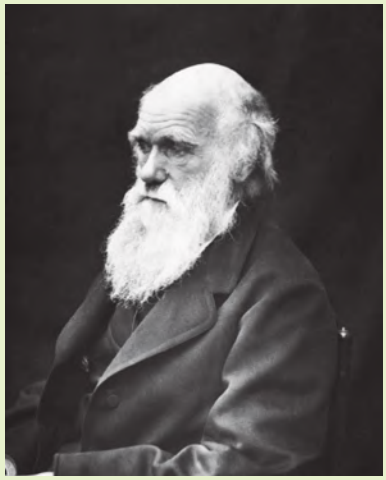
a. ***Somatic Variation*** - It pertains to body cells and it is not inherited.

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.
- Organisms are better suited to face the struggle for existence.
- Variations give the organisms an individuality of their own.

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 the shores again. He stayed at home and conducted various experiments that led him to formulate his theory of evolution. He did not know the mechanism by which the variations arose in the species. Had he been enlightened by Mendel's experiments, he would have contributed more. 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 with the role of earthworms in soil fertility.

♦ Without variations there would be no science of evolution, as all individuals of a race would be identical in all aspects.

Lamarckian View on Organic Evolution

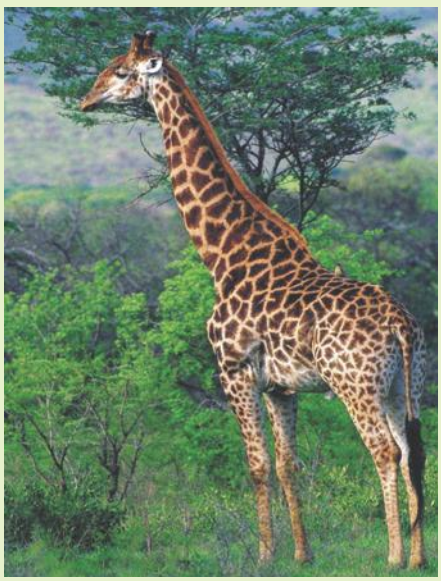


Fig. 1.5 Giraffe

Jean Baptiste Lamarck (1744-1829) postulated the Use and Disuse Theory. According to Lamarck, the use of a part / an 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 to diminish or degenerate.

Lamarck quotes the example of the development of the long neck of the 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 long legs in giraffes. Lamarck remarks that the "will or want" for a character makes the organisms to possess it at a later time.

1.3. 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 staircase of evolution.

1.3.1. 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 been occuring since millions of years, as revealed by fossil evidence.

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

1.3.2. Human Evolution

Fifteen million years ago, the hairy bodied gorilla and chimpanzees like Hominids existed in Africa. 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 beings – 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 ago, used to hide to protect themselves and buried their dead.

Archaic *Homo sapiens* arose in South Africa and moved across continents and developed into distinct races during the ice age. It is believed that homosapiens came into existence about 75,000 to 10,000 years ago. Pre-historic caves were developed about 18,000 years ago, agriculture came around 10,000 years back and human settlements started.

1.3.3. The Tree of Evolution

To understand evolution, a branching diagram (a tree diagram) is used to illustrate the inferred evolution, relationships, among

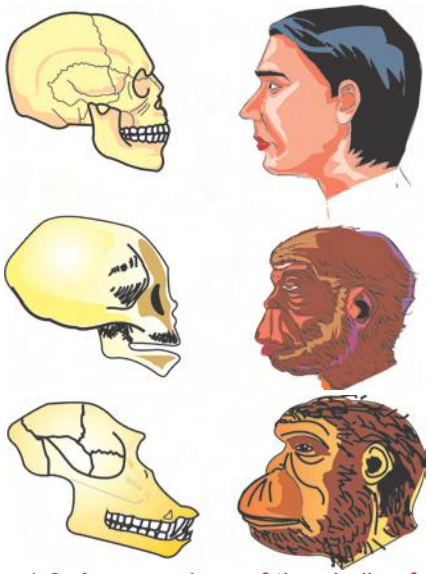


Fig. 1.6 A comparison of the skulls of: An adult modern human being, baby chimpanzee and adult chimpanzee. The skull of the baby chimpanzee is more like the adult human skull than the adult chimpanzee skull.

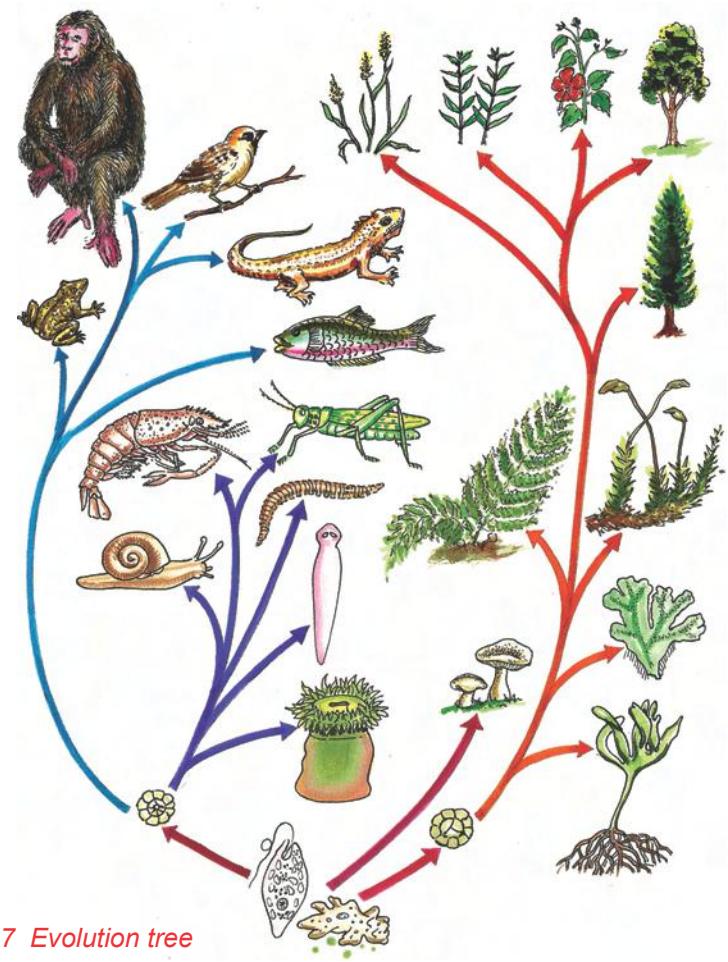


Fig. 1.7 Evolution tree

various biological species or other entities based upon similarities and differences in their physical and genetic characters.

1.4. GENETIC ENGINEERING

Genetic engineering is the modification of the genetic information of living organisms by manipulation of DNA i.e. 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 Biochemistry have resulted in the origin of this new branch of science.

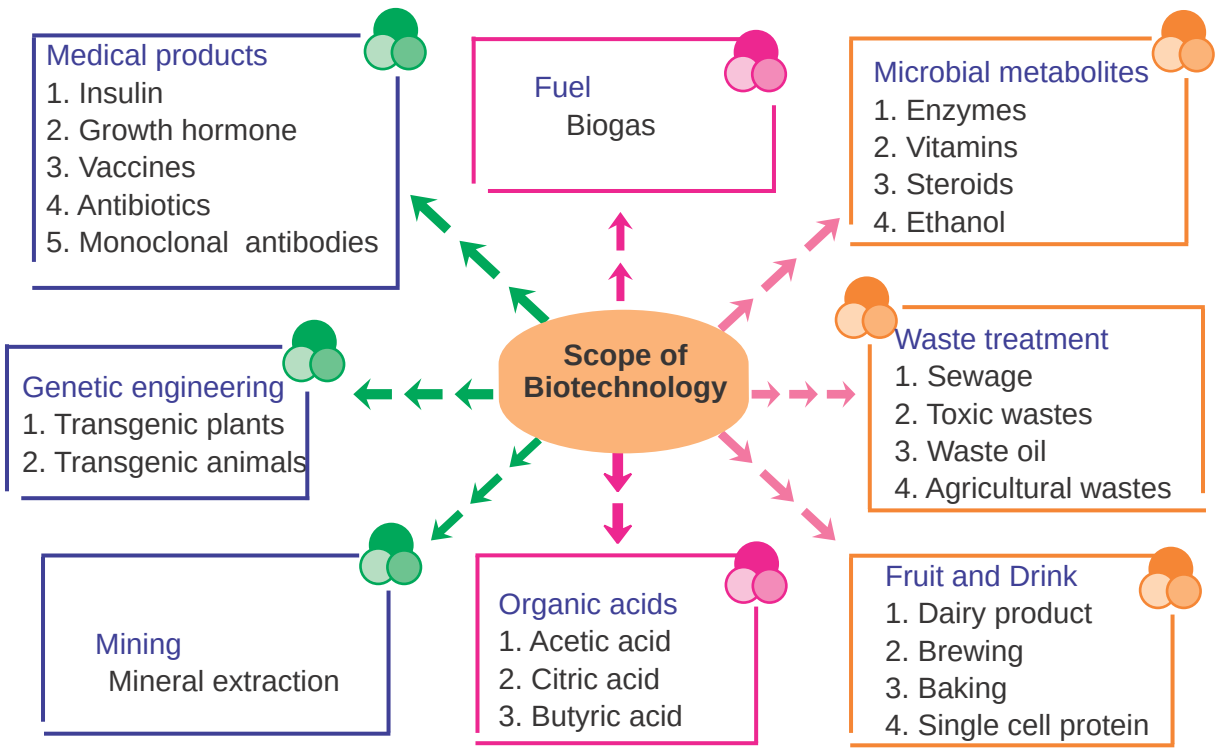
Merits of Genetic Engineering

- Understanding of the gene structure and function through basic research.
- Production of large quantities of human insulin, interferons(Anti-Viral Proteins produced by Virus infected cells) human growth hormones 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 cultivators to increase productivity.

1.4.1. Basic techniques in Genetic Engineering

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

A. Restriction enzymes or Restriction endonucleases are molecular scissors which cut DNA at specific sites.



B. DNA ligases are the paste enzymes which help in joining the broken DNA fragments.

1.5. BIOTECHNOLOGY AND CLONING

Biotechnology uses biological organisms or biological processes through modern techniques which could be profitably used in the field of medicine, agriculture, animal husbandary and in environmental cleaning. There are several applications of Biotechnology in the field of brewing industry, enzyme technology, manufacturing of antibiotics, organic acids, vitamins, vaccines, steroids and monoclonal anti-bodies.

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

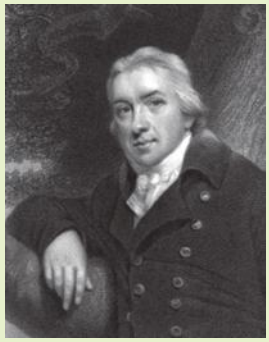
Enzyme Technology : Enzymes are biocatalysts that speed up reaction in cells. They can be used to catalyze the industrially important reactions and are more efficient than inorganic catalysts. Many enzymes are utilized in the pharmaceutical industry.

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

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

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

Edward Jenner (1749-1823)



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

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

Steroids: They are derivatives of lipids eg: Cholesterol containing steroid drugs like prednisolone, produced from the fungus Rhizopus.

Monoclonal antibodies : These are the antibodies produced from cloned cells by hybridoma technology. Monoclonal antibodies are now used in treatment of cancer.

Cloning: Cloning is an experimental technique, wherein a group of morphologically and genetically identical organisms are produced.

A clone may be defined as an exact carbon copy or copies of a single genetical parent. The word 'clone' refers only to living species. If the cloning technique is applied

Fig. 1.8 Dr. Ian Wilmut with Dolly

to veterinary science, valuable animals could be cloned from desirable adult cells.

1.5.1 Types of clones

Natural clones: The natural clones are formed through a natural process. (DNA replication)

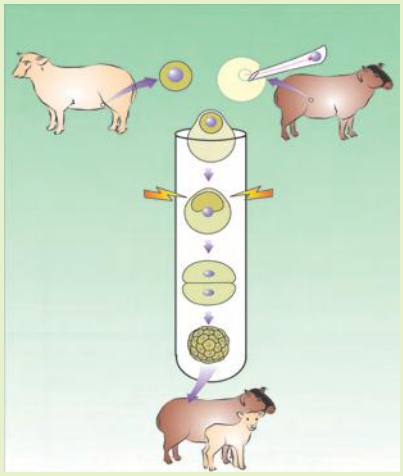
Induced clones: The induced (artificial) clones are developed by nuclear transfer into the host cell. e.g. cloning of Dolly sheep.

1.6. 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 have two important characteristic features:

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

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 the 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.

1.6.1. Types of Stem Cells

There are two kinds of stem cells

1. ***Embryonic Stem Cells:*** The embryonic stem cells can be extracted from early embryo which is developed by "invitro fertilization" (fertilization done 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 has 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.

1.7. MICROBIAL PRODUCTION

As we discussed earlier, the field of biotechnology is very vast and has a great scope in different fields like agriculture, medicine, food industry etc.

The microbial products of everyday uses are:

Vaccine: Killed or live germs suspension which is employed to induce the production of antibodies and develops immunity.

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

Vitamin B_{12}: Biotechnologically synthesized vitamin B_{12} is used to cure pernicious anaemia.

Enzymes: Biochemically significant enzymes are derived from microbes eg: Amylase is derived from amyloproteins of bacteria.

Insulin: Diabetes is treated by the biotechnologically produced insulin.

1.8. BIOSENSOR AND BIOCHIPS

Biosensor: It is a device consisting of an 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 medical field and industries.

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.

Biochips

Biochips are microchips which are developed by employing techniques of Biotechnology. In future, biological computers will be developed using biochips. Biochips will be useful in defence, medicine etc.

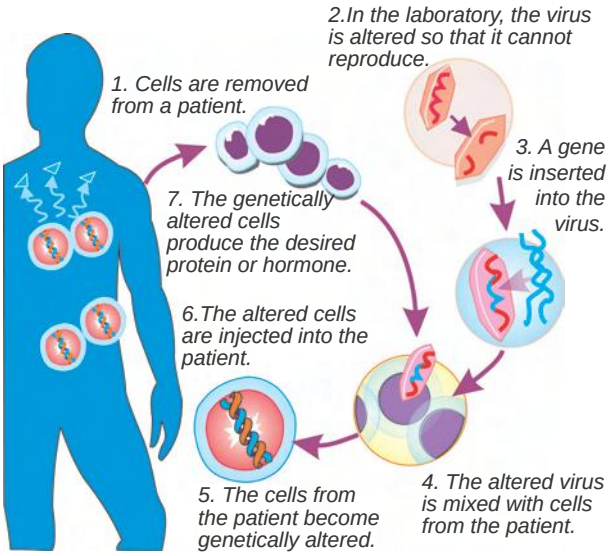


Fig. 1.9 Gene Therapy

1.9. SCIENCE TODAY - GENE THERAPY

Insulin dependent diabetes is treated with insulin injection. Insulin dependent diabetes is caused by the degeneration of beta cells of pancreas due to a defective gene. Applying the principle of Biotechnology, 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 a 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 egg) cell.

Types of Gene Therapy

1. Somatic gene therapy:- The defective gene in somatic cells is replaced with a corrective gene. This change is not passed 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.

MODEL EVALUATION

PART - A

1. *Mendel observed 7 pairs of contrasting characters in **Pisum sativum**. Which one of the following is not a part of that?*

   i) Tall and dwarf *ii) Yellow and green seed colour*

   iii) Terminal and axial flower *iv) Smooth and rough stem*

2. *Primitive man evolved in _____*

   i) Africa *ii) America* *iii) Australia* *iv) India*

3. *Which of the following is inheritable?*

   i) an altered gene in sperm *ii) an altered gene in liver cells*

   iii) an altered gene in skin cells *iv) an altered gene in udder cells*

4. The theory of Natural Selection was proposed by _____ .

   i) Charles Darwin ii) Hugo de Vries

   iii) Gregor Johann Mendel iv) Jean Baptise Lamarck

5. Somatic gene therapy causes _____.

   i) changes in sperm ii) changes in progeny

   iii) changes in body cell iv) changes in ovum

6. In a pea plant, the yellow colour of the seed dominates over the green colour. The genetic make up of the green colour of the seed can be shown as _____:

   i) GG ii) Gg iii) Yy iv) yy

7. Some people can roll their tongue and this is a genetically controlled auto-somal dominant character. [Roller = RR / Rr and Non-roller = rr]

   A child who can roll the tongue has one brother who is a non-roller and two sisters who are rollers. If both the parents are rollers, the genotypes of their parents would be ____.

   ` i) RR x RR ii) Rr x Rr iii) RR x rr iv) rr x rr

8. Hydra, a multi-cellular invertebrate of phylum cnidaria(coelenterata) can give rise to new offspring by various methods. Choose the method by which the offspring are produced with significant variations.

   i) budding ii) regeneration iii) sexual reproduction iv) asexual reproduction

9. The following are the events in the formation of the first cloned animal – the sheep Dolly.

   a) Removal of haploid nucleus from the ovum.

   b) Implantation of ovum with diploid nucleus into the surrogate mother.

   c) Collection of udder cell from the sheep.

   d) Injection of diploid nucleus of udder cell into the enucleated ovum.

   e) Development of a young clone.

   The correct sequential order of these events is _____ .

   i) abcde ii) cabed iii) cadbe iv) edcba

10. The following are statements about stem cells:

   a) There are unspecialised / undifferentiated cells.

   b) They can be transformed into any type of body cell.

   c) They can multiply rapidly to form a large number of similar types of cells.

   d) They cannot transform into cardiac cells or nerve cells.

   e) They are obtained from reproductive progeny only.

   The correct statements are _____:

   i) a, b, c only ii) c, d, e only iii) a, c, e only iv) b, c, e only

11. In persons suffering from insulin-dependent diabetes, _____ the cells of pancreas are degenerated.

i) Alpha ii) Beta iii) Gamma iv) Delta

12. Identical twins are born as a result of fertilization between_____.

i) two eggs and two sperms ii) two eggs and one sperm

iii) one egg and one sperm iv) one egg and two sperms

13. Identify the incorrect statement about identical twins.

i) developed from a single zygote ii) always of the same sex

iii) look alike in many aspects iv) differ in their blood groups

14. The correct statement about Neanderthal man is:

i) the first human like hominid ii) started agriculture

iii) ate meat and walked erectly iv) buried the dead

15. The inheritance of characteristics through generation is called “heredity”. In Mendel's Pisum sativum plant, the genetic material responsible for heredity is _____.

i) DNA ii) RNA iii) Protein iv) Cytoplasm

PART - B

1. Mendel has observed Tallness as a dominant character in the 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.

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

2. The inheritable characters vary 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.

i) This is called as _____variation.

The dentition in the rabbit and the elephant are not the same.

ii) This is called as _____ variation.

3. Sexually reproducing organisms produce offspring with marked, significant and visible variation. Asexually reproducing offspring show minor variations.

i) Do you agree with the above statements?

ii) Among the following organisms point out the asexually reproducing organism.

(Cockroach, Euglena, Earthworm and Bird)

4. Here are certain important hereditary jargons. Fill in the blanks by choosing a suitable one from the list given. (allele, variation, speciation, gene, allelomorphs)

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

ii)_____ is the alternate forms of the same gene.

iii)_____ are the expressions of contrasting pair of alleles.

5. A change that affects the body cell is not inherited. However, a change in the gamete is inherited. The effects of radiation at Hiroshima have been affecting generations. Analyze the above statements and give your interpretation.
6. Sequentially arrange the different species of man from primitive to modern man. (Neanderthal man, Homo habilis, Homo erectus, Homo sapiens)
7. Biotechnology, the modern science in biology, has helped in producing different types of products.One of the following groups does not have a product of biotechnology. Pick out and give reasons.
   i) enzymes, organic acids, steroids, vaccines
   ii) vaccines, enzymes, antibiotics, inorganic acids
   iii) antibiotics, hormones, steroids, vaccines
   iv) steroids, enzymes, antibodies, vaccines.
8. What do you mean by phenotype and genotype of an individual? Explain.
9. What are variations? Mention their types.
10. Who proposed the theory of Natural Selection? Mention the two principles of this theory.
11. What are monoclonal antibodies? Mention its use.
12. What is a clone? In what way is the cloning technique useful in the field of veterinary science?
13. In dogs, the barking trait is dominant over the silent trait. Using Punnet Square, work out the possible puppies born to two barking parents with genotype (Rr).
14. In Dr. Ian Wilmut's cloning experiment, did the new born 'Dolly' resemble the udder cell donor Dorset white sheep or the surrogate mother sheep? Give reasons.
15. The excessive use of pesticides has only resulted in the occurrence of more resistant varieties of pests rather than their complete eradication. How can you link this with Darwin's theory of Natural Selection and Evolution?
16. The first clinical gene therapy was given in 1990 to a four year old girl suffering from Adenosine Deaminase Deficiency (ADA) . Could you suggest a possible cure for such a disorder with the knowledge of gene therapy and its types?
17. Find the unmatched pairs:

Nif genes	Nitrogen Fixation
tt	Alleles
Biochips	Biological computer manufacturing
Interferon	Antiproteins of Bacteria
stem cells	Unspecialised mass of cells

18. For the experimental research Dr.Ian Wilmut used the nucleus of the udder cell from a six year old Finn Dorset white sheep and preserved the diploid nucleus (2n). He took an ovum from the ovary of another sheep. The haploid ovum was removed. The diploid nucleus of the udder cell was injected into the cytoplasm of the enucleated ovum. Then the diploid nucleus ovum was implanted into the uterus of the surrogate mother sheep. The diploid ovum developed into a young one, named "Dolly" .

    i) Why did Wilmut select the udder cell?

    ii) Define the terms haploid and diploid.

19. Match the following by identifying the pair :

    (medicines, fuel, microbes, metabolism, organic acids)

    i) vaccine ii) natural gas iii) citric acid iv) monoclonal antibodies v) vitamins

20. Mention the dominant and recessive traits observed by Mendel in the garden pea plant with respect to the seed and flower.

PART - C

1. Human evolution has undergone a record of changes during the past 15 million years.

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

    ii) When were the primitive caves developed?

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

2. Describe in brief Mendel's monohybrid cross.

3. Find out who I am?

    i) I am an acid used as a preservative and I have a sour taste.

    ii) I am organic and present in citrus fruits and I give immunity.

    iii) I am a cholesterol containing steroid obtained from bread mould. I am the steroid

    iv) I am an enzyme and I cut DNA at specific sites.

    v) I am the paste enzyme that joins segments of DNA.

4. State whether true or false. Correct the statements that are false.

    i) Variations give the organisms an individuality of their own.

    ii) Charles Darwin postulated the use and disuse theory.

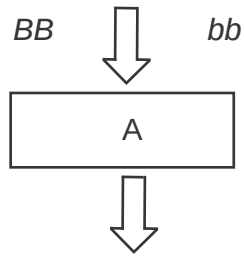
    iii) To understand evolution, a branching diagram or a tree diagram is used to show the inferred evolution and the relationship among various biological species.

    iv) Genetic engineering is the modification of the genetic information of living organisms by manipulation of DNA by adding, removing or repairing part of the DNA and changing the phenotype.

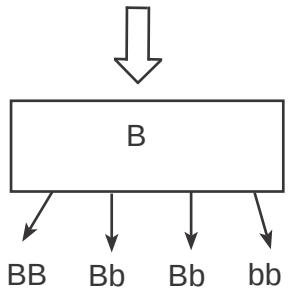
5. *Observe the flow-chart of a monohybrid cross in a clitoria plant and write the answers for A, B, C, D:*

Character : Colour of the flower

Parents : Blue flowered x White flowered



F_1 *Generation* *All are blue flowered with the genotype Bb*



F_2 *Generation*

The phenotypic ratio is C

The genotypic ratio is D

FURTHER REFERENCE

Book: 1. *Framework of Science - Paddy Gannon, Oxford University Press, New Delhi.*

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

3. *Complete Biology(IGCSE) - Oxford University press, New York*

Webliography: *http://www.britannica.com, http://www.khanacademy.org science.howstuffworks.com*

Chapter 2

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 in 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.

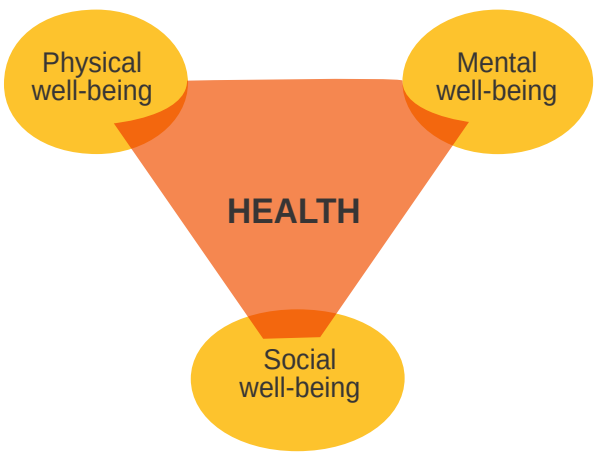


Fig. 2.1 Dimensions of health

The varying environmental factors such as temperature, humidity, pollution caused by man, radiation, malnutrition, the millions of microbes in the environment and stress affect our lives and pose challenges to our health.

Dimensions of Health

1. **Physical dimension :** A person who is free from disease, looks bright with his skin shining; enjoys normal metabolism; has lustrous hair and has no dark circles around his eyes.
2. **Mental dimension :** Mentally healthy people know their capacities and do not overestimate or underestimate themselves. They can easily judge their shortcomings and weaknesses.
3. **Social dimension :** An individual who is able to adjust in society, does not find fault with other. Such a person maintains good interpersonal relationship with family members and colleagues at workspot. He is free from interpersonal conflicts and will never quarrel with others.

ACTIVITY 2.1

Following the above criteria, make a survey of your classmates/friends in your neighbourhood and record your findings.

- *No. of students/friends who are healthy.*
- *No. of students/friends who do not have good inter personal relationship and do not enjoy social well-being.*
- *No. of students/friends who suffer from diseases that affect their metabolism.*
- *List out the positive qualities that you admire in your friend.*

2.2. DISEASES AND CAUSES

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

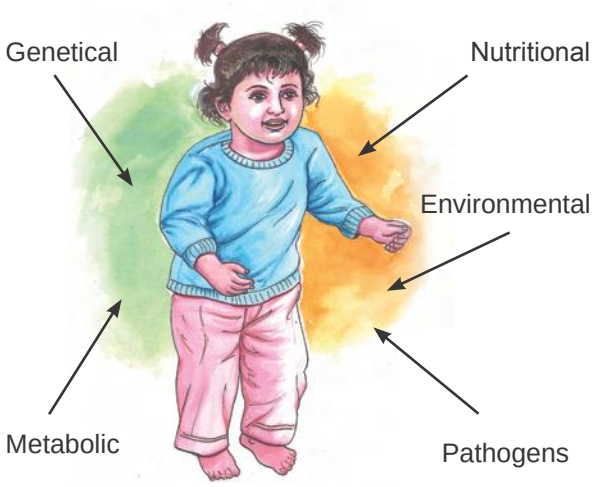


Fig. 2.2 Causes of diseases

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 two categories:

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

2.2.1. Diseases not caused by organisms – Non-communicable diseases

1. Organic diseases or Metabolic disorders:

A healthy body maintains a constant blood sugar level, which is normally 80-120 mg/dl 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 is stored in liver and muscles for future use. Later when required, glycogen is reconverted into glucose and reintroduced into the blood stream.

All these processes are controlled by the hormones, insulin and glucagon secreted by beta cells and alpha cells of Islets of Langerhans in the Pancreas. If insulin is not produced in sufficient quantity, excess of sugar cannot be stored in the liver and cannot be utilized. As a result, sugar gets accumulated in the blood and is subsequently expelled through the 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, hair 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, Colour blindness, Bubble boy syndrome, etc. are a few other genetic disorders.

Fig. 2.3 An albino

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 skin. In Kwashiorkar, the child develops an enlarged belly with face and feet swelling.

2.2.2. 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 increases in large numbers, produces poisonous substances called toxins and interferes with the host metabolism and produces a characteristic set of symptoms by which, the disease can be diagnosed.

Fig. 2.4 Kwashiorkar

Fig. 2.5 Marasmus

SOME DISEASES CAUSED BY VITAMIN DEFICIENCY ARE TABULATED BELOW:

Vitamin	Deficiency disease	Symptoms
Vitamin A	Nyctalopia	Night blindness
Vitamin D	Rickets	Defective calcification of bones
Vitamin E	Sterility	Inability to reproduce
Vitamin K	Haemorrhage	Profuse loss of blood
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

Parasitic Microorganism: The causative organism of a large number of diseases in man, are microorganisms 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 a compound microscope. Though many bacteria are harmless,

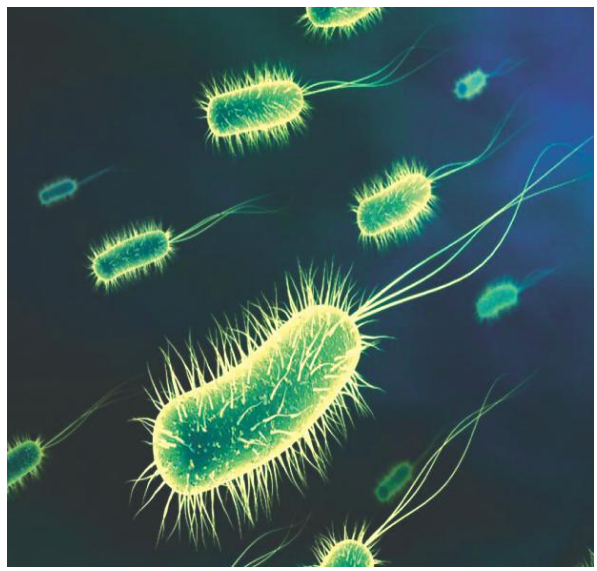


Fig. 2.6 Bacilli

some are parasitic and produce diseases. Bacteria can enter the host body through the mouth, nostrils, 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, Pertusis, Tetanus, Plague, Pneumonia, Syphilis, Gonorrhoea, etc.

3. **Fungi and Fungal Diseases:** Fungi are non-green saprophytic or parasitic plants that subsist 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. Dandruff and Athletes' foot are other fungal diseases that attack man.

Protozoan and Protozoan Diseases: Protozoans are unicellular animalcules. Some parasitic protozoans in man 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 THEIR PREVENTION

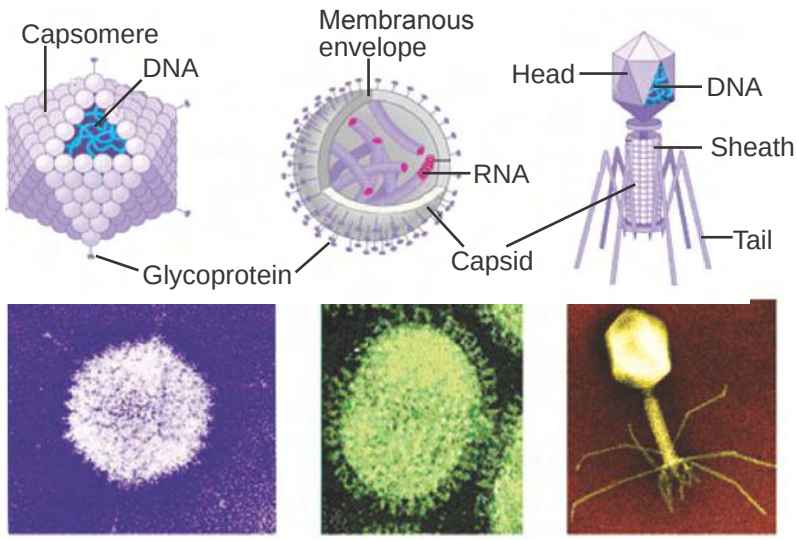
A disease caused by a parasitic organism and transmitted from one person to another by the transfer of the parasite is known as an ***infectious disease***.

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.

2.3.1. Viral diseases

Common Cold

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



(a) Adenovirus (b) Influenza virus (c) Bacteriophage

Fig. 2.7 Types of Viruses

Symptoms

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

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

Transmission

i) It spreads mostly through the nasal and oral discharge of the patient in the process of talking, laughing, sneezing, etc.

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

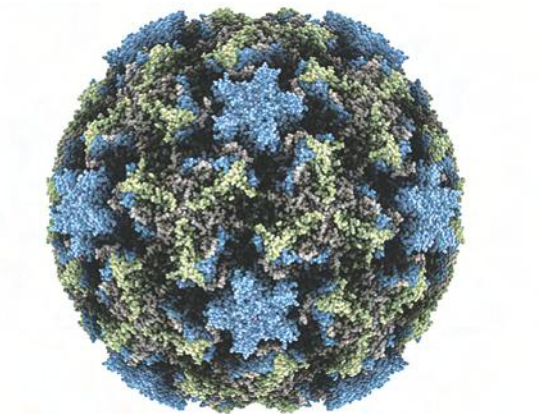


Fig. 2.8 Human rhino virus

Control and prevention: There are no effective measures to control common cold. However, eating nutritious food, avoiding contact with patients and wearing suitable clothing are suggested, to avoid common cold.

Influenza: It was once a dreadful disease and spread worldwide (pandemic) in 1970s.

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

Symptoms

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

Transmission

It spreads through the patient's nasal and oral secretions and enters into the respiratory tract of a healthy person**.** It also spreads through fomites.

Fig. 2.9 H1N1 Virus

Prevention

i. Avoid contact with the patients and cover your mouth when sneeze or cough.

ii. Wash hands to maintain good personal hygiene.

2.3.2. Bacterial diseases

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

Tuberculosis

It is an airborne disease affecting the lungs and other 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) Persistent cough.

iii) Loss of body weight.

Transmission

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

Prevention

i) Keeping oneself healthy and avoiding unsanitary conditions, overcrowding and poor-ventilation.

ii) Sunlight and fresh air are important agents that act as natural disinfectants, readily destroying the germs.

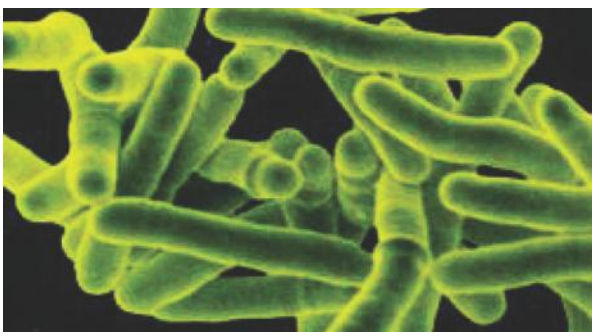


Fig. 2.10 Tuberculosis Bacteria

iii) Isolation of the patients and frequent sterilization of articles used by them are also important.

iv) Incineration (burning) of cloth/ clothes containing droplets/ the sputum of the patients can prevent infection.

v) Immunization with BCG vaccine is an effective measure to prevent this disease.

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

Typhoid

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

Symptoms

i) Persistent fever.

ii) Inflammation and ulceration of the intestine.

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

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 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 keep them in a warm place (approximately 25^0C) until the broth turns stale, owing to the growth of bacteria.

What you have produced, is a bacterial culture.

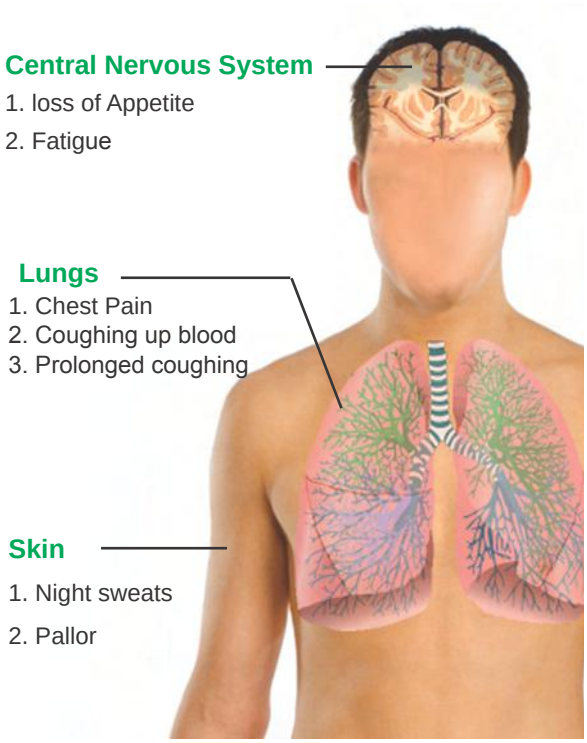


Fig. 2.11 Symptoms of tuberculosis

Transmission

Transmission of typhoid is through food and water contaminated with the germ, and through personal contact with patients and carriers. The housefly is also an important transmitting agent (vector) of this disease.

Prevention and control: Isolation of the patient, control of flies, hygienic food habits, proper sanitation are effective means of prevention of this disease. Artificial immunization with typhoid vaccine is advised.

2.3.3. Protozoan diseases

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

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* exist in India and cause malaria. Of these, the malaria, caused by Plasmodium falciparum is malignant and fatal.

Transmission

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

Symptoms

i) Malaria is characterized by chills, shivering and rise in temperature. This is followed by perspiration and lowered body temperature. The patient would feel normal for some time but the fever would recur 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) Prevent water stagnation and cover ditches and drains.

iii) Use mosquito nets and repellants.

Amoebic dysentery (Amoebiasis)

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

Symptoms

i) Fever.

ii) Constipation, abdominal pain and cramps.

iii) Stools with excess mucous and blood clot.

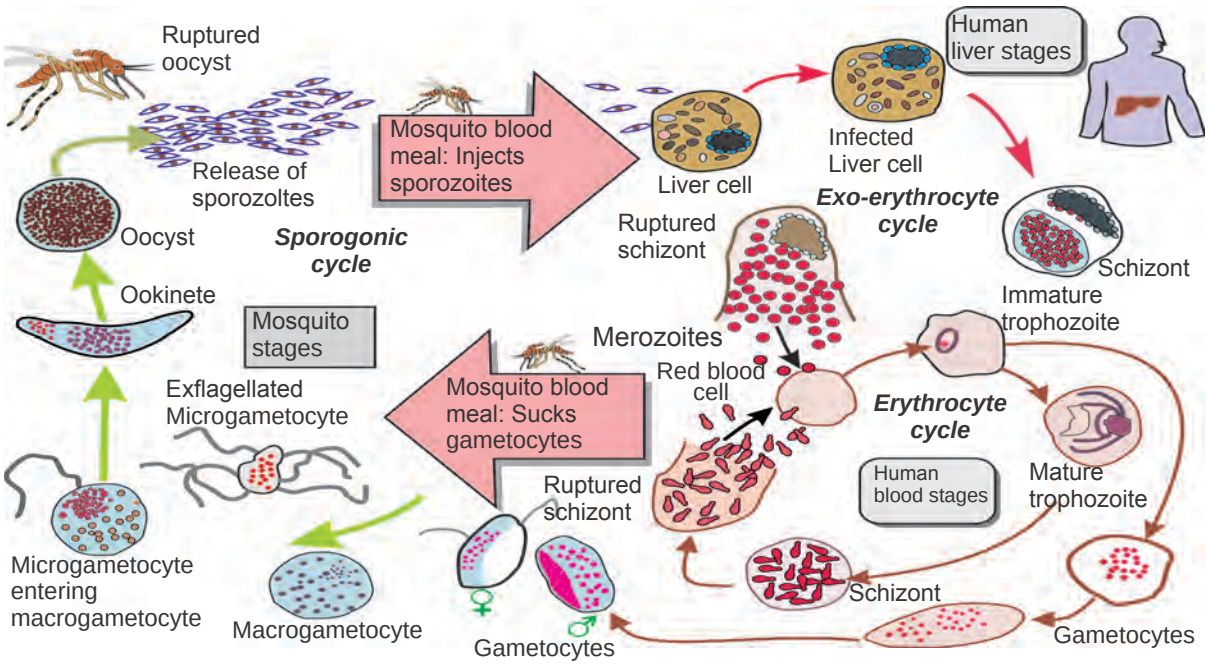


Fig. 2.12 Life cycle of malarial parasite

Life cycle of malarial parasite – Plasmodium: The sexual stage of Plasmodium takes place in female Anopheles mosquito whereas the asexual stage occurs in man. When a female Anopheles mosquito bites an infected person, these parasites enter the mosquito and undergo further development in the body of the mosquito. The parasites multiply within the body of the mosquito to form sporozoites that are stored in the salivary glands of the mosquito. When these mosquitoes bite a healthy person, the sporozoites (the infectious stage) are introduced into his body. They multiply within the liver cells first and enter the Red Blood Cells(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 every three to four days.

