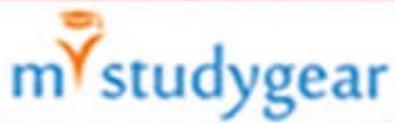


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Revised Multicolour Edition Based on CCE Pattern
As per NCERT/CBSE Syllabus

Science for Ninth Class Part - 3

Biology

Containing
answers to NCERT
book questions and
value-based
questions

DR. P.S. VERMA
DR. V.K. AGARWAL



This book has been revised according to the CCE pattern of school education based on NCERT syllabus prescribed by the Central Board of Secondary Education (CBSE) for Class IX

Science for Ninth Class (PART-3)

BIOLOGY



**As per NCERT/CBSE Syllabus
(Based on CCE Pattern of School Education)**

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**VALUE BASED
QUESTIONS
(WITH ANSWERS)**

This Book Belongs to:

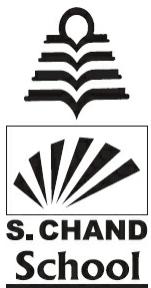
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Roll No.....

Class..... Section.....

School.....





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PREFACE TO THE REVISED EDITION

We Indians are witnessing a challenging phase of renovation and implementation of revolutionary new ideas in the development and betterment of our nation. Our National Policy makers are becoming increasingly global in their attitudes, so there is a whiff of freshness in every walk of life be it Information Technology, Finance, Education, Health, Sports, Biotechnology or Agriculture. It appears as though we have awakened from a deep slumber, have recognised our worth and confidently taking forward steps towards progress and development of the India. Modern India is marching ahead with new hopes for the masses and downtroddens. Indeed science has become a channel to provide food, fabric, medicines, bioenergy, healthy environs and new lease of life to wild biota and protecting abiotic resources of the biosphere. Manoj Prasad recently reported in the Indian Express (December 3, 2010) on how a septagenarian tribal Mr. Simon Oranon saved rainwater and jungles with three dams, five ponds for year round irrigation of crop fields and planted about 30,000 trees of sal, jackfruit, jamun and mango (to check the soil erosion). His ingenious social work has changed the lives of people in six villages of Chottanagpur (Ranchi), Jharkhand State (*i.e.*, Bero, Hariharpur, Jamtoli, Kaxitoli, Baitoli and Bhasanda villages). The present revised and enlarged multicolour edition of our book "**Science for Ninth Class (Part - 3) Biology**" is based on the latest CCE guidelines. The text part of the book is strictly according to the N.C.E.R.T Textbook. Present revised pruned edition of the book includes the following new features :

1. Text is thoroughly checked, corrected, revised and made tailor-made according to specific needs of our students.
2. The **Formative Assessment** of each chapter is updated according to needs of our readers. In [chapter 5](#), adequate new ideas for activities, topics for seminars and modus operandi of holding a group discussion, all have been suggested.
3. A variety of questions, MCQs, etc., of **Summative Assessment** have been formulated to cover each chapter more exhaustively.
4. Almost 60 per cent questions of the book have been answered.
5. [Chapter 4](#) of the book, is a bit bloated in volume since it carries entirely renewed Question Bank of practical related questions.

An attempt has also been made to include questions from the sample papers issued by CBSE Board.

Value Based Questions have been added at the end of each chapter. These questions are based on the application of Biology in our daily life. Value based questions are meant for inculcating social values amongst our young students.

Despite of all the major changes introduced in the present edition, we have maintained simplicity and modernity of the text so as to cater to all types of students including brilliant and outstanding ones.

Thanks and blessings to Ms Anubha Agarwal for painstaking editing and critical review of this book.

Our sincere thanks are extended to the management, editorial and DTP team of S. Chand & Company Ltd. Their tireless efforts

remained quite crucial in timely release of this book.

Hope, our this endeavour will help IX class students of India and fire their imagination to learn more and more about the nature.

We welcome constructive criticism and healthy suggestions from our readers for the betterment of the book.

Meerut (U.P.)

AUTHORS

DISCLAIMER

While the authors of this book have made every effort to avoid any mistake or omission and have used their skill, expertise and knowledge to the best of their capacity to provide accurate and updated information, the authors and the publisher do not give any representation or warranty with respect to the accuracy or completeness of the contents of this publication and are selling this publication on the condition and understanding that they shall not be made liable in any manner whatsoever. The publisher and the authors expressly disclaim all and any liability/responsibility to any person, whether a purchaser or reader of this publication or not, in respect of anything and everything forming part of the contents of this publication. The publisher and authors shall not be responsible for any errors, omissions or damages arising out of the use of the information contained in this publication. Further, the appearance of the personal name, location, place and incidence, if any; in the illustrations used herein is purely coincidental and work of imagination. Thus the same should in no manner be termed as defamatory to any individual.

CONTINUOUS AND COMPREHENSIVE EVALUATION (CCE) SCHEME

For Term-I & Term -II

April to March

PROPOSED EVALUATION SCHEME FOR VARIOUS SUBJECTS

- The units specified for each term shall be assessed through both Formative and Summative Assessment.
- The students will be assessed by CCE in the school itself.
- CCE over one academic year will have two terms. (April-September and October-March).
- Each term will have two **formative** and one **summative** assessment. There will be two **formative tests** and a term end **summative test**. The weightages and time schedule will be as under:

SEMESTER-I/TERM-I

Type of Test	Weightage	Time schedule	
Formative Assessment 1	10%	April to May	$FA_1 + FA_2 = 20\%$
Formative Assessment 2	10%	July to Aug.	
Summative Assessment 1	30%	Sept.	$SA_1 = 30\%$

SEMESTER - II/TERM-II

Type of Test	Weightage	Time schedule	
Formative Assessment 3	10%	Oct. to Nov.	
Formative Assessment 4	10%	Jan. to Feb.	
Summative Assessment 2	30%	March	$SA_2 = 30\%$

Design of the Question Paper for Summative Assessment

S.No.	Type of questions	No. of questions	Marks allotted to each question	Total Marks
1.	Very Short Answer Type (VSA)	03	01	03
2.	Short Answer Type - I (SA I)	04	02	08
3.	Short Answer Type - II (SA II)	12	03	36
4.	Long Answer Type (LA)	05	05	25
5.	MCQ (Practical Skills)	18	01	18
Total		42		90

FORMATIVE ASSESSMENT IN SCIENCE INCLUDES :

A. Assessment on Paper-pen test : Due weightage to be given to different types of questions (short answer, long answer, MCQ etc.). The questions should include all difficulty levels. (Easy, Average, Difficult and HOTS).

B. Practical assessment based on latest CBSE curriculum would include the following: The students should be asked to conduct experiment from all areas of curriculum. The assessments should be based on the following : Experimental Set up, Observation, Record of observation/data, Analysis of observation/data, Conclusions drawn by the student, Practical Record File, Viva.

C. Continuous Assessment in the following suggested areas :

- (1) **Home assignments/class assignments:** Due weightage to be given to Regularity, Neatness, Presentation, Correctness.
- (2) **Class response may include :** Oral Questioning, Quiz, Worksheets

S.No.	Assessment Method	Areas of Assessment
1.	Oral Questioning : Oral Questions to assess the understanding of the topic	Listening Skills, Clarity of expression, Clarity of concepts, Communication Skills
2.	Quiz : The Class students divided in groups and Questions pertaining to the topic asked to assess the students of a group.	Thinking skills, Alertness, Time management, Application of knowledge, Reasoning skill, Art of quizzing
3.	Worksheets : Use of worksheets to assess the students in the class.	Comprehension, Regularity, Application of knowledge, Attentiveness

- (3) **Seminar :** A topic may be divided among eight to ten students for them to research/study and ‘present’ it to all students. e.g. Topic “Improvement in Crop Yields” can be divided into sub-topics for presentation by the students.
- (i) Introduction
 - (ii) Crop Variety Improvement
 - (iii) Crop Production Management
 - (iv) Crop Protection Management

Areas of Assessment : Ability to research on the topic, Acquisition of content knowledge, Public speaking, Verbal expression, ICT skills, Leadership quality

Suggested topics based on the curriculum : Animal Husbandry, Diseases and their causes, Sources of energy and overcoming energy crisis. Application of Archimede’s Principle, Physical and Chemistry changes in daily life, separation of mixtures the techniques.

Symposium : Students can be asked to ‘present’ papers on the topics of their choice.

- (4) **Areas of Assessment :** Depth of the content, Presentation of the content, Use of audio-visual aids, Expression, Comprehension of the topic.

Suggested Topics based on the curriculum/related to the curriculum : Hygiene to ward off the diseases. Prevention is better than cure, Application of ultrasound, Pressure-its application in daily life, Chemical classification of

metals, Atomic models.

Group Discussion : A group of ten students can be given a topic to discuss. Students to choose their group leader, a moderator and a recorder, their roles to be clarified. The topic to be thrown open for discussion.

Group leader to ensure all students participate in the group discussion.

Moderator to ensure that there is no cross talk and no two students speak together and all listen to one speaker patiently.

Recorder to record the observation made by all students in the group including his/her own.

- (5) **Areas of Assessment :** Courage to put forth views, Team Work, Respect to peer, Knowledge of content, Appropriate body language, Communication skills, Listening skills.

Suggested Topics : Based on curriculum Or related to the curriculum : Global warming and its impact, Role of students in bringing awareness among community members on : Importance of hygiene, Saving of power and water, Importance of Immunization, Displacement of an object in the absence of any force acting on it. Energy transformation in daily life situations, Laws of chemical combination, Application of Colloids.

Projects : The students may be asked to do the investigatory or experimental projects as explained below.

(a) **Investigatory Projects include :** collection of data, Analysis & Interpretation of data, Observation, conclusion and Inference.

Areas of Assessment : Inquisitiveness, Observational skill, Thinking skill (logical, rationale), Analytical, Application of knowledge, Comprehension & Understanding (viva-voce), Computing Skills, Drawing conclusions.

Suggested topics related to the curriculum : Conservation of resources, Factors affecting buoyant force, Application of reflection of sound, Spread of diseases caused by mosquito in the locality, Soil fertility.

- (6) (b) **Experimental Projects include :** Identifying problem, Making hypothesis, Testing/experimenting, Observation, Analysis & Interpretation, Conclusion & Inference, Making a theory.

Areas of Assessment : Inquisitiveness, Observational skill, Thinking skill (logical rationale), Analytical, Application of knowledge, Comprehension & understanding (viva-voce), Computing skills, Drawing conclusions, Experimental Skills.

Suggested topics related to the curriculum : Floatation using vegetables, Density of immiscible liquids, vibrating objects produce sound, Location of apical meristem, determination of pH in different sample need in daily life (e.g. soap, lotions, food substances), Separation of substance using paper

chromatography.

Action Plan : Students of a class to be divided in 5-6 groups to make an action plan. Action Plan includes identifying a problem and making a plan to find a solution. The students to : Identify a problem. Study the causes of the problem, Interact with people (stake holders) associated with the problem, Categorize the problem in terms of – magnitude effect – effect on people – impact of on community. Make a plan to find the solution of the problem. The plan to include, Meeting people, Counselling the people, Listing people/authorities who can help find solutions, Seeking appointments with the authorities to discuss the identified problem and seek their help, A follow up action on the solution of the problem. The work to be divided among the students or all work in group as a unit. Assessment may be done group-wise or student-wise.

Areas of Assessment : Identification of a problem, Concern for the community, Team work, Analysis of the problem, Strategy planned by the students, Self confidence, Speaking skills, Follow up action see concern for people/environment. Suggested topics related to the curriculum : Smoking among teenagers vis-a-vis health, Sale of cigarettes near schools, Hygiene in and around school, Seepage of water in buildings, Leaking of water pipes, Wastage of electricity, stagnation of water in the coolers, control of contagious/infectious diseases.

Survey–Collecting information on a relevant topic of study in a group : Assessment may be done group-wise or student-wise.

Areas of Assessment : Inquisitiveness, Conversational Skills, Public relations, ICT skills, Data collection, Analytical skills.

Suggested topics as general awareness (related to science) : Garbage collection in the locality, Prevalence of diseases in a locality/community, Contamination of water of different areas, consumption/misuse of electricity.

COURSE STRUCTURE (CLASS-IX)

FIRST TERM (April-September)

Marks - 90

First Term	Marks
UNITS	
I. Food	13
II. Matter : Its Nature and Behaviour	29
III. Organisation in Living World	18
IV. Motion, Force and Work	30
Total	90

FIRST TERM PRACTICALS

List of Experiments

1. To test
 - (a) the presence of starch in the given food sample
 - (b) the presence of the adulterant metanil yellow in dal
2. To prepare
 - (a) a true solution of common salt, sugar and alum
 - (b) a suspension of soil, chalk powder and fine sand in water
 - (c) a colloidal of starch in water and egg albumin in water and distinguish between these on the basis of
 - (i) transparency
 - (ii) filtration criterion
 - (iii) stability
3. To prepare

- (a) a mixture
- (b) a compound using iron filings and sulphur powder and distinguish between these on the basis of :
- (i) appearance i.e. homogeneity and heterogeneity
 - (ii) behaviour towards a magnet
 - (iii) behaviour towards carbon disulphide as a solvent.
 - (iv) effect of heat.
4. To carry out the following reactions and classify them as physical or chemical changes.
- (a) Iron with copper sulphate solution in water.
 - (b) Burning of magnesium in air
 - (c) Zinc with dilute sulphuric acid
 - (d) Heating of copper sulphate
 - (e) Sodium sulphate with barium chloride in the form of their solutions in water
5. To prepare stained temporary mounts of (a) onion peel and (b) human cheek cells and to record observations and draw their labelled diagrams.
6. To identify parenchyma and sclerenchyma tissues in plants, striped muscle fibers and nerve cells in animals, from prepared slides and to draw their labelled diagrams.
7. To separate the components of a mixture of sand, common salt and ammonium chloride (or camphor) by sublimation.
8. To determine the melting point of ice and the boiling point of water.
9. To study the third law of motion using spring balances.
10. To determine the mass percentage of water imbibed by raisins.

SECOND TERM (October-March)

Second Term	Marks
UNITS	
I. Matter : Its Nature and Behaviour	17
II. Organisation in Living World	25

III.	Motion, Force and Work	36
IV.	Our Environment	12
	Total	90

SECOND TERM PRACTICALS

List of experiments :

1. To verify laws of reflection of sound.
2. To determine the density of solid (denser than water) by using a spring balance and a measuring cylinder.
3. To establish the relation between the loss in weight of a solid when fully immersed in
 - (a) tap water
 - (b) strongly salty water, with the weight of water displaced by it by taking at least two different solids.
4. To observe and compare the pressure exerted by a solid iron cuboid on sand while resting on its three different faces and to calculate the pressure exerted in the three different cases.
5. To determine the velocity of a pulse propagated through a stretched string/slinky.
6. To study the characteristic of *Spirogyra/Agaricus*, Moss/Fern, *Pinus* (either with male or female cone) and an Angiospermic plant. Draw and give two identifying features of groups they belong to.
7. To observe and draw the given specimens-earthworm, cockroach, bony fish and bird, for each specimen, record
 - (a) one specific feature of its phylum
 - (b) one adaptive feature with reference to its habitat.
8. To verify the law of conservation of mass in a chemical reaction.
9. To study the external features of root, stem, leaf and flower of monocot and dicot plants.
10. To study the life cycle of mosquito.



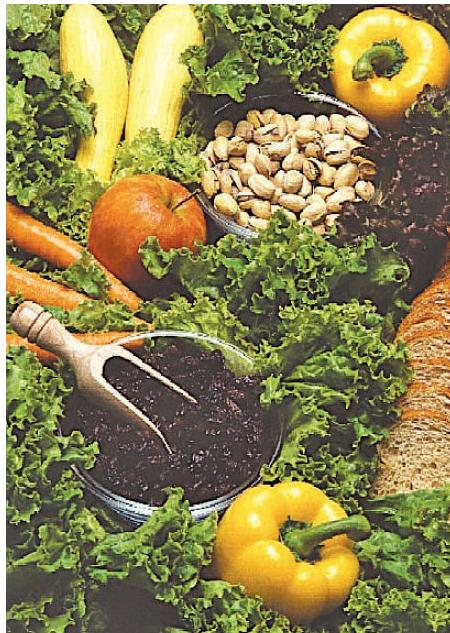
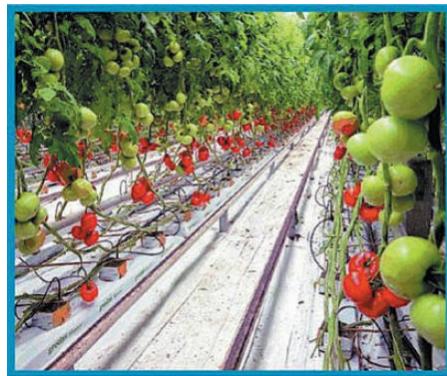
CONTENTS

FIRST TERM

1. IMPROVEMENTS IN FOOD RESOURCES

Sustainable Agriculture and Organic Farming, Improvement in Yields [Crop Production, Management (Nutrient Management), Crop Improvement for Higher Yield Through Genetic Manipulation, Crop Protection Management], Manures and Fertilisers, Manures (FYM, Compost, Green Manure), Fertilisers (Nitrogenous, Phosphatic, Potassic, Complex, Biofertilizers), Irrigation (Advantages Factors Controlling Irrigation, Irrigation Systems), Water Augmentation (Rain-Water Harvesting, Water Shed Management), Cropping Patterns, (Mixed Cropping, Inter Cropping, Crop Rotation, Plant Breeding for High-Yielding Crops, Crop Protection Management, [Weed Control, Insect Pest Control, Diseases of Crop Plants (Seed-Borne, Soil-Borne, Air-Borne and Water-Borne Diseases)], Control of Crop Diseases, Storage of Grain, Animal Husbandry, Cattle Farming [Breeds of Cows, Breeds of Buffaloes, Breed Improvement, Farm Management Practices (Components of Cattle Feed, Diseases of Cattle and Buffaloes (Parasitic ; Infectious)], Poultry Farming, Poultry Breeders, Varietal Improvement, Egg and Boiler Production, Housing Shelter and Feed, Diseases of Poultry, Fish Production (Marine Fisheries, Aquaculture, Inland Fisheries, Composite Fish Culture, Bee Keeping, Products Obtained from Apiculture, Honeybee Varieties used for Bee Keeping, Management For High Yields of honey, Diseases and Enemies of Honeybee,

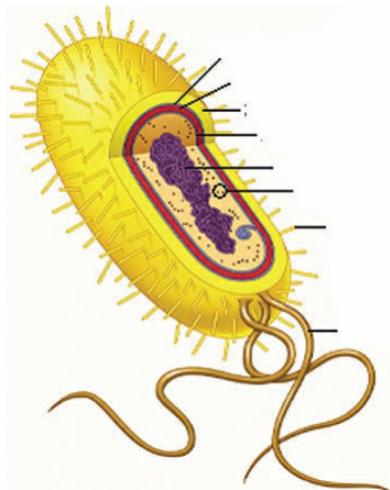
Summary, Formative Assessment, Summative Assessment, NCERT Textbook Questions and Exercises with Answers, Questions Based on NCERT Question Bank, Questions of CBSE Sample Paper, Paper Pen Test, Revision Questions, Value Based Questions with Answers.



2. THE FUNDAMENTAL UNIT OF LIFE : CELL

What is the Living Being Made of ? Prokaryotic and Eukaryotic Cell, Structure of Cell, Plasma Membrane, Cell Wall, Nucleus, Cytoplasm, (Cell Organelles viz. Endoplasmic Reticulum, Ribosomes, Golgi Apparatus, Lysosome, Mitochondria,

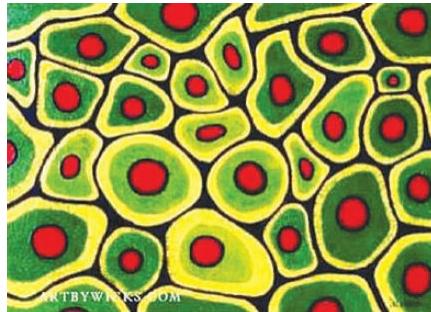
Plastids, Chloroplasts, Vacuoles, Peroxisomes, Centrosomes), Differences Between Plant and Animal Cells, Important Facts About Cells, Summary, Formative Assessment, MCQs and Viva-Voce Based on Practical Skills, Some Activity Based Questions, Paper Pen Test, Summative Assessment, NCERT Textbook Questions and Exercises with Answers, Questions Based on NCERT Question Bank (Exemplar Problems in Science), Questions of CBSE Sample Paper, Some Typical or Illustrative Questions, Questions Based on Higher Order Thinking Skills (HOTS), Revision Questions, Value Based Questions with Answers.



3. TISSUES

Division of Labour, Plant Tissues (Meristematic and Permanent), Meristematic Tissues (Apical, Lateral, Intercalary), Permanent Tissues (Simple, Complex), Simple Permanent Tissues (Parenchyma, Collenchyma, Sclerenchyma), Complex Permanent Tissues (Phloem, Xylem); Phloem (Sieve Tubes, Companion Cells), Xylem (Xylem Vessels, Tracheids) Differences Between Xylem and Phloem, Animal Tissues (Epithelial, Muscular, Connective and Nervous Tissue). Epithelial Tissue (Squamous, Cuboidal, Columnar, Grandular

and Ciliated) ; Muscular tissue (Striated, Unstriated and Cardiac), Connective Tissue [Areloar (Tendon, Ligament); Adipose ; Skeletal (Cartilage, Bone) ; Fluid (Blood, Lymph)], Summary, Formative Assessment, Summative Assessment, Questions Based on NCERT Question Bank, Questions Based on NCERT Textbook Questions and Exercises with Answers, Questions of CBSE Sample Paper, Questions Based on High Order Thinking Skills (HOTS), Paper Pen Test, Revision Questions, Value Based Questions with Answers.



SECOND TERM

4. DIVERSITY IN LIVING ORGANISMS

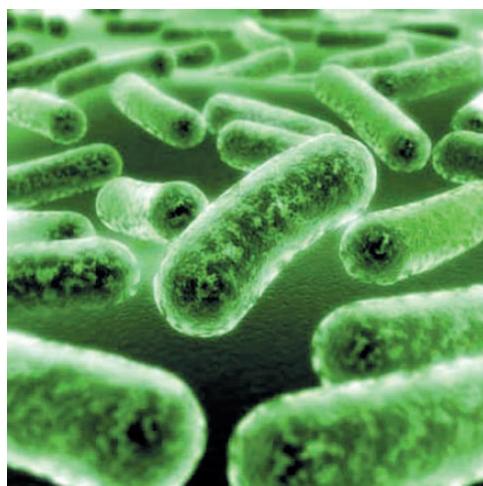
Biodiversity : Diversity of Plants and Animals ; Basic Issues in Scientific Naming ; Basis of Classification (Classification and Evolution), Artificial and Natural System of Classification, Classification Systems, Modern Scheme of Five Kingdom Classification, Hierarchy of Categories or Groups,

Characteristics of Five Kingdoms ; Detailed Classification of Kingdom Plantae (Division Algae, Division Bryophyta, Division Pteridophyta, Division Gymnospermae, Division Angiospermae), Detailed Classification of Kingdom Animalia (Phylum Porifera, Coelenterata, Ctenophora, Platyhelminthes, Nematoda, Annelida, Arthropoda, Mollusca, Echinodermata, Hemichordata, Chordata), Some Curious Facts, Summary, Formative Assessment, NCERT Textbook Questions and Exercises with Answers, Questions Based on NCERT Question Bank (Exemplar Problems in Science), Questions of CBSE Sample Papers, Some Typical or Illustrative Questions, Practical Skills Based MCQs from CBSE, Questions Based on Higher Order Thinking Skills (HOTS), Some Activity Based Questions, Paper Pen Test, Revision Questions, Value Based Question with Answers, Value Based Question with Answers, Value Based Questions with Answers.



5. WHY DO WE FALL ILL?

Health and Its Failure, Disease and Its Causes, Sources of Disease, Types of Diseases (Cogenital and Acquired) ; Acquired (Infectious and Non Infectious) ; Infectious (Contagious and Non-Contagious) ; Non Infectious (Deficiency, Metabolic, Degenerative Cancer, Metabolic Allergies, Injury), Infectious Diseases [Infectious Agents (Viruses, Fungi, Bacteria, Protozoa, Worm), Means of Spread (Air-borne, Water-Borne, Sexually Transmitted, Formite-Borne and Through Vectors), Symptoms of Disease, Principle of Treatment, Principle of Prevention of Disease, Vaccination, Examples of Diseases Caused due to Infection by Microorganisms [Protozoa (Malaria) Viruses (Influenza, Jaundice, Rabies, AIDS, Polio), Bacteria (Tuberculosis, Cholera, Typhoid, Diarrhoea, Peptic Ulcers)], Some Vital Facts about Diseases, Summary, Formative Assessment, Study Materials for Seminars, Symposia, Group Discussion, Issues on Community Awareness and Projects, Summative Assessment, NCERT Testbook Questions and Exercises with Answers, Questions based on NCERT Question Bank (Exemplar Problems in Science), Questions based on Higher Order Thinking Skills (HOTS), Questions of CBSE Sample Paper, Some Typical or Illustrative Questions, Drawing or Illustration Based Questions, Some Activity Based Questions, Paper-Pen Test, Revision Questions, Value Based Questions with Answers.



6. NATURAL RESOURCES

Biosphere and Natural Resources, Air, Importance of Atmosphere, Air Pollution, Ozone Layer and Its Depletion, Water (Rain-Water Harvesting, Conservation and Management of Water Resources, Water Pollution (Types, Sources and Harmful Effects), Soil (Formation, Soil Profile, Composition, Types, Soil Erosion, Soil Pollution), Biotic Resources (Plants, Animals), Nutrient Cycling in Ecosystem(Water Cycle, Nitrogen Cycle, Oxygen Cycle, Carbon Cycle), Global Warming (Greenhouse Effect), Summary, Formative Assessment, Summative Assessment, Paper-Pen Test, Questions on CBSE Sample Paper, Questions Based on NCERT Question Bank (Exemplar Problems in Science), NCERT Textbook Questions and Exercises with Answers, Questions

based on Higher Order Thinking Skills (HOTS), Revision Questions, Value Based Questions with Answers.



CHAPTER 1

Improvements in Food Resources



For their existence, all living organisms essentially require food. Early human beings started hunting animals and collecting fruits, flowers and roots of forest plants to meet their food requirements. Food is required for growth, development and body repair. It also protects the body from diseases and provides energy for doing all

life functions. For example, food supplies proteins, carbohydrates and fats (lipids), vitamins, minerals and water to our body.

Among all the living organisms, only green plants are **autotrophs**, *i.e.*, they make their own food. In fact, green plants perform a basic metabolic activity, called **photosynthesis**. In photosynthesis by using the energy of sunlight, green plants combine carbon dioxide (CO_2) and water (H_2O) to produce carbohydrates (Food). In contrast to green plants, animals and human beings are **heterotrophs**, *i.e.*, they depend on plants and other animals for food. Since time immemorial, human beings have been doing farming and rearing animals to meet their food requirements.

Plants as food are gift of nature to humans and most animals. In fact, different parts of plants, such as root, stem, leaf, flower and fruit, are consumed by humans in the form of cereals, vegetables, spices and fruits. Animals produce milk, egg, meat, etc., which also supplement our food requirements.

1.1. SUSTAINABLE AGRICULTURE AND ORGANIC FARMING

With 1.04 billion people, our country ranks second in population growth around the world. According to an estimate, by the year 2020, Indian population would rise to 1.343 billion. To feed such a huge population, we will require at least 241 million tonnes of grain production per annum. Therefore, it is necessary to increase production of both, plants and animals. Even in the past, to meet the demands of growing Indian population, our scientists (such as Swaminathan, Kurein) adapted methods to increase food production. This resulted in a variety of ‘revolutions’, which helped India become self-reliant. These revolutions include: **green**

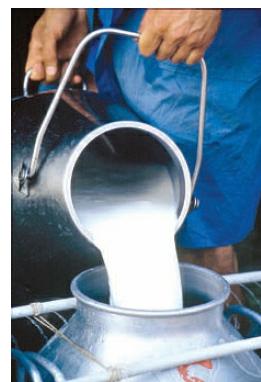
revolution (high production of food grains), **blue revolution** (enhanced fish production), **white revolution** (increased milk production) and **yellow revolution** (increased oil production). Our scientists are continuously making efforts to increase the pulse production, *i.e.* to spread the golden revolution.



Green Revolution.



Blue Revolution.



White Revolution.



Yellow Revolution.



Golden Revolution.

1. Sustainable Agriculture

Sustainable agriculture can be defined as the adoption of various farming and production management techniques to maximize agricultural yield. Implementing such practices would help in (i) conserving natural resources, (ii) maintaining environmental balance and (iii) coping with changing human needs ([Box 1.1](#)) Hence, to assure sustained livelihood of Indian farmers and related persons, it is necessary to adopt sustainable agricultural practices such as **mixed farming, crop rotation, intercropping** and **integrated farming** (also known as **integrated agriculture**).

Box 1.1

1. Farming. It is the process of harnessing solar energy from plants and animals in the form of economic produce.

2. Conservation. It means careful utilization, preservation or restoration of the natural environment and resources.

Integrated agriculture implies a combination of agriculture with other forms of culture such as pisciculture (fish culture), aquaculture, apiculture (bee-keeping), sericulture (silk worm culture), poultry farming, piggery, livestock production (animal husbandry), etc.

Box 1.2

Why sustainable agriculture?

With increasing human population of our country, the natural resources such as land, soil, water, fossil fuels, etc., are being overexploited for food, shelter and urbanisation. All these human activities have degraded our environment and have caused following problems : **soil erosion, salinization of soils, desertification, silting of rivers, floods, droughts, eutrophication, ozone depletion, deforestation, wild life extinction, pollution of air, water and land, biomagnification of toxic substances**, etc., to name a few. Thus, it has become far more important that we should increase food production without degrading our environment and disturbing the natural balance.

In recent years a concept of sustainable agriculture is developed in order to ensure that the agro-ecosystems are stabilized and sustained crop yields are assured on long term basis.

Sustainable agriculture refers to agriculture - where the agro-

ecosystems function on self sustaining basis of nutrient supply and crop protection in order to stabilize the crop yields.

Sustainable agriculture involves practices such as organic farming, biological and natural control of pests, emphasis on watershed approach to conserve the soil and water, buildup of microflora in close harmony with beneficial soil - inhabitants and complete desisting the use of synthetic chemicals. It is sustainable agriculture which ensures, pollution free food production and continuation of agriculture with least damage to ecosystem.

Advantages of Sustainable agriculture. Sustainable agriculture is an agricultural production and distribution system that

- Achieves the integration of natural biological cycles and controls.
- Protects and renews soil fertility and the natural resource base.
- Optimizes the management and use of farm resources.
- Reduces the use of non-renewable resources and purchased production inputs.
- Provides an adequate and dependable form of income.
- Promotes opportunity in family farming and farm communities.

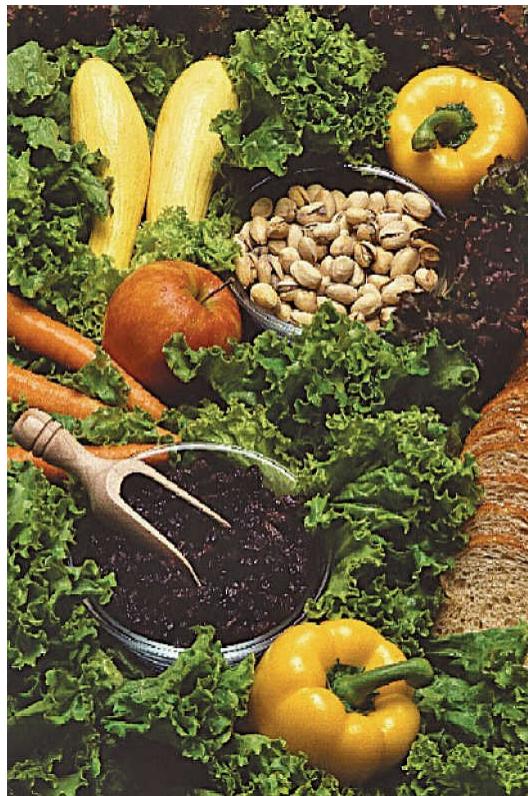


Sustainable agriculture.

Organic Farming

It is the practice of raising crops which have not been polluted with the use of manures, biofertilizers and biopesticides. Instead healthy cropping systems that provide optimum nutrients to plants and keep the pests as well as weeds under control are used. In organic farming there is little or no use of chemical fertilizers, pesticides and herbicides. Therefore, there is no toxicity due to pollution of crop plants, soil, water or air. Organic wastes are recycled in the form of manure. Biofertilizers include the nitrogen fixing organisms (bacteria and blue green algae) and mineral solubilizing bacteria. Biopesticides are organisms or their extracts

which repel or kill weeds, insects and other pests, e.g., azadirachtin (Morgosa or Neem), pyrethrum (chrysanthemum), thurioside (bacterium *Bacillus thuringiensis*). Neem leaves are often used in grain storage as biopesticides. Healthy cropping includes mixed cropping, intercropping and crop rotation. These cropping systems help in controlling insects, pests and weeds.



Organic farming.

Advantages of Organic Farming

1. It prevents pollution of any component of our environment.
2. Farm wastes are recycled.
3. The foods obtained from organic farming are free from pesticides and toxic chemicals.
4. Organic farming maintains the soil health.
5. The cropping system of organic farming keeps insect pests

and weeds under check.

1.2. IMPROVEMENT OF CROP YIELDS

Agriculture is the science and practice of farming, which mainly involves rearing of livestock, cultivating land, raising crops, harvesting and marketing the produce. It is further subdivided into many categories ([Box 1.3](#)).

Box 1.3

- 1. Agronomy.** The branch of agricultural science dealing with production of field crops and management of the soil.
- 2. Horticulture.** Branch of agriculture that deal in growth and management of fruit and flowering plants in orchards and gardens.
- 3. Olericulture.** Refers to growing and managing of vegetables.
- 4. Aquaculture.** The farming and harvesting of plants and animals in bodies of water for economical purpose.

Agronomist. An agronomist studies crop disease, selective breeding, crop rotation and climatic factors, tests the soil, investigates the causes of soil erosion and designs land reclamation and irrigation schemes.

Types of Crops

Crops are plants which are cultivated by humans for food, fodder, fiber, flowers, timber, etc. There are about 2000 plant species which are cultivated for eating purposes. Following parts of the plants are eaten as food.

1. Seeds. Not all seeds of plants are edible. For example, large seeds such as those from a lemon pose a choking hazard, whereas seeds from apple and cherries contain poison cyanide. Edible seeds include cereals, pulses, oil seeds and nuts (dry fruits).

(a) **Cereals.** They include crops such as wheat, rice, maize, barley, sorghum, etc. They are a rich source of carbohydrates.

(b) **Pulses.** They include legumes such as chickpea (chana), pea (matar), black gram (urad), green gram (moong), pigeon pea (arhar), cow pea (lobia) and lentil (masoor). They are excellent source of proteins.

(c) **Oil seed crops.** They include cotton seed, niger (Ramtil), safflower, soybean, flax (linseed oil), rapeseed, groundnut, sesame, mustard, sunflower, olive, etc. They are source of oil, fats and fatty acids. These seeds are typically high in unsaturated fats and when consumed in moderation are regarded as healthy foods. Coconut oil and palm oil are cheap sources of cooking medium.

(Note. Castor oil is not edible oil. It is mainly used as a lubricant or purgative, in the manufacturing of transparent soaps, inks, paints, phenyls, hair fixers, etc.).

(d) **Nuts or Dry fruits.** Nuts are rich in proteins and fatty acids, so are considered energetic food items. Examples include almond, walnut, cashew nut, pistachio, fig, raisin (or currant), dried apricot, coconut, peanut, date, etc.



Wheat.



Maize.

Cereal Crops.



Pea.



Chicken pea.

Pulse Crops.



Soyabean.



Ground nut.

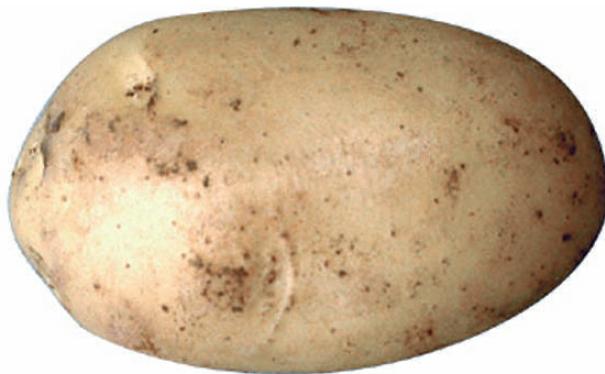
Oil seed Crops.

2. Fruits. They include apple, orange, mango, banana, pineapple, guava, papaya, watermelon, muskmelon, pomegranate,

pear, peach, apricot, grapes, dates, custard apple, etc. Essentially fruits are ripened ovaries of plants and are a good source of vitamins, minerals, roughage, proteins, carbohydrates and fats.

3. Vegetables. They are the edible parts of the herbaceous plants. They are eaten in raw or cooked form. Vegetables are of following types:

(a) **Roots.** Roots of some plants such as carrot, radish, turnip, sweet potato and beet root are eaten as vegetables.



Potato.
(Modified underground stem)

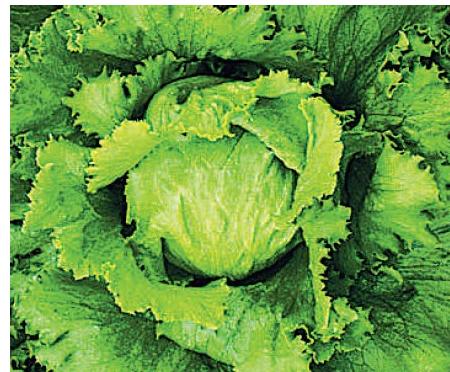


Carrot.

Root vegetables.



Spinach.



Lettuce.

Leaf vegetables.

(b) Stems. Stems of some plants such as mustard, bamboo, banana, asparagus, etc., are used as vegetables. Certain plants have modified underground stems that are eaten, *e.g.*, potato, onion, garlic, ginger, etc. Stems of sugarcane are used for making of cane juice and jaggery.

(c) Leafy vegetables. They include leaves of spinach, lettuce, cabbage, turnip, radish, mustard, methi, bathua (pigweed) and curry-leaf tree.

(d) Inflorescence vegetables. They include broccoli, cauliflower, etc., of vegetables.

Flowers of banana, fennel, gourd and saffron are also good examples of vegetables.

(e) **Fruit vegetables.** They include tomato, pumpkin, brinjal (egg plant), jack fruit, bitter gourd, bottle gourd, ridged gourd, cluster bean, cucumber, lady's finger, pumpkin (sitaphal), capsicum, lablab bean, vegetable sponge (ghia torai), faraz bean, tamarind, carmbola (kamrakh), etc.

4. Spices. Certain parts of some plants (*e.g.*, leaves, stems, flowers, fruits and seeds) are used to enhance the palatability of food. They include chilly, turmeric, black pepper, cumin, fenugreek, cardamom, fennel, nutmeg, lovage, sesame, cinnamon, dried ginger (sounth), etc.

5. Fodder crops. They provide green fodder to the cattle, *e.g.*, berseem, oat, sudan grass, sorghum, etc.

6. Other crops. Crop plants also yield fibres (*e.g.*, cotton), tobacco, tea, coffee, chocolate, peppermint, etc.

Crop Seasons

Different crop requires different climatic conditions, temperature and photoperiod for their growth and maturity. Sunlight is required for photosynthesis — the process of manufacturing food by green plants. **Photoperiods** are duration of sunlight that influences plants in their growth, flowering, formation of storage organs, leaf fall, etc. In India, there are two main seasons of crop growth: Kharif and Rabi.

1. Kharif crops. These crops grow during rainy season (June to October). They are also called **summer season crops**. The chief kharif crops (cereals and pulses) are paddy (rice), maize, millet, groundnut, soybean, arhar, black gram (urad), green gram (moong) cotton and jute. Vegetables of kharif crops are spinach, gourd,

garlic, lady finger, pumpkin and brinjal. Fruits of kharif crops are watermelon, muskmelon, mango, litchi, plum, peach, etc.

2. Rabi crops. These crops grow from November to April. Rabi crops are also called **winter crops**. The important rabi crops (cereals and pulses) are wheat, barley, gram, mustard, pea and linseeds. Vegetables of rabi crops are cabbage, cauliflower, carrot, radish, turnip, beans, etc. Fruits of rabi crops are apple, pomegranate, orange, etc.

Table 1.1. Differences between Kharif and Rabi crops.

<i>Kharif crops</i>	<i>Rabi crops</i>
1. They are monsoon or rainy season crops	1. They are non-monsoon season crops.
2. The crops grow in hot and wet conditions.	2. The crops grow in cold and nearly dry conditions.
3. These crops are sown in the beginning of rainy season in June - July.	3. These crops are sown in October-November when monsoon is retreated.
4. These crops are harvested during September - October at the end of Monsoon.	4. These crops are harvested in March-April before the advent of hot season.
5. Examples. Rice, Maize, Groundnut, Soybean, Green gram, Cotton, Black gram.	5. Examples. Wheat, Barley, Gram, Mustard, Linseed, Pea.

Improvement in Yields

Following *three* scientific approaches are adopted in India to obtain high yields from our agriculture farms :

1. Crop production management
2. Crop variety improvement
3. Crop protection management

Crop Production Management

India is an agriculture based country. In this country, agriculture sector engages about 70% of its population and accounts for 40% of the Gross National Product (GNP). Farming practices being followed depend upon size of land holding, education and financial conditions of the farmers. The production practices include “no cost” production, “low cost” production and “high cost” production. High cost production is based on improved high yield varieties, improved farming practices, modern technology, latest agricultural machines and implements. **Crop production management** refers to controlling the various aspects of crop production, to obtain the maximum and best yield. It has the following three components: 1. nutrient management; 2. irrigation and 3. cropping pattern.

Box 1.4

India is a large country with an enormous area under cultivation. India is blessed with continuous growing seasons which means that crops can be grown throughout the year. This is due to the subtropical climate, plenty of sunshine and lack of frost in most part of the country.

Nutrient Management

Nutrient management means controlling the **selection, timing** and **amount** of nutrient supply to the crops. Like other living organisms, plants also require inorganic elements for building their structure and maintaining their metabolic processes. These inorganic elements are called **nutrients**. Nutrients are supplied to the plants by air, water and soil. There are about 40 elements found in the plant ash, but only 16 of those elements are essential for

plant growth and development. Hence, these 16 elements are called **essential elements** or **essential plant nutrients**.

Out of 16 essential elements, two elements, carbon and oxygen are obtained from air and hydrogen from water. Remaining 13 elements are supplied by the soil. These 13 elements are minerals. A mineral is a substance which is obtained by mining.

Table 1.2. 16 essential nutrients of plants their sources, types and examples.

Source	Nutrients	Type
1. Air	Carbon (C), Oxygen (O)	Macronutrients (= 2)
2. Water	Hydrogen (H)	Macronutrient (= 1)
3. Soil	<ul style="list-style-type: none"> ● Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Sulphur (S) ● Iron (Fe), Manganese (Mn), Boron (B), Zinc (Zn), Copper (Cu), Molybdenum (Mo), Chlorine (Cl) 	Macronutrients (= 6) Macronutrients (= 7)

Types of Essential Nutrients

Maze (1915) divided essential plant nutrients into two categories, macronutrients and micronutrients.

(i) **Macronutrients (Macroelements).** They are those essential elements which are present in plants in easily detectable quantities, more than 1ppm of plant body (1 mg per gm of dry weight). Macronutrients take part in synthesis of organic molecules and development of osmotic potential ([Box 1.5](#)). Carbon (from air), oxygen (from air) and hydrogen (from water), are non-mineral micronutrients. Out of 13 essential mineral elements, six are macronutrients, *i.e.*, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur ([Table 1.2](#)).

Box 1.5

Osmosis. The diffusion of a solvent, such as water, through a semipermeable membrane, which separates two solutions of different concentrations. The flow of the solvent is from the more dilute to the more concentrated solution, owing to the thermodynamic tendency of the solution to equalize the concentrations of solutes on the two sides of the membrane. A better way of defining osmosis is to say that it is net movement of water through a semipermeable membrane from a solution of higher water potential to a solution of lower water potential

Osmosis was studied by **Thomas Graham**, who coined this term in 1858. Osmosis is important in dialysis and in water transport in living tissue.

(ii) **Micronutrients (Microelements).** They are those essential elements which are present in plants in small quantities, less than 1ppm or 1 mg/gram of dry matter. All of them are mineral elements. Micronutrients are mostly involved in the functioning of enzymes. Out of 13 essential mineral elements, seven are micronutrients, *i.e.*, iron, manganese, boron, zinc, copper, molybdenum and chlorine.

Table 1.3. Differences between Macronutrients and Micronutrients.

<i>Macronutrients</i>	<i>Micronutrients</i>
1. They are required in large quantities.	1. They are required in very small amounts.
2. Concentration of each macronutrient in plants is more than 1mg/gm of dry matter.	2. Concentration of micronutrients is quite below 1 mg/gm of dry matter.
3. They take part in building plant body and different protoplasmic	3. They have no such functions.

<p>structures.</p> <p>4. They have no significant role in enzyme activity and electron transport.</p> <p>Examples. Nitrogen, Phosphorous, Potassium, Calcium, Magnesium, Sulphur.</p>	<p>4. They are involved in enzyme activity and electron transport.</p> <p>6. Examples. Iron, Manganese, Boron, Zinc, Copper, Molybdenum, Chlorine.</p>
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Mineral Replenishment

Soil is the most important reservoir of plant nutrients. Crop plants regularly withdraw minerals (in the form of nutrients) from the soil. Unless and until minerals are replenished at regular intervals, the crop plants will develop disorders in structure, growth, reproduction, functioning and susceptibility to diseases. Mineral replenishment is done through the addition of manures and fertilizers to the crop fields.

MANURES AND FERTILIZERS

The deficiency of plant nutrients and organic matter in the soil is made up by adding manures and fertilizers to the soil of crop-fields. Both manures and fertilizers are major sources of nutrients of plants, so they are used in crop production.

A. Manures

Manures are natural fertilizers. They are bulky sources of organic matter which supply nutrients in small quantities, and organic matter in large quantities. Manures are prepared by the decomposed animal excreta and plant waste. Manures include farmyard manure (FYM), compost, green manures, vermicompost, etc.

Advantages of manures. Manures affect the soil in following

three ways :



Manure.

- (i) Manures enrich the soil with nutrients. They replenish the general deficiency of nutrients in the soil. Since manures contain less nutrients they need to be used in large quantities.

- (ii) Manures add organic matter (called **humus**) to the soil which restores the soil texture, for better retention of water and aeration of soil. For example, organic matter present in the manures increases the water holding capacity in sandy soils and drainage in clayey soil. They also prevent water logging in clay soils.

- (iii) The organic matter in manures provides food for the soil organisms, (decomposers such as bacteria, fungi, etc.) which help in providing nutrients to plants.

Thus, organic manures help to improve the physical properties of soil, reduce soil erosion, increase the moisture holding capacity of soil and are low cost nutrient carriers. Using biological waste material is a way of re-cycling the farm waste. Manures protect our environment from synthetic chemicals (*i.e.*, fertilizers).

Disadvantages of manures. Manures are bulky with low nutrient content. The nutrients get released slowly, unable to fulfill the high and rapid demand of nutrients required by improved high-yielding hybrid varieties of crops. Being bulky and voluminous,

they are inconvenient to handle, store and transport. Moreover, manures are not nutrient specific and, hence, are not much useful when a particular nutrient is required in the soil for a particular crop.

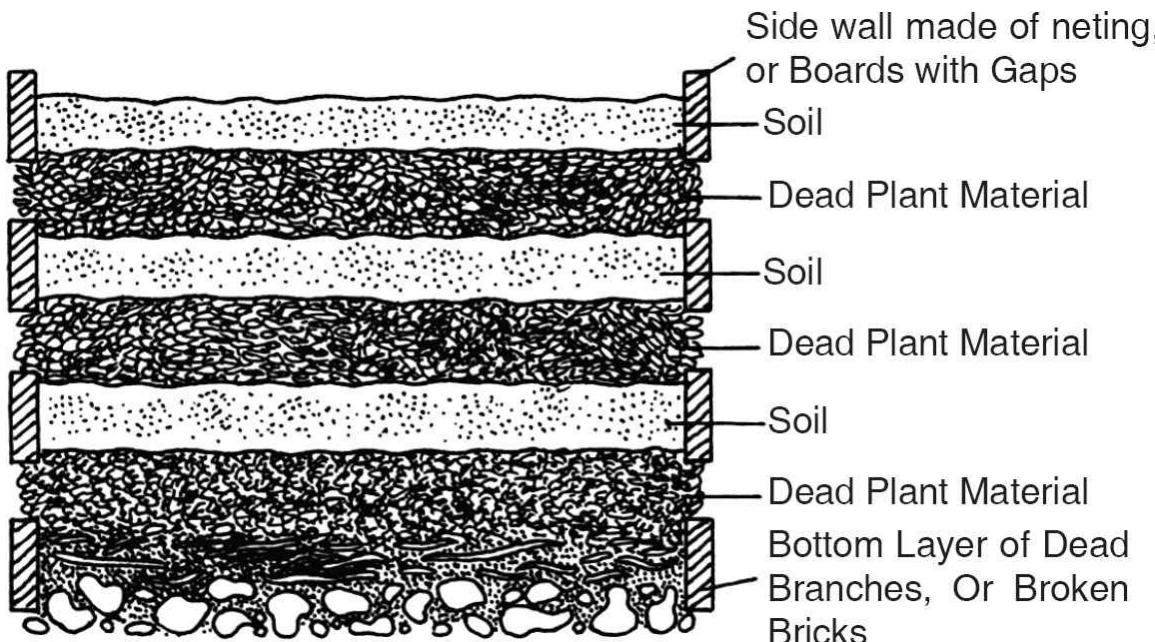
Types of manures. **1. Farmyard manure (FYM).** FYM is the decomposed mixture of cattle excreta, (dung), urine, litter (*i.e.*, bedding material used in night under cattles) and left over organic matter such as roughage, or fodder. These waste materials are collected daily from the cattle shed and stored in a pit for decomposition by the microorganisms (bacteria, fungi, etc.). FYM contains nitrogen, phosphorus and potassium. A well decomposed farmyard manure contains about 0.5 per cent nitrogen (N), 0.2 per cent phosphorus pentaoxide (P_2O_5) and 0.5 per cent potassium monoxide (K_2O).

2. Compost. Compost is prepared from farm and town refuse such as vegetable and animal refuse (*e.g.*, excreta of domestic animals such as cattle, goat, sheep, horse, donkey, camel, dogs, cats, etc.), faecal matter of human beings, sewage waste ([Box 1.6](#)), weeds, crop stubble, straw, rice hulls, forest litter, etc. **Composting** is a biological process in which both **aerobic** (organisms requiring the presence of oxygen for the respiration) and **anaerobic** (organisms, in which respiration takes place in the absence of oxygen) microorganisms decompose the organic matter. It takes about 3 to 6 months for decomposition of organic refuse. The nutrient contents of town compost are about 1.4 per cent nitrogen (N), 1.0 per cent phosphorus pentaoxide (P_2O_5) and 1.4 per cent potassium monoxide (K_2O).

Box 1.6

Sewage

In modern system of sanitation, water is used for removal of human excreta and other wastes. Sewage consists of two components: (i) The solid part, called the **sludge** and (ii) the liquid part, called **effluent** or **sewage water**. The dried sludge may be used as soil conditioner in lawns and flower gardens. Sewage water is quite rich in many nutrients of plants so can be used for fertilizing and irrigating the soil.



Preparation of compost.

Method of preparing compost. For preparing compost, a trench of suitable size, *i.e.*, 4 to 5 m long, 1.5 to 1.8 m broad and 1.0 to 1.8 m deep is dug. A layer of well-mixed refuse of about 30 cm thickness is spread in the trench. This layer is well moistened by slurry (water paste) of cattle dung and water or earth and water. A second layer of mixed refuse is spread in trench till the heap rises to a height of 45 to 60 cm above ground level. The top of this heap is then covered with a thin layer of moist earth. After three months,

the partially decomposed biomass is taken out of the trench and collected in conical heap. This heap is moistened if necessary and covered with earth. After another one or two months, the compost is ready for use in the field.

Box 1.7

Vermicomposting

The degradation of organic waste through the consumption by the earthworms is called **vermicomposting**. An earthworm is physically an aerator, crusher and mixer, chemically a degrader and biologically a stimulator of decomposition. In India, following species of earthworms are used in vermicomposting: *Dichogaster bolani*, *Drawida willsi*, *Perionyx excavatus* (Indian species) and *Eisenia foetida*, *Eudrilus eugeniae* (Exotic species).

3. Green manure. The practice of green manuring includes growing, mulching by ploughing and mixing of green crops with soil, to improve physical structure and soil fertility. A green manure crop supplies: (i) nitrogen and phosphorus; (ii) organic matter for improving hydration, aeration and crumb structure of the soil. It tends to provide protection against erosion and leaching.

Green manures are generally quick growing leguminous and non-leguminous plants. Some examples of green manure plants are
1. Dhaincha (*Sesbania aculeata*); 2. Sunn Hemp (*Crotalaria juncea*); 3. Cluster bean or guar (*Cyamopsis tetragonoloba*); 4. Cow pea or Lobia (*Vigna sinensis*); 5. Lentil or Masur (*Lens culinaris*); 6. Egyptian clover or Berseem (*Trifolium alexandrium*),
7. Horse gram (*Dolichos uniflorus*).

The green manure crops are grown in the field for about 6 to 8

weeks and are overturned when in tender stage, *i.e.*, at flowering stage. These crops remain buried for about one to two months. During this period, plants should be completely decomposed before sowing of next crop. Generally the crops which require high nutrient input, are raised in a green manured field. Such crops are rice, maize, sugarcane, cotton, wheat, etc.



B. Fertilizers

Fertilizers provide plant nutrients, commercially manufactured using chemicals. Fertilizers supply Nitrogen, Phosphorus and Potassium (NPK). They are used for good vegetative growth (*i.e.*, growth of leaves, branches and flowers), giving rise to healthy plants. Fertilizers are one of the major components for obtaining higher yields specially in expensive farming practices. Fertilizers contain much higher amount of nutrients in comparison to the manures and are, therefore, used in very small quantities. A **Complete fertilizer** is one which contains all the three **critical elements or minerals**, nitrogen, phosphorus and potassium. These fertilizers may supply one or more nutrients. Chemically they may be **inorganic compounds** (*e.g.*, ammonium sulphate) or **organic compounds** (*e.g.*, urea). On the basis of the availability of nutrients from them, fertilizers are divided into following *four* groups:

1. **Nitrogenous fertilizers.** These fertilizers supply the macronutrient nitrogen. Examples of nitrogenous fertilizers are : (i)

Urea, $\text{CO}(\text{NH}_2)_2$; (ii) Ammonium sulphate, $(\text{NH}_4)_2\text{SO}_4$; (iii) Calcium ammonium nitrate; (iv) Sodium nitrate, NaNO_3 ; (v) Ammonium nitrate, NH_4NO_3 .

2. Phosphatic fertilizers. They are the source of the macronutrient phosphorus. Examples of phosphatic fertilizers are : (i) Single superphosphate; (ii) Triple super phosphate; (iii) Dicalcium phosphate.

3. Potassic fertilizers. These fertilizers supply potassium which is one of the essential macronutrient of the plants. Examples of potassic fertilizers are : (i) Muriate of potash or potassium chloride, KCl ; (ii) Potassium sulphate, K_2SO_4 ; (iii) Potassium nitrate, KNO_3 .

4. Complex fertilizers. When a fertilizer contains at least two or more nutrients (N , P_2O_5 and K_2O), it is called **complex fertilizer**. Examples of complex fertilizers are : (i) Nitrophosphate; (ii) Ammonium phosphate; (iii) Urea ammonium phosphate.

Fertilizers should be applied scientifically, in terms of proper dose, time, pre-and post-application precautions for their complete utilisation. For example, sometimes due to excessive water, fertilizer gets washed away and do not get fully absorbed by the plants. Fertilizers generally get washed off through irrigation, rainfall as drainage, and pollute rivers, lakes, streams (causing toxicity, algal bloom and eutrophication) and disturbing the ecosystem. The water of these water bodies becomes unfit for human consumption and even kills the aquatic animals such as fishes. So chemical fertilizers must be used carefully and judiciously.

Differences between manure and fertilizer have been discussed in [Table 1.4.](#)

Table 1.4. Comparison of manure and fertilizer.

<i>Manure</i>	<i>Fertilizer</i>
1. A manure is a natural substance. It is obtained by the decomposition of animal wastes such as dung (gobar) of cattle and buffaloes and plant residues.	1. A fertilizer is a human-made substance. It is an inorganic salt or an organic compound.
2. A manure contains small amounts of essential plant nutrients such as nitrogen, phosphorus and potassium.	2. Fertilizers are very rich in plant nutrients such as nitrogen, phosphorus and potassium.
3. A manure adds a great amount of organic matter in the form of humus in the soil.	3. A fertilizer does not add any humus to the soil.
4. Nutrients present in the manure are absorbed slowly by the crop plants, since manure is not soluble in water. Nutrients exist locked inside the organic compounds of humus.	4. Being soluble in water, a fertilizer is readily absorbed by the crop plants.
5. A manure is not nutrient specific and it tends to remove the general deficiency from the soil.	5. A fertilizer is nutrient specific. It can specifically provide nutrients such as nitrogen, phosphorus and potassium to the soil according to the need.
6. A manure is voluminous and bulky so it is inconvenient to store, transport, handle and apply to the crop.	6. A fertilizer is compact and concentrated so it is easy to store, transport and apply to the crop.
7. A manure is cheap and is prepared in rural homes or fields.	7. A fertilizer is costly and is prepared in factories.

5. Biofertilizers. Organisms which enrich the soil with nutrients are called **biofertilizers**. Biofertilizers are used for the specific crop plants such as pulses, legumes, oil seeds and rice. Biofertilizers are renewable and non-pollutant sources of plant

nutrients such as nitrogen. They are not alternatives to chemical fertilizers but can play a supplementary role in supplying *nitrogen* to specific crops under specific soil conditions. Nitrogen fixing microorganisms, *i.e.*, non-symbiotic and symbiotic cyanobacteria and phosphate-solubilising microorganism, are the main type of biofertilizers that are being used in India. Recently, two biofertilizers, namely *Rhizobium* cultures and blue green algae (such as *Anabaena* and *Nostoc*) have gained popularity amongst farmers cultivating pulses, legumes, oil seeds and wet-land rice.

6. Mycorrhiza. Mycorrhiza is a symbiotic (mutualistic) association of certain fungi with roots of higher plants. Mycorrhiza increases water and nutrient uptake by plants and increase growth, vigour and yield of the plants.



Irrigation

Crop plants get water from soil. Soil obtains water from rain. However, sufficient rain is not always available. Therefore, soil is not able to supply sufficient water to crops. The extra water required by crops is met through irrigation. ***The process of supplying water to crop plants by means of canals, wells, reservoirs, tube-wells, etc., is known as irrigation.***

In our country, there are 12 major river basins and 8 composite river basins. Ground water also contributes significantly to our total water resources. This is replenished by rainfall. However, only

55% of our cropped area is either partly irrigated (about 25%) or is under assured irrigation (about 30%). Remaining about 45% of cropped area is unirrigated and is dependent on rain for the cultivation of crops. It is called ***rainfed agriculture***. The success of rainfed agriculture depends upon timely and sufficient rain during most of the growing season. Scarcity and irregular distribution of rain can cause **drought (sookha)**. Drought prone areas generally have light soil (sand-rich soil) which is unable to retain water for long. They are, therefore, more affected by drought. Poor monsoons or rains tend to result in crop failure. However, agriculture scientists have developed some crop varieties which can grow in rain fed areas and survive drought conditions. **Water management** is arranging and supplying required water to crops without harming soil aeration, change of water table or causing water-logging and soil salinity.