Sir. Ronald Ross (1857-1932)

Sir. Ronald Ross, 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 did a research study about malaria between 1882 and 1899. When he was working in Bangalore, he observed the connection between water as the 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 an infected individual to a healthy person by the bite of mosquito. In 1902, he was awarded the Nobel Prize for his work on malaria.

Six stages of hand washing technique

1. Palm to Palm
2. Back of Hands
3. Interdigital spaces
4. Finger Tips
5. Thumbs and wrists
6. Nails

Fig. 2.13 Clean habits

Transmission

It is a water-borne and food-borne disease. Houseflies act as mechanical carriers and they transmit the parasite from the faeces of infected persons to the food and water, thereby contaminating them.

Prevention and control: Precautions include drinking filtered or boiled water, eating hygienic food and maintaining proper sanitation.

2.3.4. Fungal diseases in man

Some of the fungi are parasites and cause diseases in both human beings and animals.

Ringworm

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

Symptoms

Fungi can live on the dead cells of epidermis. They can cause superficial infections in skin, hair, nail, etc. form patches and cause itching.

Transmission

It is transmitted by direct contact or through fomites such as towels, combs, etc.

Control and prevention: Avoid contact with infected persons and things used by them.

Fig. 2.14 Ringworm

2.4. MODES OF TRANSMISSION OF INFECTIOUS GERMS

The transfer of a disease-causing germ from an infected person to a 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 a patient to a healthy person through close contact. Diseases like diphtheria, pneumonia, cholera, typhoid, measles, mumps, etc,. are transmitted this way.

During sneezing, coughing and talking, the oral and nasal discharge is sprayed in the form of small droplets and gets mixed in the air. When a healthy person inhales the air laden with germs, he gets infected.

Through the umblical cord, the germs are transferred from the infected mother to the child during pregnancy.

Indirect transmission through fomites: Some germs may remain viable outside the body of the hosts and may be transferred indirectly through personal objects used by patients like clothing, bedding, handkerchiefs, towels, toilet articles, utensils and plates. Such contaminated objects are called **fomites**.

Fig. 2.15 Cover the mouth while coughing and sneezing

Transmission by animals: Ticks, mites, birds, insects and mammals transmit diseases like cholera, malaria, rabies, etc;

2.5. IMMUNIZATION

Immunity: Immunity is the body's defence against or the specific resistance exhibited towards infectious organisms.

Infectious organisms that invade the body, the toxins produced by them and the foreign proteins that enter the body are called **antigens**.

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

Types of Immunity

Natural or Innate Immunity: The **natural or innate immunity** enables an individual to develop resistance to the disease, to which, the particular species is immune. 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 remain for a long period and kill the similar pathogens, whenever they enter the body.

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

If the antibody synthesis is stimulated by administration of vaccines or any other man-made methods, the immunity thus gained is called Artificially Active Acquired Immunity. For example the polio drops and the triple antigen injection given to the child in the immunisation programme.

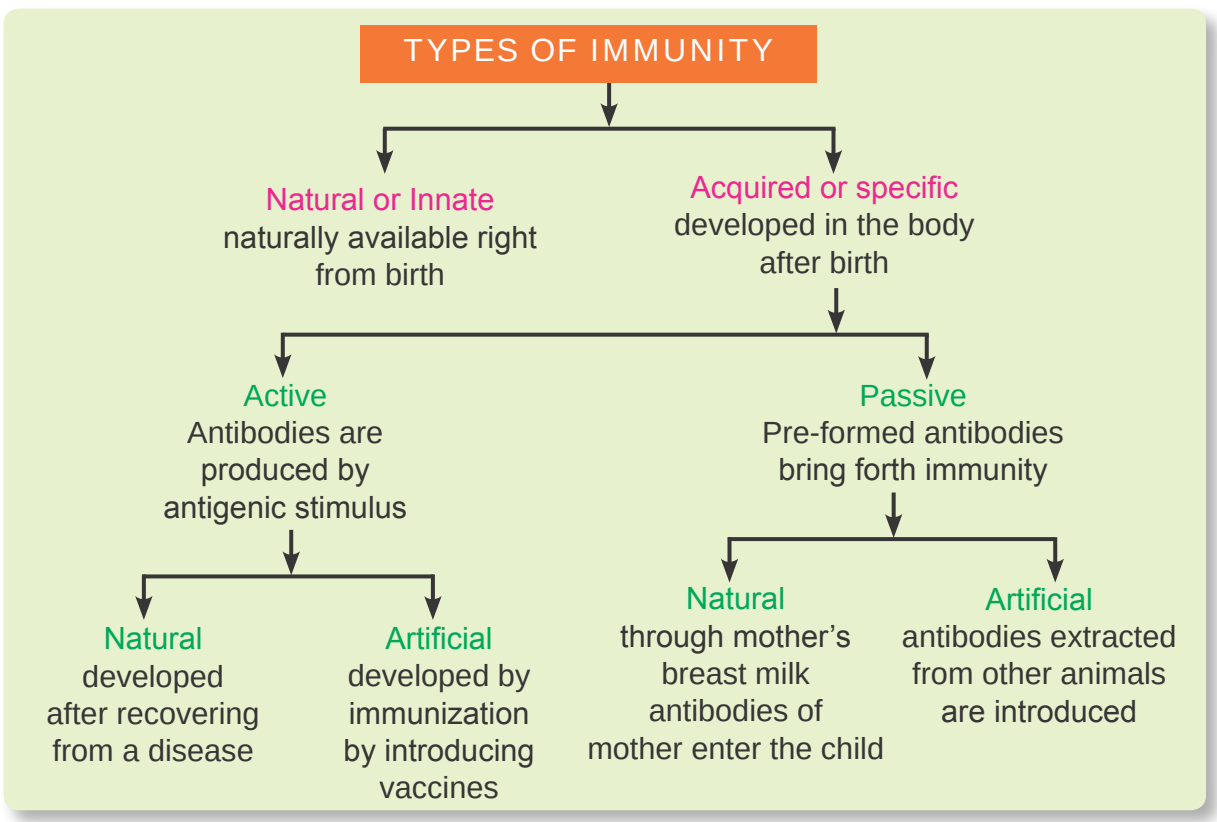
Passive Acquired Immunity: In this type of immunity, a ready-made antibody is introduced from outside, instead of stimulating the body to produce antibody with antigenic stimulus.

If the readymade antibody is taken from the mother's blood into the foetus, it is called Naturally 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 Immunity. This immunity is not permanent.

Fig. 2.16 Oral Polio Immunization

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

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



MORE TO KNOW

What kind of Immunity does a child get when it is breast fed ? MOTHER'S MILK IS THE BEST FOOD. Antibodies or Immunoglobulins are found in breast milk. Through breast milk, antibodies are passed on to the baby. Bottle fed infants do not have the advantage of fighting the ingested pathogens on their own until the antibodies are produced in them. A mother should suckle the infant for at least 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, the dosage and the stage at which they have to be administered.

BCG	Tuberculosis Vaccine
DPT	Diphtheria, Pertussis, Tetanus Vaccine (Triple antigen)
MMR	Mumps , Measles, Rubella
DT	Diphtheria, Tetanus (Dual antigen)
TT	Tetanus toxoid

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

2.6. TREATMENT AND PREVENTION OF DISEASES

Treatment means the medical management of the symptoms of a disease.

Medical Management includes:

i) Treatment involving medicine.

ii) Treatment not involving medicine.

Treatment involving medicine: Medicines are generally used to treat infectious diseases. These medicines either reduce the effect of the disease or eliminate the cause of the disease. Antibiotics are used to block the disease without affecting the individual.

Treatment not involving medicine: For a person recovering from the effect of fracture or neurotic problem, yoga and physiotherapy can greatly help him to perfrom normal activities. People addicted to alcohol and drugs are given counselling to overcome the habit.

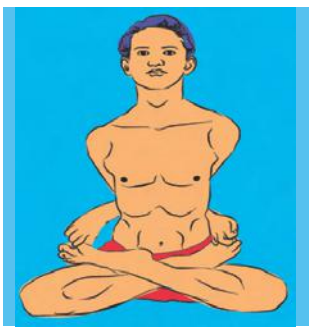


Fig. 2.17 Yoga practice

Prevention: Getting rid of 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 exposure to the germs. Hygienic life style, avoiding overcrowding, inhaling air, safe drinking water and good sanitary measures are the 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 health care, 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 Immuno Deficiency Syndrome (AIDS) is a dreadful disease transmitted through sexual contact or through transfusion of blood and blood products. Robert Gallo at National Institute of Health, USA and Luc Montagnier at Pasteur Institute, Paris isolated the 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:

i. Enzyme Linked Immuno Sorbent Assay (ELISA)

ii. Western Blot – a confirmatory test.

Prevention:

i. Protected sexual behaviour.

ii. Safe sex practices.

iii. Screening of blood for HIV before blood transfusion.

iv. Usage of disposable syringes in the hospitals.

v. Avoid sharing the razors / blades in the salon.

vi. Avoid tattooing using a common needle.

MODEL EVALUATION

PART - A

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

i) Mr. X is recovering from an infectious disease.

ii) Mr. Y takes insulin injection everyday .

iii) Mrs. Z is very depressed.

iv) Mr. K does his duty and spends time joyfully.

2. *Which one of the following is not socially balanced ?*

i) He enjoys a birthday party.

ii) He behaves rudely over trivial matters.

iii) He adjusts well to the surrounding situation.

iv) He attends to his ailing mother at the hospital.

3. *_____ is a bacterial disease.*

i) Meningitis *ii) Rabies* *iii)Tetanus* *iv) Small pox*

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

i) Tuberculosis *ii) Meningitis* *iii) Typhoid* *iv) Cholera*

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

i) ovale *ii) malariae*

iii) falciparum *iv) vivax*

6. *An example of protozoan infecting our intestine is _____.*

i) Plasmodium vivax *ii) Entamoeba histolytica*

iii)Trypanosoma gambiense *iv) Taenia solium*

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

i) sneezing *ii) coughing* *iii) through placenta* *iv) using utensils of patients*

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

   i) Artificially active acquired immunity ii) Artificially passive acquired immunity

   iii) Naturally active acquired immunity iv) Naturally passive acquired immunity

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

   i) Oral polio ii) DPT iii) DPT and Oral polio iv) BCG

10. 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 _____.

11. A child eats food rich in carbohydrates and avoids protein in its diet. Which type of nutritional deficiency will affect that child?

    i) Kwashiorkar ii) Nyctalopia iii) Diabetes iv) Down syndrome

12. Assertion (A) Expulsion of excess unused glucose in the blood through urine is observed in a diabetic mellitus person.

    Reason (R) : insulin is not produced in sufficient quantity by pancreas.

    i) Both 'A' and 'R' are true and 'R' explains 'A'.

    ii) Both 'A' and 'R' are true but 'R' doesn't explain 'A'.

    iii) Only 'A' is true but 'R' is false.

    iv) A is false but 'R' is true.

PART - B

1. 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.
2. A list of disorders are given below. Pick out the odd one out and give reasons. (Thalassemia, haemophilia, night blindness, albinism, sickle cell anaemia)
3. What are the symptoms of common cold?

   i) _____ ii) _____

4. Differentiate between the diseases-night blindness and colour blindness.
5. After observing dark patches with itching sensation on the skin of a student in a school hostel, the warden advises his room mates not to share towels, clothes and combs among themselves. Name the disease the student is suffering from and name the causative organisms.
6. Name the vector host of the malarial parasite. Mention the species of malarial parasite which causes malignant and fatal malaria.
7. Name the tests done for the diagnosis and confirmation of AIDS.

8. What is triple antigen? Name the three diseases which, can be prevented by using it.

9. Mention the type of immunity acquired by a baby through breast-feeding.

10. Study the following statements and state whether they are true or false.

i) Colour blindness is a genetic disorder, whereas night blindness is a nutritional disorder.

ii) Pernicious anaemia is a nutritional deficiency disease, whereas sickle cell anaemia is a genetic disease / disorder.

iii) Administering TT injection to an injured child is related to passive artificial immunity, whereas giving BCG vaccine is active artificial immunity.

iv) Malaria is a bacterial disease, whereas ring worm is a viral disease.

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

Tell Ramya the vitamin that is lacking in her food _____ , the name of deficiency disease she is suffering from _____ .

12. Match B and C with A:

A	B	C
Vitamins	Deficiency diseases	Symptoms
Vitamin A	Nyctalopia	Night Blindness
Vitamin B_1	Scurvy	Nervous disorder
Vitamin C	Rickets	Bleeding gums
Vitamin D	Haemorrhage	Defective calcification of bones
Vitamin K	Beri-beri	Profuse loss of blood

13. A health worker advises the people in a locality not to have tattooing done using common needles and to insist the barber to change the shaving razors/ blades in the salon. Name the dreadful disease, the spreading of which, can be prevented by following these measures. Also mention other preventive measures that can be taken with regard to this disease.

14. Match the following:

List I (Disease)	List II (Symptoms)
A. Amoebiasis	I) Chills and high fever recurring for 3 to 4 days
B. Tuberculosis	II) Patches on skin and nails with itching sensation
C. Ringworm	III) Abdominal pain with blood and mucus in stools
D. Malaria	IV) Persistent cough and loss of body weight

15. *List out the diseases based on their mode of transmission (water borne, air borne, sexual contact)*

    i) cholera ii) typhoid iii) tuberculosis iv) leprosy v) syphilis

    vi) gonorrhoea vii) pneumonia viii) common cold ix) amoebic dysentery x) AIDS

16. *i) Give any three examples for the most infectious diseases in man and their causative agents.*

    ii) To discover medicine for viral infected diseases like AIDS is more difficult than other diseases. Is the statement true or false? Discuss.

17. *A student had an attack of measles and recovered from the infection. His science teacher said that he will not get that disease again in his life time. Is it true? Why?*

18. *Name the causative organisms responsible for ring worm in humans? Mention the symptoms of the infection.*

19. *Pick out the odd ones:*

    i) AIDS : Retro virus, lymphocytes, BCG, ELISA

    ii) Bacterial disease : Rabies, cholera, common cold, influenza

    iii) DPT vaccine : Diphtheria, tuberculosis, pertusis, tetanus

    iv) Infective stage of Plasmodium in humans : Sporozoites, merozoites, trophozoites, gametocytes.

    v) Mental dimension : brightness of skin, normal metabolism, no black rings around eyes, knows his capacity.

20. *In the manufacturing of anti-venom injection against snake bite, antibodies produced in the horse are being used. Mention the type of immunity involved.*

21. *Say whether each of the following diseases is a metabolic disorder, a genetic disorder or a nutritional deficiency disease.*

    i) thalassemia ii) beriberi iii) diabetes mellitus iv) bubble boy syndrome
    v) scurvy vi) marasmus vii) obesity viii) Alzheimer's disease
    ix) nyctalopia x) haemophilia

22. *Find the correct statement (True / False) :*

    i) Tuberculosis is caused by Mycobacterium tuberculosis bacteria.

    ii) Typhoid is caused by Trichophyton fungi.

    iii) Malaria is caused by Plasmodium vivax.

    iv) Influenza is caused by Entamoeba histolytica protozoan.

23. *Malarial fever is not caused in a person immediately after introducing the sporozoites by an infected anopheles mosquito. Why?*

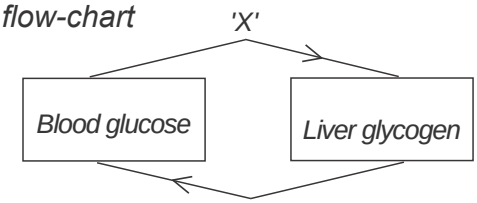
24. *Name the stages of Plasmodium.*

    i) introduced by an infected Anopheles mosquito.

    ii) picked up by Anopheles mosquito from an infected human being.

25. Name two diseases that are transmitted by houseflies. Mention their causative pathogens.

26. Observe the following flow-chart



Mention the metabolic disorder 'X' and the causative factor from the options given below:

Disorder	Factors
a) Diabetes insipidus	Deficiency of ADH hormone
b) Diabetes mellitus	Deficiency of insulin hormone
c) Coronary heart disease	Blockage of arteries supplying blood to heart muscles
d) Renal failure	Failure of nephrons to filter the blood

PART - C

1. Kala has delivered a baby,
   i) Suggest the immunization schedule for the baby, in the first six months.
   ii) What are the diseases that can be cured as per the schedule?
2. There is a widespread outbreak of malaria in your area.
   i) Suggest some controlling measures to the local authorities concerned.
   ii) Pick out the right symptom for malaria.
   (chills, shivering and a rise in temperature, diarrhoea)
3. 15th October is observed as ' World Handwashing Day' .
   i) Tell your friend the effects of hand washing.
   ii) How frequently do you wash your hands everyday and when?
4. What is immunity? Write a note on the various types of immunity.
5. Describe the life-cycle of plasmodium in man.
6. List out the various diseases caused due to nutritional deficiency. Add a note on their symptoms.

FURTHER REFERENCE

Books: 1. Biology - RAVEN, Johnson WCB McGraw - Hill, USA
2. Biology - A Modern Introduction, B.S. Beckett, 2nd Edition, Oxford University Press, New Delhi
Webliography: www.khanacademy.org, www.ase.tufts.edu/biology

Chapter 3

STRUCTURE AND FUNCTIONS OF HUMAN BODY ORGAN SYSTEMS

NERVOUS SYSTEM

When two or more people work together, each one performs the work according to his own interest and aptitude. But when the question of maintenance of order and structure enters the fray, there is a need for someone to control, coordinate and establish harmony among the workers. Our body has to work in a similar coordinated fashion. Steady state in body functioning called Homeostasis. Coordination is the process through which two or more organs interact and compliment the functions of one another. In our body, the nervous system and the endocrine system perform the task 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 quicker coordination. The endocrine system provides chemical integration through hormones. In this chapter, we shall learn the structure and functions of the nervous system and the endocrine system in man.

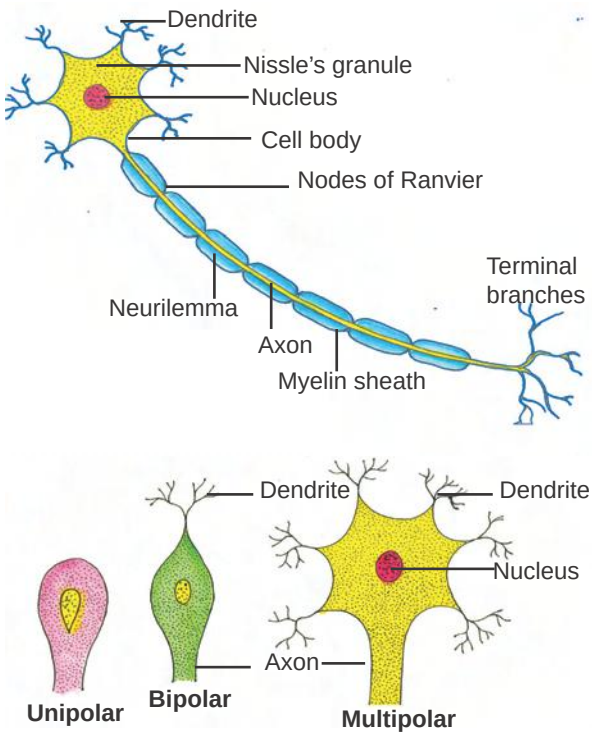


Fig. 3.1 Structure of a Neuron and its types

3.1. NERVOUS SYSTEM

The nervous system of the human is composed of:

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

BIOLOGY

ii) Neuroglial cells are the supporting cells of neurons.

iii) The nerve fibres are certain bundles of extended projections of nerve cells.

3.1.1. Nerve cells

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

The Human Brain is made up of about 86 billion neurons and many more neuroglial cells (more than 86 billion). A nerve cell is a microscopic structure consisting of three major parts namely, cell body, dendrites and axon.

Cell body

The cell structure is irregular in shape or polyhedral. It is also called cyton. Cell body contains cytoplasm with typical cell organelles and certain granular bodies called Nissle's granules. Nissle's granules are a group of ribosomes for protein synthesis.

Dendrites

Dendrites or Dendrons are short fibres which branch repeatedly and protrude 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 Axon.

The distal branch of the axon terminates in bulb-like structures called synaptic knob filled with chemicals called neuro transmitters. The cytoplasm of the axon is known as axoplasm. The axon which is covered by a myelin sheath is formed of many layers of Schwann cells. The outermost layer of Schwann cells is called Neurilemma. The gaps left by the myelin sheath are called Nodes of Ranvier. Neurilemma is discontinuous at Nodes of Ranvier. The myelin sheath ensures rapid transmission of electric impulses.

Types of nerve cell

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

c) Unipolar neurons: The developing embryonic nervous tissue contains unipolar neurons. A unipolar neuron has a nerve cell body with a single process or fibre, which acts 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 processes at the ends, one acting as axon and the other acting as dendron.

e) Multipolar neuron: The cerebral cortex contains 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 is called synapse.

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 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)

b) The Peripheral Nervous System (PNS)

c) The Autonomic Nervous System (ANS)

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

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

Central Nervous System

It comprises 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***.

The Brain

The brain is the central information processing organ and acts as the command and control system.

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

a) Forebrain
b) Midbrain
c) Hindbrain

Forebrain

The forebrain consists of cerebrum, thalamus and hypothalamus.

Cerebrum

This forms the major portion of the human brain. Nearly two-thirds 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 the white matter.

Cerebral cortex

It consists of the nerve cell bodies of several layers of greyish nerve cells giving

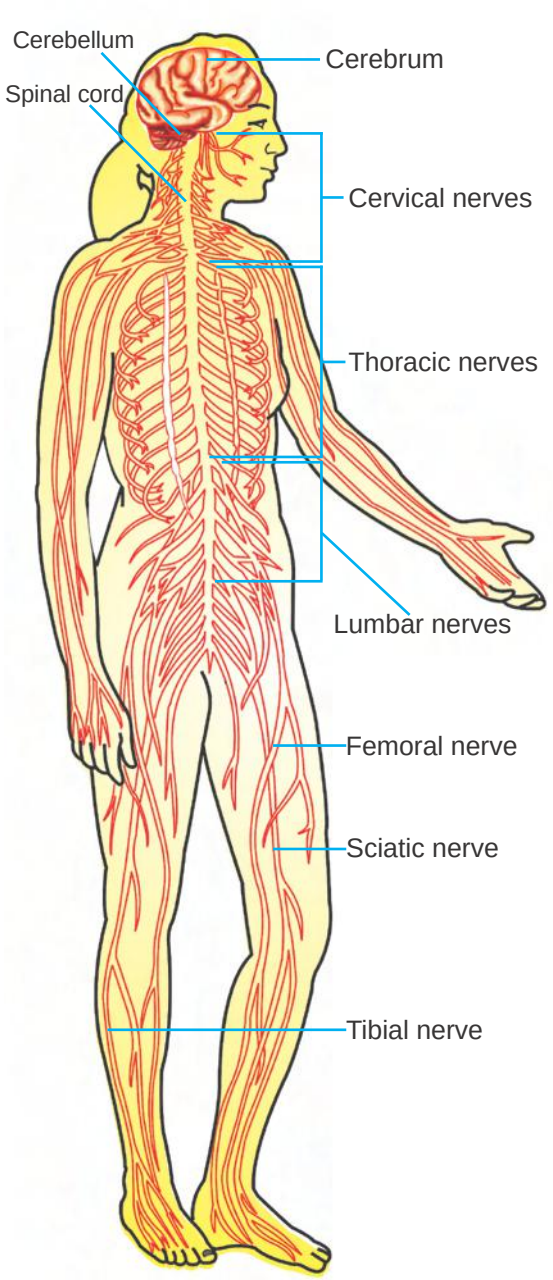


Fig. 3.2 Human Nervous System

it a grey colour and so called as the grey matter. The increased surface area of the cerebral cortex in man is folded and thrown into a pattern of convolutions consisting of ridges (gyri) and furrows (sulci).

Cerebral cortex contains

a) motor areas

b) sensory areas

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 to control the activities of the various organs of our body originates. Initiation of voluntary activities takes place here.

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 it 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.

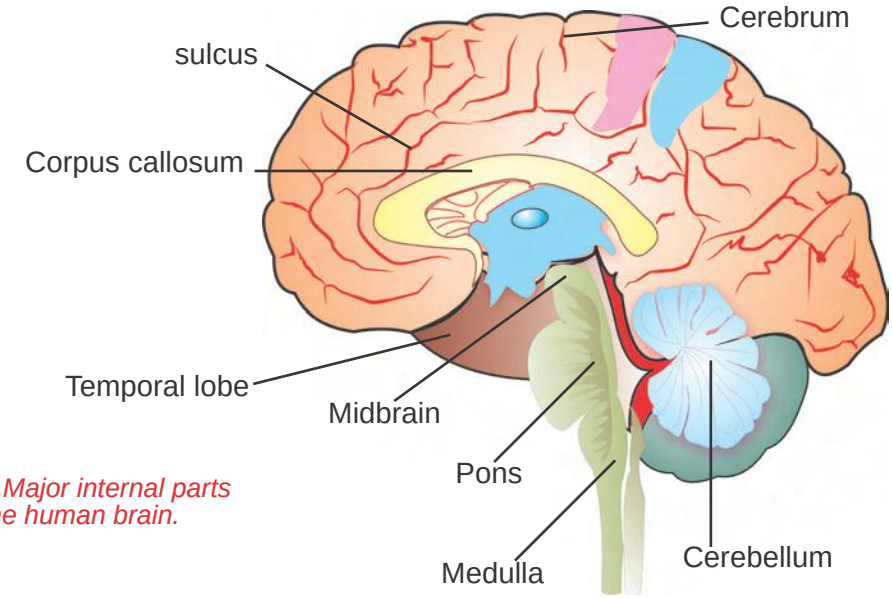


Fig. 3.3 Major internal parts of the human brain.

Specific areas of cerebrum are associated with specific functions. Thus there is a respective centre for hearing, seeing, tasting, smelling, speaking and so on. A damage in a specific centre of the cerebrum will deprive the particular part from carrying out its functions.

Thalamus

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

Midbrain

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

The midbrain together with the hind brain, forms the brain stem.

Hindbrain

The hindbrain comprises pons, cerebellum and medulla oblongata.

Cerebellum

It lies below the cerebrum and consists of a median portion and two lateral lobes.

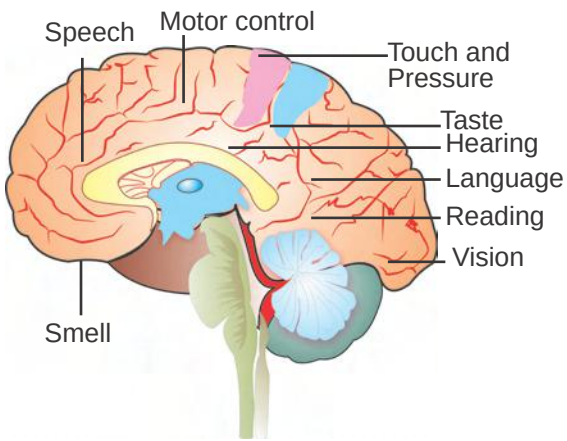


Fig. 3.4 Functional areas of human brain.

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 the cerebellum. It relays the information from the cerebrum to the cerebellum. It also contains the sleep and respiratory centres.

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 heart beat, blood vessel contraction, breathing, etc.

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

The Spinal Cord

This is a tubular structure, a continuation of the brain lying in the neural canal of the vertebral column. The meninges – Piamater, Arachnoid membrane and the Duramater cover the spinal cord as in the case of the 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. Below the lumbar enlargement, the spinal cord tapers to form a cone like region called the ***conus medullaris.*** The tip of the spinal cord is filamentous and is called ***Filum terminale.*** Then the spinal cord forms the horse tail like structure called ***Cauda equina.*** 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**. The 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.

Peripheral Nervous System (PNS)

The nerves arising from the brain and the 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 organs to the brain e.g. optic nerves from the eyes). Some of the cranial nerves are motor nerves taking impulse from the brain to the effector organ. e.g. occulomotor nerve innervating to inferior oblique muscles of the eye ball. Some cranial nerves are mixed nerves with both sensory and motor functions. e.g. facial nerves and vagus 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.

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

The chemical coordination of physiological processes to maintain the homeostasis is the work of the endocrine system. The endocrine system controls and coordinates the physical processes of growth, reproduction and sustenance of life.

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

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

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

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

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

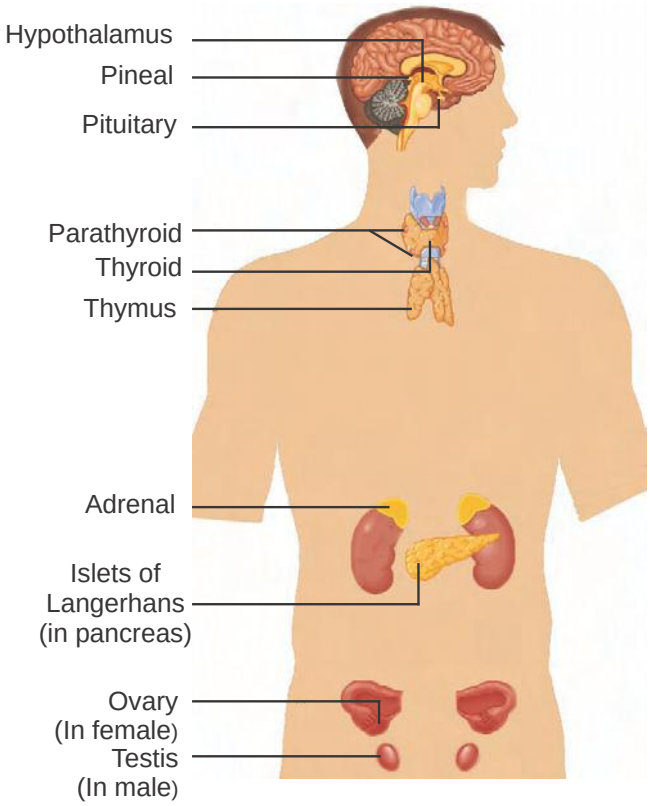


Fig. 3.5 Endocrine System in Human

Pituitary Gland

It is a tiny gland, the size of a pea, attached to the hypothalamus of the brain. The pituitary gland regulates the endocrine glands and so it is called as the conductor of the Endocrine Orchestra.

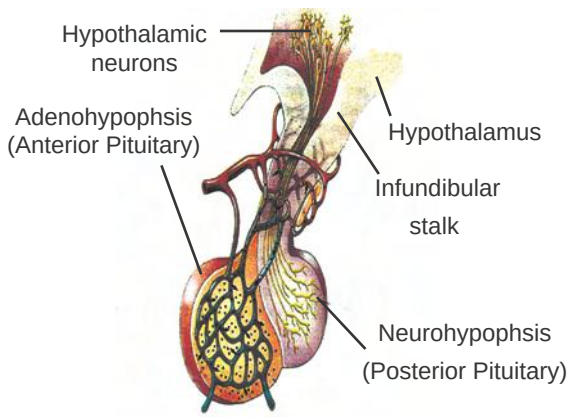


Fig. 3.6 Diagrammatic internal view of pituitary gland

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

Hormones of adenohypophysis	Functions
Somatotropic or Growth hormone (STH or GH)	• It contributes growth in general. malfunctions • 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 hormone (ACTH)	It stimulates the adrenal cortex to produce the hormones aldosterone and cortisone.
Follicle stimulating hormone (FSH)	It stimulates the maturation of graffian follicles (in the ovary) to produce eggs in females and sperm formation in males.
Lutenizing hormone (LH) in female or Interstitial cell stimulating hormone (ICSH) in male	LH in a female causes discharge of eggs from graffian follicle – a process, called ovulation and production of female sex hormone-oestrogen and progesterone. ICSH in a male, induces the interstitial cells to produce male sex hormone – testosterone.
Lactogenic hormone or prolactin	It stimulates the growth of mammary glands in females and milk production after childbirth.
Hormones of Neuro hypophysis	**Functions**
Oxytocin	It speeds up the childbirth 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 quantities. It constricts the blood vessels and raises the blood pressure. malfunctions: Less production of ADH results in diabetes insipidus, leading to excess production of dilute urine.

Thyroid Gland

The bilobed thyroid gland is located in the neck, one lobe on the either side of larynx, which secretes a hormone called ***thyroxine***. Thyroxine is an iodinated protein, composed of tyrosine (amino acid) and iodine.

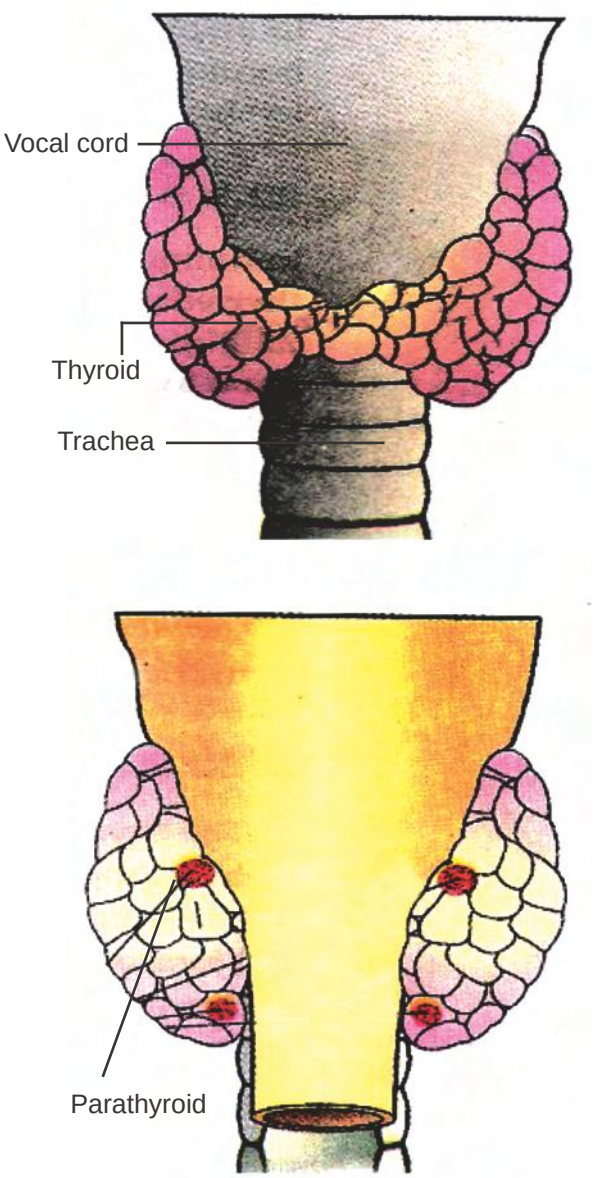


Fig. 3.7 Thyroid Gland a) Dorsal view b) Ventral view

Functions of thyroxine

- It increases the rate of metabolism.
- It stimulates a rise in body temperature.
- It promotes growth and differentiation of tissues.
- Since it indirectly affects the growth of the body, thyroxine is also called as **personality hormone**.
- It regulates iodine and sugar levels in blood.
- It controls functioning 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 adults. The symptoms are: low metabolic rate, loss of mental and physical

Fig. 3.8 a person with goitre

vigour, increase in weight, thickening of skin, lowered heart beat, mental dullness, etc.

c) Cretinism – This is caused 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, fatigue and protrusion of eyeballs.

The Islets of Langerhans

Pancreas plays a dual role both as an exocrine and an endocrine gland. The an endocrine portion is called I**slets of Langerhans**. It consists of two types of cells namely, alpha cells and beta cells. **Alpha cells** produce a hormone called glucagon and **Beta cells** produce insulin**.**

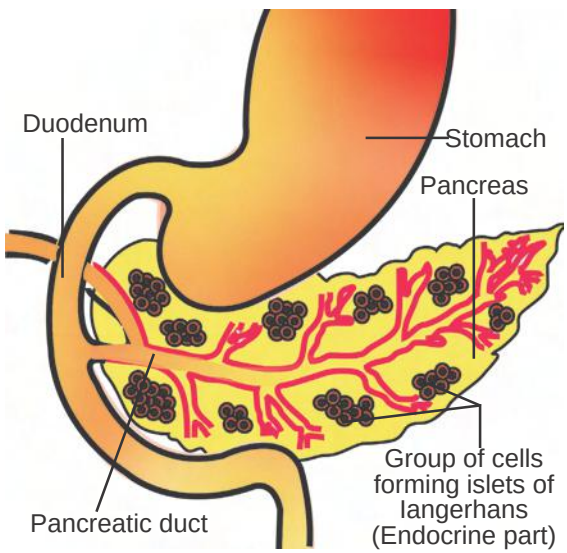


Fig. 3.9 Pancreas showing Islets of Langerhans

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.

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 the glucose level in the blood is low.
- It influences conversion of glycogen into glucose, thus raising the blood glucose level.
- A proper balance between insulin and glucagon is necessary to maintain proper blood glucose level of 80 – 120 mg / dl of blood.

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 break down of glycogen into glucose raising the blood glucose level.

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

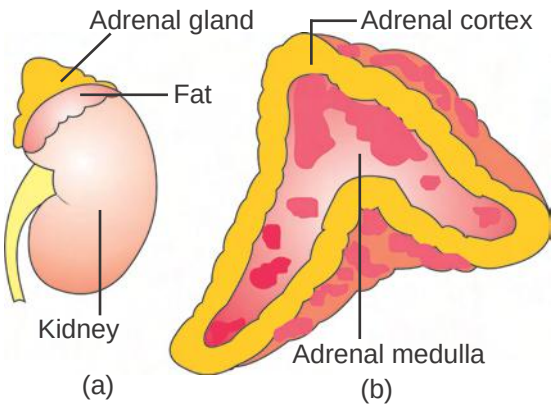


Fig. 3.10 a) Adrenal gland
b) LS of Adrenal gland

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 fight, flight and fright,** as they rapidly mobilize the body to face stress and an emergency situation.

- They increase the heart beat.
- They increase alertness.
- They increase the respiratory rate.
- They promote the conversion of glycogen into glucose.
- They cause dilation of pupils.
- They cause profuse sweating.
- They make the hair stand erect. (gooseflesh)

In short, noradrenaline and adrenaline mobilize the body to face an emergency by fighting with it or running away from it.

Testes

They are both cytogenic (producing gametes) and endocrine (producing male sex hormones) in function.

Leydig cells constitute the endocrine part of the testes. It secretes male sex hormone called ***testosterone (androgen).***

Testosterone stimulates the growth of reproductive organs and the production of male gametes- the sperm.

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

Ovaries

Ovaries are both cytogenic (producing gametes) and endocrine (producing female sex hormones, such as oestrogen, progesterone and relaxin) in function.

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

Progesterone maintains pregnancy and regulates menstrual cycle.

Relaxin relaxes the muscles of the pelvic region at the time of childbirth.

Parathyroid gland

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

Thymus gland

It is a lymphoid mass, present above the heart. It secretes ***thymosin hormone*** which stimulates the differentiation of "T" lymphocytes to resist infection.

Pineal gland

It lies under the corpus callosum in the brain. It secretes ***melatonin hormone***, 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.This type of cell division is 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. We shall study the various stages of meiosis and its significance in this unit.

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 sub-stages namely Prophase-I, Metaphase-I, Anaphase-I and Telophase-I.

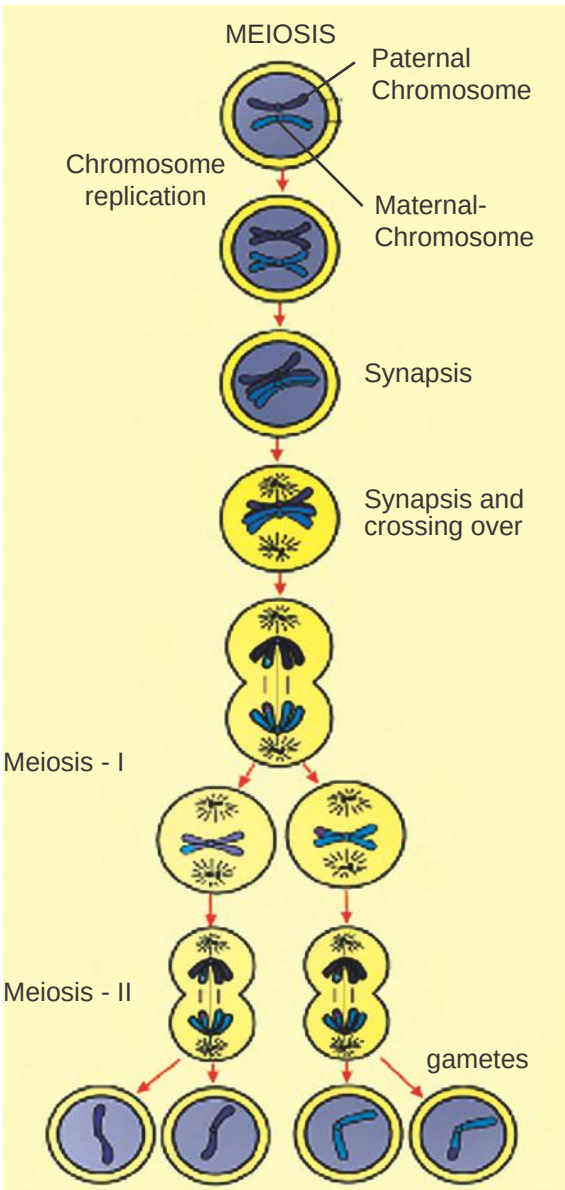


Fig. 3.11 Meiosis - stages

Prophase - I

The chromatin reticulum unwebs and individual chromosomes get 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 consists of a paternal chromosome and a maternal chromosome with similar genes). The pairing starts from the tip or from the middle and they get attached laterally throughout the length. This pairing is called **Synapsis** and the paired chromosomes are called **Bivalents.**

Pachytene: The paired chromosomes become shorter and thicker. Each bivalent appears to have four chromatids called ***tetrads*** or ***quadrivalents*****.** The point of contact between the homologous pair of chromosomes is called ***Chiasmata*****.** At the point of chiasmata, exchange of chromosomal segment takes place, between the non-sister 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 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 get shortened. The centrioles form asters and move to the poles. The nucleolus and the nuclear membrane disappear.

Metaphase - II

Chromatids arrange themselves in the equator of the cell. The centromeres are attached to the spindle fibres.

Anaphase - II

The centromere divides into two and the two chromatids separate and now, they are called 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 the 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 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.

MODEL EVALUATION

PART - A

1. Unipolar neurons are found in the _____.

i) Brain ii) Spinal Cord iii) Embryonic nervous tissue iv) Adult nervous tissue

2. The sensory organs contain _____.

i) Unipolar neuron ii) Bipolar neuron iii) Multipolar neuron iv) Medullated neuron

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

i) Cerebellum ii) Cerebrum iii) Thalamus iv) Hypothalamus

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

i) Forebrain and midbrain ii) Midbrain and hindbrain

iii) Forebrain and hindbrain iv) Forebrain and spinal cord

5. Spinal nerves are _____.

i) sensory nerves ii) motor nerves iii) mixed nerves iv)innervating the brain

6. An endocrine gland found in the neck is _____.

i) adrenal gland ii) pituitary gland iii) thyroid gland iv) pancreas

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

i) pancreas ii) pituitary iii) thyroid iv) adrenal

8. Normal blood glucose level in 1dl of blood is _____.

i) 80-100 mg/dl ii) 80-120 mg/dl iii) 80-150 mg/dl iv) 70-120 mg/dl

9. The "T" lymphocytes are differentiated to resist infection in the _____

i) parathyroid gland ii) lymph gland iii) thymus gland iv) adrenal gland

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

i) leptotene ii) zygotene iii) pachytene iv) diplotene

11. The two systems of the human body which help in the control and co-ordination of metabolic activities are _____.

i) digestive and circulatory ii) respiratory and circulatory

iii) excretory and skeletal iv) nervous and endocrine

12. Neurotransmitters are released at the synapse by _____.

i) Tips of Dendrites ii) Synaptic Knobs

iii) Organelles of Cyton iv) Myelin sheath of Axon

13. The endocrine gland related to the immune system is _____ .

i) Thyroid ii) Thymus iii) Adrenal iv) Pineal

14. The hormone administered by doctors to a pregnant woman to help in childbirth during the time of natural delivery is _____ .

i) Oestrogen ii) Progesterone iii) Insulin iv) Relaxin

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

i) Leptotene ii) Pachytene iii) Diplotene iv) Zygotene

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

i) germinal epithelial cells ii) the sensory epithelial cells

iii) cuboidal epithelial cells iv) columnar epithelial cells

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

i) involving changes in the chromatin reticulum ii) without involving changes in the chromatin reticulum iii) leading to reduction in the number of chromosomes iv) without dividing the nucleus

18. Pick out the item which has sequential arrangement.

i) zygotene -> Leptotene -> Pachytene -> Diplotene -> Diakinesis

ii) Diakinesis -> zygotene -> Leptotene -> Pachytene -> Diplotene

iii) Leptotene -> zygotene -> Pachytene -> Diplotene -> Diakinesis

19. Polio is a viral disease and the affected child suffers from physical disability of limbs. Which system of the body is mostly affected due to this infection?

i) Nervous system ii) Digestive system

iii) Respiratory system iv) Excretory system

20. Blinking when a beam of light is suddenly focussed on the eyes and sudden withdrawal of hand upon touching a hot body are some of the examples of reflex actions. Which part of the central nervous system acts as the centre these actions?

i) Forebrain ii) Spinal cord iii) Hindbrain iv) Synapse

21. The following are the parts of a neuron:

a) Axon b) Terminal branches c) Cyton d) Dendrites

The correct pathway of a nerve impulse through these parts are _____.

i) badc ii) dcab iii) bdac iv) adbc

22. For minor surgeries in the body, doctors administer local anaesthesia to a part of the body so that the pain will not be felt by the patient. At which part, do you think, the nerve impulse is being arrested due to the effect of anaesthesia?

i) at cyton ii) at axon iii) at synapse iv) in the middle of axon

23. Assertion (A) : All spinal nerves are mixed nerves.

Reason (R) : Each spinal nerve has a sensory root and a motor root.

i) Both 'A' and 'R' are true and 'R' explains 'A'.

ii) Both 'A' and 'R' are true but 'R' doesn't explain 'A'.

iii) Only 'A' is true but 'R' is false.

iv) 'A' is false but 'R' is true.

PART - B

1. Name the two systems which help in the control and co-ordination of metabolic activities. Write any one difference between them.
2. Differentiate medullated neurons from non-medullated neurons. Where are they found in the nervous system?
3. Name the part of the brain which regulates heart beat and respiration. Where is it located in the brain?
4. What is corpora quadrigemina? Name the functions associated with it.
5. What are endocrine glands? Name the secretions of these glands. How do these secretions reach the target organs?
6. Name the following endocrine glands:

i) The master of endocrine orchestra ii) The dual gland

7. Which hormone(s) is/are called i) Personality hormone ii) fight, flight and fright hormones.

8. Name the male and female sex hormones. List out their functions.

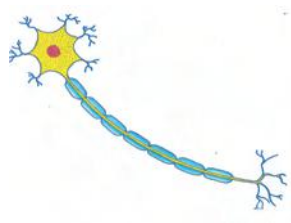
9. In which sub-stages of meiosis-I do the following events occur?

   i) pairing of homologous chromosomes ii) terminalization

   iii) crossing over iv) formation of spindle apparatus.

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

   (cyton, axon, dendron, terminal branches)



11. The diagram is of the human brain.

   Shade the areas marked A and B in the parts of the brain, corresponding with the function.

   A. Seat of smell

   B. Seat of vision

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

   i) Pituitary gland secretes hormones and enzymes.

   ii) Thyroid gland secretes thyroxine and insulin.

   iii) Leydig cells produce testosterone hormone.

   iv) Pancreas produces enzymes and hormones.

13. Correct the statements, if they are wrong.

   i) Alpha cells produce insulin and beta cells produce glucagon.

   ii) Cortisone suppresses the immune response.

   iii) Thymus gland is a lymphoid mass.

   iv) Ovary produces eggs and androgen.

14. Here are a few statements about the endocrine system in man. State whether each of them is true or false. If the statement is false write the correct statement.

   i) Endocrine system controls and co-ordinates the physical process of growth, reproduction and sustenance of life.

   ii) Endocrine glands are duct bearing glands which secrete chemical substances called hormones.

iii) The pancreas is a dual gland.

iv) Malfunctioning of the thymus gland causes goitre.

15. Copy and complete the following table:

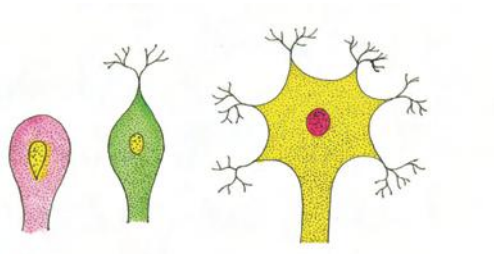
	Hormones of adenohypophysis	Functions and malfunctions
1.	somatotropic or growth hormone (STH or GH)	
2.		It stimulates the growth of thyroid gland and produces thyroxine

16.Copy the diagram and label the parts with the help of the clues given:

i) It is otherwise called supra renal gland.

ii) It secretes two hormones, namely aldosterone and cortisone.

17. Copy and identify the types of neurons given below:



18. Here are some statements about meiosis. State whether each of them is true or false:

i) It takes place in somatic cells.

ii) Meiosis is also called reduction division.

iii) Pairing of homologous chromosomes is called crossing over.

iv) Meiosis leads to variations which form the raw material for evolution.

19. Match the following:

A. leptotene	I. nuclear membrane and nucleolus disappear
B. zygotene	II. terminalization
C. diplotene	III. pairing, synapsis, bivalents
D. diakinesis	IV. chromosomes condense and appear like threads

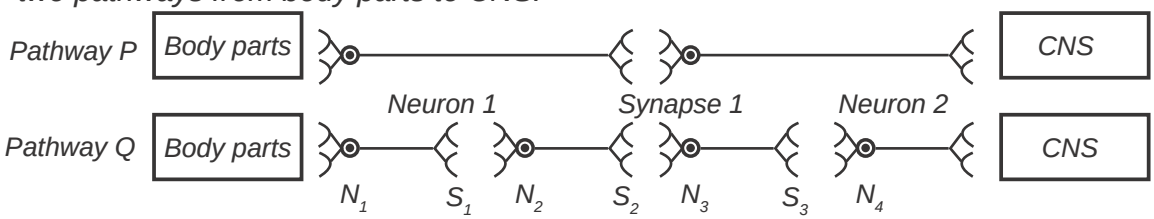
20. A person was riding a two-wheeler without wearing a helmet. He met with an accident

and sustained a head injury. He was dead before he was shifted to the hospital and it was found that his death was due to breathlessness and heart failure. Which part of his brain might have been damaged? Justify your answer.

21. *Match the following:*

List I	List II
A. Vasopressin	I. Resist infection
B. Insulin	II. Diabetes insipidus
C. Oxytocin	III. Diabetes mellitus
D. Thymosin	Iv. contraction and relaxation of uterus

22. *Observe the following diagrams that depict the transmission of nerve impulses through two pathways from body parts to CNS:*



If all the nerves at both the places are similar in thickness and structure, through which pathway will the transmission of an impulse (of same threshold) be faster and why?

23. *Which gland is called the 'dual gland'? Why?*

24. *A 16 year old boy was brought to a doctor with a complaint of non-masculine features (lack of moustache / beard / gruff voice / broadening of shoulders etc). After keen examination, the doctor found that it was a hormonal disorder and the endocrine glands responsible were not functioning properly. Mention the glands and the hormone lacking in the boy.*

PART - C

1. *Describe the structure of a neuron with the help of a neat, labelled diagram,*
2. *List out the various parts of the human brain and write a note on their functions.*
3. *Name the endocrine glands and their location in the human body. Describe any two of them in detail.*
4. *Why is meiosis called reduction division? Describe the various stages with relevant diagrams. Add a note on significance of meiosis.*
5. *Use words from the given list to complete the following paragraph. (The words may be used once/ more than once / not at all).*

   (Skull, Vertebral column, Piamater, Arachnoid membrane, Brain, Spinal cord, Meninges, Duramater)

The central nervous system is covered by three protective coverings collectively called _____. The outermost cover lying below the _____ and _____ is double thick and is called _____. The middle covering is thin and vascularised and is called _____. The innermost cover is a very thin delicate membrane and is closely stretched over the outer surface of _____and ____ and is called _____.

6. *Match these parts with their functions:-*

medulla oblongata, cerebellum, forebrain, thalamus, cerebral cortex, hind brain, pons, hypothalamus

a) Sleep centre and respiratory centre

b) Several reflexes involved in the regulation of heart beat, blood vessel contraction, breathing etc.

c) Consists of cerebrum, thalamus and hypothalamus

d) Motor and sensory areas

e) A major conducting centre for sensory and motor signalling

f) Regulation of sexual behaviour

g) Consists of pons, cerebellum and medulla oblongata

h) Co-ordinates the group movements of voluntary muscles, as in walking or running

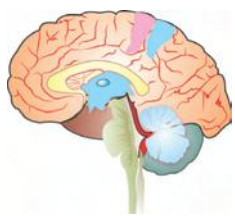
7. *Observe the diagram of the human brain and identify the areas mentioned:*

i) The area responsible for consciousness, intelligence, memory, imagination and reasoning.

ii) The area responsible for regulation and co-ordination of group movements of voluntary muscles.

iii) The area responsible for sleeping and respiration.

iv) The area responsible for reflexes involved in the regulation of heart beat, blood vessel contraction, breathing etc.



FURTHER REFERENCE

Books: 1. Biology - RAVEN, Johnson WCB McGraw - Hill, USA

2. Biology - A Modern Introduction, B.S. Beckett, 2nd Edition Oxford University Press, New Delhi

3. Complete Biology(IGCSE) - Oxford University press, New York

Webliography: www.khanacademy.org, www.ase.tufts.edu/biology www.biologyreference.com, science.howstuffworks.com http://arvindguptatoys.com/films.html

Chapter 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.

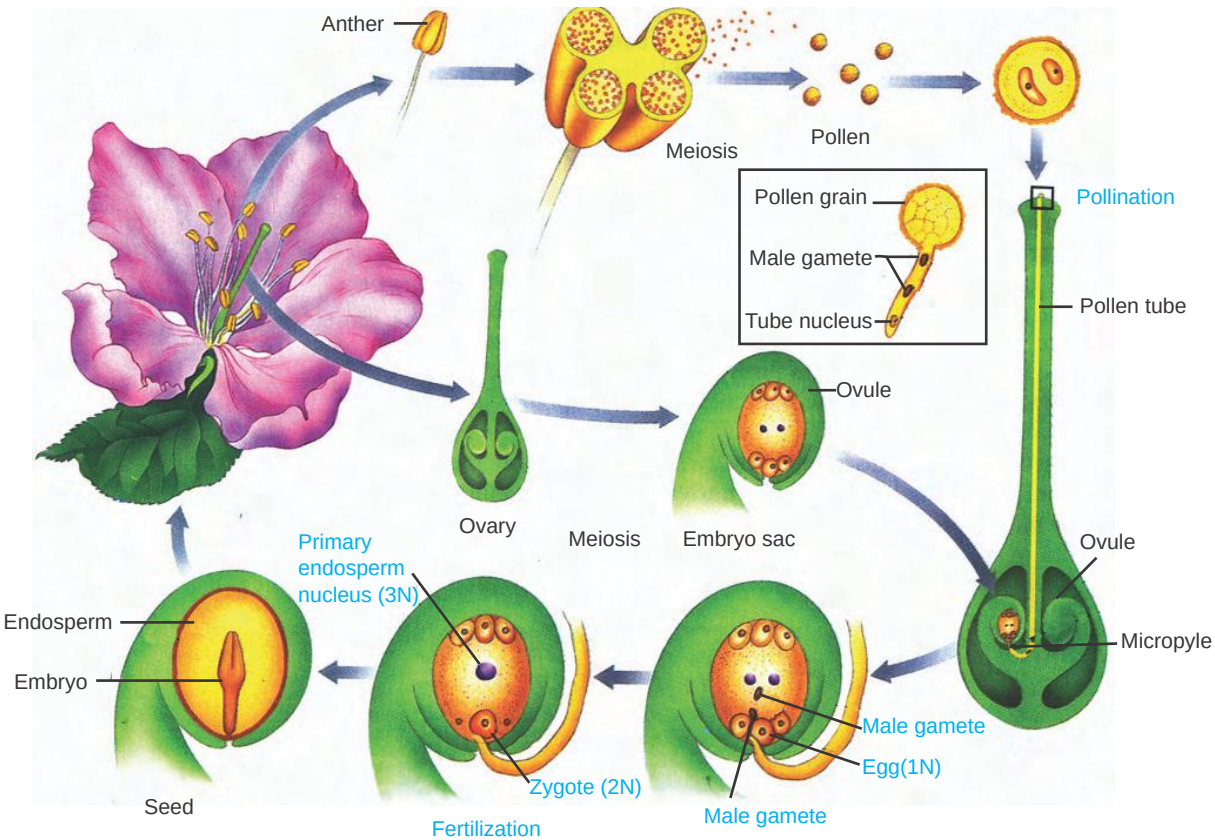


Fig. 4.1 Pollination and fertilization

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

What will happen if reproduction doesn't take place?

Questions

1. What is meant by reproduction?

2. Mention a few methods of reproduction in plants and animals.

Some Bacteria like Lactobacilli, Salmonella multiply rapidly. Others like Mycobacterium tuberculosis multiply slowly.

Activity beneficial to humans: Conversion of milk into curd by *Lactobacilli*

Activity harmful to humans : Bacteria like *Mycobacterium tuberculosis* cause tuberculosis.

4.1. MODES OF REPRODUCTION

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 each half develops into new ones. This method is called binary fission.

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 for a week.*
- *Record your observations .*

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.*

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.

Reproduction in unicellular organisms :
By Fission

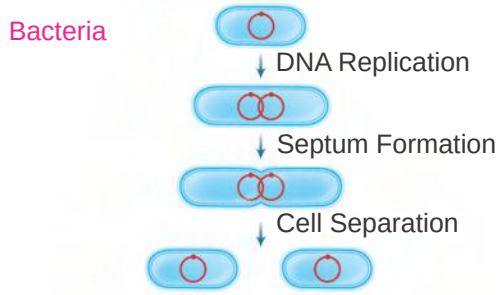
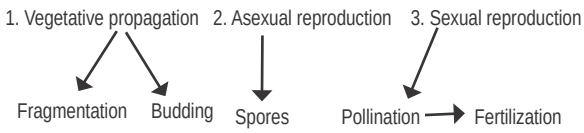


Fig. 4.2 Reproduction in unicellular organisms

Modes of reproduction in multicellular organisms:



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

Vegetative propagation:

It is the ability of plants to reproduce by bringing forth new plants from the existing vegetative structures without sexual reproduction.

Think, read and analyse

Why are there 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. It takes place 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).

Fragmentation

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

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

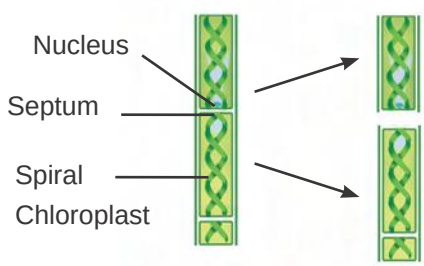


Fig. 4.3 Fragmentation in Spirogyra

ACTIVITY 4.3

- *Collect some water from a lake or pond that appears dark green and contains filamentous structures.*
- *Place one or two filaments on a slide.*
- *Pour 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 into an outgrowth due to repeated cell division at one specific site. These buds develop into tiny individuals and when fully matured, get detached from the parent body to become new independent individuals.

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

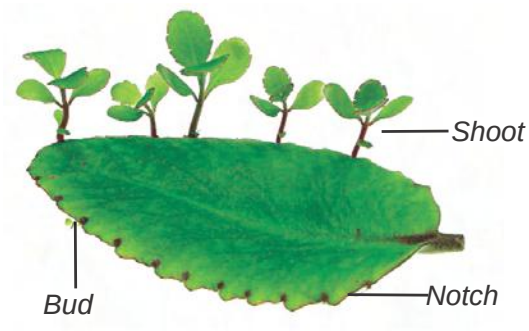


Fig. 4.4 Bryophyllum

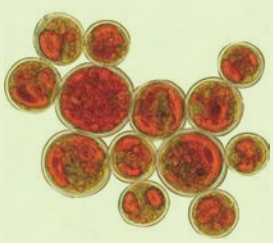
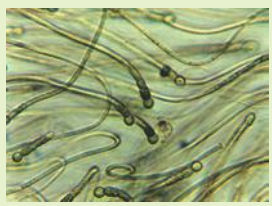
Asexual reproduction

In lower group of plants, asexual 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 begin to grow.

Questions

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

Some of the spores in different algae and fungi :

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**.
 *Aplanospores*	 *Zoospores*	 *Akinetes*	 *Conidia*

4.2. SEXUAL REPRODUCTION IN PLANTS

Sexual reproduction is the process in which two **gametes** (male and female) are fused to produce offspring of their own kind.

A bull alone cannot produce calves. It needs a cow. A female sheep (ewe) alone cannot produce lambs. It needs a male sheep (ram).

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

You have already learnt that the flower is a reproductive organ of a flowering plant. To understand this further we need to first study the structure of a flower.

Parts of a typical flower

A **flower** is a modified shoot with a limited growth to carry out sexual reproduction.

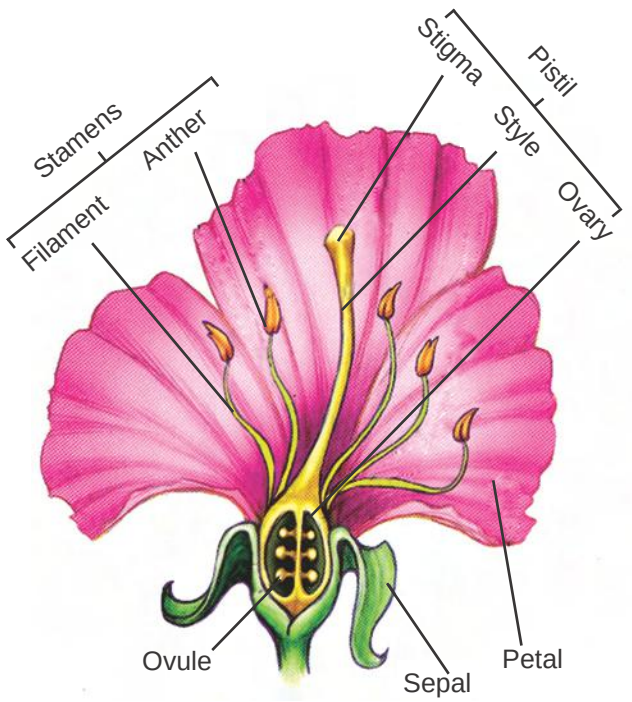
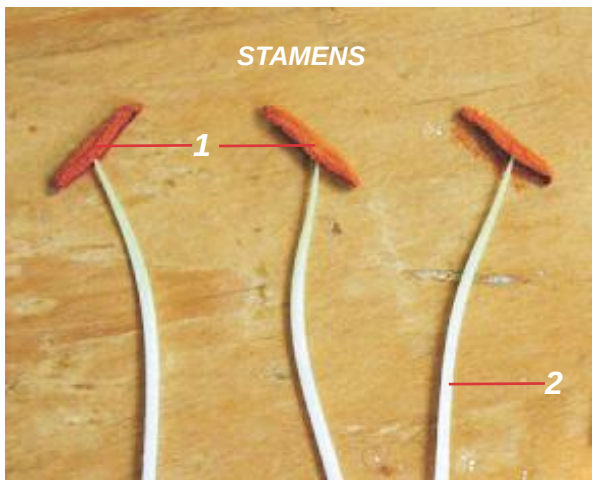


Fig. 4.5 Parts of a Flower

The main whorls of a complete flower are:

1. *Calyx (Composed of sepals)*
2. *Corolla (Composed of petals)*
3. *Androecium*
4. *Gynoecium*

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



1. Anther 2. Filament

Fig 4.6 Androecium

Androecium is composed 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 produced in the anther within the pollen sacs.

Gynoecium is the female part of the flower and is made of carpels. It has three parts :

1. Ovary 2. Style 3. Stigma

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

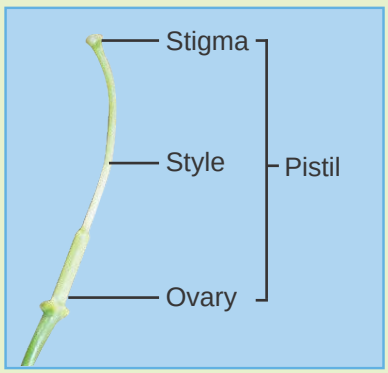


Fig. 4.7 Gynoecium

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 a microscope.*

4.2.1. Pollination

How does sexual reproduction take place in flowering plants?

The sexual reproduction in flowering plants involves

1. Pollination
2. Fertilization

1. Pollination

The transfer of pollen grains from the anther to stigma of a flower is called pollination. Pollen grains are transferred mainly by wind, water, insects and animals. They are called pollinating agents.

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

4.2.2. Types of Pollination

Pollination is of two types. They are:

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

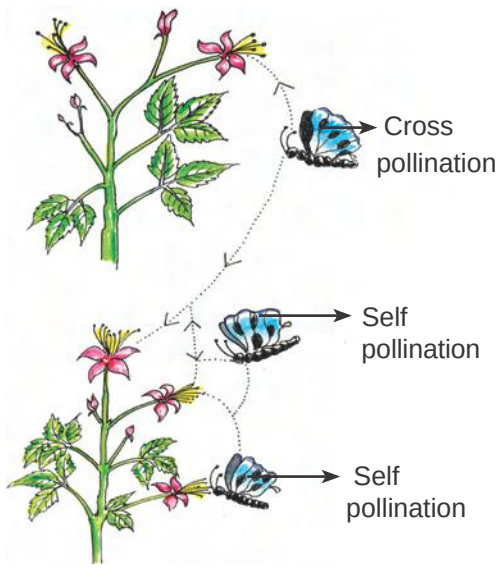


Fig. 4.8 Pollination

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 do not depend on agents for pollination.
3. There is no wastage of pollen grains.

Disadvantages of self pollination

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

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

Agents of cross pollination

How is it possible to transfer 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 the agency of animals, insects, wind and water.

a) Pollination by animals (Zoophily)

b) Pollination by birds (Ornithophily)

c) Pollination by insects (Entamophily)

Entamophily

Insects like butterflies and honey bees are attracted to the bright petals of the flowers. These flowers are large in size and have a sweet smell. Some of these flowers produce nectar. This is the most common of all types of pollination. This kind of pollination is called Entamophily. (Pollination by insects).

Fig. 4.9 Zoophily

ACTIVITY 4.5

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

Anemophily (Pollination by wind)

The flowers pollinated by wind are mostly small in size and do not have any attractive colour, smell and nectar. They produce a large number of pollen grains to make up for the wastage of pollen in transit.

Fig. 4.10 Anemophily

The pollen grains are non-sticky, dry, light, 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 zoophilous, anemophilous and hydrophilous flowers.*
- *Prepare a chart and make a note of their adaptations to suit the corresponding pollination.*

Pollination by Water (Hydrophily)

Pollination by water is called hydrophily. It is observed in some aquatic plants like **Vallisneria, Hydrilla, Zosteria**.

The flowers of these plants are not colourful and have no nectar.Pollen grains have mucilaginous covering to protect them from getting wet.

Fig. 4.11 Hydrophily - Vallisneria

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 a 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).

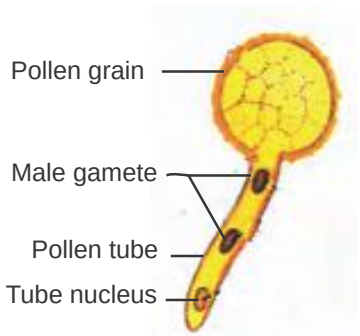


Fig. 4.12 Germination of Pollen grain

Process of fertilization

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

Double fertilization

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

The fusion of this nucleus with the second male gamete is known as triple fusion. The triple fusion nucleus is called primary endosperm nucleus because it develops into an endosperm. Endosperm is a nutritive tissue meant for the development of the embryo. The process of fusion of a male gamete with an egg and the other gamete with a secondary nucleus is known as double fertilization.

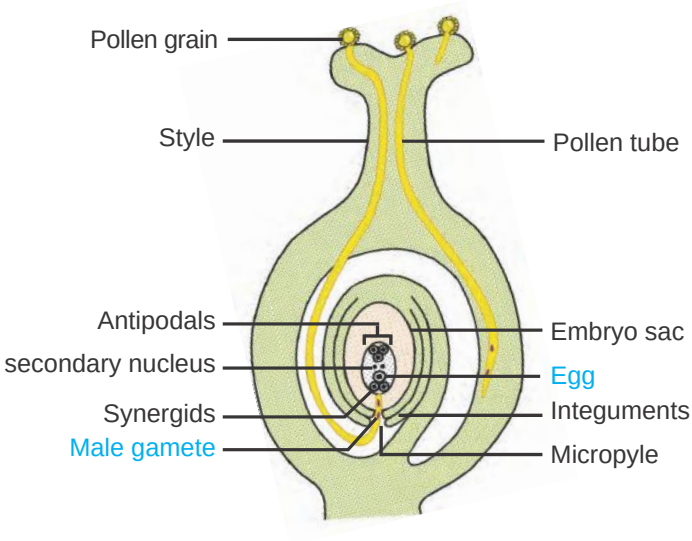


Fig. 4.13 Process of Fertilization

Post fertilization changes :

i. The ovule develops into a seed.

ii. The integuments of the ovule develop into seed coats.

iii. The ovary enlarges and develops into a fruit.

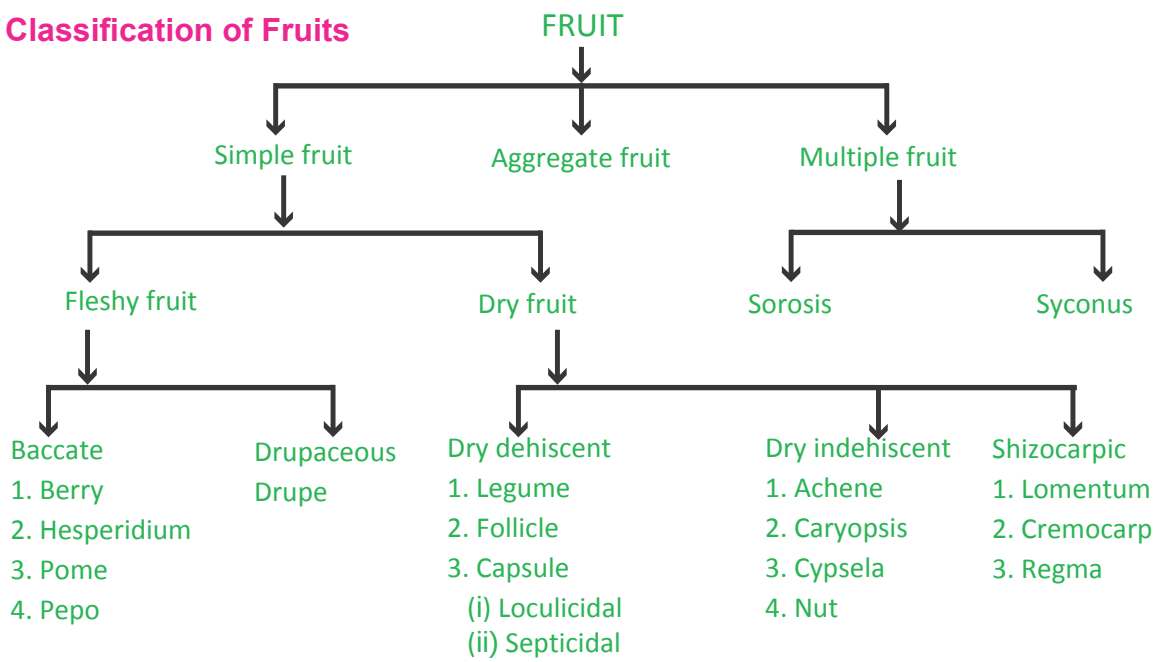
4.4. FRUIT FORMATION

Fruits form a part of our daily diet. Fruits are rich in vitamins and give us energy.

The fruit may be defined as a fertilized and ripened ovary. The ovary wall becomes the fruit wall (pericarp) and the ovule becomes the seed.

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

Classification of Fruits



Simple fruits

A simple fruit is developed from a single ovary with a monocarpellary or multicarpellary, syncarpous gynoecium.

Based on the nature of the pericarp, the simple fruits are classified into fleshy fruits and dry fruits.

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 made up of three layers, 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.

Baccate:

Sl. No.	Type	Description
1.	Berry - Tomato 	It is a one or many - seeded fruit. Epicarp is thin and mesocarp is fleshy. They form a pulp which is edible and the seeds are embedded in it. It develops from a bicarpellary, syncarpous, superior ovary.
2.	Hesperidium - Orange 	It develops from multicarpellary, superior ovary with axile placentation. The epicarp is thick, leathery and contains 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 a 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.

Sl. No.	Type	Description
5.	Drupaceous: Drupe - Mango 	It is a one - seeded fleshy fruit and develops from a monocarpellary ovary. The pericarp is differentiated into outer skinny epicarp, fleshy middle mesocarp and stony inner endocarp. Due to the presence of a stony endocarp, the fruit is also known as stone fruit.

Simple dry fruits

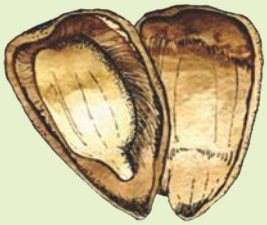
These fruits have a dry pericarp. They are classified based on mode of dehiscense as dry dehiscent, dry indehiscent and schizocarpic fruits.

Dry dehiscent fruit: These fruits split open at maturity to disperse the seeds.

Sl. No	Type	Description
1.	Legume - Peas 	It develops from a monocarpellary, unilocular, superior ovary with marginal placentation. Pericarp dehisces along both dorsal and ventral sutures e.g.pea, bean.
2.	Follicle - Calotropis 	It develops from a bicarpellary, syncarpous, superior ovary. It is like a legume fruit, but the pericarp dehisces along one suture only. e.g. Calotropis.
3.	Capsule (a) Septicidal capsule - Cotton  (b) Loculicidal capsule - Lady's finger 	This is a many - seeded fruit developing from a superior, multicarpellary syncarpous ovary. Capsules dehisce by various methods.When the fruit wall opens along the middle of each locule, it is called loculicidal capsule. When the fruit wall splits open along the line of septum, it is called septicidal capsule.

Dry indehiscent fruit

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

Sl. No.	Type	Description
1.	Achene - Clematis,Mirabilis 	This is a single - seeded fruit which develops from a monocarpellary, unilocular ovary. Pericarp is hard and leathery. It remains free from the seed coat.
2.	Caryopsis - Paddy 	It is a one - seeded fruit which develops from a monocarpellary superior ovary.Pericarp is fused with the seed coat e.g. paddy, wheat, maize.
3.	Cypsela - Tridax 	This fruit develops from a bicarpellary syncarpous inferior ovary. The pericarp and the seed coat remain free e.g. Tridax.
4.	Nut - Cashew nut 	It is a dry indehiscent, one seeded fruit with hard and woody pericarp. The nut is developed from a bicarpellary or a multicarpellary superior ovary e.g. Cashew nut.

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 both dehiscent and indehiscent fruits.

Sl. No.	Type	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 a bicarpellary syncarpous, bilocular and inferior ovary. It dehisces longitudinally into two indehiscent mericarps e.g. Coriandrum.
3.	Regma - Castor 	It develops from a tricarpellary syncarpous superior ovary and breaks up into three one - seeded cocci e.g. Castor.

Aggregate Fruit

It is developed from a single flower with a 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 matured ovaries of carpels after fertilization (fruitlets) are united and appears like a single fruit.

Fig. 4.14 Polyalthia

Fig. 4.15 Custard apple

Composite or Multiple fruit

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

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

ACTIVITY 4.7

Collect a variety of fruits. Identify the type of each fruit and write a note on them.

4.5. SEED FORMATION

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

Seeds vary greatly in size, shape, colour and texture. In orchids, there are many seeds which are tiny dust like particles. In coconut, there is a large sized seed. In both cases, the seed grows into a full plant.

Think, read and find out :

Why are there so many varieties of fruits?

Based on the number of cotyledons in the seed, the angiosperms have been divided into two groups.

1. **Dicotyledons:** Seeds with two cotyledons e.g. pea, bean and castor.
2. **Monocotyledons:** Seeds 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 come out through the micropyle.