Advantages of Irrigation

In agriculture irrigation fulfil the following goals :

1. Crop plants are irrigated with freshwater to supply two essential elements to them, hydrogen and oxygen. Both of these elements are present in water molecules and are necessary for growth and development of crop plants.
2. Irrigation of crop fields is necessary to provide sufficient moisture for the germination of seeds, as seeds do not germinate in dry soils.
3. Irrigation of crop plants is essential for the growth and elongation of the roots of the crop plants. This is because roots of crop plants fail to develop and elongate in dry soil.
4. Irrigation is necessary to increase the number of aerial branches (called **tillers**) in crop plants so as to get a good crop yield.

5. Irrigation is essential for the absorption of nutrient elements by the crop plants from the soil. The irrigation water tends to dissolve the nutrients present in the soil of a crop field to form a solution. This solution of nutrients is then absorbed by the roots of crops for the development of the plants.

Some other Advantages of Irrigation

Irrigation has many other advantages compared to natural rain water supplies.

- (i) The supply of water by irrigation is regular and reliable, whereas rainfall is often seasonal or unpredictable.
- (ii) Irrigation water supplied by rivers in flood often carries silt which adds to soil of the fields, enhancing fertility and crop yield.
- (iii) With irrigation, cultivation can be done round the year and not during the rainy season only.
- (iv) In desert areas, the constant flow of irrigation water through the soil helps to reduce the salinity of the soil. However, if the water is allowed to evaporate in the fields, salt content of soil will increase.
- (v) Modern multipurpose dams not only provide water for irrigation but also help to control floods, generate hydroelectric power and improve the navigability of the rivers.

Factors Controlling Irrigation

The irrigation or water requirements of crop plants depends on the following two factors :

1. Irrigation dependent on the nature of the crop plants (*i.e.*, crop-based irrigation).
2. Irrigation dependent on the nature of soil of the crop fields (*i.e.*, soil-based irrigation).

- 1. Crop-based irrigation.** Water requirements of different

crops are different during the various stages of their growth and maturation (ripening). Some crop plants require more water, while others need less water. For example, paddy crop (rice crop) is **transplanted** in standing water (wet lands) and requires continuous water supply, whereas, other crops such as wheat, gram and cotton requires less water. For cereals such as wheat, irrigation is required before ploughing the field (*i.e.*, before tilling), at the time of flowering and at the time of development of the grain.

2. Soil based irrigation. Irrigation also depends on the nature of the soil in which crop is grown. The crops grown in a **sandy soil** need irrigation more frequently, whereas the frequency of irrigation is comparatively less for crops grown in a **clayey soil**. Let us find out why this occurs ! Sandy soil is highly porous, and has high permeability. When the crop plants standing in a sandy soil are irrigated, water quickly percolates down the soil and the crop plants are not able to absorb adequate amounts of water. So, due to the poor water retaining capacity of the sandy soil, the crops cultivated in sandy soil need more frequent irrigation. In contrast to sandy soil, clayey soil is much less permeable, so it can retain water for a much longer time. So, when the crops grown in a clayey soil are irrigated, the water persists in the soil for a longer time and as a consequence plants grown in clayey soil can absorb this water in adequate amount. Thus, due to good water retaining capacity of the clayey soil, the crops cultivated in clayey soil need irrigation less frequently.

Irrigation Systems

Our country is blessed with large water and land resources with varied climatic conditions. Under such circumstances, various types of irrigation systems have been adopted to supply water to the agricultural lands. Some most commonly used irrigation

systems are the following :

1. Canal system. In canal system, the human-made canals receive water from one or two reservoirs or from rivers. This is usually an elaborate and extensive irrigation system. Thus, **main canal** is distributed into **branch canals** and branch canals further have **distributaries** or **field channels**. These unlined field channels may serve individual fields or a group of fields. Under the canal irrigated areas, the rotation system is followed. Rotation system is known as **water bandhi** or **intermittent water delivery method**. This provides adequate irrigation to all the fields, when the water supply is short. Each field or group of fields are given water by rotation.

2. Tanks. Tanks are small storage reservoirs, which catch and store the runoff of smaller catchment areas. Small dams are built below the higher elevations of the catchment areas. In the tanks, outflows are controlled according to the availability of water. Otherwise it causes an uneven distribution of water. The main drawback of uneven distribution of irrigation water is that it causes shortage of water at tail end and excessive use at the top.

3. Wells. Wells are constructed wherever exploitable ground water is present. Wells are of two types :

Dug wells. In the dug wells, the water is collected from water bearing strata. These dug wells have their base below the ground

- (i) water table. The water from the shallow strata slowly accumulates in the pit. From these wells, water is lifted by mechanical means, e.g., bullock operated devices.

Tube wells. A tube well ([Fig. 1.1](#)) can tap water from the deeper strata. From these wells, water is lifted by diesel or electricity run

- (ii) pumps. Deep bore tube well can supply water continuously for many years.

Box 1.8

1. Wells and tube wells are successful in those areas where underground water is not saline, in areas where underground water is saline, canal water is used for irrigation.
2. Excessive irrigation causes water logging and increases surface salinity. In water logged soil plant, roots do not get proper aeration.

4. River lift system. River lift system is more useful in those areas where canal flow is insufficient or irregular due to inadequate water release. In this system, water is directly drawn from the rivers for supplement irrigation.

5. River valley system. Certain parts of the country such as Karnataka and Kerala which lie along the Western Ghats, use water that is discharged into the steep and narrow riverine valleys, during the raining season. In these parts of India, the rainfall is heavy but concentrated in four or five months period of the year. This is followed by drying up during the *rabi* season. On the slopes of these valleys and in the valleys perennial plants (= crops) such as coconuts, areca nuts (supari), coffee, rubber and tapioca are cultivated. The bottom flat lands of the valleys are used for growing a single rice crop.

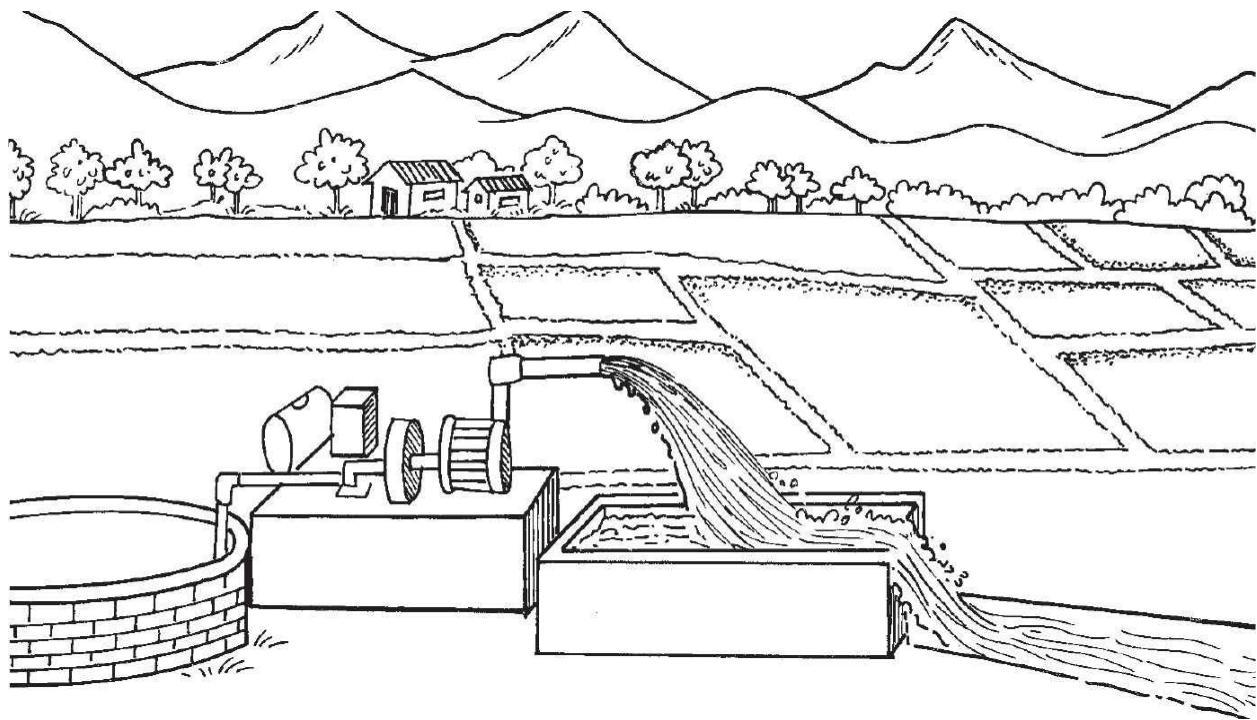


Figure 1.1. Tube well.

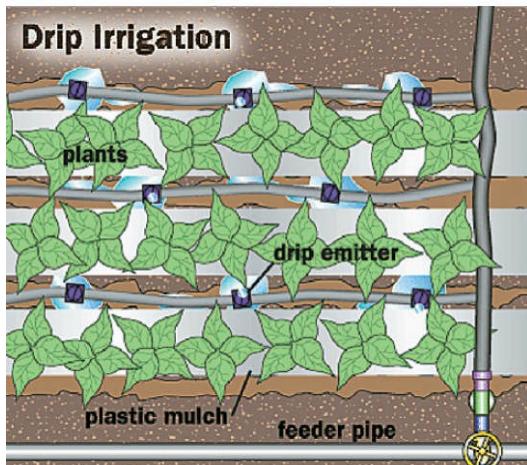
 mystudygear



Box 1.9

1. **Sprinkler irrigation system** is being introduced in canal irrigated areas of Haryana, Rajasthan and Madhya Pradesh. 2. **Drip irrigation system** is being encouraged in Maharashtra, Karnataka, Andhra Pradesh, Orissa and Tamil Nadu for fruit crops. **Fertigation** is an innovation of applying fertilizer through drip irrigation to maximise farm productivity with available water.

6. Drip and sprinkler system. Overhead pipes for spraying water and sprinkler system save a lot of water and are more natural. They however, require a pumping system. These methods are very common in U.S.A., Britain, Europe and parts of India ([Box 1.9](#)).



Sprinkle irrigation.

Water Augmentation

Water availability for irrigation can be assured by augmenting ground water. It is carried out by following two methods.

1. Rain water harvesting. Rain water is not allowed to go waste. It is collected and used for recharging ground water by sinking deep drain pipes. It can also be poured into wells or used to recharge ground water by digging up wells.

2. Water shed management. Small check dams are built up in water shed areas to increase percolation of water into ground, reduce flow of rain water and prevent soil erosion.

CROPPING PATTERNS

These are models of raising crops which help in obtaining maximum benefit from the same piece of land, reduce risk of crop failure, disease and infestation. Three common types of cropping

patterns are mixed cropping, intercropping and crop rotation.

(i) Mixed Cropping

Farming is an agricultural process of harnessing solar energy in the form of economic produce of plants and animals. The Indian farmers depend a great deal on the monsoon rain for water. Monsoons sometimes bring very heavy rain and cause **floods**. Sometimes there are dry spells which lead to **drought** conditions. Also, the amount of rainfall in a particular season is not dependable. Therefore, the small and marginal farmers, particularly in the rain-fed regions cannot take the risk of growing specialized crops. They prefer a farming system, called **mixed cropping** which *is the practice of growing of two or more crops simultaneously in the same piece of land*. It is an age-old practice in our country. Indian farmers used to mix the seeds of two crops and sow in the field.



Mixed cropping.

1. Objective of mixed cropping. The basic objective in mixed cropping is to minimise the risk and insure against the crop failure due to abnormal weather conditions.

2. Crop-combination used in mixed cropping. In India, the

following combinations of the crops are used by farmers in mixed cropping :

- (i) Maize + Urad bean
- (ii) Cotton + Moong bean
- (iii) Groundnut + Sunflower
- (iv) Sorghum + Pigeon pea
- (v) Wheat + Chick pea
- (vi) Barley + Chick pea
- (vii) Wheat + Mustard.

3. Criteria for the selection of the crops for mixed cropping.

While selection of the crop is made for the mixed cropping, the following criteria are maintained :

The different crops to be grown together are so selected that the products and waste materials from one crop stimulates the growth of the other crop. For example, if a cereal crop such as wheat is grown along with a leguminous crop such as pulse (e.g., gram),

(i) then the uptake of nitrogen from the soil by the cereal is compensated by the nitrogen-fixing legume. This has two advantages : the fertility of the soil is increased and ultimately yield of the crop too is improved.

(ii) Care is taken to select crops that do not compete with each other for light, nutrients and water. For example :

(a) One crop is of long duration and other crop is of short duration. Thus, if one crop fails due to shortage of moisture or nutrients, the other crop can cover the risk of complete failure.

(b) One crop is tall growing and other is short growing. Thus, component crops used in mixed cropping have different **canopy**. The *crop canopy* means the structure of leaves, stems and flowers found above ground.

- (c) If one crop is deep rooted, the other has shallow roots.
- (d) One crop needs comparatively lesser water and nutrients than the other.

Box 1.10

In mixed cropping :

- 1. Seeds of two crops are mixed before sowing and there is no definite pattern for sowing the seeds.
- 2. Same fertilizers and pesticides are used for all crops.
- 3. Products of different crops are harvested, threshed, marketed and consumed in mixed form.

Advantages of Mixed Cropping

- 1. The risk of total crop failure due to uncertain monsoon is reduced.
- 2. Farmers tend to harvest a variety of produce such as cereal, pulses or vegetables or fodder to meet the various requirements of family or of an agricultural farm.
- 3. Due to complementary effect of component crops, yield of both crops is increased, *e.g.*, wheat and gram.
- 4. Fertility of the soil is improved by growing two crops simultaneously.
- 5. Chances of pest infestation are greatly reduced.



(ii) Intercropping

Intercropping is a practice of growing two or more crops simultaneously in a same field in definite row patterns with the objective of increasing productivity per unit area. The practice of intercropping is adopted by small farmers and where farmers have least access to irrigation. Intercropping is an improved version of mixed cropping. All the crop combinations in mixed cropping can also be practiced in intercropping. But row patterns are definite, i.e., 1 : 1, 1 : 2 or 1 : 3. It means after one row of main crop, one, two, or three rows of intercrops can be grown.



Intercropping.

Advantages of Intercropping

1. It makes better use of the natural resources of sunlight, land and water.
2. Soil erosion is effectively arrested.
3. Since the seeds of the two crops are not mixed before sowing, fertilizers can be added as per the need of the crops.
4. Since the seed maturity period of these crops vary, the different crops can be harvested and threshed separately.
5. The produce of each crop can be marketed and consumed separately.

The comparison between mixed cropping and intercropping has

been tabulated in [Table 1.5](#).

Table 1.5. Comparison between mixed cropping and intercropping.

<i>Mixed cropping</i>	<i>Intercropping</i>
1. It aims to minimise risk of crop failure.	1. It aims to increase productivity per unit area.
2. Seeds of two crops are mixed before sowing.	2. Seeds of two crops are not mixed.
3. It involves no set pattern of rows of crops.	3. It involves set patterns of rows of crops.
4. In this method there is a difficulty of fertilizer application to individual crops.	4. In intercropping fertilizer can be placed as per need of the crops.
5. Spraying for pest control to individual crop is difficult.	5. Pesticides can be easily applied to individual crop.
6. Harvesting and threshing of crops separately not possible.	6. Both crops can be easily harvested and threshed separately.
7. Marketing and consumption of only mixed produce is possible.	7. Product of each crop can be marketed and consumed separately.

(iii) Crop Rotation

If we grow a crop continuously in the same field for many years, it results into various problems such as (i) depletion (deficiency) of same types of nutrients and (ii) build up of diseases and insect-pests. This demands for the requirement of the practice of crop rotation. **Crop rotation** can be defined as *the practice of growing of different crops on a piece of land in a preplanned succession*. Depending upon the duration crop rotation may be of following three types ([Table 1.6](#)).



Crop rotation.

Table 1.6. Types of crop rotation

Type of crop rotation	Component crops involved in rotation
1. One year rotation	1. Maize - Mustard 2. Rice - Wheat
2. Two years rotation	1. Maize - Mustard-Sugarcane - Fenugreek (Methi) 2. Maize - Potato - Sugarcane - Peas
3. Three years rotation	1. Rice - Wheat - Moong - Mustard - Sugarcane - Berseem 2. Cotton - Oat-Sugarcane - Peas - Maize - Wheat

Selection of Crops for Rotation

Most commonly, legumes are included in the crop rotation programme. They are used to increase soil fertility. Those crops which require high fertility level (*e.g.*, wheat) may be grown after growing legumes (*e.g.*, pea). Thus, *high input crops* such as sugarcane, potato, maize, wheat and rice may be grown before low input required crops. This is necessary for maintaining the soil fertility that, crops of same family should not be repeatedly grown in the same field. This practice will promote build up of diseases and insect pests and decrease the similar nutrients from the soil. Thus, while making selection of crops for crop rotation, the

following points should be considered :

- (i) Availability of moisture through rain or irrigation;
- (ii) Status of nutrients in the soil;
- (iii) Availability of inputs such as fertilizers, pesticides, human power and machine power;
- (iv) Duration of crop—short or long;
- (v) Marketing and processing facilities.

Box 1.11

The Norflok Rotation

This is one of the best known crop rotation technique. It involves the growing of four crops in a given field over a period of four years. These crops are wheat (cereal), clover or bean (legume), barley (another cereal) and turnip or sugar beet (a root crop).

Advantages of Crop Rotation

1. It controls pests and weeds. Most pathogens survive on crop residue, but only for a limited time, and most pathogens do not infect multiple crops. By naturally breaking the cycles of weeds, insects and diseases, the application and cost of insecticides may be reduced.
2. Crop rotation reduces the need of fertilizers. For example, nitrogen supply is maintained in the crop field when leguminous crops are alternated with others.

[Note : Nitrogen fixers (*e.g., Rhizobium meliloti* of root-nodules of soybean plant (*Glycine max*) work hardest when the nitrogen supply in their environment is low, adding nitrogen fertilizer to a

legume crop shuts down biofixation (nitrogen-fixation)].

3. Several crops may be grown in succession with only one soil preparation (ploughing). For example, land is ploughed for maize and the maize stubbles (which retain nutrients) is left on the land for wheat.
4. By alternation between deep and shallow rooted crops, the soil may be utilised more completely.



ACTIVITY 1.1.

Sow seeds of wheat, paddy, vegetables in different pots with and without manuring and fertilizer application. Record observations given below and note on each crop with special emphasis on the following aspects :

1. Percentage of seed germination.
2. Flowering and maturity time.

(2) Crop Variety Improvement

The art of recognising valuable traits and incorporating them into future generation is very important in plant breeding. Breeders search for individual plants that exhibit desirable traits. The two most desirable qualities of food plants are **high yield** and **natural resistance to disease**. Such traits occasionally arise spontaneously

through a process called **mutation**, but the natural rate of mutation is too slow and unreliable to produce all the plants that breeders would like to see.

Plant breeders select plant varieties with desired characters and cross them. The developed offsprings combine the attributes of both parents. These varieties are multiplied and supplied to farmers.

(i) Need for Higher Crop Yield

- 1. Higher yield.** The main aim of crop improvement is to improve the productivity of economic produce, *e.g.*, grain, vegetables and fodder. Quality seeds of improved varieties are used for their commercial production.
- 2. Improved quality.** Quality considerations of crop products varies from crop to crop, *e.g.*, baking quality in wheat, protein quality in pulses, oil quality in oil seeds and preserving quality of fruits and vegetables.
- 3. Biotic and abiotic resistance.** Under different situations crop suffers due to **biotic stresses** (such as diseases, insects and nematodes) and **abiotic stresses** (such as drought, salinity, water logging, heat, cold and frost). If we develop crop varieties which are resistant to these stresses, then we can improve significantly the crop production. For example, **MUW 318** is a HYV (high yielding variety) of wheat which is released for cultivation in non-tradional areas as Nilgiri and Palni hills and resistant to all the rusts.

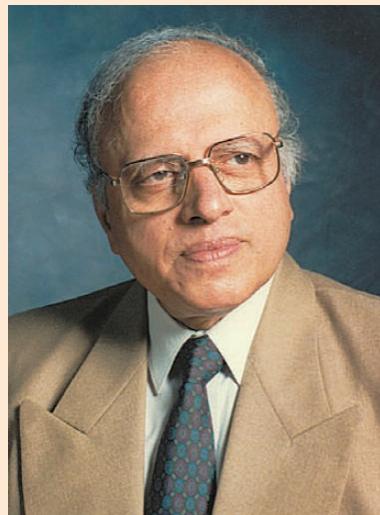
Box 1.12

Green Revolution in India

The bumper increase in the yield of food grains (especially

the wheat crop) as during the 1970s, is often termed as **green revolution**. The 1970 Nobel laureate, American scientist **Dr.N.E. Borlaug** was the person behind triple dwarf Mexican wheat varieties. Their colour was changed to Indian liking through gamma irradiation (**by M.S. Swaminathan, Father of Green Revolution in India**).

Green revolution has made our country self-sufficient in food, increased the buffer stock of food grains and improved the economic conditions of Indian farmers as well as provided employment avenues to large number of people.



M.S. Swaminathan

4. **Changes in maturity duration.** In some of the short duration crops, early maturing varieties can make the crop fit into double and multiple cropping system. This will also reduce the crop's cost of production. Uniform maturity will make the harvesting process easy and reduce the loss of produce during harvesting.
5. **Photo-insensitivity and thermo-insensitivity.** Most of the plants are sensitive to certain abiotic factors as light and

temperature. Development of photo-insensitive and thermo-insensitive crop varieties will help in crossing the cultivation boundaries, e.g., a HYV of wheat, **MACS 2469** can tolerate high temperature.

6. **Desirable agronomic traits.** If we develop those varieties of crops which contain desired agronomic traits then it will help in setting higher production. Thus, tallness, high tillering and profuse branching are desirable characters for the fodder crops. Whereas, dwarfness is desired in cereals as dwarf varieties provide protection from lodging. For example, breeding for resistance to **red rot** has led to sugarcane varieties such as **Co 975** and **Co 62399** which increase cane production in problem areas. Likewise new varieties of chicken pea as **BG 244** and **ICC 34** grow erect, have many branches and pods from base to tip.
7. **Wider adaptability.** If we develop those varieties of crops which have wider adaptability, then it will help in stabilizing the crop production under different environmental conditions. For example, **ICPH 8** is a hybrid pigeon pea plant which takes a short duration to mature, escapes diseases such as **fusarium wilt** and **sterility mosaic** and yields 30 to 40 per cent more than the popular breed. It performs well under drought as well as high-moisture conditions.

Mechanism

Crop variety improvement is manipulation of crop plants for increasing their yield, improving quality, suitability to varied conditions and resistance to biotic and abiotic stresses. **Genetic manipulation** is incorporation of new genes for various traits from other genotypes into the crop variety so as to bring about desired

changes. It is carried out through hybridization, mutation, breeding, polyploidy and DNA recombination technology.

The plant breeding means *production of new varieties or strains by a programme of artificial selection spanning several generations of the organism concerned*. Plant breeding is a science as well as art of improving genetic make up of plant in relation to their economic use. Various approaches which are used for genetic improvement of crop plants are referred to as **plant breeding methods** or **techniques**. Genetic improvement of various crop plants has been done by adopting the following *three* steps : Introduction, Selection and Hybridization.

1. Introduction. This refers to transportation of crop plants from the place of their cultivation to the place where they were never grown earlier. Thus, the process of introducing new plants from their growing place to a new region with a different climate is termed as **plant introduction**. The adjustment of such plants to their new region is called **acclimatization**. It is a quick method to bring about improvement with minimum effort and cost. For example, crops such as potato, coffee, tea, tobacco, groundnut, papaya, etc., have been introduced in India from the other parts of the world.

2. Selection. This process involves selection of the most desirable offspring of a variety of plant for controlled propagation. Selection favours the survival and further propagation of some plants having more desirable characters (related to yield and quality) than others. There are following *two* patterns of selection:

(a) Mass selection. Seeds from a number of similar plants having the desired traits are mixed and sown to raise the new offspring. Offsprings with the undesirable traits are eliminated and the process is continued with the remaining progeny in the same

manner until the desired improvement is achieved. Grapes, apples, pear, watermelon, radish, onion and maize have been improved by this method.

(b) Pure-line selection. Seeds from a single plant having the desirable trait is sown in separate rows to produce the offspring. Desired plants are again selected from the progeny and the process is continued for several generations. The inferior varieties are eliminated in each generation. Wheat varieties such as Kalyan Sona-227 and PV-18 have been developed by this method.

Box 1.13

Selection by human beings is also called **artificial selection**. Artificial selection operating over long time spans can give rise to varieties strikingly different from starting generation. For example broccoli, cabbage, cauliflower and other varieties have been obtained through artificial selection from wild cabbage.

3. Hybridisation. The **crossing** between genetically dissimilar plants to produce a new kind (**hybrid**) is called **hybridisation**. Crossing may be between two different varieties (**intervarietal cross-breeding**), between two different species of the same genus (**interspecific cross-breeding**) and between different genera (**intergeneric cross-breeding**). This method incorporates the desired (good) characteristics of both parents in one variety. The most common type of breeding is inter varietal.

Box 1.14

Cross-breeding

Cross-breeding of two varieties of plants (one high-yielding

and other having resistance to diseases) is carried out to obtain an improved variety of plants which will combine in it both the desired characteristics of the parent crop plants. For example, the new improved variety of crop plant, thus, obtained will give high yield of food grains and it will be disease resistant too. This process of cross-breeding of different plants to obtain a new improved variety of crops is called hybridisation. The new varieties of crop plants, thus, obtained are called “hybrid varieties” “improved varieties” or “high yielding varieties” (HYV) of crops.



In India crops are grown in diverse types of soil and different climatic conditions by poor to progressive farmers. Keeping in mind climatic factors, input application, disease and pest resistance, quality and adaptability, etc., a large number of varieties have been developed in India ([Table 1.7](#)). These varieties are high yielding and resistant to diseases and pests; they have better quality and early to late maturing time.

Table 1.7. Improved varieties or high yielding varieties (HYV) of some important crop plants.

Commodities	Crops	Varieties
1. Cereals	1. Rice	IR 8, Jaya, Heera, VL Dhan 221, C ST 7-1, Jawahar, TRC - C 10, IR 36, Pusa Basmati 1, Kasturi, Vikas, PNR - 591 - 18, Padma
	2. Wheat	MIKS 11 KML 7406, HUW 318, MACS 2496, HD 2687, HD 2285, C 306, PBW 154, HW 157, Pusa Lerma, Sharbati Sonora
	3. Maize	Ganga 5, HIM128, Shakti, Navjot, Vikram
2. Pulses	1. Chick pea (gram)	BE 244, ICC 34, K 850, H 208, Pusa 240, Pant 114
	2. Pigeon pea	ICPH 8, Pusa Ageti, UPAS 120, Pusa 84 Manak, T21
	3. Urad bean	LB G 17, ADT 3, T9 Pant 430, PS 1, CO5
	4. Moong bean	MLZ 67, CO4, PS 16, S8, T 44, K851, Aasha
3. Oil seeds	1. Groundnut	MH 2, ICGS 1, M37, GG 11, TMV 12, Kaushal, ICGS 11, ICGS 44
	2. Mustard	Pusa Bold, Kranti, Pusa Agarni, RLM 514, RH 30
	3. Soyabean	PK 262, PK 327, Pusa 24, Durga, Gaurav
	4. Sunflower	BSH 1, MSF H 8, Morden, Arun, Paras

4. Mutation breeding. Mutations are sudden inheritable variations. They are produced at random through **gamma irradiation** and a number of other physical and chemical agents called **mutagens**. Triple dwarf Mexican varieties of wheat were developed by **N.E. Borlaugh** (1963) through incorporation of mutations by selective hybridization. They were, however, red grained. The same were converted into amber grained forms (e.g., Pusa Lerma, Sharbati Sonora) through mutation carried out by gamma irradiation.

5. Polyploidy. It is increasing the chromosome number. Polyploids are generally more robust with higher yields, e.g., potato.

6. DNA recombinant technology. This technology refers transfer of genes from one organism to another so as to modify the latter. They are called **genetically modified organisms (GMOs)** or **transgenic organisms**. Such transgenic food plants are called **genetically modified food (GMFs)**. Bt cotton is a genetically modified crop which carries bacterial genes that protect plants with insects. Bt stands for the bacterium *Bacillus thuringiensis* whose genes are used by transgenic crops such as cotton, rice, mize, potato, tomato, brinjal, cauliflower, cabbage, etc., to get protection from their insect pests.

(3) Crop Protection Management

Field crops are infested with a variety of **pests**. A *pest* is any destructive organism which causes great economic loss by destroying crop plants or products obtained from them. Pests of crop plants include weeds, insects, mites, nematodes, rodents, fungi, bacteria and viruses. Field crops are infested by a large number of insect pests and diseases. If these pests are not controlled at appropriate time they can damage the crops to the extent of 50 to 70 per cent.

There are various methods by which insects and diseases can be controlled. One of the most common and effective methods is the use of **pesticides** or **biocides** which include **insecticides** (for killing the insects), **weedicides** (for killing the weeds) and **fungicides** (for killing the fungi). Thus, chemicals (poisons) used to kill pests, e.g., weeds, insects, mites, rodents and fungi are called **pesticides**. These chemicals (*i.e.*, pesticides) are sprayed on crop plants or used for treating seeds and soil. However, one should try to avoid the use of these toxic chemicals (pesticides) as they cause environmental pollution. In fact, it would be far better if we adopt the **preventive measures** rather than allowing the crops to be

infested by pests and then control them by pesticides. Some of the preventive measures of pests are the following :

1. Use of resistant varieties of crop plants;
2. Selection of optimum time of sowing the crops;
3. Crop rotation and multiple cropping;
4. Clean cultivation;
5. Summer ploughing.

For example, humid and warm climate is regarded as more favourable for infestation of insect pests and diseases. That is why “*kharif*” crops (e.g., maize, millet) are more prone to these pests in contrast to “*rabi*” crops (e.g., wheat, gram, sugarcane, pea, etc.).

I. Weed Control

Weeds are unwanted plants in the cultivated fields. In other words, plants other than crops are the weeds. Weeds tend to compete with the crops for food (water and nutrients), space and light. In comparison of cultivated crops, the seeds of weeds, germinate easily, their seedlings grow faster, they flower early, their seed production begins after a short growth period and they produce large number of seeds. In fact, weeds take up all the nutrients and reduce the growth of crop in various ways. Therefore, removal of weed plants from cultivated field in early stage of crop is essential to harvest high input returns in terms of high yield. In **un-irrigated condition** weeds affect the water availability and in **irrigated condition** there is competition for nutrient uptake between weeds and crop plants. For example, barley or mustard plants act as weeds in a wheat field and compete with crop for nutrition. Likewise, wild sorghum grown in cultivated crop fields of sorghum (jowar) acts as a weed plant and compete with crop for water and nutrients.

Types of weeds. Infestation of weeds is more during ‘*kharif*’

season than in ‘rabi’ season. Based on the morphology of plants, weeds can be classified into **narrow-leaf weeds** and **broad-leaf weeds**. ([Fig. 1.3](#)):



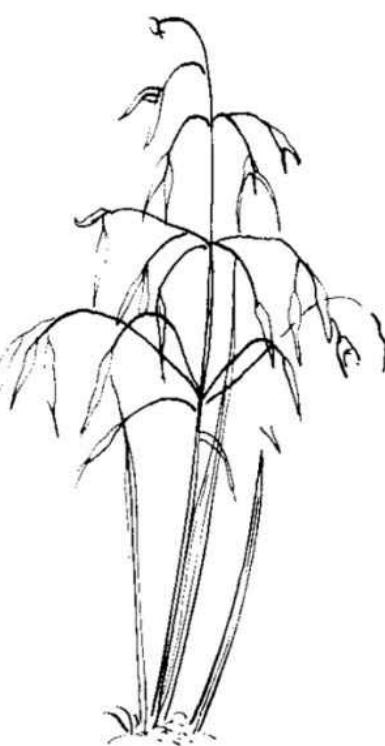
Amaranthus



Chenopodium



Convolvulus



Wild oat



Grass

Figure 1.2. Certain common weeds.

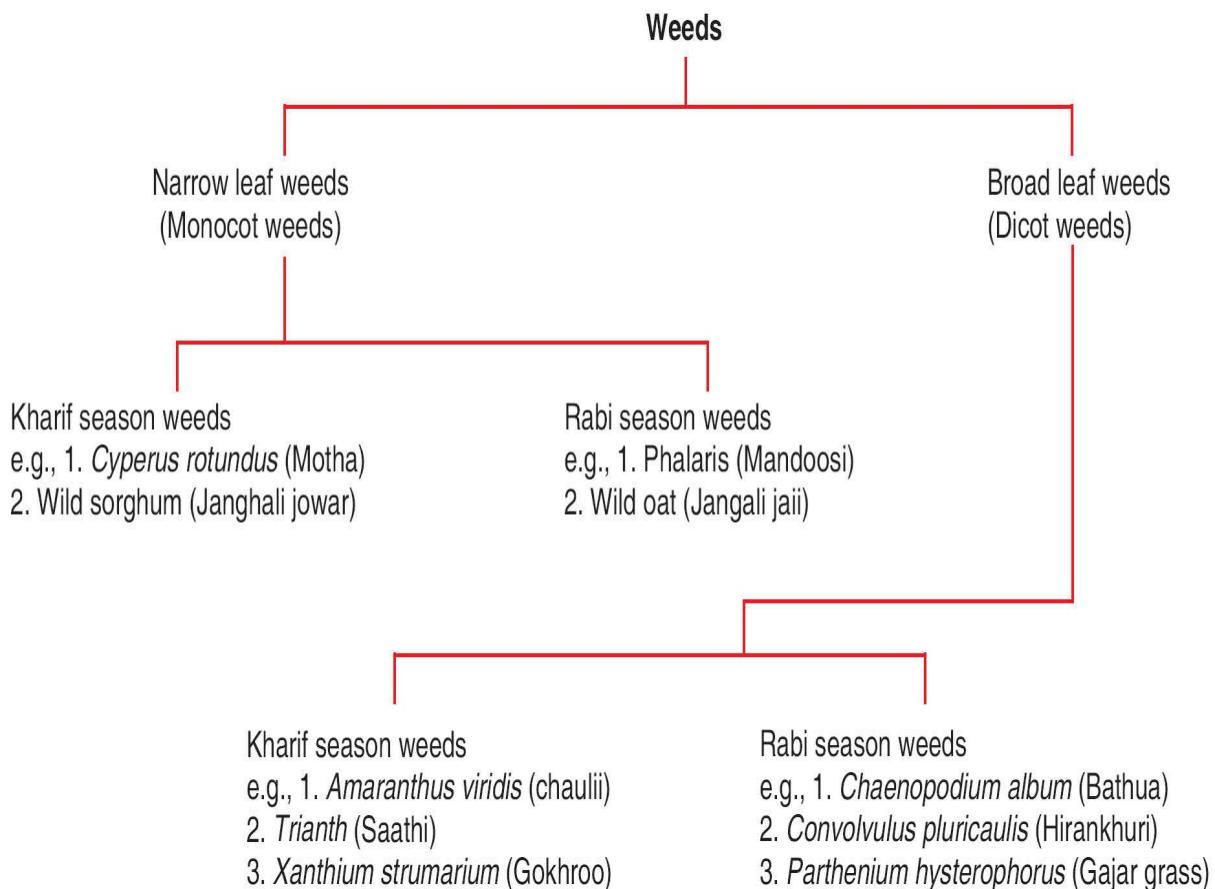


Figure 1.3. Classification of weeds.

Further, during ‘kharif’ season, short duration (*e.g.*, maize and millet), short saturated (*e.g.*, groundnut) and slow growing (*e.g.*, pigeon pea) crops are more susceptible to weeds. Critical period of controlling weeds in these crops is 35 to 45 days.

Methods of weed control. Weeds can be controlled by following methods :

1. Mechanical methods. These include the following methods : **uprooting**, **weeding** with trowel or ‘khurpi’ or harrow (a comb-like implement), **hand hoeing** (scraping), **interculture**, **ploughing**, **burning** and **flooding**.

The process of removing the weeds from crop field is called **weeding**. Weeding can be done by the following methods : 1. Weeds may be pulled out with hand. Ploughing helps in removing large number of the weeds because it uproots majority of them. 2. Before sowing or transplantation, weeds are removed by using a big comb like harrow. Harrow cannot be used in standing crops because it will also uproot the crop plants. The weeds which appear during the growth of crop plants are removed manually by using a trowel (khurpa).

2. Cultural methods. They include the following methods : proper bed preparation, timely sowing of crops, intercropping and crop rotation.

3. Chemical methods. Chemical weed killers, called **herbicides** or **weedicides**, are sprayed on weeds to destroy (kill) them. This is called **chemical control of weeds**. Some common examples of weedicides are the following : (i) 2, 4-D (2, 4-Dichlorophenoxy acetic acid); (ii) Atrazine; (iii) Fluchloralin; (iv) Isoproturon.

4. Biological control. Biological control of weeds involves the deliberate use of insects or some other organisms which consume and specifically destroy the weed plants. The best Indian example of biological control is eradication of prickly-pear cactus (*Opuntia*) by using the cochineal insects in Maharashtra and Tamil Nadu. Generally, a combination of one or more of these weed control methods are employed to get good results. Aquatic weeds are controlled by the fish grass carp.

Effects of Weeds on Crop Plants

1. The growth of weeds in the crop fields is harmful because they compete with the crops of nutrients, water, space and light.

Weeds are generally more efficient than crop plants. They grow quickly, absorb more nutrients and water and deprive the crop plants of essential inputs. As a result the growth of the crop is reduced.

2. The weeds spread crop pests and diseases by acting as alternate host to insects and microorganisms.
3. Some weeds may produce toxic substance which may interfere with growth of crop plants.
4. During harvesting weeds get mixed with crop's produce to downgrade its quality.

ACTIVITY 1.2.

Visit a weed infested field in the month of July or August and make a list of weeds, insect pests and diseases noticed in crops of the field.

II. Insect Pest Control

Many insects are serious pests of plants. They attack all stages, parts and products of plants. Insects attack the crop plants in the following *three* ways :

1. Chewing insects. The chewing insects destroy all sort of crop plants. They cut root, stem and leaf of crop plants by the help of their chewing mouth parts. Thus, chewing insects tear off bits of leaves, delicate branches, chew them and then swallow them, e.g., locusts, grasshoppers (*Hieroglyphus*), caterpillars, grubs, etc.

2. Sucking insects. The sucking insects suck the cell sap from various parts of the plant. They include various common pests of crop plants such as aphids (e.g., *Aphis*), leaf hoppers (*Pyrilla*),

plant bugs (Gundhi bug of rice, painted bug or *Bagrada* of cruciferous plants, and red cotton bug or *Dysdercus*). They possess piercing-sucking mouth parts. Sucking insects make fine punctures in the skin of the plants with their needle-like, hollow beaks and suck the sap.

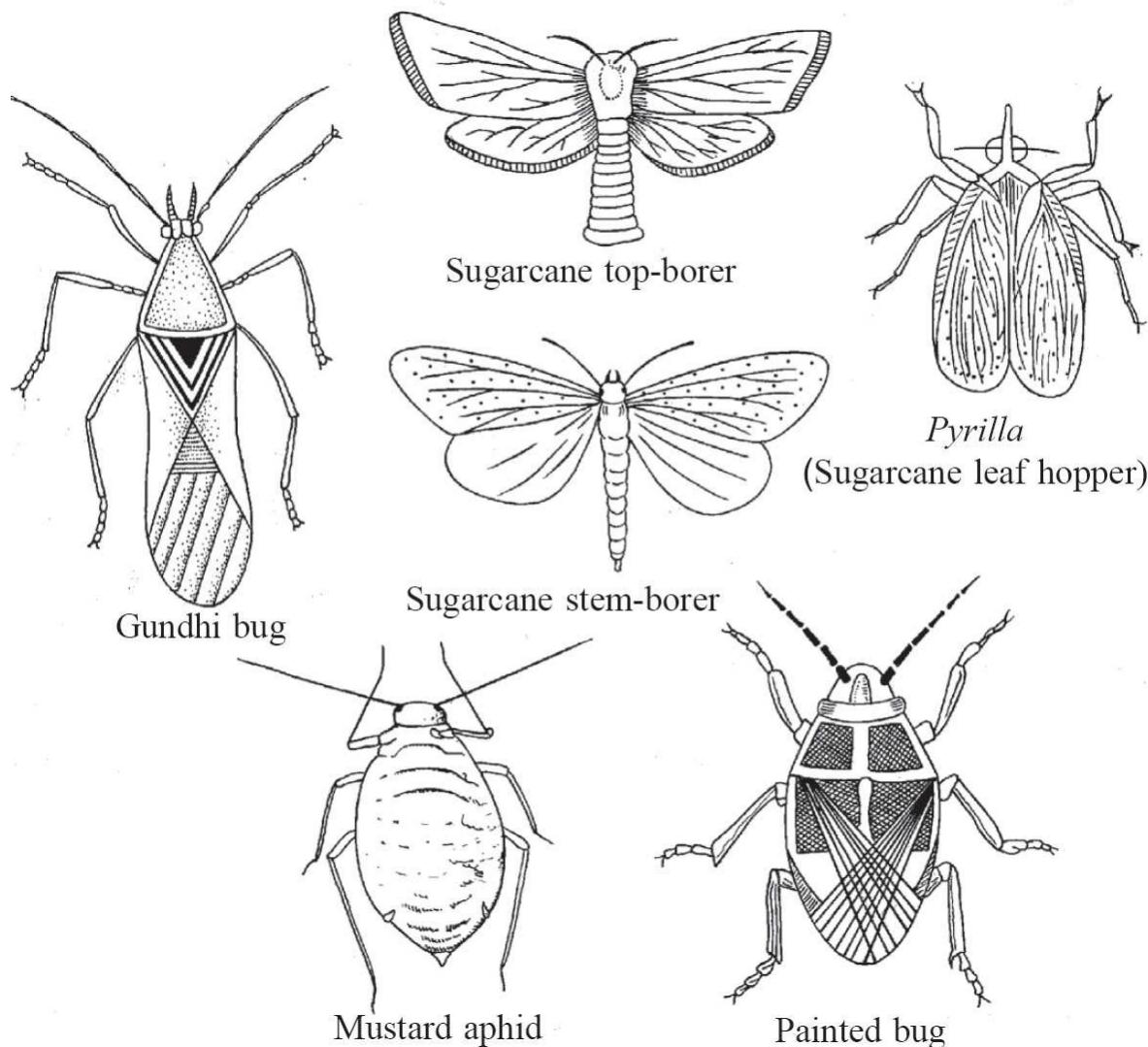


Figure 1.4. Certain common Indian insect pests of crop plants.

3. Internal feeders. The internal feeders live inside the plant parts. They are called **borers** when they live in twigs or roots as **sugarcane borers**. **Pod borer** make holes in pods of chick pea and feed on developing grain. They are called **weevils** when they attack

the fruits and seeds such as **cotton-boll weevil** and **grain weevil**. The maggots of fruit-flies live inside the fruits such as guava, *ber*, *karela*, *ghia tori*, etc., and render them unfit for human consumption.

Further, **grubs** (larvae of beetle) and **termites** (*e.g.*, *Microtermes obesi* and *Odontotermes obesus* damage sugarcane) attack the root zone of crops and then reach the aerial parts causing great damage.

Infestation of different types of insect pests can be controlled by the following methods :

(i) Root cutting types of insects are controlled by mixing insecticide in soil, *e.g.*, **chloropyriphos**.

Stem and leaf cutting and boring type of insects are controlled by dusting or spraying the contact insecticides ([Table 1.8](#)), *e.g.*, **malathion**, **lindane** and **thiodan**.

All sap sucking insects can be controlled by spraying systemic insecticides *e.g.*, **dimethoate** and **metasystox**. An insecticide entering the plant via the roots or shoots and passing through the tissues is called **systemic**. A systemic insecticide harmlessly penetrates the tissues of host plant and poison insects feeding on it (*e.g.*, Aphids).



III. Diseases of Crop Plants

Our environment contains a variety of pathogens. When they

get favourable conditions for their growth and propagation, they spread and infest the crop plants causing diseases. Depending upon their mode of occurrence, crop diseases are of following *four* main types :

1. Seed-borne diseases. These diseases spread through seeds, *e.g.*, “ergot of bajra” or of pearl millet; “leaf spot of rice”; “loose smut of wheat”; red rot of sugarcane; — all are caused by fungi.

2. Soil-borne diseases. These diseases spread through the soil and mostly affect roots and stems of crop plants, *e.g.*, “smut of bajra,” “tikka disease of groundnut”.

3. Air-borne diseases. These crop diseases are transmitted by the air, *e.g.*, “rust of wheat”, “blast of rice”, etc. Air-borne diseases attack all aerial parts of the plants, *e.g.*, leaf, flower, and fruits.

4. Water-borne diseases. Pathogens of these crop diseases are transmitted by the water, *e.g.*, “bacterial blight of rice”.

Control of crop diseases. All the seed-borne and soil-borne diseases can be controlled by treating the seed or soil. Air-borne diseases are controlled by spraying fungicide solution on infested parts. Diseases of the major crops and their control measures have been given in [Table 1.8](#).



Rust of wheat



Tikka Disease of Groundnut



Red rot of sugar cane

 studygear

The logo for studygear features a stylized orange graduation cap icon followed by the word "studygear" in a blue sans-serif font.

Table 1.8. Diseases of major crops, their symptoms and control measures

Name of the crop	Disease	Pathogen	Symptoms	Control measures
1. Rice (paddy)	Blast	Fungus, <i>Pyricularis oryzae</i>	Brown boat-shaped lesions (spots) appear on the margins of leaves.	1. Seed treatment with Thiram 2.5 g/kg seed. 2. Spray Bavistin (1 g/l water) at 10 days interval.
2. Wheat	Rust	Fungus, <i>Puccinia graminis</i>	Yellow, brown or black elongated spots appear on leaves and straws.	Spray Dithane M45 at 2 g/l water at 10 days intervals.
3. Chick pea	Wilt	Fungus	The leaves become yellow and dry up. Roots turn black and decompose.	Deep sowing at 8-10 cm depth in the light soils.
4. Pigeon pea	Stem rot	Fungus	Development of brown to dark brown lesions on the stem near soil surface. These lesions girdle the stem and plant dies.	1. Grow sorghum and pigeon pea mixed cropping. 2. Avoid water logging.
5. Mustard	1. White rust 2. Downy mildew	Fungus	White or cream yellow scattered pustules appear on the lower surface of leaves. Yellow irregular spots appear on leaves. In severe infection, the inflorescence is malformed, twisted and covered with white powder.	Spray Dithane Z.78 or Dithane M45 at 2g/l water. Spray the crop with 0.2% Ziram or Maneb

(4) Storage of Grain

Most crops are harvested only once a year. Thus, they are available in plenty during a selective time. For getting seasonal foods regularly throughout the year, they are stored in safe storage. Cereals or food grains are **stored** at following *three* levels : 1. at producer (farmer) level (called **rural storage**); 2. at trader's level (this is done by keeping food grains in gunny bags, [Fig. 1.5](#)); 3. at

FCI (Food Corporation of India) level (This is done by storing grains in silos, [Fig. 1.6.](#)). During storage, grains and seeds are subjected to spoilage and wastage by various means. This loss has been estimated to be 9.3 per cent annually. During storage damage of grains can take place by following two main types of factors :



Figure 1.5. Grain storage in gunny bags (showing spraying insecticides on them).

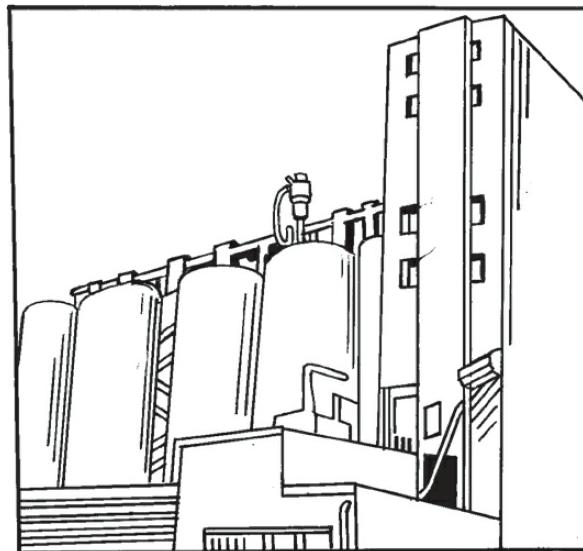


Figure 1.6. A grain-silo.

ACTIVITY 1.3

Make herbarium of cereals, pulses and oil seeds and mention their seasons of sowing and harvesting.

1. Biotic factors such as **insects** ([Box 1.15](#); [Fig. 1.7](#)), **rodents** (e.g., striped squirrel, house rat, house mouse, lesser bandicoot, etc.), **birds** (e.g., parakeet, sparrow, bulbul, blue rock pigeon, crow, etc.), **mites** and **bacteria**.

Box 1.15

Some Common Insect Pests of Stored Grain

- Gram dhora or pulse beetle** (*Callosobruchus maculatus*)
– Its grub damage stored gram.
- Rice weevil** (*Sitophilus oryza*) – Both grub and beetle (adult) damage rice.
- Khapra or wheat weevil** (*Trogoderma granarium*) – Infests stored wheat.
- Grain and flour moth** (*Sitotroga cerealella*) – Its caterpillars bore into grains of rice, wheat, barley, maize and jowar.
- Rust red flour beetle** (*Tribolium castaneum*) – Both larvae and adult damage flour and flour products.
- Rice moth** (*Corcyra cephalonica*) – Larvae damage rice and maize.
- Lesser grain borer** (*Rhizopertha dominica*) – Both grub and adult (beetle) damage the grains, reducing them to perforated shells ([Fig. 1.7](#)).

2. Abiotic factors such as moisture contents and temperature.

(a) Effect of temperature. The growth of insects and microorganisms in the stored food materials depends upon the fluctuation of temperature. As the maximum growth rate of the insects is at a higher temperature at 30°C to 32°C, the microorganisms and enzymes are most active at 30°C to 40°C.

Therefore, the food-grains / materials should be stored at lower temperature, *i.e.*, below 30°C, then the insects and microorganisms and enzymes will become less active and the damage of material is minimised.

(b) Effect of moisture. For safe-storage, the moisture content of the food-grains should be 14 per cent by weight or less. The greater amount of moisture present in food grains increases the rate of decay of food materials caused by microorganisms and enzymes and the population of insects increases rapidly. When these insects respire they release a lot of heat, so the temperature of stored food grain rises. The rise in temperature of stored food-grains due to the heat released by the respiration of a large number of insects, microorganisms (fungi such as molds, yeast, etc.) is called **dry heating of food grains**.

Another disadvantage of the presence of greater moisture is that, it increases the size of the food-grains, due to which these grains require more space.

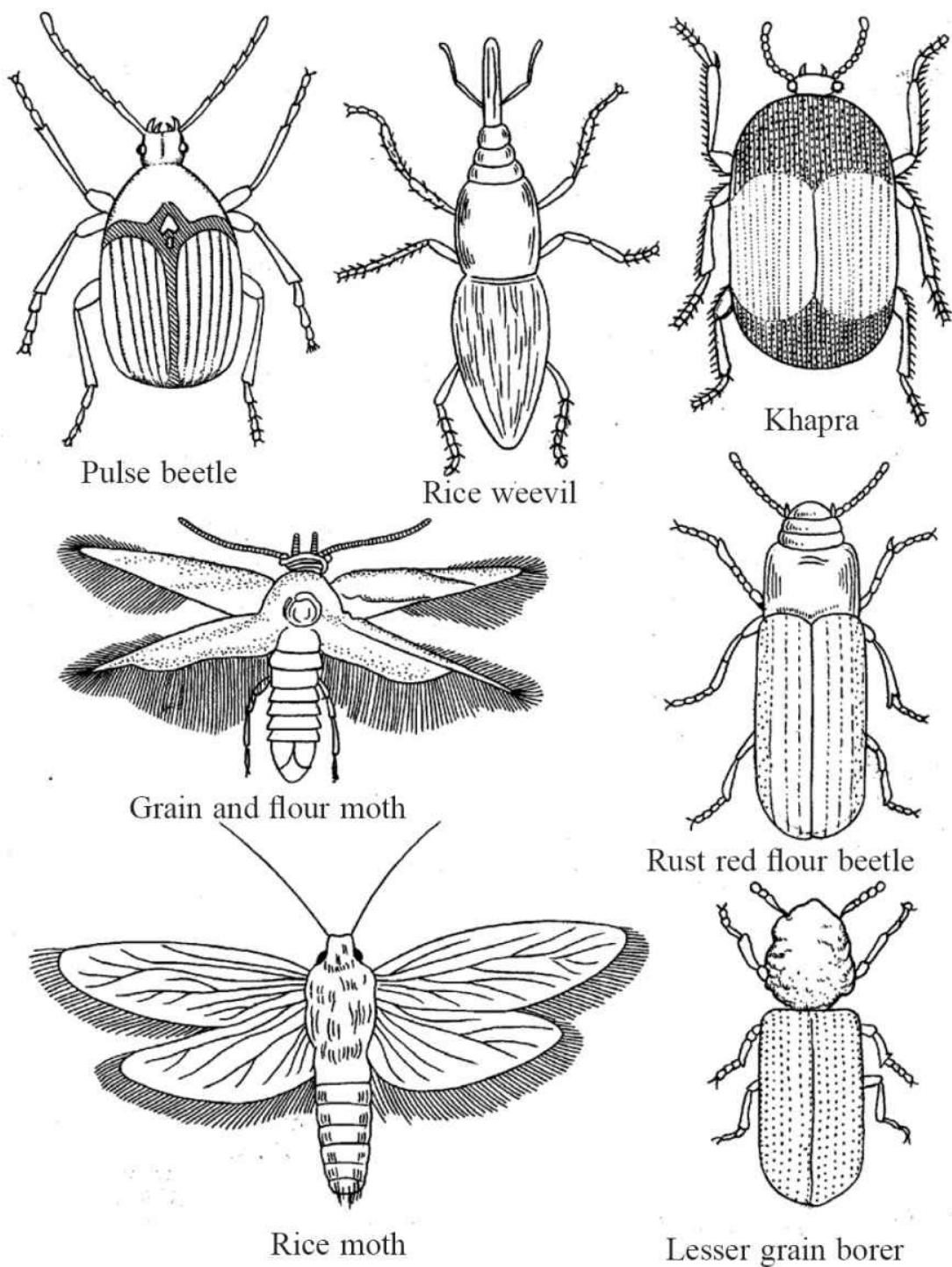


Figure 1.7. Some insect pests of stored grains.

(c) Effect of humidity. The moisture contents present in air is known as **humidity**. It promotes the growth of moulds (*e.g.*, *Mucor*, *Penicillium*) on the stored food materials. High humidity

content also initiates the germination process of stored seeds which also releases the heat. Therefore, as the moisture content of the grains increases from 14 to 18 per cent, the temperature may shoot up to 66°C. *The rise in temperature of stored food-grains due to the growth of moulds and fungi and germination of stored food-grains under high humidity conditions of air is called wet heating or damp grain heating.*

Thus, dry heating and wet heating both lowers the quality of stored food-grains and badly affect the germination of grains.

Combination of biotic and abiotic factors causes infestation of insects, degradation in quality, loss in weight, poor germinability, discolouration of produce, poor marketability and economic loss. Therefore, stored grains must be protected from all types of losses and damages.

Preventive and Control Measures

Biotic and abiotic factors which cause destruction of grains during storage can be prevented and controlled by using the following methods.

1. Drying. The proper time of **harvesting** a crop is very important, because the time of harvesting a crop determines the yield of the crop production as well as the storing qualities of the crop products.

At the time of harvesting of the crop, moisture content in grains varies from 15-35 per cent. But, for safe storage the seeds and grains should have moisture content below 14%. So the step of drying of grains is a vital preventive measure.

The harvested food grains should be dried by spreading them over plastic sheets or on cemented floor (This is done because if the grains are spread directly on the ground, they will absorb more

moisture from the ground). All the sun dried food grains are allowed to cool to the room temperature before storing them.

On commercial bases, mechanical drier with hot air is used.

2. Cleaning. The grains and other agriculture produce should be properly cleaned before their storage. They should be filled in new gunny bags before keeping in godowns, warehouses or stores.

3. Safe and proper storage. Godown, warehouses and stores should be properly cleaned, dried and repaired. Pathways (alleys) should be provided between the stacks of grain-filled bags, for the periodic inspection, for spraying ([Fig. 1.5](#)) or for fumigation.

For the large scale storage of grains, the **grain silos** are used. The silos are big and tall cylindrical structures ([Fig. 1.6](#)). They store different stocks of food items at different levels. Silos are provided with outlets (chutes) at different levels to withdraw the desired stock of grains. They have built in arrangement for aeration, temperature control, protection from insects, rats, birds and mammals, for fumigation and inspection of their grain stocks.

4. Chemical control. The pesticide solution is sprayed over the gunny bags containing food grains by using manual sprayer or a mechanical sprayer. The spraying of pesticides is more suitable for disinfecting the whole godown before the arrival of the fresh stock of grains. The following pesticides can be sprayed : BHC (benzene hexa chloride), malathion and pyrethrum. Pesticides can be mixed with the grains only when they are to be used as seeds for sowing.

5. Fumigation. Those pesticides which can destroy insects by forming toxic fumes are called **fumigants** and process of their use is called **fumigation**. Fumigants may be solid, liquid or gaseous. Ultimately they volatalise or react with moisture of the air, forming poisonous fumes. Examples.

1. Aluminium phosphate (*solid fumigant*) tablets commonly known as **black poison** (3g each) can be used at the 2 tablets per tonne grain or 160 tablets per 100 cubic metre volume of grain.
2. Ethylene dichloride plus carbon tetrachloride or EDCT (*liquid fumigant*). Ethyl dibromide (EDB) is another liquid fumigant.
3. Methyl bromide (*gaseous fumigant*).

Fumigation is the most effective method of destroying insects in stored food grains.

1.3. ANIMAL HUSBANDRY

The branch of agriculture that deals with the feeding, caring and breeding of domestic animals is called **animal husbandry**. *Husbanding* means to use a resource carefully and without waste. Thus, animal farming or animal husbandry requires planning for domestic animal's shelter, breeding, health, disease control and proper economic utilisation. Our domestic animals or livestock includes those animals which are raised for farm purposes, e.g., cattle (cow, bull or ox), buffalo, yak, horse, ass, goat, sheep, camel, etc.



Cattle production.



Poultry.



Fish farming.



Bee keeping.

A. Cattle Farming

In India, cattle (cows and buffaloes) are next to land in use for farmers. Human beings domesticate them for milk, also for meat,

leather and transportation. Thus, cattle raising is done to fulfill the specific needs for dairy, draught or dual purpose of breeds. Generic name of cow is *Bos indicus*; it is adapted for drier regions of the country such as Gujarat and Rajasthan. Buffalo is commonly called Indian water buffalo; its generic name is *Bubalus bubalis*. It is well adapted for wet areas and river beds of Kerala, Bengal, Andhra Pradesh and Tamil Nadu.

1. Breeds of Cows

Cows are classified as draught, dairy and dual purpose breeds ([Table 1.9](#)):

Table 1.9. There are 26 breeds of cows (cattle) in India. Some of the cattle breeds of India and their distribution.

Cattle Breed	Distribution
	Milch Breeds
1. Gir	Gujarat, Rajasthan
2. Sahiwal	Punjab, Haryana, Uttrar Pradesh
3. Red Sindhi	Andhra Pradesh
4. Deoni	Andhra Pradesh
Draught Breeds	
5. Malvi	Rajasthan, Madhya Pradesh
6. Nageri	Delhi, Haryana, Uttar Pradesh
7. Hallikar	Karnataka
8. Kangayam	Tamil Nadu and other parts of South India
General Utility Breeds	
9. Ongole	Andhra Pradesh
10. Kankrej	Gujarat
11. Tharparkar	Gujarat, Andhra Pradesh

Box 1.16

A **breed** is a group of animals of common origin within a species that has certain distinguishing characteristics not found in other members of the same species.