The embryo is enclosed by the seed coat. It consists of cotyledons attached to the primary axis which has a 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 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 on fruits).The seed coat is very thin. The fruit wall (pericarp) is thin and fused with the seed coat. The fruit is generally covered with yellowish bract and bracteoles which are commonly known as chaff. The embryo consists of a single cotyledon called scutellum and a shoot axis. The lower part of the axis is the radicle, covered by a sheath called coleorhiza (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 moist soil, the coleorhiza 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 the fibrous root system of the matured plant.

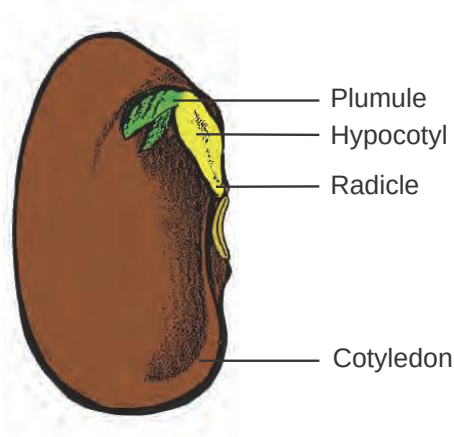


Fig. 4.16 Dicot Seed (Bean)

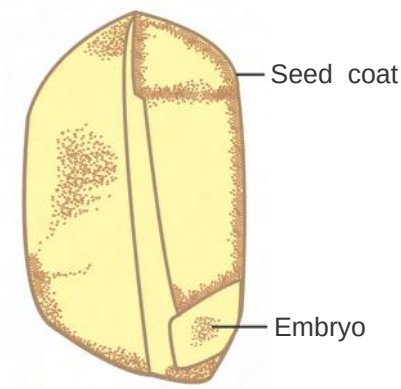


Fig. 4.17 Monocot Seed (Paddy)

4.6. DISPERSAL OF SEEDS

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

The reproductive capacity of plants is so tremendous that a very large number of seeds are 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. When the seedlings are grouped together in one place, they can easily be destroyed by grazing animals. Such a situation would be detrimental to the species.

ACTIVITY 4.8

- *Soak a few seeds of bengal gram (channa) and keep them overnight in a wet cloth.*
- *Take care that the bengal gram does not swollen absorbing excess of water. (The bengal gram should not decay due to 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 open the seed carefully and observe the different parts.*
- *Compare your observations with the diagram and see if you can identity all the parts.*

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 overcrowding, 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 wind through an explosive mechanism.

ACTIVITY 4.9

Label the jars filled with seawater and seeds. After 7 days, put the seeds in a sieve and rinse them under a tap. Then plant them in labelled pots.

Anemochory is the wind dispersal of fruits and seeds.The wind blows them away and for this 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

Fig. 4.18 Anemochory (Tridax)

Fig. 4.19 Autochory (Balsam)

by wind are Calotropis (Erukkum), Moringa (drumsticks)etc.

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

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

The spongy thalamus with air chamber of the Lotus floats in streams of water 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 hair,etc. on their outer coat. With the aid of these out growths, these fruits stick to the furry coats or skins of some animals and get carried from one place to another.

The fruits of Xanthium have sharp-pointed stiff hooks and in 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. 4.20 Hydrochory(Lotus)

Fig. 4.21 Zoochory(Xanthium)

In fruits like tomato and guava, the seeds are eaten along with the edible portion and are later passed out in the 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 become acclamatised to the new surroundings far away from their original habitat.

MORE TO KNOW

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

Fig. 4.22 Zoochory(Achyranthus)

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

Can you find out their botanical names?

ACTIVITY 4.10

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

MODEL EVALUATION

PART - A

1. *The method of reproduction in unicellular organisms like amoeba and bacteria in which they split into two equal halves and produce new ones is called _____.*

   i) fragmentation ii) binary fission iii) budding iv) spore formation

2. *In sexual reproduction of flowering plants, the first event involved in this is _____.*

   i) fertilization ii) germination iii) regeneration iv) pollination

3. Which of the following statement is true?

   i) Thin-walled non-mobile spores are called zoospores.

   ii) A motile asexual spore produced by some algae, bacteria and fungi are Akinetes.

   iii) Uninucleate, non-motile, asexual spores produced by fungus are called conidia.

   iv) Thick-walled vegetative cells produced by algae during adverse conditions are called aplanospores.

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

   i) Aggregate fruit ii) Composite fruit iii) Simple fruit iv) Multiple fruit

5. If a water soaked seed is pressed, a small drop of water comes out through the _____.

   i) stomata ii) lenticel iii) micropyle iv) radicle

6. The mango fruit is called a stone fruit because it has _____.

   i) skinny epicarp ii) stony mesocarp iii) fleshy endocarp iv) hard endocarp

7. Pick out the wrong statement.

   i) In a dicot seed there is a short longitudinal whitish ridge called the raphae.

   ii) The minute opening in a dicot seed is known as micropyle.

   iii) The rudimentary stem portion is known as radicle.

   iv) The rudimentary root portion is called radicle.

8. Consider the following statements regarding the dispersal of fruits and seeds by wind and select the correct answer.

   i) Fruits and seeds are dispersed with a sudden jerk by an explosive mechanism.

   ii) The fruits of tridax carry a persistent calyx modified into pappus.

   iii)The fruits of xanthium have sharp pointed stiff hooks.

   iv) The mesocarp of coconut is fibrous.

9. The product of triple fusion which acts as nutritive tissue for the development of an embryo is _____.

   i) zygote ii) placenta iii) scutellum iv) endosperm

10. The disadvantage of self-pollination is _____.

    i) There is no wastage of pollen grains. ii) The seeds are less in number.

    iii) Self-pollination is sure in bisexual flowers iv) Flowers need not depend on agents of pollination.

11. The flower is important to a plant because it helps in _____.

    i) attracting ii) production of nectar iii) pollination iv) sexual reproduction

12. The essential organs of the flower are _____ .

    i) Calyx and Corolla ii) Androecium and Gynoecium

    iii) Calyx and Androecium iv) Corolla and Gynoecium

13. Cross pollination is important for producing _____ .

    i) new varieties of plants ii) plants with better growth

    iii) More viable seeds iv) all of the above

14. Anemophily occurs in _____ .

    i) Vallisneria ii) Grass iii) Coconut iv) Datura

15. Which of the following structure / arrangement favours entamophily ?

i) Pollen grains with wings and feathery stigma ii) Colourful petals and nectar secretion
iii) A bunch of flowers with less pollen iv) Pollen grains with mucous covering.

16. Post-fertilization, the ovule changes into a/an _____ .

i) seed ii) fruit iii) endosperm iv) pericarp.

17. Which of the following is correctly matched?

i) False fruit – mango ii) Multiple fruit – apple
iii) Aggregate fruit – polyalthia iv) Caryopsis – banana

18. Identify the mismatched pair.

i) Legume – Dry dehiscent fruit ii) Cypsela – Dry indehiscent fruit
iii) Pome – Fleshy fruit iv) Regma – Resembles legume

PART - B

1. Write any two differences between asexual and sexual modes of reproduction.
2. What is vegetative propagation? Mention the vegetative propagules in:
   i) Bryophyllum ii) Sprirogyra
3. Arrange the following events of sexual reproduction in plants in the correct sequential order :

   seed formation, pollination, dispersal of seeds, fertilization.
4. Define pollination.
5. Define fertilization.
6. Name the agents of pollination in the following cases:

   i) Bright coloured flowers with scent and nectar glands.

   ii) No colour / scent/ nectar but pollen grains are dry, light weight and powdery. Stigma is feathery.

   Also mention the plants in cases (i) & (ii).
7. Name the events (i) & (ii) and mention the nature of the nuclear structures formed at the end in the following cases:

   (i) male gamete (n) + egg (n) = Zygote (2n)

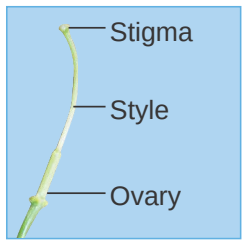
   (ii) male gamete (n) + secondary nucleus (2n) = Endosperm nucleus (3n).
8. Differentiate dehiscent fruits and indehiscent fruits with suitable examples.
9. What are monocotyledons and dicotyledons? Give examples.
10. Give suitable terms for the following methods of seed / fruit dispersal, with one example each: (i) by wind (ii) by water (iii) by animals.
11. Give any two examples for each of the following cases where dispersal of fruits and seeds take place : (i) by birds (through excreta) (ii) by human beings

12. What is double fertilization?

13. What is triple fusion?

14. a. Identify Fig. A and B.

b. Which part of A is modified into B.



A

B

15. The methods of reproduction and the organisms are given below. Match the type of reproduction with the suitable organism.

Fission	Spirogyra	Yeast
Budding	Protozoans	Flatworms
Fragmentation	Bryophyllum	Bacteria

16. i) Composite fruits are formed by all the flowers of _____,

ii) _____ fruit is developed from a single flower with a multicarpellary apocarpous superior ovary.

17. Draw the given diagram and label the following parts:

i) Exine ii) Tube nucleus.

18. Match the following with respect to dispersal of fruits / seeds:

a) Autochory	I) Lotus
b) Anemochory	II) Xanthiun
c) Hydrochory	III) Tridax
d) Zoochory	IV) Balsam

19. Use words from the given list to complete the following paragraph. (The words may be used once / more than once / not at all).

(seed, fruit, pollination, dispersal, germination, fertilization, flower, reproduction)

Ramu went to the field along with his father. He sowed mustard seeds in the soil. After a few days he observed the process of _____ . The seeds grew into plants and produced _____. On maturity, these flowers produced pollen grains that were transferred to the stigma by _____ . The male gametes fused with the female gametes during the process of _____ .

20. Coconut seeds are dispersed by Hydrochory (dispersal by water). Mention the part of the fruit whose modification help in this mechanism.

PART - C

1. i) Name the process by which a fruit is developed.

   ii) Explain the development process in brief.

   iii) Draw a neat, labelled diagram of that process.

2. Write the two events involved in the sexual reproduction of a flowering plant.

   i) Discuss the first event and write the types.

   ii) Mention the advantages and the disadvantages of that event.

3. i) Fruit is the product of fertilization. Is there any fruit which is formed without the act of fertilization?

   ii) Represent the classification of fruits in a diagrammatic sketch.

4. Compare aggregate fruits with multiple fruits and give suitable examples.

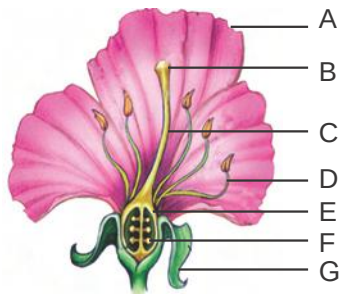
5. Describe the structure of a dicot seed.

6. Describe the structure of a monocot seed.

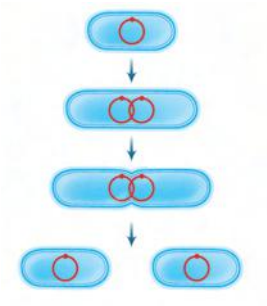
7. Observe the given diagram:

   i) Draw the diagram and label the parts.

   ii) What happens to the parts labelled ‘ E’ and ‘F’, after the process of fertilization?



8. Look at the diagram given below:



   Answer the following:

   i) Name the method of reproduction depicted here.

   ii) Name an organism in which you find this method of reproduction.

   iii) Does this method of reproduction favour variation?

9. *Imagine you have a garden with the plants listed below. A swarm of bees visit your garden. Do you think the bees will visit all the flowers? Name the flowers which you think the bees will be attracted to. Give reasons to substantiate your answer.*

   (Jasmine, Nerium, Gulmohar, Rose, Lotus, Corn, Sugarcane, Bamboo, Chrysanthemum, Dahlia, Grass, Coconut and Peas)

10. *A farmer has two fields A and B. He cultivates peas (Pisum sativum) in both the fields. Field A is covered with nets to keep out birds and insects. Field B is left uncovered.*

    i) Name the type of pollination that would occur in field 'A' and field 'B'

    ii) Which of these fields will give a higher yield?

    iii) To raise the next crop, from which field should the seeds be chosen by the farmer. Give reason to support your answer.

11. *Mango and Coconut are both drupes.The mesocarp of mango is edible, while it is not so in coconut. Based on this fact, answer the following:*

    i) Which part of the coconut is edible?

    ii) Why does the coconut have a fibrous mesocarp?

    iii) Can you mention any other use of the fibrous mesocarp?

12. *Group the following under the given heads: (a) fruit (b) seed (c) neither fruit nor seed.*

    tomato, cucumber, sprouted pulses, naked bean, grapes, celery, potato, sugarcane, apple, runner bean.

13. *Ramu and Somu happened to observe Calotropis seeds floating in the air. They decided to follow a few of them till the seeds landed on the ground. They recorded their observations in a table as follows:*

Distance travelled by seeds in metre	Time taken in minutes
25	6
50	15
37	10
87	17
17	2

    i) Draw a graph for the above data taking Distance on 'X' axis and Time on 'Y' axis.

    ii) Is there any relationship between the distance travelled and the efficiency of dispersal?

    iii) State the inference you draw from the graph.

14. Given below is a list of dry fruits. Assign the fruits to their relevant types.

(Cotton, Tridax, Paddy, Castor, Coriander, Beans, Peas, Calotropis, Mirabilis, Cashew, Acacia, Lady's finger)

i) Achene ii) Caryopsis iii) Cypsela iv) Nut

v) Cremocarp vi) Lomentum vii) Regma viii) Loculicidal capsule

ix) Septicidal capsule x) Follicle xi) Legume

15. Monish enters the kitchen and happens to see his mother getting the ingredients ready to prepare kadamba sambar. He sees the ingredients laid out in the kitchen. Help him sort out the ingredients into the fruit types you have studied.

(dhal, tamarind, brinjal, tomato, drumstick, coriander, mustard, lady's finger, mango)

16. Name the parts of a dicot seed based on the given clues:

i) Rudimentary root_____.

ii) Rudimentary shoot_____.

iii) Fleshy structure storing food for the embryo_____.

iv) The outer protective layer of a seed is _____.

v) The minute opening seen in the seed coat is _____.

17. What are the types of pollination? Which among them is more advantageous? Why?

18. What is self-pollination? Mention its merits and demerits.

19. What is known as pollination? List out biotic and abiotic factors which are involved in pollination?

FURTHER REFERENCE

Book: 1. Plant Reproduction - S.R.Mishra - Discovery Publishing House Pvt. Ltd, New Delhi.

2. Complete Biology (IGCSE) - Oxford University press, New York.

Webliography: www.biologyreference.com science.howstuffworks.com

NAMES OF PLANTS IN ENGLISH AND TAMIL

S.No.	Botanical Name	Common Name in English	Tamil Name	How is it called locally?
1	Abelmoscus esculentus	Lady's finger	வெண்டை	
2	Acacia coccina	Soap acacia	சிகைக்காய்	
3	Achyranthes aspera		நாயுருவி	
4	Anacardium occidentale	Cashew	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	Coriander	கொத்துமல்லி, தனியா	
12	Gossypium arboreum	Cotton	பருத்தி	
13	Cucumis sativus	Cucumber	வெள்ளரிக்காய், தோசைக்காய்	
14	Cucurbita maxima	Pumpkin	பூசணிக்காய்/ பரங்கிக்காய்/ அரசாணைக்காய்	
15	Cuscuta reflexa	Amar bell	அம்மையார் கூந்தல்	
16	Ficus glomerata	Fig	அத்தி	
17	Impatiens balsamia	Balsam	பால்சம்/பால்செண்டு	
18	Lablab purpurreus	Bean	அவரை	
19	Lycopersicon esculentum	Tomato	தக்காளி	
20	Mangifera Indica	Mango	மா	
21	Mimosa pudica	Touch-me-not plant	தொட்டால் வாடி/ தொட்டால் 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	
29	Tridax procumbens		வெட்டுக்காயப் பூண்டுச்செடி	

Chapter 5

A REPRESENTATIVE STUDY OF MAMMALS

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

5.1. MORPHOLOGY

Mammalian morphology is very divergent, because mammals occupy different habitats. Sea mammals like dolphins and whales are not forms of fish and they differ in structure and behaviour. They originated (evolved) from land mammals. The nocturnal bat gliding in the sky, looks like a bird but is really a mammal.

Mammals are distinguished from other vertebrates by two fundamental characteristics that no other living vertebrate possesses. They are:

1. Epidermal Hair 2. Milk producing glands

Epidermal Hair

All mammals have hair. Even apparently hairless whales and dolphins possess hair in the embryonic stage and grow sensitive bristles on their snouts when they turn adults. Mammalian hair is a new form of skin structure- a derivative of the skin. Hair is an insulator against heat loss. The colour and pattern of mammal's skin usually matches its background. Hair is also a sensory structure, as the whiskers of cats and dogs are sensitive to touch. Hair also acts as a defensive mechanism for porcupine and hedgehogs. Their long, sharp, stiff hair called ***quills*** protect them from predators.

Milk producing glands

All female mammals possess functional mammary glands that secrete milk. New-born mammals born without teeth are suckled by their mothers. Milk producing glands are modified sweat glands.

5.2. HABITAT

Habitat is the place where an organism lives. 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 regions, grasslands, deserts, fresh water and marine habitats. Some mammals and their habitats are listed below:

High mountains	- mountain goat, big-horned sheep, grizzly bear.
Plains and forests	- porcupine, giant squirrel, deer, elephant, tiger, leopard, rhinoceros, Hippopotamus.
Tundra	- reindeer, muskdeer, ox, rodent.
Deserts	- black buck, Indian wild ass.
Fresh water bodies	- beaver, platypus, otter.
Oceans	- whale, dolphin, dugong, porpoise, seal, walrus.

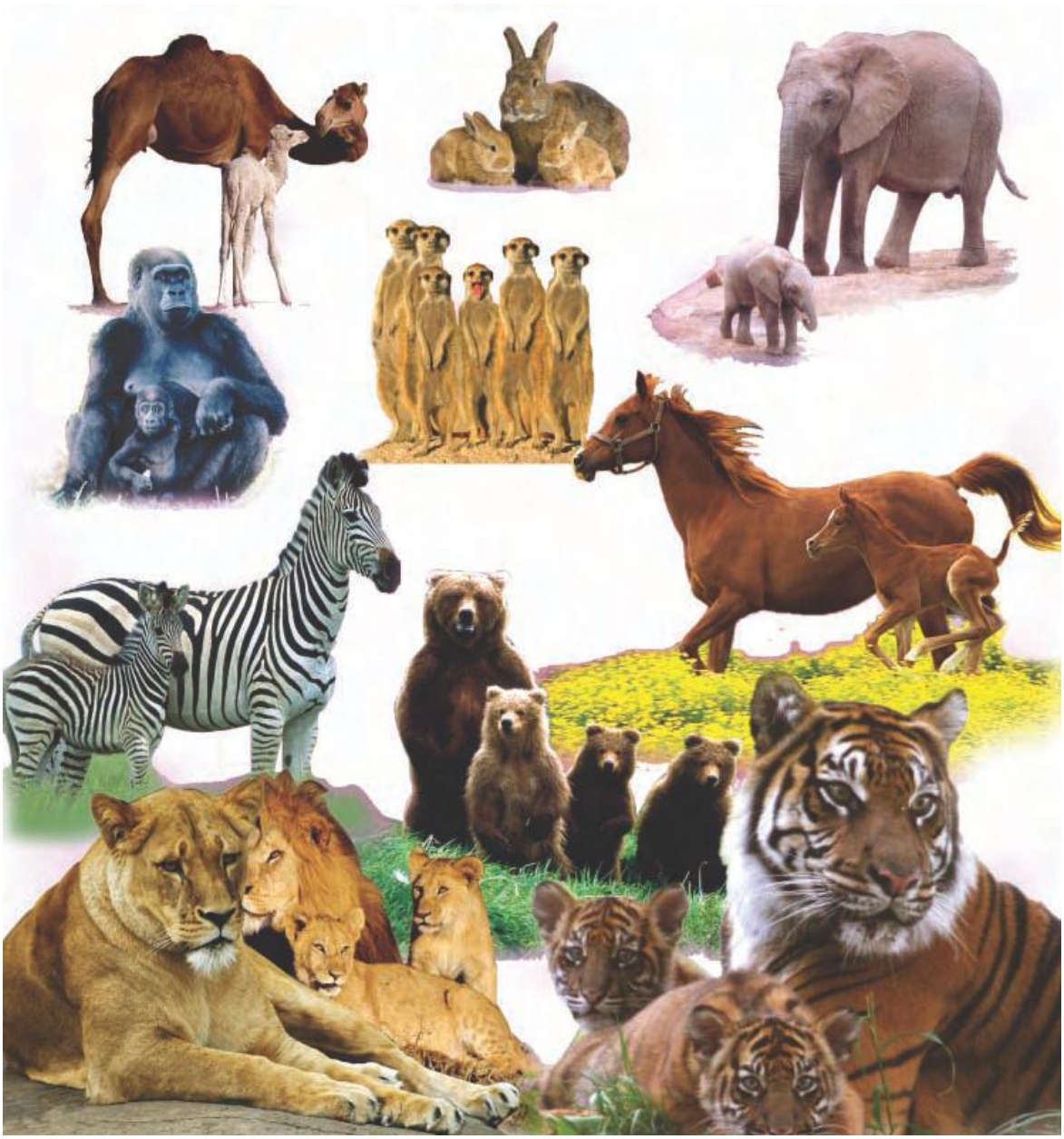


Fig. 5.1 Mammals from divergent habitats and their young

5.3. MAMMALIAN ADAPTATIONS

Mammals are the most successful group of animals adapted to various conditions of life.

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

ii) The skin of the camel is doubly thick and contains water-storing osmotic cells to conserve water, as they live in deserts.

They have thick bushy eyebrows covering the eyes to protect their eyes from sand storms. Their nostrils can be closed during desert storms to prevent the entry of sand particles.

iii) Some mammals are herbivores, eating only plants. To digest the cellulose-rich food, they have developed a mutual partnership with bacteria that have cellulose-splitting enzymes(cellulase).

iv) Mammals such as cows, buffaloes, antelopes, goats, deer have a huge four-chambered stomach that functions as storage and fermentation vats. The stomach of cattle also helps them to ruminate or chew the cud.

v) Mammals have heterodont dentition with different types of teeth that are highly specialized to match specific eating habits. For example, the carnivorous animals have canine teeth to tearing flesh. In elephants, the incisors are modified into tusks and are used in defence.

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

vii) Marsupials, like kangaroo, have developed abdominal pouches to bear young ones.

viii) Polar bears have thick skin and wooly fur so as to withstand cold weather in the polar regions.

ix) Man is an intellectual social animal. The fingers and toes are adapted for extremely deft movements in holding fine objects, in writing and handling delicate instruments.

ACTIVITY 5.1

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

Fig. 5.2 Bat

5.4. BASIC PHYSIOLOGICAL FUNCTIONS

The physiological functions and processes are highly complex in mammals.

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° F to 98.6° F. The regulation of temperature is performed as a team work, by the sweat glands of skin, kidneys, lungs and blood.

In summer, we sweat more as a cooling mechanism, to conduct the heat out through 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 form of sweat.

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

In mammalian red blood cells (RBC) are fully packed with the respiratory red blood pigment called haemoglobin, to carry maximum amount of oxygen. The mammalian RBCs are without nucleus, as the space occupied by the nucleus is taken up by the haemoglobin molecules.

5.5. CIRCULATORY SYSTEM OF MAN

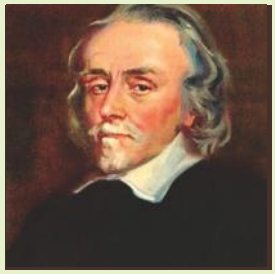
The circulatory system has evolved in order to transport substances from one part of the body to the other. In man, the circulatory system is composed of :

i) the heart

ii) the blood vessels namely arteries, veins and capillaries

iii) the blood

iv) the lymph.



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

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

The Heart

The human heart is a hollow, fibro-muscular organ. It is in the shape of an inverted cone. The heart is covered by a protective double layered membrane called pericardium filled with pericardial fluid. The heart is made up of a special type of muscle, called cardiac muscle. The partitions within the heart divide the heart into four chambers the auricles and the ventricles. The right half of the heart receives and pumps out deoxygenated blood and the left half of the heart receives and pumps out oxygenated blood.

Auricles

The auricles are the thin-walled upper chambers of the heart. They 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

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

Apertures of the Heart

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

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 it prevent the back flow of blood.

A bicuspid valve or mitral valve with two flaps is found in the left auriculo ventricular aperture to regulate the flow of blood, from left auricle to left ventricle and prevents the back flow of blood.

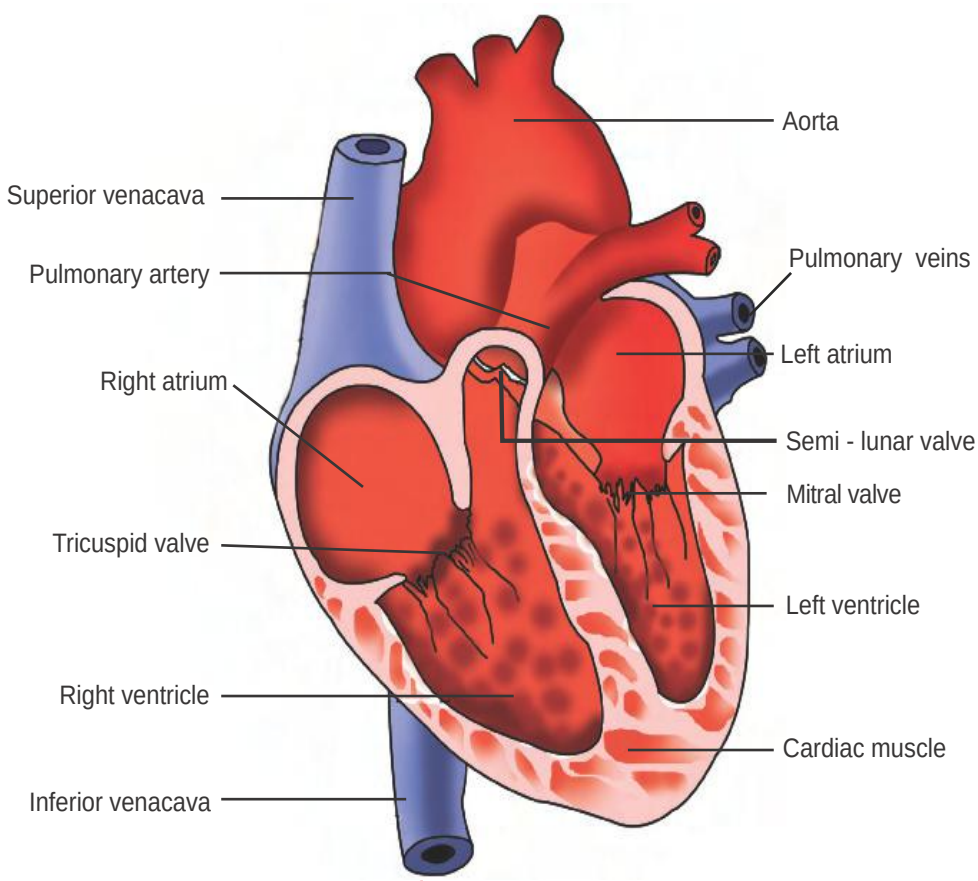


Fig. 5.3 Human Heart

ACTIVITY 5.2

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

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

At the base of the aorta is present the aortic valve. It regulates the flow of blood from the left ventricle into the aorta.

Heart Function

The 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, the ventricles will push the blood into the aorta and the pulmonary artery by their contraction (ventricular systole).

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

Heartbeat

The closure of the valves of the heart produce two different cardiac sounds- “lubb” and “dubb”. The human heart beats 72 times a minute when the body is at rest. Heartbeat is an inherent capacity of the heart. The heartbeat begins and is 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 various 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.

Capillaries

Capillaries are tiny blood vessels that form a network, called capillary network around the tissues. They enable the passage of substances from the blood into the tissues.

Veins

The veins carry the blood from different parts of the body to the heart. The capillaries reunite to form venules, which carry the deoxygenated blood from the tissues. The small venules rejoin the big veins and open

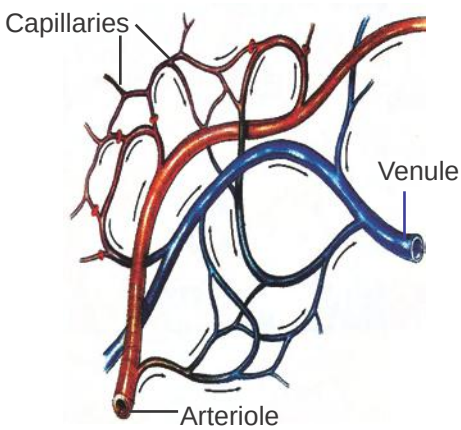


Fig. 5.4 Arteries, Capillaries and Veins

into the superior venacava and inferior venacava. Except for the pulmonary veins, all other veins carry deoxygenated blood.

Blood

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

Plasma

The liquid component of blood is the plasma. It is composed of water, organic substances, inorganic substances, etc,. The important organic substances of plasma are the plasma proteins 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. They float freely in the plasma.

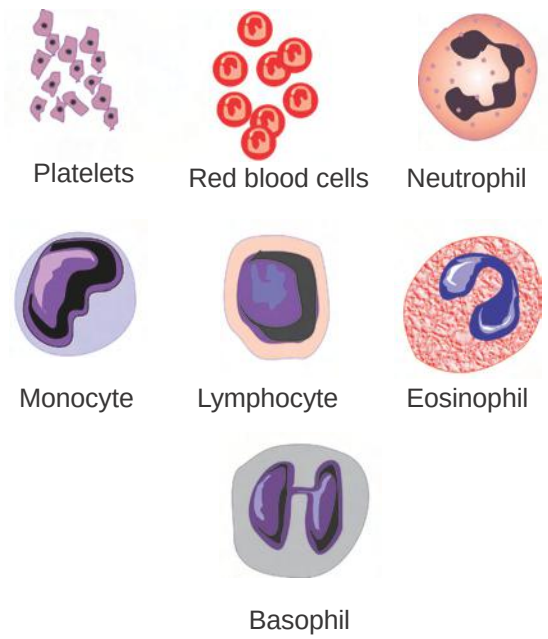


Fig. 5.5 Blood Cells

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 the carrying of respiratory gases.

White Blood Cells – Leucocytes

WBCs are amoeboid in shape with prominent nuclei. WBCs are involved in phagocytosis i.e engulfing the germs and producing antibodies to resist the pathogens entering the body(immunity).

Blood Platelets – Thrombocytes

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

5.6. EXCRETORY SYSTEM IN MAN

Excretion is getting rid of metabolic waste products from the body.

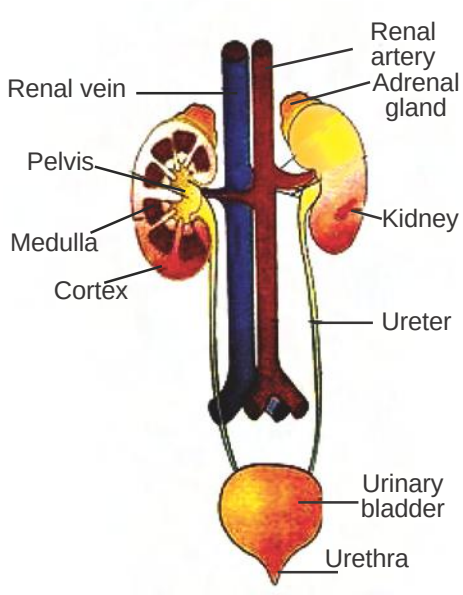


Fig. 5.6 Excretory System of Man

The principal excretory organs of our body are the kidneys. They maintain the chemical composition of the blood and so are called as the master chemists 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 the ureter. The two ureters open into the distensible muscular sacs called the urinary bladder, stores urine. From the urinary bladder arises the urethra through which, urine passes out of the body.

Internal Structure of Kidney

The outer portion of the kidney is dark in colour and is called renal cortex. The 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 Uriniferous tubules.

Malpighian Capsule

This consists of a network of blood capillaries called glomerulus and a double-walled cup called Bowman's Capsule. The glomerulus is a network of blood capillaries, formed by the branches of the wider afferent renal arteriole. From the glomerulus arises

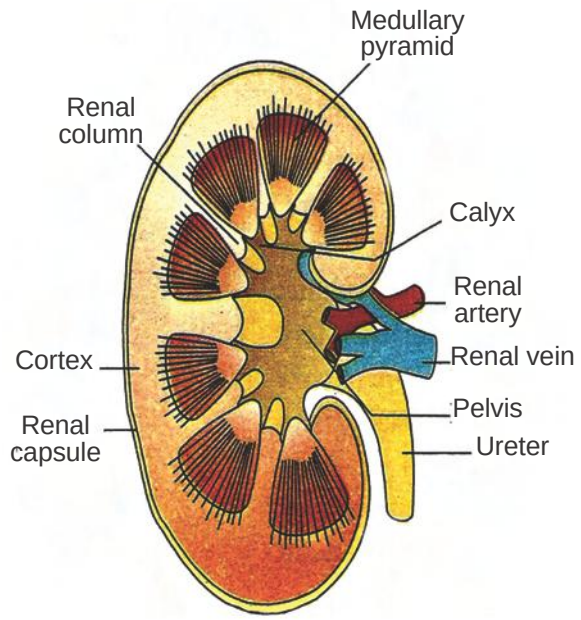


Fig. 5.7 LS of Kidney

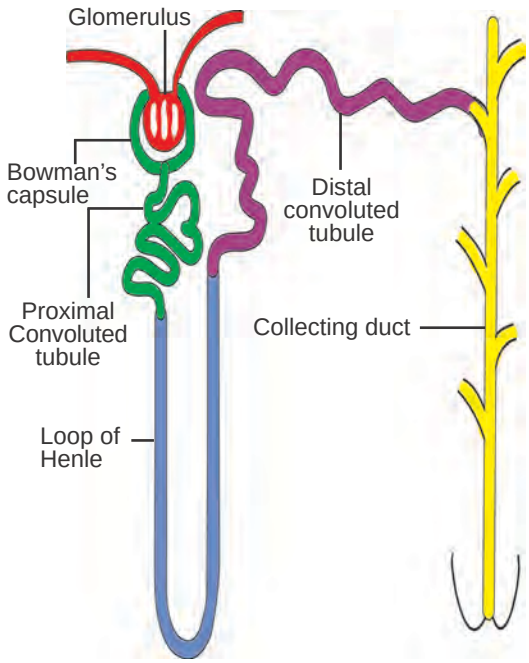


Fig. 5.8 Nephron

The important excretory organ and their excretory products

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

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 tubule. It is divided into three parts 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 BETWEEN STRUCTURE AND FUNCTION

Based on the functional need, a particular organ or part is modified in structure. Thus a structure is well adapted to perform a specific function. So structure and function go hand-in-hand. The fore-limbs of different mammals are modified suitably to perform different functions, according to their environment. For example, all the vertebrates in general, and all mammals in particular, have a common basic pattern of construction of their forelimbs. The forelimbs of mammals consist of five parts namely upper arm, fore arm, wrist, palm and phalanges, but they are used differently in different animals as follows:

i) Man uses his forelimb to hold an object, write, play musical instruments and handle delicate digital devices. The thumb is deviant from other four fingers, to enable man to perform the above tasks.(opposable thumb)

ii) A horse uses its fore-limb to gallop.

iii) A rat or bandicoot uses its fore-limb to make holes in the ground to live in.

iv) A giraffe uses its long and stout forelimbs to reach the vegetation, on top of plants and tall trees.

v) A monkey leaps from one branch of the tree to another using its forelimb to hold, swing and jump.

vi) In whales the limbs are modified into flippers which are used as oars to swim.

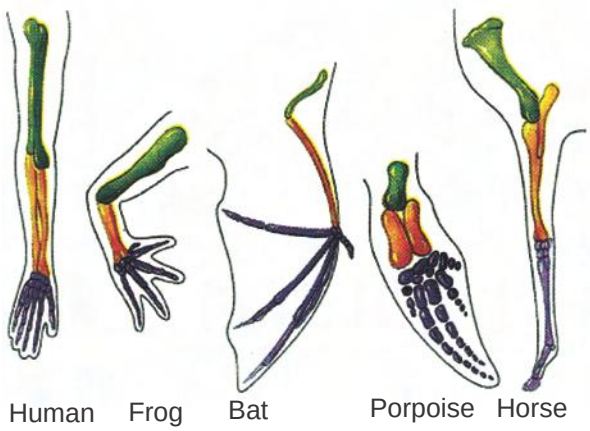


Fig. 5.9 Basic pattern of forelimbs of vertebrates

Fig. 5.10 Honey Bee

5.8. ANIMAL BEHAVIOUR

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

Social Behaviour

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

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

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

In an elephant herd, it is always the oldest she-elephant that leads the herd, while the strong males form the periphery of the herd and the young calves and other she - elephants will be in the middle.

Sexual Behaviour

The opposite sexes coming close 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.

Sexual Imprinting

It is a process in which an individual animal 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 behaviour exhibited by one sex to attract the opposite sex is called courtship signalling. Many courtship signals are species-specific to help animals avoid making errors in mating.

Parental Care

Any investment made or any effort taken by the parent to take care of the young ones in order to increase the chance of

Fig. 5.11 Parental care in elephants

survival of the offspring and hence increase the reproductive rate of success is called parental care. The parents care for their young ones, provide good nutrition, protect them from predators and help the young ones lead a successful life.

Feeding the young one with milk secreted from its mammary glands and aggression exhibited against the predator are the best examples of parental care. Even after nutritional independency is acquired by the young one (i.e. it is able to feed itself), the parental care is extended in some species beyond this stage.

5.9. A RESEARCHER'S CASE STUDY ON ANIMAL BEHAVIOUR

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:
Researcher – Mr.Arun Venkatraman)

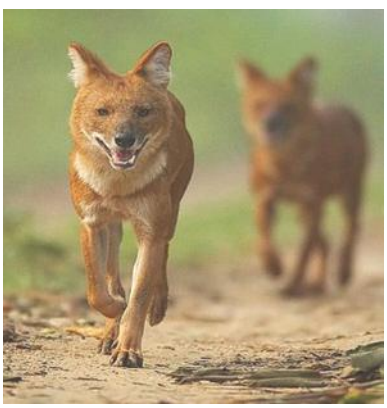


Fig. 5.12 Dholes

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 of 8-10 which consist of old females, males, females and pups. The pack members co-ordinate while attacking and killing a large prey such as an 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 grab the choicest piece of meat. The young pups are allowed to take their share of 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 shifting their den frequently so that the pups are kept safe from predators such as leopards and hyenas.