1. Draught breeds. Their meat is tough and they give little milk. Hence, they are used as beasts of burden in various agricultural practices such as tilling (to plough the land), irrigation (in running the water wheel or Persian wheel) and carting (to transport humans and materials from place to place). Small and marginal farmers still make use of draught breeds of cow.

2. Dairy breeds. They have large digestive systems and a spacious udder because as much as possible of the food they consume must be turned into milk.

3. Dual purpose breeds. These breeds provide milk as well as help in agricultural tasks. In India, dual-purpose breeds are favoured by farmers because in these breeds the cows are fairly good milk yielders and the bullocks (sterilized males) good for draught work.

Milk producing female population of animals is called **milch animals** or **dairy animals**. These include cow, buffalo, goat, camel and yak. Buffalo and cow, both are excellent dairy animals, as well as, their males or he-buffaloes and oxen (bullocks) are used for various draft purposes (*i.e.*, bullock labour) in agriculture. Therefore, buffalo and cattle production is done for milk, draft (labour) and dual purposes, *i.e.*, both for milk and draft purposes. Common breeds of indigenous buffaloes are **Murrah**, **Mehsana** and **Surti**. Indigenous cows are **Red Sindhi**, **Sahiwal** and **Gir**.



Indigenous breeds of cow. Indigenous breeds of dairy cows are mainly of *three* types (varieties):

(i) Red Sindhi. This cow is medium in size and red in colour with dark and light red shades ([Fig. 1.8](#)).

(ii) Sahiwal. This breed of cow is superior to other dairy cows. The animal is large and of heavier built ([Fig. 1.9](#)).

(iii) Gir. This is the native breed of Gir forest in Gujarat. This cow is medium in size and fairly good milk yielder ([Fig. 1.10](#)).

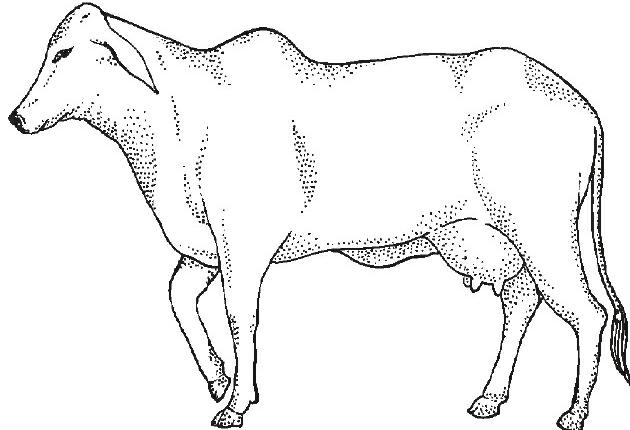


Figure 1.8. Red Sindhi cow.

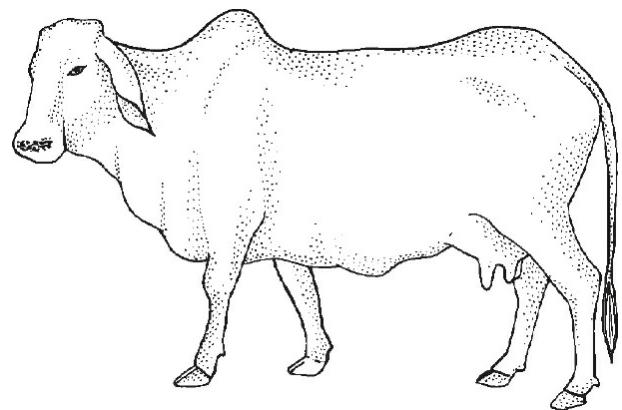


Figure 1.9. Sahiwal cow.

2. Breeds of Buffaloes

In India, buffaloes are domesticated in great number. There are ten breeds of buffaloes in our country. The important breeds of buffaloes with high yield of milk are as follows :

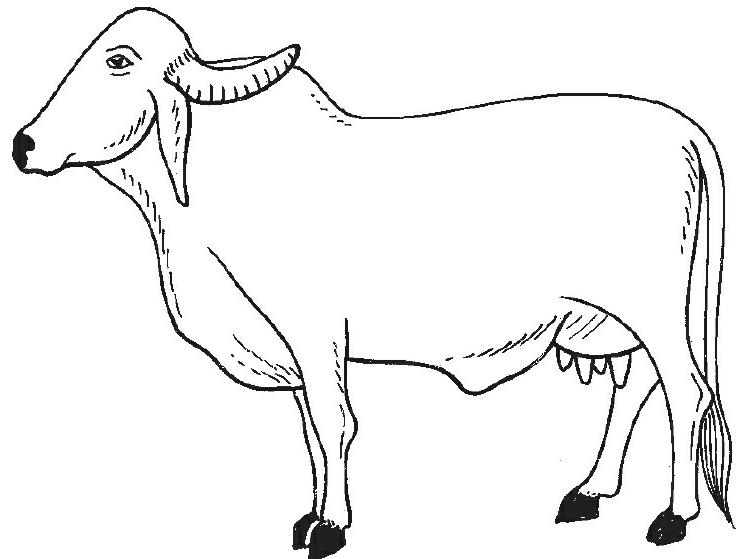


Figure 1.10. Gir breed of cow.

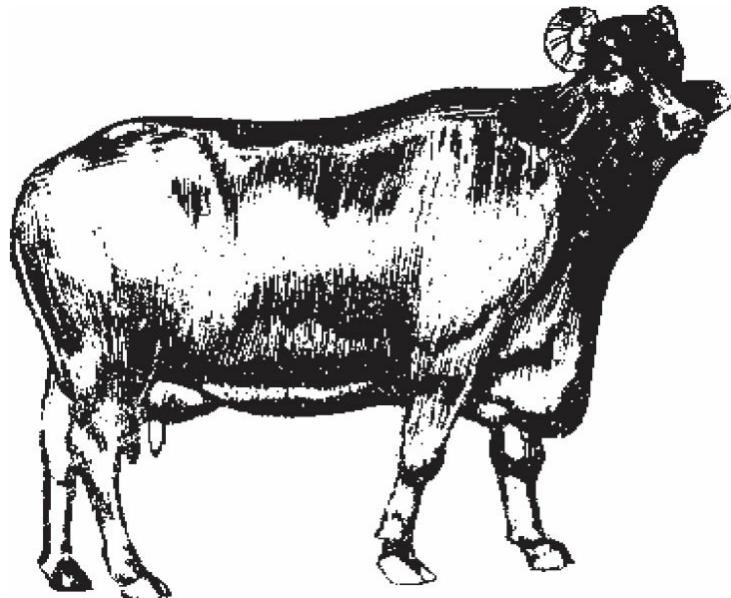


Figure 1.11. Murrah, a high milk-yielding breed of buffalo.

(i) Murrah. This is original breed of Haryana and Punjab ([Fig. 1.11](#)). This breed has massive body ; short and tightly curved horns ; adult female weighing 430-500 kg and male 530-575 kg. During its lactation period, its average yield of milk is 1800 to 2500 litres with fat contents up to seven per cent.

(ii) Mehsana. This is a breed of Gujarat especially from Vadodara and Mehsana districts. It is cross between Murrah and Surti. Usually black or gray. Their milk production is about 1200 to 2500 litres. They are known for giving milk at comparatively early age with regular breeding intervals. The bullocks/he-buffaloes (average weight 569 kg) are slow but good for heavy work.

(iii) Surti. This breed of buffalo is native of Kaira and Vadodara districts in Gujarat. Black or brown, eyes prominent, horns are sickle-shaped. Their average milk yield is from 1600 to 1800 litres. The fat content of milk is about 8 to 12 per cent. This breed of buffalo is capable of adjusting in other parts of the country.

Quality of Buffalo Milk

Buffalo is potentially the most productive economic animal. It has an exceptionally long productive life of about 20 years. Also, buffalo's milk is richer in fat, tocopherol (vitamin E), proteins, calcium, phosphorus and contains low sodium, potassium, cholesterol. Buffalo's milk is ideal for making milk products such as khoa, rabri, dahi, ghee, etc., and is always in great demand. Milk in comparison to other food products from animals such as egg and meat contain all the major food constituents such as carbohydrates (sugars), protein, fat, minerals (mainly phosphorus, calcium) and water. Certain vitamins such as vitamin A and D are also present in milk. The nutritional value of animal products is given in [Table 1.10.](#)

Table 1.10. Nutritional values of animal products.

Animal product	Per cent (%) Nutrients					
	Fat	Protein	Sugar	Minerals	Water	Vitamins
1. Milk (cow)	3.60	4.00	4.50	0.70	87.20	B ₁ , B ₂ , B ₁₂ , D, E
2. Egg	12.00	13.00	*	1.00	74.00	B ₂ , D
3. Meat	3.60	21.10	*	1.10	74.20	B ₂ , B ₁₂
4. Fish	2.50	19.00	*	1.30	77.20	Niacin, D, A

* Present in very little amount.

Breed Improvement for Higher Production of Milk

Milk production of milching animals depends on their **lactation period**, i.e., period of milk production between birth of a young one and the next pregnancy. For example, lactation period of some indigenous breeds of cows are as follows :

1. Red Sindhi – 231 to 345 days

2. Sahiwal – 184 to 354 days
3. Gir – 230 to 394 days

So, milk production can be increased by increasing lactation period. For achieving this target the technique of **selective breeding** has been used.

In India, the poor genetic material of most of the livestock is one of the prime reason for the meagre produce. Efforts are underway to improve the yield by the development of new and better varieties of livestock by the practice of selective breeding ([Box 1.17](#)). This involves mating parents of different varieties, each having some desired trait which are then passed on to the offspring. The different desired traits or characteristics of the parent generally chosen for breeding are the following : 1. tolerance to climatic conditions ; 2. lactation period ; 3. high yield of the produce (milk/meat) ; 4. resistance to diseases ; 5. proper age of reproduction ; 6. good health ; 7. general appearance.

Box 1.17

Breeding means to reproduce. In case of animals, breeding is done to obtain animals with desired characters. The two individuals of desirable characters can be selected as parents. These are then crossed to obtain new breed of the animals, e.g., by cross breeding a cow of low milk yielding breed with a male bull of high milk yielding breed, we can get a new breed of cow which produces more milk.

In fact, the production of milk from our *indigenous dairy breeds* of cows comes to an average of 6–8 litres per day, whereas *exotic breeds* of cow ([Box 1.18](#)) provide on an average 60 litres of milk in a day. The **lactation period** of exotic breeds is relatively longer

than our indigenous breeds. To improve the production of milk of our indigenous cows, cross breeding programme has been undertaken at a number of research centres in our country.

Methods of breeding animals. There are two methods of breeding animals: (i) Natural method; (ii) Artificial method.

(i) Natural method of breeding. It is a traditional method of breeding. It takes place by cross-breeding between the desi (indigenous cow) and the bull of high milk yielding exotic breed by the natural physical mating process during the heat period (fertility period) of cow.

The yield of milk and prolongation of lactation period have significantly improved in successful crossbreeds ([Table 1.11](#)). Improved crossbreeding programme has been widely extended to entire country by the process of artificial insemination.

Table 1.11. Milk production during lactation period by various breeds of cow.

Dairy breeds of cows	Average milk production (litre)	Lactation period
1. Sahiwal	2800	300
2. Freiswal	5000	326
3. Holstein-Friesian	16000	365

(ii) Artificial method of breeding. Scientifically this method is called **artificial insemination**. The process of injecting the semen obtained from desired male bull of high milk yielding breed into the genital or reproductive tract of female animal during heat period is called **artificial insemination**.

It generally gives improved breeds. This method is widely used

to improve the qualities of cow, buffaloes, poultry, horse, sheep, goats and pigs.

Box 1.18

Exotic Breeds of Cows

1. **Jersey** (Native of Island of Jersey, in English channel).
2. **Holstein - Friesian** (Native of Holland)
3. **Brown Swiss** (Native of Switzerland)

Improved Breeds of Cows in India

1. **Karan Swiss** (Brown Swiss X Sahiwal)
2. **Karan - Fries** (Holstein - Friesian X Thaparkar)
4. **Frieswal** – (Holstein - Friesian X Sahiwal)

Technique of artificial insemination. The semen of a healthy and tough animal of high milk yielding breed is collected and preserved by freezing or chemical methods. This preserved semen is then injected artificially into the genital tract of the female animal during fertility (heat) period (During heat period, cows and buffaloes are sexually excited and ready to mate). It is a more reliable method of animal breeding. The first experiment in this field was performed in the year 1780 by **Spallanzani** to obtain pups (young ones of dog).

More than 6000 artificial insemination centres have been established in the different parts of India to benefit the dairies and farmers at village level. One such centre is located at **Indian Veterinary Research Institute (IVRI)**, Izatnagar.

Precautions for Artificial Insemination

The various precautions to be observed to ensure high fertility by artificial insemination method are as follows:

1. The semen should be obtained from high quality (healthy and high yielding) male animal.
2. The female animal selected should-be healthy and of sound breeding age (*i.e.*, proper age for reproduction).
3. Artificial insemination should be carried out only at the proper heat-period of female animal.
4. The instruments used in artificial insemination should be properly sterilised. Proper technique should be used for artificial insemination.

Advantages of Artificial Insemination

Artificial insemination method of breeding has following advantages:

1. Bulls of selected breeds are kept in climatic conditions most suitable for their healthy living.
2. The bulls are reared in most hygienic conditions under the direct supervision of experts.
3. Through selective breeding, animals of desired characteristics can be raised.
4. It is economical (*i.e.*, cheaper) because semen from a single bull can be used to impregnate several thousand cows (about 3000).
5. Semen can easily be transported, even to remote places.
6. High quality semen is available all the time and all the places. However, a high quality bull is not always available at all the places.
7. This method is more reliable and hygienic than the natural

method of breeding animals by mating.

8. It gives high rate of successful fertilization.

Box 1.19

Superovulation and embryo transplantation

Generally one ovum is released from each ovary at the time of ovulation. But by hormone injection, more ova can be produced from the ovary. This is called **superovulation**. In USA in 1979, a prized cow was super ovulated, mated and the embryos were removed. The embryos were implanted in foster mothers. In that year, this one cow could have produced 89 calves by this method.

In the technique of embryo transplantation the developing embryo from a pregnant superior breed is removed and transferred into another female with inferior characters, for further development. The Superior breed can be made to bear another embryo in quick succession.

ACTIVITY 1.4

Visit a livestock (*e.g.*, Dairy) farm. Note the following :

1. Number of cattle
2. Types of different breeds and their number.
3. Production of milk on daily basis from different breeds.

Give your comments whether improvement of cattle breed is required or not.

B. Farm Management Practices

In a farmhouse, the requirement of proper cleaning and shelter

for cows and buffaloes is must due to two reasons : (i) for the production of clean milk; (ii) for the health of the animal. Both cow and buffaloes require regular grooming (brushing) to remove dirt and loose hairs. They are sheltered under roofed sheds that protect them from rain, heat, direct sunlight and cold. The floor of the cattle shed is made brick-lined and sloping for facilitating cleaning and keeping their sitting place dry. Generally a cow requires about six square metre space and buffaloes need little more space. In the shelter, the animals are provided with feeding passage and feeding trough. The sheds or shelters should be provided with **cross ventilation** with sufficient number of inlets and outlets.

The food eaten by animals is called **feed**. **Feeding of animal** means providing food to animal. The food requirement of dairy animals is of two types :

1. Maintenance requirements. The food is required by the animal to support it to perform the basic functions of life.

2. Milk producing requirement. It includes the type of food required during lactation period. Maintenance part of the ration depends upon the **body weight**, while milk production part is dependent upon the **level and composition of the milk**.

1. Components of Cattle Feed

The animal feed includes two types of substances :

(i) Roughage. It largely contains fibres such as green fodder, silage, hay (straw of cereals) and legumes (e.g., berseem, lucerne, cow pea and agathi).

(ii) Concentrates. The concentrates used in feed of cattle and buffaloes are a mixture of substances which are rich in one or more of the nutrients (e.g., carbohydrates, fats, protein, minerals and vitamins). Concentrates are low in fibres and contain relatively

high proteins and other nutrients. Concentrates include cotton seeds, oil seeds, grains of maize, oats, barley, jowar, bajra, gram and their byproducts such as wheat barn, rice barn (polish), gram husk, oil seed cakes and molasses.

Box 1.20

1. Milk yield of an animal depends upon the amount and the kind of food provided to it.
2. Oil cakes are mainly fed to milching cows. Oil cakes are made from the residues available after extraction of oil from the oil seeds such as mustard, cotton seed, groundnut, etc.
3. A calf needs more food and nutrients than an old cow. This is because more energy is required for the growth process of the calf.
4. In India, the attitude of feeding animals with waste material from the farm is gradually changing because the farmers are now cultivating such grasses as lucerne, alfalfa and are making available green fodder.

The dairy cattle is given a **balanced ration**, which contains all nutrients in proportionate amounts. A **ration** is the amount of food which is given to the animal during a twenty-four hour period. The daily average feed (ration) of a cow is given below :

1. Green fodder and dry grasses (roughage) = 15 to 20 kg
2. Grain mixture (concentrates) = 4 to 5 kg
3. Water 30 to 35 litres.

Besides above mentioned nutritious food material, dairy animals require certain additive feeds, which contain **antibiotics**,

minerals and **hormones**. Such additive feeds promote the growth of the animals, facilitate good yield of milk and protects them from diseases. **A poor quality of feed directly affects the yield of milk in cows and buffaloes.**

2. Diseases of Cattle and Buffaloes

Cows and buffaloes suffer from various diseases. The diseases adversely affect the production of milk and cause mortality of sick animals.

Diseases of dairy animals are broadly classified into following *three* categories : 1. parasitic diseases: 2. infectious diseases; and 3. non-infectious diseases.

1. Parasitic diseases. The parasites of cattle may be both external and internal. The **external parasites** include **fleas, lice** (blood-sucking lice), ticks and mites. They live on skin of cows and buffaloes and mainly cause skin diseases. Buffaloe leech (*Hirudinaria granulosa*) sucks blood of bufalloe and causes **anaemia** disease. The **internal parasites** such as worms (e.g., *Ascaris ritulorum*) affect stomach and intestine of cows and buffaloes and flukes (e.g., *Fasciola gigantica* and *F. hepatica*) of the host (cow/buffaloe) damage the liver.

2. Infectious diseases. Infectious diseases are mainly caused by viruses and bacteria. They are contagious diseases and spread by contact from animal to animal.

(a) Examples of viral diseases. Foot and mouth disease, cow pox or vaccinia and Rinderpest. Symptoms of foot and mouth disease include blisters on feet and mouth, excessive formation of saliva (trail of saliva hangs from the mouth), soreness of mouth, diminished appetite and high fever.

(b) Examples of bacterial diseases. Anthrax, Hemorrhagic

septicemia, Black quarter, etc. Hemorrhagic septicimia is caused due to infection of *Pasteurella multocida* and black quarter is caused by *Clostridium chanroei*.



Fleas on cattle.



Foot and Mouth disease.

Table 1.12. Common diseases of cattle and their symptoms.

<i>Viral Disease</i>	<i>Symptoms</i>
1. Cow pox	Fever accompanied by appearance of small nodules.
2. Rinder pest	Constipation followed by severe diarrhoea, discharge from the eyes and nostril, loss of appetite.
3. Foot-and-mouth	Blisters appear on the mouth and foot resulting in extreme soreness of the parts. Loss of appetite, excessive salivation, high fever accompanied by shivering. Inability to work.

4. Rabies	Marked changes in behaviour, restless, paralysis (symptoms appear in 14-90 days).
5. Dermatitis	Irritation, blisters and eruptions on the skin surface.
<i>Bacterial Disease</i>	<i>Symptoms</i>
1. Anthrax	Fever with swelling of body, milk secretion reduced.
2. Haemorrhagic septicemia	High fever, anorexia, increased respiration, marked salivation.
3. Black quarter or Black leg	A fatal toxemia especially of young cattle.
4. Tuberculosis	Fever, infection of udders, lungs, intestines and other parts.
5. Brucellosis	Sterility due to infection in the reproductive organs, e.g., uterus in females and testes in males.
6. Mastitis	Fever, udders become swollen, milk is watery.
7. Salmonellosis	Fever, diarrhoea with blood clots.
<i>Fungal Disease</i>	<i>Symptoms</i>
Ringworm	Small, circular, discoloured raised patches
Parasitic Disease	
1. External parasites (Lice, ticks)	Live on skin and cause skin disease
2. Internal parasites (Worms, fluke)	Live in the stomach, intestines and damage the liver of cattle

There are some of the diseases of domestic animals that can be transmitted to human beings ([Box 1.21](#)).

Box 1.21

Diseases of Animals Transmitted to Human Beings

- 1. Viral diseases.** Rabies, Cow pox, Encephalitis.
- 2. Bacterial diseases.** Anthrax, Tuberculosis, Brucellosis.
- 3. Fungal diseases.** Actinomycosis, Aspergillosis,

Ringworm.

4. Parasitic diseases. Amoebiasis, Trypanosomiasis, Ascariasis.

Box 1.22

Dr. V. Kurien

Born on 26th November, 1921, **Dr. V. Kurien** is the founder chairman of the **National Dairy Development Board (NDBD)**. NDBD designed and implemented as the world's largest dairy development programme, called "**Operation Flood**". Operation flood programme was started with the pledge to provide milk to one and all. Dr. Kurien is known as the **Architect of India's Modern Dairy Industry** and the **Father of White Revolution**. White revolution means huge increase in milk production and it becomes possible by using new, improved breeds of cattle and buffalo, giving them better feed and care.



Dr. V. Kurien

1.4. POULTRY FARMING

The poultry industry with its production in the form of eggs and meat is of particular importance in providing a balanced diet for the human population. Poultry birds serve human beings in various ways. They are not only efficient converters of agricultural byproducts, particularly of wastes into high quality meat but also provide egg, feathers and rich manure. **Proper management** of poultry includes improved methods of hatching, rearing, housing, sanitation, prevention from diseases and a sound marketing arrangement.

The word, *poultry* has originated from the old French word ‘*poult*’ means chicken, the young one of common domestic fowl. So this word should have been used only for domestication (rearing) of chicken or fowls. However, poultry also includes ducks, geese, turkeys, guinea-fowls and pigeons. Poultry is the choice of millions as staple food world over. The constant efforts in the field of poultry farming has made it possible to increase the production of eggs in our country. India has become 5th largest country in the world in poultry production after China, former USSR, USA and Japan.

An egg laying poultry is called **egger** or **layer** and the poultry reared for obtaining meat is called **chicken** or **broiler**. Poultry farming is undertaken basically to raise domestic fowl for egg production and chicken meat.

Table 1.13. A comparison between layers and broilers.

<i>Layers</i>	<i>Broilers</i>
1. Layers are egg-laying birds, managed for the purpose of getting	1. Broilers are maintained for getting meat.

<p>eggs.</p> <p>2. Layers start producing eggs at the age of 20 weeks. So they are kept for layer period depending upon laying period (about 500 days).</p> <p>3. They require enough space and adequate lighting.</p>	<p>2. They are raised upto 6-7 weeks in poultry farms and then sent to market for meat production.</p> <p>3. They require conditions to grow fast and low mortality.</p> <p>4. Their daily food requirement (ration for broilers) is rich in protein and vitamin A and K. The fat content also should be adequate.</p>
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1. Poultry Breeds

In India, available poultry breeds are included in following *three* categories :

1. Desi or indigenous breeds. We have only four pure breeds of indigenous or desi fowls. They are **Aseel**, **Chittagong**, **Ghagus** and **Busra**.

Aseel or **Indian game** is most popular breed of India and selected for poultry farming. This breed provides high yield of meat and also is good egg layer. The average weight of cocks varies from 4 to 5 kg and of hens from 3 to 4 kg. There occur only four popular varieties of Aseel, namely (a) **Peela** (golden red), (b) **Yakub** (black and red), (c) **Nurie** (white), and (d) **Kajal** (black).

The indigenous breeds of poultry are hardy (strong) and possess natural immunity against common diseases. The disadvantages of *desi* hens are (i) They are smaller in size ; (ii) They are slow growing ; (iii) They lay less number of eggs (*i.e.*, 60 eggs per year) and (iv) They produce small sized eggs.

(ii) Exotic breeds. Exotic breeds mean varieties of other

countries or foreign breeds. There are present numerous exotic breeds of poultry which have been successfully acclimatized in India. The following two exotic breeds of poultry are most popularly used in our country :

(a) White Leghorn. This very popular exotic breed of fowl produces long white eggs. Since white leghorn has small body size (body weight 2.7 kg of cock and 2.0 kg of hen), so need less feed for its maintenance. Thus, its farming proves quite economical.

(b) Rhode Island Red. This breed of fowl was developed on the farm of Rhode Island in U.S.A. This is a dual type of breed, it is fairly good egg layer and also meat yielding (broiler). Some other exotic breeds of fowls in our country are **Black Minorcha, Plymouth and Light Sussex** ([Fig. 1.12](#)).



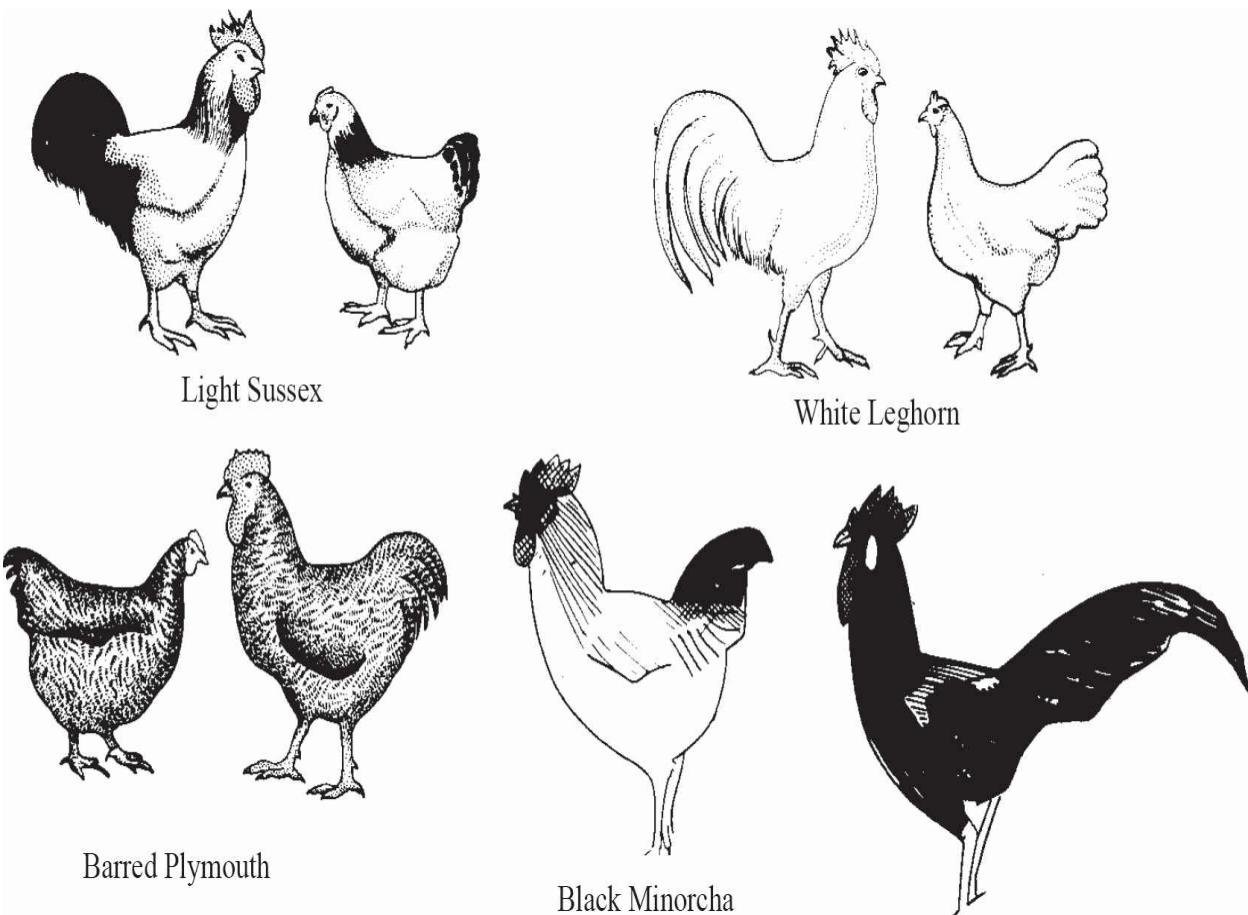


Figure 1.12. Some exotic breeds of fowl.

(iii) Cross breeds or Improved breeds of poultry. The majority of the present day chickens used for production of egg and meat are the crossbreed blocks. In India, a number of research programmes are going on to produce improved quality commercial egg layers and broilers through cross breeding. Some improved crossbreed strains of fowl are **HH-260, IBL-80, B-77 and ILS-82**.

Box 1.23

1. Poultry industry has shown a phenomenal growth in last two decades. Large increase in egg production in India has been named **silver revolution**.

2. Central Poultry Breeding Farm at Bombay,

Bhubaneshwar, Hassarghatta and Chandigarh are engaged in scientific poultry breeding programme and have developed high egg producing hybrid and fast growing broiler breeds.

2. Variety Improvement

The programmes of cross breeding between Indian (indigenous) and foreign (exotic) breeds for variety improvement are focused to develop new varieties for the following desirable traits :

1. Quantity and quality of chicks ;
2. Dwarf broiler parent for commercial chick production for summer adaptation capacity/tolerance to high temperature ;
3. Low maintenance requirement ;
4. Improvement in hen housed for egg production and reduction in the size of the layer with ability to utilize more fibrous, cheap diet formulated using agricultural byproducts.

Egg and Broiler Production

There are two basic targets of poultry farming : (i) obtaining more and more eggs; (ii) getting flesh.

1. Production of Eggs

In chickens, egg production is the most important economic trait. A layer starts laying eggs at the age of 20 weeks. The egg production period in commercial layer is 500 days.

To develop new varieties or to improve quality of chicken with respect to quantity and quality of eggs, the following points are considered : 1. Egg number ; 2. Sexual maturity ; 3. Egg weight ; 4. Body weight; 5. Feed efficiency ; 6. Egg size; 7. Egg shape ; 8. Shell colour ; 9. Shell quality ; and 10. Internal quality of egg.

Production of vegetarian eggs. The fertile eggs rot rapidly

than the infertile eggs, thus, the production of infertile eggs is desired. Hens can lay eggs without a cock and the eggs thus obtained are infertile. Such eggs are called **vegetarian eggs**.

2. Production of Broilers

Chickens are raised up to 6-7 weeks in the poultry farm. They grow to a weight of 700 gm to 1.5 kg in this period. They are fed with vitamin rich supplementary feed for good growth rate and better feed efficiency. Care is taken to prevent mortality and enable feathering and maintain carcass quality. They are produced as broilers and sent to market to be sold as meat.

3. Poultry Care

Good management practices are essential for producing good poultry. These practices are often different for broilers and egg layers.

A. Housing, Shelter and Feed

Both layer and broiler breeds require different type of care :

1. Care for the layers. There are following two distinct phases in the life of a layer :

(i) Growing period. The first phase of the life of poultry (*i.e.*, the layer) is growing period (upto sexual maturity). During this period the chickens are called **growers**. The growers require enough space. Over-crowding tends to suppress their growth. The feed is given in a restricted and calculated manner.

(ii) Laying period. The period from sexual maturity till the end of egg laying is called **laying period** and the chickens are known as **egg layers**. The layers require enough space and adequate lighting. Light's intensity and its duration has favourable effect on

the laying output of the hens. Feed with vitamins, minerals and micronutrients also influence hatchability of eggs.

2. Care for the broilers. The housing, nutritional and environmental requirements of broilers are different from layers. Conditions provided have to be favourable for the fast growth and low mortality of broilers. The ration for broilers is protein rich with sufficient fat. In the poultry feed, the contents of vitamin A and K are kept high.

B. Diseases of Poultry

The poultry birds suffer from various diseases caused by *viruses* (Flue, Dermitis, Fowl pox, Ranikhet), *bacteria* (Tuberculosis, Cholera, Diarrhoea), *fungi* (Aspergillosis), *animal parasites* (worms, mites, lice), etc. They also suffer from nutritional deficiency diseases. Some common diseases of poultry have been highlighted in [Table 1.14](#).

Table 1.14. Some common diseases of fowl and their symptoms.

Name of disease	Causative organism	Symptoms
1. Dermitis	Virus	Irritation, blisters and eruption on the skin surface.
2. Fowl pox	Virus	Wart-like pox lesions on comb, wattles, eyelids and feet, lesions in mouth, difficulty in breathing, yellow cheese like discharges from eyes and nose.
3. Fowl cholera	Bacteria	Loose motions and dehydration.
4. Aspergillosis	Fungus	Patches on skin due to growth of moulds.

ACTIVITY 1.5

Visit a local poultry farm. Observe types of the breeds and

make a note on the type of ration, housing, lighting facilities and incubator facilities given to them. Identify the growers, layers and broilers. Find if the management of the poultry farm is proper and adequate.

1.5. FISH PRODUCTION

Fish is an important aquatic food which is rich in proteins. A large section of Indian population uses fish as food, particularly that living in coastal areas. It is highly nutritious and easily digestible. Fish can be useful in eradicating problem of malnutrition. Fish liver oil is rich in vitamin A and D. Out of the total fish obtained from the Indian oceans, 45% is procured by India.

Fisheries

Fisheries are establishments connected with capture, preservation, exploitation and utilization of various types of fishes, prawns, lobsters, crabs, oysters, other molluscs, etc. On the basis of product, fisheries are of two types :



Fishery.

(a) Fin fishery. It is capture, management and exploitation of cartilaginous and bony fishes.

(b) Shell fishery. It is the capture management and exploitation of crustaceans (crabs, prawns, lobsters) and molluscs (oysters, mussels, octopods, etc.).

Depending up on the mode of obtaining fish, fisheries are of two types, capture and culture.

1. Capture fishery. The fish is caught from natural waters, both marine and inland. Modern technology is used for capture and storage before marketing. Electronic equipment is used to locate fish in the sea. Mechanised fishing boats and deep sea trawlers are often employed in capture fishery.

2. Culture fishery. It is cultivating, rearing and harvesting of fish. Culture fishery is also called **fish farming** or **pisciculture**. The growing of various types of aquatic organisms in water bodies is called **aquaculture**.

Table 1.15. Differences between capture fishery and culture fishery.

<i>Capture fishery</i>	<i>Culture fishery</i>
1. It is a method of obtaining fish from natural resources.	It is a method of obtaining fish from fish farming (water agriculture).
2. There is no seeding and raising of fish.	The fish is seeded and reared.
3. Capture fishery is undertaken in both inland and marine waters.	Culture fishery is undertaken mostly inland and near sea shore.

Box 1.24

1. In common usage, the term fish has often been used to describe a mixed assortment of water-dwelling animals. we speak of jelly fish, cuttlefish, starfish and shell fish, knowing fully well that when we use the word “fish” in such combinations, we are not referring to a true fish.

2. A true fish is a gill-breathing, ectothermic, aquatic vertebrate that possesses fins and skin that is usually covered with scales.

3. The word *fish* is commonly used both as singular and plural, but a zoologist uses *fishes* to mean more than one kind of fish.

Seventy per cent of the Earth is covered with water. Based on the water sources of fish production, following *three* types of fisheries can be recognised.

1. Marine fisheries. They include capture fisheries of oceans and seas.

2. Fresh water fisheries. They include capture and culture fisheries in freshwater systems such as rivers, canals, lakes, reservoirs, tanks, ponds and paddy fields.

3. Brackish water fisheries. They include fishing activities in brackish water (slightly salty) such as *estuaries* (last part of river that gets tidal water from sea), *lagoons* (shallow salt water lakes separated from sea bank, coral reef, etc.) and *mangrove swamps* (tropical trees growing in mud of sea-shore).

Fresh water fisheries and brackish water fisheries are collectively called **inland fisheries**.

With the increase in our population, fish production has been increased both for food and as a business activity. Modern technologies are being used both for capturing and culture of fish in marine and freshwater ecosystems. In this section we will study various methods for increasing the production of fish in all sort of aquatic ecosystems ([Box 1.25](#)).

Box 1.25

Few Facts about Indian Fisheries (include both capture and culture)

1. Total fish production in India – 7th position in world
2. Marine fish production in India – 10th position in world
3. Aquaculture production in India – 2nd in South East Asian countries
4. Fish industry contribution – Rs. 400 crores annually as foreign exchange
5. Kinds of Fresh water Fish Culture Systems :
 - (i) Carp culture (composite fish culture)
 - (ii) Sewage fed fish culture
 - (iii) Air breathing fish culture
 - (iv) Fish culture in cages
 - (v) Paddy-cum-fish culture
 - (vi) Integrated fish culture
 - (vii) Fish culture in cold water
 - (viii) Fish culture in bundhs
 - (ix) Fish culture in seasonal ponds
 - (x) Freshwater pearl culture

1. Marine Fisheries

India has a vast scope of marine fishery. Our marine fishery resources include 7500 kms coast line and extensive deep sea. Marine waters providing profitable fishing are Arabian sea, Bay of

Bengal, many small bays, gulfs, lagoons, coral reefs, etc. Central Marine Fisheries Research Institute (CMFRI) at Ernakulam, Cochin, Kerala has been set up to explore and utilise the marine resources of the country. Following 12 marine fishes of India are most preferred sea fishes or **table fishes**, i.e., popularly consumed fishes :

1. Pomphrets, 2. Mackerels, 3. Tuna, 4. Sardines, 5. Bombay duck, 6. Eel, 7. Hilsa, 8. Salmon, 9. Ribbon fish, 10. Flat fish or sole, 11. Seer, 12. Flying fish.

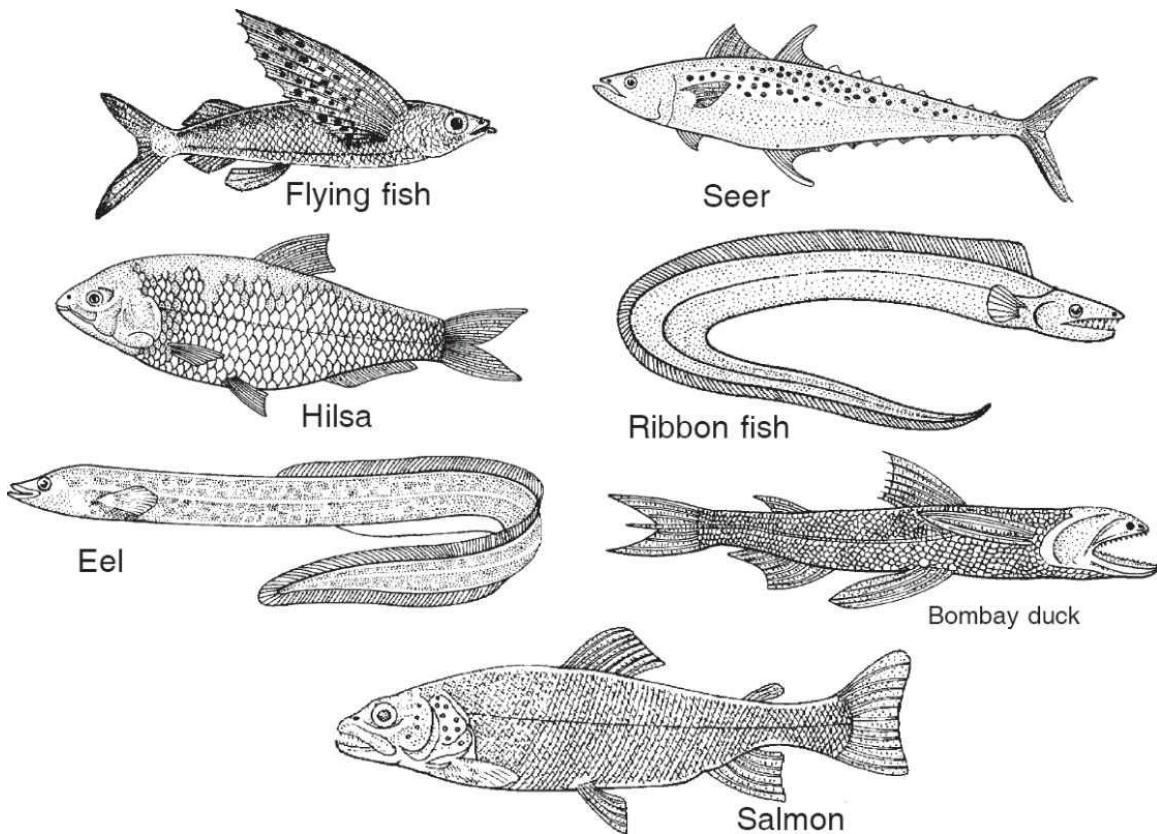


Figure 1.13. Some marine table fishes of India.

These marine table fishes are caught by fishing nets and gears operated by fishing vessels. A vessel that drags a net behind it is called **fishing trawler**; such fishing trawlers fitted with electronic fish locating device have been put into service for boosting deep-sea fishing. The modern technologies for catching more fish

includes **echosounders** and use of **satellites** to fish shoals or schools (assemblages of fish).

2. Aquaculture

Aquaculture pertains to production of useful (*i.e.*, of high economic value) aquatic plants and animals such as fishes, prawns, crayfish, lobsters, crabs, shrimps, mussels, oysters and seaweeds by proper utilisation of available waters in the country. It is an important means of increasing the country's food output. India has a great potential for the aquaculture because of a lengthy coastline and numerous inland water spreads.

Aquaculture includes mariculture and freshwater culture fisheries.

Mariculture. The marine fishes cultured in coastal waters of India on commercial basis include mullets, *bhetki*, pearl spots, sardines, eel and milk fish.

Freshwater culture fishery of exotic carps has good prospects in lakes. These carps include the common carp, English carp, tench and trouts. Trout hatcheries have been established in Kashmir and other places.

3. Inland Fisheries

It includes (i) riverine fishery ; (ii) reservoir fishery ; (iii) lake or lacustrine fishery ; (iv) pond fishery and (v) estuarine fishery. Inland capture fisheries are rapidly expanding in our country. Introduction of exotic species from abroad and inter-regional transplantation of fish from northern to southern waters have proved to be great boon. Increasing pollution of water is adversely affecting the inland fisheries. Construction of dams have harmed many regional fisheries. Indiscriminate fishing is also causing

immense damage to fisheries.

Major share of fish production from inland resources is, however, through aquaculture practices. For table fish production, common and most advantageous culture system is **composite fish culture**. Fish culture in **integrated fish culture system** is also taken up with agriculture farming include *paddy-cum-fish culture* ([Box 1.26](#)). Different types of fish culture systems have been given in the [Box 1.25](#). Some interesting fish culture systems are following :

1. Cage culture. Fish is cultured in large cages, made of bamboo or steel, which are lowered into the river. Generally, carnivorous species are cultured in cages.

2. Integrated fish culture. Fish culture is practiced along with some agricultural crops such as paddy, banana and coconut to give higher yield. Fish is also cultured in ponds near the poultry or piggery, and the excreta of these animals is used as food in ponds.

Box 1.26

Paddy-cum-fish culture

The fish species that can be stocked in paddy fields include *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Clarias* spp. (catfish), *Channa* spp. (murrels), *Mugil* spp., *Lates calcarifer*, etc. These species are able to live in shallow water of paddy fields and able to tolerate high temperature or turbidity.

4. Composite Fish Culture (Polyculture of Fish)

Fish production by culturing a single species in a pond (called **monoculture**) using old traditional methods gives a low yield ; but if several species of fish are stocked together in a pond, the

production increases with the same cost. Hence it is necessary to select species having different feeding habits so that all the available food in the pond is effectively utilised. Fast growing compatible species are selected, so that, there is little competition between them and all ecological zones are exploited for achieving maximum yield. This method is called **composite fish farming** or **polyculture of fishes**.

Experiments have shown that Indian major carps (*i.e.*, Catla, rohu and mrigal; [Fig. 1.14](#)) when stocked along with three species of exotic carps (*i.e.*, silver carp, grass carp and common carp, [Fig. 1.15](#); all the three species are transplanted from China), the yield goes up 8–9 times, as compared to monoculture. The food habits of these six species are as follows :

1. The silver carp (*Hypophthalmichthys molitrix*) is a **surface feeder** and feeds on phytoplankton.
2. The catla (*Catla catla*) is also **surface feeder** and it feeds on zooplankton.
3. The rohu (*Labeo rohita*) feeds in middle zone of the pond, *i.e.*, **column feeder**, and feeds on decaying plants and detritus.
4. The grass carp (*Ctenopharyngodon idella*) feeds on all macro-vegetation and consumes the aquatic plants/weeds not used by other species in this group.
5. The mrigal (*Cirrhinus mrigala*) is a **bottom feeder** using decaying plants and detritus.
6. The common carp (*Cyprinus carpio*) is an omnivorous **bottom feeder**.

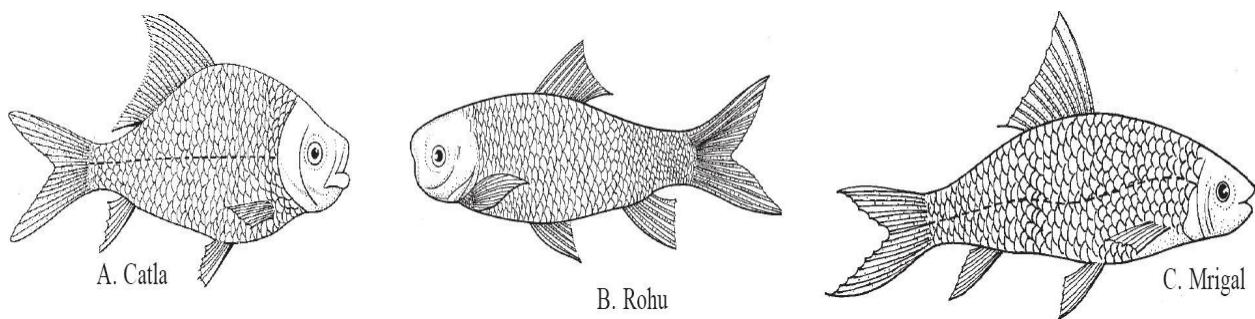


Figure 1.14. Indian major carps.

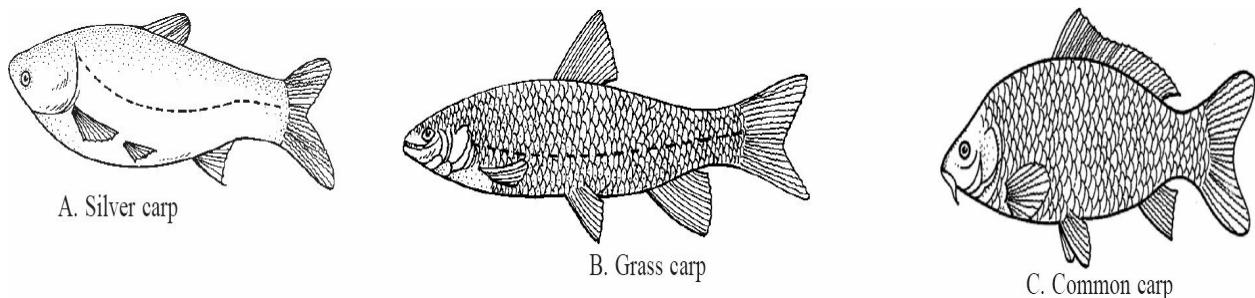


Figure 1.15. Exotic carps used in composite culture.

These six species have complementary feeding habits and do not harm each other, and constitute a good combination of polyculture.

Important factors to be taken into consideration for fish culture include : (i) Topography or location of pond ; (ii) Water resources and quality ; (iii) Soil quality, i.e., composition of particle size as well as nutrients. The time of stocking also depends on the water temperature. Low water temperature (18–20°C) is most favourable for growth.

Qualitative and Quantitative Improvement of fish and fish seed. The different fish used in the composite culture do not breed in pond environment. The carps breed in rivers during monsoon month (July, August). The eggs and seeds collected from riverine water were seldom pure. [Note. *Fish seed* is a commercial term for (i) **spawn** (fertilized developing eggs); (ii) **Hatchlings** (upto 4-5 mm size); (iii) **Fry**; (iv) **Fingerlings** (adult-like fish)]. The problem

of quality seed and breeding the carps in ponds was solved by **Alikunhi** (1957) through the technique of **induced breeding** by injecting fish pituitary hormones (called **hypophysation**). This technique of induced spawning (release of fertilized developing eggs) in fishes led to blue revolution through fish culture. Currently synthetic hormones such as **ovaprim**, **ovatide** and **nova** are used for induced breeding. This technique ensures supply of pure seeds of fish in desired quantity.

ACTIVITY 1.6

During educational tour of your school visit a fish farm in breeding season of fishes (*e.g.*, monsoon for Indian carps) and note the following :

1. Varieties of fish in the ponds.
2. Types and number of each type of ponds.
3. Ingredients in supplementary feed being used in the farm.
4. What is the annual production of the fish farm ?
5. From where fish seeds brought to the farm for stocking.
6. Observe male and female ripe breeders of catla, rohu and mrigal. Try to identify male fish from female fish.
7. Visit a fish hatchery farm to learn about methods of induced breeding.

Based on the observations, explain what are the problems being faced by the fish farmers.

1.6. BEE KEEPING

Bee keeping or **apiculture** (*L. apis* = bee; *culture* = cultivate) is the rearing, care and management of honey bees for obtaining honey, wax and other substances. Honey is known to have

medicinal value. It is found to be quite useful in the treatment of various disorders of humans related to digestion, dysentery, vomiting and stomach or liver ailments. Honey is considered as a blood purifier, a cure against cough, and cold sore throat, ulcers of the tongue, ulcer of stomach and intestine, etc. Since honey is rich in iron and calcium, it helps in growth of human body. Honey is also used as a source of sugar in confectionary items such as pastries, cakes, etc. Visualising these important uses of honey, bee keeping has been undertaken on commercial basis as a business.

Bee keeping being, a low-investment enterprise, has become a favourite source of some extra income for the Indian farmers. Bee keeping also helps in cross pollination of flowers of crop plants, since pollens are transferred from one flower to another by bees while they are collecting the nectar ([Box 1.27](#)).

Box. 1.27

How is nectar changed into honey?

Nectar is a sweet viscous secretion secreted by flowers of plants ; by attracting the insects it helps in pollination. When the bee sucks the nectar from the flowers, it passes this nectar to its **honey sac** where it gets mixed with some acid secretion. In honey sac, sucrose (sugar) of the nectar is converted into dextrose and levulose by the action of invertase enzyme. After regurgitation the treated nectar finally changes into honey which is stored in special cells of hive for future use.

I. Products Obtained From Apiculture

Apiculture or bee keeping provides us the following useful products : honey, wax, propolis, royal jelly and bee venom.



Honey.

1. Honey. Honey is a sweet, viscous edible fluid containing sugars, water or moisture, minerals, vitamins, amino acids, enzymes and pollen. Sugars present in honey include levulose, dextrose, sucrose and dextrin. Minerals of honey are calcium, iron, phosphate and manganese. Vitamins present in honey are Pantothenic acid, Biotin, Pyridoxin, Choline, Ascorbic acid, Thiamine, Riboflavin and Niacin. The colour, flavour and odour of honey usually depend on the flowers from which nectar is gathered. One kilogram of honey contains 3200 calories and is an energy rich food.



Bee wax.

2. Bee wax. It is a wax of high melting point (about 140°F). It is secreted by wax glands of worker bees. Bee wax is utilised in the construction of hive. This wax is used by human beings for several purposes such as manufacturing of cosmetics, cold creams, shaving

creams, polishes, candles, ointments, lipsticks, lubricants, in modelling work, etc.

3. Propolis and balms are other collections of bee from the plants. These substances are used in repairing and fastening of comb.

4. Poison of bee is used in manufacturing of certain Ayurvedic and Homeopathic medicines.

II. Honey Bee Varieties Used for Bee Keeping

Both indigenous and exotic varieties of honey bees are used for commercial production of honey in India.

A. Indigenous Varieties of Honey Bees

1. *Apis cerana indica F.* (Indian bee); 2. *Apis dorsata F.* (Rock bee); 3. *Apis florea F.* (Little bee).

B. Exotic Varieties of Honey Bees

1. *Apis mellifera* (European or Italian bee);
2. *Apis adamsoni* (South African bee).

Italian bee (*Apis mellifera*) is commonly domesticated in India to increase yield of honey.

Italian bee is preferred because

- (i) It is gentle in nature
- (ii) It has good honey collection capacity.
- (iii) It has the ability to protect itself from enemies, and
- (iv) It has prolific queen with less swarming.

III. Colony and Castes of Honey Bee

Honey bee is a social insect. The nest of the honey bee is known as the **bee-hive** ([Box 1.28](#)). Honey bees provide a good example of team work and division of labour.

Box 1.28

In nature, honey bees raise their nests, called **hives**, on tall trees in forests or cities and even on tall buildings in urban areas. Compartments made by workers with the wax of their wax glands are called **combs**. A comb is a vertical sheet of wax, composed of double layer of hexagonal cells. The hexagonal shape of cells contain maximum space in minimum use of wax and labour. Storage cells of comb contain honey and pollen. Brood cells contain young stages and are of three types : worker cells, drone cells and a queen cell. Queen cell is single and largest. Adults do not live in cells but move on the surface of comb.

Honey bees live in a colony and different tasks are done by different groups of bees in the same colony. A colony of Italian bee normally has one queen, 40,000 to 100,000 workers and few hundred (up to 300) of drones. Due to existence of several morphological forms, called **castes**, bees are said to be the **polymorphic species**. A *caste* can be defined as a collection of individuals within the colony that are morphologically distinct from individuals in other castes and perform specific tasks. According to roles, there are following three types of castes in the colony of bee :

1. Queen. The body size of queen is much larger than other castes of bees of the colony. Her legs are strong for she is always walking about on the comb. The queen, as the mother of the

colony, is responsible for laying eggs. She lays up to 2000 eggs everyday of each season. Queen lays both fertilized (diploid, $2n$) and unfertilized (haploid n) eggs. Queen and workers emerge from the fertilized eggs, whereas drones come out from unfertilized eggs. Thus, queens are larger, they mate, lay eggs, eat proteinaceous food ([Box 1.29](#)) and often do not forage or defend the colony.

Box 1.29

Eggs of queen hatch into white, legless **larvae** which spin delicate silken cocoons around themselves and turn into **pupae**. Each pupa develops into an adult. The adult comes out by cutting wall of cocoon first and secondly by breaking the wax cap of the cell.

During first 2 to 3 days, all larvae of bee are fed on a special proteinaceous food, called “**Royal jelly**” or **bee milk** which is secreted by the hypopharyngeal glands of the young workers. After that coarser food, the “**Bee Bread**”, which is mixture of honey and pollen grain is given. However, the queen forming larvae are fed on royal jelly for the full larval life and these larvae are also taken for further development into a special chamber called the queen’s chamber or cell.

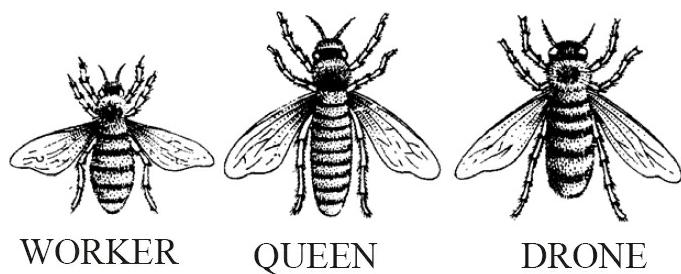


Figure 1.16. Three different castes of a colony of honey bee.

2. Drone. It is haploid, fertile male. Drones are larger in size than workers and are quite noisy. They are unable to gather food, but eat voraciously. Drones are stingless and their main role is to mate with queen and remain in colony to sleep and eat honey. Since their role is only in the breeding season, therefore, they are made to leave the hive to save honey from them.

3. Worker. Worker is diploid, sterile female (*i.e.*, it can not reproduce). The size of worker is the smallest among the castes of bee. Workers are the most active members of the colony ; they have almost all responsibilities on their shoulder. For various indoor and outdoor chores the workers are provided with a variety of organs such as *hypopharyngeal glands* (for secretion of bee milk), *wax glands* (for building the cells of comb), *pollen baskets* on their hind legs (for the collection of pollen), *sucking type* mouth parts (for collecting the nectar), high level of secretion of *invertase* enzyme (in the honey sac for honey formation) and a *sting* at the tip of abdomen (for the defence of the colony; [Box 1.30](#)).

Workers live for 3 to 12 months. The function of workers change with age. During the first half of their life, workers are engaged in indoor duties as scavengers, nurse bees, fanner bees and guard bees. During the second half, they perform outside duties as scout bees and forager bees, the worker been of a hive fall under three major age groups. These are

(a) **Scavenger bees.** For the first three days, each worker bee acts as a scavenger. Cleaning the walls and floor of empty cells of the colony for reuse.

(b) **Nurse bees.** From the fourth day onwards, each worker bee feeds the entire brood, like a foster mother, with a mixture of honey and pollen. By seventh day it starts producing royal jelly, which is fed to queen and future queen bees. Nurse bees also perform guard

duties. They defend the colony from intruders. They kill the intruder by stinging but also get killed with the loss of sting.

(c) **Foraging or field bees.** They explore new sources of nectar (as scout bees). Forager bees collect nectar, pollen and propolis. Nectar is changed into honey in their crops.

Box 1.30

Worker bees tend to maintain a constant temperature of the bee hive by their behaviour, *i.e.*, by flapping their wings for cooling and by huddling together for warming.

Forager bees communicate about the location of the foraging grounds with their colony mates in the form of **round-dance** and **waggle-dance**. For decoding the meaning of these dances, a Austrian Zoologist **Karl von Frisch** (1886 – 1982) took 20 years of research and got Nobel Prize in 1973 for his discovery.

Helping behaviour existing between members of a social group (workers) is called **altruism** (which means self-sacrifice).

IV. Management for High Yields of Honey

For the purpose of commerical production of honey, apiaries are established. An **apiary** is a place where bee hives (wooden boxes) are kept to get honey and other products of bee. To obtain good quality and higher yields of honey the following considerations are done :

1. Pasturage/Crop/Flora. The quality and taste of honey depends upon the flora, pasturage or orchards available for the nectar and pollen collection.

Pasturage/orchard flora of honey bees include a variety of

flowering plants such as Mango (*Aam*), Coconut (*Narial*), Almond (*Badam*), Tamarind (*Imli*), *Ber*, *Berseem*, *Litchi*, Cotton, Shishame, Apple, *Mahua*, Coriander, Cashew, Coffee, Rubber plants, Guava, Sunflower, *Neem*, etc.

2. Bee-hive. In India, generally three types of artificial bee-hives are used in apiaries : 1. Langstroth (Fig. 1.19); 2. Newton and 3. Jeolikote. Newton and Jeolikote type hives are mostly used in plains and Langstroth hive is used in hill region.

Bee-hive is a box ([Fig. 1.17](#)) raised over a stand. The box has a wire gauze covered brood chamber for egg laying and a multiframe honey chamber for honey collection as honey reserve. Each bee-hive is of 46×23 cm size.

3. Apiary location. Apiary means setting up of a number of bee-hives in good and desirable locations in such a systematic way which allows maximum nectar and pollen collection. An apiary should be set in a locality rich in vegetation especially the flowering plants ; rich flora should be available in 1 to 2 km radius for honey collection. Each hive should face East. It should receive sunlight during morning and evening and some shade during mid-day. Water should be available nearby and an open space in the front of hive entrance is also necessary.

4. Honey flow and seasons. At a given location in a season yield of honey is dependent on the duration for which abundant flora is available. The total time during which honey bees collect nectar and pollens is called **honey flow period**. Therefore, to obtain large quantities of honey, apiaries should be established, at a location, where there is abundance of flowers for the longer duration.

5. Swarming (Reproduction). It is a natural phenomenon whereby mass movement of bees from one place to another takes

place. In honey bees, swarming is done in spring season for the purpose of reproduction. For swarming, new (young) queen leaves the old hive along with some workers and drones and takes a new shelter. Frequent transfer results in low yield of honey and maintenance cost of hives is also increased.

6. Selection of variety of honey bee and site selection for bee keeping. Less swarming variety is selected such as *Apis mellifera* (Italian bee) ; this bee also has other desirable characteristics (as discussed earlier). Suitable site for apiary should have good pasturage which have longer honey flow time.

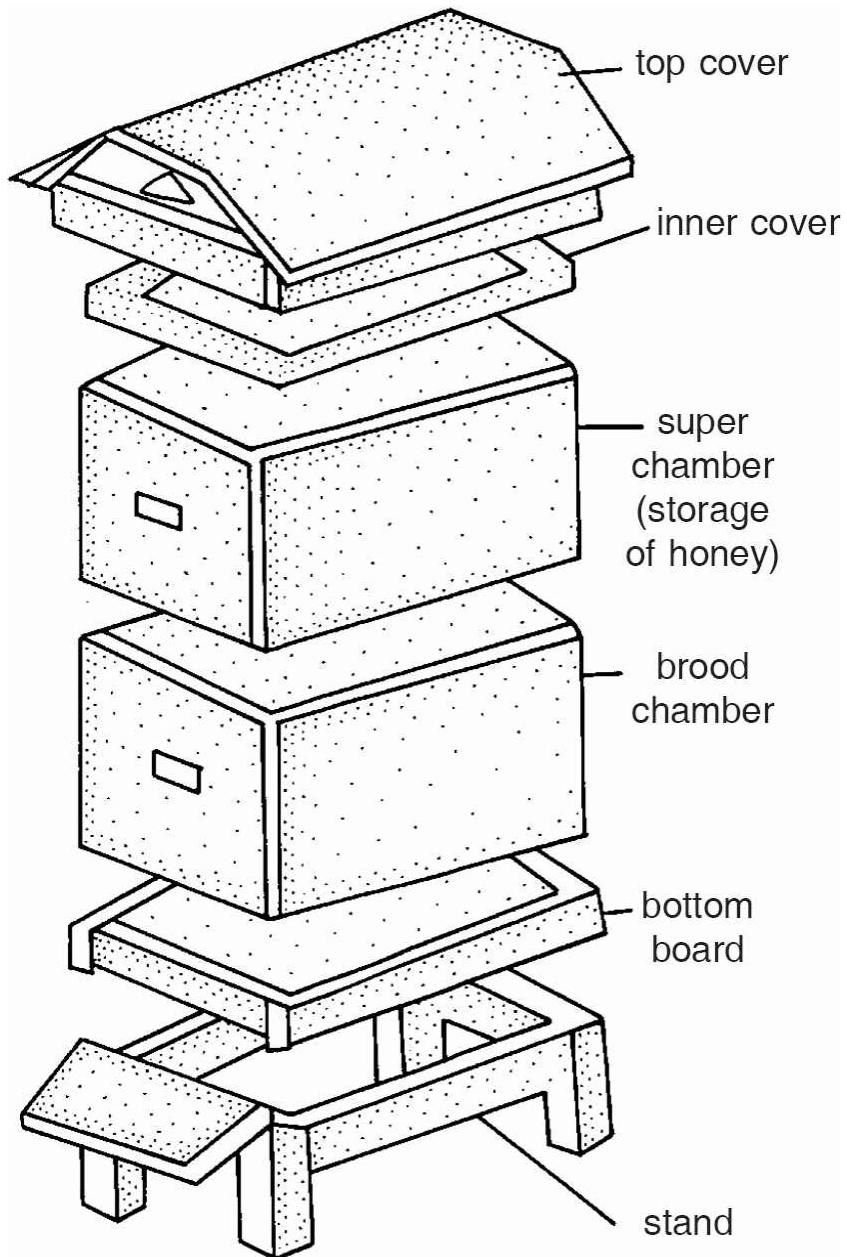


Figure 1.17. Outer view of a two-story Langstroth frame hive.

V. Diseases and Enemies of Honey Bee

Honey bees are commonly infected by viruses, bacteria, fungi and protozoa. For example, the bacterium *Bacillus apisceptiosus* infects blood of bee causing septicemia. **Brood foul** disease takes place by Schizomycetes (fungi). **Nosema disease** and **amoeba disease** are caused by protozoan pathogens *Nosema apis* and

Vahlkampfia mellifica, respectively. Common pests / enemies of bees are wasps, wax moths and mites. Dysentry, paralysis and acrine diseases are caused by a parasitic mite *Acarapis woodi*. Various birds such as king crows, blue tits, fly-catchers, chaffinch, green blue eater, sparrows, etc., use bee as their meal. Wasps are controlled manually (*i.e.*, by destroying the wasp nests from the locality of apiary). Wax moth is controlled by exposing bees in bee hive to sun, by increasing temperature. Bee-eater birds are scared away by some device.

SUMMARY

- Plants serve as food for humans and their domestic animals.
- Agriculture is the cultivation of desired economic plants or crops in a field.
- Crops are the plants of same kind grown at a place.
- Crops depending on season are of two kinds : Rabi season crops (winter crops) are grown from November to April and Kharif season crops (rainy season crops) are grown from June to October.
- Kharif season crops are paddy (*dhan*), soyabean, *arhar*, maize, cotton, *urad* and *moong* ; rabi season crops include wheat, gram, pea, mustard and linseed.
- 16 nutrients are essentially required by crop plants. Four nutrients are required in large quantities; they are called macronutrients. Nine nutrients are used in small quantities ; they are known as micronutrients.
- Manures and fertilizers are the main sources of nutrient supply to the plants.
- Manures are natural fertilizers. They include farmyard manure, compost, green manures and vermicompost.
- Fertilizers are commercially manufactured material from chemicals. They mainly supply nitrogen, phosphorus and potassium (NPK).
- The process of supply water to crop plants by means of canals, reservoirs, wells, etc., is called irrigation.

- Mixed cropping is growing of two or more crops simultaneously on the same piece of crop field. Main objective of mixed cropping is to minimise the risk of crop failure.
- Intercropping is growing two or more crops simultaneously in a same field in definite row patterns. Main objective of such a farming practice is to increase productivity per unit area and time.
- The growing of different crops on a piece of land in pre-planned succession is called crop rotation.
- Breakthrough in cereal production due to use of seeds of higher-yielding varieties, higher dose of fertilisers and assured irrigation is known as green revolution.
- Harbinger of green revolution in India is Dr. Swaminathan.
- Varietal improvement is required for higher yield, good quality and changing situations.
- Plant breeding can be defined as a science as well as an art of improving genetic make up of crop plants in relation to their economic value. It is based on hybridisation and DNA recombinant technology.
- Field crops are infested with a variety of pests such as weeds, insects, mites, nematodes, rodents, fungi, bacteria and viruses. These pests have to be controlled by the use of pesticides (biocides) and biological control.
- Cows, buffaloes, fowl, fish, goat and sheep are useful animals. They provide us food, *i.e.*, milk, egg and meat (fowl and goat). Buffalo milk has great economic value.
- Farm animals require proper care and management such as shelter, feeding, breeding (by artificial insemination) and disease control. This is known as animal husbandry.
- Artificial insemination is a technique to facilitate cross breeding at large scale. It is available at the veterinary aid units all over the country.
- Poultry farming is done to raise domestic fowls, ducks, geese, turkeys, pigeons, etc.
- Poultry production includes egg production (by layers) and poultry meat production (by broilers).
- To enhance the poultry production, cross breeding is done between

Indian and exotic breeds for variety improvements.

- Chickens are raised up to 6 to 7 weeks in the poultry farm and as broilers marketed when they grow to 700 g to 1.5 kg in weight.
- By captured fisheries, fishes may be obtained from seas, i.e., marine resources and inland resources.
- By fish culture (a part of aquaculture), choiced variety of fishes are cultured in marine and inland ecosystems to increase their production.
- Fishes are caught by fishing nets and gears operated from fishing vessels having modern devices such as echo-sounders and navigational gadgets.
- In freshwater fish culture, induced breeding technique is very useful in obtaining quality fish seeds in large quantities.
- Fish seed may include spawn (fertilized eggs), hatchlings, sac fry, fry, juveniles, fingerlings and yearlings.
- Polyculture or composite fish culture system is used commonly to produce table fish such as silver carp, catla, rohu, grass carp, mrigal and common carp.
- Fisheries is comprised of fin fishes (true fishes) and shell fish (prawn, molluscs, etc.).
- Fish are obtained from sea and marine ecosystems. Marine fisheries deal with catching or capturing of fish. Mariculture deals with culture of fish in marine ecosystems near sea costs. India has a 75000 kms long coastline.
- India has 1.6 million hectare of inland water resources covering river, lakes, reservoirs, ponds, lagoons, estuaries, etc.
- Beekeeping is done to get honey and wax.
- A colony of Italian honeybee (*Apis mellifera* which is most commonly reared in India) has one queen, 40,000 to 100,000 workers and drones are in hundreds (300).
- Pasturage or flora include flowering crops such as mango, coconut, tamarind, litchi, *ber*, *berseem*, *badam*, apple, guava, neem, etc.
- Honey flow period is the total time period during which bee collect nectar and pollen.

FORMATIVE ASSESSMENT

A. CLASS ASSIGNMENT

I. True or False Questions

1. Jersey is an Indian breed of cow.
2. Mehsana is a breed of buffaloe.
3. Rinderpest is a parasitic disease.
4. Karan Swiss is produced by crossbreeding between Jersey and Red Sindhi.
5. The process of introducing new plants from the place of their cultivation to a place with different climate is termed as acclimatization.
6. Hybridisation involves crossing of genetically similar plants.
7. Ganga 5 is the variety of rice.
8. K850 is the variety of chicken pea.
9. HD2687 is the variety of wheat.
10. Organic farming is the method of farming where synthetic chemicals are used.
11. Japan is known to have lowest pesticide load on their crop.
12. Awareness to use organic food is very high in developed societies.
13. Nutrients can be provided to crops by fertilizers only.
14. Weed management techniques aim at keeping the land weed free.
15. Sussex is an exotic breed of poultry.
16. Mixed cropping is an insurance against crop failure due to abnormal weather conditions.
17. Aphids are insect pests that attack plant such as mustard.
18. Worm castings in the vermicompost have nutrients that are 97% utilizable by the crop plants.

ANSWERS

True or False Questions

1. False;
2. True;
3. False;
4. False;
5. False;
6. False;
7. True;
8. True;
9. True;
10. False;
11. False;
12. True;
13. False;
14. True;
15. True;
16. True;
17. True.
18. True.

II. Fill in the Blanks

1. *Puccinia* causes disease in wheat.
2. Blast is a disease of paddy.
3. Chemicals used to kill weeds are called
4. Pesticides are chemicals.
5. are plants that grow in places where they are not wanted.
6. is a method of control of pest or weed in which one living organism is used to control another living organisms.
7. Organic materials which are added to soil of crop field to improve its physical conditions are called
8. The aphid is a pest of plants.

9. and climate is more congenial for infestation of weeds, insect-pests and diseases.
10. Growing two or more crops but in the definite row pattern is known as
11. The practice of growing of two crops simultaneously on the same piece of land is called
12. Long white eggs are produced by.....
13. is a carp.
14. Aseel is a popular breed of
15. Kasturi the variety of
16. Ganga 5 is the variety of
17. Vikas is the variety of
18. Organic farming is a method of farming wherein.....chemical is not used in any form.
19. Food grown on organic farming principles is called.....food.
20. Japan is known to have highest.....load on their crop.
21. In organic farming diseases are controlled by..... and.....methods.
22. India has.....major river basins and composite river basins that form the surface water resource.
23. The process of supplying.....to crops in the fields by means of canals, reservoirs, wells, river valley systems and river lift systems is known as
24. Open wells are not very
25. wells are very deep.
26. Organic manures include manure, compost, manure and vermicompost.
27. Vermicompost is a type of soil made by and microorganisms.
28. Mixed cropping is done to reduce the between component crops for, nutrients and water.
29. involves breeding among unrelated animals.
30. is the maintenance of honey bee colonies, commonly in hives, by humans.

ANSWERS

1. Rust;
2. Fungal;
3. Weedicides;
4. Toxic;
5. Weeds;
6. Biological control;
7. Manures ;
8. Mustard ;
9. Humid, warm
10. Intercropping ;
11. Mixed cropping ;
12. White Leghorn;
13. Catla;
14. Fowl;
15. Rice;
16. Maize;
17. Rice;
18. Synthetic;
19. Organic;
20. Pesticide;
21. Cultural, biological;
22. 12, 8;
23. Water, irrigation;
24. Deep;
25. Tube;
26. Farmyard, green;
27. Earthworm;
28. Competition, light;
29. Outbreeding;
30. Beekeeping/Apiculture.

III. Matching Type Questions

1. Single Matching. Match the articles given in column I and column II

<i>Column I</i>	<i>Column II</i>
1. C306	(a) Maize
2. Navjot	(b) Wheat
3. Ganga 5	(c) Rice
4. Kasturi	(d) Maize
5. Green manure	(e) Brown-Swiss
6. Exotic breed	(f) Guar
7. Pella	(g) Black
8. Yakub	(h) Golden red
9. Nurie	(i) Black and red
10. Kajal	(j) White

2. Double Matching. Match the columns I, II and III.

<i>Column I</i>	<i>Column II</i>	<i>Column II</i>
1. Oil seeds	(a) Red Sindhi	(i) Sahiwal
2. Intercropping	(b) Mustard	(ii) Sunflower
3. Local breeds	(c) Vitamin A	(iii) Maize
4. Poultry feed	(d) Soyabean	(iv) Vitamin K

3. Check List or Key Items

In composite fish culture mark the fish as surface feeder (S), middle zone feeder (M) and bottom feeder (B)

<i>Fish</i>	<i>Feeding</i>
(a) Catla	
(b) Common carp	

- (c) Mrigal
 (d) Rohu

4. Match the stimulus with appropriate response

<i>Seed</i>	<i>Cereal A</i>	<i>Pulse B</i>	<i>Oil seed C</i>
(i) Lentil			
(ii) Sesame			
(iii) Millets			
(iv) Black gram			
(v) Maize			

ANSWERS

1. Single Matching

- 1 – (b);
 2 – (d);
 3 – (a);
 4 – (c);
 5 – (f);
 6 – (e);
 7 – (h);
 8 – (i);
 9 – (j);
 10 – (g).

2. Double Matching

- 1 – (b) (ii);
 2 – (d) (iii);
 3 – (a) (i);
 4 – (c) (iv).

3. Check List

- (a) S;
 - (b) B;
 - (c) B;
 - (d) M.
4. (i) – B;
(ii) – C;
(iii) – A;
(iv) – B;
(v) – A.

IV. Question — Answer

1. Define crop ? Name the various types of crops. What are Kharif and Rabi crops ?
2. Describe the mechanism of crop variety improvement.
3. How are minerals replenished in the soil of a crop field ?
4. What is organic farming ? What are its advantages?
5. What is irrigation ? Discuss the various methods of irrigation.
6. Describe the various cropping patterns.
7. Write an essay on crop protection management.
8. What all treatments grains are subjected to under prophylactic treatment ?
9. Define animal husbandry. Write about its scope.
10. Write a note on cattle feed.
11. What is artificial insemination ? Give its uses.
12. Write down symptoms of sick animals. Discuss any two diseases of cattle.
13. Name two exotic and two indigenous breeds of cow.
14. Name two indigenous and two exotic breeds of poultry. Write a note on egg production and broiler production.
15. Name the various types of fisheries. Write a note on culture fishery.
16. Write a note on bee keeping.
17. How many centres have been established in India for artificial

- insemination of cows and buffaloes ?
18. Name the components of cattle feed.
19. How much drinking water is required daily for a cow ?

V. Multiple Choice Questions (MCQs)

1. Increase in oil production is
 - (a) golden revolution
 - (b) yellow revolution
 - (c) white revolution
 - (d) blue revolution
2. The place for keeping and studying dry plants is called :
 - (a) arboreum
 - (b) vasculum
 - (c) herbarium
 - (d) museum
3. 'Organic farming' does not include
 - (a) green manures
 - (b) chemical fertilizers
 - (c) crop rotation
 - (d) compost and farmyard manures
4. Pulses are rich in
 - (a) carbohydrates
 - (b) proteins
 - (c) oils
 - (d) vitamins and minerals
5. The technique used to obtain variety with high yield and other desirable characters is
 - (a) introduction
 - (b) selection
 - (c) hybridization
 - (d) both (a) and (b)
6. Pusa Lerma is an improved variety of
 - (a) rice
 - (b) wheat
 - (c) maize

- (d) soyabean
7. Growing two or more crops in definite row pattern is
(a) mixed farming
(b) mixed cropping
(c) inter-cropping
(d) crop rotation
8. The botanical name of Dhaincha is
(a) *Crotalaria juncea*
(b) *Lens culinaris*
(c) *Trifolium alexandrium*
(d) *Sesbania aculeata*
9. The botanical name if Sunn hemp is
(a) *Crotalaria juncea*
(b) *Lens culinaris*
(c) *Trifolium alexandrium*
(d) *Sesbania aculeata*
10. The botanical name of lentil is
(a) *Crotalaria juncea*
(b) *Lens culinaris*
(c) *Trifolium alexandrium*
(d) *Sesbania aculeata*
11. The botanical name of Egyptian clover is
(a) *Crotalaria juncea*
(b) *Lens culinaris*
(c) *Trifolium alexandrium*
(d) *Sesbania aculeata*
12. Which one is a micronutrient for the crop plants ?
(a) calcium
(b) iron
(c) magnesium
(d) potassium
13. The common biofertilizers used in organic farming are
(a) margosa
(b) pyrethrum
(c) green manure
(d) nitrogen fixing bacteria and cyanobacteria

- 14.** Growing different crops in the same field in a preplanned succession is
- (a) crop management
 - (b) crop rotation
 - (c) intercropping
 - (d) plant breeding
- 15.** Maximum milk yielding buffalo is
- (a) nagpuri
 - (b) surti
 - (c) mehsana
 - (d) murrah
- 16.** Lactation period is maximum in
- (a) Frieswal
 - (b) Sahiwal
 - (c) Holstein-Friesian
 - (d) Karan-Swiss
- 17.** Exotic breed of poultry bird having high egg laying capacity is
- (a) White leghorn
 - (b) Broilers
 - (c) White cornish
 - (d) New Hemisphere
- 18.** The fungus disease causing maximum death of poultry bird is
- (a) coryza
 - (b) pullorium
 - (c) rickets
 - (d) aspergillosis
- 19.** The method maximum used in cattle breeding is
- (a) random mating
 - (b) artificial insemination
 - (c) controlled breeding
 - (d) super ovulation and embryo transfer
- 20.** Which of the following is the high milk yielding variety of cow?
- (a) Holstein
 - (b) Dorset
 - (c) Sahiwal
 - (d) Red Sindhi

- 21.** Wax glands of honey bee are present in :
- (a) queen
 - (b) drones
 - (c) workers
 - (d) both (a) and (c)
- 22.** “Drones” in the honeybee colony are born out from:
- (a) unfertilized eggs
 - (b) fertilized eggs and well nourished larvae
 - (c) same as worker bee
 - (d) fertilized eggs giving heat treatment
- 23.** Several embryos can be produced at a time in a single cow by the process of
- (a) hybridization
 - (b) artificial insemination
 - (c) embryo transfer
 - (d) random mating
- 24.** Rinderpest disease of poultry is caused by
- (a) insects
 - (b) bacteria
 - (c) virus
 - (d) protozoa
- 25.** The Jersey bull used for cross breeding is exotic variety from
- (a) England
 - (b) Scotland
 - (c) Switzerland
 - (d) Holland
- 26.** Layers continue to produce eggs upto
- (a) 350 days
 - (b) 425 days
 - (c) 500 days
 - (d) 600 days
- 27.** Alikunhi is famous for development of the technique of
- (a) hypophysation
 - (b) composite fish culture
 - (c) mariculture
 - (d) shell culture

ANSWERS

1. *b*
2. *c*
3. *b*
4. *b*
5. *c*
6. *b*
7. *c*
8. *d*
9. *a*
10. *b*
11. *c*
12. *b*
13. *d*
14. *d*
15. *d*
16. *c*
17. *a*
18. *d*
19. *b*
20. *a*
21. *c*
22. *a*
23. *c*
24. *c*
25. *a*
26. *c*
27. *a*

B. CLASS RESPONSE

VI. Oral Questions

- 1.** What is the time of sowing rabi crops ?
- 2.** What is HYV ?
- 3.** From where do plants obtain hydrogen ?
- 4.** Who is father of green revolution in India ?
- 5.** What are macronutrients of the plants ?
- 6.** What are advantages of manure ?
- 7.** Name two ecological problems which are caused by application of synthetic chemicals to crop fields.
- 8.** What are weeds ?
- 9.** Give name of a solid fumigant.
- 10.** What are the signs of infestation of stored grains?
- 11.** Enlist four types of diseases of animals which can also be transmitted to human beings.
- 12.** How many varieties of Aseel are popular among Indians ?
- 13.** What are broilers ?
- 14.** When do the layers start laying eggs ?
- 15.** What is aquaculture ?
- 16.** Give names of six fishes used in composite fish culture in India.

VI. Quiz

- 1.** What is green revolution ?
- 2.** Name three patterns of cropping.
- 3.** Give names of some fodder crops.
- 4.** What is that technique of farming which does not disturb the balance of nature ?
- 5.** Name a high yielding variety of rice.
- 6.** What is the complete fertilizer ?
- 7.** Which one is the best system of irrigation ?
- 8.** Why are leguminous plants often used in crop rotation ?
- 9.** What is biological control ?
- 10.** For proper storage of grains what is the ideal moisture content of grains?
- 11.** What is the name of cow breed having milch females?
- 12.** Give example of cow breed which provides draught animals.

13. What are symptoms of foot and mouth disease of cattle ?
14. What is normal body temperature of cow and buffalo?
15. Name two viral diseases of chickens.
16. Which vitamins occur in abundance in fish liver oil?
17. What is sugar content of honey ?
18. What is nosema disease ?

C. HOME ASSIGNMENT

VIII. Answer the following Questions

1. Give examples of different rabi and kharif crops
2. Enlist different desired traits of the parents chosen for selective breeding.
3. Name the two external factors that have favourable effect on egg-laying of hens.
4. Mention different aspects of fish culture.
5. Mention the factors affecting stored grains and describe their preventive measures.

D. GROUP DISCUSSION

IX. Organise group discussion on each of the following topics.

1. Various measures to control the insect-pest infection of crops. Discuss also its ecological hazards.
2. Some people have a fixation that products obtained from organic farming should only be consumed. Critically analyse their claim.
3. Need of animal husbandry in a predominantly agricultural based country such as India.

E. SEMINAR / SYMPOSIUM

X. Organise a seminar / symposium on each of the following topics.

1. Should we stop killing the domesticated animals for our food,

- instead depend solely on a vegetable diet?
2. Poultry - India's most efficient converter of low fibre food stuff into high nutritious animal protein food.
 3. India should give equal care to crop production and crop's safe storage.
 4. Ecological hazards of Agriculture.

F. GROUP ACTIVITY

XI. Investigatory Projects

1. Collect samples of bees found in different crop fields and try to identify each of them.
2. Collect some crop plants available locally and study whether they are infested with any pathogen. Try to identify some diseases of the crop plants.
3. Collect information related to the production of milk and milk product in nearby dairy farm.

XII. Experimental Projects / Survey

1. Collect information regarding poultry birds of India. You can collect photographs of different breeds of chickens and paste them in your scrapbook or chart.
2. Visit a nearby crop field and collect information regarding techniques of removal of weeds and chemical control of insect pests.
3. Visit a fish farm in fish breeding season and study types of ponds, varieties of fish in the ponds, feed ingredients, production capacity and common problems faced by the fish farm owners.

SUMMATIVE ASSESSMENT

Open-ended Questions

Categories the following under (a) Poultry, (b) Livestock, and (c)

Q.1. Fishery: Turkey, Prawns, Crabs, Cows, Fowls, Buffaloes.

(a) **Poultry:** Turkey, Fowls

Ans. (b) **Livestock:** Cows, Buffaloes

(c) **Fishery:** Prawns, Crabs

Q.2. Which one is nutrient specific—fertilizer or manure?

Ans. Fertilizers are nutrient specific and provide specific nutrient to the soil.

Q.3. Which one of the following crops require a minimum quantity of NPK or urea for its proper growth: paddy, peas, wheat, sugarcane

Ans. The crop of peas would require a minimum quantity of NPK or urea because pea is a dicot and its roots contain nitrogen fixing bacteria in root nodules.

Illustration-Based Questions

What type of irrigation is showed in the figure

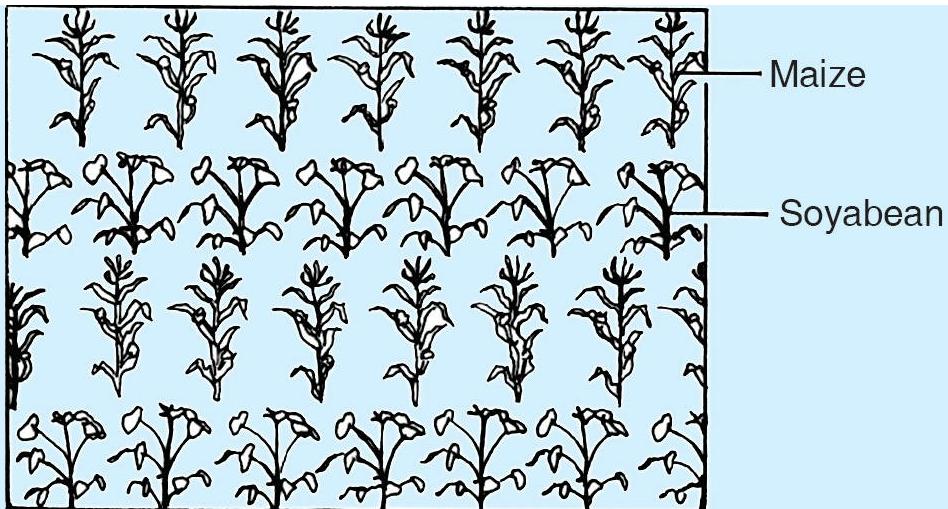
Q.4.



Ans. Drip irrigation.

A field with maize and soyabean plants is shown here

Q.5.



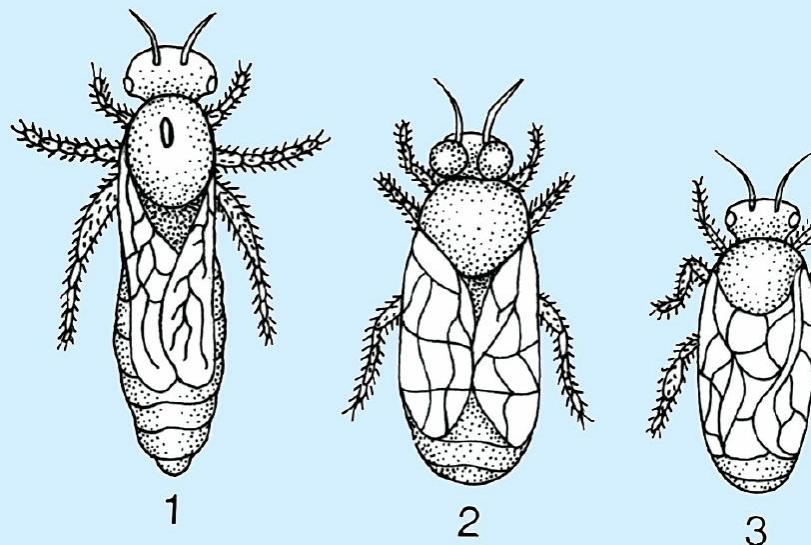
- (a) What pattern of cropping does the field shows?
- (b) Mention any two advantages of this type of cropping pattern.
- (a) The field shown intercropping of maize and soyabean crops.
- (b) The advantages of intercropping are as follows:

Ans.

- (i) Intercropping increases the productivity of crops per unit area.
- (ii) Intercropping helps maintain soil fertility and makes better use of resources.

Look at Figures 1, 2 and 3 given along side and answer the following questions:

Q.6.



- (a) What do these figures show all together?
- (b) Which one is queen bee?
- (c) Which one of them is the haploid, fertile male? What is it called?
- (d) What is the status of the insect shown in the figure:

- individual/social?
- Ans.**
- (a) These are different castes of honey bee.
 - (b) Figure 1 shows the queen bee.
 - (c) Figure 2 is a haploid and fertile male bee. It is called a drone bee
 - (d) Honey bee is a social insect.

Communication Skill-Based Questions

Q.7. What should be do to get maximum benefit from a crop field?

Ans. To get the maximum benefit from a crop field, we should

- (i) maintain the soil fertility through judicious use of manure and fertilizers.
- (ii) practise crop rotation.
- (iii) employ mixed cropping and intercropping method of agriculture.
- (iv) keep the weeds and insect pest population under control.

Q.8. What are biofertilizers? In what sense are they better than chemical fertilizers?

Ans. Some microorganisms such as nitrogen fixing bacteria, cyanobacteria, fungi and other microflora harbour near the roots of plant inside soil. They convert nitrogen of the air into nitrogenous compounds (ammonia and nitrate) which serve as plant nutrients. Since these microorganisms enrich the soil with nutrients and improve soil fertility, hence also collectively known as biofertilisers.

Q.9. The production of food from animal sources has increased greatly in the last few decades. Justify it.

Ans. The ever increasing human population and the resultant decrease in agricultural land has compelled human beings to move towards animal husbandry to obtain food from animal sources. The last few decades have seen enormous rise in animal meat production and byproducts. Poultry, fisheries, piggery, cattle, sheep and goat farming have developed considerably. Through Operation Flood and the Silver Revolution, milk and egg production have registered a record increase.

Q.10. Each beehive consists of thousands of hexagonal thin-walled fragile cells. Name the material which is used to make these cells and mention the significance of the hexagonal shape of the cell.

Ans. Bee hive is made up of wax which is secreted from the wax glands present in the abdomen of worker bees. The hexagonal shape of the cells cover maximum space with minimum use of wax and labour.

Multiple Choice Questions

Type 1. Interpretation Type Questions

- 1. All animals are**
 - (a) parasitic
 - (b) saprophytic
 - (c) autotrophic
 - (d) heterotrophic
- 2. Which is the most important source of food and fodder ?**
 - (a) algae
 - (b) fungi
 - (c) lichen
 - (d) cereal
- 3. Application of nitrogenous manure to a plant causes**
 - (a) vigorous vegetative growth
 - (b) early flowering
 - (c) early fruiting
 - (d) growth retardation due to toxicity of NH_3
- 4. The element which is required in largest quantity by plants is**
 - (a) sulphur
 - (b) calcium
 - (c) phosphorus
 - (d) nitrogen
- 5. Nodules with nitrogen-fixing bacteria are present in**
 - (a) mustard
 - (b) wheat
 - (c) gram
 - (d) cotton
- 6. Inland fisheries is referred to**
 - (a) culturing fish in freshwater
 - (b) trapping and capturing fishes from sea coast

- (c) deep sea fisheries
 - (d) extraction of oil from fishes
- 7. Plants can be made disease-resistant by**
- (a) heat treatment
 - (b) hormone treatment
 - (c) colchicine treatment
 - (d) breeding with their wild relatives
- 8. The process of cross breeding two different varieties of crop plants each having a desired characteristic, is known as**
- (a) selection
 - (b) hybridization
 - (c) crossing
 - (d) introduction
- 9. Milk does not provide**
- (a) vitamin A and D
 - (b) carbohydrates, proteins and fats
 - (c) minerals such as phosphorus and calcium
 - (d) iron
- 10. Which of the following statement is correct about fertilizer ?**
- (a) it is nutrient specific
 - (b) it is water insoluble
 - (c) it is readily absorbed by the plant
 - (d) it is compact and easy to transfer
- 11. Which of the following is incorrect for greenmanure ?**
- (a) it supplies organic matter
 - (b) it supplies nitrogen
 - (c) it prevents soil erosion
 - (d) it allows leaching
- 12. When both crops and livestock are raised on the same farm, it is known as**
- (a) mixed farming
 - (b) mixed cropping
 - (c) intercropping
 - (d) crop rotation

Type 2 : Identity- Relationship Type Questions

- 1. Living organisms are used in**
 - (a) organic manure
 - (b) biofertilizers
 - (c) natural insecticides
 - (d) pesticides
- 2. The principal cereal crop of India is**
 - (a) wheat
 - (b) rice
 - (c) maize
 - (d) sorghum
- 3. Gundhi bug is a pest of**
 - (a) sugarcane
 - (b) cotton
 - (c) rice
 - (d) wheat
- 4. Sustainable agriculture involves**
 - (a) mixed farming
 - (b) mixed cropping
 - (c) crop rotation
 - (d) all of the above
- 5. Which of the following have been artificially selected ?**
 - (a) cabbage
 - (b) cauliflower
 - (c) broccoli
 - (d) all of these
- 6. Kranti, Pusa agarni and pusa bold are improved varieties of**
 - (a) urad bean
 - (b) sunflower
 - (c) chick pea
 - (d) mustard
- 7. Which of the following is not a draught animal ?**
 - (a) camel
 - (b) elephant
 - (c) sheep
 - (d) horse
- 8. Which of the following is a leguminous green fodder**

commonly available in winter ?

- (a) cow pea
- (b) elephant grass
- (c) berseem and lucerne
- (d) rice and jowar

9. Which one of the following is micronutrient ?

- (a) nitrogen
- (b) phosphorus
- (c) potassium
- (d) boron

10. Which of the following is not an exotic breed of cow ?

- (a) Jersey
- (b) Holstein-Friesian
- (c) Sahiwal
- (d) Brown Swiss

11. The first experiment in artificial insemination was performed by

- (a) Aristotle
- (b) Berzelius
- (c) Spallanzani
- (d) Linneaus

12. Which of the following yields maximum milk/year ?

- (a) Holstein-Friesian
- (b) Frieswal
- (c) Red sindhi
- (d) Sahiwal

13. What is pulse rate of buffalo/minute ?

- (a) 16-18/minute
- (b) 40-45/minute
- (c) 40-60/minute
- (d) 70-72/minute

14. Which of the following poultry bird lays maximum number of eggs?

- (a) ILS-82
- (b) B-77
- (c) HH-260

(d) IBL-80

15. Which one of the following is the fastest growing carp ?

- (a) rohu
- (b) catla
- (c) mrigal
- (d) singhara

16. Which of the following is gaseous fumigant ?

- (a) DDT
- (b) aluminium phosphide
- (c) ethylene dichloride
- (d) methyl bromide

17. Which of the following is natural insecticides?

- (a) nicotene
- (b) neem
- (c) pyrethrum
- (d) all of these

18. Which of the following is broad leaf weed ?

- (a) *Chenopodium*
- (b) *Convalvulus*
- (c) *Amaranthus*
- (d) all of the above

Type 3. NCERT Question Bank

1. Find out the wrong statement from the following :

- (a) white revolution is meant for increase in milk production
- (b) blue revolution is meant for increase in fish production
- (c) increasing food production without compromising with environment quality is called as sustainable agriculture
- (d) none of the above

2. To solve the food problem of country, which among the following necessary ?

- (a) increased production and storage of food grains
- (b) easy access of people to the food grain
- (c) people should have money to purchase the grains
- (d) all the above

3. Which one is an oil yielding plant among the following ?

- (a) lentil
- (b) sunflower
- (c) cauliflower
- (d) *Hibiscus*

4. Which one is not a source of carbohydrate ?

- (a) rice
- (b) millets
- (d) Brown Swiss
- (c) sorghum
- (d) gram

5. Weeds affect the crop plants by

- (a) killing of plants in field before they grow
- (b) dominating the plants to grow
- (c) competing for various resources of crops (plants) causing low availability of nutrients
- (d) all the above

6. Find out the correct sentence

- (i) hybridisation means crossing between genetically dissimilar plants
 - (ii) cross between two varieties is called as inter-specific hybridisation
 - (iii) introducing genes of desired characters into a plant gives genetically modified crop
 - (iv) cross between plants of two species is called as inter varietal hybridisation
- (a) (i) and (iii)
 - (b) (ii) and (iv)
 - (c) (ii) and (iii)
 - (d) (iii) and (iv)

7. Which one of the following species of honey bee is an Italian species ?

- (a) *Apis mellifera*
- (b) *Apis dorsata*

- (c) *Apis florea*
- (d) *Apis cerana indica*

8. Find out the correct sentence about manure

- (i) manure contains large quantities of organic matter and small quantities of nutrients
 - (ii) it increases the water holding capacity of sandy soil
 - (iii) it helps in draining out of excess of water from clayey soil.
 - (iv) its excessive use pollutes environment because it is made of animal excretory waste
- (a) (i) and (iii)
 - (b) (i) and (iii)
 - (c) (ii) and (iii)
 - (d) (iii) and (iv)

9. Cattle husbandry is done for the following purpose

- (i) milk production
 - (ii) agricultural work
 - (iii) meat production
 - (iv) egg production
- (a) (i), (ii) and (iii)
 - (b) (ii), (iii) and (iv)
 - (c) (iii) and (iv)
 - (d) (i) and (iv)

10. Which of the following are Indian cattle ?

- (i) *Bos indicus*
 - (ii) *Bos domestica*
 - (iii) *Bos bubalis*
 - (iv) *Bos vulgaris*
- (a) (i) and (iii)
 - (b) (i) and (ii)
 - (c) (ii) and (iii)
 - (d) (iii) and (iv)

11. Poultry farming is undertaken to raise following

- (i) egg production

- (ii) feather production
 - (iii) chicken meat
 - (iv) milk production
- (a) (i) and (ii)
- (b) (i) and (iii)
- (c) (ii) and (iii)
- (d) (iii) and (iv)
- 12. Poultry fowl are susceptible to the following pathogens**
- (a) viruses
 - (b) bacteria
 - (c) fungi
 - (d) all the above
- 13. Which one of the following fishes is a surface feeder ?**
- (a) rohus
 - (b) mrigals
 - (c) common carps
 - (d) catlas
- 14. Animal husbandry is the scientific management of**
- (i) animal breeding
 - (ii) culture of animals
 - (iii) animal livestock
 - (iv) rearing of animals
- (a) (i), (ii) and (iii)
- (b) (ii), (iii) and (iv)
- (c) (i), (ii) and (iv)
- (d) (i), (iii) and (iv)
- 15. Which one of the following nutrients is not available in fertilizers ?**
- (a) nitrogen
 - (b) phosphorus
 - (c) iron
 - (d) potassium
- 16. Preventive and control measures adopted for storage of grains include**
- (a) strict cleaning
 - (b) proper disjoining

- (c) fumigation
- (d) all the above

ANSWERS

Type 1 MCQs

- 1. (d);
- 2. (d);
- 3. (a);
- 4. (d);
- 5. (c);
- 6. (a)
- 7. (d);
- 8. (b);
- 9. (d);
- 10. (b);
- 11. (d);
- 12. (a)

Type 2 MCQs

- 1. (b);
- 2. (b);
- 3. (c);
- 4. (d);
- 5. (d);
- 6. (d)
- 7. (c);
- 8. (c);
- 9. (d);
- 10. (c);
- 11. (c);
- 12. (a)
- 13. (b);
- 14. (c);
- 15. (b);
- 16. (d);

17. (d);
18. (d)

Type 3 MCQs

1. (d);
2. (d);
3. (b);
4. (d);
5. (c);
6. (a)
7. (a);
8. (a);
9. (a);
10. (a);
11. (b);
12. (d)
13. (d);
14. (d);
15. (c);
16. (d)

NCERT TEXTBOOK QUESTIONS AND EXERCISES WITH ANSWERS

NCERT Questions

Q.1. What do we get from cereals, pulses, fruits and vegetables?

Ans. The cereals (*i.e.*, wheat, rice, maize, millets and sorghum) provide us carbohydrates. The pulses (*i.e.*, gram, pea, black gram, green gram, pigeon pea, lentil, etc.) give us protein. Fruits and vegetables give us carbohydrates, proteins, fat, vitamins, minerals, and lots of fibers.

Q.2. How do biotic and abiotic factors affect crop production?

Ans. Crop production can go down due to *biotic* (*diseases* due to infection by viruses or fungi, insects and nematodes) and *abiotic* (drought, salinity, water logging, heat, cold and frost) *stresses* under different situations.

Q.3. What are the desirable agronomic characteristics for crop improvement?

Ans. If we develop those varieties of crops which contain desired agronomic traits (*e.g.*, high yield, dwarfness, early maturing, etc.) then it will help in setting higher production. Thus, tallness and profuse branching are desirable characters for fodder crops. Dwarfness is desired in cereals, so that less nutrients are consumed by these crops. Dwarf varieties of cereals also provide protection from lodging.

Q.4. What are the macronutrients and why are they called macronutrients?

Ans. The macronutrients are nitrogen, phosphorus, potassium, calcium, magnesium and sulphur. They are called macronutrients because they are required by crop plants in large amounts.

Q.5. How do plants get nutrients?

Ans. There are *three* different sources from where a plant gets the 16 essential nutrients: air, water and soil (see [Table 1.2](#)). The nutrients taken from air and water are carbon, oxygen and hydrogen and these are taken by stomata (of leaf), lenticel (of stem) and root-hairs (of roots). Rest 13 nutrients are obtained from soil. These 13 nutrients remain dissolved in water in the soil and are absorbed by the plant roots.

Q.6. Compare the use of manure and fertilizers in maintaining soil fertility.

Ans. Manure contains many organic substances of biological origin which can be easily degraded and absorbed by plants. It helps in recycling of biological waste. Manures increase the fertility of soil for long duration without causing any harm. However, the chemical fertilizers (*e.g.*, urea) improve soil fertility for short duration but cause environmental hazard. Continuous use of fertilizers in a particular area/crop field causes destruction of soil fertility.

Which of the following conditions will give most benefits? Why?

- Q.7.**
- (a) **Farmers use high quality seeds, do not adopt irrigation or use fertilizers.**
 - (b) **Farmers use ordinary seeds, adopt irrigation or use fertilizers.**
 - (c) **Farmers use quality seeds, adopt irrigation, use fertilizers and use crop protection measures?**

The conditions of (c) will give the most benefits because all these conditions are required for good crop production. High quality seeds

Ans. germinate properly and grow to healthy plants. Irrigation helps crop plants to fight against draught stress. Fertilizers provide desired nutrients and crop protection measures (*e.g.*, use of pesticides, etc.) protect the crop plants from diseases, weeds and pests.

Q.8. **Why should preventive measures and biological control methods be preferred for protecting crops?**

Preventive measures (such as use of resistant varieties of crops) and biological control methods should be preferred for protection of crops because they are ecologically safe, target specific and harmless to other life forms.

Q.9. **What factors may be responsible for losses of grains during storage?**

Ans. There are two main factors responsible for loss during storage. **A. Biotic factors** include:

1. Insects, *e.g.*, grubs of pulse beetle; grubs and adults of rice weevil; wheat weevil; caterpillar of grain and flour moth; larvae and adult of rust red flour beetle; larvae of rice moth and grubs and adults of lesser grain borer.
2. Rodents, *e.g.*, striped squirrel, house rat, house mouse, lesser bandicoot rat, etc.
3. Birds, *e.g.*, parakeet, sparrow, bulbul, blue rock pigeon, crow, etc.
4. Mites; 5. Fungi; and 6. Bacteria.

B. **Abiotic factors.** They include moisture, temperature and other non-living environmental factors.

Q.10. **Which method is commonly used for improving cattle breeds and why?**

Ans. The milk production of cattle can be increased by the technique of selective breeding. This is done by cross breeding between a local breed (indigenous breed, *e.g.*, Red Sindhi, Sahiwal) cow and an exotic (foreign breed, *e.g.*, Brown Swiss) bull. The local cow is selected for the character of disease resistance. The exotic breed of bull is selected for the character of prolonged period of lactation and high yield of milk. The breeding may be done by natural methods or by artificial insemination (*i.e.*, injecting the semen obtained from the desired bull into reproductive tract (vagina) of the cow during fertility period). The desired characters are thus obtained in the next generation.

Discuss the implication of the following statement:

Q.11. “It is interesting to note that poultry is India’s most efficient converter of low fiber food stuff (which is unfit for human consumption) into highly nutritious animal protein food”.

Ans. Poultry birds utilise such agricultural products which are unfit for human consumption. In return, they give us eggs and high quality meat which serve as a cheap source of animal protein.

Q.12. What management practice are common in dairy and poultry farming?

Ans. In both dairy and poultry farming, there are: (i) Maintenance of temperature; (ii) Proper housing facilities having hygienic conditions; (iii) Proper feeding ; and (iv) Prevention and control of diseases and pests.

Q.13. What are the differences between broilers and layer and in their management?

Ans. See [Table 1.13](#).

Q.14. How are fish obtained?

Ans. There are two methods of obtaining fish. One method is **capture fishing** in which the fish are obtained from natural resources such as fresh water resources (*i.e.*, canals, pools, reservoirs and rivers), brackish water resources (*i.e.*, estuaries and lagoons) and marine fishery resources (*i.e.*, coastline and deep seas). The other method is by **fish farming** (or **culture farming**), which is concerned with culturing, feeding, breeding and fish production. Fish farming is based on **aquaculture** which pertains to production of useful aquatic plants and animals such as fishes, prawns, crayfish, lobsters, crabs, shrimps, mussels, oysters and seaweeds by proper utilisation of available waters in the country. Aquaculture includes mariculture and freshwater culture fisheries.

Q.15. What are the advantages of composite fish culture?

Ans. Composite fish culture is also called **polyculture of fishes**. It is advantageous, economical and profitable from business point of view. It yields about 8-9 times more production as compared to **monoculture**. In composite fish culture, 5 or 6 species of fast growing fish are cultured in single fish pond which do not compete with each other for space and nutrition. They live in distinct zones inside the pond and have distinct feeding habits. For example, a highly yielding Indian fish pond may contain following six species of fishes : 1. Silver carp which is a

surface feeder and feeds on phytoplankton; 2. Catla which is also a surface feeder but it feeds on zooplankton; 3. Rohu which is column feeder and it feeds on detritus; 4. Grass carp which feeds on aquatic plants (including weeds); 5. Mrigal which is a bottom feeder and it feeds on detritus; and 6. Common carp which is omnivorous bottom feeder.

Q.16. What are the desirable characters of bee varieties suitable for honey production?

Ans. The desirable characters of bee varieties suitable for honey production are : 1. They sting less. 2. They stay for longer periods in a given bee hive. 3. They breed well. 4. They produce comparatively more honey and wax.

Q.17. What is pasturage and how is it related to honey production?

Ans. Pasturage is the availability of flowers for nectar and pollen collection for the honeybee. The quality and taste of the honey is determined by the kind and quantity of pasturage.

NCERT Exercises

Q.1. Explain any one method of crop production which ensures high yields.

Ans. Refer the heading Nutrient Management.

Q.2. Why are manures and fertilizers used in fields?

Ans. Manure and fertilizers are added to the soil of crop field to increase the fertility of soil and productivity of crop. They overcome the deficiency of nutrients in the soil of the field.

Q.3. What are the advantage of inter-cropping and crop-rotation?

Ans. Refer the heading ‘Cropping Patterns’.

Q.4. What is genetic manipulation? How is it useful in agriculture practices?

Ans. Refer the heading ‘Crop variety Improvement’.

Q.5. How do storage grain losses occur?

Ans. Refer the heading ‘Storage of Grain’.

Q.6. How do good animal husbandry practices benefit farmers?

Ans. Refer text of Animal Husbandry.

Q.7. What are the benefits of cattle farming?

Ans. Refer [Section 1.3](#). Animal Husbandry.

Q.8. For increasing production. What is common in poultry, fisheries and bee-keeping ?

Ans. Variety improvement, housing, rearing, sanitation, disease control and marketing.

Q.9. How do you differentiate between capture fishing, mariculture and aquaculture ?

Ans. In following table a comparison has been made between capture fishing, mariculture and aquaculture.

<i>Capture fishing</i>	<i>Mariculture</i>	<i>Aquaculture</i>
In capture fishing, the fish catching is done from various natural resources, lakes, rivers, oceans, seas, etc.	In mariculture, culture of marine fishes is done in the coastal water. The desired marine fishes and other animals are cultivated and obtained.	In aquaculture, culturing of fish is done using any water body which may contain salt water or fresh water. Mariculture is a type of aquaculture.

Questions Based on NCERT Question Bank (Exemplar Problems in Science)

Fill in the blanks

- Q.1.** (a) are rich in vitamins.
(b) The crops which are grown in rainy season are called crops.
(c) crop grows in winter season.
(d) Pigeon pea is a good source of
(e) Berseem is an important crop.

Ans. (a) Vegetables; (b) Kharif; (c) Rabi; (d) Protein; (e) Fodder.

Q.2. Match the items of column A with those of column B.

<i>Column A</i>	<i>Column B</i>
(a) Fish farming	(i) Bottom feeder
(b) Catla	(ii) Culture fishery
(c) Rohu	(iii) Surface feeder

(d) Mrigal

(iv) Middle zone feeder

Ans. a – ii; b – iii; c – iv; d – i.

Q.3. What is GM crop? Name any one crop which is grown in India.

Ans. GM or genetically modified crop is the one which has been developed through introduction of some specific genes from other sources, e.g.,

insect resistant Bt cotton (being grown in India), vitamin A rich Golden rice.

Q.4. List out some useful traits in improved crop ?

Ans. (i) Higher yield; (ii) Improved quality; (iii) Resistance to biotic and abiotic stresses; (iv) Change in maturity; (v) Wider adaptability; (vi) Desirable agronomic trait.

Q.5. Why is organic matter important for crop production ?

Ans. Organic matter forms **humus**. It is essential for crop production because it makes the soil fertile. Organic matter has the following advantages:

- (i) It improves soil structure by forming soil crumbs.
- (ii) It increases water holding capacity of sandy soils.
- (iii) It improves aeration of clayey soils.
- (iv) During its decomposition, it liberates minerals (inorganic molecules) which enrich the soil.
- (v) Biochemicals present in decaying organic matter improve growth of crop plants.

Q.6. Why is use of excess fertilizer detrimental for environment ?

Ans. Use of excess fertilizers tend to cause :

- (i) Mineral loading of underground water.
- (ii) Excess minerals in the crop plants.
- (iii) Salinization of soil.
- (iv) Run off from fertilizers rich soil, will cause eutrophication of water bodies.

Q.7. Give one word for the following :

(a) Farming without the use of chemicals as fertilizers, herbicides and pesticides is known as

(b) Growing of wheat and groundnut on the same field is called

(c) Planting of soyabean and maize in alternate rows in the same field is called

(d) Growing different crops on a place on a piece of land in preplanned succession is known as.

(e) *Xanthium* and *Parthenium* are commonly known as

(f) Causal organism of any disease is called as

Ans. (a) Organic farming ; (b) Mixed cropping ; (c) Inter-cropping ; (d) Crop rotation ; (e) Weeds ; (f) Pathogen.

Q.8. Match column A and column B

<i>Column A</i>	<i>Column B</i>
(a) Milch	(i) Milk producing female
(b) Sahiwal, Red Sindhi	(ii) Broiler
(c) Cattle used for tilling and carting	(iii) Draught animals
(d) Indian breed of chicken	(iv) Local breed of cattle
(e) Chicken better fed for obtaining meat	(v) Aseel

Ans. a – i; b – iv; c – iii; d – v; e – ii.

Q.9. If there is low rainfall in a village throughout the year, what measures will you suggest to the farmers for better cropping.

Ans. (i) Reduce tilling; (ii) Enrich soil with humus which increases its water holding capacity; (iii) Use of drought resistant and early maturing varieties of crop.

Q.10. Group the following and tabulate them as energy yielding, protein yielding, oil yielding and fodder crop: Wheat, Rice, Berseem, Maize, Gram, Oat, Pigeon gram, Sudan grass, Lentil, Soybean, Groundnut, Castor and Mustard.

Ans. (i) Energy yielding crop : Wheat, Rice, Maize, Oat.
(ii) Protein yielding crop : Gram, Pigeon gram, Lentil, Sudan grass.
(iii) Oil yielding crop : Groundnut, Castor, Mustard, Soybean.
(iv) Fodder crop : Berseem, Oat, Sudan grass.

Q.11. Define the terms hybridization and photoperiod.

Hybridisation. It is crossing of two (or more) types of individuals with different useful traits in order to bring them together in the progeny.

Ans. **Photoperiod.** It is duration of day light that influences plants and other

organisms in their growth, reproduction and maturation.

Fill in the blanks :

Q.12.

- (a) Photoperiod affect the
- (b) Kharif crops are cultivated from to
- (c) Rabi crops are cultivated from to
- (d) Paddy, Maize, Green Gram and Black gram are crops.
- (e) Wheat, Gram, Pea and Mustard are crops.

Ans.

- (a) Flowering (of plants) ; (b) June, October ; (c) November, April ; (d) Kharif ; (e) Rabi.

Q.13.

Cultivation practices and crop yield are related to environmental conditions. Explain.

Ans.

All crops do not grow under similar conditions. Some require high temperature, some low temperature, longer duration of sunlight, shorter duration of sunlight, more humidity, low humidity, moderate humidity, loam soil, sandy soil, etc. Apple cannot be grown in plains because it requires several days of low temperature. In plains, there are two major seasons of crop plants : kharif (rainy season) and rabi (winter season).

Q.14.

Fill in the blanks :

- (a) A total of nutrients are essential to plants.
- (b) and are supplied by air to plants.
- (c) is supplied by water to plants.
- (d) Soil supplies nutrients to plants.
- (e) nutrients are required in large quantity and called as
- (f) nutrients are needed in small quantity for plants and are called

Ans.

- (a) 16 ; (b) carbon, oxygen ; (c) Hydrogen ; (d) 13 ; (e) Six, macronutrients, (f) Seven, micronutrients.

Q.15.

Differentiate between compost and vermicompost.

Ans.

<i>Compost</i>	<i>Vermicompost</i>
1. It is prepared from all types of organic remains-garbage, sewage, sludge, animal refuse, farm waste, straw, uprooted weeds, etc.	1. It is prepared from domestic waste, vegetable waste, uprooted weeds and farm refuse.

2. Organic remains are decomposed by released enzymes of the microorganisms.	2. Organic remains are fed by earthworms and in pulverized state.
3. It takes 3 to 6 months to prepare.	3. It takes 1 to 2 months to prepare.

Arrange these statements in correct sequence of preparation of green manure :

- Q.16.** (a) Green plants are decomposed in soil
 (b) Green plants are cultivated for preparing manure or crop plants are used.
 (c) plants are ploughed and mixed in soil
 (d) After decomposition, it becomes green manure.

Ans. (b) → (c) → (a) → (d).

- Q.17.** An Italian variety *Apis mellifera* has been introduced in India for honey production. Write about its merits over other varieties.

Ans. See text.

- Q.18.** In agriculture practices, higher input gives higher yield. Discuss how ?

In agriculture, higher yield can be obtained only by applying higher yielding varieties, improved farming practices, modern technology,

Ans. latest agricultural machines and implements, nutrient supply, etc. All these require high cost and knowledge of new techniques and improvements. Therefore, a farmer's purchasing capacity for inputs determines the cropping system and production exercises.

- Q.19.** Discuss the role of hybridisation in crop improvement.

Ans. See text.

- Q.20.** Define (i) Vermicompost ; (ii) Green Manure ; (iii) Biofertilizers.

(i) Vermicompost. It is a manure rich pulverised organic matter and worm castings. Vermicompost is formed by the activity of earth worms

Ans. on organic remains.

(ii) Green Manure. See text.

(iii) Biofertilizers. See text.

- Q.21.** Discuss various methods of weed control.

Ans. See text.

- Q.22.** Differentiate between the following.

- (i) Mixed cropping and inter cropping.
- (ii) Capture fishery and culture fishery.
- (iii) Bee keeping and poultry farming.

Ans. (i) Differences between Mixed cropping and Inter cropping. See text.
(ii) Differences between Capture fishery and Culture fishery. See text.
(iii) Difference between Bee keeping and Poultry farming.

<i>Bee keeping</i>	<i>Poultry farming</i>
1. It is the practice of rearing, care and management of honey bees.	1. It is the practice of raising domestic fowl.
2. It provides honey, bee wax and related products.	2. It provides egg and meat.
3. Bees obtain their food from flowers.	3. Poultry birds are provided with feed by their rears.

Q.23. Give merits and demerits of fish culture.

Ans. **Merits.** 1. Economically important desired fishes are made available.
2. A large number of fishes are raised in a small area.
3. Fishes are made to breed in different seasons.
4. There is a little mortality in the younger stages of the fishes.
5. Through selective hybridisation, yield and quality of fishes are improved.
1. Only some selected high yielding and economically important breeds are reared.
2. Fish culture is a threat to biodiversity, since other forms of aquatic organisms are being ignored. Even natural waters are being seeded with economically important fishes ; this too is affecting the natural biodiversity of the water bodies.

Q.24. What do you understand by composite fish culture ?

Ans. See text.

Q.25. Why bee keeping should be done in good pasturage ?

Ans. See text.

Q.26. Write the modes by which insects affect the crop yield.

Ans. See text.

Q.27. Discuss why the pesticides are used in very accurate concentration and at very appropriate time.

Ans. Pesticides are very toxic substances, they should not be used indiscriminately. Only very accurate dose should be applied at appropriate time. Even slight excess of the pesticides is extremely harmful.

- (i) Pesticides are harmful to soil biota. Therefore, they reduce soil fertility.
- (ii) They pass into ground water and make it toxic.
- (iii) They enter the crop plants and make their products (leaves, stem, flowers, fruits and seeds) toxic.
- (iv) Pesticides pass into surface water through run off from sprayed fields and harm the aquatic biota.

Q.28. Name two types of animal feed and write their functions.

Ans. See text.

Q.29. What would happen if poultry birds are larger in size and have no summer adaptation capacity ? In order to get small sized poultry birds having summer adaptability, what methods will be employed ?

Larger sized birds require more feed. Summer adaptation is connected with egg laying. Little summer adaptation reduces egg laying. In order to get small sized poultry birds having summer adaptability, it is desirable to (i)

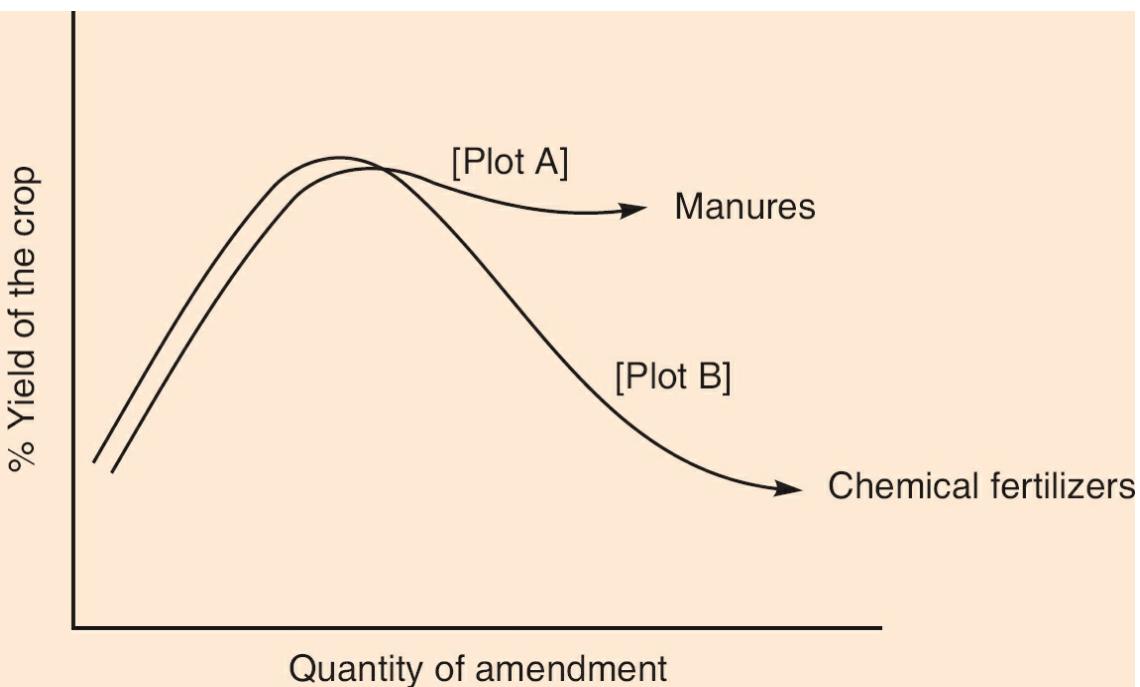
Ans. Either introduce the required exotic birds from outside and (ii) Cross breed the local birds with exotic birds from outside. Small sized poultry birds are preferred for (a) Lower requirement of feed ; (b) Higher egg laying capacity ; (c) Lower requirement for space.