CASE STUDY

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

ACTIVITY 5.3

- *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 path or go in disarray.*
- *Try to observe for a few minutes to see if they resort to any change in their route. Prepare a report of their behaviour and submit.*

MODEL EVALUATION

PART - A

1. Select important characteristic features of mammals

   i) four-chambered heart ii) fore-limbs and hind limbs

   iii) milk-producing glands iv) post anal tail

2. Carnivorous animals use these teeth to tear flesh.

   i) incisors ii) canines iii) premolars iv) molars

3. The Henle's loop of nephron is mainly responsible for reabsorption of water in the kidney. Which of the following has a long loop of Henle in its nephrons to conserve water?

   i) polar bear ii) camel iii) frog iv) whale

4. Which blood cells of mammals are concerned with immunity?

   i) Young Erythrocytes ii) Leucocytes iii) Thrombocytes iv) Matured Erythrocytes

5. You were given two unlabelled slides with blood smears of an amphibian and a mammal. You would differentiate the blood samples by observing the _____ .

   i) colour ii) nature of RBC's iii) nature of WBC's iv) contents of plasma

6. For the digestion of cellulose, an enzyme called cellulase is required. Some mammals lodge cellulase producing bacteria in their digestive system by offering them food and shelter. These mammals are mostly _____.

   i) Herbivores ii) Carnivores iii) Omnivores iv) Sanguivores

7. Forelimbs of mammals have a common basic structure or pattern, but are different in their usage/ function in different animals. They can be called _____ .

   i) Homologous organs ii) Analogous organs

   iii) Vestigial organs iv) Rudimentary organs

8. Sensitive whiskers are found in _____.

   i) Bat ii) Elephant iii) Deer iv) Cat

9. The tusks of elephants are modified _____.

10. Pick out an animal which has a four-chambered stomach.

    i) Elephant ii) Dolphin iii) Deer iv) Kangaroo

11. Normal body temperature of man is _____.

    i) 98.4 – 98.6°F ii) 96.6 – 96.8°F iii) 94.4 – 98.6°F iv) 98.4 – 99.6°F

12. Mitral valve is found between _____.

i) Right auricle and right ventricle ii) Left auricle and left ventricle

iii) Right ventricle and pulmonary artery iv) Left ventricle and aorta

13. Assertion (A) : Mammalian heart is called myogenic heart.

Reason (R) : Heartbeat is regulated by a specialized muscle bundle (pacemaker) in mammals.

i) Both 'A' and 'R' are true and 'R' explains 'A'.

ii) Both 'A' and 'R' are true but 'R' doesn't explain 'A'.

iii) 'A' is true but 'R' is false.

iv) A is false but 'R' is true.

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

i) dolphin, walrus, porcupine, rabbit, bat ii) elephant, pig, horse, donkey, monkey

iii) antelope, deer, cow, buffalo, black buck iv) dog, cat, crocodile, lion, tiger

15. The epidermis of mammals contains _____ .

i) hair, bristles, quills ii) hair, nails, claws

iii) hair, bristles, horns iv) hair, nails, scales

16. Based on relationship, fill in:

Whale: Flippers:: Bat : _____

17. Fill in the blank.

RBC: Carrier of oxygen; WBC: _____

18. Based on modifications, make the pairs:
incisor: tusks of elephant; _____ : quills of porcupine

PART - B

1. Mention the two unique characteristics of mammals.
2. Give two examples each: (i) ruminating mammals (ii) marine mammals.
3. What type of dentition is seen in mammals? What are elephant tusks?
4. Mention any four adaptations seen in the camel so that it can live successfully in deserts.
5. What is echo location? Give an example.
6. Mention the various valves and their location in the human heart.
7. Write any four differences between arteries and veins in mammals.

8. Name the three important blood proteins seen in plasma. Add a note on their functions.

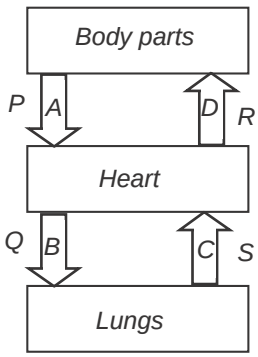
9. Which blood cells are without nuclei? What is the advantage of this condition?

10. Name the protein and the blood-cells responsible for the clotting of blood.

11. i) What are the structural and functional units of kidney?
ii) Arrange the organs of the human excretory system in the correct order, based on the passage of urine.

Ureter, Urethra, Kidney, Urinary bladder

12. Observe the following flow-chart depicting blood-circulation in mammals.



Pick out the correct blood vessels A,B,C,D from the following:

i) Pulmonary veins ii) Venacava iii) Pulmonary artery iv) Aorta

Among the P,Q,R and S samples, identify the correct match from the following

a) P & Q = Oxygenated and R& S = Deoxygenated

b) P & Q = Deoxygenated and R& S = oxygenated

c) All are Oxygenated

d) All are Deoxygenated

13. Study the following passage:

Most of the vertebrates have jaws with teeth. The mode of arrangement of teeth on the jaws is called dentition.

The various types of teeth seen in mammals are incisors(I) canines (C) premolars (P) and molars (M). They are used for biting , tearing, chewing and grinding respectively. Canines, the tearing teeth are well-developed in carnivores and ill-developed or absent in herbivores.

Now answer the following questions:

i) In frogs, all the teeth in the upper jaw look alike, whereas in human beings they are different. The type of dentition in man can be called_____.

a) Homodont b) Isodont c) Heterodont d) Acrodont

ii) The dental formula of a mammal is written as ICPM =2023/1023. The teeth missing in it are _____ .

a) incisors b) canines c) premolars d) molars

14. Fill in the empty boxes with suitable answers with respect to the valves of a mammalian heart.

Valve(s)	Location	Function
Bicuspid valve or Mitral valve		Prevents the backward flow of blood from left ventricle to left auricle
	At the right auricular ventricular aperture	Regulates the flow of blood from right auricle to right ventricle
Aortic valve	At the base of Aorta	
Semilunar valve		Regulates the flow of blood from right ventricle to pulmonary artery

15. Any change in the lifestyle, the food habits and the body form of an organism in order to make it comfortable in the environment / habitat, is called adaptation. Identify the suitable adaptation given below against each mammal.

i) conservation of body heat in large marine mammals like whale (Jaws are modified into baleen plates / Forelimbs are modified into flippers / Fat is deposited in subcutaneous tissue.)

ii) Locating food source by bats-(Forelimbs are modified into wings / Hanging upside down using legs / Production of sounds and detection of the echo)

16.The Master chemists of our body are the kidneys. Justify.

i) Kidneys filter all chemicals in the body.

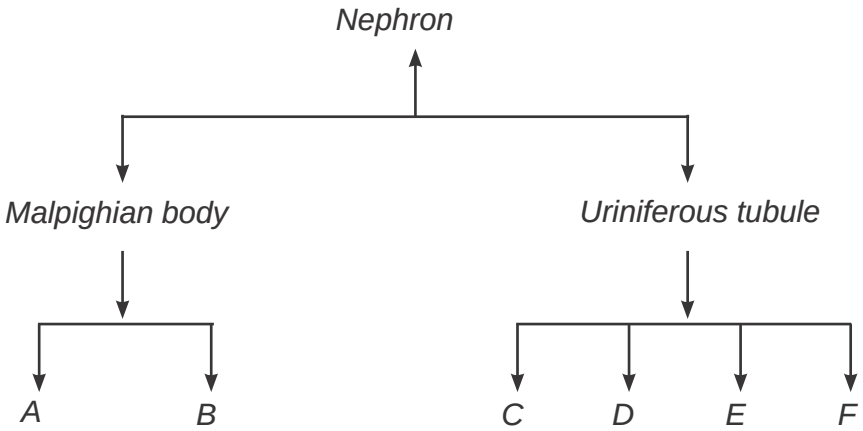
ii) Kidneys maintain the chemical composition of blood.

iii) Kidneys eliminate all chemicals absorbed by the body.

iv) Kidneys store the chemicals accumulated in the body.

PART - C

1. Observe the chart depicting the structure of a nephron.



i) Mention the structures A to F ii) Explain the main function of a nephron.

2. With a suitable diagram, describe the structure and functions of the human heart.

3. Draw the L.S of kidney and label the parts.

4. What is adaptation? Mention the adaptations found in the following mammals.

a) Whale b) Polar bear c) Kangaroo d) Herbivorous mammals.

FURTHER REFERENCE

Books:

1. Biology - RAVEN, Johnson WCB Mc Graw - Hill, USA

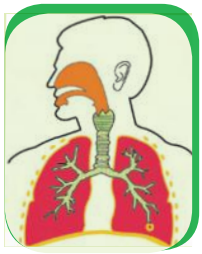
2. Biology - A Modern Introduction, B.S. Beckett, 2nd Edition Oxford University Press, New Delhi.

3. Frame work of Science - Paddy Gannon, Oxford University Press, New Delhi

4. Complete Biology (IGCSE) - Oxford University press, New York

Webliography: http://www.khanacademy.org

Chapter 6



LIFE PROCESSES

How do you differentiate living things from non-living things?

If we see a dog running

(or)

a cow chewing cud

(or)

a child playing on the street,

we know that these are living beings.

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

We would still think that they are alive, but how do 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 and stages of growth as common evidence for being alive.

What are life processes?

The maintenance of living organisms must go on even when they are not physically active. Even when we sit idle and during sleep this maintenance job, through the functioning of cells, 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 living beings are described below:

Nutrition

Nutrition is 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 the breaking down of organic substances into simpler compounds called respiration.

Transportation

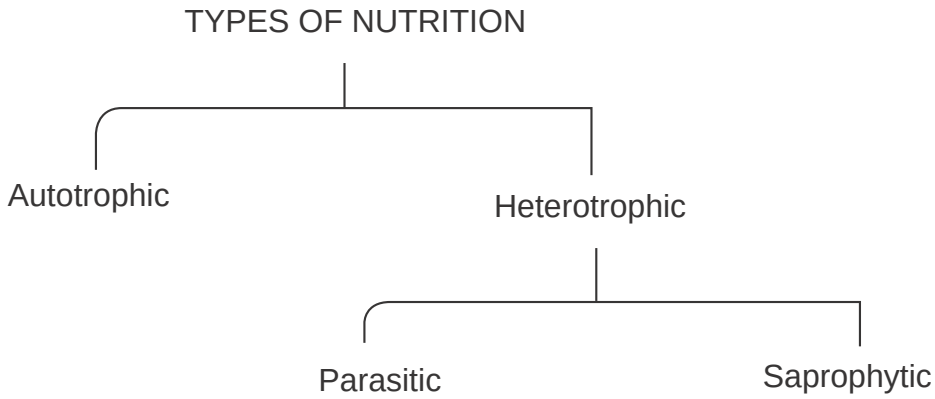
Transportation is the process by which the food and oxygen is carried from one organ to the other organs in the body.

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 the external sources for the organism's consumption?
3. What processes are essential to maintain our body?



6.1. NUTRITION IN PLANTS

Do you know that we need energy for all activities?

Where do we get that energy from?

The source of energy is the food we eat.

Types of Nutrition

Autotrophic Nutrition

Most of the green plants can 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. Materials are taken in the form of carbon dioxide and water and 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:

The raw materials and other necessary substances required for photosynthesis are sunlight, water, CO_2 and chlorophyll.

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

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.

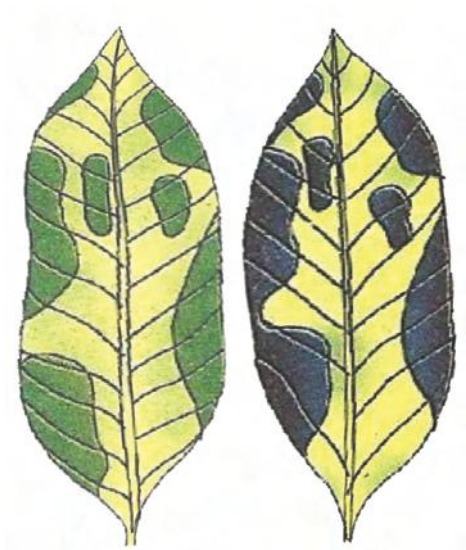


Fig. 6.1 Variegated Leaf

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

BIOLOGY

Let us do an activity to demonstrate 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 a 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 are of two types saprophytes and parasites. Likewise all organisms, except the green plants, do not possess chloroplasts, as they do not perform 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 on which the parasites live for nourishment are called hosts. Parasitic plants have some special roots, which penetrate the host plant and absorb food from the phloem, water and minerals from the xylem. These roots are called haustoria. (e.g. *Cuscuta and Viscum*).

Fig. 6.2 Cuscuta - a parasitic plant

Fig. 6.3 Viscum - a parasitic plant

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 nutrients from the humus through their mycorrhizal roots.

Questions

1. What are the differences between autotrophic nutrition and heterotrophic nutrition?
2. What are the sources from which plants obtain materials required for photosynthesis?

6.2. DIGESTIVE SYSTEM

Intracellular Digestion

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

The digestive system in higher animals and human being consists of the alimentary canal and the digestive glands that to produce digestive juices. Food enters into the body and passes through the alimentary canal. In the regions of digestion like mouth, stomach and duodenum, digestive juices is are secreted by the digestive glands and the complex food is broken down into simpler food molecules by the action of the enzymes of the digestive juices. Since digestion takes place in the space or lumen of the 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 sustaining chemical reactions.

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 the stomach and the 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

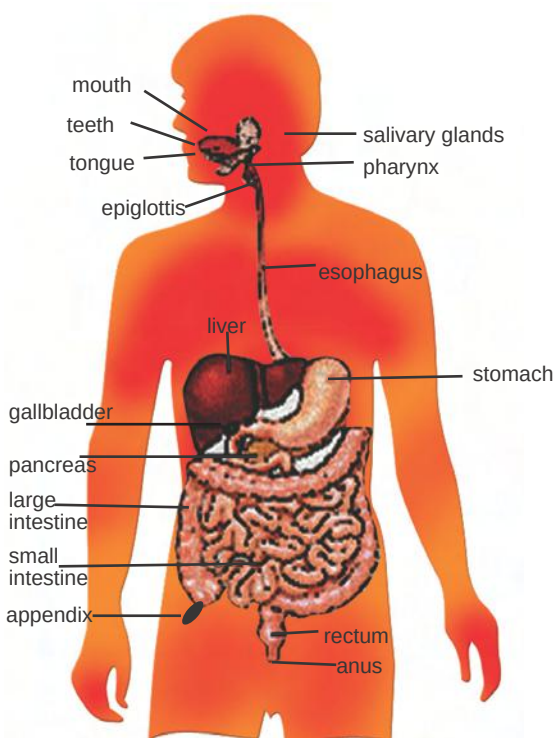


Fig. 6.4 Human Digestive System

ACTIVITY 6.2

- *Take I ml of starch solution (1%) in two 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 change in colour?*
- *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 is more energy from external sources consumed?*

Digestion takes place step by step 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. It starts from the mouth and ends in the anus. The mouth, buccal cavity, pharynx, oesophagus, stomach, small intestine, large intestine, rectum and anus are parts of the alimentary canal.

6.3. RESPIRATION IN PLANTS

Why should we eat?

Why should plants synthesize food?

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

Where does this energy come from?

Starch that is synthesized by plants is the source of energy for humans.

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 for the various activities of the cells.

In addition to ATP, two other substances are formed during respiration. They are CO_2 and H_2O.

$$\underset{\text{(Glucose)}}{C_6H_{12}O_6} + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \underset{\text{(ATP)}}{2900\text{KJ energy}}$$

The 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 classified into two types:

1. Aerobic respiration.
2. Anaerobic respiration.

1. Aerobic Respiration

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

The process of Aerobic Respiration takes place in four stages:

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

During Glycolysis, glucose (a simple carbohydrate) is split into two molecules of pyruvic acid. This takes place in the cytoplasm, through a series of reactions and a number of enzymes are involved in the process. 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.

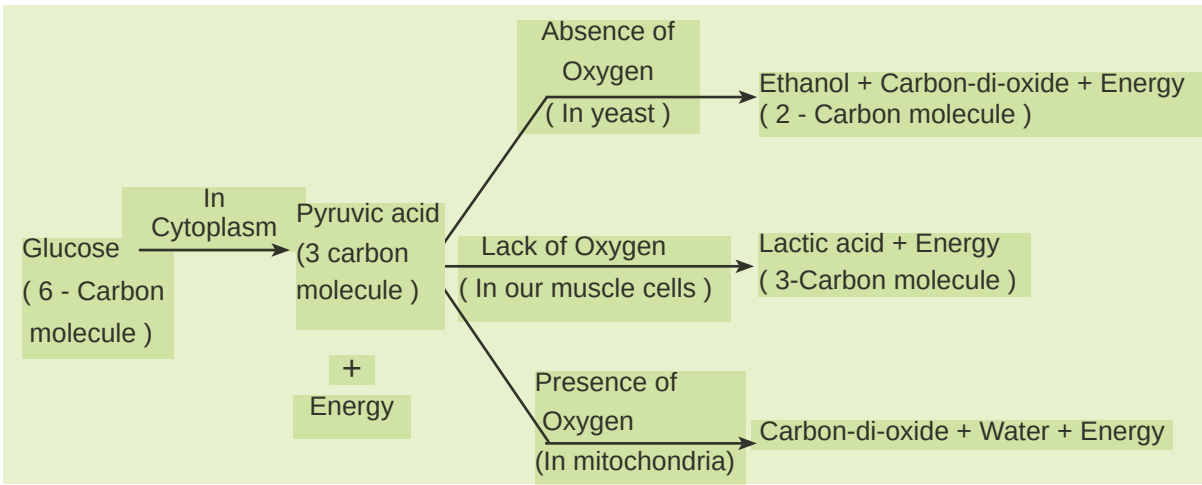


Fig. 6.5 Break-down of glucose by various pathways

ACTIVITY 6.3

- *Take some fruit juice or sugar solution and add some yeast to it. 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 a test tube containing freshly prepared lime water.*
- *What change do you observe 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?*

MORE TO KNOW

- *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* $\xrightarrow{Energy}$ *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 nerve impulses and many other activities.*

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

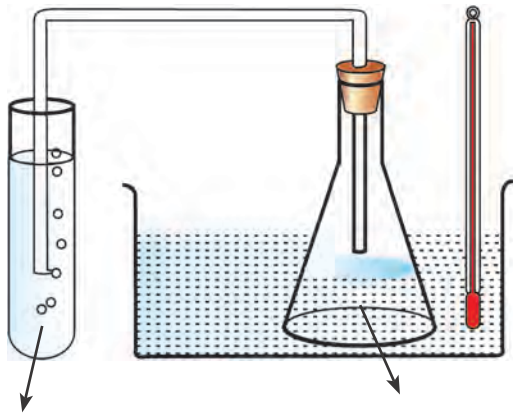


Fig 6.6 Anaerobic Respiration apparatus

The repiratory organ of a fish is gills; a frog is its lungs and skin; for land vertebrates it is the lungs.

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 of the terrestrial organisms. Fishes take in water through their mouth and force it out through their gills, where the dissolved oxygen is absorbed 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 a 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, is usually within the body. So there are air passages present, that will carry atmospheric air to this area. In addition, there is a mechanism for blowing the air in and out of the area where oxygen is absorbed.

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

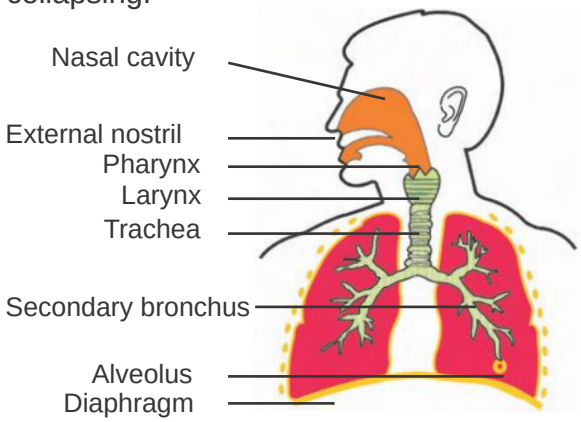


Fig. 6.7 Human Respiratory System

ACTIVITY 6.4

- *Observe the fish 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. Is the timing of the opening and closing of the mouth and gill slits co-ordinated?*
- *Count how many times the fish opens and closes its mouth in a minute.*
- *Compare this with the number of times you breathe in and breathe out in a minute.*

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

6.5. TRANSPORTATION IN PLANTS

We have discussed earlier, how 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 present in the leaf. So the leaf is the site for photosynthesis. The food prepared in the leaf should be transported to all the other parts of the plant.

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

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

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 plants.

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

i) Xylem transports water with dissolved minerals absorbed by the root hairs from the soil, to other parts of the plant.

ii) Phloem transports products of photosynthesis (food) from the leaves to all other 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 the roots, the root hair cells are in contact with the soil and they actively take up ions.

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

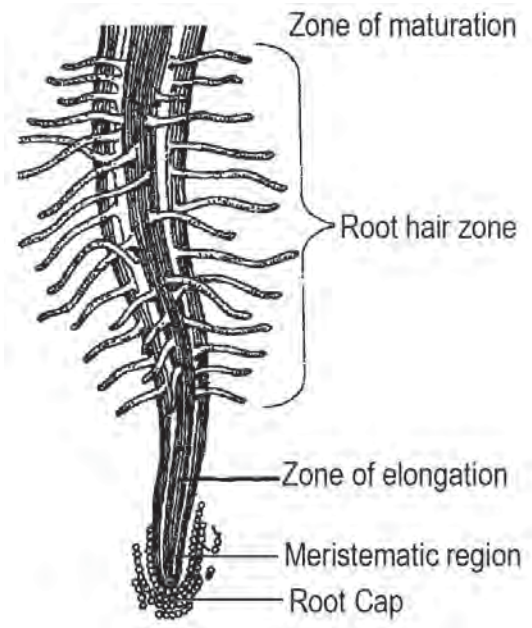


Fig. 6.8 Root hair region

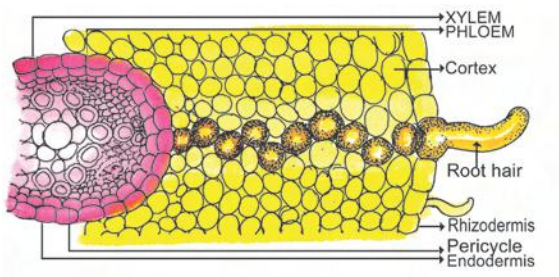


Fig. 6.9 Path of water across the root

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

Will this pressure be enough to conduct the water through the height of tall and huge trees?

Plants use another strategy to carry the water in the xylem upwards to the highest points of the plant body. This is by the process of transpiration. When the plant has an adequate supply of water, the water which is lost through the stomata is replaced by water from the xylem vessels in the leaf.

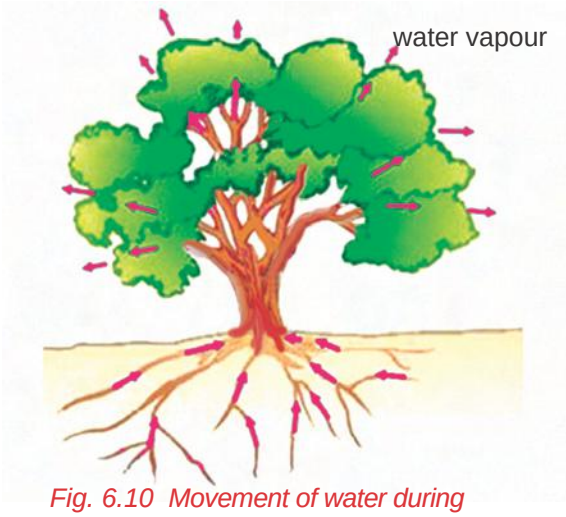


Fig. 6.10 Movement of water during transpiration in a tree

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

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 the minerals 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 the 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 the 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 the pipe-line from the leaves to the other parts of the plant) with the help of companion cells both in the upward and downward directions.The translocation by the 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 the tissues which have less pressure. This allows the phloem to move the material according to the plant's needs. For example, in the spring, sugar stored in root or stem tissues 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 transported to different parts in plants?
3. How is food transported in plants?

ACTIVITY 6.5

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

6.6. TRANSPORTATION IN ANIMALS

In microscopic organisms such as Amoeba and Paramoecium, 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-dioxide diffuses out of an

amoeba with sufficient speed to prevent it getting accumulated within the cell to harmful levels.

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 tightly packed. 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 the human body, for example, the transport system consists of a pump called the 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 transports it to every cell in the body. Blood also picks up waste products such as carbon-dioxide and many other substances like salts from the cells and eliminate them from the body.

Lymph

In humans 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 the veins. Lymph carries digested and absorbed fat, from the intestines and drains the excess fluid in extra cellular spaces back into the blood.

ACTIVITY 6.6

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

6.7. EXCRETION IN PLANTS

What is excretion?

How does 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 of excretion.

1. Plant waste products are stored in cellular vacuoles.
2. Waste products may be stored in leaves that fall.
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.

6.8. EXCRETION IN ANIMALS

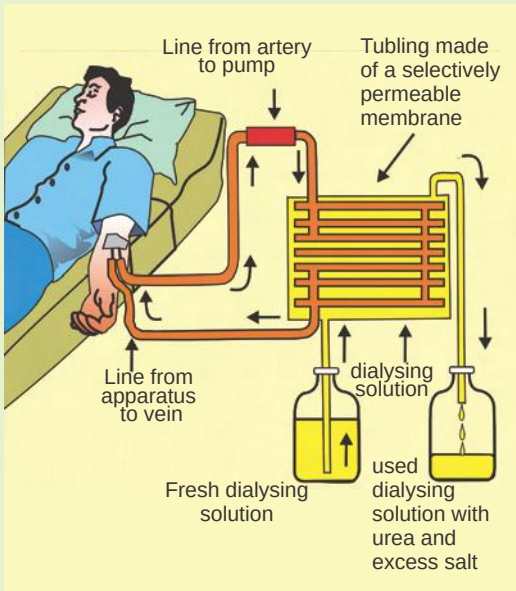
In unicellular protozoans, the excreta is discharged through the contractile vacuoles, which are formed by the absorption of water and other excreta.

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

In flat worms and round worms, the excretory tubes develop, for transporting the excreta to the exterior. In annelids,

Artificial Kidney (Haemodialysis)

Kidneys are vital organs for survival. Several factors like infection, injury or restricted blood flow reduce the activity of the 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-permeable 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 the dialysing fiuid by diffusion. The purified blood is pumped back into 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 per day, because the renmaining filtrate is re-absorbed into the kidney tubules.

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

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

6.9. 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 perfectly co-ordinated. This means that they

work together, performing various functions at certain time 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 work together during a movement. When a boy /girl runs to catch a ball, for example, he/she uses hundreds of muscles to move the joints in his arms, legs and back using information from his sense organs. The nervous system co-ordinates these muscles so that they contract in proper sequence with the perfect degree of power, and for precisely the correct length of time needed to get him/her to the spot from where he/she 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 maintain sugar and salt levels in the blood. Furthermore, all these co-ordinations occur as an unconscious process.

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

In insects, ganglia are connected by a ventral nerve cord functioning as a 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 the nervous and endocrine systems.

The nervous system consists of tissues which conduct “messages”, called nerve impulses, at high speed to and from all parts of the body.

6.10. CO-ORDINATION IN PLANTS

How do plants co-ordinate?

Unlike animals, plants have neither a nervous system nor muscles.

Then, 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 and the stem arises above the soil.

What happens during the above actions?

In the first instance, when the leaves of a sensitive plant is touched, the leaflets fold and the whole leaf droops down immediately. In this movement, no growth takes place.

In the second instance, the root grows towards the earth and the stem grows towards light. Here the Tropism is caused by growth. So it is a growth movement.

Therefore, plants show two different types of movements:

1. Movement independent of growth
2. Movement dependent growth

6.11. MOVEMENT- INDEPENDENT OF GROWTH

Immediate Response to Stimulus

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

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

If we touch the touch-me-not plant at one point, all the leaflets show the folding movement. This indicates that the stimulus

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.*

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

at one point is communicated. Unlike in animals, there is no specialized tissue in plants for transmitting the information. The folding effect of touch-me-not plant is caused by a change in the turgidity of the leaflets brought about by the movement of water into and out of the parenchymatous cells of the pulvinus or swollen leaf base.

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 the light 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?*

Movement Dependent on Growth:

More commonly, plants respond to stimuli slowly by growing in a particular direction. Since 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 in the direction of light (Phototropism).
2. Response of the plant in the direction of gravitational force (Geotropism).
3. Response in the direction of water (Hydrotropism).
4. Response in the direction of chemicals (Chemotropism).

Phototropism

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

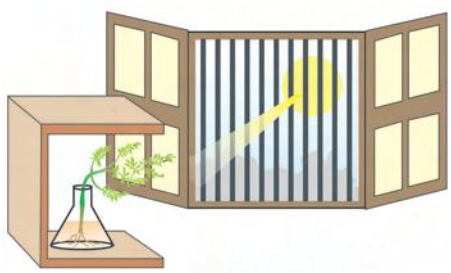


Fig. 6.12 Phototropism

Geotropism

Geotropism 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 the coconut tree are seen growing towards the water source.

Chemotropism

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

MODEL EVALUATION

PART - A

1. *In monotropa the special type of root which absorbs nourishment is the _____*

   i) Haustoria ii) Mycorrhizal root iii) Clinging root iv) Adventitious root

2. *The product obtained in the anaerobic respiration of yeast is _____*

   i) Lactic acid ii) Pyruvic acid iii) Ethanol iv) Acetic acid

3. *The roots of a coconut tree are seen growing far from the plant. Such a kind of movement of root for want of water is _____ .*

   i) Phototropism ii) Geotropism iii) Chemotropism iv) Hydrotropism

4. *The xylem in the plants is responsible for _____.*

   i) transport of water ii) transport of food

   iii) transport of amino acids iv)transport of oxygen

5. *The autotrophic nutrition requires*

   i)CO_2 and water ii) chlorophyll iii) sunlight iv) all the above

6. *Leaf pores / stomata help in _____.*

   i) intake of CO_2 during photosynthesis ii) release of O_2 during photosynthesis

   iii) release of water vapour during transpiration iv) All of these

7. *_____ of green plants are called factories of food production.*

   i) Mitochondria ii) Chloroplasts iii) Endoplasmic reticulum iv) Nucleus

8. The special root-like structure of plant parasites in cuscuta and viscum are called _____ .

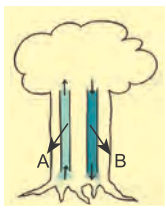
   i) Rhizoids ii) Haustoria iii) Hyphae iv) Stolons

9. Pick out the odd one : The parts of the alimentary canal are

   i) pharynx ii) mouth iii) buccal cavity iv) pancreas

PART - B

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



   i) Name A and B

   ii) What materials are transported through A?

   iii) What materials are transported through B?

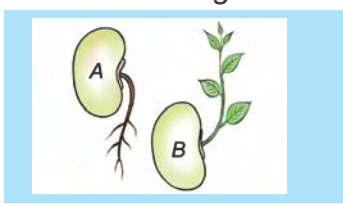
   iv) How do the materials in A move upwards to the leaves?

2. What is nutrition? What type of nutrition is seen in green plants and the majority of animals?

3. Match the methods of nutrition of special organs with suitable examples:

Autotrophs	Mycorrhiza	Cuscutta
Parasites	chlorophyll	Monotropa
Saprophytes	Haustoria	Hibiscus

4. Observe the diagram



   i) Mention the type of movements shown in figure A and B.

   ii) How does this movement differ from the movement of mimosa?

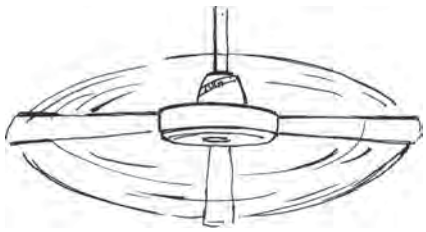
5. In the process of anaerobic respiration, _____ is a 6 carbon compound which gets converted into _____carbon compound called lactic acid.

6. Sugar is converted into alcohol. In the above reaction what kind of process takes place? Which micro-organism is involved?

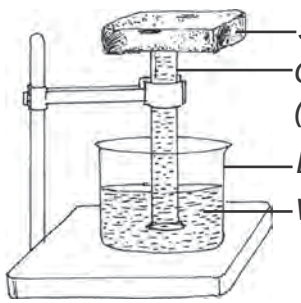
7. In human beings, air enters into the body through _____ and moves into _____. In fishes, water enters into the body through _____ and the dissolved oxygen diffuses into _____.

8. Give two examples of root parasites of plants. Mention the special structures present in them to draw the nutrients from the host plant.

9. What are saprophytes? Give two examples.
10. What is the length of the alimentary canal in human beings? List out the parts of the gastro-intestinal tract in the correct sequential order based on the passage of food.
11. What is respiration? Give a balanced equation for aerobic respiration.
12. A fish taken out of water can not survive for a long time. Why?
13. What are ammoniatelic and ureotelic animals? Give examples.
14. Describe the change that occurs in a touch-me-not plant when it is touched?
15. Study the following model with which the transpiration mechanism in plants can be demonstrated



Rotating ceiling fan



With which structure of the plant do you compare each of the following?

(i) Sponge (ii) Glass tube filled with water.

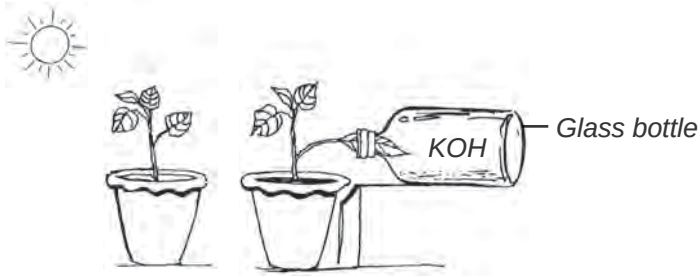
PART - C

1. Describe the various movements of plants giving suitable examples.
2. Describe the various methods of excretion in animals.
3. Compare the respiration in higher plants with the respiration in lower plants
4. In the touch - me - not plant the leaves show movements. What type of movement have you observed? Discuss.
5. Differentiate extra-cellular digestion from intra-cellular digestion. Which one is an advanced form?
6. Differentiate aerobic respiration from anaerobic respiration. Mention the event that is common to both.

7. Observe the given model that can be used to demonstrate the breathing mechanism in human beings.

Name the structures which can be compared to:
(i) Lungs (ii) Diaphragm (iii) Trachea (iv) Nostrils (Nose)

8. Observe the following figures:



A B

Both the plants 'A' and 'B' were kept in sunlight after watering. The part of the leaf of plant 'B' which was inserted in the glass bottle containing KOH (Potassium hydroxide) did not turn blue in the iodine test/ starch test, indicating the absence of starch. The part of the leaf outside the bottle turns blue in the said test. Photosynthesis didn't occur in that part of the leaf due to the non-availability of _____ .

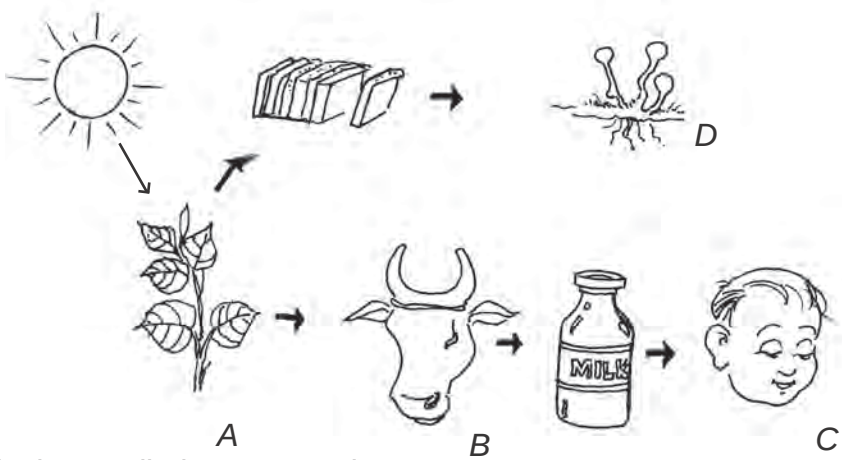
a) Sunlight b) ChlorophyII c) CO_2 d) Water

(i) List out the factors which are available to the part of the leaf outside the bottle.

9. Look at the illustration depicting the food chain:

a. The correct explanation of the organisms is:

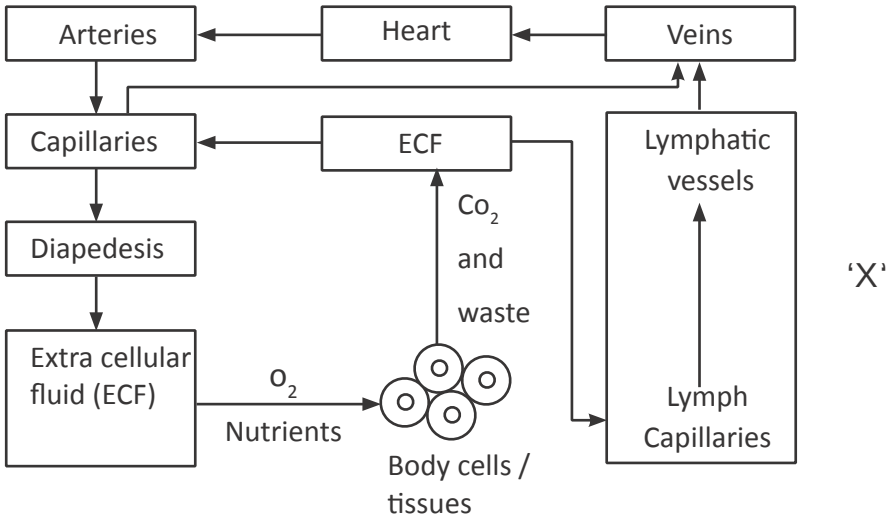
	A	B	C	D
a)	Saprophyte	Heterotrophs	Autotrophs	Heterotrophs
b)	Heterotrophs	Autotrophs	Saprophyte	Saprophyte
c)	Autotrophs	Saprophyte	Autotrophs	Heterotrophs
d)	Autotrophs	Heterotrophs	Heterotrophs	Saprophyte



A B C

b. Why is 'A' called an autotroph?

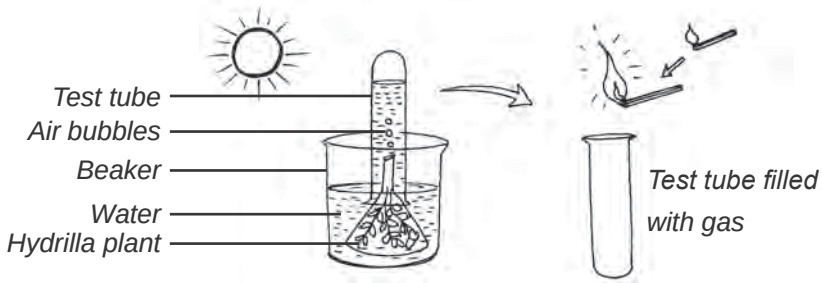
10. Observe the following flow-chart:



a) What is 'X' in this figure denote?

b) In what way is it different from blood?

11. Observe the following experiment:



i) Name the phenomenon it depicts and the gas that is released.

a) Respiration, CO_2 b) Photosynthesis, O_2 c) Transpiration, H_2O d) Excretion, N_2

ii) What is photosynthesis? Write a balanced equation for this bio-chemical reaction.