Q.30. Suggest some preventive measures of the diseases of poultry birds.

Ans. See text.

The figure shows two crop fields (plots A and B) have been treated by manures and chemical fertilizers, respectively, keeping other environmental factors same. Observe the graph and answer the following questions:

Q.31.



- (i) Why does plot B shows sudden increase and then gradual decrease in yield?
- (ii) Why is the highest peak in plot A graph slightly delayed?
- (iii) What is the reason for the different pattern of the two graphs.

Sudden increase. Chemical fertilizer supplies the minerals immediately in good quantity.

- Ans.**
- (i) **Gradual decrease.** It is due to depletion of nutrients caused by absorption by plants, leaching to lower layer of the soil and killing of decomposer microorganisms.
 - (ii) Manures decompose slowly so that release of minerals is also delayed. Manures take time to mix up with the soil and form crumbs, that increase water holding and aeration of the soil.
 - (iii) The difference in the two graphs indicates that manuring the soil of crop fields is more beneficial than the use of chemical fertilizers. Rather, use of chemical fertilizers is harmful in the longer run.

QUESTIONS OF CBSE SAMPLE PAPER

- Q.1.** Give one example of an Indian and foreign poultry breed which when crossed produce an improved variety. List any one desirable

trait expected from such cross breeding.

(2 marks : 2010)

Indian poultry breed — Aseel

Ans. **Foreign poultry breed** — Loghorn.

Desirable trait after cross breeding — Better quantity and quality of eggs and meat with good tolerance of local conditions.

Q.2. (a) What are the two ways of obtaining fish ?

(b) What is the major problem faced in fish farming ? How can it be overcome.

(2 marks : 2010)

Ans. (a) The two ways of obtaining fish are

(i) **Capture fishery.** Fish is caught from natural waters both marine as well as inland (freshwater bodies).

(ii) **Culture fishery.** Fish is grown in water bodies through human efforts. The mature fish is harvested.

Major problem of fishery (or fish farming). It is procurement of pure seeds of high quality fish. This problem has been solved through hypophysation or hormonal treatment of selected fishes in breeding hapas.

Q.3. (a) Discuss two ways of incorporating desirable characteristics into crop varieties.

(b) What is inter-cropping? How are crops selected for inter-cropping?

(3 marks; 2010)

Ans. Desirable characteristics can be incorporated in a crop variety by two methods:

(i) **Hybridization.** This is a genetical technique. This method involves crossing of the selected plants having one or more of the desirable characteristics (ii) **Genetic engineering.** Introduction of desirable characteristics with the help of techniques available in biotechnology.

(b) **Intercropping.** It is growing of two or more crops simultaneously in the same field but in different row patterns.

Crops are selected for intercropping on the basis of different nutrient requirement and different sowing and reaping (harvesting) times, e.g., soybean and maize.

Q.4. Aditya added 1-2 drops of iodine to three test tubes A, B and C, containing 2 ml of food samples. A dark blue-black colour appeared in test tubes A and B. The correct order of food samples taken in test tubes A, B and C is :

(1 mark, 2010)

- (a) rice, dal, potato
- (b) rice, potato, dal
- (c) potato, dal, rice
- (d) dal, rice, potato

Ans. (b)

Q.5. The following statements, describe the steps to detect the presence of metanil yellow in dal. One of the four statements given below is incorrect.

(1 mark, 2010)

- (a) take 2 ml of food extract
- (b) grind 3-5 g of dal and prepare solution
- (c) add 2-3 drops of concentrated H_2SO_4
- (d) filter the contents and collect the filter

Ans. (c).

PAPER-PEN TEST

Time 30 minutes

Maximum marks 17

MCQ

1. Bee keeping is known as
- (a) pearl culture
 - (b) pisculture
 - (c) sericulture
 - (d) apiculture

1

Blanks

2. Ganga 5 is the variety of -----.

1

T/F

3. Concentrates are low in fibres but rich in proteins and other nutrients.

Matching 4. Match the items of column I and II

<i>Column I</i>	<i>Column II</i>
1. Green manure	(a) Carp
2. Micronutrient	(b) Rice
3. Catla	(c) Iron
4. Kasturi	(d) Cluster bean(guar)

HOTS 5. Write down the composition of a fresh water composite fish culture. How is competition avoided between fishes ?

S.A.I 6. Compare layers and broilers.

S.A.II 7. What are weeds ? How do they affect crop plants ? Describe biological control of weeds

L.A 8. Describe fertilizers and compare them with biofertilizers and composts.

REVISION QUESTIONS

Very Short Answer Questions (Carrying 1 mark each)

1. What is green revolution ?

Ans. The enormous increase in the production of food grain (especially wheat) during the last three decades, due to use of seeds of HYV (= High Yielding Varieties), higher dose of fertilizers and pesticides, and irrigation is known as **green revolution**.

2. Mention the crop whose production has increased by blue revolution and yellow revolution.

Ans. Fish and oil production.

3. Give one example each of kharif and rabi crops.

Ans. Rice and what, respectively.

4. What are plant nutrients ?

Ans. Plant nutrients are inorganic raw materials that are absorbed from soil (water and air) by the plants for building up organic matter.

5. Name the three most important mineral elements required for plant growth.

Ans. Nitrogen, Phosphorus and Potassium.

6. Name any two micronutrients, required by plants.

Ans. Manganese and Zinc.

7. Name any two macronutrients required by plants.

Ans. Carbon and Sulphur.

8. What name has been given to the elements required by plants in (a) smaller amount, (b) larger amount.

Ans. (a) Micronutrients; (b) Macronutrients.

9. State whether iron is a micronutrient with respect to plants.

Ans. Iron is a micronutrient of plants.

10. What is manure ?

Ans. Manure is partially decomposed organic matter formed from animal wastes (such as dung of cattle) and crop residue that is added to soil for increase in fertility.

11. Why are manures used in bulk to increase soil fertility ?

Ans. Since the manures contain nutrients in small quantities they have to be used in bulk.

12. Name two potassic fertilizers.

Ans. Potassium sulphate and potassium chloride.

13. Name the nitrogenous fertilizers.

Ans. Urea and ammonium nitrate.

14. Why even excessive application of manure does not cause pollution ?

Ans. Manures are biodegradable, so they do not cause harm to soil.

- 15. Name one inorganic nitrogenous fertilizer.**
- Ans.** Ammonium sulphate.
- 16. Which one is nutrient specific, fertilizer or manure ?**
- Ans.** Fertilizer.
- 17. What will happen, when we use sodium nitrate excessively in the soil ?**
- Ans.** Soil becomes alkaline.
- 18. Define green manure. Give one example.**
- Ans.** A quick growing crop which is cultivated and ploughed under, to incorporate it into the soil for the purpose of improving its physical structure and fertility, is known as green manure. For example, sunn hemp (sanai)- *Crotalaria juncea*.
- 19. Give one disadvantage of fertilizers.**
- Ans.** Fertilizers cause water and soil pollution.
- 20. Name the substance which has been traditionally used as manure in our country.**
- Ans.** Dung of cattle (cow and buffalo).
- 21. Define irrigation.**
- Ans.** The process of providing water to crop plants in the fields through human efforts by means of canals, wells, reservoirs, etc., is known as irrigation.
- 22. Name one crop which can tolerate water logging in the fields and one which cannot.**
- Ans.** Paddy crop can tolerate water logging but wheat crop cannot.
- 23. At what time is irrigation required by all crops?**
- Ans.** At the time of germination of seeds, irrigation is required by all crops.
- 24. What is water logging ?**
- Ans.** The excessive accumulation of water in the soil that drives away air is called water logging.
- 25. Name two factors on which irrigation requirements of crop depends.**
- Ans.** Nature of crop and nature of soil.
- 26. What happens when a matured wheat crop is irrigated ?**

- Ans.** If matured wheat crop is irrigated, lodging will take place.
- 27.** **Mention two functions of multipurpose dams.**
- Ans.** To control flood and generate hydroelectric power.
- 28.** **What percent of cropped area of India is still unirrigated ?**
- Ans.** 45%.
- 29.** **Give one example of mixed cropping.**
- Ans.** Groundnut and Sunflower are grown together in mixed cropping.
- 30.** **Mention one criterion for selection of mixed crops.**
- Ans.** Root pattern of both of the crops.
- 31.** **Mention one advantage of mixed cropping.**
- Ans.** No risk of crop failure.
- 32.** **Define intercropping.**
- Ans.** Growing two or more crops simultaneously in a same field in definite row pattern is called **intercropping**.
- 33.** **Mention one advantage of intercropping.**
- Ans.** Farmer can apply fertilizers and pesticides as per need of the crop.
- 34.** **A farmer grows gram crop between two cereal crops. What agricultural practice is being followed ?**
- Ans.** Crop rotation.
- 35.** **Define crop rotation.**
- An agricultural practice in which different types of crops are grown alternately in the same field in a pre-planned succession is called **crop rotation**.
- 36.** **Name the bacteria found in root nodules of leguminous plants.**
- Ans.** *Rhizobium*.
- 37.** **Mention one advantage of crop rotation.**
- Ans.** It helps in the control of weeds, pests and diseases of crop plants.
- 38.** **Give one example of two year crop rotation.**
- Ans.** Maize-Potato-Sugarcane-Pea.
- 39.** **Define selection.**
- Ans.** The sorting out of best individual plant or groups of plants from mixed

- population is known as **selection**.
- 40. Name the oldest method of crop improvement.**
- Ans.** Introduction.
- 41. Name the improved varieties of the following crops: (a) pigeon pea ; (b) wheat**
- Ans.** (a) Manak ; (b) PBW 154.
- 42. In which form the new crops are introduced ?**
- Ans.** The new crops are introduced in the form of seeds, bulbs or cutting.
- 43. What is plant breeding ?**
- The plant breeding means production of new varieties or strains by a programme of artificial selection spanning several generations of the organism concerned.
- 44. What is pest ?**
- Ans.** Organism which damages cultivated plants or plant products or make them unfit for human consumption is known as **pest**.
- 45. Define pesticide.**
- Ans.** The chemical which is used to eliminate (kill) pests is called **pesticide**.
- 46. Give one word for the following: A toxic substance effective against insects.**
- Ans.** Insecticide.
- 47. Name one insecticide.**
- Ans.** Chlorophyriphos.
- 48. Name the crop plant which is affected by red rot.**
- Ans.** Sugarcane.
- 49. Name the common disease of wheat plant.**
- Ans.** Rust.
- 50. Give example of an insect pest of rice.**
- Ans.** Gundhy bug.
- 51. Name the following: (a) seed borne disease; (b) air borne disease.**
- Ans.** (a) Red rot of sugarcane; (b) Rust of wheat.
- 52. Name one common disease of paddy.**

- Ans.** Blast.
- 53.** **Give an example of biological weed control.**
- Ans.** Cochineal insects are used to eradicate the weed called *Opuntia*.
- 54.** **Give one example of natural insecticide.**
- Ans.** Leaves of Margosa (Neem).
- 55.** **Define the weed.**
- Ans.** The unwanted plants which grow along with a cultivated crop are called **weeds**.
- 56.** **What percent of food grains produced in our country is lost every year ?**
- Ans.** 9.3%.
- 57.** **Mention two factors which affect food grains.**
- Ans.** Biotic and abiotic factors.
- 58.** **Write down two harmful effects of biotic factors on food grains.**
- Ans.** Degradation in quality of food grains and poor germination capacity.
- 59.** **What percent of moisture should be present in the food grains at the time of storage?**
- Ans.** Below 15%
- 60.** **Give one example of solid and one of liquid fumigant.**
- Ans.** Solid fumigant: Aluminium phosphide; Liquid fumigant: Ethylene dichloride-carbon tetrachloride.
- 61.** **Which method is most effective for destroying insects in stored grains, spraying or fumigation?**
- Ans.** Fumigation.
- 62.** **How the food grains should be dried on commercial basis ?**
- Ans.** By using mechanical drier.
- 63.** **Name two natural pesticides.**
- Ans.** Pyrethrum and fruit of black pepper.
- 64.** **What is feed ?**
- Ans.** Domestic animal's food that contains essential components needed for the growth, development, and general maintenance of body is called

feed.

65. Name one (a) Leguminous green fodder, (b) Non-green dry fodder.

Ans. (a) Berseem; (b) Pounded straw of wheat (Bhusa).

66. Give two examples of concentrates.

Ans. Grains of maize and oil cakes.

67. How are oil cakes are formed?

Ans. Oil cakes are formed from remains of oil seeds after the extraction of oil by oil mills.

68. Name two main groups of cattle feed.

Ans. Roughage and concentrates.

69. Name one high yielding breed of cow and one of buffalo respectively.

Ans. Karan-Swiss and Murrah respectively.

70. Name two indigenous breeds of draught cows.

Ans. Nageri and Malvi.

71. Name two breeds of buffalo

Ans. Murrah and Surti.

72. What is the lactation period of Holstein-Friesian ?

Ans. 365 days.

73. What is the yield of milk from Murrah buffalo?

Ans. 1800-2500 liters of milk (during lactation period).

How are the following breeds developed ?

74. (a) Karan Swiss

(b) Frieswal

Ans. By the crosses between following breeds of cow:

(a) Brown Swiss and Sahiwal ;

(b) Holstein-Friesian and Sahiwal.

75. What are fat content in milk of: (a) Murrah; (b) Surti ?

Ans. (a) 7% (b) 8-12%

76. Write full form of NDRI.

Ans. NDRI-National Dairy Research Institute.

77. Name any one Indian breed of: (i) cows and (ii) buffaloes.

- Ans.** (i) Gir; (ii) Murrah.
- 78. Name two exotic varieties of cow.**
- Ans.** Holstein-Friesian and Brown Swiss.
- 79. Give name of one improved crossbreed cows.**
- Ans.** Karan-Fries.
- 80. Who performed first experiment in artificial insemination ?**
- Ans.** Spallanzani.
- 81. Give one advantage of artificial insemination.**
- Ans.** It is economical, more reliable and hygienic method.
- 82. How many cows can be impregnated from a semen of single bull ?**
- Ans.** 3000 cows.
- 83. Who is regarded as ‘Father of white Revolution’?**
- Ans.** Dr. V. Kurien.
- 84. Name two viral diseases of the cattle.**
- Ans.** Pox and rinderpest.
- 85. What are the symptoms of the foot and mouth disease of cattle?**
- Ans.** Blisters on feet and mouth, excessive salivation.
- 86. Name the diseases of cows against which vaccination is available.**
- Ans.** Rinderpest and foot and mouth diseases.
- 87. Name the disease of cow in which high fever, excessive salivation and lesions of mouth occur.**
- Ans.** Rinderpest.
- 88. Name one cause of non-communicable diseases.**
- Ans.** Nutritional deficiencies.
- 89. What is (a) the normal body temperature of cow ? (b) the normal body temperature of buffalo ?**
- Ans.** (a) 38.3°C (b) 37.2 – 38.2°C
- 90. Name two HYV of poultry.**
- Ans.** NH-260 and IBL-80 (or B-77 and IIS-82).
- 91. Name two indigenous breeds of hen of India.**

- Ans.** Aseel and Busra.
- 92.** **Name two exotic breeds of hen which have been successfully acclimatised in India.**
- Ans.** White Leghorn and Rhode Island Red.
- 93.** **Name the most efficient converter of low fibre food stuff into highly nutritious animal protein food.**
- Ans.** Poultry.
- 94.** **Name the two phases in the life cycle of poultry.**
- Ans.** Growers and layers.
- 95.** **Write down two diseases caused by bacteria in poultry.**
- Ans.** Cholera and tuberculosis.
- 96.** **Why special care of broiler is taken ?**
- Ans.** Special care is taken to avoid mortality and maintain feathering and carcass.
- 97.** **Name one bacterial and one viral disease of poultry respectively.**
- Ans.** Cholera and Ranikhet respectively.
- 98.** **Name two fresh water fishes of India.**
- Ans.** Rohu (*Labeo rohita*) and catla (*Catla catla*).
- 99.** **Name two marine fishes of India.**
- Ans.** Salmon (trout; *Salmo sola*) and Bombay-duck (Nehari; *Harpodon nehereus*).
- 100.** **Name one fresh water and one marine fish of India.**
- Ans.** Fresh water fish-Catfish (lachi; *Wallago attu*); Marine fish – Flying fish (*Exocoetus*).
- 101.** **Define pisciculture.**
- Ans.** Pisciculture is the rearing and breeding of fishes under controlled conditions.
- 102.** **Name two types of fisheries.**
- Ans.** Fin fishery and shell fishery.
- 103.** **Name two other sea food items except fish.**
- Ans.** Lobsters or crabs and oysters

104. Define inland fisheries

Ans. Inland fisheries deal with the fishery aspects of fresh and brackish water.

105. Define culture fishery

Ans. Culture fishery is the type of inland fishery practiced in small water bodies where desired fish is reared and then harvested.

106. What is polyculture ?

Ans. Growing of two or more than two fishes together in the same water body.

107. Name the most advantageous fish culture system.

Ans. Composite fish culture.

108. Give the technical term for bee keeping.

Ans. Apiculture.

109. Name three castes of honey bee family.

Ans. Worker, queen and drone.

110. Name the species of honey bee, which is used for commercial production of honey.

Ans. *Apis mellifera*.

111. Name a protozoan disease of honey bee.

Ans. Nosema.

112. Name two products of honey bee, except honey.

Ans. Bee wax and bee venom.

113. What is swarming ?

Ans. The process by which a queen leaves the old hive along with approximately one half of the workers in that colony and takes a new shelter in called swarming.

114. Which is most active member of honey bee colony.

Ans. Worker (*i.e.*, sterile female).

115. How many eggs are laid by queen bee in a single day ?

Ans. 2000 ova (or eggs).

116. How is wax moth controlled ?

Wax moth is controlled by exposing bees in hive to sun for increasing

Ans. temperature.

117. How does honey bee help in cross fertilization ?

Bee keeping helps in cross pollination of flowers of crop plants, since
Ans. pollens are transferred from one flower to another by bees while they
are collecting the nectar.

Short Answer Questions (Carrying 2 marks each)

1. Distinguish between micronutrients and macronutrients. Give suitable examples.
2. Classify nutrients according to their sources.
3. How plants get nutrients ?
4. Name three most important nutrients required for plant growth.
5. Choose plant's micronutrients and macronutrients from the following Iron, Chlorine, Sulphur, Copper, Nitrogen, Calcium, Manganese, Potassium, Zinc, Magnesium, Molybdenum, Phosphorus.
6. What are advantages of using manure ?
7. Give two limitations of using manure.
8. Compare the use of manures and fertilizers in maintaining soil fertility.
9. Write down two advantages of fertilizer over manure.
10. During the downpour in a village, the rain water carried away excess of nitrogenous and other compounds present in the soil to a pond. How will they affect the growth of algae and phytoplankton in the pond ?
11. Explain the term eutrophication with suitable example.
12. How does chemical nature of the soil change due to continued use of chemical fertilizers ?
13. Explain various methods of fertilizer application.
14. Distinguish between farmyard manure and compost manure.
15. Define manure. What are different manures and how do they

- affect the soil ?
16. What is green manuring ? Give suitable examples for green manures.
 17. What are fertilizers ? Classify fertilizers.
 18. Give a short account of biofertilizers.
 19. Explain why a legume crop does not require nitrogenous fertilizers ?
 20. Why is irrigation essential ?
 21. How does excessive irrigation lead to soil salinity ?
 22. Mention three effects of excessive irrigation.
 23. Why water should be used judiciously ?
 24. Explain advantages of irrigation.
 25. Explain, how efficiency of irrigation can be increased.
 26. Explain the various factors which are responsible for the loss of stored food grains.
 27. Explain the various preventive measures which are taken before storing the food grains.
 28. Describe how drying of food grains is done.
 29. Write down three unique characteristics of storage structure.
 30. Describe the various methods of controlling pests attacking stored grains.
 31. As an incharge of a grain store, how will you find out the presence of pests ?
 32. How does fumigation differ from spraying ?
 33. ‘Milk is a very nutritious food’. Use the table given in the book to justify statement.
 34. Name four animals which provide us food.
 35. Write down the names of animal products which are used as food.
 36. How does roughage differ from concentrates with reference to cattle feed ?
 37. Give an example of average daily feed of a cow.
 38. What are the sources of “concentrates” given in a cattle feed?
 39. Write down four main characteristics of good cattle shelter.
 40. Which method will you suggest for improving the cattle breed and why ?
 41. Write short notes on:

- (a) General utility breeds of cow
 - (b) Breeds of buffalo.
- 42.** Mention four steps involved in artificial insemination.
- 43.** Define artificial insemination. Write down two advantages of it.
- 44.** Write down four symptoms of sick animals.
- 45.** Write the characteristic symptoms of :
- (a) Mastitis
 - (b) Foot-and-mouth-disease
- 46.** How are high yielding breeds of poultry advantageous over indigenous breeds ?
- 47.** Mention four advantages of fishery.
- 48.** Write a short note on ‘Prevention of poultry diseases’ ?
- 49.** Write advantages of bee keeping.
- 50.** What are the advantages of composite fish culture ?

Short Answer Questions (Carrying 3 marks each)

- 1.** Write notes on plants and animals as sources of food.
- 2.** Define green revolution, what are the common objectives of crop improvement ?
- 3.** What we do get from cereals, pulses, fruits and vegetables ?
- 4.** Explain the objectives of mixed cropping. How are crops selected for mixed cropping.
- 5.** Distinguish between mixed cropping and intercropping.
- 6.** Explain the advantages and disadvantages of mixed cropping.
- 7.** Define intercropping. How does it differ with mixed cropping ?
- 8.** Write down disadvantages of crop rotation.
- 9.** Write about three main criteria which should be considered while selecting the crops for rotation?
- 10.** Why are leguminous crops desirable in crop rotation?
- 11.** Explain various steps in hybridization of crop plants.
- 12.** Define plant breeding ? Describe the various methods of plant breeding.
- 13.** Describe the biological method of weed control.

14. Classify plant diseases depending upon their occurrence and transmission.
15. Mention three different ways in which insect pests can attack the crop plant.
16. Explain the methods of controlling insect pests.
17. Give two examples each of
 - (a) Narrow leaved rabi season weed.
 - (b) Broad leaved kharif season weed.
18. Explain various methods of weed control.
19. Explain various effects of weeds on crop plants.
20. What are crop's pests ? Suggest preventive measures to control pests.
21. What is the advantage of using insect resistant varieties ?

Long Answer Questions (Carrying 5 marks each)

1. Distinguish between fertilizer and manure. Give suitable examples. What are advantages and disadvantages of using fertilizer ?
2. Explain the mechanism of compost formation.
3. Explain what will happen if in a cultivated field only manures are supplied and in another field only fertilizers are supplied, keeping all other conditions similar.
4. Define irrigation. Why is irrigation of crops essential ? Mention the harmful effects of excessive irrigation.
5. Explain various types of irrigation systems in India. How can efficiency of applied water be increased in agriculture.
6. Compare between mixed cropping and intercropping. Write down from advantage of both of these techniques.
7. Explain the various methods of crop improvement. Name one improved variety of Rice, Maize, Soyabean, Sunflower and Mustard.
8. Discuss the various methods which are used to control plant diseases.

9. Explain the various preventive measures against insect pests.
10. What is feed ? What are different type of feed ? How is it differ with respect to age and functions ?
11. What is artificial insemination ? Describe this technique.
12. Write a short note on prevention of animal diseases.
13. How bee colony works ? What values can be seen in the organisation of bee colony ?
14. Write down the desirable characters of bee variety suitable for bee keeping.
15. What is pasturage and how it is related to honey production ?
16. For increasing production, what is common in poultry, fisheries and bee-keeping ?
17. How do you differentiae between capture fisheries, inland fisheries and aquaculture?
18. Explain the role of workers in a bee colony.

VALUE BASED QUESTIONS

Q.1. On holidays, Rahul used to go to morning walk with his grandfather and on the way he used to collect milk from milk man for his home. One day, the milkman told dadaji that he is going to purchase a Murrah breed buffalo as he is not able to fulfill the demand of his customers to supply good quality milk. Rahul asked his grandfather following questions:

- (i) What are Murrah buffaloes ?
 - (ii) What are the advantages of keeping them in dairy ?
- Murrah is a high-milk yielding variety of buffaloes. It can yield 1800-2500 liters of milk. [Cross breeds of buffalo have been developed at National Dairy Research Institute (NDRI), Karnal, Haryana].
- Murrah gives higher quantity of good quality milk in comparison to other local breeds that is why dairy owners prefer to keep them in dairy.

Ramlal has been cultivating wheat crop year after year in the same field. Recently he has observed decline in the yield despite best

- Q.2.** inputs. Agriculture inspector of the area suggested him to sow some legume crop (e.g., pea, chick pea or soyabean) for one or two years before again using the field for wheat crop. What is the logic behind this suggestion.

Sowing the same crop in the same field year after year results in reduction of nutrients from the particular depth of the soil, increase in populations of soil borne pathogens and pests of wheat crop and growth of weeds, infections and infestations. Growing some root - nodules

- Ans.** containing legume crops such as pea, chick pea, soyabean, etc., in the field will improve soil structure and fertility as it will draw water and nutrients from different levels of soil and add nitrogen salts to the soil ([Box 1.31](#)). Weeds, soil borne pathogens and pests of wheat crops will be eliminated as they do not find their host.

Box 1.31

Biological Nitrogen Fixation

Legume plants are involved in biological nitrogen fixation. Nitrogen of air is converted into organic nitrogen only by prokaryotic cells: bacteria and cyanobacteria. A group of Gram negative bacteria, the **rhizobia**, from symbiotic association with numerous legume host plants and produce root nodules where nitrogen fixation occurs. Root nodules of soyabean (*Glycine max*) has *Sinorhizobium meliloti* (old name *Rhizobium meliloti*). While root nodules of pea (*Pisum sativum*) and chick pea (*Cicer arietinum*) have *Rhizobium leguminosarum*.

In the process of nitrogen fixation, dinitrogen (N_2) of air is taken by endosymbiotic bacteria of root nodules and is converted into ammonia (NH^+) which diffuses out of bacteria. Inside tissues of root nodule, this ammonia is converted either in amide amino acid (glutamine, e.g., pea) or ureides (e.g., soybean) which are exported via xylem tissue to leaves of host plant. In leaves amides and ureids are used in the synthesis of various amino acids.

If legume plants grown in the presence of nitrogen fertilizers (e.g., nitrate – NO_3^-), they will use this fertilizer as a source of nitrogen nutrition and

they will not form symbiotic root nodules (*i.e.*, there will be no biological nitrogen fixation).

Pawan went to attend a wedding reception with his mother and father. There was a good variety of food items. He tasted many items and left many items in the plate. This was done by many guests attending the party. His parents drew his attention to the amount of food wasted in this manner.

- Q.3.** (a) **Why was Pawan's parents concerned about the wastage of food ?**
(b) **What steps you can suggest to ensure food security ?**

With Indian population reaching 1.3 billions by the end of year 2020, we will require about 240 million tonnes of grains production every year. In order to produce such an enormous amount of grains, we need extra land for cultivation which is beyond our scope as it is surely going to create ecological disturbances. Therefore, it is essential to wisely use the available food resources.

Ans. (a)

Further, due to unemployment, poverty and inflation, millions of Indians are unable to get adequate meals. Hunger and rampant malnutrition of poor sections of human society can be managed by proper utilisation of food items served in the lavish parties of marriages, birthdays, inaugurations, etc.

- (b) We can adopt the following methods for ensuring food security.
- (i) Development of disease resistant, high yielding crop varieties having low maturity durations.
 - (ii) By improving production management.
 - (iii) Crop protection management.
 - (iv) Proper storage and distribution of agriculture produce.

Q.4. Why should organic foods be preferred over conventional foods ?

The conventional foods are raised using chemical fertilizers and chemical pesticides. These agrochemicals are often toxic, xenobiotic (human made) and nonbiodegradable. These agrochemicals pass into conventional foods in small traces. Repeated use of conventional foods increases the concentrations of agrochemicals in our bodies. Ultimately

Ans. they become toxic and cause a number of ailments (e.g., cancers) and harms can occur to us or our pets. By rains and floods, chemical fertilizers are washed out from crop fields and contaminate and pollute our water bodies such as ground water and surface water such as ponds, lakes and rivers. They result in eutrophication and other ecological accidents such as depletion of oxygen in water and death of aquatic life such as fishes.

On the other hand, organic foods are free from any traces of agrochemicals as they are raised by using manures, biofertilizers (e.g., Nitrogen fixing crops and cyanobacteria), biopesticides (neem products) and biological control. Being nontoxic, organic foods should be preferred over conventional foods. Manure used in raising organic foods is environmentally clean method of disposing off and recycling organic wastes.

Q.5. **Why is fumigation regarded a better option than spraying in godowns ? Give examples of both types of pesticides.**

Ans. Fumigation is comparatively a safe and economical option of pest control than spraying of stored grains due to following reasons:

In fumigation, the worker does not come in contact with the fumigant. There is some contact with the pesticide during spraying. In spraying, the worker suffers irritation in eyes, nose, vomiting, etc.

- (ii) No residue persist over articles in fumigation. In spraying some residue can enter the sprayed articles.
- (iii) Fumigants are volatile while sprays are seldom volatile.
- (iv) Fumigation disinfects the whole areas. Spraying disinfects only the sprayed articles.
- (v) In fumigation less amount of pesticide is used. While in spraying, large volume of pesticide is consumed.

Examples of fumigants are aluminium phosphate, EDCT and methyl bromide. Pesticides which are sprayed include BHC, malathion and pyrethrum.

Q.6. What is the need of crossing the exotic breeds of cattle with local (Indian) breeds, when exotic cattle have higher yield as compared to the hybrid breed of cattle ?

Ans. Hybrids produced by cross breeding exotic breed with local breed yields less milk as compared to the exotic breed. Even then, exotic breed

cannot be incorporated in our dairy farms due to following reasons:

- (i) Most of the exotic breeds have come from colder countries. Colder areas are limited in our country.
- (ii) The exotic breeds will fall prey to local pests and pathogens easily as they are not resistant to them.
- (iii) The feed available locally does not match with the feed required by the exotic breeds.

Therefore, best available option is to import a few exotic cattle and cross-breed them with local cattle for obtaining hybrid cattle acclimatized to local climate and resistant to local diseases.

Vikash went to vegetable market with his elder sister, a M.Sc. Botany student. There he saw many varieties of different vegetables such as different kinds of chilies (short, long, round, pungent, less pungent, green, reddish, orange), several varieties of potato and tomatoes. He asked his sister the following questions:

- (i) What is the need of producing so many varieties of different crop plants.
- (ii) What is the name of branch of science which deals with crop improvement ?
- (iii) What are the methods used by plant breeders ?
- (iv) What is hybridization ?

There exists a great variety of agro climatic conditions and different varieties of a vegetable are suitable for preparing different food items. A particular variety of a crop plant generally

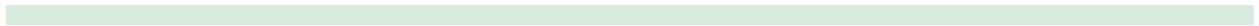
Ans. (i) gives good yield in a particular set of agro climatic conditions. Therefore, different varieties with varying traits are produced in keeping in view the agro climatic conditions and market demands.

- (ii) Plant breeding (a branch of Genetics).

Techniques of plant breeders include following steps:

- (a) Introduction;
- (b) selection;
- (iii) (c) Hybridization;
- (d) Recombinant DNA Technology or Genetic Engineering by which GM crops or genetically modified crops are produced.

- (iv) Hybridization is a technique in which the two plants having the desired characters are made to cross and develop hybrid seeds.



CHAPTER 2

The Fundamental Unit of Life: Cell



2.1. WHAT IS THE LIVING BEING MADE UP OF ?

Our earth is inhabited by different kinds of living organisms, who look very different from each other. These living organisms are archaebacteria, eubacteria, protista (*Amoeba, Chlamydomonas*), fungi, plants and animals. The bodies of living organisms are made up of microscopic units called **cells**. The cell has same central position in biology as an atom in the physical sciences. *The cell is the basic structural and functional unit of living organisms.*

Present-day cells share common fundamental properties. For instance, all cells employ DNA as their genetic material, are surrounded by a plasma membrane, and use the same basic mechanisms for energy metabolism. On the other hand, present-day cells have evolved a variety of different life-styles. Many organisms, such as bacteria (both archaebacteria and eubacteria), protozoa (*e.g.*, amoeba) and yeasts, consists of single cells (called **unicellular organisms**) that are capable of independent self-replication. More complex organisms, called **multicellular organisms**, are composed of collections of cells that function in a coordinated manner, with different cells specialized to perform the particular tasks. The human body, for example, is composed of more than 200 different kinds of cells, each specialized for such distinctive functions as memory, sight, movement and digestion. The diversity exhibited by the many different kinds of cells is striking; for example, consider the differences between bacteria and the cells of human brain.

All cells, whether they exists as one celled organisms (unicellular organisms) or as a part of multicellular organisms are capable of carrying out certain basic functions such as nutrition, respiration, growth and reproduction. These functions are essential for the survival of the cells.

Table 2.1. Differences between unicellular and multicellular organisms.

<i>Unicellular organisms</i>	<i>Multicellular organisms</i>
1. An unicellular organism is represented by a single cell.	1. A multicellular organism consists of large number of cells.
2. All activities of the organisms are performed by a single cell.	2. A single cell performs one or few activities of the organisms.
3. There is no division of labour as the single cell perform all life activities.	3. Cells are specialized to perform different functions of the body so that there is a division of labour

	within cells.
4. Reproduction consumes a single cell.	4. Only some cells of the body called germ cells take part in reproduction. Other cells (somatic cells) remain intact.
5. The life span of an individual is short.	5. The life span of an individual is long.

The most important and fundamental level in the organisation of living world is the **cellular level**. *Cells are the fundamental structural and functional units of living organisms and are the basic unit of life.* **Cell biology** is the study of cells in all aspects of structure and functions.

Discovery of Cell

While studying a thin slice of cork, **Robert Hooke** saw that the cork resembled the structure of honeycomb consisting of many little compartments. Cork is a substance which is obtained from the bark of a tree. This was in the year 1665 when Hooke made this chance discovery through a self designed microscope ([Fig. 2.1.](#)) Robert Hooke called these boxes — cells. Cell in Latin means “little room” ([Box 2.1](#)). Robert Hooke’s discovery was important, because it indicated for the first time that living organisms consisted of a number of smaller structures or **units**.



Robert Hooke.

Box 2.1

Cell Theory

The word cell is derived from the Latin word ‘*cellula*’ which means “a little room”. An English scientist, **Robert Hooke** (1635 – 1703), in 1665 discovered and named the cells, while examining a thin slice of bottle cork under a primitive microscope made by him ([Fig. 2.1](#)). Hooke observed cork’s honeycombed or porous structure ([Fig. 2.2](#)). Hooke found porous structure of cork to resemble with monasteries and called the units, cells. He published his work in a book ‘*Micrographia*’ in 1665.

In 1674, **Anton von Leeuwenhoek** (1632 – 1723), a Dutch microscopist, made an improved microscope ([Fig. 2.3](#)) and using this microscope he discovered the free living cells in pond water for the first time (1674). In 1678, he discovered sperm and identified the sperm cells of humans, dogs, rabbits, frogs, fish and insects.



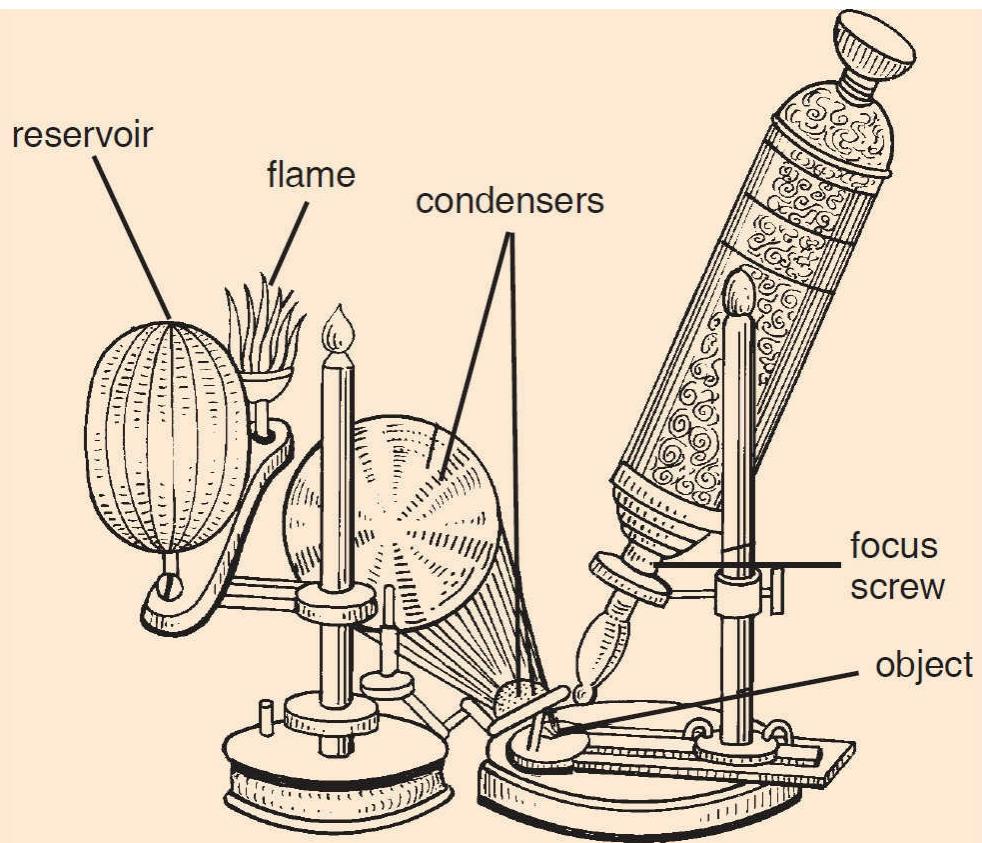


Figure 2.1. Robert Hooke's microscope.

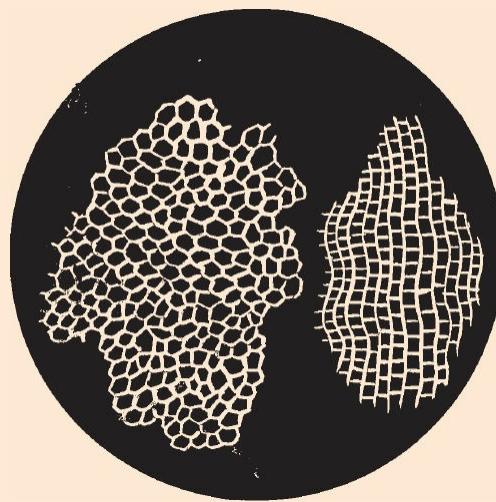


Figure 2.2. Dead cork cells as seen by Robert Hooke.

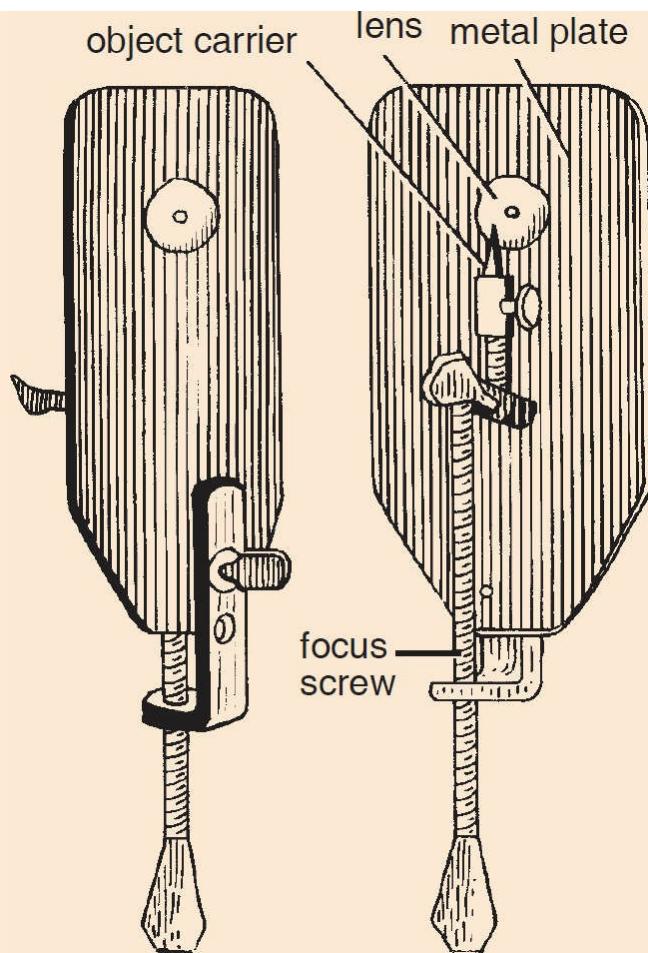


Figure 2.3. Leeuwenhoek's microscope.

However Hooke had only seen the thickened walls of the cells and not the substance contained within these walls. In 1831, a Scottish botanist, **Robert Brown** (1773 – 1858) discovered and named the **nucleus** in plant cells. **J.E. Purkinje** (1787 – 1869), a Czech animal physiologist, in 1839 gave the term **protoplasm** for the living fluid substance present inside the cell. In 1866, **Haeckel** established that the nucleus was responsible for storing and transmitting hereditary characters.

Cell Theory. In 1838, **Jakob Matthias Schleiden** (1804 – 1881), a German botanist, first proposed the idea that all plants consist of cells. A year later, in 1839, **Theodor Schwann** (1810 – 1882), a German zoologist, independently asserted that all

animals and plants are made up of cells. This joint finding forms the basis of the **cell theory**.

The cell theory was refined further in 1855, when another German biologist, **R. Virchow** presented the idea that all cells arise from pre-existing cells (His actual aphorism was '*Omnis cellulae a cellula*'). Thus, the cell theory comprises of the following postulates :

1. All organisms are composed of cells and cell products (*e.g.*, secretions).
2. All metabolic reactions take place in cells. Thus, cells are structural and functional units of life.
3. All cells arise from pre-existing cells only. No cell can originate spontaneously or *de novo* (anew) but comes into being only by division of already existing cells.
4. Every organism starts its life as a single cell. Viruses are an exception to cell theory.

Box 2.2

Instruments for Studying Cells

Cells are too small to be seen with naked eyes. Cells are studied with the help of **microscopes**. Microscopes are high resolution instruments that are used for observing the fine details of very minute objects. Two common types of microscopes are light microscope and electron microscope.

1. Light or Compound Microscope

The simple student's microscope which is often used in schools is called **compound microscope**. In these microscopes many lenses are combined together and their magnification power range from 300 to 1500 times. These microscopes use

light (generally sunlight) to illuminate the object, so these compound microscopes are called **light microscopes**. Let us try to get acquainted with various parts of a light microscope.

As shown in [Fig. 2.4](#) the **object** or **specimen** on a **glass slide** is kept on a stage under an objective piece (having lenses) almost in the middle of the microscope. Light is passed through the object/specimen with the help of a mirror (called **reflector**) and a condenser from below the stage. From the eyepiece on the top one can see a magnified image of the object/specimen. A sharp image forms by focussing the side knobs properly. The upper and large knob is meant for **coarse adjustments** and it is used for rapid and precise focussing of the object. The lower and small knob is used for **fine adjustments** (*i.e.*, for getting perfect image of the object). The magnification of an image can be increased or decreased by changing the objectives of high or low power (5 X, 10 X, 15 X, etc.) accordingly.

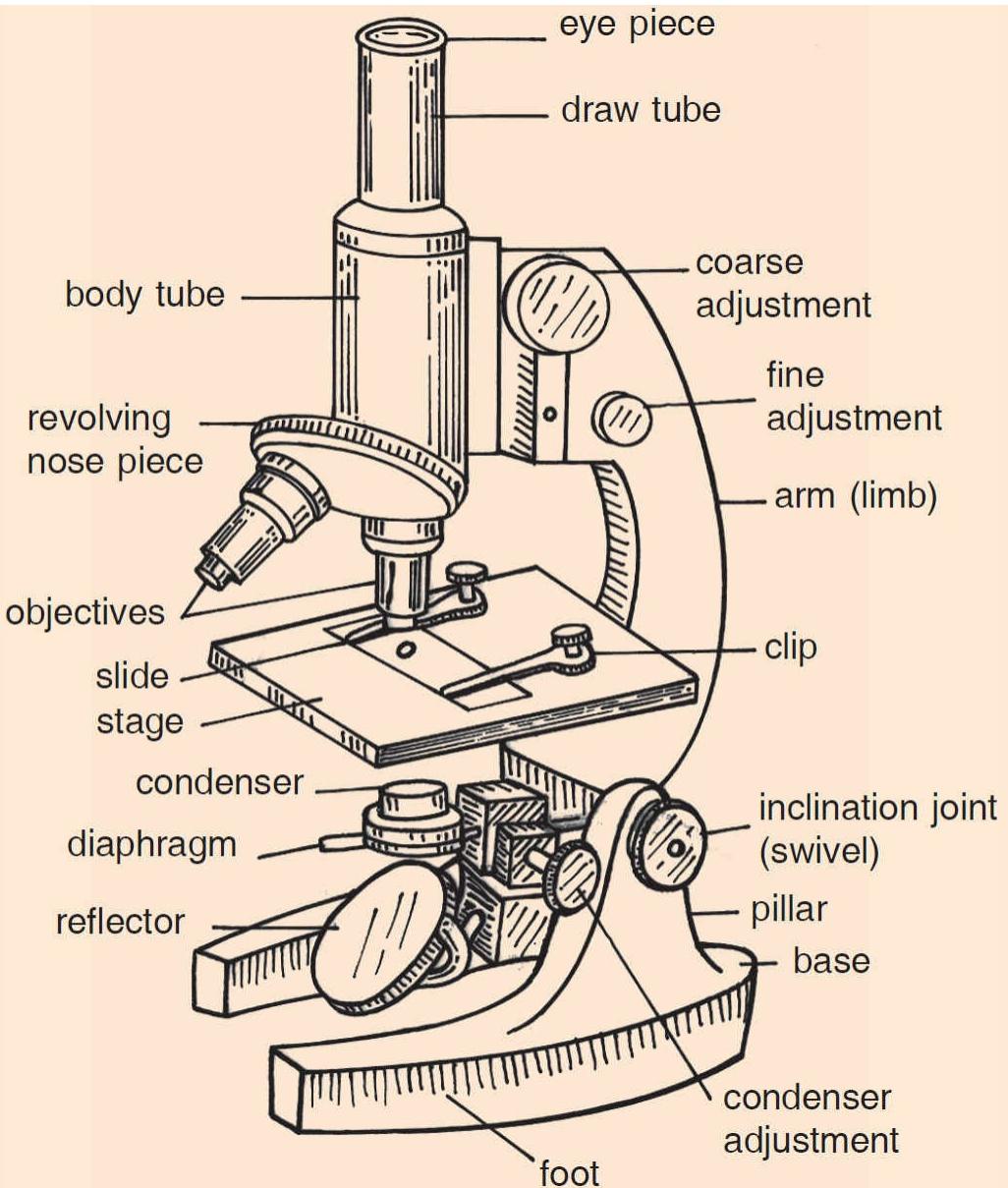
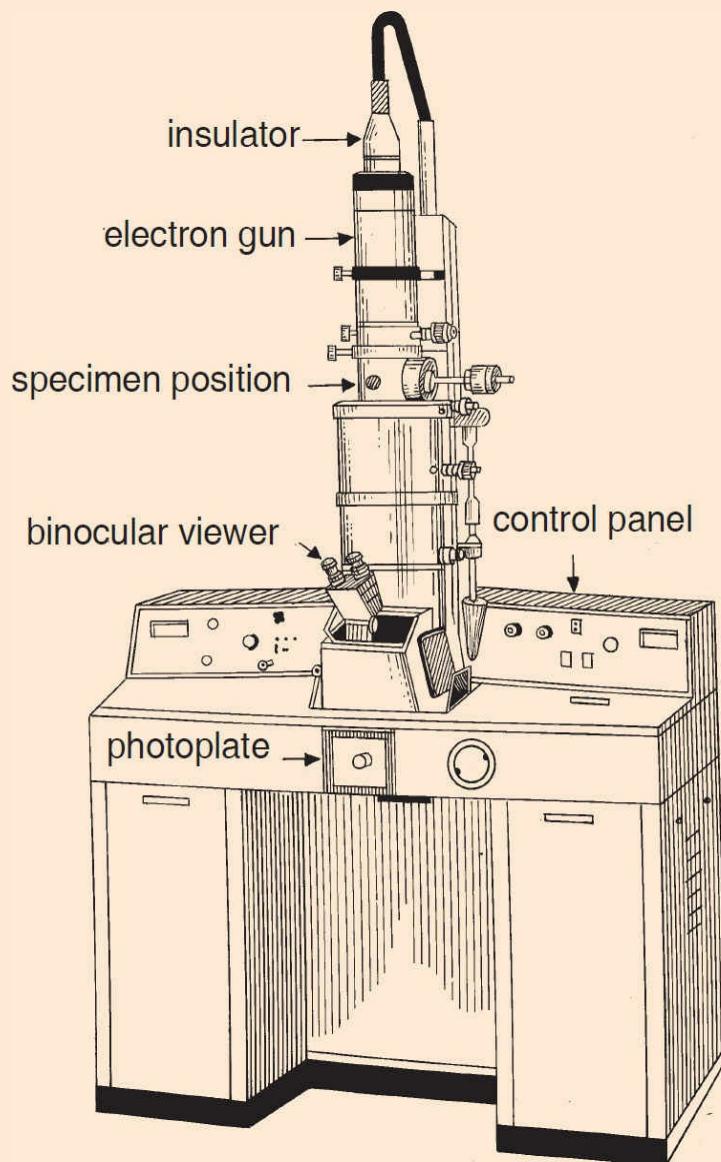


Figure 2.4. Light or Compound microscope.

2. Electron Microscope

As shown in [Fig. 2.5](#), an electron microscope is a very large instrument that uses electromagnets for magnification and electrons for illumination. This remarkable instrument was developed by **Knoll** and **Ruska** of Germany in 1932 and it was put to use in 1940. It uses very high voltage electricity. Electron microscope helps in observing subcellular structures which

cannot be seen through a compound microscope. An internal vacuum is essential for its working. The object must be ultra thin and dry. It is impregnated with some metal to enhance contrast. The image of the object is obtained on a photographic film or screen. Magnification is 100,000 to 500,000.



Electron microscope.

Figure 2.5. An electron microscope.

Table 2.2. Differences between light microscope and electron microscope.

<i>Light microscope</i>	<i>Electron microscope</i>
1. It uses glass lenses.	1. It uses electromagnets.
2. It uses a beam of light to illuminate the object.	2. It uses a beam of electrons instead of light.
3. Internal vacuum is not required.	3. Internal vacuum is essential.

ACTIVITY 2.1

Let us take an inner fleshy leaf of onion bulb. With the help of a set of forceps, we can peel off the skin (called the **epidermis**; it is one cell thick) from the concave side (inner layer) of the onion. This layer can be put immediately in a petridish (a glass dish) or watch-glass containing water. This will avoid the peel getting folded and getting dry also. What do we do with this onion peel?

Let us take a glass slide, put a drop of clean water on it and transfer a piece of peel from the petridish or watch-glass to the slide. Make sure that peel is perfectly flat on the slide. You may need a thin camel hair paint brush to help you to transfer the peel. At this stage put a drop of iodine solution on the piece of onion peel followed by a cover slip. In this way you have prepared a **temporary mount** of onion peel. You can observe this slide under the low and high power of a **light compound microscope** ([Fig. 2.4](#)).

What do you observe as you look through the lens? Can you draw the structures that you are able to see through the microscope in your observation sheet? Does it look like the [Figure 2.6B](#).

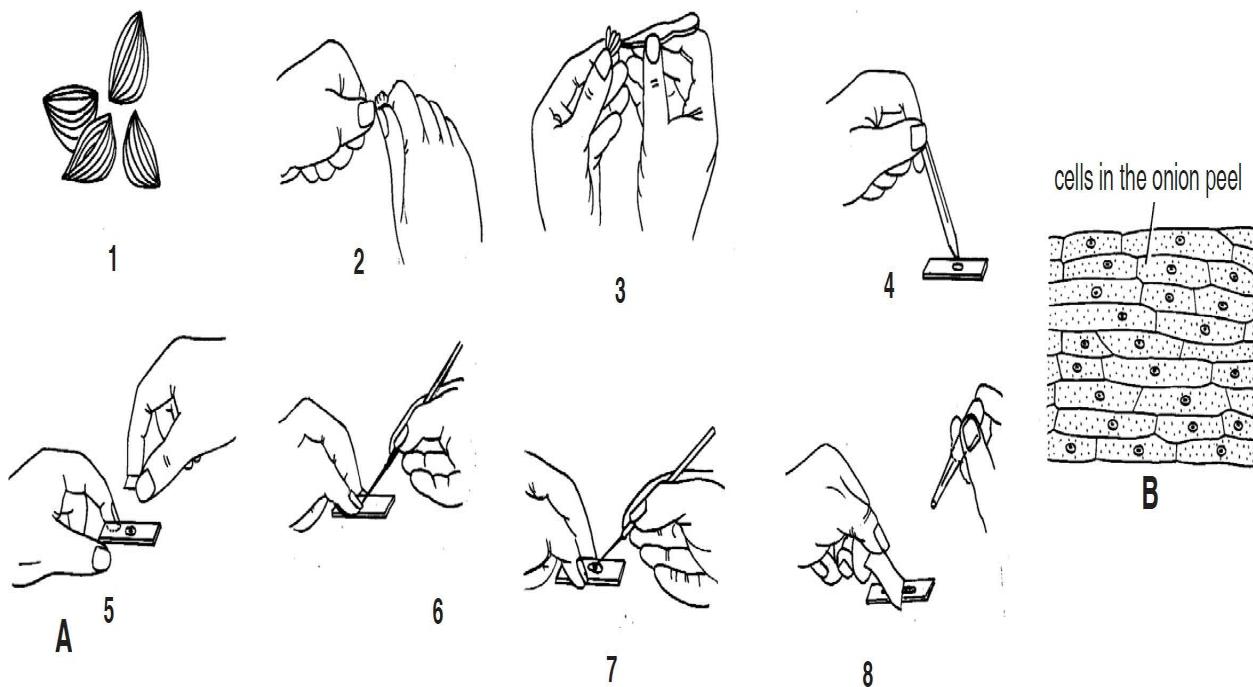


Figure 2.6. A—How to mount a sample of onion peel on a microscopic slide;
B—The cells of the onion peel.

If you prepare temporary mounts of onion peels with different sizes, you will observe that they all have similar small structures. These structures look similar to each other and together they form a big structure such as an onion bulb. These small microscopic structures that you see in an onion peel are the *basic building units of onion bulb*. These structures are called **cells**. Not only onion but all organisms that you see around are made up of cells.

ACTIVITY 2.2

You can try preparing temporary mounts of leaf peels, tip of roots of onion or even peels of onions of different sizes. For this purpose, you can take leaf of maize, mustard or *Tradescantia*.

Take a red coloured *Tradescantia* leaf. With a sudden jerk a small segment can be peeled off from the lower surface of leaf. Make a temporary mount of this peel and observe under the

microscope. You will observe that each cell is filled with red coloured cell sap.

By performing experiments of Activities 2.1 and 2.2 you will be able to answer the following queries regarding the cell : *Do all cells look alike in terms of shape and size ?* You should answer that the cells of an multicellular organism are different in shape and size. Cells of different organisms are different. *Can you find differences among cells from different parts of a plant body?* During discussion of plant tissues you will find that indeed cells of different parts of plant body are different in shape, size and structure. *What similarities can you find in different types of cells ?* Basic similarities among all cells of higher organisms are as following : they have a plasma membrane, a cytoplasm with organelles and a nucleus.

Box 2.3

1. Protoplasm. The contents of a living cell, contained within the plasma membrane, form protoplasm. Protoplasm is usually differentiated into the nucleus and cytoplasm.

2. Gene. It is a distinct unit of hereditary information. Gene is inherited from one generation to next and determines an observable characteristic or trait of an organism. Genes have to carry coded information of parents to their children or progeny, so that children remain exactly like their parents. Generally a gene is made of DNA molecule, but sometimes it is made of RNA molecule as observed in Tobacco mosaic virus (TMV).

3. DNA. Deoxyribonucleic acid; a polymeric nucleic acid.

4. RNA. Ribonucleic acid; a polymeric nucleic acid.

Prokaryotic and Eukaryotic Cells

All living organisms present on Earth can be classified into following *two* types:

1. Non-cellular organisms that do not contain any cell in their body organisation, *e.g.*, viruses. Viruses lack any membrane and hence do not show characteristics of life until they enter a living body (*i.e.*, prokaryotic cell or eukaryotic cell) to use its cell machinery to reproduce.

2. Cellular organisms that contain either one or many cells in their bodies, *e.g.*, bacteria, plants and animals.

Cellular organisms are again divided into following *two* main types :

(a) Prokaryotes. These organisms have primitive and incomplete cells. Thus, they contain **prokaryotic cells** in their body structure. Prokaryotic cells have all three basic structures of a typical cell but lack nuclear membranes around their genetic substances (DNA).

Nuclear material of a prokaryotic cell consists of a single chromosome which is in direct contact with cytoplasm. Here the undefined nuclear region in the cytoplasm is called **nucleoid**, *i.e.*, there is no nuclear membrane. In a prokaryotic cell other membrane bound organelles, such as mitochondria, are also absent. Ribosomes, however, are present in prokaryotic cells. The prokaryotes include **archaeabacteria**, **bacteria** and **cyanobacteria** (which earlier called **blue-green algae**).

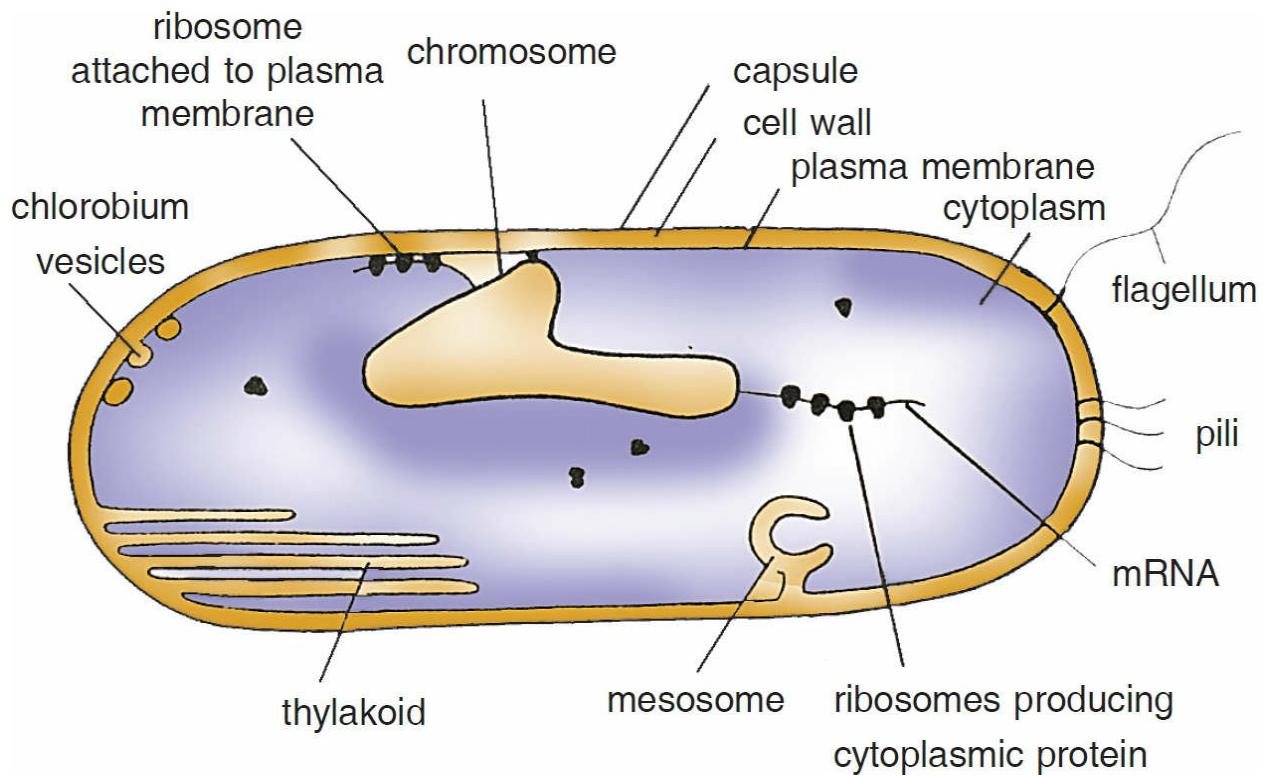


Figure 2.7. A typical prokaryotic cell of a bacterium.

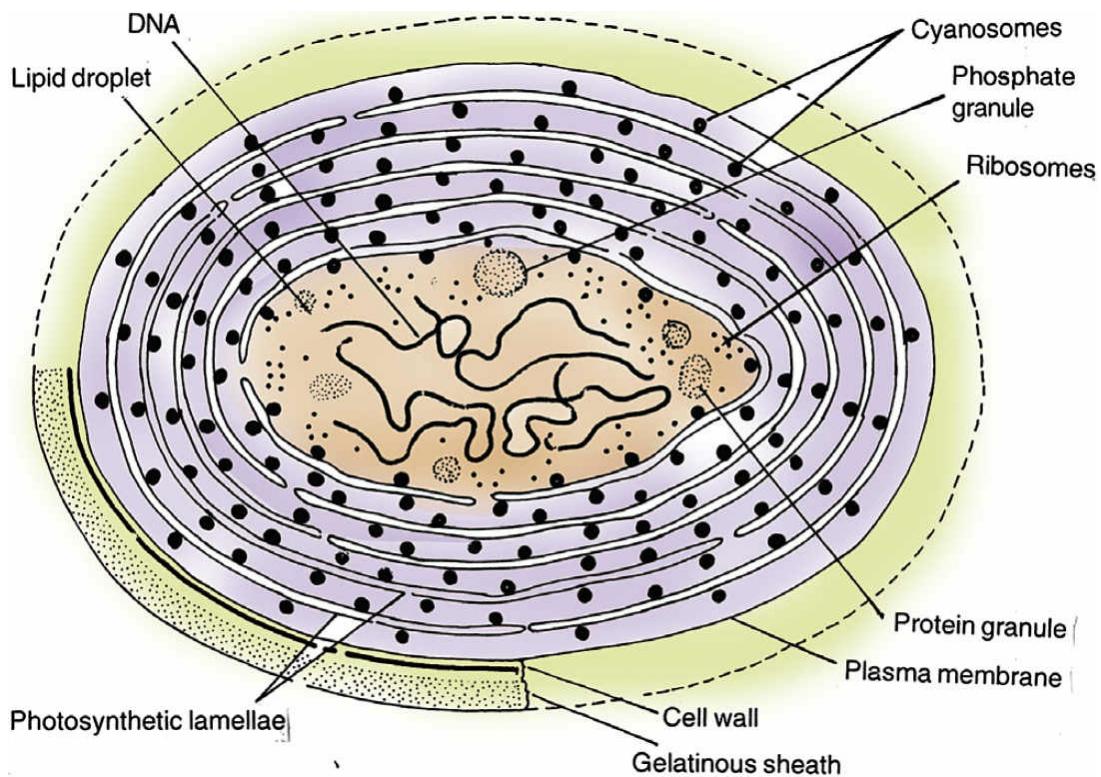


Figure 2.8. Photosynthetic prokaryotic cell. Ultrastructure of a cell of blue-

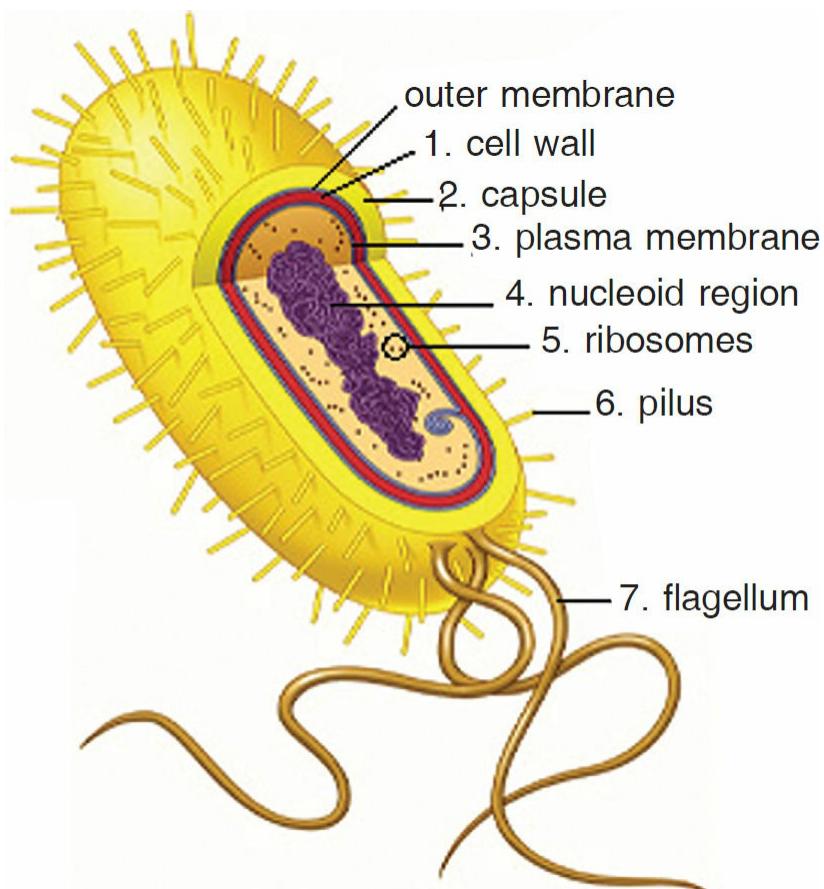
green algae or cyanobacteria.

(b) Eukaryotes. These have advanced and complete cells. These cells contain membrane bound nuclei and other cellular organelles and are called **eukaryotic cells**. Such cells are found in unicellular and multicellular plants and animals and contain plasma membrane, nucleus, DNA and cytoplasm with ribosomes and cellular organelles such as mitochondria.

The differences between prokaryotic cell and eukaryotic cell are given in [Table 2.3](#).

Table 2.3. Differences between prokaryotic cells and eukaryotic cells.

<i>Prokaryotic cell</i>	<i>Eukaryotic cell</i>
1. Size of a cell is generally small (1–10 mm).	1. Size of a cell is generally large (5 – 100 mm).
2. Nucleus is absent (Nuclear region or nucleoid is not surrounded by a nuclear membrane).	2. Nucleas is present (Nuclear material is surrounded by a nuclear membrane).
3. It contains single chromosome.	3. It contains more than one chromosome.
4. Nucleolus is absent.	4. Nucleolus is present.
5. Membrane bound cell organelles are absent.	5. Membrane bound cell organelles such as mitochondria, plastids, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, etc., are present.
6. Cell division takes place by fission or budding (no mitosis).	6. Cell division occurs by mitotic or meiotic cell division.



Prokaryotic cell.

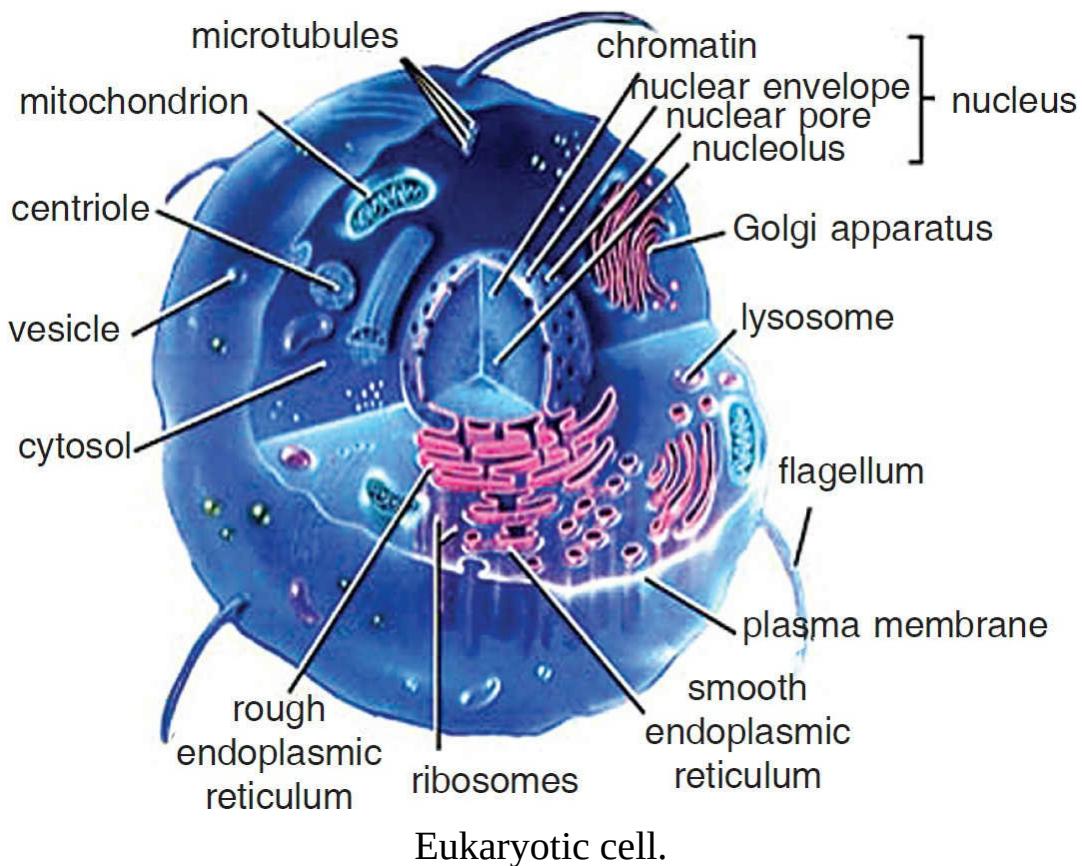


Table 2.4. Differences between nucleus and nucleoid.

Nucleus	Nucleoid
1. It is larger in size.	1. It is comparatively smaller in size.
2. It has a covering of double membrane envelope.	2. A covering membrane is absent. It lies free in the cytoplasm.
3. Nucleolus is present in it.	3. Nucleolus is absent in it.
4. Its DNA content is equal to two or several DNA molecules.	4. Its DNA content is equal to a single DNA molecule.
5. Its DNA is associated with histone proteins to form chromatin.	5. In it histones are absent. DNA of a nucleoid is often naked.

Division of Labour

If you closely study the [Figure 2.10](#), you will notice that an organism such as a human being can have cells of different kind,

e.g., sperm, leucocyte (white blood cell), osteocyte (bone cell), muscle cell, nerve cell, fat cell, etc. This is due to the fact that *there is a division of labour within multicellular organisms*, e.g., human beings. This means that different parts of human body perform different functions. Human body has heart to pump blood, stomach to digest food, skeletal muscles to perform movement and locomotion and so on. Heart has a special type of muscle cells called **cardiac muscles** which contract rapidly, rhythmically and tirelessly ; they never fatigue during life time of an organism. Stomach has special cells such as **mucous cells** to secrete mucus for lubricating the food, **zymogen cells** (or Chief cells) to secrete a proenzyme of protein digestive enzyme, the pepsin, called **pepsiogen, parietal cells or oxyntic cells** to secrete hydrochloric acid (HCl) activating pepsinogen into functional pepsin and also for killing germs of food. Skeletal muscles are striated and voluntary muscles, i.e., their contraction depends on your will or control. Due to this property of skeletal muscle cells, you are able to move your hands and ten fingers in desired ways.

Like the human body, the cell itself has got division of labour. In fact, each cell has got certain specific components within it known as **cell organelles** ([Table 2.5.](#)). Each kind of cell organelle performs a special function, e.g., making of new material in the cell such as protein synthesis by ribosomes, food (glucose/starch) synthesis by chloroplasts, clearing up the waste substances from the cell by the lysosomes, etc. Thus, a cell is able to live and perform its functions because of these organelles. These organelles together constitute the basic building blocks called **cells**. Quite interestingly, all cells are designed to have the same basic structure, no matter what their function is or what organism they are found in.

Table 2.5. Differences between organs and organelles.

Organs	Organelles
1. They are found in multicellular organisms.	1. They are found in all eukaryotic cells.
2. They are large sized or macroscopic.	2. They are very small sized, either microscopic or submicroscopic.
3. They may be external or internal to the body of an organisms.	3. They are mostly internal (<i>i.e.</i> , intracellular).
4. The organs are formed of tissues, tissues comprise of cells and cells are formed of organelles.	4. An organelle is made up of micromolecules and macromolecules.
5. Organs coordinate to form organ systems, while organ systems form the body of an organism.	5. Organelles coordinate to produce the cell.

Cell Shape

The basic shape of eukaryotic cell is spherical, but the shape of cell is ultimately determined by the specific function of the cell. Thus, the shape of the cell may be **variable** (*i.e.*, frequently changing its shape) or **fixed**. Variable or irregular shape occurs in *Amoeba* ([Fig. 2.9](#)) and white blood cells or leucocytes. In fact, leucocytes are spherical in circulating blood, but in other conditions they may produce pseudopodia and become irregular in shape. Fixed shape of cell occurs in most plants and animals (including *Euglena* and *Paramecium*). In unicellular organisms, the cell shape is maintained by tough plasma membrane (*e.g.*, *Paramecium*) and exoskeleton (*e.g.*, *Elphidium* or *Polystomella*). In multicellular organisms, the shape of a cell depends mainly on its functional adaptations and partly on the surface tension, viscosity of the protoplasm, the mechanical action exerted by adjoining cells and rigidity of the cell membrane (*e.g.*, presence of rigid cell wall in plant cells). Thus, cells may have diverse shapes such as **polyhedral** (with 8, 12 or 14 sides), **spherical** (*e.g.*, eggs of many

animals), **spindle-shaped** (e.g., smooth muscle fibre), **elongated** (e.g., nerve cells), **branched** (e.g., chromatophores or pigment cells of skin), **discoidal** (e.g., erythrocytes or red blood cells) and so on ([Fig. 2.10](#)).

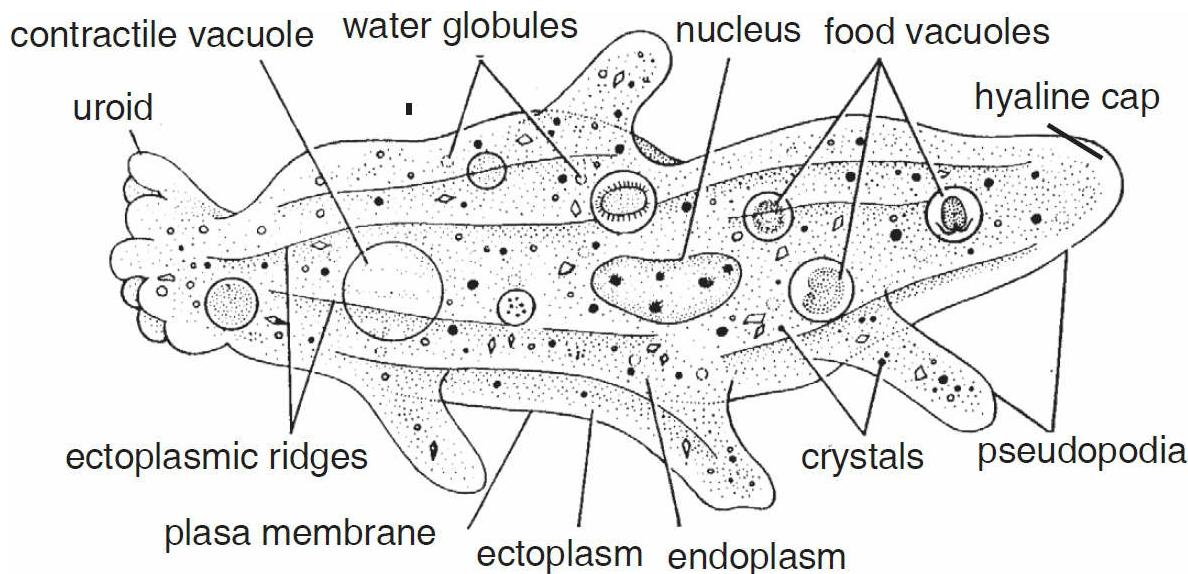


Figure 2.9. Amoeba showing its irregular body shape.

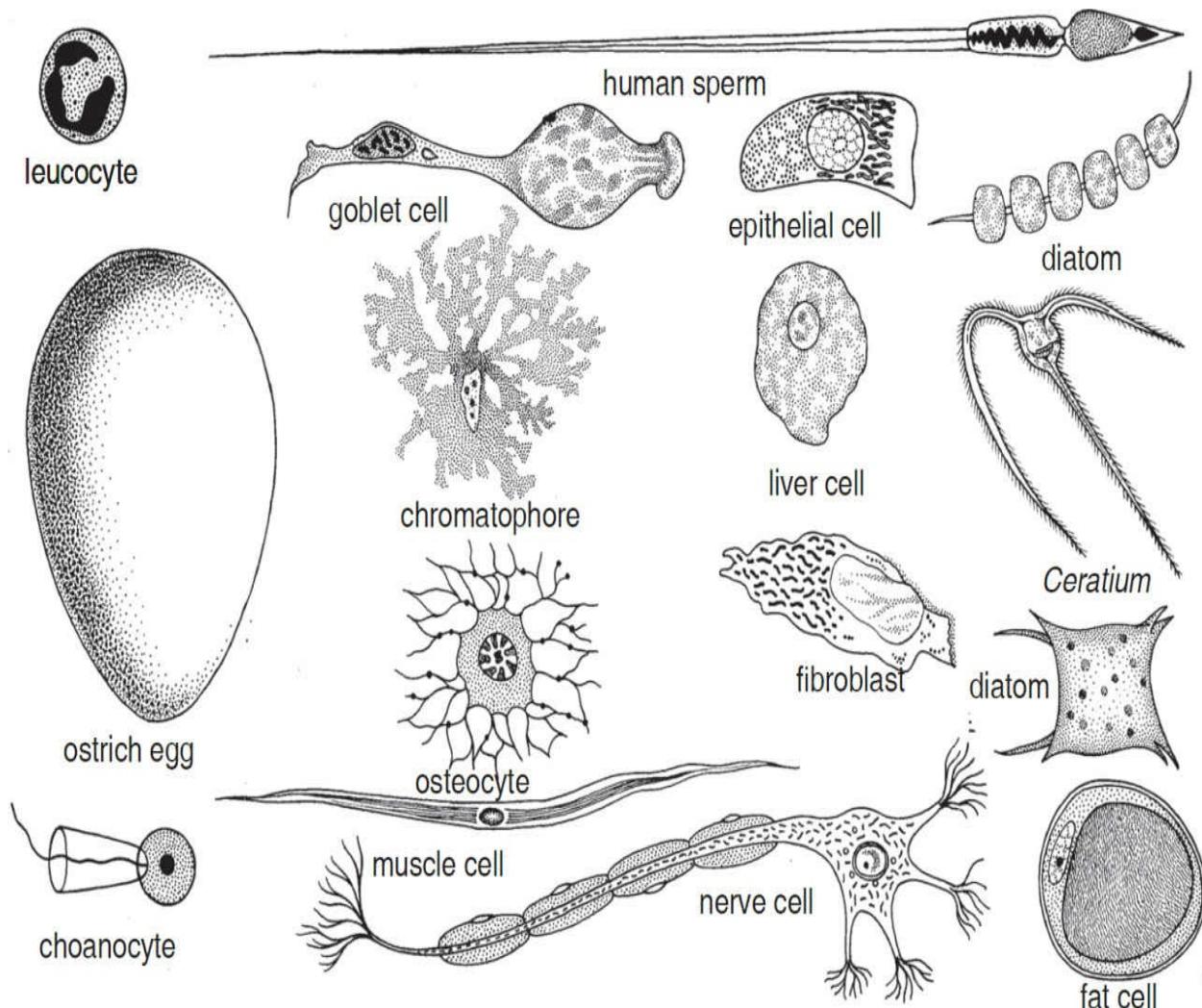


Figure 2.10. Various types of eukaryotic cells showing different shapes. In this figure, except certain cells such as diatom, *Ceratium*, ostrich egg and choanocyte, all remaining cells are showing diversity of cells in human body.

Cell Size

The size of different cells ranges between broad limits. Some plant and animal cells are visible to the naked eyes. Most cells, however, are visible only with a microscope, since they are only a few micrometres in diameter. A micrometre (μm) is one thousandth of a millimetre. The size of cells varies from the very small cells of bacteria (0.2 to 5.0 μm) to the very large eggs of the ostrich (18 cm) (Among the multicellular plants, the largest cell is the ovule of

Cycas.) Some nerve cells of human beings have a metre long ‘tail’ or axon. The single marine alga, *Acetabularia*, measures nearly 10 cm in height ([Fig. 2.11](#)). The fibre cells (i.e., sclerenchyma cells) of Manila hemp similarly, are over 100 cm in length.

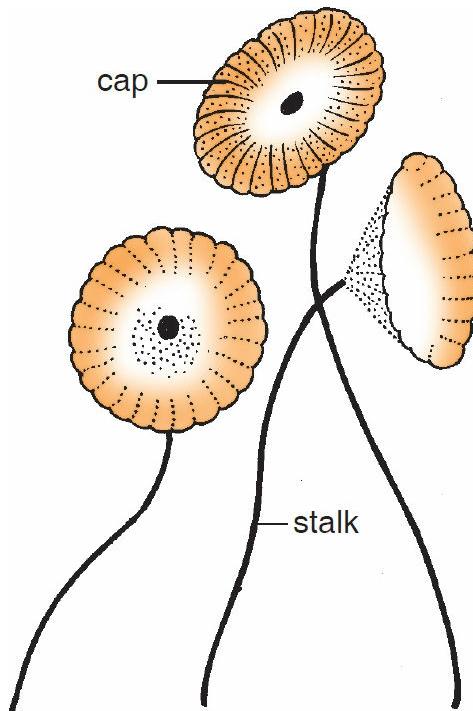


Figure 2.11. *Acetabularia*.

The prokaryotic cells usually range between 1 to 10 μm . The eukaryotic cells are typically larger (mostly ranging between 10 to 100 μm). Size of unicellular organisms is larger than a typical cell of multicellular organisms. For example, *Amoeba proteus* is biggest among the unicellular organisms; its length being 60 μm .

The size of typical cells of multicellular organisms ranges between 20 to 30 μm . The smallest cells are those of *Mycoplasma gallisepticum*, an organism intermediate between virus and bacteria. Their size is about 0.1 μm .

Box 2.4

Measurement of cells

1. Millimetre (mm) $1\text{ mm} = 1000 \mu$
2. Micrometre (mm) or micron (μ) *
3. Nanometre (nm) or millimicron (mm) $1\mu = 1000 m\mu$
4. Angstrom (\AA°) $1\text{\AA}^\circ = 10^{-1}\text{m}\mu = 10^{-4}\mu = 10^{-7} \text{ mm}$

*Micron (μ) is a unit of length in the CGS system, equal to one millionth of a metre. In SI units it is replaced by the micrometre (μm).

Cell Volume

The volume of a cell is fairly constant for a particular cell type and is independent to the size of an organism. For example, kidney or liver cells are approximately the same size in a bull, horse and mouse. The difference in the total mass of the organ or organism depends on the number, not on the volume of the cells. Thus, the cells of an elephant are not necessarily larger than those of other tiny animals or plants. The large size of an elephant is due to the larger number of cells present in its body.

Cell Number

The number of cells in most multicellular organisms is **indefinite**, but the number of cells may be fixed in some multicellular organisms such as rotifers and nematodes ([Box 2.5](#)).

Box 2.5

In the nematodes (e.g., *Ascaris*), the number of cells in various organs is fixed and it is attained by the time hatching takes place. Most growth in size of a nematode results from an increase in cell size. The phenomenon of having a constant and genetically fixed number of cells is called **eutely**. In eutelic animals mitosis stops following embryonic development.

The number of cells in multicellular organisms usually is correlated with the size of an organism. Thus, small-sized organism has less number of cells in comparison to large-sized organisms. For example, large-sized organisms such as elephant, whale, camel, neem tree or banyan tree have countless number of cells. In human beings, the number of cells is estimated to be about 100 trillion (10^{14}). [Note. Trillion is a cardinal number. In numeration system of USA in a trillion 1 is followed by 12 zeros.]

2.2. STRUCTURE OF CELL

Though their shape, size and activities vary, all cells have following *three* major functional regions :

1. The cell membrane or plasma membrane, and cell wall,
2. The nucleus, and
3. The cytoplasm.

The outer boundary of the cell is the **plasma membrane**. Inside it lies the **cytoplasm**. Various **cellular** or **cell organelles** and **inclusions** are suspended in the cytoplasm ([Table 2.6](#)). All activities inside the cell and interaction of the cell with its environment is possible due to these features. Out of these

organelles, **nucleus** is visible under a light microscope. The other organelles can be seen under an electron microscope only.



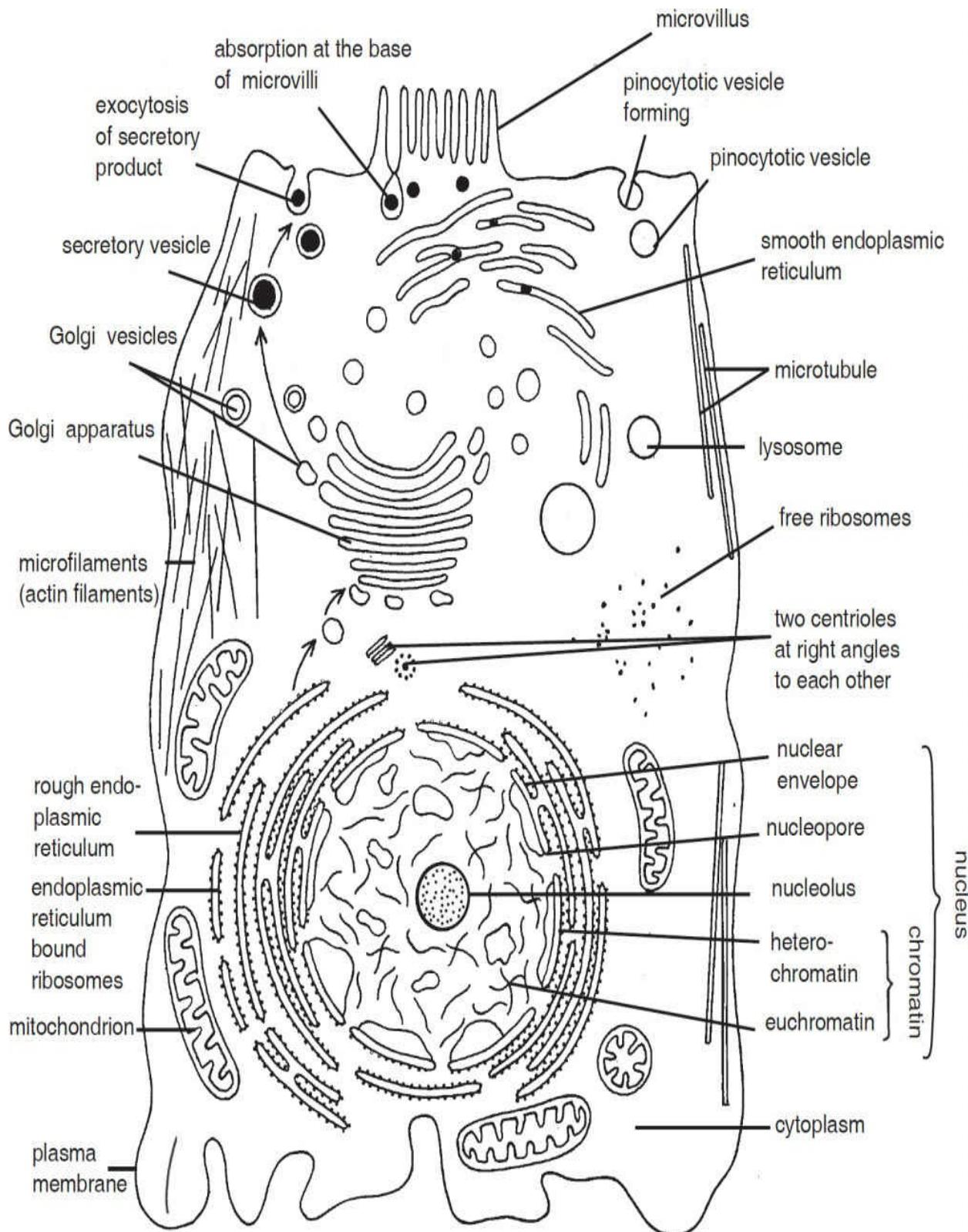


Figure 2.12. Ultrastructure of a generalised animal cell as seen with electron microscope.

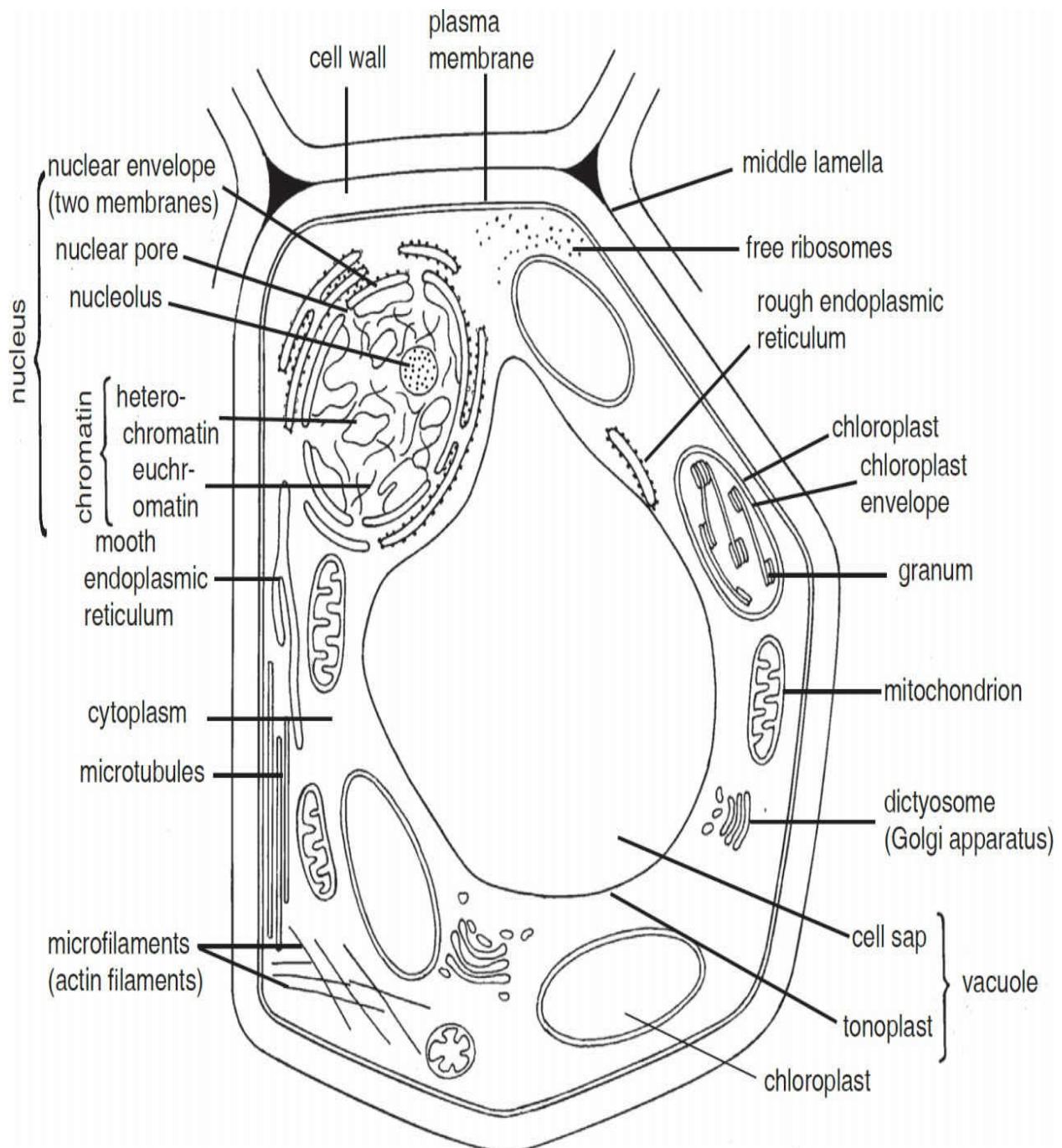


Figure 2.13. Ultrastructure of a generalised plant cell.

1. Plasma Membrane

Nature and Occurrence

Most cellular organelles such as mitochondria, chloroplasts,

lysosomes, peroxisomes, Golgi apparatus, nucleus and endoplasmic reticulum, are all enclosed by the unit membrane. The cell surface membrane or plasma membrane is the outer covering of each cell. It is present in cells of plants, animals and microorganisms.

Structure

Plasma membrane is a living, thin, delicate, elastic, selectively permeable membrane. It is about 7 nm (70\AA) thick. Under a light microscope this merely appears as a single line. However, the development of electron microscope has made it possible to investigate the detailed structure of biological membranes (*i.e.*, plasma membrane and other membrane of cellular organelles).

Table 2.6. Cell organelles and inclusions.

A. Living parts of a cell	B. Non-living parts of a cell
1. Plasma membrane	1. Cell wall (plants only)
2. Cytoplasm	2. Vacuoles
(i) Endoplasmic reticulum (ER)	3. Granules (cell inclusions)
(a) Smooth ER	
(b) Rough ER	
(ii) Mitochondria	
(iii) Golgi apparatus	
(iv) Ribosomes	
(v) Lysosomes	
(vi) Centrioles (animals only)	
(vii) Plastids (plants only)	
3. Nucleus	

Chemical analysis has shown the membrane to be 75 per cent **phospholipids**. In addition, the membrane contains **proteins**, **cholesterol** and **polysaccharides**. However, it is the phospholipids

that form key elements in the structure of plasma membrane.

In 1972 **Singer** and **Nicolson** suggested a model, called **fluid mosaic model**, to explain the ultrastructure of the plasma membrane or any other membrane of the cell. According to them plasma membrane is made up of a bilayer (two molecule thick layers) of phospholipids. Two types of protein molecules ‘floated about’ in the fluid phospholipid layer : **Intrinsic proteins**, which completely covers the lipid bilayer and **extrinsic proteins**, which occur either on the outer surface or on the inner surface of the lipid membrane. The fluid mosaic model of the membrane has been described as “*a number of protein icebergs floating in the sea of lipids*”. This model is the most accepted one, as it describes both properties and organisation of the membrane.

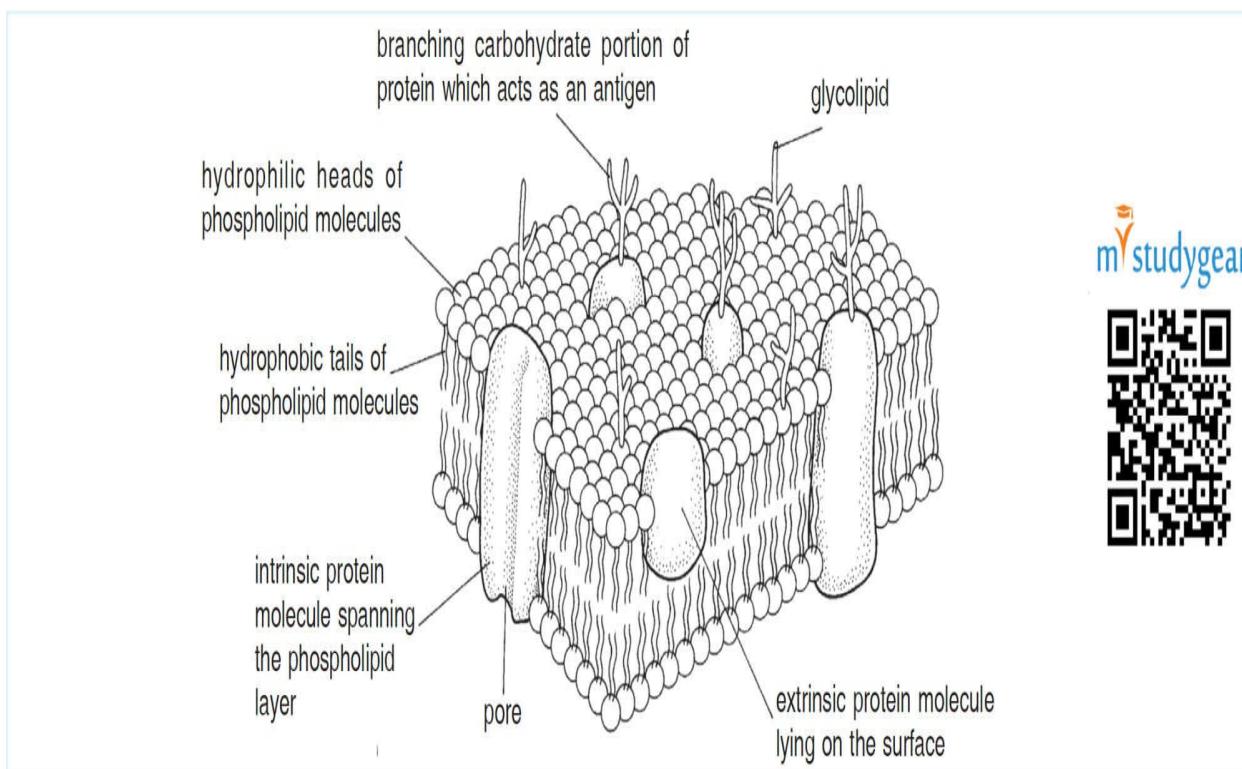


Figure 2.14. Fluid mosaic structure of the plasma membrane.

The proteins are present not to give strength to the membrane

but to serve as (i) **enzymes** (catalyse chemical reactions within the membrane), (ii) **transport proteins** or **permeases** (for movement of water soluble ions) ; (iii) **pumps** (for active transport) and (iv) **receptor proteins** (for endocytosis). Presence of lipids and proteins provides flexibility to the plasma membrane. This property of flexibility of the plasma membrane helps in endocytosis.

Box 2.6

Advantages of selective permeability

Selective permeability of plasma membrane ensures that

1. The useful molecules enter the cell
2. The metabolic intermediates remain within the cell, and
3. Secretions and wastes leave the cell.

Thus, selective permeability of the cellular membranes enables the cell to maintain **homeostasis**, *i.e.*, a constant internal environment inspite of the changes outside it.

The substances generally drawn in the cell includes: (1) raw materials for metabolism, *i.e.*, food, water, salts and oxygen; and (ii) regulatory substances, *e.g.*, vitamins and hormones.

The substances generally ousted of the cells include : (i) the products of metabolism, namely nitrogenous wastes and carbon dioxide; and (ii) secretions such as proteins, proenzymes, hormones, milk, tear, mucus, immunoglobulins (antibodies), etc.

Functions

Plasma membrane permits the entry and exit of some materials in the cells. Therefore, the plasma membrane is called a **selective permeable membrane**. Let us see how the movement of

substances takes place in out of a cell !

Studies on function of plasma membrane have shown that, it performs certain physical activities, such as diffusion and osmosis for the intake of some substances. Also certain biological or physiological activities such as active transport and endocytosis are performed by the plasma membrane.

1. Diffusion. Some substances (molecules, ions) such as carbon dioxide (CO_2), oxygen (O_2), water, etc., can move across the plasma membrane through a process called **diffusion**. These substances are of very small size, so, they diffuse readily through the phospholipid layer of the plasma membrane. To understand this process let us perform [Activity 2.3](#).

ACTIVITY 2.3

Let us take a glass beaker or a glass tumbler half filled with clean water. Put a few drops of blue ink or any coloured fluid into the beaker or tumbler. What do you observe ? Does the water in the beaker or tumbler gets uniformly coloured throughout at once ?

You will observe that the ink diffuses into the water gradually until the ink molecules get uniformly distributed in the water. This is a spontaneous movement of a substance from a region of its high concentration to a region where its concentration is low.

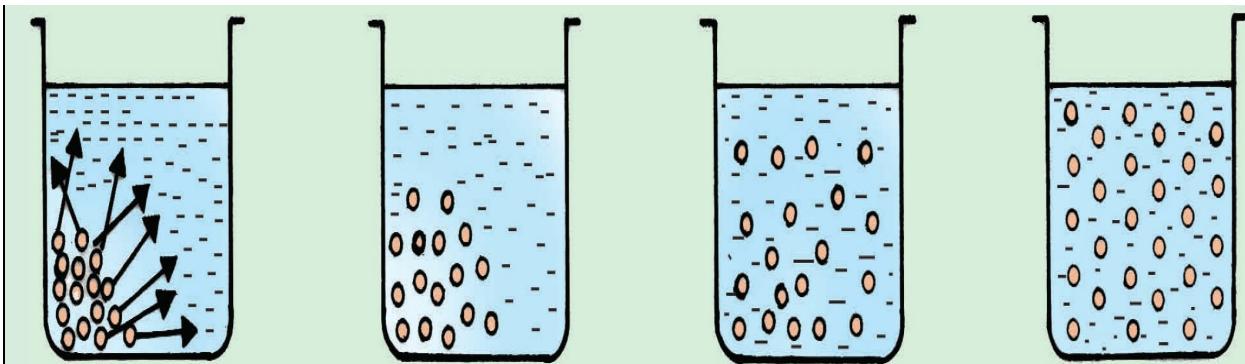


Figure 2.15. Representation of diffusion which is the movement of molecules or ions from an area of higher concentration to the region of lower concentration.

Thus, diffusion is the spontaneous movement of molecules from a region of high concentration to one of lower concentration, until uniform concentration is finally achieved. Diffusion is faster in the gaseous phase than in liquids and solids.

Something similar to diffusion of ink in [Activity 2.3](#) happens in cells when for example, a gas such as CO_2 gets accumulated in high concentration inside a cell. In the external environment of cell, the concentration of CO_2 is low as compared to inside of the cell. As soon as there is a difference of concentration of CO_2 , inside and outside of a cell, CO_2 moves out of the cell, i.e., from region of its high concentration to region of low concentration by the process of diffusion. In a similar way, oxygen (O_2) enters the cell (e.g., *Amoeba* ; [Fig. 2.16](#)) by the process of diffusion when the level or concentration of O_2 inside the cell decreases.

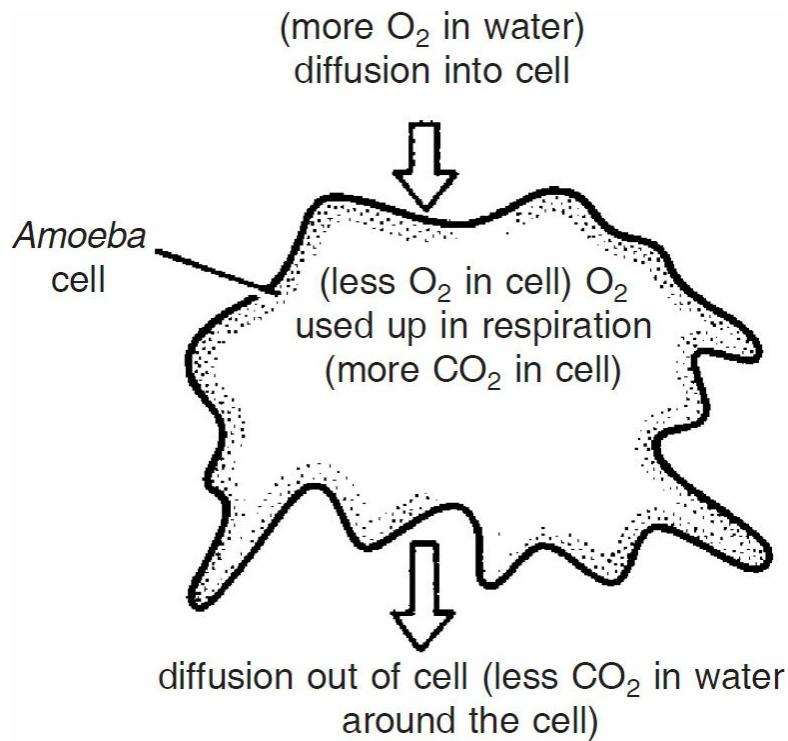


Figure 2.16. Diffusion of oxygen (O₂) and carbon dioxide (CO₂) across the plasma membrane of *Amoeba* (an unicellular organism).

2. Osmosis. Water also follows the law of diffusion. The spontaneous movement of water molecules through a selective permeable membrane (e.g., plasma membrane) is called **osmosis**. The movement of water across the plasma membrane of the cell is affected by amount of substance dissolved in water. Thus, *osmosis is the passage of water from a region of high water concentration through a semi-permeable membrane to a region of low water concentrations* ([Fig. 2.17](#)). Osmosis is purely a mechanical diffusion process by which cells absorb water without spending any amount of energy.

Let us see what will happen if you put an animal cell (e.g., red blood cells or RBCs) or plant cells (e.g., *Rheo* leaves) into a solution of sugar or salt prepared in water ? One of the following *three* things could happen :

1. If the medium surrounding the cell has a higher water concentration than the cell, *i.e.*, if solution is a very dilute solution, the cell will gain water by osmosis. Such a dilute solution is called **hypotonic solution**.

While water molecules are free to pass across the plasma membrane in both directions, more water will enter the cell than leave. The net (over all) result is that water enters the cell. In such a situation, cell is likely to swell up, *i.e.*, become inflated or turgid ([Fig. 2.18A](#)). Such swollen RBCs may ultimately burst, *i.e.*, haemolysed. ([Fig. 2.19B](#)).

2. If the medium surrounding the cell is of exactly the same water concentration as the cell, there will be no net movement of water across the plasma membrane ([Fig. 2.18B](#) and [Fig. 2.19 A](#)). Such a solution is called **isotonic solution** (*e.g.*, Ringer's solution is an isotonic solution for the animal cells).

In this case, water crosses the plasma membrane in both directions, but the amount going in is the same as the amount going out, so there is no overall movement of water. In such a situation, the cell will maintain the same size.

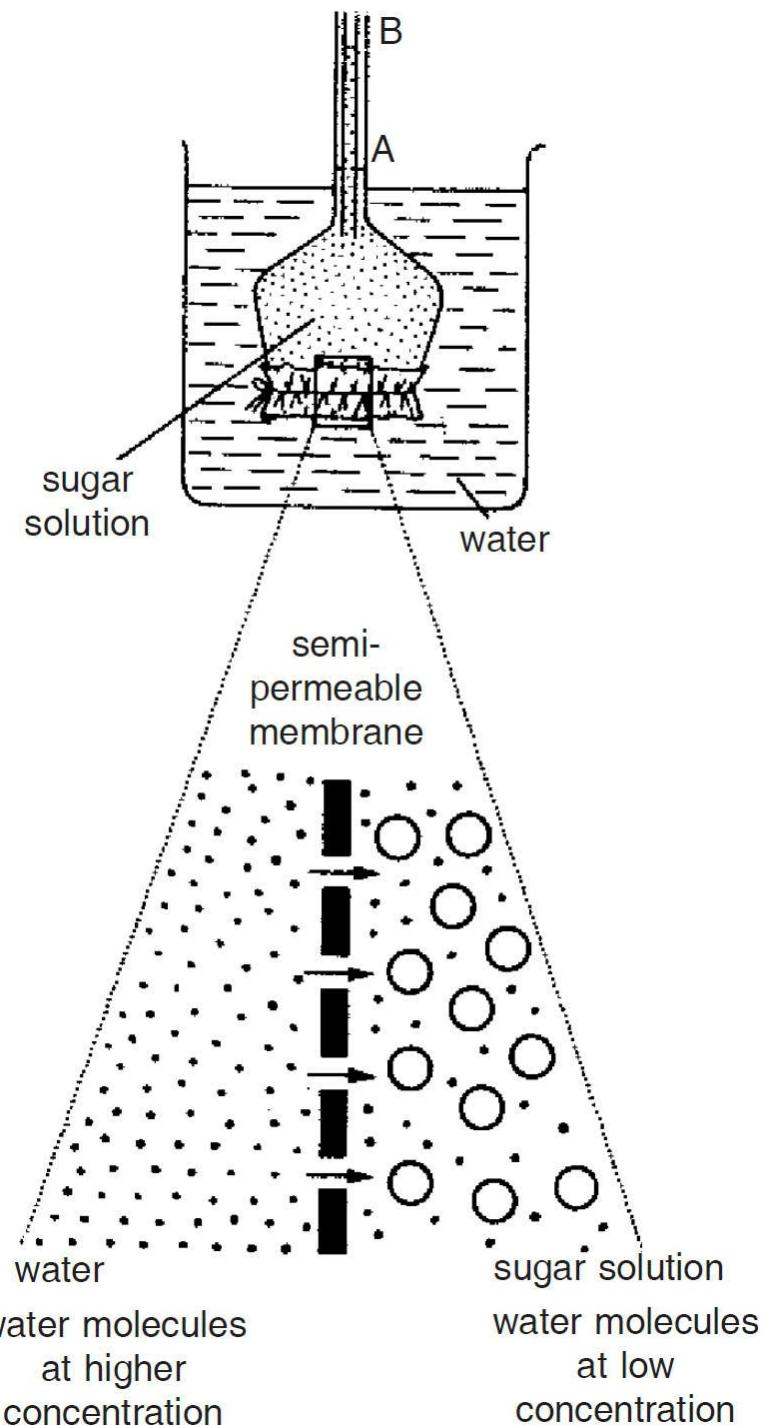


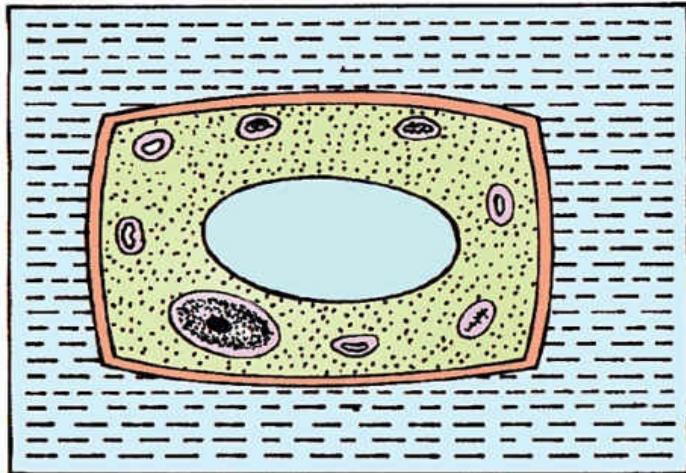
Figure 2.17. Experiment to explain the process of osmosis.

3. If the medium has a lower concentration of water than the cell, i.e., if it is very concentrated solution, the cell will lose water by osmosis. Such a concentrated solution is called **hypertonic solution**.

In this case too, water crosses the plasma membrane in both directions, but this time more water leaves the cell than enters it. Therefore, the cell will shrink. In this situation, plant cell is said to be **plasmolysed** ([Fig. 2.18C](#) and [Fig. 2.26D](#)) and animal cells (Red blood cells) is said to **crenated** ([Fig. 2.19C](#))

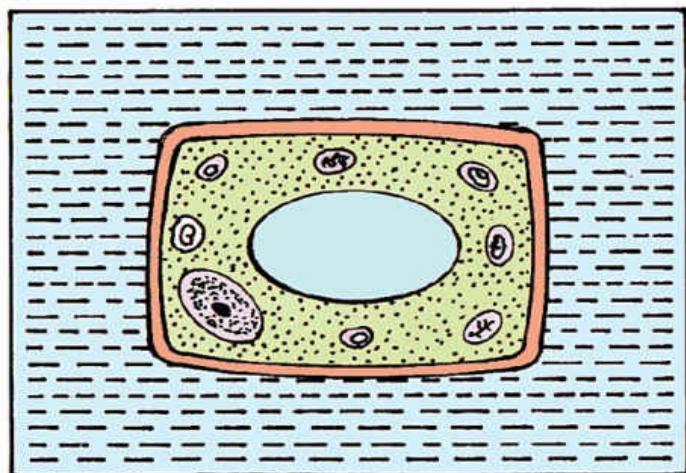
To understand osmosis more clearly, you can perform the [Activities 2.4, 2.5](#) and [2.6](#).

A



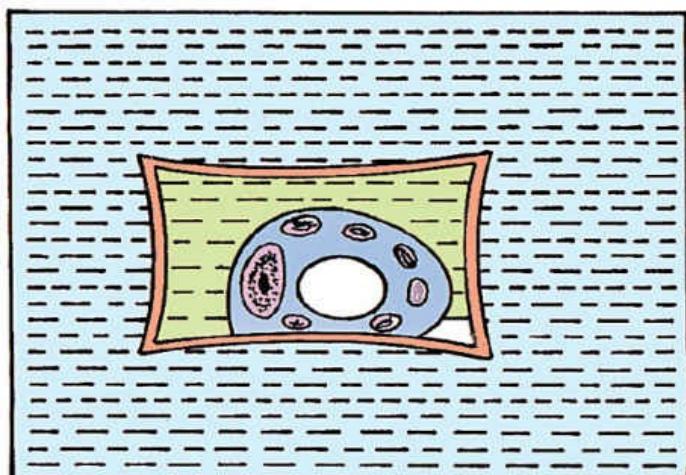
Hypotonic solution

B



Isotonic solution

C



Hypertonic solution

Figure 2.18. Effect of different solutions on plant cells.

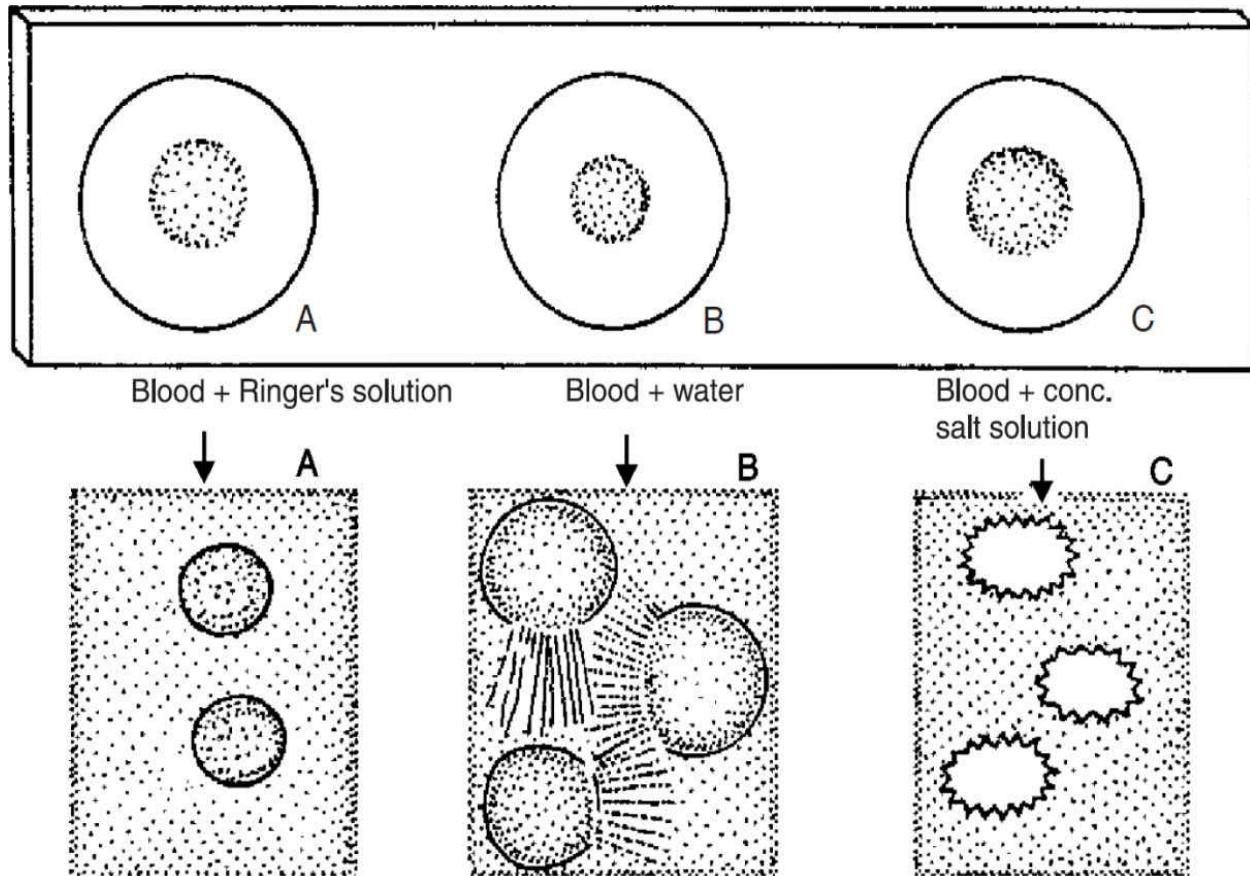


Figure 2.19. Slide showing normal RBCs (A); swollen and haemolysed RBCs (B) and shrunken or crenated RBCs (C).

ACTIVITY 2.4

Osmosis with Human RBCs

Under the supervision of your teacher, clean ring finger of your left hand with spirit and prick it with a disposable needle. Take three drops of blood on a plain slide and mark them as A, B and C. To drop A add a drop of Ringer's solution (an isotonic solution). (Ringer solution is a balanced aqueous solution that contains chloride, sodium, potassium, calcium, bicarbonate and phosphate ions. This solution is used as an isotonic medium for

animal cells in the physiological experiments). To drop B add a drop of water (a hypotonic solution) and to drop C add a drop of concentrated salt solution (a hypertonic solution) ([Fig. 2.19](#)).

Observe the blood drops under a light microscope. Circular, biconcave, non-nucleated red blood cells (RBCs) are seen in drop A. In drop B, RBCs appear swollen and haemolysed/bursted. In drop C, RBCs appear shrunken (crenated).

ACTIVITY 2.5

Osmosis with an Egg

Take a hen's egg and remove the egg shell by putting the egg in diluted hydrochloric acid (HCl) solution. The shell of an egg is made up mainly of calcium bicarbonate. A thick outer skin (called **shell membrane**), now encloses the egg. Put this processed egg in pure water and observe after 3–5 minutes. You will observe that the egg swells because water enters the egg by osmosis.

In another set of experiment, place a similar processed egg in a concentrated salt solution and observe for 5 minutes. You will observe that the egg shrinks. The egg shrinks, since water passes out of the egg solution into the salt solution as the salt solution is more concentrated.

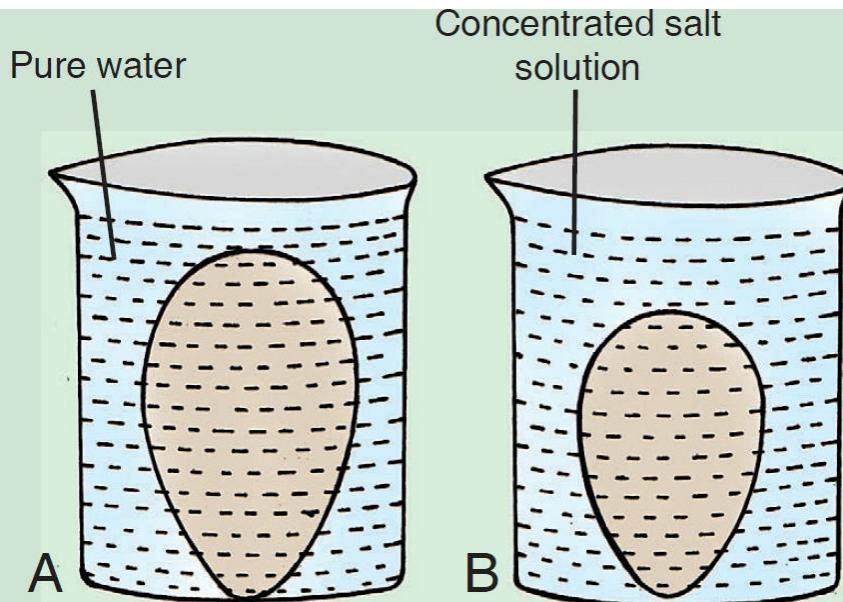


Figure 2.20. Deshelled hen's eggs showing endosmosis (A) and exosmosis (B).