FURTHER REFERENCE

Books : 1. Modern Plant Physiology R.K.Sinha, Narosa publishing house, New Delhi

2. Fundamentals of plant physiology Jain .V.K.S.Chand & Company Ltd. New Delhi

3. Complete Biology(IGCSE) - Oxford University press, New York

Webliography: www.britannica.com, science.howstuffworks.com

http://arvindguptatoys.com/films.html

Chapter 7

CONSERVATION OF ENVIRONMENT

Living organisms live in different surroundings. Some plants and animals 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 and human beings survive the interaction between themselves 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 lifestyle of human beings.

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

In the course of development, unplanned utilization and exploitation of natural resources like water, forest produce, land and mineral resources have taken place. This has led to an imbalance in nature and release of many harmful substances into the atmosphere.

Not only is man greatly influenced by his environment, but he also affects the environment considerably. Overpopulation, environmental pollution, pest control and conservation of natural resources are some

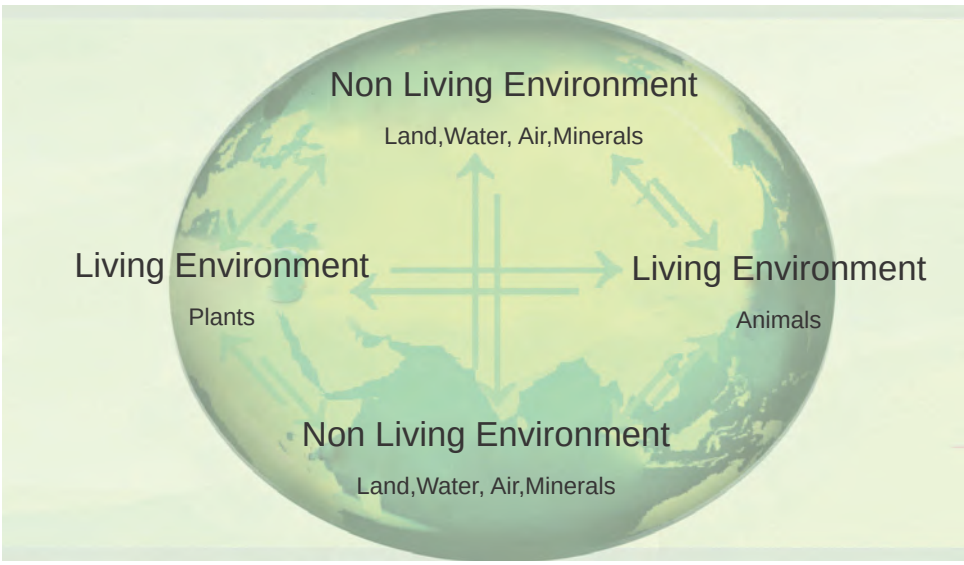


Fig. 7.1 Interaction between non-living and living components in the biosphere

BIOLOGY

of the challenges human beings face.

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

- Name some of these waste material.
- What happens after the disposal of waste material?

Human activities related to livelihood and welfare measures generate waste. All wastes are pollutants and they create pollution in one way or the other. 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 adversely affects the environment is called pollutant. e.g. sulphur-dioxide, 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 or microbial action are called bio-degradable wastes. e.g. grass, flowers and leaves.

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

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? Observe how much waste is generated at home in a day and how much of this waste is bio-degradable?*
- *Observe the amount of waste generated in the classroom in a day and how much of this waste is non bio-degradable?*
- *Suggest some ways on how to deal with this waste.*

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 little thought was given to the fact 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?

How can we protect ourselves from these hazardous wastes ?

Why does the government and so many organizations conduct awareness 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

This involves drilling a well into dry porous material below ground water. Hazardous waste liquids are pumped into the well. They soak into the porous material and 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 is called solid waste management.

Reuse and Recycling Technique

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

Paper (54% recovery)

Paper can be repulped and reprocessed into recycled paper, cardboard and other products.

Glass (20% recovery)

Glass can be crushed, re-melted and made into new containers or the crushed glass can be used as a substitute for gravel or sand in construction materials such as concrete and asphalt.

Food waste and yard waste (leaves, grass etc.) can be composted to produce humus soil.

7.2. WATER MANAGEMENT

Due to the increasing demand 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 almost every human activity. Perhaps more than any other environmental factor, the availability of water determines the location and activities of human beings.

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

7.2.1. Sources of Water

Water is a basic natural resource and a valuable asset to all nations. Human beings depend on water for all their needs such as bathing, washing, cooking, transportation and power generation. 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 is 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 ground water is important for plant growth. Man also taps this water through tubes and borewells. Scanty rainfall and unnecessary felling of trees affect the ground water level.

7.2.2. Fresh Water Management

To deal with water scarcity, we need to implement 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 a great potential for increasing the supply of fresh water. Desalination is more expensive than most other methods of obtaining fresh water. In desalination, the common methods of evaporation and re-condensation are involved.

iii) Dams, Reservoirs and Canals

Dams and storage reservoirs trap run-off water in them and transfer the water from areas of excess to areas of deficit using canals and underground pipes.

iv) Water Shed Management

The management of rain water and the 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 buildings or courtyards and storing it underground 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 drawing the 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.

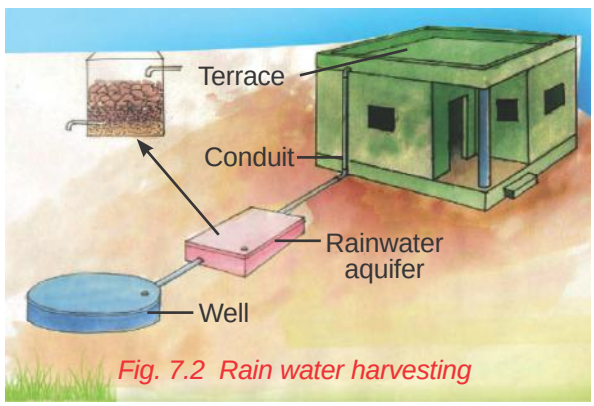


Fig. 7.2 Rain water harvesting

vi) Wetland Conservation

It preserves natural water storage and acts as aquifer recharge zones.

vii) Domestic Conservation

As an individual, everyone can reduce the water loss by using a bucket of water

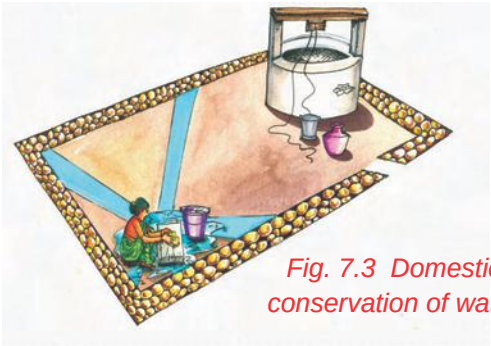


Fig. 7.3 Domestic conservation of water

than by taking a 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.

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 advantage and for 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.

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. Plants could yield products of immense medicinal value in future. Wildlife also forms a 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

A wildlife sanctuary is an area constituted by a competent authority where hunting or capturing of animals is prohibited except by or under control of the highest authority responsible for the 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 zoological parks and 13 biosphere reserves in the country covering an area of 1.6 lakh sq.km.

7.4. BALANCE IN ECO-SYSTEM

What is Eco-system?

- Fishes live in water.
- Tigers live in forests.

How can they lead their life in their respective habitats?

A community of organisms that interact with one another and exist in particular environment is called an eco-system. The eco-system is of two types, namely aquatic and terrestrial.

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 Sanctuary	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 Ramnad 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, monkey.
Mukkurthi National Park	The Nilgiris	tigers.
Point Calimere Wildlife Sanctuary	Nagapattinam district	chital, wild bear, plovers, stilts, bonnet macaque.
Anaimalai 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 also a tiger reserve)	Karnataka	Indian bison, chital, sloth bear, elephant.
Corbett National Park (India's first national park) (Also a tiger reserve)	Uttaranchal	tiger, chital, elephant, leopard, jungle cat and sloth bear.
Gir National Park	Gujarat	Asiatic lion
Kanha National Park (Tiger reserve)	Madhyapradesh	deer, tiger, wilddog, chital.
Bharathpur Bird Sanctuary	Rajasthan	374 species of birds, 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 langur
Sunderbans National Park (Tiger reserve)	West Bengal	unique royal Bengal tigers.

What are the major components in an 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

The abiotic factors 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

They include 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 birds that feed on small fishes.

Decomposers

Several bacteria and fungi form the decomposers in the pond.

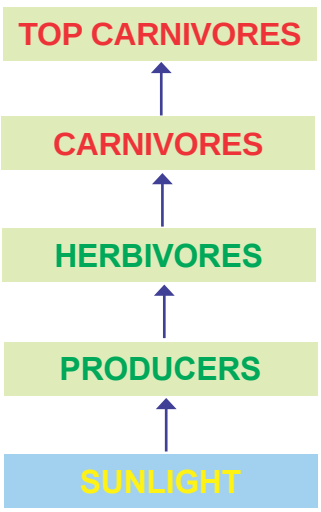


Fig. 7.4 Flow of energy in an ecosystem

BALANCE IN ECO-SYSTEM

A balanced eco-system is an ecological community, together with its environment and functioning as a complex unit.

An eco-system is maintained by the balance in nature such as the balance between hawks and mice. If the hawk population is larger than the mice population, then it is not balanced.

ACTIVITY 7.2

- *In your house, have you observed lizards eating insects and a cat chasing a rat? What is the reason?*
- *Form groups and discuss how each of the aquatic organisms is dependent on the other.*
- *Make a food chain of an aquatic eco-system (atleast three steps).*
- *Would you consider any one group of organisms to be of primary importance? Why or why not?*

There is a balance between resources like banana trees and monkeys. If banana trees stop growing, monkeys will not get bananas.

An ecosystem maintains the balance between the number of resources and the number of users or the balance between the predators and their prey.

What is Food Chain and Food Web?

Food Chain

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 (Producers) → Grasshopper (Herbivores) → Frog (Primary carnivores) → Snake (Secondary carnivores) → Eagle (Tertiary carnivores)

Fig. 7.5 Grassland Ecosystem

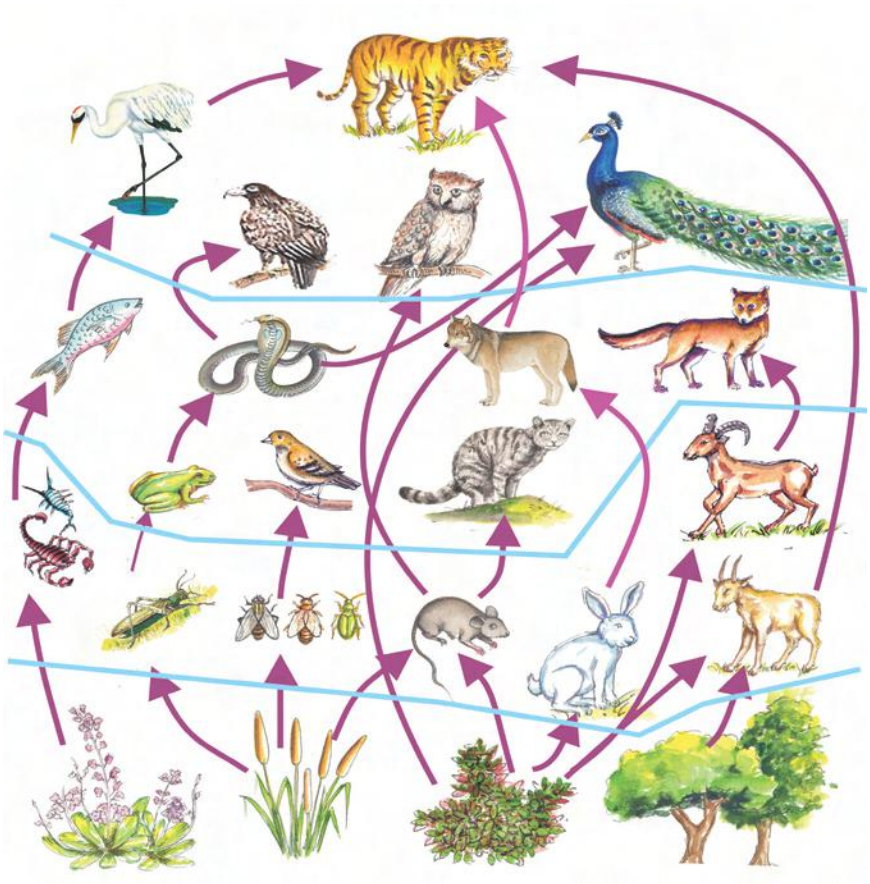


Fig. 7.6 Food web

Food Web

The food chains are interlinked to form food webs. So every component of the eco-system is connected with one another.

How is the Eco-system Maintained?

There are many factors which naturally maintain the harmony in an eco-system. Disturbing any one factor could have a drastic impact upon the living conditions of other organisms resulting in an imbalance. For example, removal of trees and vegetation would affect both land and water eco-systems, as there will be no food for organisms. Killing animals and polluting land, air and water also disturb the balance in nature.

In order to maintain the eco-balance in an ecosystem, there should be recycling of nutrients, minerals, and water. Discreet use of natural resources will help to maintain the eco-balance. Thus eco-balance or ecological balance is the maintenance of balance between living components and the 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 trapped by the plants. Then it is transferred to herbivores and carnivores, i.e. the energy flows in one direction only. But the minerals like phosphate, nitrate etc. that are required in the ecosystem are continuously absorbed by plants and transferred to animals. As the minerals are drawn from the soil, they have to be

replaced. These minerals are restored to the soil by the decomposition of dead and decaying materials by saprophytic organisms such as bacteria and fungi.

7.5. COAL AND PETROLEUM

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 worldwide, as well as one of the largest worldwide sources of CO_2 emission. Gross CO_2 emission from coal usage is high and more than that from petroleum and about double the amount from natural gas.

Fig. 7.7 Coal

Coal is obtained through mining or from 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-dioxide gas. Coal is processed in industries to obtain some useful products such as coke, coal tar and coal gas.

ACTIVITY 7.3

- *Visit Neyveli Lignite corporation.*
- *Find out the methods of coal extraction.*
- *Discuss with your classmates about the uses of coal.*

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 causes acid rain.
3. Interference with ground water and water table levels.
4. Contamination of land and water bodies.
5. Dust pollution.
6. Release of CO_2, a green house gas, causing climate change and global warming.
7. Coal is the largest contributor to the man-made increase of CO_2 in the air.

Petroleum

In today's modern life, we are dependent on 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 petroleum was 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, fibres (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'.

Fig 7.8 Petroleum Industry

Environmental Effects

Oil Spills

1. Crude oil (refined fuel) spills from tanker ships due to accidents have damaged the natural ecosystem.
2. Oil spills at sea generally cause more damage than those on land. These can kill sea birds, mammals, shellfish and other organisms, because of their lateral spread on the surface of the water.

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.

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 the 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.

- Greener reaction conditions for an old synthesis. e.g. replacement of an organic solvent with water or the use of no solvent at all.

MORE TO KNOW

- *Many countries are making commitments to lower green house gas emissions according to the Kyoto Protocol.*
- *Coal is used in thermal power stations and petroleum products like petrol and diesel are used in transportion like motor vehicles, ships and aeroplanes. We cannot really imagine a life without electrical appliances and transportation. Can you think of ways by which consumption of coal and petroleum products can be reduced?*

- A greener synthesis for an old chemical. (e.g. a synthesis which uses biomass rather than petrochemical feedstock 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 into 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 reduce waste generation than to treat or clean up waste after it is generated.
- Wherever practically feasible, synthetic methodologies should be designed to use and generate substances that possess a little or no toxicity to humans and the environment.
- Chemical products should be designed to preserve efficacy of function while reducing toxicity.

Products Produced by the Process of Green Chemistry

- Lead free solders and other products alternative 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.

Fig. 7.9 Green Chemistry

(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 Global Village

"Global Village" is the term used to mean that the world has shrunk into a small village by means of different types of media, especially the World Wide Web, making it easy to pass messages (like news) thereby making the world become a single village where people can easily and quickly contact each other.

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).

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 websites together. This new reality has implications for forming new sociological structures within the context of culture.

MODEL EVALUATION

PART - A

1. Which of the following groups contain only bio-degradable items?

i) Grass, flowers and leaves *ii) Grass, wood and plastic*

iii) Fruit peels, cake and plastic *iv) Cake, wood and glass*

2. Which of the following constitutes a food chain?

i) Grass, wheat and mango *ii) Grass, goat and human*

iii) Goat, cow and elephant *iv) Grass, fish and goat*

3. Which of the following are environmental friendly practices?

i) Carrying cloth bags for shopping

ii) Switching off light and fans when not in use

iii) Using public transport *iv) All the above*

4. What is called as 'black gold'?

i) hydrocarbons *ii) coal* *iii) petroleum* *iv) ether*

5. Based on the food chain, pick the odd one out:

plants → grasshopper → frog → tiger → snake

6. Example for product of green chemistry is _____.
   i) plastic ii) paper iii) bio plastics iv) halogen flame retardants
7. _____ is a green house gas which causes climate change and global warming.
   i) hydrogen ii) oxygen iii) nitrogen iv) carbondioxide
8. The _____ form decomposers in the pond ecosystem.
   i) plants ii) bacteria iii) frogs iv) phytoplanktons
9. _____ is used in seeding clouds.
   i) potassium iodide ii) calcium carbonate
   iii) sulphurdioxide iv) ammonium phosphate
10. An example for fossil fuel is _____ .
    i) copper ii) iron iii) magnesium iv) coal
11. Air pollution is caused by transport exhaust fumes and emission of gases like SO_2, CO_2, NO_2 from industies. Similarly, water pollution is caused by _____ .
    i) sewage ii) crop cultivation iii) rain iv) soil erosion
12. If wild animals are killed, what difficulty would we face?
    i) imbalance in nature ii) decrease in fog rain
    iii) decrease in population iv) increase in rain
13. Water is an essential commodity for survival. What can we do to help increase water resources?
    i) deforestation ii) reducing the use of vehicles
    iii) the burning of the wastage iv) afforestation
14. The tiger and the lion are carnivores. Likewise the elephant and the bison are _____.
15. Assertion (A) : Coal and petroleum are called fossil fuels.
    Reason (R) : Fossil fuels are formed from the remains of dead organisms after millions of years.
    i) Both 'A' and 'R' are true and 'R' explains 'A'.
    ii) Both 'A' and 'R' are true and but 'R' doesn't explain 'A'
    iii) Only 'A' is true but 'R' is false.
    iv) 'A' is false but 'R' is true.
16. Compressed Natural Gas (CNG) is considered a better fuel than coal/ petroleum, because _____.
17. Now-a-days water bottles and lunch boxes are made from agricultural products like fruit pulp. These are called _____ .

PART - B

1. Classify the following into producers, consumers, decomposers.

   i) butterfly ii). grass hopper iii) calottes iv) snakes

   v). shoe flower vi) nitrobacteria

2. Living organisms adapt themselves according to their habitat.

   Match the following:-

a. fish	wings
b. camel	hard skin
c. frog	fins
d. birds	hind limbs with web

3. Fill in the blanks

   i) Animals give out _____ through respiration.

   ii) In the presence of sunlight, plants prepare _____.

4. `Bacteria and fungi are responsible for the decay of dead plants and animals. Decaying matter is recycled to grow plants. What do we call this?

5. Fill in the blanks with suitable answers from those given in the brackets.

   (harmful, heavy metals, carbon dioxide, sulphur particles)

   Generation of waste products which contain Mercury, Uranium, Thorium, Arsenic, and other _____ are _____ to human health and environment. _____ present in the coal will cause acid rain and the release of _____, a green house gas, causes climate change and global warming.

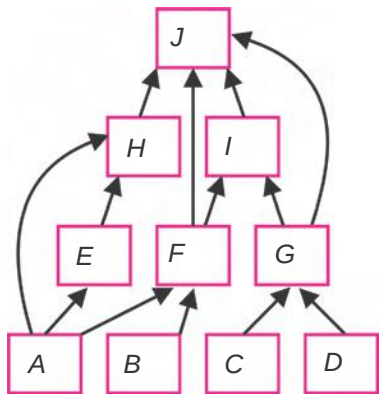
6. Depict a food chain by placing the following organisms in the correct trophic levels:

   (snake, grass, eagle, frog, grasshopper)

7. Show an aquatic food chain using the following organisms.

   (Small fish, Phytoplanktons, Kingfisher, Zooplanktons)

8. Observe the following food web:

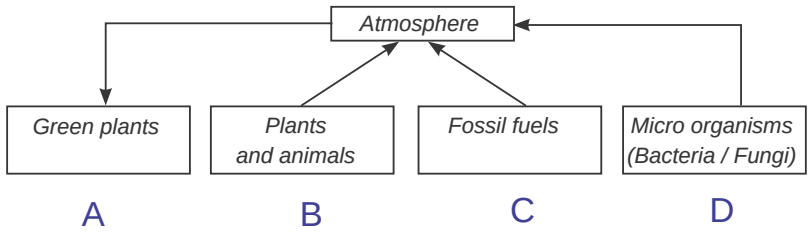


(i) Find out the wrong statement:

a) 'A' is a producer
b) 'F' is a herbivore
c) 'H' is an omnivore
d) 'I' is a climax carnivore

(ii) Find out how many food chains are present in the above food web.

9. Observe the following Bio-geo chemical cycle.



i) Mention the nutrient in the given cycle.

ii) Write the activities from'A' to 'D'.

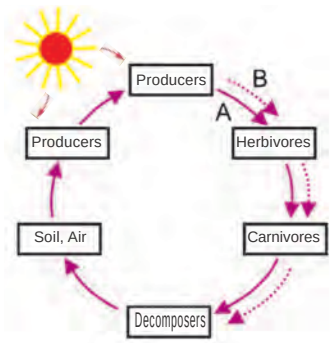
10. Study the food chain below, correct it and convert it into a pyramid of energy.

Mulberry -> Sparrow -> Caterpillar -> Kite

11. Study the illustration and answer the questions:

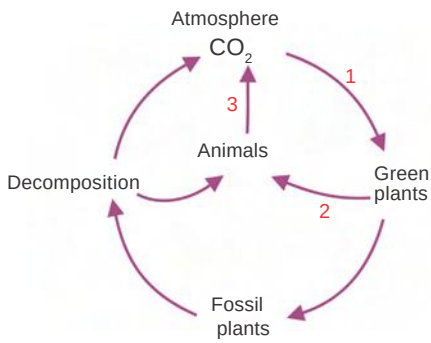
i) Which line (A or B) represents the flow of energy? Why do you say so?

ii) Give an example of a decomposer.



12. i) Name the processes noted as No. 1 and 3.

ii) Define process 1.



PART - C

1. i) Classify the following substances – wood, paper, plastic and grass.

ii) Give a detailed account of your classification.

2. In your locality people are affected due to water scarcity. What measures will you take to deal with the problem of water scarcity?

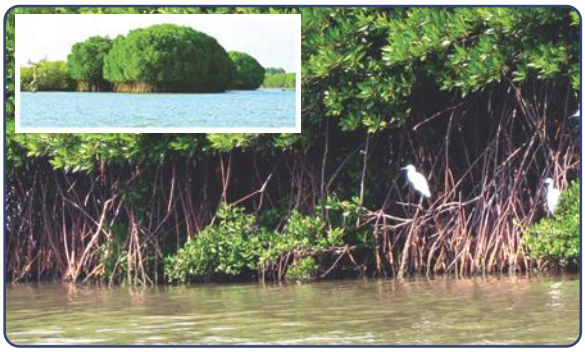
3. We are surrounded by smoke. Is this situation good for our health. Give reason.

4. List out the harmful effects of burning coal.

Unique Ecosystems of Tamilnadu

Sholas and Grasslands
Western Ghats

Theri Kaadu
Mukuperi, Thoothukudi



Mangrove Forests
Pichavaram, Cuddalore

Neela Kurinji- Plant that blooms once in 12 years
The Nilgris

The Sholas and grasslands of the 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. Environmental Studies, Dr. J.P. Sharma, Laxmi publication, New Delhi.

2. Complete Biology(IGCSE) - Oxford University press, New York

Webliography: www.enviroliteracy.org/article.php/600 html,

science.howstuffworks.com

Chapter 8

WASTE WATER MANAGEMENT

Human beings have been abusing the water-bodies around the world by disposing all kinds of wastes into them. 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 wash away through our rivers and drains?

Due to such activities of human beings, the ponds, lakes, streams, rivers, estuaries and oceans are polluted in several parts of the world. So we should manage the waste water in order to prevent water pollution and its harmful 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. Without water, life cannot sustain on the earth because of this feature.

Water Cycle

A large quantity of water is present in 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 lakes and rivers, seeps into the ground water table and flows into the ocean, also gets fixed in glaciers and deposited over mountains. Plants absorb water from the soil, utilize it for its metabolic activities and release it into the atmosphere mainly through transpiration.

Sources of Water

Water is widely distributed in nature and is found in various forms viz., solid, liquid and vapour. Rainfall brings the available primary source of water over the earth's surface. Oceans are the largest among all the water resources. Only a little quantity of water i.e. 2.4 percent of water is fresh and most of this fresh water is in glaciers or as ground water. Geologic layers containing water is known as **aquifers** from which water can be extracted**.** On some areas of the earth's crust, fresh water flows freely which is called as an **artesian well** or spring. Rivers carry a 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 generated from residential, institutional, commercial and industrial establishments and includes household solid and liquid waste from toilets, baths, showers, kitchens, sinks and so forth. The sewage is disposed through sewer lines.

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 fig. 8.1 sewage 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: 1.primary 2. secondary 3. tertiary

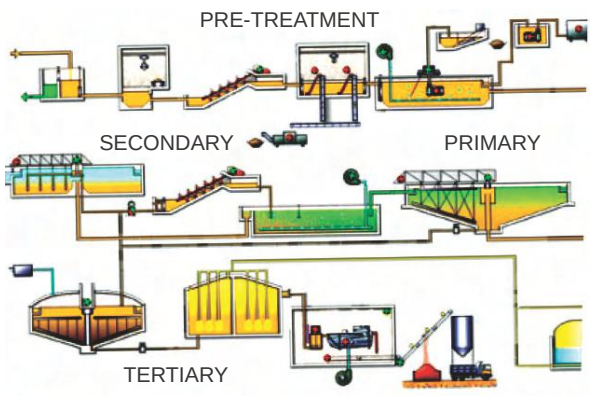


Fig. 8.1 Sewage water treatment

Primary Treatment

Primary Treatment involves temporary holding of the sewage in a quiescent basin, where heavy solids get settled at the bottom while oil, grease and lighter solids float over the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment.

Secondary Treatment

Secondary Treatment is used to remove the dissolved and the suspended biological matter. This process is typically performed by indigenous, water borne microorganisms in a managed habitat. Secondary treatment may require a separation process to remove the microorganisms from the treated water, prior to discharge for tertiary treatment.

Tertiary Treatment

Tertiary Treatment is defined as either chemical or treatment of filteration done after the primary and the secondary treatment. Treated water is sometimes disinfected chemically or physically (for example by lagoons and microfiltration.). Before discharging the treated effluent into a stream, river, bay, lagoon or wetland, it can be used for the irrigation of a golf course a green way or a park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

Bioremediation in Sewage Treatment

Bioremediation is a technique which is used to clean up the environment using microorganisms. Nitrosomonas europaea can be used to treat sewage, freshwater, walls of buildings and the surface of monuments especially in polluted areas, where there are high levels of nitrogen compounds.

8.4. DOMESTIC PRACTICES

Sewage comprises of waste water i.e. waste liquid from toilets, bathrooms, kitchens and so forth, released from homes.

The process of converting household waste into grey water and black water is becoming more common in our country. Grey water is permitted to be used for watering plants or recycled for use in flushing toilets.

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?*

Waste Water

Waste water is often referred to as grey water. Any water that has been used in the households, 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 yards and gardens
2. Filtering septic systems
3. Irrigating fields

Benefits of household waste water recycling systems:

1. Less fresh water usage
2. Reduce stain 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 quantity 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 humans, chemicals and industrial wastes can result in a variety of communicable diseases through ingestion or physical contact.

Waterborne diseases

Waterborne diseases are caused by the ingestion of water, contaminated by human or animal faeces or urine containing pathogenic bacteria or viruses. They include cholera, typhoid, amoebic and bacillary dysentery and other diarrhoeal diseases.

Water-washed Diseases are caused by poor personal hygiene and skin or eye contact with contaminated water. They include scabies, trachoma and flea, lice and tick-borne diseases.

Water-based Diseases are caused by parasites found in intermediate organisms living in water. They include dracunculiasis, schistosomiasis and other helminthes.

Water-related Diseases are caused by insect vectors which breed in water. They include dengue, filariasis, malaria, onchocerciasis, trypanosomiasis and yellow fever.

- Contaminated water that is consumed may result in waterborne diseases including viral hepatitis, typhoid, cholera, dysentery 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 are a result of 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.

ACTIVITY 8.2

- *Wash your hands thoroughly before and after using the toilet.*
- *Clean food and water containers properly and keep them closed when they are in use.*
- *During floods and other natural calamities, water should be used only after boiling.*
- *People who live near accumulated hazardous industrial waste or polluted water areas should be very careful while using ground water.*

- Drinking water supplies that contain high amounts of 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 every year.

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 purpose. Wastewater can also be used as a fertilizer, thus minimizing the need for chemical fertilizers. This reduces the cost, 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 eat food from the same source, there is a greater risk of the spread of diseases such as, cholera, hepatitis, 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 takes place 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 should have toilet compartments only.
4. There must be a wash 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 at business, public-sector / government organizations and homes.

Energy Saving Measures

Energy Management is the process of monitoring, controlling and conserving energy in any household or organization.

8.8.1. Energy Audit

An energy audit is an inspection, survey and analysis on energy flow for energy conservation in a building, process or system. It is done with a view to reduce the amount of energy input into the system without negatively affecting the output(s).

Home Energy Audit

Home energy audit is a service where the energy efficiency of a house is evaluated using professional equipment such as blower doors and infra-red cameras, with the aim to suggest effective 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 and physical condition on programming of mechanical systems such as heating, ventilation, air-conditioning equipment and thermostat.

A home energy audit may include a written report estimating energy consumption at given local climate criteria, thermostat settings, roof overhang, and solar orientation. This could show the amount of energy consumed 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 the Central Government.

Energy Audit in Schools

The function of an energy audit is to expose different ways that affect energy consumption and identify numerous options for reducing energy consumption.

The money your school saves through energy audit service 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 energy efficiency in places like schools, we can obtain the same benefits as by using less energy. For example, substituting energy efficient compact fluorescent light bulbs (CFL) for standard incandescent bulbs will save on an 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.

ACTIVITY 8.3

- *Using a thermometer, observe the room temperature of your classroom and the temperature under a Neem tree on a hot day.*
- *Light a tungsten lamp and a compressed fluorescent lamp and compare the energy consumption.*

Another important way to conserve 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 generate. 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 equal to 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 harnessed directly from the sun. Along with nuclear energy, it is the most abundant source of energy on the earth. The fastest growing type of alternative energy increasing at 50

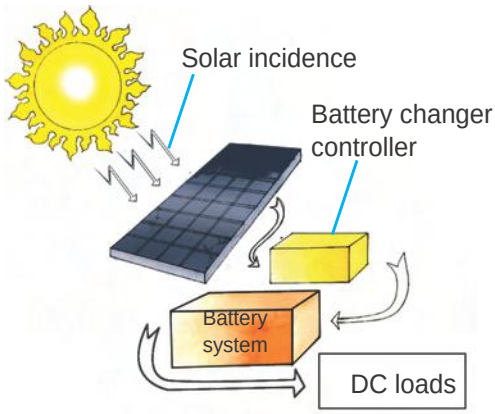


Fig. 8.2 Solar Energy

percent a year is the photovoltaic cell, which converts sunlight directly into electricity. In a year, the sun generates more than 10,000 times the energy that humans currently consume.

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 the advantages and limitations of using solar cookers or water heaters.*

Hydrogen

Hydrogen has been found to be the best choice among all the alternative fuel options. It can be produced in virtually unlimited quantities with production technologies in hand. 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 in 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 (30-35 %) is greater than that of gasoline (20-25%).

Fig. 8.3 Windmills

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 utilized. The largest wind energy farm has been established near Kanyakumari in Tamilnadu and it generates 380MW of electricity.

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 is used to turn mechanical machinery to do physical work, like crushing grain or pumping water.

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 which are energy rich are 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

Coal

Coal 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.

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.

Natural gas can be used as a fuel only after it undergoes extensive processing to eliminate almost all materials other than methane. The by-products of methen processing include ethane, propane, butane, pentane and higher molecular weight hydrocarbons, elemental sulphur, carbon-dioxide, water vapour and sometimes helium and nitrogen.

Natural gas is often informally referred to as 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 the purpose of cooking in gas stoves and ovens. Natural gas heater is used as clothes dryers. Some homes and buildings which have boilers, furnaces and water heaters use natural gas.

Natural gas is a major feedstock for the production of ammonia and fertilizers.

Other Uses: Natural gas is also used in the manufacture of fabrics, glass, steel, plastics, paint and other products. With our ever increasing need for energy, we have been using fossil fuels indiscriminately. In the process, harmful materials contributing to air pollution are produced.

8.8.4. Biofuels – 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. Biofuels are gaining increased public and scientific attention driven by factors such as oil price hikes, the need for increased energy security and concern over greenhouse gas emissions from fossil fuels.

The various liquid biofuels for transportation are :

1. Bioalcohol
2. Green diesel
3. Biodiesel
4. Vegetable oil
5. Bioethers
6. Biogas

Bioalcohol (Bioethanol)

Bioethanol is an alcohol prepared 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 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 biodegradable waste material or by the use of energy crops fed into anaerobic digesters to supplement gas yields. The solid digestable byproduct, can be used as biofuel or fertilizer.

8.8.5. Energy Conservation

Energy Conservation

Energy Conservation refers to efforts taken 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 will lead to an 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 conservation is the important element of energy policy.

ACTIVITY 8.5

Debate the following two issues in class:

- *The estimated coal reserves are said to be sufficient for human use for another 200 years. Do you think we need to worry about coal getting depleted in this case? Why do you think so?*
- *It is estimated that the sun will exist 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.*

Lighting

1. Turn off the lights when not in use.
2. De-dust lighting fixtures to maintain illumination.
3. Focus the light, where you actually 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 Box

1. Use iron boxes with automatic temperature cut off.

2. Use appropriate regulator position for ironing.
3. Do not sprinkle 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. Blue flame denotes that your gas stove is operating efficiently.
3. Yellowish flame 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 instead of an electric water heater.

Electronic Devices

1. Do not switch on the power when the TV and Audio system are not in use. i.e. idle operation leads to an energy loss of 10 watts / device.
2. Battery chargers of laptops, cell phones and digital cameras draw power, whenever they are plugged in and are very inefficient. Remove the plug and save energy.

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 to wash only very dirty clothes.
6. Always use cold water in the rinse cycle.

MODEL EVALUATION

PART - A

1. An example of water-borne disease is _____.

i) scabies *ii) dracunculiasis* *iii) trachoma* *iv) typhoid*

2. The sedimented and floating materials are removed by this treatment process.

i) primary treatment *ii) secondary treatment*

iii) tertiary treatment *iv) peripheral treatment*

3. Which is a non-renewable resource?

i) coal *ii) petroleum* *iii) natural gas* *iv) all the above*

4. _____ is the chief component of natural gas.

i) ethane *ii) methane* *iii) propane* *iv) butane*

PART - B

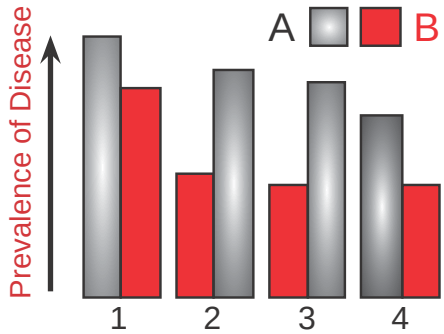
1. *The bar-graph indicates the prevalence / widespread attack of infectious diseases in two cities A and B. Observe it and answer the questions given below:*

   1. Dengue fever 2. Rat fever 3. Cholera 4. Chikungunya

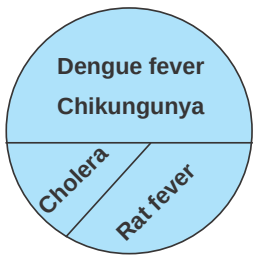
   a. *What may be the reason for the disease in city A?*

   b. *Which city needs more effective system of waste-disposal and cleaning?*

   c. *How can the disease be controlled in city A?*



2. *The pie diagram represents a survey result of infectious diseases in a village during 2008 – 2009. Analyse it and answer the following:*



   i) Which diseases affect the majority of the population?

   ii) How are these diseases transmitted?

   iii) Mention any three measures that can control the other two diseases.

3. *Match the suitable renewable and non-renewable sources.*

Sources	A	B	C
Renewable	Coal	Wind	Petroleum
Non- Renewable	Hydrogen	Natural gas	Solar energy

4. *Find the odd one out:*

   i) bioalcohol, green diesel, bioethers, petroleum

   ii) cholera, typhoid, scabies, dysentry

5. A non-renewable resource is a natural resource, if it is replaced by natural process at a rate equal to or faster than its rate of consumption by humans.

   Read this statement and say whether it is correct or incorrect. If it is incorrect, give the correct statement.

6. Pick out the appliances that can conserve electric energy.

   Florescent bulbs, copper choke, solar water heater, electric water heater, tungsten bulbs, electronic choke.

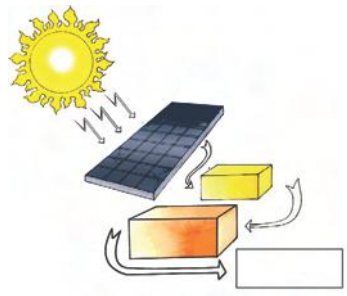
PART - C

1. Observe the picture given below and find out what type of energy is produced

   i) Identify whether this energy is conventional or non-conventional.

   ii) Draw the given diagram and label it with the parts given below:
   (battery, battery charger controller, solar incidence, DC load, battery system)

   iii) In the given picture, _____energy is transformed into _____energy.



2. i) What type of energy is produced in this picture?

   ii) What difficulties do we face in harnessing this energy? Explain.

   iii) Why do we say that this energy is better than solar energy and atomic energy?

3. Fossil fuels are formed by decomposition of biomass buried under the earth over millions of years ago.

   i) Name any three fossil fuels.

   ii) Which fuel is used in the production of fertilizers?

   iii) What is natural gas made up of ?

4. Wind power is generated from uneven heating of the earth's surface by the sun and the hot core.

   i) Which country is called the country of winds?

   ii) Which country leads the world in harnessing wind energy?

   iii) In which district of Tamilnadu do we have wind energy farm?

   iv) In which of the following land forms will you be able to harness maximum amount of wind energy?
   (plains, canals, valleys)

5. Match the following:

Water borne diseases	Water related diseases	Water based diseases
Typhoid	dengue	scabies
Malaria	amoebiasis	cholera
filariasis	lice	trachoma

6. Water contaminated by human beings, chemical or industrial wastes can cause a variety of communicable diseases through ingestion or physical contact.

   i) Name any two diseases caused by polluted water.

   ii) Why do we drink boiled water?

   iii) How can you reuse waste water in your houses?