ACTIVITY 2.6

Osmosis with Raisins and Apricots

Put dried raisins and apricots in pure water and leave them for some time ([Fig. 2.21](#)). Then place them into a concentrated solution of sugar or salt. Each gains water and swells when placed in pure water due to endosmosis. When such swollen raisins/apricots are placed in the concentrated solution, each of them loses water, and consequently shrinks again(due to exosmosis).

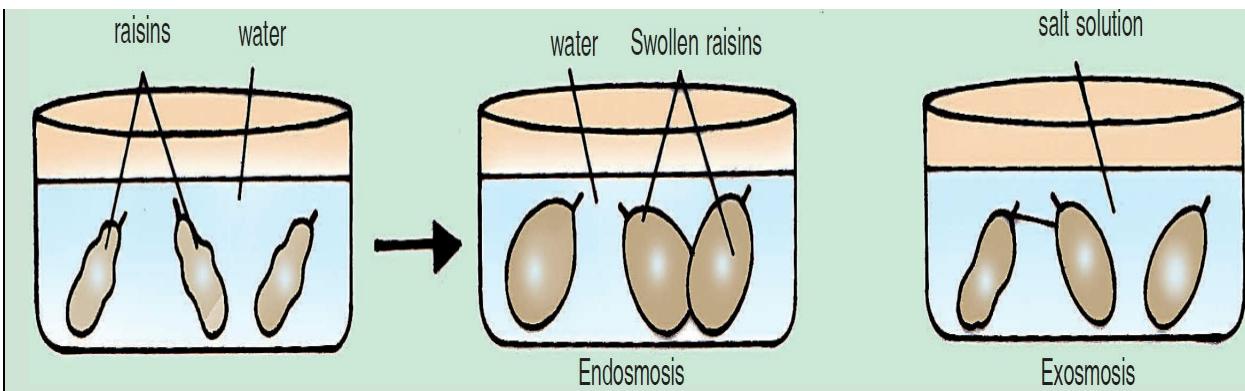


Figure 2.21. Dried raisins placed in water to demonstrate endosmosis and exosmosis

Examples of osmosis. Unicellular freshwater organisms and most plant cells tend to gain water through osmosis. Absorption of water by plant-roots (*i.e.*, by root hairs) is an example of osmosis. ([Fig. 2.22](#)).

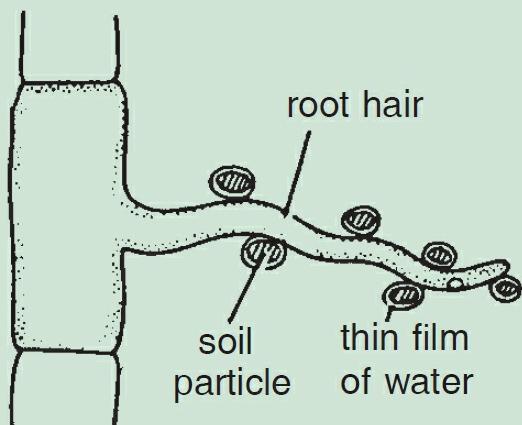


Figure 2.22. Absorption of soil water by root hair through osmosis.

Table 2.7. Differences between diffusion and osmosis.

<i>Diffusion</i>	<i>Osmosis</i>
1. Diffusion can occur in any medium.	1. It occurs only in liquid medium.
2. The diffusing molecules may be solids, liquids or gases.	2. It involves movement of solvent molecules only.

3. Semipermeable membrane is not required.	3. Semipermeable membrane is required.
4. It is dependent upon the free energy of the molecules of diffusing substance only ; presence of other substances in the system is of no importance.	4. Though it is the diffusion of solvent molecules only, yet influenced by the presence of other substances (solutes) in the system.
5. An equilibrium in the free energy of diffusion molecules is achieved in the system.	5. Equilibrium in the free energy of solvent molecules is never achieved.

3. Mediated Transport

We have seen that the cell/plasma membrane acts as an effective barrier to the free diffusion of most molecules of biological significance. Yet, it is essential that some materials enter and leave the cell. Nutrients such as sugars and materials of growth such as amino acids must enter the cell, and the wastes of metabolism must be thrown out. Such molecules are moved across the membrane by special proteins called **transport proteins** or **permeases**. Permeases form a small passageway through the membrane, enabling the solute molecule to cross the phospholipid bilayer. Permeases are usually quite specific, only a limited group of chemical substances or perhaps even a single substance they recognise and transport.

Types of Mediated Transport

It is of following two types :

(1) Facilitated transport/diffusion. In this case, the permease assists a molecule to diffuse through the membrane that it cannot otherwise penetrate.

(2) Active transport. In this case, the energy is supplied to the system (called **pump**) to transport molecules in a direction opposite

to a concentration gradient.

Facilitated diffusion, therefore, differs from active transport in that it promotes movement in a downhill direction (*i.e.*, in the direction of concentration gradient) only and requires no metabolic energy to drive the transport system. In many animals, facilitated transport (or facilitated diffusion) aids in the transport of glucose (blood sugar) into the body cells that oxidises it to get ATPs. The concentration of glucose is greater in the blood than in the cells that consume it, favouring inward diffusion. Glucose is a water soluble molecule that by itself is unable to penetrate the membrane rapidly enough to support the metabolism of many cells. The carrier system (*i.e.*, mediated transport) increases the inward flow of glucose.

Table 2.8. Differences between active transport and diffusion.

<i>Active transport</i>	<i>Diffusion</i>
1. It is a rapid process.	1. It is a slow process.
2. It can move materials through a biological (cellular) membrane against the concentration gradient.	2. It can move materials across a biomembrane down the concentration gradient.
3. It takes place in one direction only	3. It takes place in both directions.
4. It needs carrier (or transport) proteins to occur.	4. It occurs without the help of carrier proteins.
5. It uses energy of ATP.	5. It does not use energy.
6. It brings about selective uptake of materials.	6. It allows all transmissible molecules to pass through membrane.
7. It leads to accumulation of materials in the cell.	7. It does not accumulate material in the cell.

In **active transport**, molecules are moved uphill against the forces of passive diffusion. Active transport always involves

expenditure of energy (from ATP) because materials are pumped against the concentration gradient. The most important active transport system in all animals are those, that maintain *sodium and potassium gradients* between cells and the surrounding extracellular fluid or external environment. *Most animal cells require a high internal concentration of potassium ions for the protein synthesis by the ribosomes and for certain enzymatic functions.* The potassium ion concentration may be 20 to 50 times greater inside the cell than outside. Sodium ions, on the other hand, may be 10 times more concentrated outside the cell than inside. Both of these ionic gradients are maintained by the active transport of potassium ions into and sodium ions out of the cell.

4. Endocytosis

Endocytosis is the ingestion of material by the cells through the plasma membrane. It is a collective term that describes three similar processes : **phagocytosis** (“cell eating), **potocytosis** (“cell drinking) and **receptor-mediated endocytosis** ([Fig. 2.23](#)). These processes are pathways to specifically internalize solid particles, small molecules and ion, and macromolecules, respectively. All of them require energy, so they may be regarded as different forms of active transport.

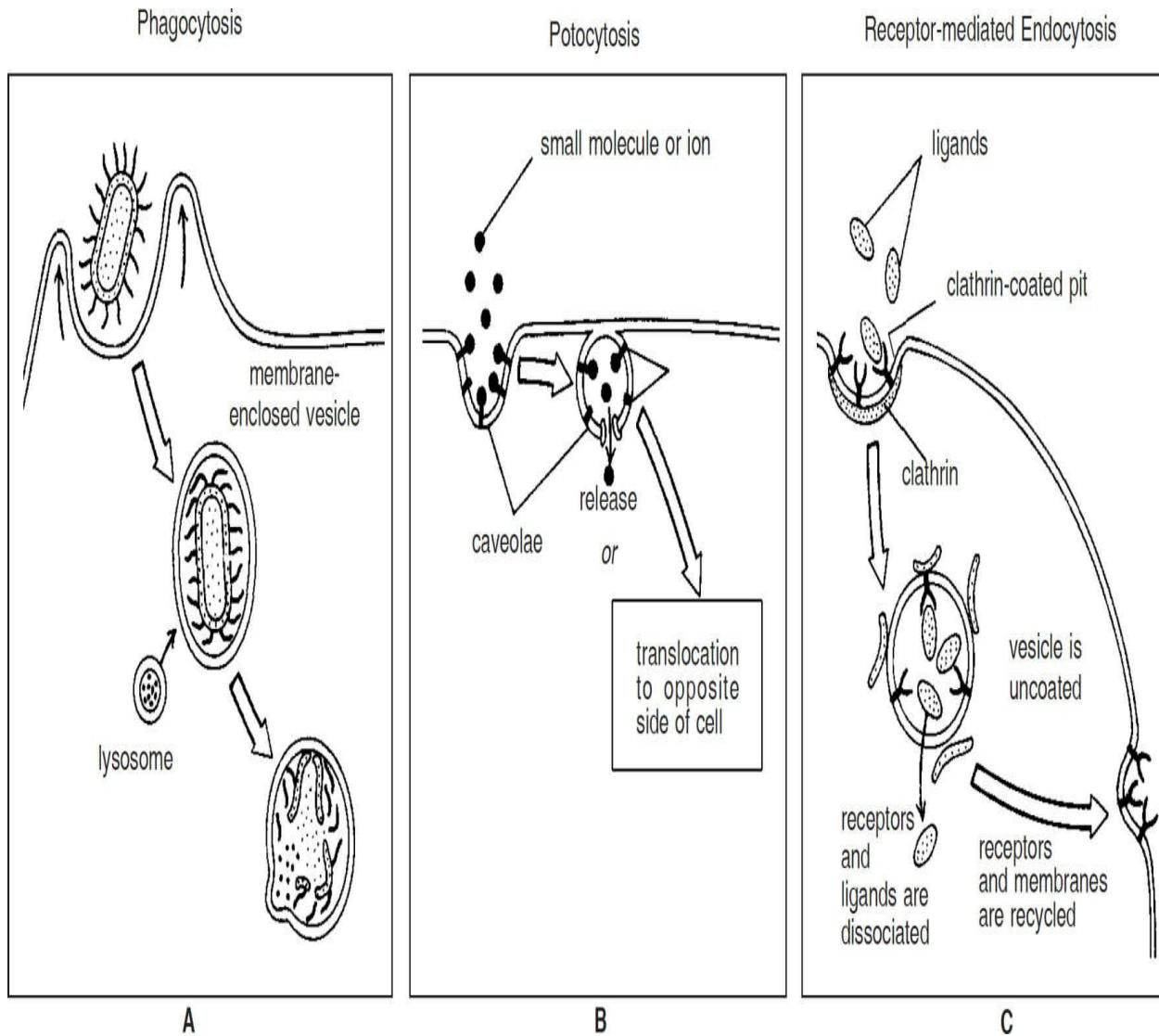


Figure 2.23. Three types of endocytosis. In *phagocytosis* the plasma membrane binds to a large particle (adsorption) and extends to engulf it. In *potocytosis* small areas of plasma membrane, bearing specific receptors for a small molecule or ion, invaginate to form caveolae. *Receptor-mediated endocytosis* is a mechanism for selective uptake of large molecules (the ligands) in clathrin-coated pits. Binding of the ligand to the receptor on the surface/plasma membrane stimulates invagination of pits.

Phagocytosis. It literally means “cell eating”. It is a common method of feeding among the protozoa (*Amoeba*) and lower metazoa (e.g., sponges). It is also the way in which white blood cells (leucocytes) engulf cellular debris and uninvited microbes

(viruses and bacteria) in the blood. Like WBCs, there are other phagocytes, such as the macrophages found in connective tissue and liver sinusoids. In the phagocytosis, an area of the plasma membrane, coated initially with **actin-myosin**, forms a pocket that engulfs the solid material (e.g., bacteria, debris). The membrane-enclosed vesicle, *phagosome*, then detaches from the cell surface (= plasma membrane) into the cytoplasm where its contents are digested by lysosomal enzymes ([Fig. 2.24](#)).

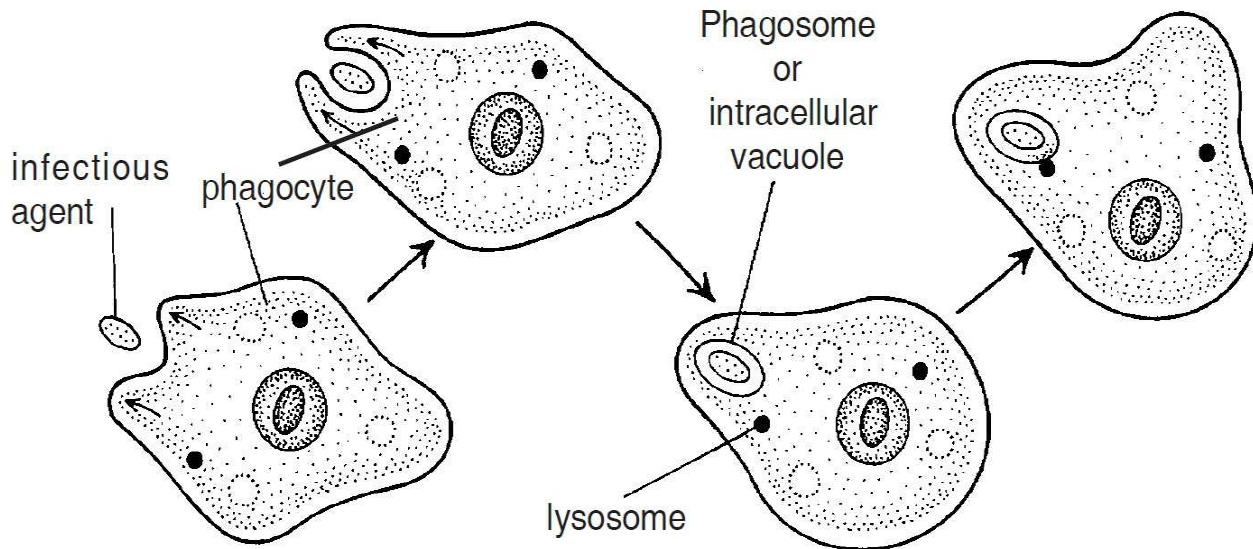


Figure 2.24. Phagocytosis. In pseudopodial movement, the phagocyte (a type of white blood cell) engulfs the particle. Lysosomes join with the vacuole containing ingested particle, and pour their contents (the digestive enzymes) into the vacuole, to destroy the particle.

Table 2.9. Differences between endocytosis and phagocytosis.

<i>Endocytosis</i>	<i>Phagocytosis</i>
1. It is the intake of extra-cellular fluid, droplets and macromolecules.	1. It is the intake of extracellular particles.
2. Plasma membrane invaginates to take up the materials.	2. Plasma membrane grows around the particle as pseudopodia.
3. It is a nutritive process.	3. It is a nutritive and a defensive process.

4. Endocytotic vesicles are only 0.1 μm wide.

4. Phagocytotic vesicles are 1 to 2 μm or more wide.

5. Exocytosis

Just as materials can be brought into a cell by invagination and formation of a vesicle, the membrane of a vesicle can fuse with the plasma membrane and extrude its contents to the surrounding medium. This process is called **cell vomiting** or **exocytosis**. Exocytosis occurs in various cells to 1. remove undigested residues of substances brought in by endocytosis, 2. secrete substances such as hormones, enzymes, and 3. transport a substance completely across a cellular barrier. For example, a substance (*e.g.*, IgA or immunoglobulin/antibody) may be picked up on one side of the wall of blood vessel by phagocytosis, moved across the cell, and released by exocytosis.

In the process of exocytosis ([Fig. 2.25](#)), the undigested waste-containing food vacuole or the secretory vesicle budded from a Golgi apparatus, is first moved by cytoskeleton from the interior of the cell to the surface. The vesicle membrane comes in contact with the plasma membrane. The lipid molecules of the two bilayers rearrange themselves and the two membranes are, thus, fused. A passage is formed in the fused membrane and the vesicle discharges its contents outside the cell.

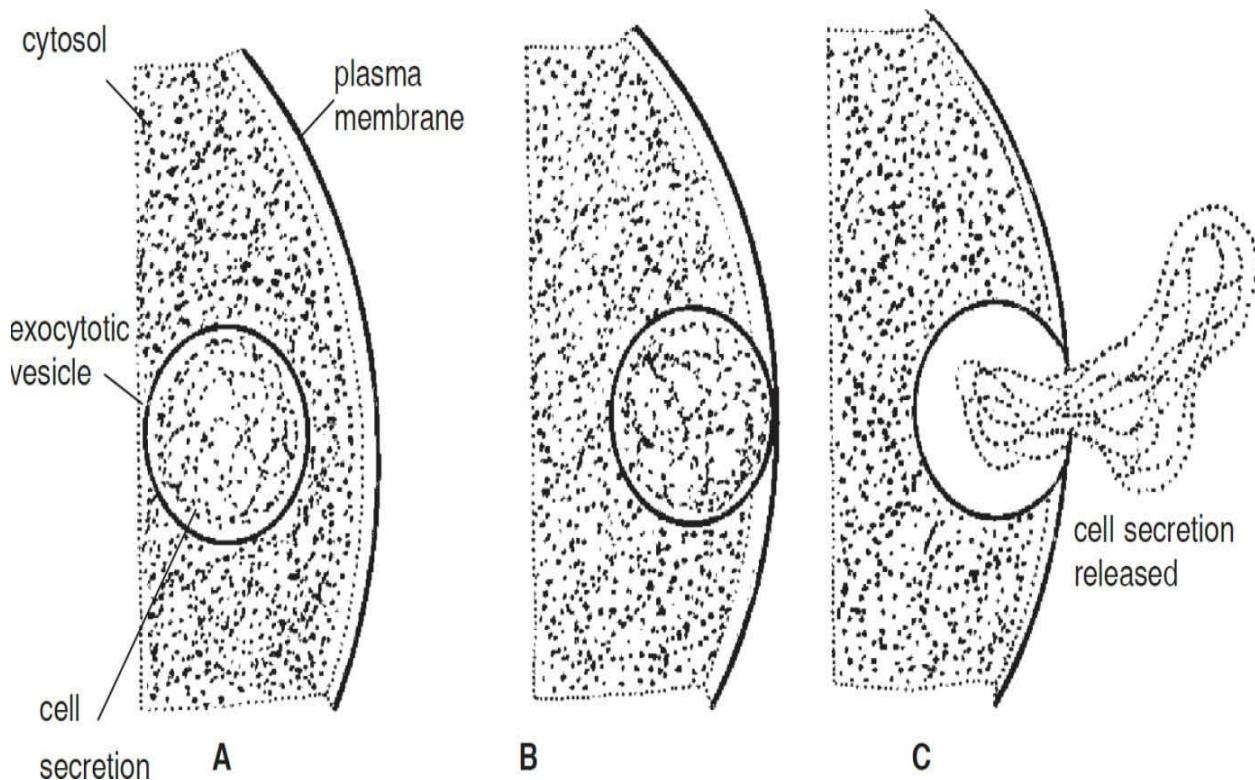


Figure 2.25. Exocytosis by a cell.

ACTIVITY 2.7.

Note about electron microscopes from resources in the school library or through the internet. Discuss it with your teacher.

2. CELL WALL

In plant cells, there occurs a rigid **cell wall** which lies outside the plasma membrane. Cell wall is non-living and freely permeable and is secreted by the cell itself for the protection of its plasma membrane and cytoplasm. It determines the shape of a plant cell and prevents desiccation of cells. It is made up of a fibrous polysaccharide (carbohydrate) called **cellulose**. The plant cell wall, thus, consists of tiny cellulose fibres called **microfibrils**, glued together by a mixture of polysaccharides. Each microfibril is made

up of thousands of cellulose molecules bound together by pectins and hemicellulose.

As you may recall from your observation of cells of onion peel, the presence of cell wall make plant cells clearly visible as distinct units when viewed under a microscope.

Functions of a cell wall. Cell wall of plants performs the following functions :



1. It permits the plant cell to become **turgid**. As water enters the vacuole through osmosis, the plant cell expands. The cell wall has to be strong enough to resist this expansion and so enables the cell to become turgid.
2. It provides mechanical strength to support the cell. The cellulose microfibrils are very strong. The strength may be further increased by the addition of **lignin** in tissues such as xylem. In cells such as collenchyma, extra cellulose is added to the cell wall to increase mechanical support.
3. It is freely permeable to water and substances in solution.
4. It has narrow pores, called pits, through which fine strands of cytoplasm, called **plasmodesmata**, are able to pass. These intercellular connections allow exchange of materials between the living cell contents.
5. The cell walls of adjacent cells are glued together by the **middle lamella**. Middle lamella is a jelly-like substance made up of calcium and magnesium pectate.

Plasmolysis. When a living plant cell loses water through osmosis, there is a shrinkage or contraction of the protoplasm away from the cell wall ([Fig. 2.26](#)). This phenomenon is called **plasmolysis**. Thus, if a living plant cell is immersed in a concentrated sugar solution, the concentration of water molecule inside the cell will be higher than outside. As a result, water will move by *osmosis* from the *higher water potential* inside the cell to the *lower water potential* outside. The cell contents will shrink away from the cell wall and it will be plasmolysed ([Activity 2.8](#)).

ACTIVITY 2.8

Mount a complete *Rheo* leaf in water on a slide and examine cells of leaf under the high power of a microscope. Note the location of small green granules which represent the chloroplasts having chlorophyll pigment. Put a few drops of strong solution of sugar or salt on the mounted leaf on the slide. Wait for a minute, so that process of osmosis may occur and water may come out from the leaf cells. Again observe the leaf under the microscope. You will observe that the cell contents are separated from the cell wall, *i.e.*, space between cell wall and chloroplast-containing cell content (protoplasm) is widened ([Fig. 2.26 D](#)).

These changes can be explained by the fact that outer medium is hypertonic, so water moves out leaf cells to cause plamolysis.

Now place some *Rheo* leaves in boiling water for a few minutes. This kills the cells of a leaf. Then mount one boiled leaf on a slide and observe it under the microscope. Put a few drops of strong solution of sugar or salt on the mounted leaf on the slide. Wait for a minute and observe it again. In this experiment, you will observe that plasmolysis does not occur.

This means that the process of osmosis does not occur in boiled plant (leaf) cells. In other words, it is proved by this experiment that property of selective permeability exists only in the living plasma membrane.

Thus, only living cells possess selectively permeable plasma membrane and they are, therefore, able to absorb water by osmosis.

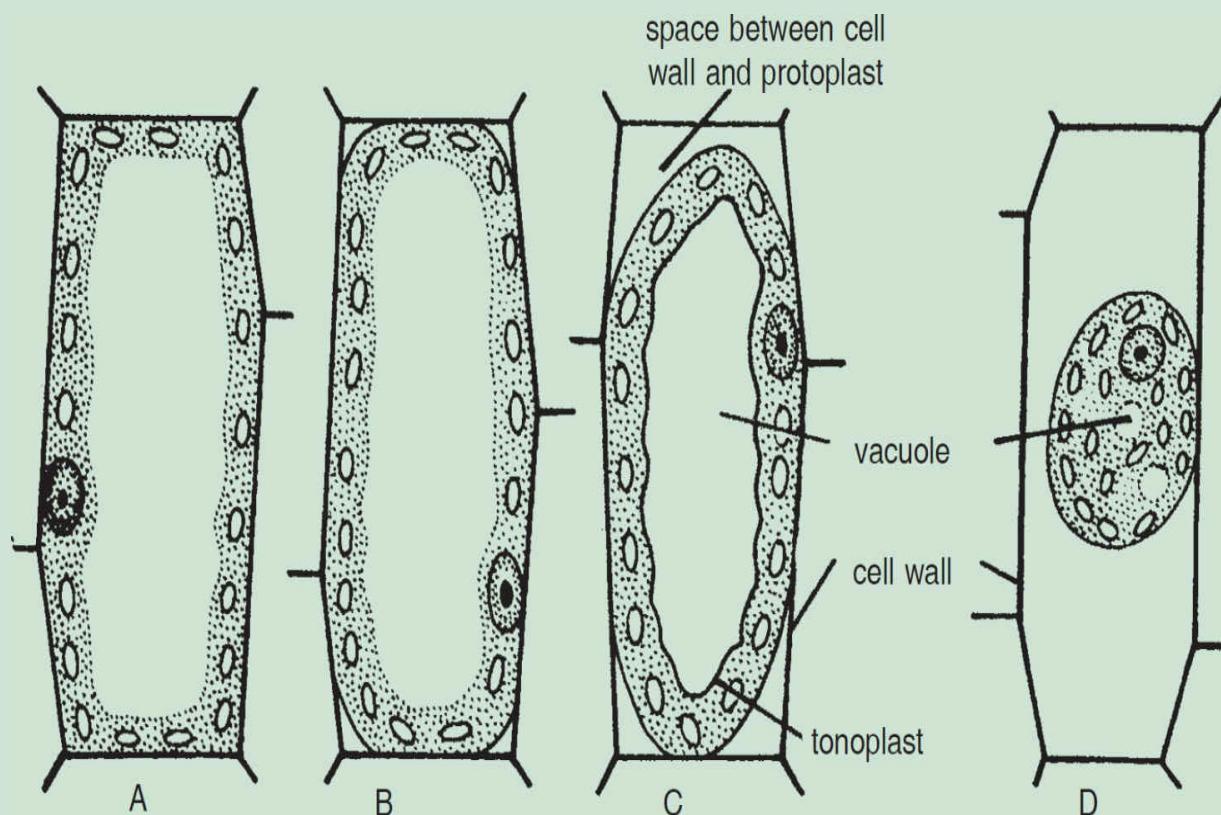


Figure 2.26. Plasmolysis. A—A turgid or normal plant cell of *Rheo*; B – D – Successive stages in the shrinkage of cell content (protoplasm) from the cell wall.

Table 2.10. Differences between cell wall and plasma membrane.

<i>Cell wall</i>	<i>Plasma membrane</i>
1. It occurs in plant cells.	1. It is found in both plant and animal cells.

2. It lies outside of the cells.	2. It lies on the outside of animal cells and inner to cell wall in plant cells.
3. It is nonliving and quite thick in plant cells.	3. It is living and quite thin.
4. It is rigid.	4. It is flexible.
5. It is generally permeable.	5. It is selectively permeable.
6. It is formed of cellulose, hemicellulose and pectin.	6. It is formed of lipids and proteins and small number of small carbohydrates (i.e., oligosaccharides).
7. Its major function is to provide protection and strength to the cell.	7. Its major function is to hold cellular contents and control passage of materials in and out of the cell.

3. NUCLEUS

Nature and occurrence. The nucleus is a large, centrally located spherical cellular component ([Activity 2.9](#)). It is bounded by two nuclear membranes, both forming a **nuclear envelope** ([Fig. 2.27](#)). Nuclear envelope encloses a space between two nuclear membranes and is connected to a system of membranes called the ER (endoplasmic reticulum; [Fig. 2.28](#)).



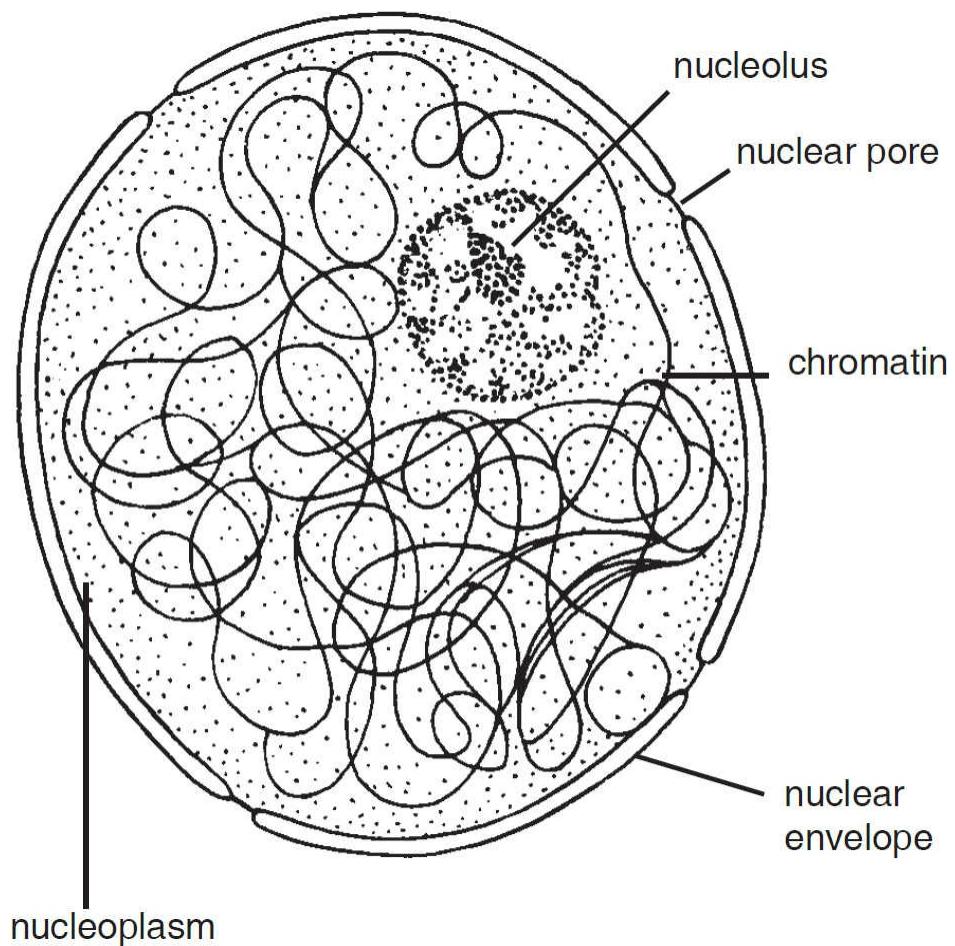


Figure 2.27. Structure of a nucleus.

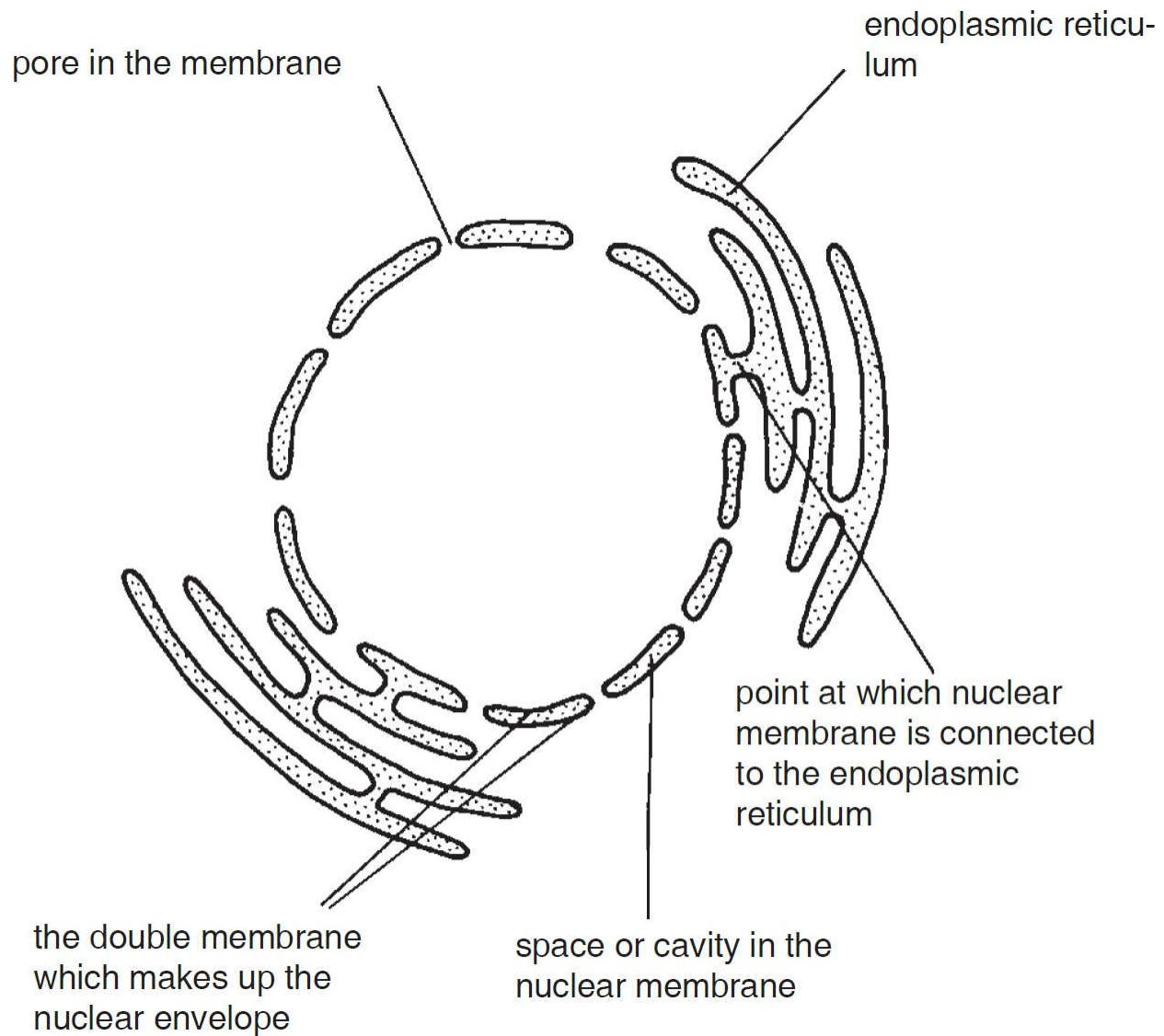


Figure 2.28. Connection of nuclear envelope with ER.

The nuclear envelope separates the nucleus from the cytoplasm. The nuclear envelope contains many pores (the **nuclear pores**) and encloses the liquid ground substance, the **nucleoplasm**. Nucleopores allow transfer of materials between the nucleoplasm and the cytoplasm. Within nucleoplasm two types of nuclear structures are embedded—the nucleolus and chromatin material. The **nucleolus** may be one or more in number and is not bounded by any membrane. It is rich in protein and RNA (ribonucleic acid) molecules and acts as the site for ribosome formation. Nucleolus is

known as **factory of ribosomes**. Ribosomes are helpful in protein synthesis in the cytoplasm.

ACTIVITY 2.9

Observation of Nucleus in the Animal Cells

Take a glass slide and put a drop of water on it. This is done to put the material under microscopic observation. Using a toothpick or an ice-cream spoon you can scrape the inside surface of your cheek. With the help of a needle you can transfer this material and spread it evenly on the cleaned glass slide. To colour this material, you can put a drop of **methylene blue** solution/stain on it. Finally put a coverslip over this stained material and observe this temporary mount/slide under the high power of a microscope. You will observe a spherical or oval dot-like structure, called **nucleus** near the centre of each cheek cell ([Fig. 2.29](#)). In the chapter of Tissues, you will learn that these cells are of squamous epithelium. You can draw diagrams of these cells on your observation sheet and label them. Similar structure (*i.e.*, nucleus) has been observed in the onion peel cells.

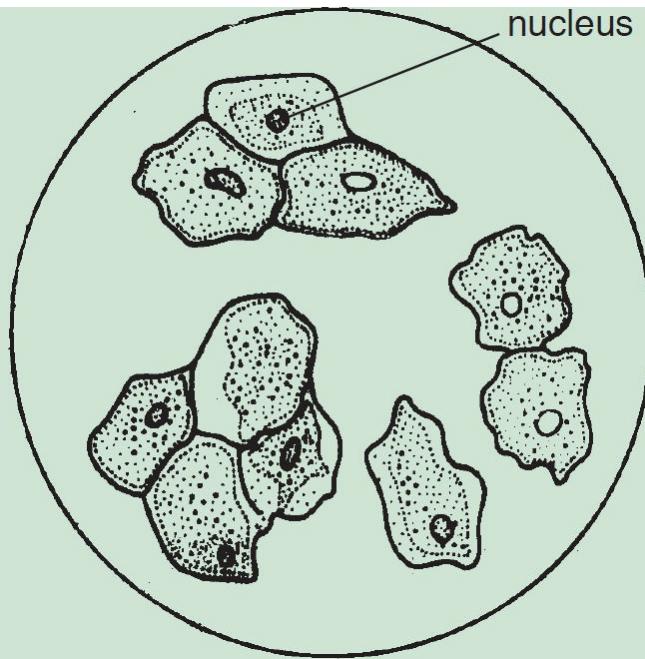


Figure 2.29. Microscopic view of cheek cells.

The **chromatin material** is a thin, thread-like intertwined mass of chromosome material and composed of the genetic substance **DNA** (deoxyribonucleic acid) and proteins (*i.e.*, histones). Basically chromatin is formed of repeating subunits, the **nucleosomes**, each of which has a DNA molecule coiled around a disc of histones. DNA stores all the information necessary for the cell to function (*i.e.*, metabolism), to grow and to reproduce further cells of the next generation. Distinct segments of DNA are called **genes**. The chromatin is condensed into two or more thick ribbon-like **chromosomes** during the division of cell.

Table 2.11. Differences between nucleus and nucleolus.

<i>Nucleus</i>	<i>Nucleolus</i>
1. It represents the whole eukaryotic complex that contains genetic information.	1. It is a component of nucleus.
2. It is covered by a two membrane	2. It does not have a covering

envelope.

3. It controls the structure and working of cells.

membrane.

3. It synthesizes ribosomal subunits.

Structure of Chromosomes

Chromosomes are thread-like structures usually present in the nucleus that become visible only during cell divisions (mitosis and meiosis). Chromosomes contain hereditary information of the cell in the form of genes (hereditary units; see [Box 2.3](#)). Each chromosome is made up of *two components* :

1. DNA (deoxyribonucleic acid), and
2. Proteins (*e.g.*, histones and acidic proteins).



A chromosome during cell division

DNA is the most important component of chromosome. It is the material of genes (*i.e.*, genetic material).

Most chromosomes consist of two **arms** that extend out from a specialised region of DNA, called the **centromere** (meaning "middle body"). Centromere or **primary constriction** gives a particular shape to chromosomes due to its position. The chromosome extremities or terminal regions on either side are called **telomeres**.

Chromatids. Before a cell divides, it duplicates its chromosomes (*i.e.*, each DNA molecule of each chromosome makes a copy of itself and becomes associated with proteins). The two copies of chromosomes remain attached at their centromeres. As long as two copies of a chromosome are attached to the common centromere, they are called **sister chromatids**. Both chromatids of a chromosome are identical, with identical genes. During cell division, the two sister chromatids separate and each chromatid becomes an independent daughter chromosome ([Fig. 2.30](#)).

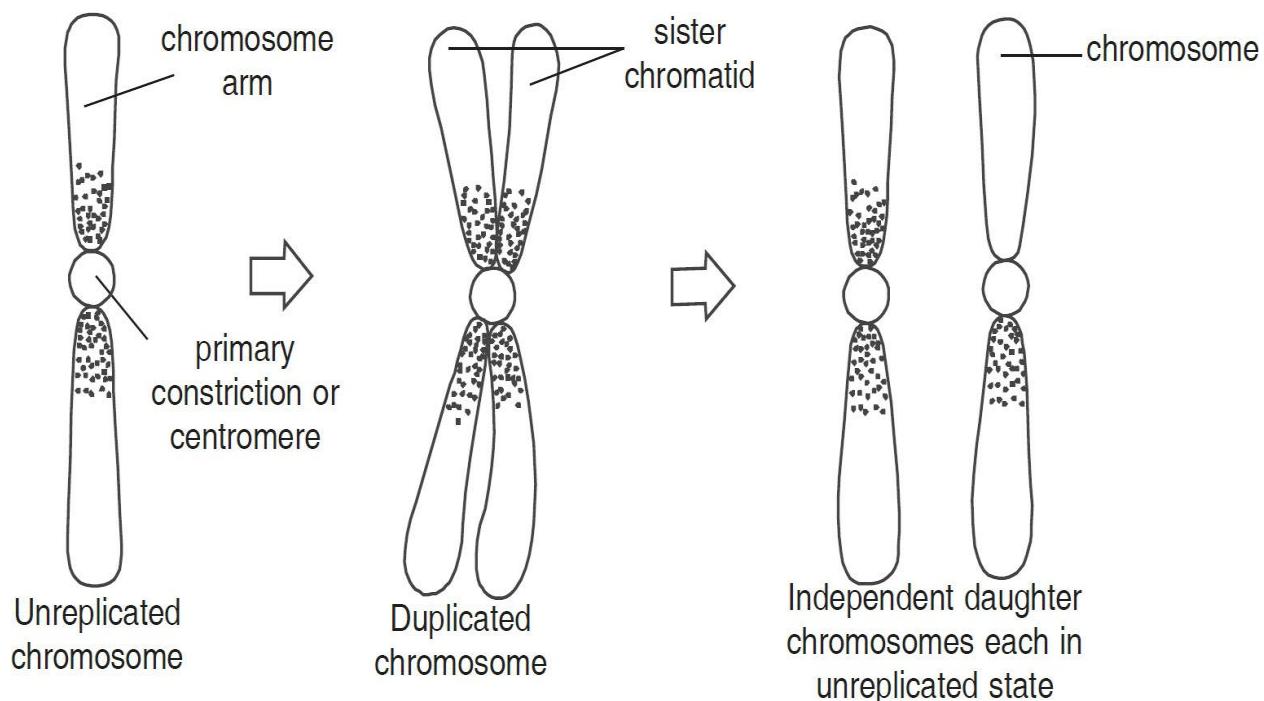


Figure 2.30. Sister chromatids and daughter chromosomes.

Diploid and Haploid Number of Chromosomes

Every eukaryotic species has a fixed number of chromosomes in its cells. The number of chromosomes varies from minimum two (in roundworm, *Ascaris megalcephala*) to a few hundred in different species. In human beings there are 46 chromosomes (44 autosomes + 2 sex chromosomes) in each body (or somatic) cell.

There is always a pair of chromosomes of each kind ([Box 2.7](#)). The paired condition of chromosomes is known as **diploid** and a cell which has the full number of chromosomes (*i.e.*, two of each kind) is called **diploid cell**. Body cells in human beings are diploid.

A set comprising of unpaired chromosomes of each kind is said to be **haploid** and a cell which has half the number of chromosomes (*i.e.*, one of each kind) is called a **haploid cell**. The gametes in human beings are haploid.

Box 2.7

Significance of Diploidy

Diploid state of organisms is originated during process of fertilization of sexual reproduction. During fertilization, two haploid cells or gametes of different types : sperm of man and ovum of woman are fused together to produce a diploid egg (zygote). This egg divides by mitotic cell divisions to form numerous diploid body cells, making the body of the diploid organism.

Thus, 46 chromosomes (*i.e.*, two of each kind or 23 pairs) in each body cells in human beings represent diploid number and 23 chromosomes (*i.e.*, one of each kind) in the sex cells or gametes (sperm and ovum) in human beings represent haploid number.

Box 2.8

Cells which lack the nucleus

1. Red blood cells of humans and other mammals lose their nuclei and this enables them to carry more haemoglobin

- and hence pick up more oxygen.
2. Phloem sieve tubes provide the transport system for sucrose in plants. They lose most of the cell organelles including their nuclei. This makes it easier for materials to flow through it.

Functions :

1. The nucleus controls all metabolic activities of the cell. If the nucleus is removed from a cell, the protoplasm ultimately dries up and dies.
2. It regulates the cell cycle.
3. It is concerned with the transmission of hereditary traits from the parent to offspring.

4. CYTOPLASM

Nature and occurrence. The part of the cell which occurs between the plasma membrane and nuclear envelope is called the **cytoplasm**. The inner granular mass of the cytoplasm is often called **endoplasm**, while the outer, clearer (glassy) layer is called **cell cortex or ectoplasm**.

Cytoplasm consists of an aqueous ground substance, the **cytosol**, containing a variety of cell organelles and other inclusions such as insoluble waste and storage products (starch, glycogen, lipid, etc.).

(a) Cytosol

It is the soluble part of cytoplasm. It forms the ground substance or “background material” of the cytoplasm and is located between the cell organelles. Cytosol contains a system of protein fibres called **cytoskeleton** ([Box 2.9](#)), but otherwise appears transparent and structureless in the electron microscope. Cytosol is about 90 per cent water and forms a solution which contains all

biochemicals of life. Some of these are ions and small molecules forming **true solutions** such as salts, sugars, amino acids, nucleotides, vitamins and dissolved gases ([Table 2.12](#)). Others are large molecules such as proteins which form **colloidal solution**. A colloidal solution may be a **sol** (non-viscous) or a **gel** (viscous); often ectoplasm is more gel-like.

Box 2.9

Cytoskeleton

Recently complex networks of fibrous protein structures have been shown to exist in the cytosol of eukaryotic cells. These networks collectively form **cytoskeleton** which contains three types of protein fibres :

1. Microtubules (of tubulin protein),
2. Microfilaments (of actin protein),
3. Intermediate filaments (of keratin and other types of proteins).

These fibrous proteins help in cellular **movement** i.e., amoeboid movement and cyclosis). They also help the cells to maintain their shapes.

Table 2.12. Chemical constituents of the cytoplasm or cytosol.

<i>Chemical</i>	<i>Percentage</i>
1. Oxygen	64.00
2. Carbon	18.00
3. Hydrogen	10.00
4. Nitrogen	0.3.00
5. Trace elements (Ca, P, Cl, S, K, Na, Mg, I, Fe)	0.5.00

Functions :

1. Cytosol (cytoplasm) acts as a store of vital chemicals such as amino acids, glucose, vitamins, ions, etc.
2. It is the site of certain metabolic pathways, such as glycolysis. Synthesis of fatty acids, nucleotides, and some amino acids also take place in the cytosol.
3. Living cytoplasm is always in a state of movement.



(b) Cell Organelles

A cell has to perform different functions with the help of its various membrane-bound organelles ([Table 2.6](#)):

1. It has to **synthesize** substances, *e.g.*, protein synthesis by ribosomes, lipid synthesis on the surface of smooth endoplasmic reticulum (SER), photosynthesis of food (*e.g.*, glucose, starch) by chloroplasts.
2. It has to **secrete** cell products, *e.g.*, enzymes, hormones, mucus, etc.
3. It has to **digest** those substances which are taken up by the cell during endocytosis. Such intracellular digestion is done by enzymes of lysosomes.
4. It has to **generate energy**, *e.g.*, synthesis of energy-rich ATP (adenosine triphosphate) by mitochondria.

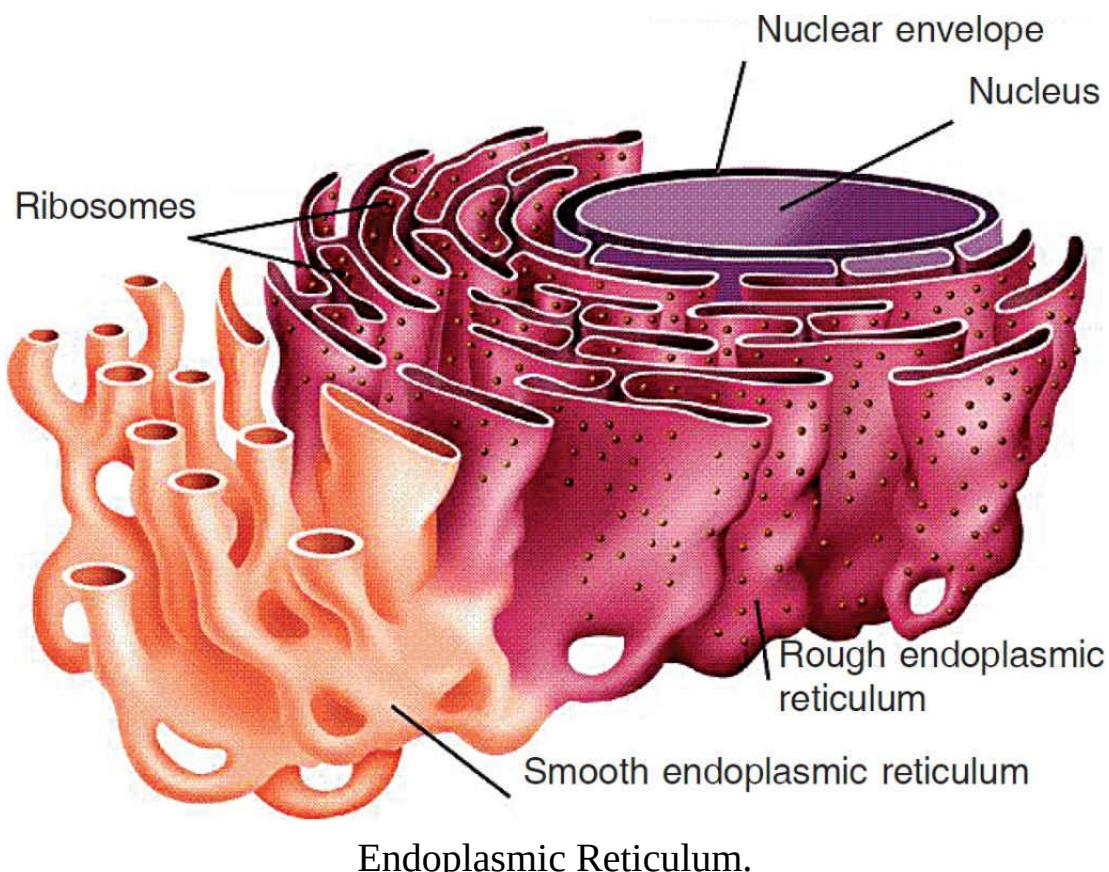
Membrane is a remarkable cellular structure. Every cell is bounded by a membrane and thus, keeps its own contents separate

from the external environment. Larger or more evolved cells, or cells from multicellular organisms, have a great deal of metabolic activities to support their complicated structure or function. To keep metabolic activities of different types separate from each other, cells have membrane bound organelles within themselves. Cell organelles are “small organs” of the cell and are found embedded in the cytosol. They form living part of the cell and each of them has a definite shape, structure, and function. Examples of such organelles are nucleus, mitochondria, chloroplasts, endoplasmic reticulum, Golgi apparatus, lysosomes, ribosomes, etc. We have already discussed about the nucleus in a previous section. In this section, we will discuss the cellular organelles one by one.

1. Endoplasmic Reticulum (ER)

Nature and occurrence. Inside the cell there exists a membranous network enclosing a fluid-filled lumen which almost fills up the intracellular cavity. It is called **endoplasmic reticulum (ER)**. At one end ER is connected to the outer membrane of the nucleus and at the other end to the plasma membrane. ER occurs in *three* forms : **cisternae** (*i.e.*, closed, fluid-filled sacs), **vesicles** and **tubules** ([Fig. 2.31](#)). It is of two types : 1. **Rough endoplasmic reticulum (RER)** with ribosomes attached on its surface for synthesizing proteins. 2. **Smooth endoplasmic reticulum (SER)** which is without ribosomes and is meant for secreting lipids.

Three-Dimensional Endoplasmic Reticulum



 studygear

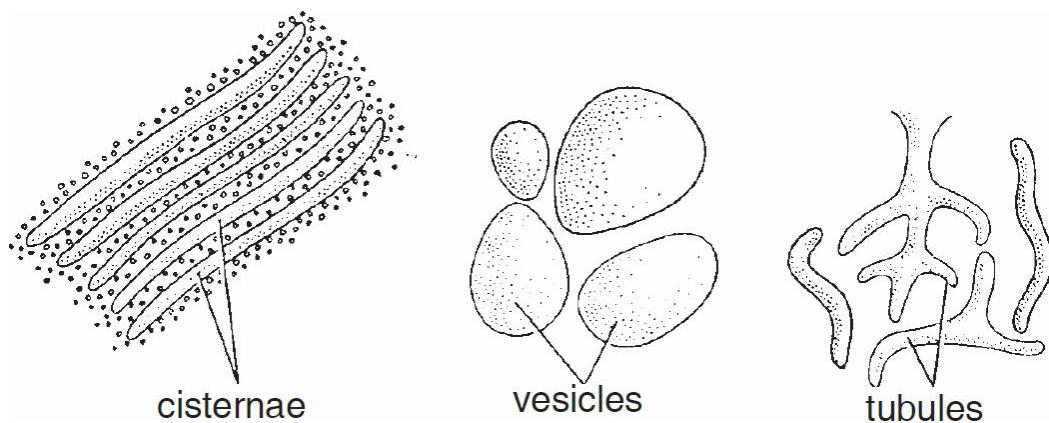


Figure 2.31. Various parts of ER.

The ER is absent in the red blood cells of mammals.

Functions :

1. It forms supporting skeletal framework of the cell.
2. ER provides a pathway for the distribution of nuclear material from one cell to the other.
3. Certain enzymes present in smooth ER synthesize fats (lipids), steroids and cholesterol.
4. Rough ER is concerned with the transport of proteins which are synthesized by ribosomes on their surface.

Some special functions of endoplasmic reticulum.

Endoplasmic reticulum performs the following important functions :

1. Smooth ER of liver of vertebrates helps in **detoxification**. It metabolises various toxic or poisonous substances such as drugs, aspirin, insecticides (DDT), petroleum products and pollutants. These toxic substances make their entry in animal's body through food, air or water.
2. Smooth ER plays an important role in the biosynthesis of **glycolipids**, **phospholipids** and **cholesterol**. These lipids are used in the formation of plasma or cell membrane and various steroid hormones.
3. Hormones are either steroids or proteins. Smooth ER synthesizes steroid hormones such as estrogen, testosterone and cortisol.
4. Enzymes are proteins. Digestive (hydrolytic) **enzymes of lysosomes** are produced by rough ER. Any enzyme which is meant for the lysosomes is synthesized on the ribosomes attached to the surface of rough ER. It then enters in the lumen of rough ER. From the rough ER this enzymatic

protein is transported to Golgi apparatus where it is marked to be included into lysosome.

5. Plasma membrane and other cellular membranes are also formed by endoplasmic reticulum. The **lipid molecules** for cell membrane are formed and inserted into the smooth ER membrane by smooth ER itself. The **protein molecules** of cell membrane are mostly synthesized and inserted into membrane at the level of rough ER. In the process of **glycosylation**, short chains of sugars, called **oligosaccharides**, are added to molecules of proteins and lipids at the level of Golgi apparatus. For example, the formation of plasma membrane, called **membrane biogenesis**, involves the following organelles, all forming the so-called **endomembrane system** :

Rough ER → Smooth ER → Golgi apparatus → Secretory vesicle → Plasma membrane.

6. Proteins which are synthesized by the cell and then are released into outer medium of the cell, are called **secretory proteins**. Examples of secretory proteins include mucus, digestive enzymes and hormones (e.g., insulin). These proteins are synthesized by rough ER.

Table 2.13. Differences in rough endoplasmic reticulum (RER) and smooth endoplasmic reticulum (SER).

<i>Rough Endoplasmic Reticulum</i>	<i>Smooth Endoplasmic Reticulum</i>
1. It contains flattened sacs called cisternae.	1. It is mainly formed of vesicles and tubules.
2. Ribosomes are attached to the outer surface of its membrane.	2. It does not contain ribosomes.
3. It is specialized to synthesize proteins.	3. It is specialized to synthesize lipids and steroids.
4. It is abundant in exocrine	4. It is abundant in liver and the

pancreatic cells and antibodies secreting plasma cells.

testicular cells (e.g., Leydig cells) synthesizing steroid hormones.

2. Ribosomes

Nature and occurrence. Ribosomes are dense, spherical and granular particles which occur freely in the matrix (cytosol) or remain attached to the endoplasmic reticulum (RER). Chemically, the major constituents of ribosomes are the ribonucleic acid (RNA) and proteins. Lipids are not present in ribosomes. Ribosomes are not bounded by a membrane. They are present both in prokaryotic and eukaryotic cells (except mammalian RBC).

Function. Ribosomes play an important part in the synthesis of proteins ([Fig. 2.32](#)).

3. Golgi Apparatus (Golgi Body or Golgi Complex)

Nature and occurrence. Golgi apparatus consists of a set of membrane-bounded, fluid-filled vesicles, vacuoles and flattened cisternae (closed sacs). Cisternae are usually stacked together (placed one above the other) in parallel rows([Fig. 2.33](#)). Golgi apparatus exists as an extensive network near the nucleus in the animal cells. However, the plant cells contain many freely distributed subunits of Golgi apparatus, called **dictyosomes**. Cisternae are formed at one end of the stack, called *cis* face of Golgi. They are budded off as vesicles at the other face of Golgi apparatus, called *trans* face of Golgi.

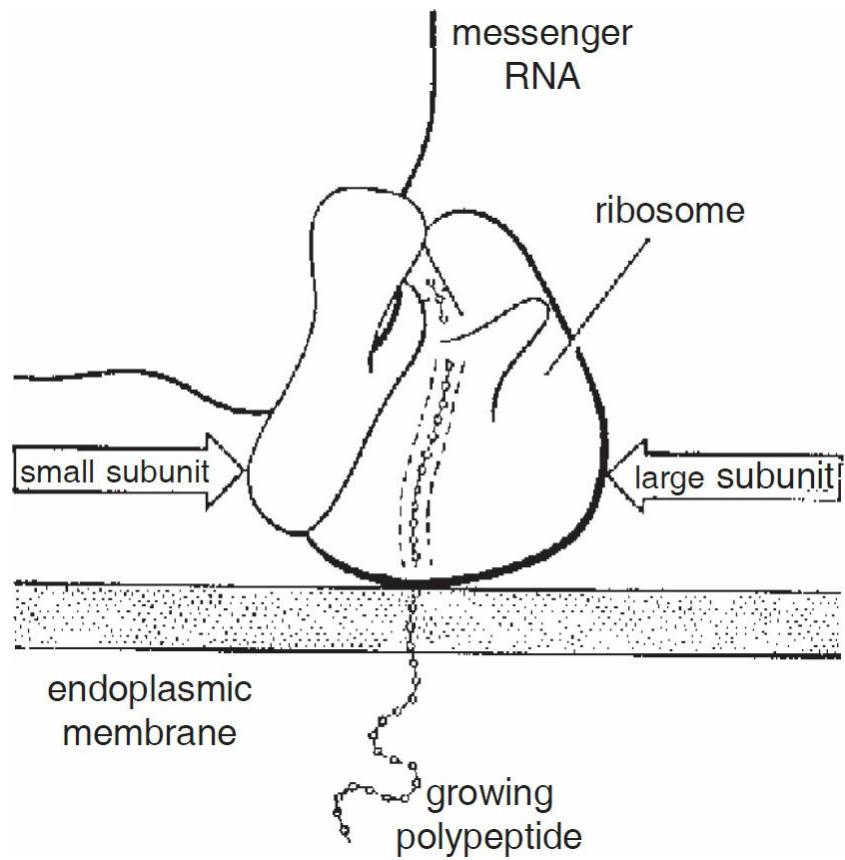


Figure 2.32. Protein synthesis on the Ribosome of RER.