7. Water, a precious physical substance, is essential to all living organisms.

   i) Which is the largest water resource?

   ii) What are the various sources of water?

   iii) Which is the primary source of water?

   iv) What are the ways by which you can raise the ground water level in your house?

8. An energy audit is an inspection, survey and analysis of energy flow to ensure energy conservation in a building, process or system.

   i) How will you measure consumption of electrical energy at home?

   ii) What are the benefits of implementing this method in your school?

9. We should manage the waste water in order to prevent water pollution and its harmful effects.

   i) What are the ways by which water gets contaminated?

   ii) How will you control water contamination in your house?

FURTHER REFERENCE

Book: 1. Land treatment of waste water M.B. Gohil, New Age International (p) Ltd, New Delhi

2. Complete Biology(IGCSE) - Oxford University press, New York

Webliography: en.wikipedia-org/wiki/sewage

Chapter 9

SOLUTIONS

Advantage of health drink

Health drink

Anu has got back home from the playfield after winning a match. She is received cheerfully by her mother with a glass of health drink.

Anu : Mother! What is this?

Mother: This is your health drink; it is a mixture of fruit juice and sugar. This solution will revitalise your energy.

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. The term **Homogeneous** refers to the state in which two or more substances are uniformly present in a given mixture. If a solution contains two components, then it is called as a **Binary Solution**.

Salt solution - common salt dissolved in water is an example for binary solution.

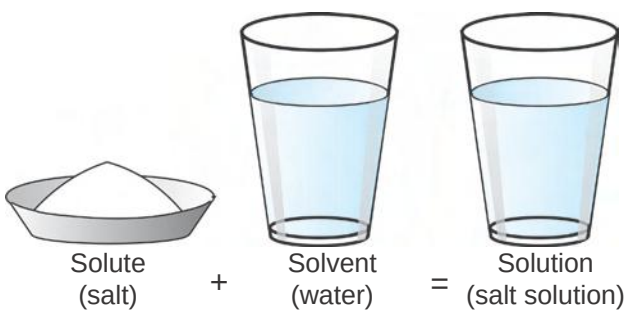


Fig. 9.1 A solution is a homogenous mixture of solute and solvent

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 a 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 Solution: It is a homogeneous mixture that contains small solute particles that are dissolved throughout the solvent eg. sugar in water.

2. Colloidal Solution: 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)

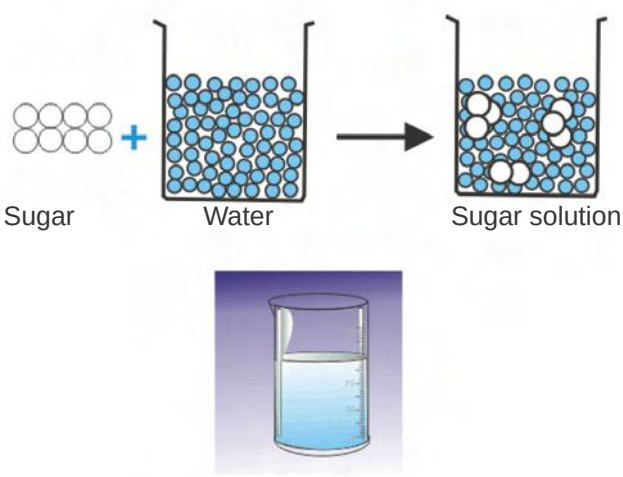


Fig. 9.2 Mixture of sugar and water forming true solution

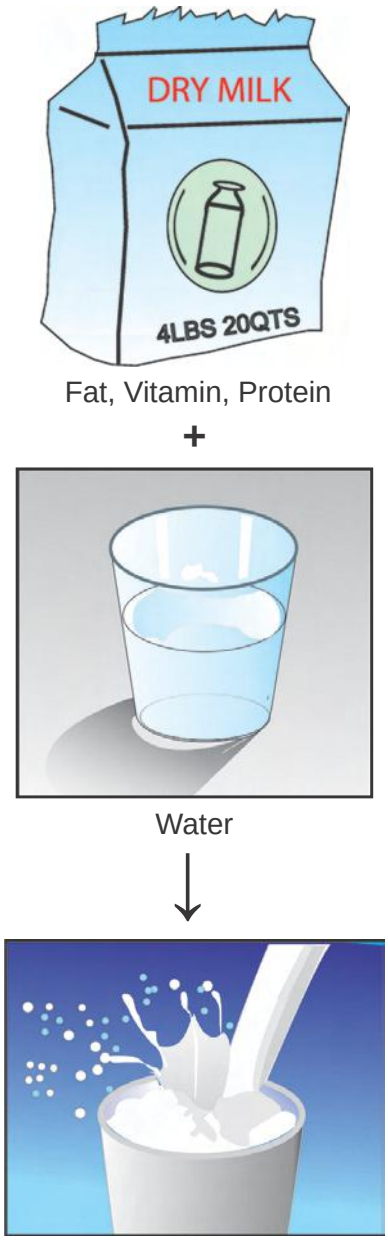


Fig. 9.3

3. Suspension: It is a heterogeneous mixture of small insoluble particles in a solvent. In a suspension, the solid particles stay in clusters that are large enough to be seen. (e.g. chalk powder in water).

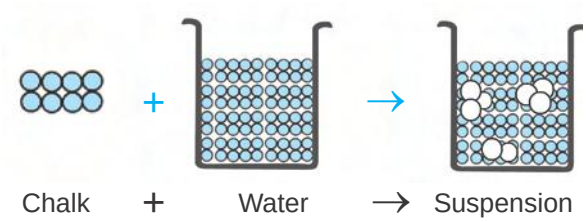


Fig. 9.4 A mixture of chalk powder and water forming suspension

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 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

Observe the scattering of light (Tyndall effect) when sunlight passes through the window of the classroom, the dust particles scatter the light, making the path of light visible.

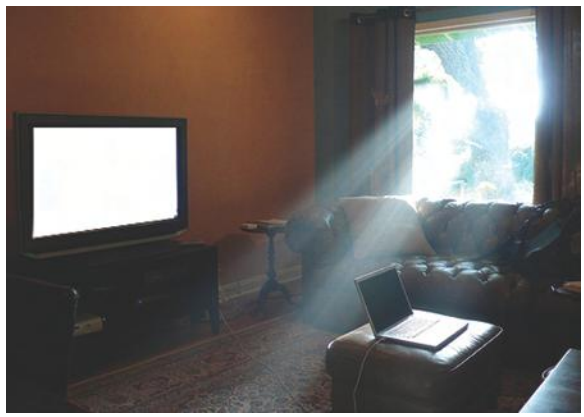


Fig. 9.5 Tyndall effect in nature

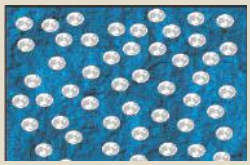
MORE TO KNOW

Brownian movement: *The phenomenon by which the colloidal particles are in continuous random motion is called* **Brownian movement.**

Brownian motion is named after 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 Å (1Å = 10^{-10}m)	 1Å to 10 Å	 10Å to 2000 Å	 More than 2000 Å
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	Scatters light	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**. (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, carbon disulphide (CS_2) acetone are a few examples for non-aqueous solvents to dissolve organic compounds.)

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:** Unsaturated solution is a solution in which more of the solute can be dissloved at a given temperature. 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.36g of NaCl in 100g of water at room temperature forms a saturated solution.

3. Super Saturated Solution: A solution which has more of solute than the saturated solution at a given temperature is called **super saturated solution**.

MORE TO KNOW

Nitrogen in soil is an example for saturated solution in nature.(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 to the solution at a particular temperature.

Take a glass containing 100ml of water, three packets of common salt 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 after stirring it at each stage.

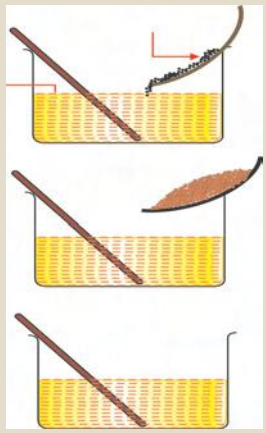


Fig. 9.7 To test Unsaturation, Saturation and Super Saturation in a given solution

9.2.4 Based on the physical state of the solute, the solvent and 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 a dilute solution, whereas a solution containing a large amount of solute is known as a concentrated solution. It may be noted that dilute and concentrated are 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 a saturated solution of KCl in about 30 ml of water at room temperature. Add more of KCl ensuring that the solution is saturated and some KCl is left undissolved.*
- *Filter the solution to remove the solid KCl.*
- *Find the temperature of the solution by immersing a thermometer in it.*
- *Use a low flame to avoid burning, evaporate the liquid till only the solid remains.*
- *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 a dehydrating agent, and it absorbs moisture).*
- *Take out the evaporating dish and weigh it again.*
- *The observations and calculations are given as follows:*

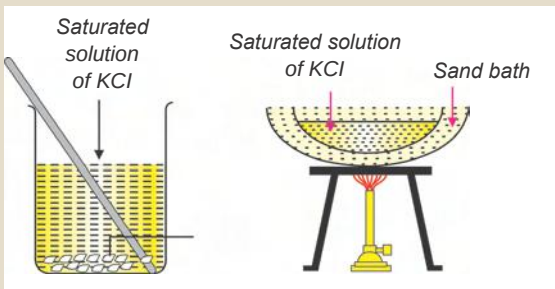


Fig. 9.8 Determination of solubility

Observation

Weight of the dish = Wg

Weight of dish + saturated solution of KCl = W_1g

Weight of dish + dry KCl = W_2g

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 :

Ionic Compound	*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 and 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.

Solubility of oxygen is more in cold water.

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 in liquids. An increase in pressure increases the solubility of a gas in a liquid. For e.g. 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.

SOLUTION

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, the amount of potassium sulphate dissolved is 2g.

In 1g of water, the amount of potassium sulphate dissolved is 2/12.5 g.

Hence, in 100g of water, the amount of potassium sulphate dissolved is (2 x 100)/12.5=16g.

The solubility of potassium sulphate in water at 60°C is 16g.

PROBLEM 3

50g of saturated solution of NaCl at 30°C is evaporated to dryness and 13.2g of dry NaCl was obtained. Find the solubility of NaCl at 30°C in water.

SOLUTION

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. After adding 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 100 g H_2O.

MODEL 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. A solution that contains water as the solvent is called an aqueous solution. If carbon disulphide is a solvent in a given solution, then the solution is called _____. (aqueous solution, non- aqueous solution)
3. The solubility of common salt in 100g of 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 the window of a classroom, its path is visible. This is due to _____of light. (reflection, scattering)
6. The particles in various forms are visible only under an ultramicroscope. A solution containing such particles is called _____. (true solution, colloidal solution)
7. The number of components in a binary solution are/is _____ (one / two)
8. The mixture of gases used by deep-sea divers is _____(helium-oxygen, oxygen-nitrogen)
9. Soil cannot store more nitrogen than it can hold. Hence soil is said to be in a state of _____.(saturation, unsaturation)
10. In an endothermic process, solubility increases with _____ in temperature. (increase, decrease)
11. Aquatic species are more comfortable in cold water because _____

    i). as the temperature decreases, the solubility of dissolved oxygen increases.

    ii) as the temperature increases, the solubility of dissolved oxygen increases.

    iii) as the temperature increases, the solubility of dissolved oxygen decreases.

PART - B

1. From the table given below, furnish your points of inference.

Substance	Solubility at $25^{o}C$
NaCl	36g
NaBr	95g
NaI	184g

2. Distinguish between the saturated and unsaturated solution at a temperature of $25^{o}C$ using the data given below (Note : Solubility of NaCl is 36g)

    i) 16g NaCl in 100g water ii) 36g NaCl in 100g water

3. *Differentiate true solution and colloidal solution.*

4. *You have prepared a saturated solution of sugar at room temperature. Is it possible to dissolve some more grams of sugar to this solution? Justify your answer.*

5. *Find the concentration of solution in terms of weight percent if 20g of common salt is dissolved in 50g of water.*

6. *Valli took some common salt, naphthalene balls, camphor, baking soda and washing soda. She attempted to dissolve these substances either in water or in acetone. Complete the table with the expected results.*

SUBSTANCE	MEDIUM IN WHICH IT IS SOLUBLE	REASON
a. Common salt		
b. Naphthalene balls		
c. Camphor		
d. Baking soda		
e. Washing soda		

7.

i) Which gas is dissolved in soft drinks?

ii) What will you do to increase the solubility of this gas?

8. *Beaker A has sugar mixed with water and Beaker B has starch dissolved in water.*

i) Which solution will scatter light?

ii) In which beaker does the Brownian movement take place?

iii) Name the type of solution that beaker A and beaker B contain.

iv) Which of the two solutions is homogeneous?

v) Identify the beaker that has particles of size 10 A^{o} to 2000 A^{o}.

9. *Name the type of solution formed in the following cases:*

i) 20g of NaCl in 100g of water. *ii) 36g of NaCl in 100g of water.*

iii) 45g of NaCl in 100g of water at 80°C. *iv) Sulphur dissolved in CS_2*

v) Nitrogen in soil.

10. *Give the dispersed phase and the dispersion medium in each of the following:*

a. cheese *b. soda water* *c. smoke*

11. Radha prepared a solution which could be separated by filtration.

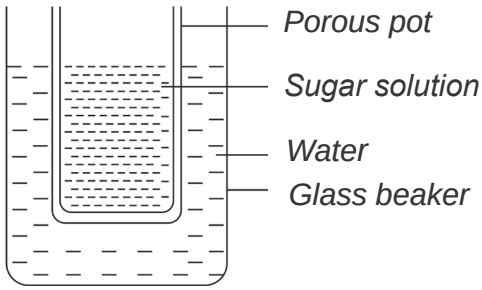
i) Name the type of solution.

ii) Is the solution transparent or opaque?

iii) Mention the nature of the solution.

iv) Mention the size of the solute particle.

12.



In the above case, Sekar observed that the water turned sweeter after sometime. Explain the reason for the same.

13. Beaker 'A' has chalk powder mixed with water and beaker 'B' has protein dissolved in water.

i) Which solution shows Brownian movement?

ii) Identify the solution that has particle size greater than 2000A^{o}.

iii) Which beaker contains colloidal solution?

iv) Mention the size of the particle present in beaker B.

v) Say whether colloidal solution is homogeneous or heterogeneous.

14. Justify the following statements with an explanation:

i) Solubility of calcium oxide decreases with increase in temperature.

ii) What happens to the solubility in exothermic process with regard to temperature?

iii) In endothermic process, solubility increases with increase in temperature.

iv) At a given temperature, increase in pressure increases the solubility of the gas.

FURTHER REFERENCE

Books: 1. Physical Chemistry by : Puri & Sharma - Vishal Publishing Co, Punjab.

2. Advanced Chemistry by: Bahl & Arun Bahl - S.Chand publishers, New Delhi.

3. Complete Chemistry(IGCSE) - Oxford University press, New York

Webliography: www.chemistry explained.com

Chapter 10

ATOMS AND MOLECULES

Rani shows a piece of chalk to Vani and asks her to break it into minute particles. The breaking spree, goes on and on endlessly and finally they conclude that the minutest particle is a group of invisible atoms. They wish 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. However, towards the end the 19th and the beginning of the 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.**

10.1. MODERN ATOMIC THEORY

The findings of **modern atomic theory** are given as follows:-

- An atom is the smallest particle which takes part in chemical reaction.
- An atom is considered to be a divisible particle.
- The atoms of the same element may not be similar in all respects.
  eg: Isotopes ($_{17}Cl^{35}$, $_{17}Cl^{37}$)
- The atoms of different elements may be similar in some respects.
  eg. Isobars ($_{18}Ar^{40}$, $_{20}Ca^{40}$)
- 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)
- The atoms of one element can be changed into the atoms of another element by transmutation.
- The mass of an atom can be converted into energy. This is in accordance with Einstein's equation $E = mc^2$.

E = Energy, m= mass, c= speed of light

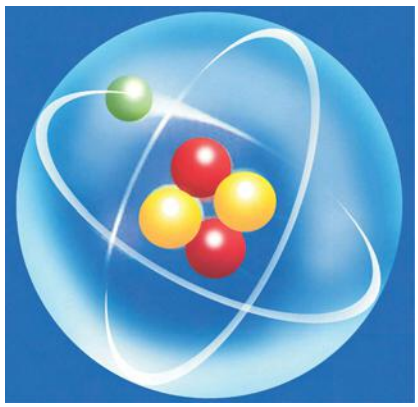
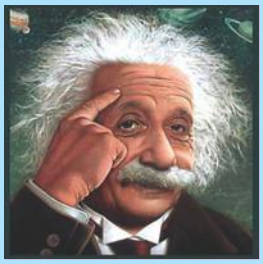


Fig. 10.1 Inner view of an Atom

ALBERT EINSTEIN



He related the mass of the substance converted into energy by an equation. When a nuclear reaction occurs, the mass of the product is found to be lesser 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 = mass and c = speed of light. This famous equation of Einstein caused a revolution in nuclear science.

10.2. AVOGADRO'S HYPOTHESIS

Amedeo Avogadro put forward a hypothesis based on the relation between the number of molecules and the volume of gases.

Avogadro's Law: Equal volumes of all gases under the same conditions of temperature and pressure contain an equal number of molecules.

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 compounds.
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.

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 : $({}_{6}C^{13}, {}_{7}N^{14})$

TO DEDUCE THE ATOMICITY OF ELEMENTARY GASES

Atomicity

The number of atoms present in one molecule of an element is called the atomicity of the element.

e.g.

$N_2 + O_2 \rightarrow 2\,NO$

Nitrogen Oxygen Nitric oxide

(1 Vol) (1 Vol) (2 Vols)

After applying Avogadro's Law, the equation,becomes

$N_2 + O_2 \rightarrow 2\,NO$

1 Molecule 1 Molecule 2 Molecules

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, the 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.

To establish the relationship between vapour density and relative molecular mass of a gas:

vi. **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.

$$\text{Relative molecular mass of a gas} = \frac{\text{Mass of 1 molecule of the gas or vapour}}{\text{Mass of 1 atom of hydrogen}}$$

vii. **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,

$$\text{V.D} = \frac{\text{Mass of 1 molecule of gas or vapour}}{2 \times \text{Mass of 1 atom of hydrogen}}$$

MORE TO KNOW

Avogadro, an Italian Scientist (1766 – 1856) was the one to propose that the volume of a gas at a given temperature and pressure is proportional to the number of particles.

$$2 \times \text{V.D} = \frac{\text{Mass of 1 molecule of gas or vapour}}{\text{Mass of 1 atom of hydrogen}}$$

2 x V.D = relative molecular mass of a gas or vapour

2 x Vapour density = Relative molecular mass

MORE TO KNOW

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

$$GMV\ OF\ OXYGEN = \frac{GMM\ of\ O_2}{DENSITY\ OF\ O_2}$$

$$= 32/1.429$$

$$= 22.4\ lit$$

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.

10.3. ATOMS AND MOLECULES

Atoms and molecules are the building blocks of 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. 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.

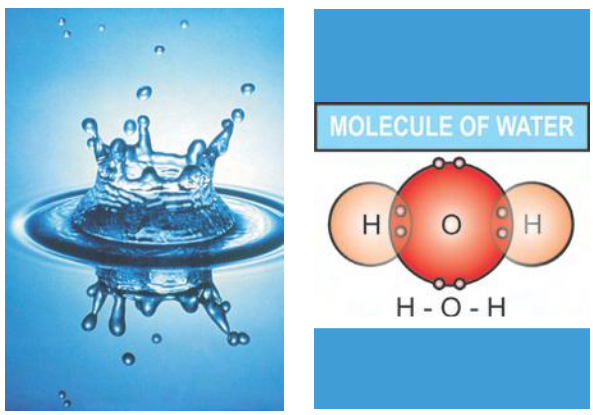


Fig 10.2 Molecule of Water

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 at STP.

A molecule can exist freely and it is a combined form of bonded units, whereas an atom is the singular smallest form of a non-bonded unit.

POINT TO EXPLORE

Name the elements and find the number of atoms in one molecule of: a) Nitrogen b) Water c) Ammonia d) Sulphuric acid.

10.3.3. Difference between an Atom and a 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.*

Types of Molecules :

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 polyatomic molecules showing that they contain one, two, three or more than three atoms respectively.

For any homo atomic molecule, atomicity can be deduced using the formula

$$\text{Atomicity} = \frac{\text{Molecular Mass}}{\text{Atomic mass}}$$

Atomicity	*No. of atoms per molecule*	*Example*
Monoatomic molecule	*1*	*Helium (He) Neon (Ne) Metals*
Diatomic molecule	*2*	*Hydrogen H_2 Chlorine Cl_2*
Triatomic molecule	*3*	*Ozone (O_3)*
Polyatomic molecule	*>3*	*phosphorous P_4 Sulphur S_8*

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.*

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)

$$\text{RAM} = \frac{\text{Mass of 1 atom of an element}}{\text{Mass of 1 atom of hydrogen}}$$

10.4.1. Definition (based on hydrogen scale)

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 - 12 scale)

$$\text{RAM} = \frac{\text{Mass of 1 atom of an element}}{\frac{1}{12}\text{ th part of the mass of one atom of carbon-12}}$$

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 -12.

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)

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.

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 1/12th part of mass of one atom of carbon - 12 .

Relative Molecular Mass is a pure ratio and has no unit. If the molecular mass of a given substance is expressed in grams, 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)

Calculations:

$$2(H) = 2 \times 1 = 2$$
$$1(O) = 1 \times 16 = 16$$
$$18$$

$\therefore$ **Gram molecular mass of H_2O= 18g**

2.Find the gram molecular mass of carbon dioxide (CO_2)

Calculations:

$$1(C) = 1 \times 12 = 12$$
$$2(O) = 2 \times 16 = 32$$
$$44$$

Gram molecular mass of CO_2 = 44 g

10.6. MOLE CONCEPT

To know the number of atoms or molecules involved in a reaction, the **concept of mole** was introduced. The quantity of a substance is expressed in terms of mole.

$N_A = 6.023 \times 10^{23}$

N_A = Avogadro number = 1 Mole

Shown here in Fig.10.3 is one mole quantity of each of the following materials: (clockwise from top left) 180g of aspirin, 18.0g of water, 342g of sucrose, 201g of

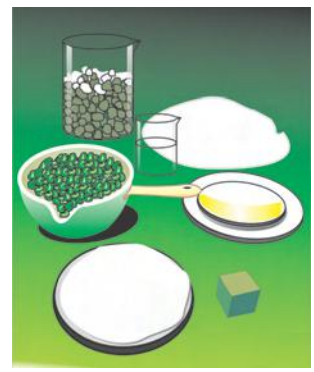


Fig. 10.3 Mole in various forms

mercury, 55.9g of iron, 58.5g of sodium chloride 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: The number of atoms or molecules or ions present in one mole of a substance is called Avogadro Number. Its value is $6.023 \times 10^{23.}$

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 used:

$$\text{Number of moles} = \frac{\text{Mass}}{\text{Atomic Mass}}$$

$$\text{Number of moles} = \frac{\text{Mass}}{\text{Molecular Mass}}$$

$$\text{Number of moles} = \frac{\text{No. of Atoms}}{6.023 \times 10^{23}}$$

$$\text{Number of moles} = \frac{\text{No. of Molecules}}{6.023 \times 10^{23}}$$

WATCH OUT !

It must 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 the 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 = atomic 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:*

Mass of a substance

$$= \frac{\text{gram molecular mass x number of particles}}{6.023 \times 10^{23}}$$

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 of 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 the 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.

Fig. 10.4 Illustrations of mole in various forms

MODEL 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 32 g. Density of Oxygen is 1.429 g/litre. Find the gram molar 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 = 1 g
   Gram atomic mass of Oxygen = 16 g
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.
7. _____ have equal number of neutrons.
   i) Isobars ii) Isotones iii) Isotopes iv) Mass Numbers
8. Classify the following based on atomicity:
   i) Chlorine ii) Neon iii) Phosphorous iv) Ozone
9. Identify and correct the mistake in each of the following:
   i) The molar volume of gas at STP is 22.4 cm^3.
   ii) 2 x R.M.M. = V.D.
   iii) An atom cannot exist independently.
   iv) The ratio of atoms in a molecule may be integral or simple or may not be fixed.
   v) H_2O is a homo atomic molecule.
10. Give a single term substitute for each of the following:
    i) 6.023×10^{23} molecules ii) 22.4 litres of gas at STP
    iii) 1/12th part of the mass of one atom of carbon
    iv) The half of relative molecular mass
    v) Molecular mass / atomic mass

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. *How will you establish the relation between vapour density and molecular mass of a gas by applying Avogadro's law?*
3. *Calculate the number of moles in:*

   i) 12.046 x 10^{23} atoms of Copper ii) 27.95g of Iron

   iii) 1.51 x 10^{23} molecules of CO_2
4. *Find the gram molecular mass of the following from the data given:*

   i) H_2O ii) CO_2 iii) NaOH iv) NO_2 v) H_2SO_4

ELEMENT	SYMBOL	ATOMIC No.	ATOMIC MASS
Hydrogen	H	1	1
Carbon	C	6	12
Oxygen	O	8	16
Nitrogen	N	7	14
Sodium	Na	11	23
Sulphur	S	16	32

5. *Complete the table given below:*

ELEMENT	ATOMIC MASS	MOLECULAR MASS	ATOMICITY
Chlorine	35.5	71	
Ozone		48	3
Sulphur	32		8

6. *Calculate the number of water molecules present in one drop of water which weighs 0.18 g.*
7. *Fill in the blanks using the given data:*

   The formula of Calcium oxide is CaO. The atomic mass of Ca is 40, Oxygen is 16 and Carbon is 12.

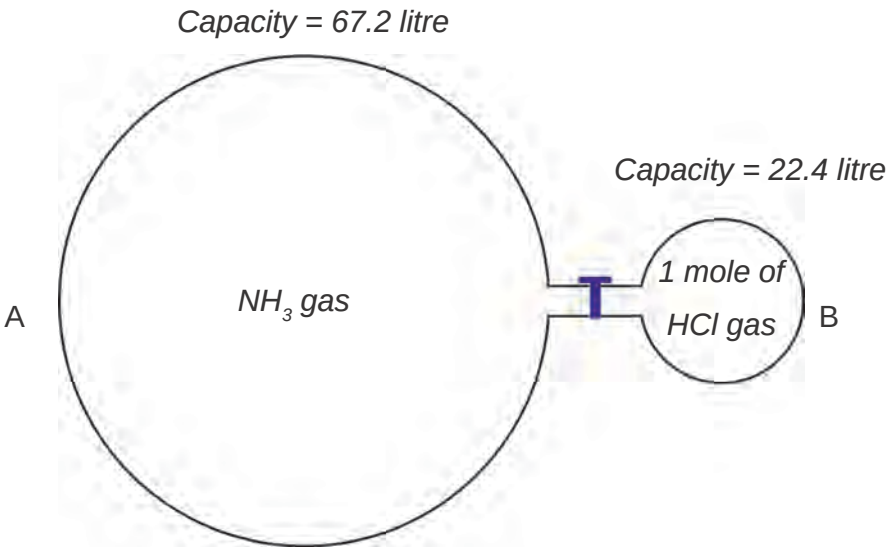
   i) 1 mole of Ca (____g) and 1 mole of Oxygen atom (___g) combine to form _____ mole of CaO (____g).

   ii) 1 mole of Ca (___g) and 1 mole of C (___g) and 3 moles of Oxygen atom (___g) combine to form 1 mole of $CaCO_3$ (___g)
8. *How many grams are there in:*

   i) 5 moles of water ii) 2 moles of Ammonia iii) 2 moles of Glucose

PART - C

1. When ammonia reacts with hydrogen chloride gas, it produces white fumes of ammonium chloride. The volume occupied by NH_3 in glass bulb A is three times more than the volume occupied by HCl in glass bulb B at STP.



i) How many moles of ammonia are present in glass bulb A?

ii) How many grams of NH_4Cl will be formed when the stopper is opened? (Atomic mass of N = 14, H = 1, Cl = 35.5)

iii) Which gas will remain after completion of the reaction?

iv) Write the chemical reaction involved in this process.

2. Nitro glycerine is used as an explosive. The equation for the explosive reaction is

$$\underset{(\ell)}{4C_3H_5((NO_3))_3} \longrightarrow \underset{(g)}{12CO_2} + \underset{(\ell)}{10H_2O} + \underset{(g)}{6N_2} + \underset{(g)}{O_2}$$

(Atomic mass of C = 12, H = 1, N = 14, O=16)

i) How many moles does the equation show for i) Nitroglycerine ii) gas molecules produced?

ii) How many moles of gas molecules are obtained from 1 mole of nitroglycerine?

iii) What is the mass of 1 mole of nitroglycerine?

3. Sodium bi carbonate breaks down on heating:

$$2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$$

(Atomic mass of Na = 23, C = 12, H = 1, O=16)

i) How many moles of sodium bi carbonate are there in the equation?

ii) What is the mass of sodium bicarbonate used in this equation?

iii) How many moles of carbon dioxide are there in this equation?

4. 40 g of calcium was extracted from 56 g of calcium oxide
(Atomic mass of Ca= 40, O=16)

i) What mass of oxygen is there in 56 g of calcium oxide?

ii) How many moles of oxygen atoms are there in this ?

iii) How many moles of calcium atoms are there in 40 g of calcium?

iv) What mass of calcium will be obtained from 1000 g of calcium oxide?

5. How many grams are there in the following?

i) 1 mole of chlorine molecule, Cl_2 ii) 2 moles of sulphur molecules, S_8

iii) 4 moles of ozone molecules, O_3 iv) 2 moles of nitrogen molecules, N_2

6. Find how many moles of atoms are there in:

i) 2 g of nitrogen. ii) 23 g of sodium iii) 40 g of calcium.

iv) 1.4 g of lithium v) 32 g of sulphur.

FURTHER REFERENCE

Books: 1. Physical Chemistry by : Puri & Sharma - Vishal Publishing Co, Punjab.
2. Inorganic Chemistry : P.L. Soni - S.Chand publication, New Delhi.
3. Complete Chemistry(IGCSE) - Oxford University press, New York

Webliography: www.chem4kids.com/tag/atomsandmolecules

Chapter 11

CHEMICAL REACTIONS

All living beings born in this beautiful world adopt and follow their own life styles. Have you observed and analyzed your daily life from the view point of a chemist? Chemical reactions take place around us, all the time and even in our body.

Any change can be classified as physical change or chemical change. Physical changes can be easily reversed but, it is not easy to reverse a chemical change. What is the reason? During chemical changes, new substances are formed and it is difficult to regenerate the original substances. Chemical changes are more permanent than physical changes. All chemical changes are accompanied by chemical reactions.

How do we come to know that a chemical reaction has taken place? Let us perform some activities to find out the answer to this question.

ACTIVITY 11.1

- *Look at the new silver anklet of your mother or sister.*
- *Note the colour of the anklet.*
- *Observe the colour of an old anklet.*
- *What change do you observe?*

The lustrous white colour of the silver anklet slowly changes into slightly black colour. We say, the silver anklet has got tarnished. Can you guess the reason behind it?

Fig. 11.1 Silver Anklet

It is due to the formation of silver sulphide (Ag_2S), as a result of the reaction between silver and hydrogen sulphide in the air.

ACTIVITY 11.2

- *Take lead nitrate solution in a beaker*
- *Take potassium iodide solution in a test tube.(Both solutions are colourless)*
- *Add potassium iodide solution slowly to the lead nitrate solution*
- *What do you observe?*

You observe a deep yellow precipitate, don't you?

It is lead iodide (PbI_2).

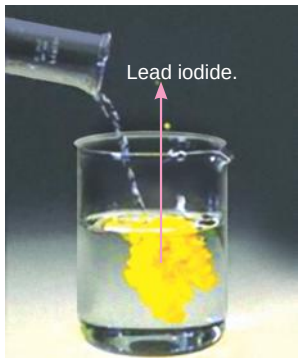


Fig. 11.2 Yellow precipitate of lead iodide.

ACTIVITY 11.3

- *Take 5g of calcium oxide (quick lime) in a beaker.*
- *Add water to it slowly.*
- *Touch the beaker.*
- *What do you feel?*

Do you feel the heat? Let us learn what happens.

Calcium oxide reacts with water to produce slaked lime (calcium hydroxide). This reaction is exothermic and is accompanied by a hissing sound and formation of bubbles, leading to the release of considerable amount of heat.

ACTIVITY 11.4

- *Take a pinch of calcium carbonate powder in a test tube.*
- *Add dilute hydrochloric acid.*
- *Note the changes that take place in the test tube carefully.*

Do you observe any brisk effervescence? It is due to the evolution of carbon dioxide gas.

Fig. 11.3 Reaction of calcium carbonate with dil.HCl

These are some of the common observations in a chemical reaction. From the activities that we have discussed, it is clear that chemical reactions bring about a permanent change, resulting in the formation of new product(s).

The substances taking part in the reaction are known as reactants and those formed as a result of the reaction are called products.

MORE TO KNOW

A solution of slaked lime produced in Activity 11.3 is used for white-washing. Calcium hydroxide reacts slowly with carbon dioxide in air to form a thin layer of calcium carbonate on the walls. Calcium carbonate is formed after two to three days of white-washing and gives a shiny finish to the walls. It is interesting to note that the chemical formula for marble is also $CaCO_3$.

11.1. TYPES OF CHEMICAL REACTIONS

Since there are numerous chemical reactions, the study of these reactions can be made easier by classifying them. All the chemical reactions are classified under six broad categories depending on how the product is formed.

Let us see the different types of classifications of chemical reactions.

1. Combination reaction

A combines with **B** to form a new product **AB**. It is the simple representation of combination reaction.

ACTIVITY 11.5

- *Take a clean piece of magnesium ribbon.*
- *Hold the ribbon with a pair of tongs.*
- *Burn it in air using a burner (keeping the Mg ribbon far away from your eyes).*
- *Collect the ash.*

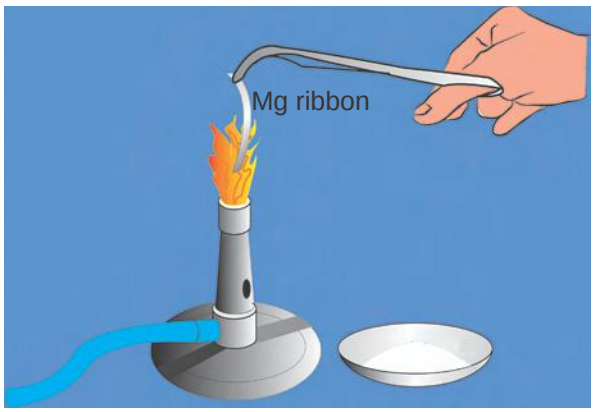


Fig. 11.4 Burning of Mg ribbon

In the above activity, magnesium combines with oxygen to form a single product, the magnesium oxide. **A reaction in which a single product is formed from two or more reactants is known as combination reaction.**

$$2Mg + O_2 \rightarrow 2MgO$$

Repeat "**Activity 11.3**". This reaction is also an example of COMBINATION REACTION. Now write the equation for the reaction.

Let us discuss some more examples of such combination reactions.

Combustion of coal

$$C + O_2 \rightarrow CO_2 \uparrow$$

Combustion of hydrogen

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

2. Decomposition reaction

AB splits into **A** and **B.** It is the representation of decomposition reaction.

ACTIVITY 11.6

- *Take about 2 g of copper carbonate powder in a dry test tube.*
- *Note the colour of copper carbonate.*
- *Heat the test tube over the flame.*
- *Observe the change after heating.*

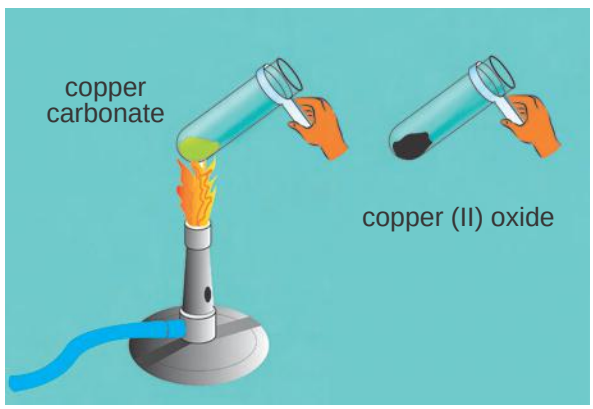


Fig. 11.5 Heating the test tube containing copper carbonate

Change of colour from green to black is observed. This is due to the decomposition of copper carbonate into copper (II) oxide.

$$CuCO_3 \xrightarrow{\Delta} CuO + CO_2 \uparrow$$

ACTIVITY 11.7

- *Take lead nitrate in a test tube.*
- *Heat it over the flame.*
- *Observe the changes.*

Liberation of a reddish brown gas (NO_2) is observed. This is because of the decomposition of lead nitrate into lead oxide, nitrogen dioxide and oxygen.

$$2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2\uparrow + O_2\uparrow$$

From the above two activities (11.6 and 11.7), it can be noticed that a **single compound breaks down to produce two or more substances. Such type of reaction is called decomposition reaction.**

A few more examples for decomposition reaction are:

1. Decomposition of lime stone

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2\uparrow$$

2. Decomposition of ammonium dichromate

$$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} Cr_2O_3\uparrow + N_2\uparrow + 4H_2O\uparrow$$

MORE TO KNOW

At a very high temperature,ammonium dichromate decomposes immediately into green vapour, which gets released along with the steam. It will appear as if a volcano erupts and is termed as chemical volcano.

3. Displacement Reaction

In the reaction between **A** and **BC, A** displaces **B** from **BC** to form **AC**. This shows that A is more reactive than **B**.

ACTIVITY 11.8

- *Take 20 ml of copper sulphate solution in a beaker.*
- *Drop an iron nail into the beaker.*
- *Leave it for a few days.*
- *Observe the colour of the copper sulphate solution and the iron nail.*

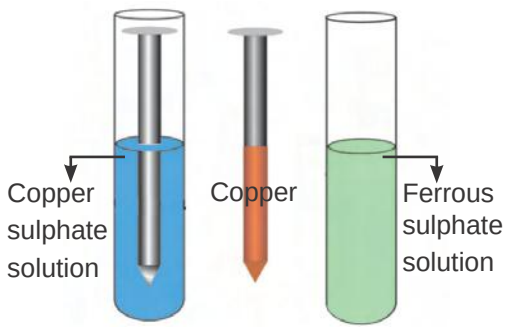


Fig. 11.6 Iron displaces copper from copper sulphate solution

Blue colour of the copper sulphate solution changes into green colour and the iron nail acquires a brownish colour. It is a noticeable change. Is it not? This change confirms that iron is more reactive than copper. The following chemical reaction takes place in this activity.

$$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$$

In this reaction, iron displaces copper from $CuSO_4$ solution.

Repeat "**Activity 11.8**" but use a zinc rod instead of an iron nail. What colour changes do you observe on the rod and in the solution? Write the chemical equation.

Here is another example:

$$Pb + CuCl_2 \rightarrow PbCl_2 + Cu$$

Lead can displace copper from its salt solution. Can copper displace zinc or lead from their salt solutions? No, because copper is less reactive than zinc and lead.

The reaction, in which, a more reactive element displaces a less reactive element from its compound is called displacement reaction.

4.Double Decomposition Reaction (Double Displacement Reaction)

In the reaction between **AB** and **CD**, both the reactants decompose to form **AD** and **CB** through the rearrangement of ions.

ACTIVITY 11.9

- *Take 5ml of sodium sulphate solution in a test tube.*
- *In another test tube, take 5ml of barium chloride.*
- *Mix both the solutions.*
- *What do you observe?*

Fig. 11.7 Formation of barium sulphate

You will observe the formation of a white substance, which is insoluble in water. The insoluble substance formed is known as *precipitate*. Any reaction that produces a precipitate is called a **precipitation reaction.** The white precipitate is barium sulphate. It is formed due to the reaction of SO_4^{2-} and Ba^{2+} ions. The other product formed is sodium chloride.

$$Na_2SO_4 + BaCl_2 \rightarrow BaSO_4\downarrow + 2NaCl$$

Repeat **"Activity 11.2"** for double decomposition reaction. Observe the reaction and write the equation.

Double Decomposition Reaction is the reaction in which exchange of ions between two reactants occurs, leading to the formation of two different products.

Other example :

$$CuSO_4 + H_2S \rightarrow CuS\downarrow + H_2SO_4$$

5. Oxidation and reduction

We are all aware of the fact that oxygen is the most essential element for sustenance of life. One can live without food or even water for a few days, but not without oxygen. In our day-to-day life, we come across various phenomena like fading of colours of clothes, burning of combustible substances like cooking gas, wood and coal, and also rusting of iron articles. All such processes fall into the category of a specific type of chemical reaction called oxidation – reduction reaction (redox reaction). A large number of industrial processes like electroplating and extraction of metals like aluminium are based on redox reaction.

Oxidation:

A chemical reaction which involves addition of oxygen or removal of hydrogen or loss of electron(s) is called Oxidation.

$2Mg + O_2 \rightarrow 2MgO$ (addition of oxygen)

$H_2S + Br_2 \rightarrow 2HBr + S$ (removal of hydrogen)

$Fe^{2+} \rightarrow Fe^{3+} + e^-$ (loss of electron)

Reduction:

A chemical reaction which involves addition of hydrogen or removal of oxygen or gain of electron(s) is called Reduction.

$2Na + H_2 \rightarrow 2NaH$ (addition of hydrogen)

$CuO + H_2 \rightarrow Cu + H_2O$ (removal of oxygen)

$Fe^{3+} + e^- \rightarrow Fe^{2+}$ (gain of electron)

Redox Reaction:

Redox reaction is a chemical reaction in which oxidation and reduction take place simultaneously.

$$Zn + CuSO_4 \rightarrow Cu + ZnSO_4$$

Write an equation of any other redox reaction.

During the conversion of copper(II) oxide to copper, the copper(II) oxide loses oxygen and is reduced. The hydrogen gains oxygen and is oxidised. In other words, one reactant gets oxidised while the other is reduced during the reaction. Such reactions are called oxidation-reduction reactions or redox reactions.

Oxidation is	Reduction is
Gain of oxygen	Loss of oxygen
Loss of hydrogen	Gain of hydrogen
Loss of electron(s)	Gain of electron(s)

Oxidation and reduction always takes place together, so the reaction is called redox reaction.

ALWAYS REMEMBER

Loss of electron is oxidation.(LEO)

Gain of electron is reduction.(GER)

The short forms in brackets will help you remember this.

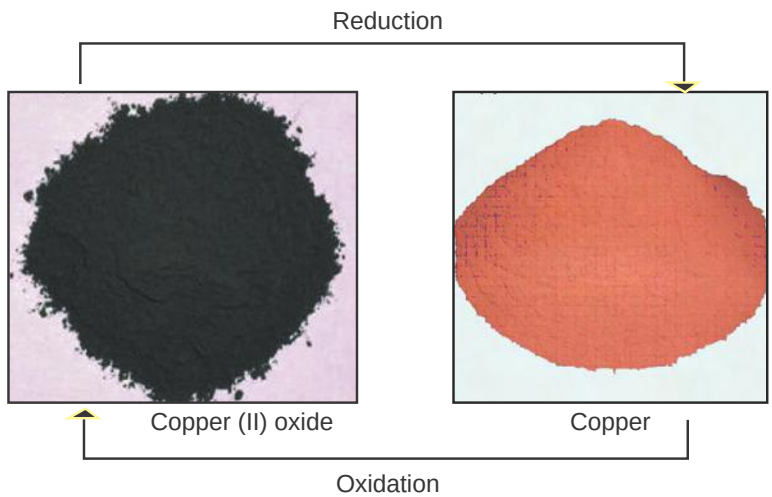


Fig. 11.8 Redox Reaction

MORE TO KNOW

Oxidation also has damaging effects on food and eatables. When food containing fat and oil is left as such for a long time, it becomes stale. The stale food develops bad taste and foul smell. This is very common in curd or cheese, particularly in summer. Oils and fats are slowly oxidised to certain foul-smelling compounds.

6. Exothermic and endothermic reactions

During chemical reactions, one of the most common changes is a change in temperature. When detergent is dissolved in water to wash clothes, heat is given out. When glucose is kept on our tongue, a cooling effect is felt. During these processes, heat is either given out to the surrounding or absorbed from the surrounding. In the same way, in most of the chemical reactions, energy is either taken in or given out.

a. Exothermic Reactions

The chemical reactions which take place with the evolution of heat energy are called exothermic reactions.

$$N_2 + 3H_2 \rightarrow 2NH_3 + \text{Heat}$$

All combustion reactions are exothermic. Heat energy is liberated as the reaction proceeds.

b. Endothermic Reactions

The chemical reactions which take place with the absorption of heat energy are called endothermic reactions.

$$\mathbf{2NH_3 + Heat \rightarrow N_2 + 3H_2}$$

11.2 THE RATE OF CHEMICAL REACTION

The rate of chemical reaction is defined as the change in concentration of any one of the reactants or product per unit time.

Consider the reaction

$$A \rightarrow B$$

Rate of the reaction is given by

$$\text{Rate} = -\frac{d[A]}{dt} = +\frac{d[B]}{dt}$$

[A] - concentration of reactant A

[B] - concentration of product B

- ve sign indicates decrease in concentration of A with time.

+ve sign indicates increase in concentration of B with time.

11.2.1 Factors influencing the rate of the chemical reaction

ACTIVITY 11.10

- *Take magnesium ribbon in two test tubes A and B.*
- *Add hydrochloric acid to test tube A.*
- *Add acetic acid to test tube B.*
- *Observe the changes in both the test tubes.*

1. Nature of the reactants

Magnesium ribbon reacts with both hydrochloric acid and acetic acid but reaction is faster in hydrochloric acid than in acetic acid. Do you know why? Hydrochloric acid is more reactive than acetic acid. It shows that **the nature of the reactant influences the rate of the reaction**.

2. Concentration of the Reactants

ACTIVITY 11.11

- *Take 3g of granulated zinc in test tubes A and B.*
- *Add 5 ml of 1 M hydrochloric acid in test tube A.*
- *Add 5 ml of 2 M hydrochloric acid in test tube B.*
- *Observe the changes.*

Granulated zinc reacts with both 1M hydrochloric acid and 2M hydrochloric acid. The rate of evolution of hydrogen gas is more in test tube B than in test tube A. This is because 2M hydrochloric acid is more concentrated than 1M hydrochloric acid. That is, **the greater the concentration of the reactant, the greater will be the rate of the reaction.**

3. Surface Area of the Reactants

ACTIVITY 11.12

- *Take powdered calcium carbonate in beaker A.*
- *Take marble chips (calcium carbonate) in beaker B.*
- *Add hydrochloric acid to both the beakers.*
- *Observe the changes.*

Powdered calcium carbonate reacts more quickly with hydrochloric acid than marble chips. What is the reason?.

Powdered calcium carbonate offers large surface area for the reaction to occur at a faster rate. **This shows that the greater the surface area, the greater is the rate of the reaction.**

4. Temperature

ACTIVITY 11.13

- *Take 3g of marble chips in a beaker.*
- *Add 5 ml of 1M hydrochloric acid.*
- *Observe the changes.*
- *Heat the beaker.*
- *Observe the changes.*

Calcium carbonate present in the marble chips react slowly with hydrochloric acid at room temperature and evolves carbon dioxide at a slower rate, whereas on heating, the evolution of carbon dioxide is faster. **This shows that increase in temperature increases the rate of the reaction.**

5. Catalyst

ACTIVITY 11.14

- *Take potassium chlorate in a test tube.*
- *Heat the test tube.*
- *Observe what happens.*
- *Add manganese dioxide as a catalyst.*
- *Observe the changes.*

When potassium chlorate is heated, oxygen is evolved very slowly, whereas after the addition of manganese dioxide to the reactant, oxygen is liberated at a faster rate. **This shows that manganese dioxide acts as a catalyst and influences the rate of the reaction.**

GROUP ACTIVITY

- *From dawn to dusk observe any 10 chemical changes that take place around you and classify them.*
- *Prepare a table model of a volcano using ammonium dichromate (vigorous)*
- *Prepare a table model of a volcano using baking soda (silent).*

MORE TO KNOW

A substance which alters the rate of reaction without undergoing any change in mass and composition is known as catalyst.

ACIDS, BASES AND SALTS

Nivi :	*Hai Vini, you look tired. Take this fresh lime juice.*
Vini :	*No, it has a sour taste.*
Nivi :	*Do you know why it is sour?*
Vini :	*Sorry, I have no idea.*
Nivi :	*It is due to the presence of acid. Let's learn more about this.*

Acids, bases and salts are used in everyday life. Let it be a fruit juice or a detergent or a medicine. They play a key role in our day-to-day activities. Our body metabolism is carried out by means of hydrochloric acid secreted in our stomach.

11.3. ACIDS

Acid is a substance which furnishes H^+ ions or H_3O^+ ions when dissolved in water. Acids have one or more replaceable hydrogen atoms. The word 'acid' is derived from the Latin name 'acidus' which means sour taste. Substances with 'sour taste' are acids. Lemon juice, vinegar and grape juice have sour taste, so they are acidic. They change blue litmus to red. They are colourless with phenolphthalein and pink with methyl orange. Many organic acids are naturally present in food items.

Fig. 11.9 Acid solution turns blue litmus paper red

11.3.1 Classification of Acids

1. **Based on their sources :** Acids are classified into two types, namely, organic acids and inorganic acids.

   Organic Acids:- Acids present in plants and animals (living things) are **organic acids** e.g. HCOOH, CH_3COOH (Weak acids).

   Inorganic Acids:- Acids in rocks and minerals are **inorganic acids** or mineral acids e.g. HCl, HNO_3, H_2SO_4 (Strong acids).

2. Based on their Basicity

Monobasic Acid: - It is an acid which gives one hydrogen ion per molecule of the acid in solution, e.g. HCl, HNO_3.

Dibasic Acid:- It is an acid which gives two hydrogen ions per molecule of the acid in solution, e.g. H_2SO_4, H_2CO_3.

Tribasic Acid:- It is an acid which gives three hydrogen ions per molecule of the acid in solution, e.g. H_3PO_4

Source	Acid present
Apple	*Malic acid*
Lemon	*Citric acid*
Grape	*Tartaric acid*
Tomato	*Oxalic acid*
Vinegar (food preservative)	*Acetic acid*
Curd	*Lactic acid*

MORE TO KNOW

For acids, we use the term basicity which refers to the number of replaceable hydrogen atoms present in one molecule of an acid. For example, acetic acid has four hydrogen atoms but only one can be replaced. Hence it is monobasic.

3. Based on Ionisation

Acids are classified into two types based on ionisation.

Strong Acids:- These are acids which ionise completely in water, e.g.HCl.

Weak Acids:-These are acids which ionise partially in water, e.g. CH_3COOH.

4. Based on Concentration:- Based on the percentage or amount of acid dissolved in water, acids are classified into concentrated acids and dilute acids.

Concentrated Acid:- It is an acid having a relatively high percentage of acid in its aqueous solution.

Dilute Acid:- It is an acid having a relatively low percentage of acid in its aqueous solution.

MORE TO KNOW

Care must be taken while mixing any concentrated mineral acid with water. The acid must always be added slowly to water with constant stirring. If water is added to a concentrated acid, a large amount of heat is generated. The mixture splashes out of the container and it may cause burns.

11.3.2 Chemical Properties of Acids

1. Reaction of Metals with Acid

Note that zinc reacts with dilute hydrochloric acid to form zinc chloride and hydrogen gas.

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

When a burning candle is brought near a bubble containing hydrogen gas, the

ACTIVITY 11.15

- *Take 5 g of zinc granules in a test tube.*
- *Add 10 ml of dilute hydrochloric acid through a thistle funnel.*
- *During the course of addition, what do you observe?*

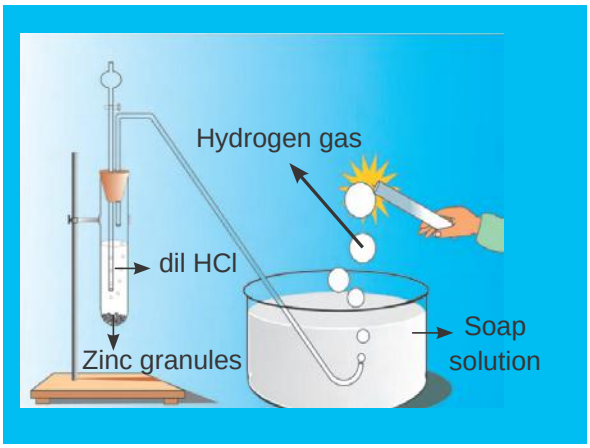


Fig. 11.10 Reaction of Zn granules with dilute HCl

flame goes off with a '**popping**' sound. This confirms that metal displaces hydrogen from the dilute acid. (Hydrogen gas burns with a '**popping**' sound)

Metal + Acid → Salt + Hydrogen

Another example:

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2\uparrow$$

MORE TO KNOW

Few metals do not liberate hydrogen gas on reaction with acids. eg. Ag,Cu.

Lime stone, chalk and marble are different physical forms of calcium carbonate. They react with acids giving the corresponding salt, carbon dioxide and water.

2. Reaction of Metal carbonate and Metal bicarbonate with Acids

ACTIVITY 11.16

- *Take two test tubes. Label them I and II.*
- *Take a small amount of washing soda (Na_2CO_3) in test tube-I and a small amount of baking soda ($NaHCO_3$) in test tube-II.*
- *Add dilute hydrochloric acid to both the test tubes.*
- *What do you observe?*
- *Pass the gas produced in each case, through lime water $Ca(OH)_2$ solution and record your observations.*

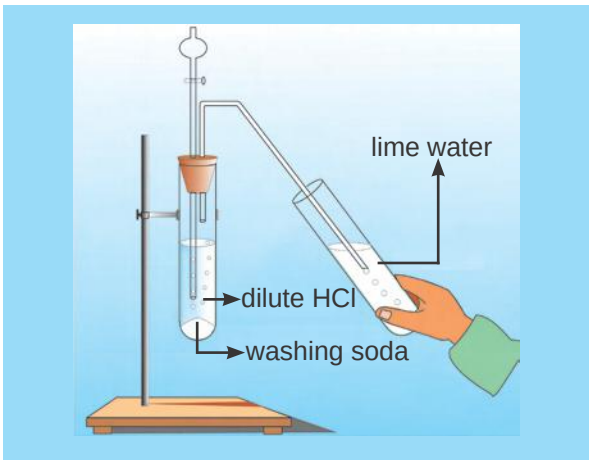


Fig. 11.11 Testing of carbon dioxide

Test tube I

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

Test tube II

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

When carbon dioxide is passed through lime water, it turns milky.

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

(milky)

From the activity 11.16 the reaction can be summarized as:

Metal carbonate or metal bicarbonate + acid → salt + water + carbon dioxide. Some other examples:

$MgCO_3 + 2\ HCl \rightarrow MgCl_2 + H_2O + CO_2\uparrow$

$Mg(HCO_3)_2 + 2\ HCl \rightarrow MgCl_2 + 2H_2O + 2CO_2\uparrow$

MORE TO KNOW

Since metal carbonates and metal bicarbonates are basic, they react with acids to give salt and water with the liberation of carbon dioxide.

3. Reaction of Metallic oxides with Acids

ACTIVITY 11.17

- *Take about 2g copper (II) oxide in a watch glass and slowly add dilute hydrochloric acid to it.*
- *Note the colour of the salt.*
- *What has happened to the copper (II) oxide?*

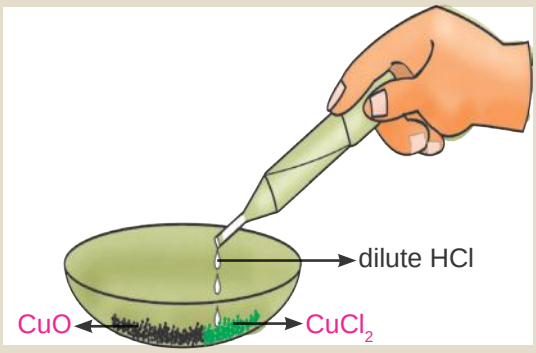


Fig. 11.12 Reaction of copper(II) oxide with dilute hydrochloric acid

The colour changes from **black to green.** This is due to the formation of copper (II) chloride in the reaction. Since metal oxides are basic, they react with acid to form salt and water.

$$CuO + 2HCl \rightarrow CuCl_2 + H_2O$$

From the above activity, we conclude that

Metallic oxide + Acid → Salt + Water

Another example is

$$CaO + 2HCl \rightarrow CaCl_2 + H_2O$$

4 . Action of Acids with Water

An acid produces hydrogen ions in water.

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

Hydrogen ions cannot exist alone, but they exist in the form of hydronium (H_3O^+) ions. When water is absent, the separation of hydrogen ions from an acid does not occur.

11.3.3. Uses of Acids

1. Sulphuric acid (King of chemicals) is used in car batteries and in the preparation of many other compounds.
2. Nitric acid is used in the production of ammonium nitrate which is used as a fertilizer in agriculture.
3. Hydrochloric acid is used as a cleansing agent in toilets.
4. Tartaric acid is a constituent of baking powder.
5. Salt of benzoic acid (sodium benzoate) is used in food preservation.
6. Carbonic acid is used in aerated drinks.

MORE TO KNOW

The atmosphere of Venus is made up of thick white and yellowish clouds of sulphuric acid. Do you think, life can exist on this planet?

11.4. BASES

Base is a substance which releases hydroxide ions(OH^-) when dissolved in water. It is bitter in taste and soapy to touch (e.g. washing soda, caustic soda and caustic potash). They change red litmus to blue. They are pink with phenolphthalein and yellow with methyl orange.

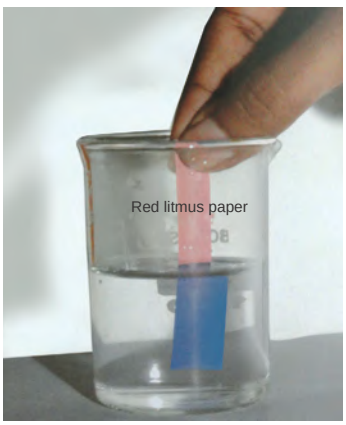


Fig. 11.13 Bases turns red litmus paper blue

11.4.1. Classification of Bases

1. Based on Ionisation

Strong Bases:- These are bases which ionise completely in aqueous solution e.g.NaOH, KOH.

Weak Bases:- These are bases which ionise partially in aqueous solution. e.g. NH_4OH, $Ca(OH)_2$.

2. Based on their Acidity

Monoacidic Base:- It is a base which ionises in water to give one hydroxide ion per molecule. e.g.NaOH, KOH.

Diacidic Base:- It is a base which ionises in water to give two hydroxide ions per molecule. e.g. $Ca(OH)_2$, $Mg(OH)_2$.

Triacidic Base:- It is a base which ionises in water to give three hydroxide ions per molecule. e.g. $Al(OH)_3$, $Fe(OH)_3$.

MORE TO KNOW

The term acidity is used for base, which means the number of replaceable hydroxyl groups present in one molecule of a base.

3. Based on Concentration:

Depending on the percentage or amount of base dissolved in water, bases are classified as concentrated alkali and dilute alkali.

Concentrated Alkali:- It is an alkali having a relatively high percentage of alkali in its aqueous solution.

Dilute Alkali:- It is an alkali having a relatively low percentage of alkali in its aqueous solution.

MORE TO KNOW

Bases which dissolve in water are called alkalies. All alkalies are bases, but not all bases are alkalis. NaOH and KOH are alkalies, whereas $Al(OH)_3$ and $Zn(OH)_2$ are bases.

11.4.2. Chemical Properties Of Bases

1. Reaction of Base with Metals

Zinc reacts with sodium hydroxide to form sodium zincate with the liberation of hydrogen gas.

$$Zn + 2\,NaOH \rightarrow Na_2ZnO_2 + H_2\uparrow$$

Metal + Base → Salt + Hydrogen

MORE TO KNOW

Few metals do not react with sodium hydroxide, e.g. Cu, Ag, Cr.

Another example is

$$2\,Al + 2\,NaOH + 2\,H_2O \rightarrow 2\,NaAlO_2 + 3\,H_2\uparrow$$

2. Reaction of Non-metallic oxides with Bases

Sodium hydroxide reacts with carbon dioxide and gives sodium carbonate and water.

$$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

The above reaction indicates that

Non metallic oxide + Base → Salt + Water

Another example is

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

3. Action of Bases with Water

Bases generate hydroxide (OH^-) ions when dissolved in water.

$$NaOH \rightarrow Na^+ + OH^-$$

4. Reaction of acids with bases

In the activity 11.18, the effect of a base is nullified by an acid.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

ACTIVITY 11.18

- *Take 20 ml of 0.1N sodium hydroxide solution in a conical flask and add a few drops of phenolphthalein.*
- *What colour do you observe?*
- *Add 20 ml of 0.1N hydrochloric acid solution to the conical flask drop by drop.*
- *Do you observe any colour change in the reaction mixture?*

The above reaction between an acid and a base is known as neutralisation reaction.

Acid + Base → Salt + Water

11.4.3 Uses of Bases

1. Sodium hydroxide is used in the manufacture of soap.
2. Calcium hydroxide is used in white-washing buildings.
3. Magnesium hydroxide is used as a medicine for stomach disorder.
4. Ammonium hydroxide is used to remove grease stains from clothes.

Fig. 11.14 Reaction of sodium hydroxide with hydrochloric acid

11.5. IDENTIFICATION OF ACIDS AND BASES

ACTIVITY 11.19

- *Collect lemon juice, washing soda solution, soap solution and soft drinks.*
- *Take 2 ml of each solution in a test tube and test with a litmus paper or indicator.*
- *What change in colour do you observe with red litmus, blue litmus, phenolphthalein and methyl orange?*
- *Tabulate your observations.*

Sample solution	Red litmus	Blue litmus	Phenolphthalein	Methyl orange
Lemon juice				
Washing soda solution				
Soap solution				
Soft drinks				

The same activity can be repeated for dilute hydrochloric acid, dilute sulphuric acid, sodium hydroxide solution and potassium hydroxide solution with the help of your teacher.

INDICATOR	COLOUR IN ACID	COLOUR IN BASE
Litmus	red	blue
Phenolphthalein	colourless	pink
Methyl orange	pink	yellow

11.6. p^H SCALE

p^H stands for the power of hydrogen ion concentration in a solution. p^H values decide whether a solution is acidic or basic or neutral. p^H scale was introduced by S.P.L. Sorenson. It is mathematically expressed as

$$p^H = -\log_{10}[H^+]$$

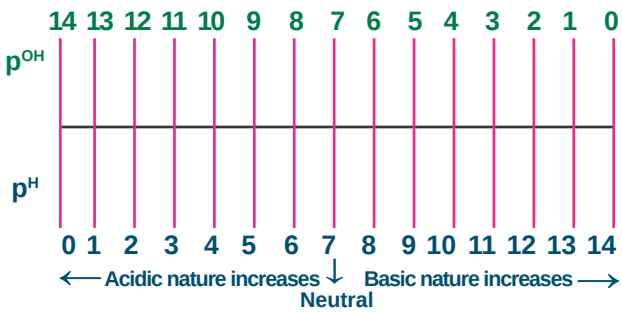
For neutral solution $[H^+] = 10^{-7}M$; $p^H = 7$

For acidic solution $[H^+] > 10^{-7}M$; $p^H < 7$

For basic solution $[H^+] < 10^{-7}M$; $p^H > 7$

When OH^- ions are taken into account, the p^H expression is replaced by p^{OH}

$$p^{OH} = -\log_{10}[OH^-]$$



Problems

1. The hydrogen ion concentration of a solution is 0.001M. What is the p^H of the solution?

Solution

$p^H = -\log_{10} [H^+]$

$p^H = -\log_{10} (0.001)$

$p^H = -\log_{10} (10^{-3})$

$= -(-3) \log_{10} 10$ [$\log 10 = 1$]

$p^H = 3$

2. The hydrogen ion concentration of a solution is 1.0×10^{-9} M. What is the p^H of the solution? Find out whether the given solution is acidic, basic or neutral.

Solution

$p^H = -\log_{10} [H^+]$

$p^H = -\log_{10} (1.0 \times 10^{-9})$

$p^H = -(\log_{10}1.0 + \log_{10}10^{-9})$ [$\log_{10} 1 = 0$]

$= -(0 - 9 \log_{10} 10)$

$p^H = -(0 - 9) = 9$

$p^H = 9$ ie $p^H > 7$

Therefore, the given solution is basic.

3. The hydroxide ion concentration of a solution is 0.001M. What is the p^H of the solution?

Solution

$p^{OH} = -\log_{10}[OH^-]$

$p^{OH} = -\log_{10} (10^{-3})$

$p^{OH} = 3$

$p^H = 14 - p^{OH}$

$p^H = 14 - 3 = 11$

$p^H + p^{OH} = 14$

$p^H = 14 - p^{OH}$

4. The hydroxide ion concentration of a solution is 1.0×10^{-9} M. What is the p^H of the solution?

Solution

$p^{OH} = -\log_{10}[OH^-]$

$p^{OH} = -\log_{10} (1.0 \times 10^{-9})$

$p^{OH} = 9$

$p^H = 14 - p^{OH}$

$p^H = 14 - 9 = 5$

11. 6.1. P^H Paper

a more common method of measuring p^H in a school laboratory is by using p^H paper. p^H paper contains a mixture of indicators, which gives different colours across the entire p^H range. p^H value of the various solutions are given in the table.

$p^H = -\log_{10} [H^+]$

$p^H = \log_{10} \left[\frac{1}{H^+}\right]$

$[H^+] = 10^{-pH}$

$[H^+] = 1 \times 10^{-7}$; $p^H = 7$

$[H^+] = 1 \times 10^{-2}$; $p^H = 2$

$[H^+] = 1 \times 10^{-14}$; $p^H = 14$

Solution	Approximate p^H
Lemon juice	2.2 – 2.4
Tomato juice	4.1
Coffee	4.4 - 5.5
Human saliva	6.5 - 7.5
Household ammonia	12.0

Fig. 11.15 p^H paper

ACTIVITY 11.20

- *Take lemon juice, orange juice, 1M NaOH, 1M HCl, pure water and vinegar.*
- *Dip p^H paper into these solutions.*
- *Observe the changes.*

Sl. No.	*Sample*	*Colour of p^H paper*	*Approximate p^H*	*Nature of substance*
1.	*Lemon juice*			
2.	*Orange juice*			
3.	*1M NaOH*			
4.	*1M HCl*			
5.	*Pure H_2O*			
6.	*Vinegar*			

11.6.2. Importance of p^H in Everyday Life

1. p^H in Human Body

(i) Using p^H factor, the general health condition of our body can be examined. At p^H level 6.9, the body becomes prone to viral infections like cold, cough and flu. Cancer cells thrive inside the body at a p^H of 5.5.

(ii) The p^H of a normal, healthy human skin is 4.5 to 6. Proper skin p^H is essential for a healthy complexion.

(iii) p^H of stomach fluid is approximately 2.0. This fluid is essential for the digestion of food.

(iv) Human blood p^H range is 7.35 to 7.45. Any increase or decrease in this value, leads to diseases. The ideal pH for blood is 7.4.

(v) p^H of saliva normally ranges between 6.5 to 7.5.

(vi) White enamel coating of our teeth is calcium phosphate, the hardest substance in our body. It does not dissolve in water. If p^H of mouth falls below 5.5, the enamel gets corroded. Toothpastes which are generally basic and used for cleaning the teeth can neutralize the excess acid and prevent tooth decay.

2. p^H of Soil

In agriculture, the p^H of soil is very important. Citrus fruits require slightly alkaline soil, while rice requires acidic soil and sugarcane requires neutral soil.

3. p^H of Rain Water

p^H of rain water is approximately 7 showing the high level of its purity and neutrality. If rain water is polluted by SO_2 and NO_2, acid rain occurs, bringing the p^H value less than 7.

11.7. SALT

When you say salt, you may think of the white stuff sprinkled on chips, but that is just one kind of salt called common salt. There are many other salts used in other fields. Salts are the products of the reaction between acids and bases (see reaction of acids and bases). Salts produce positive ions and negative ions when dissolved in water.

11.7.1. Classification of Salts

1. Normal Salts

A normal salt is obtained by complete neutralization of an acid by a base.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

2. Acid Salts

Acid salts are derived from the partial replacement of hydrogen ions of an acid by a metal. When a calculated amount of a base is added to a polybasic acid, acid salt is obtained, as follows:

$$NaOH + H_2SO_4 \rightarrow NaHSO_4 + H_2O$$

3. Basic Salts

Basic salts are formed by the partial replacement of hydroxide ions of a diacidic or triacidic base with an acid radical.

$$Pb(OH)_2 + HCl \rightarrow Pb(OH)Cl + H_2O$$

(Diacidic base) Basic salt

A basic salt may further react with an acid to give a normal salt.

4. Double Salts

Double salts are formed by the combination of the saturated solution of two simple salts in equimolar ratio followed by crystallization. e.g. potash alum

11.7.2. Uses of Salts

Common Salt (NaCl)

It is used in our daily food and also as a preservative.

Washing Soda (Na_2CO_3)

1. It is used in softening hard water.
2. It is used as a cleaning agent for domestic purposes.

Baking Soda ($NaHCO_3$)

1. It is used in making of baking powder, which is a mixture of baking soda and tartaric acid. Baking powder is used to make cakes and bread, soft and spongy
2. It is an ingredient in antacid. Being alkaline, it neutralises excess of acidity in the stomach.

Bleaching Powder ($CaOCl_2$)

1. It is used for disinfecting drinking water to make it free from micro-organisms.
2. It is used for bleaching cotton and linen in the textile industry.

Plaster of Paris($CaSO_4 . ½H_2O$)

It is used for plastering fractured bones and in making casts for statues.

GROUP ACTIVITY

Prepare the following salts in the laboratory:

1. Sodium chloride 2. Potash alum

MODEL EVALUATION

PART - A

1. $Zn + 2HCl \rightarrow ZnCl_2 + H_2 \uparrow$

   The above reaction is an example of _____ .

   i) Combination reaction ii) Double displacement reaction

   iii) Displacement reaction iv) Decomposition reaction.

2. A reddish brown coloured element 'X' on heating in air, becomes a black coloured compound 'Y'. X and Y are_____ and _____(Cu, CuO / Pb, PbO).

3. A student tests the p^H of pure water using a p^H paper. It shows green colour. If a p^H paper is used after adding lemon juice to water, what colour will he observe? (Green / Red / Yellow)

4. Chemical volcano is an example of _____ .
   (combination reaction / decomposition reaction)

5. When crystals of lead nitrate on heating strongly produces _____ gas and the colour of the gas is _____.

6. When aqueous solution of silver nitrate and sodium chloride are mixed, _____ precipitate is immediately formed (white / yellow / red).

7. Aluminium can displace Zinc metal from aqueous solution of Zinc sulphate because_____
   (zinc is more reactive than aluminium / aluminium is more reactive than zinc).

8. To protect tooth decay, we are advised to brush our teeth regularly. The nature of the tooth paste commonly used is _____ in nature.

9. Vinegar is present in acetic acid. Curd contains _____ acid.
   (Lactic acid / Tartaric acid).

10. $p^H = - \log_{10} [H^+]$. The p^H of a solution containing hydrogen ion concentration of 0.001M solution is _____ (3 / 11 / 14)

PART - B

1. What type of chemical reaction takes place when i) limestone is heated? ii) a magnesium ribbon is burnt in air?

2. The p^H values of certain familiar substances are given below:

Substance	p^H value
Blood	7.4
Baking soda	8.2
Vinegar	2.5
Household ammonia	12

Analyse the data in the table and answer the following questions:

i) Which substances are acidic in nature?

ii) Which substances are basic in nature?

3. *Why does the colour of copper sulphate change when an iron nail is kept in it? Justify your answer.*

4. *The hydroxide ion concentration of a solution is 1.0 x 10^{-8}M. What is the p^H of the solution?*

5. *Equal lengths of magnesium ribbons are taken in test tubes A and B. Hydrochloric acid is added to test tube A, while acetic acid is added to test tube B. The amount and concentration taken for both the acids are same. In which test tube does the reaction occur more vigourously and why?*

6. *Two acids 'A' and 'B' were kept in beakers. Acid 'A' undergoes partial dissociation in water, whereas acid 'B' undergoes complete dissociation in water.*

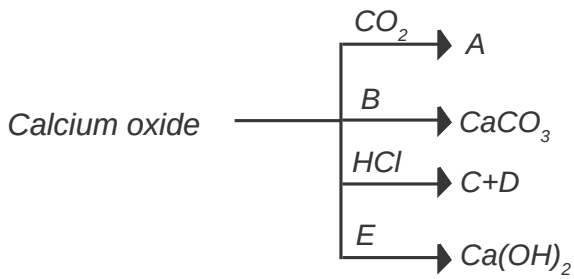
i) Of the two acids 'A' and 'B' , which is weak acid and which is strong acid?

ii) What is a weak acid?

iii) What is a strong acid?

iv) Give one example each.

7. *Observe the given chemical change and answer the following:*



i) Identify 'A' and 'B'.

ii) Write the commercial name of calcium hydroxide.

iii) Identify products 'C' and 'D' , when HCl is allowed to react with calcium oxide.

iv) Say whether calcium oxide is acidic or basic.

8. *Take copper nitrate in a test tube and heat it over the flame.*

i) What is the colour of cupric nitrate?

ii) What do you observe?

iii) Name the type of reaction that takes place.

iv) Write the balanced equation.

9. *Identify the wrong statements and correct them.*

   i) Sodium benzoate is used in food preservative.

   ii) Nitric acid is not used as fertilizer in agriculture.

   iii) Sulphuric acid is called the king of chemicals.

   iv) The P^H of acid is greater than 7.

   v) Acetic acid is used in aerated drinks.

10. *Redox reactions are reactions during which electron transfer takes place. Here magnesium atom transfers two electrons one each to the two chlorine atoms.*

   i) What are the products of this reaction?

   ii) Write the balanced equation for the complete reaction.

   iii) Which element is being oxidized?

   iv) Which element is being reduced?

   v) Write the reduction part of the reaction.

11. *Suggest a reason for each observation given below.*

   i) In fireworks, powdered magnesium is used rather than magnesium ribbon.

   ii) Zinc and dilute H_2SO_4 react much more quickly when a few drops of copper sulphate solutions are added.

   iii) The reaction between magnesium carbonate and dilute hydrochloric acid speeds up when some concentrated HCl is added.

12. *Sodium hydroxide and hydrochloric acid react as shown in this equation.*

$$\underset{(aq)}{NaOH} + \underset{(aq)}{HCl} \longrightarrow \underset{(aq)}{NaCl} + \underset{(l)}{H_2O}$$

   i) Which type of chemical reaction is this?

   ii) The reaction is exothermic. Explain what that means.

   iii) Differentiate exothermic reaction and endothermic reaction.

   iv) What happens to the temperature of the solution as the chemicals react?

13. *Take two conical flasks. Label them as I and II. Take a small amount of copper sulphate solution in the first conical flask. Take a small amount of granulated zinc in the second conical flask. Allow the copper sulphate solution to react with the zinc.*

   i) Name the type of reaction.

   ii) Say whether the metal zinc is more reactive or less reactive.

   iii) Write the complete and balanced reaction.

   iv) Say whether this change is reversible or irreversible.

14. Relate the information given in all the four columns of the table.

Compound	Chemical formula	Chemical name	Use
1. Washing soda	$CaOCl_2$	calcium sulphate hemihydrate	for making statues
2. Baking soda	Na_2CO_3	sodium bicarbonate	softening of hard water
3. Bleaching powder	$CaSO_4 . ½ H_2O$	sodium carbonate	for making cake
4. Plaster of paris	$NaHCO_3$	calcium oxy chloride	bleaching

15. When lead powder is added to copper chloride solution, a displacement reaction occurs and solid copper is formed.

i) Write the equation for the reaction.

ii) Why does the displacement reaction occur?

16. When zinc and copper (II) sulphate are heated together, the following redox reaction occurs:

$$Zn_{(s)} + CuSO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + Cu_{(s)}$$

i) What does the word redox stand for?

ii) Show how electrons are transferred in the reaction.

iii) Write the ionic equation for the redox reaction.

17. If a substance gains oxygen during a reaction, it is being oxidized. If it loses oxygen, it is being reduced. Oxidation and Reduction always take place together, so that if one substance is oxidized, another is reduced. Using this idea, say which substance is oxidised and which substance is reduced in each reaction.

i) $Mg_{(s)} + O_{2(g)} \longrightarrow 2MgO_{(s)}$

ii) $ZnO + C \longrightarrow Zn + CO$

iii) $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

iv) $Cr_2O_3 + 2Al \longrightarrow 2Cr + Al_2O_3$

18. The hydrogen ion concentration of a solution is 1×10^{-8} M

i) What is the P^H of the solution?

ii) What is the P^{OH} of the solution?

iii) Is the given solution, acidic or basic?.

Discuss in Groups:

1. When solutions of silver nitrate and potassium bromide are mixed, a pale yellow precipitate is formed.

The ionic equation for the reaction is $Ag^+ + Br^- \longrightarrow AgBr$

i) a) What is the name of the pale yellow precipitate?

b) Is it soluble or insoluble?

ii) Is the formation of silver bromide precipitate, a result of redox reaction or not ? Justify your answer.

iii) What is this type of reaction called?

FURTHER REFERENCE

Books: 1. Text book of Inorganic Chemistry–P.L. Soni- S.Chand & sons publishers, New Delhi.

2. Principles of Physical Chemistry –B.R.Puri, L.R.Sharma, Vishal Publishing Co, Punjab.

3. Complete Chemistry(IGCSE) - Oxford University press, New York

Webliography: www.chem4kids.com http://arvindguptatoys.com/films.html