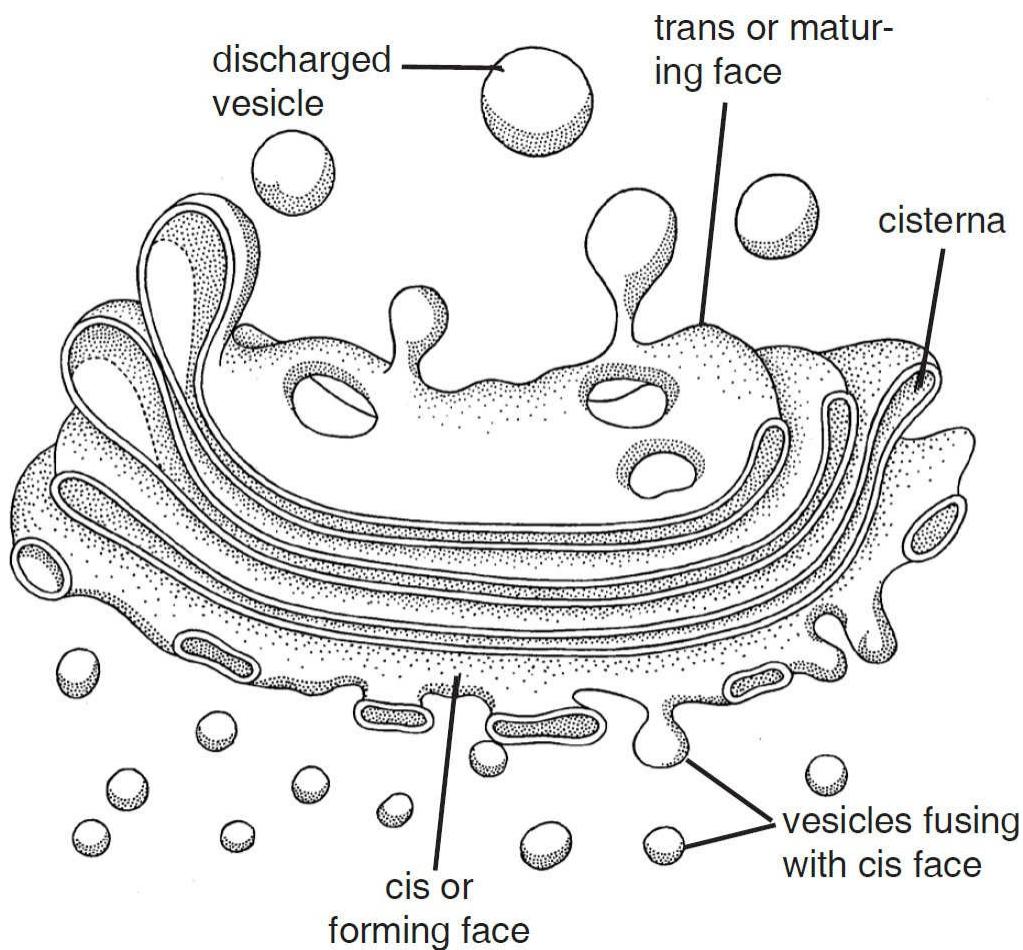


Figure 2.33. Golgi apparatus.

Golgi apparatus is absent in bacteria, blue-green algae, mature sperms and red blood cells of mammals and other animals.

The Golgi apparatus arises from the membrane of the smooth endoplasmic reticulum, which in turn originates from the rough endoplasmic reticulum. The proximal Golgi saccules (cisternae at cis face) are formed by fusion of ER-derived vesicles, while distal saccules (cisternae at trans face) “give their all” to vesicle formation and disappear. Thus, Golgi saccules are constantly and rapidly **renewed**.

Functions :

1. The main function of the Golgi apparatus is **secretory**. Golgi apparatus acts as a way-station or assembly area for the

storage, processing and packaging of various cellular secretions. It **packages** materials synthesized in the cell and **dispatches** them either to intracellular targets such as plasma membrane and lysosomes or extracellular targets (*e.g.*, zymogens).

2. It produces **vacuoles** or **secretory vesicles** which contain cellular secretions, *e.g.*, enzymes, proteins, cellulose, melanin pigment, lactoprotein of milk, etc.
3. Golgi apparatus is also involved in the synthesis of cell wall, plasma membrane and lysosomes.

4. Lysosomes

Nature and occurrence. Lysosomes are simple tiny spherical sac-like structures evenly distributed in the cytoplasm. Each lysosome is a small vesicle surrounded by a single membrane and contains powerful enzymes. These enzymes are capable of digesting or breaking down all organic materials. Lysosomal enzymes are made by RER.

Functions :

1. Lysosomes serve as intracellular digestive system, hence, called **digestive bags**. They destroy any foreign material which enter the cell such as bacteria and virus. In this way they protect the cells from bacterial infection.
2. Lysosomes also remove the worn out and poorly working cellular organelles by digesting them to make way for their new replacements. In this way, they remove the cell debris and are also known as **demolition squads**, **scavengers** and **cellular housekeepers**. Thus, lysosomes form a kind of **garbage disposal system** of the cell.
3. During breakdown of cell structure, when the cell gets

damaged, lysosomes may burst and the enzymes eat up their own cells. Therefore, lysosomes are also known as **suicide bags** of a cell ([Box 2.10](#)).

Box 2.10

Significance of Lysosomes

- 1. In WBC or leucocytes.** Cells of leucocytes digest foreign proteins, bacteria and viruses.
- 2. In autophagy.** During starvation, the lysosomes digest stored food contents such as proteins, fats and glycogen of the cytoplasm and supply the necessary amount of energy to the cell.
- 3. In metamorphosis (Frog).** During the transformation of a tadpole into frog, the embryonic tissues such as gills and tail are digested by the lysosomes and utilized by other body cells.
- 4. In fertilization.** The lysosomal enzymes present in the **acrosome** of sperm cells digest the limiting membrane of the ovum (egg). Thus, the sperm is able to enter the ovum and start the fertilization.



5. Mitochondria

Nature and occurrence. The mitochondria (singular : mitochondrion) are tiny bodies of varying shapes (cylindrical, rod-shaped, spherical) and size (0.2 mm to 2 mm), distributed in the cytoplasm. Each mitochondrion is bounded by a double membrane envelope. Outer membrane is porous. The inner membrane is thrown into folds and, therefore, have an area several times the surface of area of the outer membrane ([Fig. 2.34](#)). These folds are called **cristae** and are studded (dotted) with small rounded bodies known as **F₁ particles** or **oxysomes**. The interior cavity of the mitochondria is filled with a proteinaceous (gel-like) **matrix** which contains a few small-sized ribosomes, a circular DNA molecule and phosphate granules. Mitochondria are absent in bacteria and the red blood cells of mammals.

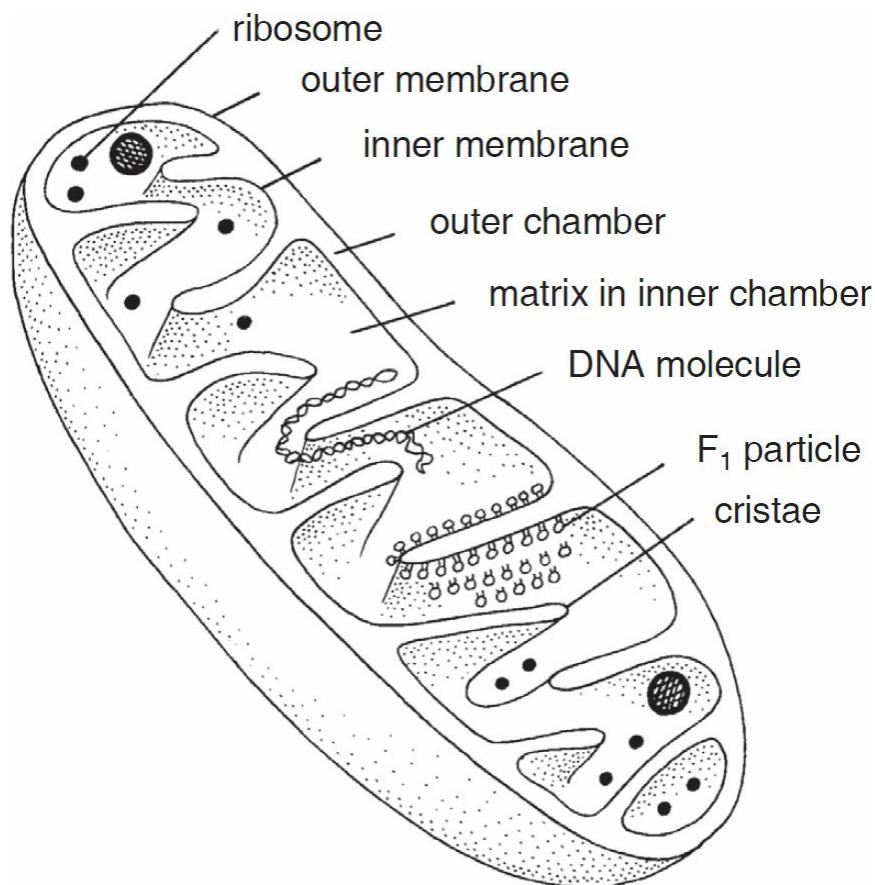


Figure 2.34. A longitudinally cut mitochondrion showing its internal

structure.

Functions :

Mitochondria are sites of cellular respiration. They use molecular oxygen from air to oxidise the carbohydrates and fats (lipids) present in the cell to carbon dioxide and water vapour. Oxidation releases energy, a portion of which is used to form ATP (adenosine triphosphate). Since the mitochondria synthesize, energy-rich compounds (ATP), they are known as '**power house**' of the cell. The energy stored in ATP is used by the cell.

ATP stands for the organic compound adenosine triphosphate. ATP is generally known as **energy carrier** or **energy currency** of the cell. It is a common cellular fuel, *i.e.*, it is used to drive numerous energy-requiring processes of the cell. The body of an organism uses the energy stored in ATP for 1. **synthesis of chemical compounds** (*e.g.*, DNA replication, transcription of RNAs, and synthesis of proteins, carbohydrates and lipids) and 2. **mechanical work**, such as contraction of muscles (for movement, locomotion, peristalsis), movement of cilia and flagella, conduction of nerve impulse and production of heat, electricity (*e.g.*, electric eel), and light (*e.g.*, fire flies).

Mitochondria are able to make some of their own proteins; so, they are regarded as **semiautonomous organelles**.



6. Plastids

Nature and occurrence. Plastids occur in most plant cells and are absent in animal cells. Like the mitochondria, the plastids also have their own genome (*i.e.*, DNA) and ribosomes. They are self-replicating organelles like the mitochondria, *i.e.*, they have the power to divide. Plastids are of following three types :

1. **Chromoplasts.** Coloured plastids (except green colour).
2. **Chloroplasts.** Green-coloured plastids.
3. **Leucoplasts.** The colourless plastids.

Table 2.14. Differences between leucoplasts and chromoplasts (nongreen plastids).

<i>Leucoplasts</i>	<i>Chromoplasts</i>
1. They are colourless.	1. They range from brownish to reddish in colour.
2. They are cylindrical or rounded in shape.	2. They are irregular in shape.
3. They are found in unexposed cells.	3. They are found in both exposed and unexposed cells.
4. They can change to other types of plastids.	4. They do not change into other types of plastids.
5. They take part in storage of food, <i>e.g.</i> , amyloplasts (carbohydrates), elaioplasts (lipids), aleuroplasts (proteins).	5. They provide colour to organs to attract pollinators and disseminators.

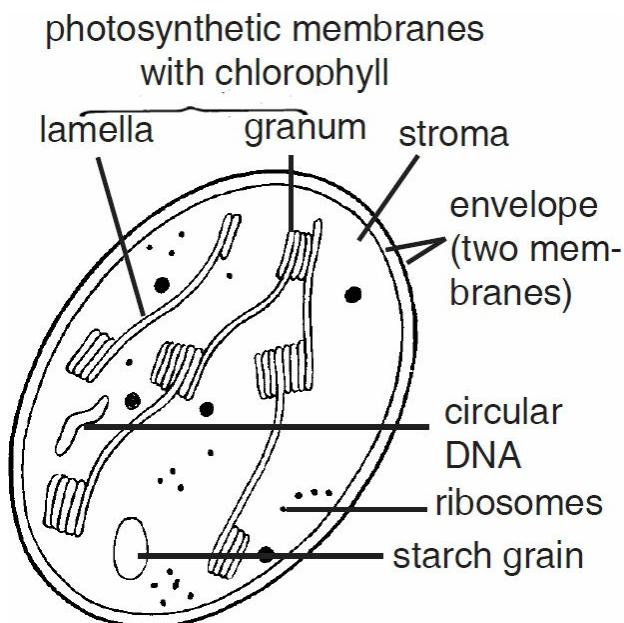
Table 2.15. Differences between chloroplasts and chromoplasts.

<i>Chloroplasts</i>	<i>Chromoplasts</i>
1. They are green plastids.	1. They are non-green coloured plastids.
2. They contain chlorophylls and carotenoids.	2. Chlorophylls are absent. Only carotenoids are present.

3. Lamellae are present.	3. Lamellae are absent.
4. Chloroplasts are sites of photosynthesis.	4. They add colour to the organs (e.g., flowers, fruits) for attracting animals to perform pollination and fruit dispersal.

7. Chloroplasts

Nature and occurrence. Chloroplasts are present in green algae and higher plants. They have a green pigment called **chlorophyll** and they are involved in the photosynthesis of food. So chloroplasts are the “**kitchens of the cells**”. Each chloroplast ([Fig. 2.35](#)) is bounded by two unit membranes like the mitochondria. It shows two distinct regions : **1. Grana** are stacks of membrane-bounded, flattened discoid sacs (called **thylakoids**) containing the molecules of chlorophyll. They are the main functional units of chloroplasts. **2. Stroma** is the homogeneous matrix in which grana are embedded. Stroma contains a variety of photosynthetic enzymes, starch grains, DNA and ribosomes.



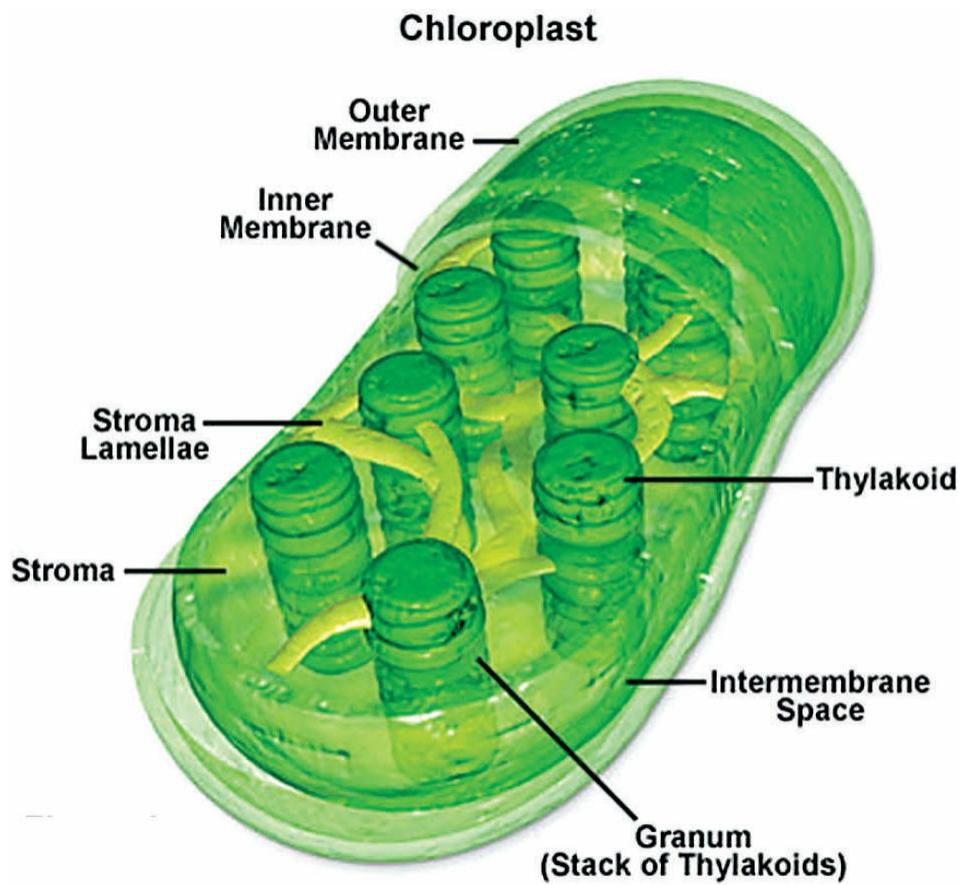


Figure 2.35. Internal structure of chloroplast.

Grana is the site of **light reaction** during photosynthesis, while stroma is the site of **dark reaction** during photosynthesis.

Functions :

Plastids perform the following functions :

1. Chloroplasts trap solar energy and utilises it to manufacture food for the plant.
2. Chromoplasts impart various colours to flowers to attract insects for pollination.
3. Leucoplasts store food in the form of carbohydrates (starch), fats and protein.

Table 2.16. Differences between mitochondria and chloroplasts.

Mitochondria	Chloroplasts
--------------	--------------

1. They occur in the cells of aerobic organisms (plants and animals) with the exception of mammalian RBCs.	1. They occur in the cells of green photosynthetic parts (e.g., leaves) of plants.
2. They are colourless.	2. They are green in colour.
3. The shape is rod-like or sausage-shaped.	3. They are generally disc-like in outline.
4. Inner membrane of each mitochondrion is thrown into folds called cristae.	4. Their inner membrane forms flattened sacs called thylakoids or lamellae.
5. They liberate energy.	5. They trap solar energy and convert it into chemical energy.
6. They perform oxidation of food.	6. They synthesize food by photosynthesis.
7. They consume O ₂ and liberate CO ₂ .	7. They consume CO ₂ and liberate O ₂ .

8. Vacuoles

Nature and occurrence. Vacuoles are fluid-filled or solid-filled and membrane-bounded spaces. They are a kind of storage sacs. In animal cells, the vacuoles if present are small and temporary. They store water, glycogen and proteins. The vacuolar membrane is typically a single unit membrane and is often associated with the maintenance of water balance (e.g., they serve as osmoregulatory organelles in protozoans) or ingestion of nutrient material (food vacuole). Thus, food vacuole of a single celled organisms such as *Amoeba* or *Paramecium*, contains the food item that the animal has consumed.

In plant cells, the vacuoles are large, distinct and permanent. In mature plant cells the vacuole occupies almost the entire (i.e., 90%) volume of the cell. Because of the central position of a vacuole, the nucleus and other cell organelles in plant cells are pushed near the boundary wall. The vacuole is bounded by a membrane, called

tonoplast. The vacuole is filled with **cell sap** which is a watery solution rich in sugars, amino acids, proteins, minerals and metabolic wastes (such as anthocyanins, alkaloids).

Functions. Vacuoles help to maintain the osmotic pressure in a cell (osmoregulation). They store toxic metabolic by-products or end products of plant cells. They provide turgidity and rigidity to the plant cells.

9. PEROXISOMES

Nature and occurrence. Peroxisomes are small (0.3 to 1.5 mm in diameter) and spherical organelles containing powerful oxidative enzymes. They are bounded by a single membrane. Peroxisomes are mostly found in kidney and liver cells. Inner contents of peroxisomes are finely granular, but sometimes a **crystalline core** is visible by electron microscope in the centre of peroxisomes. This crystalline core is a crystallized protein, called **catalase enzyme**.

Functions :

Peroxisomes are specialized for carrying out some oxidative reactions, such as **detoxification** or removal of toxic substances from the cell ([Box 2.11](#)).

Box 2.11

Catalase enzyme of peroxisomes, catalyses the decomposition of **hydrogen peroxide** (H_2O_2) to water and oxygen (hence the name, ‘peroxisome’). Hydrogen peroxide is a byproduct of certain cell oxidations and is also very **toxic**, so must be eliminated immediately.

10. CENTROSOME

Nature and occurrence. Centrosome is found only in the animal cells. It is not bounded by any membrane but consists of two granule-like **centrioles**. Centrioles are hollow and cylindrical structures which are made up of microtubules ([Fig. 2.36](#)). In plant cells, the **polar caps** perform the function of centrioles.

Functions :

1. Centrosome helps in cell division in animal cells. During cell division centrioles migrate to the poles of animal cells and are involved in the formation of the spindle.
2. In plant cells, cell division involves polar caps for the spindle formation.

Each cell, thus, acquires its distinct structure and function due to the organisation of its membrane and organelles in a specific way. As a result each type of cell has a basic structural organisation. Such an organisation helps different cells to perform some basic functions such as respiration, obtaining nutrition, clearing of waste material, forming new proteins, etc. A cell is the fundamental **structural unit** of living organisms. It is also the basic **functional unit** of life. This conclusion forms the main point of the cell theory.

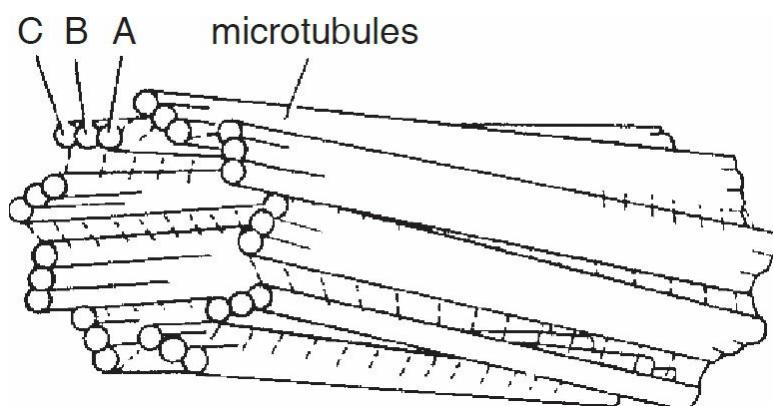


Figure 2.36. Centriole.



2.3. DIFFERENCES BETWEEN PLANT AND ANIMAL CELLS

The cells of animals and plants have the following differences :

Table 2.17. Differences between animal and plant cells.

<i>Animal cell</i>	<i>Plant cell</i>
1. Animal cells are generally small in size.	1. Plant cells are larger than animal cells.
2. Cell wall is absent.	2. The plasma membrane of plant cells is surrounded by a rigid cell wall of cellulose.
3. Except the protozoan <i>Euglena</i> , no animal cell possesses plastids.	3. Plastids are present.
4. Vacuoles in animal cells are many, small and temporary.	4. Most mature plant cells have a permanent and large central sap vacuole.
5. Animal cells have a single highly complex and prominent Golgi apparatus.	5. Plant cells have many simpler units of Golgi apparatus, called dictyosomes.
6. Animal cells have centrosome and centrioles.	6. Plant cells lack centrosome and centrioles.

GIVE IMPORTANT FACTS ABOUT CELLS

- Smallest Cellular Organelle – Ribosome.
- Largest cellular organelle in plants – Plastid.
- Largest cellular organelle in animals – Mitochondria.
- Largest cell structure – Nucleus.
- The thin protoplasmic projections connecting two adjacent plant cells – Plasmodesmata.
- The connecting layer between two adjacent plant cells – Middle lamella.
- The membrane of vacuole in plant cell is called tonoplast.
- Mitochondria and plastids can replicate themselves (they both have DNA and ribosomes).
- Viruses are neither prokaryotic nor eukaryotic.
- Viruses are molecular organisms.
- In eukaryotic cell, the cell organelles have membranous coverings. Mitochondria, chloroplasts and other plastids and nucleus have two membranes around them whereas Golgi apparatus, endoplasmic single reticulum, vacuoles and lysosomes have single membrane. There are also naked (without membrane) cell organelles such as ribosomes, nucleolus and centriole.
- In prokaryotic cells, DNA is not enclosed in a nuclear membrane. So it is called nucleoid.
- In prokaryotic cells, ribosomes are present but are of smaller size (*i.e.*, 70 S in contrast to 80 S ribosomes of eukaryotes).

SUMMARY

- Cell is the smallest unit of structure and function of all organisms (except viruses).
- A typical cell is bounded by plasma membrane, has cytoplasm and genetic material (DNA) and RNA.
- Cells of bacteria and blue green algae (cyanobacteria) do not contain a distinct nucleus. They are called prokaryotic cells. Such cells have only one membrane and that is the plasma membrane.
- Plant cells and animal cells have eukaryotic cells. Each of these cells has a true nucleus (a nucleus which is bounded by nuclear

membranes). These cells also have various membrane bound organelles such as ER, Golgi apparatus, mitochondria, plastids, etc.

- Activities performed by an organism are the sum total of the actions performed by its constituent cells.
- Unicellular organisms (*e.g.*, *Amoeba*) have only one cell in their bodies.
- Multicellular organisms (*e.g.*, human beings) have many co-ordinated compartments in their bodies, the cells.
- Plasma membrane is a living selectively permeable membrane. Chemically it comprises phospholipids, cholesterol, proteins and carbohydrates molecules. These molecules are organised in such a way that plasma membrane is said to have a fluid-mosaic structure.
- Functions of plasma membrane include diffusion, osmosis, mediated transport (*i.e.*, facilitated diffusion/transport and active transport) and endocytosis (*i.e.*, phagocytosis, potocytosis and receptor-mediated endocytosis). *Amoeba* takes food by phagocytosis.
- Each plant cell is covered by a cell wall which is a non-living, rigid, freely permeable, layer of cellulose microfibrils. When a plant cell is put in a hypertonic solution (having less water), it loses water due to osmosis (exosmosis) and as a result its protoplast (*i.e.*, plasma membrane, cytoplasm and nucleus) is shrunk away from the cell wall. This phenomenon is called plasmolysis.
- The colloidal ground substance of cytoplasm is called cytosol.
- Cellular organelles without any membrane are ribosomes, centrioles and nucleolus. Ribosomes also occur in the prokaryotic cells.
- Various membrane-bound cell organelles present in a eukaryotic cell are nucleus, endoplasmic reticulum, Golgi apparatus, mitochondria, plastids, lysosomes, peroxisomes, etc.
- Nucleus, mitochondria and plastids are covered by two membranes.
- Mitochondria form the power house of the cell. They use molecular oxygen and generate energy-rich compound, the ATP. ATP is used as energy currency for various cellular activities such as biosynthesis of DNA, RNA, proteins, carbohydrates and lipids and mechanical work such as muscle contraction, ciliary/flagellar movement, endocytosis, etc.
- Chloroplasts are chlorophyll-containing green plastids. They use

water and carbon dioxide and convert radiant energy of sunlight into chemical energy of carbohydrates. This process is called photosynthesis.

- Both mitochondria and chloroplasts are semiautonomous organelles, since both of them have their own genome (DNA) and ribosomes to synthesize some of their own proteins.
- Ribosomes are sites of protein synthesis.
- Endoplasmic reticulum (ER) may be of smooth (SER) or rough (RER) type. SER synthesizes lipids and RER synthesizes proteins.
- Golgi apparatus is an assembly area for the storage, processing and packaging of various cellular secretions (*e.g.*, cellulose, glycoproteins, glycolipids, etc.). It is also a site of origin of lysosomes.
- Lysosomes form garbage disposal system of animal cells. With the help of their various digestive enzymes, lysosomes are capable of digesting most types of organic molecules (which are present in ingested viruses, bacteria and damaged cellular organelles).
- Nucleus controls all metabolic activities of the cell. A cell without a nucleus dies in short time, *e.g.*, human erythrocytes.
- Nucleus of a non-dividing cell contains chromatin, which is an uncoiled thread-like material of chromosome. Chromatin contains a DNA molecule and almost equal amount of basic histone proteins. Chromosomes occur during cell division and they are formed due to coiling and folding of chromatin having bead-like units called nucleosomes.
- Genes are hereditary units and they represent various segments of DNA. They carry parental hereditary information to next generation.

FORMATIVE ASSESSMENT

A. CLASS ASSIGNMENT

I. True or False Questions

1. Viruses are non-cellular living organisms.
2. *Amoeba* is a multicellular organism.
3. Plant cells are bounded by a wall composed of cellulose.
4. Cellulose is a protein.
5. Plasma membrane is present in all cells.
6. Blue green algae have prokaryotic cells.
7. All kinds of plastids have pigments.
8. Nucleolus has a limiting membrane.
9. Outer and inner membranes of chloroplasts have chlorophyll pigment.
10. Ribosomes are made up of deoxyribonucleic acid and proteins.
11. The oxidation of food in a cell takes place in mitochondria.
12. Plastids are called the kitchen of a plant cell.
13. Cell wall of plant cell is a living structure.
14. Cork comes from bark.
15. Robert Brown discovered protoplasm in 1831.
16. Cell forming body of *Amoeba* has an ever changing shape.
17. Movement of a substance from the area of low concentration to an area of high concentration is called diffusion.
18. A dilute solution is called hypertonic solution.
19. Lysosomes keep the cells clean by digesting foreign materials and worn out cell organelles.
20. Smooth endoplasmic reticulum detoxifies many poisons and drugs.
21. Central vacuole occupies 10-20% of plant cell volume.

ANSWERS

Alternate Response Type Questions

1. T
2. F
3. T
4. F
5. T
6. T

7. F
8. F
9. F
10. F
11. T
12. F
13. F
14. T
15. F
16. T
17. F
18. F
19. T
20. T
21. F

II. Fill in the Blanks

1. The are an exception to cell theory.
2. The nuclear region of prokaryotic cells is called
3. The term protoplasm was coined by
4. Ultrastructure of cell organelles can be studied by
5. An ostrich egg is the animal cell.
6. *Amoeba* can change their continuously.
7. Cell is the basic and unit of all living organisms.
8. Cellular organelles called are often referred to as suicidal bags.
9. Ribosomes are concerned with the synthesis of
10. Function of mitochondria is production.
11. Chromosomes are made up of nucleic acid and
12. Cell theory was first given by and
13. The additional protective layer in plants present outside the plasma membrane is called

14. Cell wall is found only in cells.
15. Mitochondrial cristae form a large surface area for generation reactions.
16. Plant cell wall is mainly composed of
17. Cell organelles perform function in all organisms.
18. Cell theory was refined by
19. Cells were discovered by Robert Hooke in

ANSWERS

Fill in the Blanks :

1. Viruses;
2. Nucleoid;
3. J.E. Purkinje;
4. Electron microscope;
5. Largest;
6. Shape;
7. Structural, functional;
8. Lysosomes;
9. Proteins;
10. Energy
11. Proteins;
12. Schleiden, Schwann;
13. Cell wall;
14. Plant.
15. ATP;
16. Cellulose;
17. Similar;
18. Virchow
19. 1665.

III. Match the Columns

1. Single Matching Questions

Match the contents of the column I and II.

Column I	Column II
1. Robert Hooke	(a) protoplasm
2. Robert Brown	(b) cell theory
3. Schleiden and Schwann	(c) the term 'cell'
4. Von Mohl	(d) diffusion
5. Cellulose	(e) nucleus
6. Glycogen	(f) inheritance
7. Mitochondria	(g) energy
8. Chromosomes	(h) glucose synthesis
9. Chloroplasts	(i) Golgi apparatus
10. Nucleus	(j) storage
11. Cell wall	(k) Cellulose
12. Central vacuole	(l) DNA plus histone
13. Chromatin	(m) double membrane
	(n) cell sap

ANSWERS

Match the Columns (Single Matching)

1. (c)
2. (e)
3. (b)
4. (a)
5. (i)
6. (j)
7. (g)
8. (f)
9. (h)
- 10 (m)
11. (k)

12. (n)
13. (l).

2. Double Matching Questions

Match the contents of Columns I, II and III.

<i>Column I</i>	<i>Column II</i>	<i>Column III</i>
(a) Multicellular organisms	(i) Lipids	I. Turgidity
(b) Mitochondrion	(ii) Plants	II. Inner folded membrane
(c) Plasma membrane	(iii) Cell sap	III. Proteins
(d) Central vacuole	(iv) Outer permeable membrane	IV. Animals
(e) Chloroplast	(v) Digestive enzymes	V. Phagosome
(f) Lysosomes	(vi) Carbon dioxide	VI. Thylakoid

ANSWERS

Match the columns (Double Matching)

- (a) - (ii) - IV;
 (b) - (iv) - II;
 (c) - (i) - III;
 (d) - (iii) - I;
 (e) - (vi) - VI;
 (f) - (v) - V

3. Key or Check List Items

Which type of metabolism, anabolism (A) and catabolism (C) are performed by the following organelles.

<i>Organelle</i>	<i>Metabolism</i>
1. Mitochondria
2. Lysosomes

3. Chloroplasts
4. Endoplasmic reticulum (ER)
5. Golgi apparatus

ANSWERS

1. (C);
2. (C);
3. (A);
4. (A);
5. (A).

IV. Question – Answer

1. Write down three basic characteristics of a cell.
2. What do you mean by unicellular and multicellular ?
3. What is division of labour? Explain it in context of multicellular organisms.
4. Why does viruses form a exception to cell theory?
5. Name the largest plant cell.
6. Define the following terms: cell, prokaryotic cell, eukaryotic cell, organelle.
7. Briefly describe the structure and functions of cell wall.
8. Describe the structure and functions of nucleus.
9. What are diploid and haploid number ?
10. Describe structure of a chromosome.
11. Describe structure and functions of plasma membrane.
12. What do you mean by passive and active transport ? Write a note on diffusion.
13. Describe the mechanism of osmosis. Give its importance.
14. Write a note on plasmolysis.
15. What is endoplasmic reticulum ? Give its types and functions.
16. Describe structure and functions of Golgi apparatus.

- 17.** What are lysosomes ? How are they formed ? Give their functions.
- 18.** Discuss the structure and functions of mitochondria.
- 19.** With the help of a labelled diagram describe the structure of a chloroplast.

V. Multiple Choice Questions (MCQs)

- 1.** The term ‘cell’ was given by
 - (a) Leeuwenhoek
 - (b) Robert Hooke
 - (c) Flemming
 - (d) Robert Brown
- 2.** Who proposed the cell theory ?
 - (a) Schleiden and Schwann
 - (b) Watson and Crick
 - (c) Darwin and Wallace
 - (d) Mendel and Morgan
- 3.** The longest cell in the human body is
 - (a) nerve cell
 - (b) muscle cell
 - (c) liver cell
 - (d) kidney cell
- 4.** The number of lenses in compound light microscope is
 - (a) 2
 - (b) 3
 - (c) 4
 - (d) 1
- 5.** The history of the cell began in 1665 with the publication of *Micrographia* in London by
 - (a) Robert Hooke
 - (b) Robert Brown
 - (c) Straburger
 - (d) Dujardin
- 6.** The idea ‘*omnis cellula e cellula*’ which means that all living cells arise from preexisting cells was given by

- (a) Robert Brown
 - (b) Purkinje
 - (c) Rudolf Virchow
 - (d) Schleiden
7. Which of the following has an irregular or variable shape ?
- (a) *Euglena*
 - (b) *Paramecium*
 - (c) *Amoeba*
 - (d) *Acetabularia*
8. Genetic material of a eukaryotic cell is contained in
- (a) nucleolus
 - (b) nucleus
 - (c) nucleoplasm
 - (d) nucleoid
9. Nucleolus is a seat of
- (a) protein synthesis
 - (b) ribosome synthesis
 - (c) enzyme synthesis
 - (d) mRNA synthesis
10. Middle lamella is formed of
- (a) calcium pectate
 - (b) cellulose
 - (c) hemicellulose
 - (d) lignin
11. Plasma membrane is
- (a) permeable
 - (b) selective permeable
 - (b) semipermeable
 - (d) impermeable
12. A cell placed in solution swells up. The solution is
- (a) hypertonic
 - (b) isotonic
 - (d) hypotonic
 - (d) both a and b
13. A cell placed in hypotonic solution bursts up. It is
- (a) animal cell

- (b) bacterial cell
 - (b) fungal cell
 - (d) plant cell
- 14.** Bulk transport occurs through
- (a) endocytosis
 - (b) exocytosis
 - (c) endosmosis
 - (d) both A and B
- 15.** Cytoplasm is
- (a) unit mass of protoplasm
 - (b) protoplasm excluding plasma membrane
 - (c) protoplasm excluding plasma membrane and nucleus
 - (d) protoplasm excluding plasma membrane and cell organelles
- 16.** Rough ER contains
- (a) detoxification centres
 - (b) carbohydrate synthesizing machinery
 - (c) ribosomes
 - (d) lysosomes
- 17.** Protein storing plastid is
- (a) aleuroplast
 - (b) amyloplast
 - (c) elaioplast
 - (d) both b and c
- 18.** Seat of photosynthesis is
- (a) leucoplast
 - (b) chloroplast
 - (c) chromoplast
 - (d) both a and c
- 19.** Mitochondria are seats of
- (a) aerobic respiration
 - (b) Krebs cycle of aerobic respiration
 - (c) glycolysis of aerobic respiration
 - (d) anaerobic respiration
- 20.** Golgi apparatus is involved in synthesis of
- (a) new membranes
 - (b) new membranes and lysosomes

- (c) cellulose
 - (d) glucose
- 21.** Lysosomes are also called
- (a) suicide bags
 - (b) digestive bags
 - (c) demolition squads
 - (d) all the above
- 22.** Contractile vacuoles take part in
- (a) absorption of water from outside
 - (b) osmoregulation
 - (c) excretion
 - (d) both b and c
- 23.** Centrosome occurs in
- (a) plant cells
 - (b) animal cells
 - (c) animal cells and some lower plant cells
 - (d) all the above

ANSWERS

1. (b)
2. (a)
3. (a)
4. (a)
5. (a)
6. (c)
7. (c)
8. (b)
9. (b)
10. (a)
11. (b)
12. (d)
13. (a)
14. (d)
15. (c)

16. (c)
17. (a)
18. (b)
19. (a)
20. (c)
21. (d)
22. (b)
23. (c).

B. CLASS RESPONSE

VI. Oral Questions

1. Who discovered the cell ?
2. Name the publication in which Robert Hooke (1665) described his discovery of the cell.
3. Who coined the term protoplasm for living matter ?
4. Who did propose cell theory ?
5. Name the largest cell.
6. Name the longest animal cell.
7. Give an example of prokaryotic cell.
8. What is example of a eukaryotic cell ?
9. Name the phenomenon by which raisins placed in water swell up.
10. Whether ATP molecules are consumed in the process of osmosis ?
11. What is the function of lignin deposition in cell wall ?
12. What is the characteristic of nuclear envelope ?
13. What structures are involved in the formation of chromatin ?
14. Where is nucleus located in a cell ?
15. What is the term used for subcellular structures having characteristic forms and functions ?
16. What is cytosol ?
17. How is food vacuole formed ?
18. What is the name of membrane surrounding sap vacuole?

- 19.** What is the name of fluid contained in a vacuole of a plant cell ?
- 20.** What is dictyosome ?
- 21.** Where are vesicles are formed in Golgi apparatus ?
- 22.** Where does ATP synthesis occur in mitochondria ?

VII. Quiz

- 1.** When did Robert Hooke discover cell ?
- 2.** Who among Schleiden and Schwann was zoologist and botanist ?
- 3.** Who developed electron microscope ?
- 4.** What is shape of a RBC ?
- 5.** What is the peculiarity of nerve cell ?
- 6.** What will happen if a plant cell is placed in a hypertonic solution ?
- 7.** What will happen if an animal cell is placed in hypertonic solution ?
- 8.** Cytoplasmic bridges between adjacent plant cells are called ?
- 9.** How many chromosomes are present in human cells ?
- 10.** What is tonoplast ?
- 11.** Inner mitochondrial membrane has a number of infoldings called
- 12.** Which one are the protein factories of the cells?
- 13.** Where are photosynthetic pigments present in chloroplast ?
- 14.** Where do contractile vacuoles occur ?

C. HOME ASSIGNMENT

VIII. Answer the Following Questions

- 1.** Differentiate between the following
 - (i) Endocytosis and exocytosis
 - (ii) Cis and trans faces of Golgi apparatus
 - (iii) Chromosome and chromatid
 - (iv) Write function of nucleolus
- 2.** Describe secretion in cell.

D. GROUP DISCUSSION

IX. Organise group discussion on each on the following topics.

1. Plasma membrane
2. Golgi apparatus
3. Semiautonomous cell organelles

E. SEMINAR / SYMPOSIUM

X. Organise a seminar / Symposium on each of the following topics

1. Grana – The kitchen of the cell
2. Mitochondria- Oxygen consumer
3. Lysosomes-Scavengers of the cell

D. GROUP ACTIVITY

XI. Investigatory Projects

1. Study the basic differences between animal and plant cells.
2. Collect the information about chromosome number of organisms known to you.

XII. Experimental Projects / Survey

1. Perform an activity to study the principle of diffusion
2. Study the plasmolysis in *Rheo* leaf peels

MCQs AND VIVA-VOCE BASED ON PRACTICAL SKILLS

Experiment 1.

To prepare stained temporary mounts of (a) onion peel, and (b) human cheek cells and to record observations and draw their labelled diagram.

Note: Refer the following figures ([Fig. 2.37](#) and [Fig. 2.38](#)) before answering the questions.

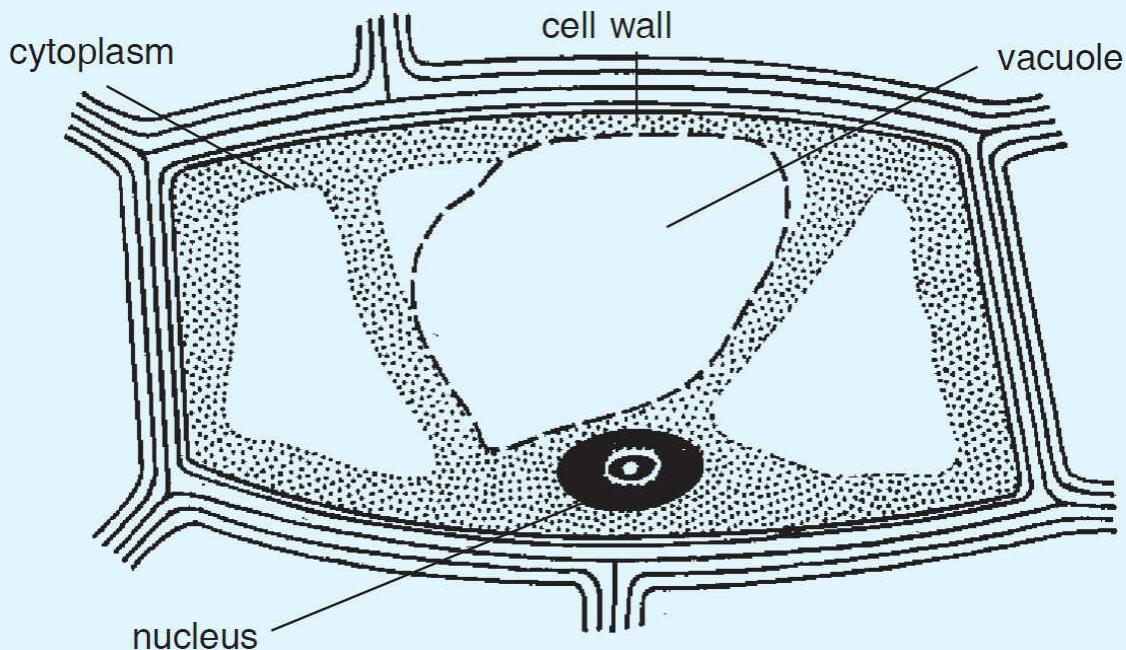


Figure 2.37. A cell of stained epidermal peel of onion bulb to show the detailed structure.

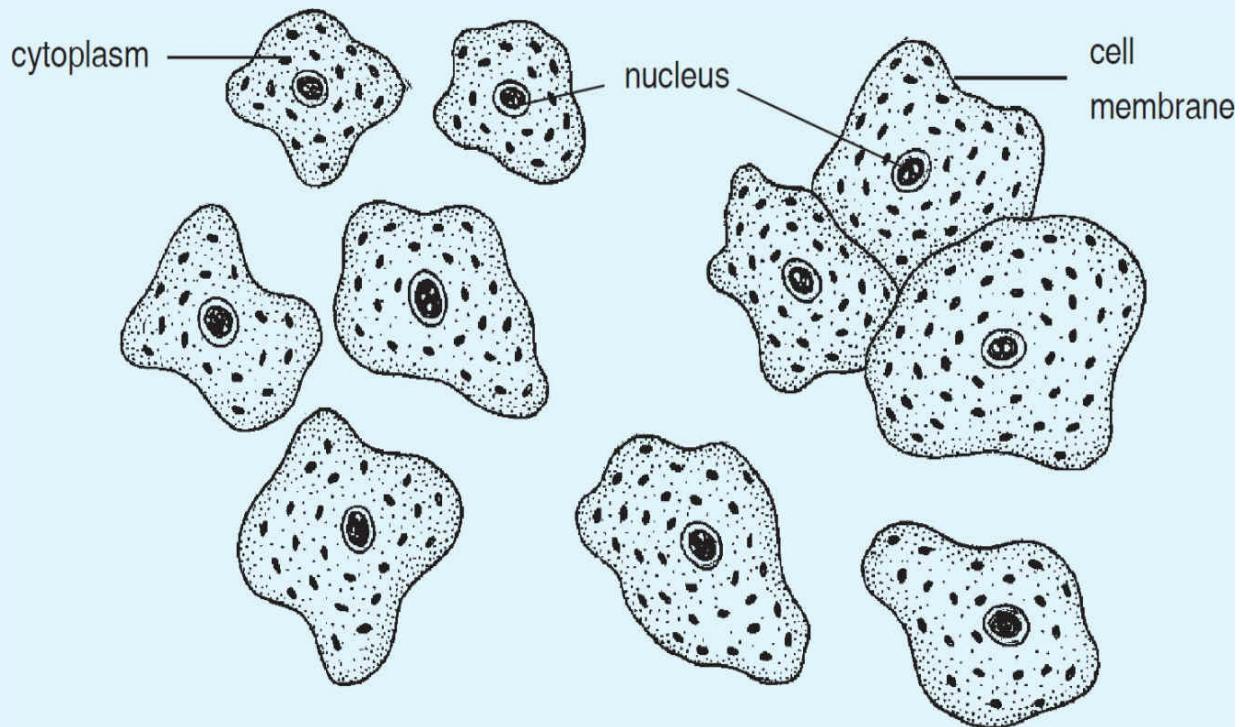


Figure 2.38. Cheek cells of human beings.

- 1. Human cheek cells are commonly stained with**
 - (a) safranin
 - (b) methylene blue
 - (c) acetocarmine
 - (d) eosine
- 2. Name the stain which is commonly used to study plant cells**
 - (a) safranin
 - (b) cotton blue
 - (c) methylene
 - (d) acetocarmine
- 3. Temporary mount of a tissue is made in**
 - (a) wax
 - (b) alcohol
 - (c) glycerine
 - (d) xylene
- 4. Safranin is a reagent that is used to stain**
 - (a) nucleus
 - (b) cytoplasm
 - (c) cell wall
 - (d) plasmodesmata
- 5. We generally mount the material in the slide**
 - (a) in the centre
 - (b) on the left side of slide
 - (c) on the right side of slide
 - (d) both (b) and (c)
- 6. Coverslip is put on the mounted material on a slide very gently to**
 - (a) avoid the crushing of mounted material
 - (b) avoid the entry of air bubble
 - (c) avoid oozing of stain
 - (d) avoid oozing of glycerine
- 7. Definite shape of cell is seen in case of**
 - (a) plant cell
 - (b) animal cell
 - (c) both animal and plant cell
 - (d) neither animal nor plant cell

- 8. The outer most layer of human cheek cells is**
 - (a) cytoplasm
 - (b) plasma membrane
 - (c) cell wall
 - (d) nuclear membrane
- 9. The outer most covering of a plant cell is**
 - (a) plasma membrane
 - (b) cell wall
 - (c) vacuole membrane
 - (d) nuclear membrane
- 10. Cell wall in plant cells is made of**
 - (a) starch
 - (b) glycogen
 - (c) cellulose
 - (d) chitin
- 11. The structural or functional unit of life is**
 - (a) tissue
 - (b) organ
 - (c) organ system
 - (d) cell
- 12. Nucleus was discovered by**
 - (a) Robert Hooke
 - (b) Robert Brown
 - (c) Virchow
 - (d) Schleiden
- 13. In plant cells, nucleus is generally placed**
 - (a) in the centre
 - (b) on one side of the cell
 - (c) attached to plasma membrane
 - (d) on one corner of the cell
- 14. In human cheek cells, nucleus is generally located**
 - (a) near the plasma membrane
 - (b) on one side
 - (c) in the centre
 - (d) on border
- 15. In plant cells, cell wall is**

- (a) dynamic and live
 - (b) rigid and nonliving
 - (c) dynamic and non - living
 - (d) rigid and living
- 16. In plant cells, cell to cell contact is maintained through**
- (a) tight junctions
 - (b) desmosomes
 - (c) interdigititation
 - (d) plasmodesmata
- 17. In plant cells, nucleus is generally**
- (a) cylindrical
 - (b) rounded
 - (c) discoidal
 - (d) elliptical
- 18. Plant cells generally have**
- (a) big but less number of vacuoles
 - (b) small but large number of vacuoles
 - (c) no vacuole at all
 - (d) all equal sized vacuoles
- 19. The cells are first focussed in microscope under**
- (a) 40 X
 - (b) 10X
 - (c) 100 X
 - (d) any of these
- 20. The organelle not present in human cheek cells is**
- (a) nucleus
 - (b) plasma membrane
 - (c) mitochondria
 - (d) chloroplast
- 21. The cell wall of plants is made up of cellulose which is a**
- (a) lipid
 - (b) protein
 - (c) polysaccharide
 - (d) amino acid

ANSWERS

1. (b);
2. (a);
3. (c)
4. (c);
5. (a);
6. (b);
7. (b);
8. (b);
9. (b);
10. (c);
11. (d);
12. (b);
13. (b);
14. (c);
15. (b);
16. (d);
17. (b);
18. (a);
19. (b);
20. (d);
21. (c).

VIVA - VOCE ON EXPERIMENT 1

1. What is microscope ?

Ans. Microscope is an optical instrument consisting of a lens or combination of lenses which renders minute objects distinctly visible.

2. What is microscopic ?

Ans. Any object visible only by the aid of a microscope, e.g., *Amoeba*, bacteria.

Name the instrument used for obtaining magnified images of

3. small objects.

Ans. Microscope.

4. Name the parts of a compound microscope in which two different types of lenses are used.

Ans. Eye piece and objectives.

5. How can you calculate the magnification of a microscope ?

Magnification of a microscope is calculated by multiplication of the power of eyepiece and objective, e.g., if you are using a 5 X eyepiece and 10X objective, the magnification is $5 \times 10 = 50$.

6. Why is light microscope called a ‘compound microscope’ ?

Ans. Light microscope is called compound microscope because it consists of two or more lens system.

7. Give one main difference between a light microscope and an electron microscope.

Ans. Visible light (sunlight, lamp light) is used in a light microscope whereas electrons are used in the electron microscope.

8. What is the use of glycerine in mounting of stained materials on slides ?

Ans. The stained material remains in its normal condition for a long period when mounted in glycerine. It does not get dried easily.

9. Why should you hold coverslip only from its edges ?

Ans. It is because dust particles of our fingers may make the coverslip dirty if it is handled from its upper and lower surfaces.

10. What is outer most layer found in animal cells ?

Ans. Plasma membrane.

11. What is outer most layer found in the plant cell ?

Ans. Cell wall.

12. Name two structures found in plant cells and not in animal cells.

Ans. Chloroplast and cell wall.

13. Give one single character, on the basis of which you can say that the given diagram is of a plant cell.

Ans. Presence of cell wall.

14. Name two structures found only in animal cells and not in plant cells.

Ans. Lysosomes and centrioles.

SOME ACTIVITY BASED QUESTIONS

Q. 1. A drop of ink is placed gently at the base of a beaker containing water by means of a dropper. What will happen ?

Ans. The ink slowly moves in all directions and ultimately makes the water uniformly coloured. This happens due to diffusion.

Q. 2. Plasma membrane is permeable to water. How does a cell show endosmosis or exosmosis ?

Water passes through the plasma membrane both inwardly as well as outwardly. Net movement occurs along its concentration gradient, from the side of pure water or dilute solution (high water concentration) to the side of concentrated solution (low water concentration).

Ans. A cell placed in dilute solution (hypotonic solution) will show endosmosis because the external solution has higher concentration of water. A cell placed in hypertonic solution (i.e., concentrated solution) will show exosmosis because cell sap has higher concentration of water.

Q.3. Hypertonic solution causes plasmolysis where the protoplast shrinks and withdraws from the cell wall at most places. What is present between the shrunken protoplast and cell wall ?

Ans. Hypertonic solution.

Q.4. What is crenation ?

Ans. It is a wrinkled appearance of animal cells (e.g., human erythrocytes) placed in a hypertonic solution.

Q.5. What would happen if shelled raw egg and deshelled boiled egg are placed in water ?

Ans. There will be no change in the size of the eggs. In case of raw egg, shell acts as an impermeable covering. The boiled egg does not show any change because its membranous covering has become dead.

Why do dry apricot placed in salt solution do not swell while they

Q.6. do so when kept in water ?

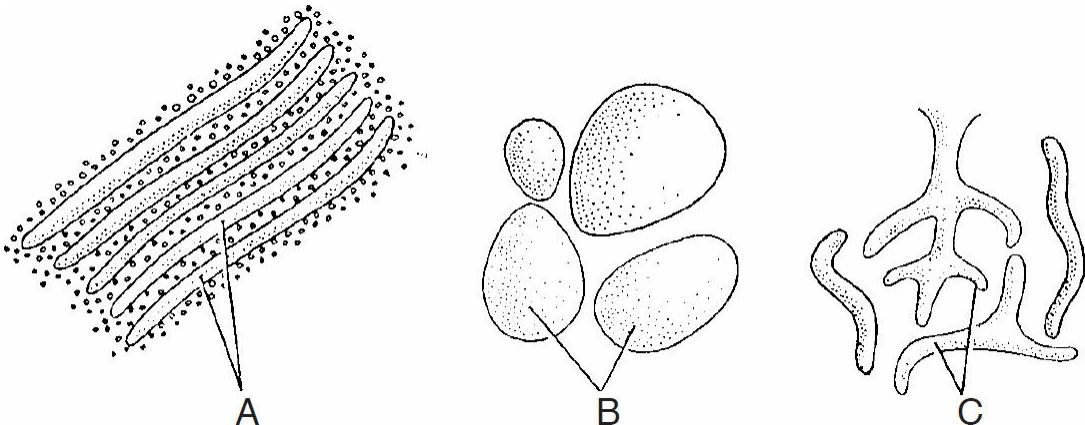
Dry apricot swell up in water because their cells have a high osmotic concentration which causes passage of water into them (endosmosis).
Ans. They do not swell up when placed in salt solution because the external solution is hypertonic.

PAPER-PEN TEST

Time : 30 minutes**Maximum marks : 17**

V.S.A.	1. What type of organisation is found in plasma membrane ?	1
M.C.Q.	2. Double membrane is absent in	1
	(a) nucleus (b) mitochondria (b) chloroplast (d) lysosomes	
Blanks	3. Plasmolysis in plant cells occurs due to	1
True / False	4. Lysosomes form a kind of demolition squads of the animal cell.	1
Matching	5. Match the stimuli with response	1

<i>Organelle</i>	<i>Storage of protein A</i>	<i>Oxysome B</i>	<i>Cell division C</i>
1. Mitochondria			
2. Centrioles			
3. Aleuroplasts			



- HOTS** 6. What does the figure depict ? Label A, B and C 2
- S.A.I** 7. Differentiate between plasma membrane and cell wall. 2
- S.A.II** 8. Describe the structure and function of nucleus. 3
- L.A.** 9. Describe the structure and functions of mitochondria. Write two differences in function of mitochondria and chloroplasts 2 + 2 + 1

SUMMATIVE ASSESSMENT

Multiple Choice Questions

Type 1. Interpretation Type Questions

1. Main difference between animal cell and plant cell is
 - (a) nutrition
 - (b) growth
 - (c) movement
 - (d) respiration
2. Animal cell lacking nuclei would also lack in
 - (a) chromosome
 - (b) ribosome
 - (c) lysosome

- (d) endoplasmic reticulum
- 3. Plasmolysis occurs due to**
- (a) absorption
 - (b) endosmosis
 - (c) osmosis
 - (d) exosmosis
- 4. Solute concentration is higher in the external solution**
- (a) hypotonic
 - (b) isotonic
 - (c) hypertonic
 - (d) none of the above
- 5. A cell placed in hypotonic solution will**
- (a) shrink
 - (b) show plasmolysis
 - (c) swell up
 - (d) no change in shape or size
- 6. Which of the following is known as “physical basis of life” ?**
- (a) gene
 - (b) protoplasm
 - (c) nucleolus
 - (d) mitochondria
- 7. Which of the following is incorrect pair ?**
- (a) chloroplast - kitchen of the cell
 - (b) mitochondria - power house of the cell
 - (c) lysosome - secretory granules
 - (d) nucleus - brain of the cell
- 8. Photosynthetic pigments are located in**
- (a) stroma
 - (b) outer membrane of chloroplast
 - (c) grana
 - (d) inner membrane of chloroplast
- 9. Which of the following act as garbage disposal system of the cell ?**
- (a) Golgi apparatus
 - (b) lysosome
 - (c) vacuole

- (d) peroxisome
- 10. Ribosomes are made up of**
- (a) lipoprotein
 - (b) RNA
 - (c) protein
 - (d) both (b) and (c)
- 11. Colourless plastids are known as**
- (a) leucoplasts
 - (b) chromoplasts
 - (c) chloroplasts
 - (d) none of the above
- 12. Chlorophyll is present in**
- (a) matrix
 - (b) stroma
 - (c) cristae
 - (d) thylakoid

Type 2. Identity - Relationship Type Questions

- 1. Cell wall of plant cells is chiefly composed of**

 - (a) hemicellulose
 - (b) cellulose
 - (c) phospholipids
 - (d) proteins

- 2. Intercellular connections in plant cells are called**

 - (a) middle lamella
 - (b) microfibrils
 - (c) matrix
 - (d) plasmodesmata

- 3. The infoldings in mitochondria are known as**

 - (a) cristae
 - (b) matrix
 - (c) cisternae
 - (d) grana

- 4. Aleuroplasts in a cell store**

 - (a) starch

- (b) oil
 - (c) protein
 - (d) nutrients
- 5. Well defined nucleus is absent in**
- (a) plant cell
 - (b) animal cell
 - (c) eukaryotic cell
 - (d) prokaryotic cell
- 6. Mitochondria are the seat of**
- (a) anaerobic respiration
 - (b) trapping of sunlight
 - (c) Krebs cycle
 - (d) Calvin cycle
- 7. First living cells were observed by**
- (a) A.V. Leeuwenhoek
 - (b) Robert Hooke
 - (c) R. Virchow
 - (d) Robert Brown
- 8. Membrane which allows passage of only solvent through it is**
- (a) differentially permeable
 - (b) semipermeable
 - (c) impermeable
 - (d) both (a) and (b)
- 9. Unicellular organisms take in oxygen and pass out carbon dioxide through**
- (a) diffusion
 - (b) exosmosis
 - (c) endosmosis
 - (d) active transport
- 10. Root hairs of plants absorb water from soil through**
- (a) diffusion
 - (b) imbibition
 - (c) osmosis
 - (d) all the above

Type 3. MCQs from NCERT Question Bank (Exemplar)

Problems)

- 1. The undefined nuclear region of prokaryotes is also known as**
 - (a) nucleus
 - (b) nucleolus
 - (c) nucleic acid
 - (d) nucleoid
- 2. The only cell organelle seen in prokaryotic cell**
 - (a) mitochondria
 - (b) ribosomes
 - (c) plastids
 - (d) lysosomes
- 3. Cell theory was given by**
 - (a) Schleiden and Schwann
 - (b) Virchow
 - (c) Hooke
 - (d) Haeckel
- 4. Cell arise from pre-existing cell was stated by**
 - (a) Haeckel
 - (b) Virchow
 - (c) Hooke
 - (d) Schleiden
- 5. Kitchen of the cell is**
 - (a) mitochondrion
 - (b) chloroplast
 - (c) endoplasmic reticulum
 - (d) Golgi apparatus
- 6. Organelle without a cell membrane is**
 - (a) ribosome
 - (b) nucleus
 - (c) mitochondrion
 - (d) chloroplast
- 7. Which of the following are covered by a single membrane ?**
 - (a) mitochondria
 - (b) vacuole
 - (c) nucleus

- (d) plastid
- 8. Lipid molecules in the cell are synthesized by**
- (a) smooth endoplasmic reticulum
 - (b) rough endoplasmic reticulum
 - (c) Golgi apparatus
 - (d) plastids
- 9. The proteins and lipids, essential for building the cell membrane, are manufactured by**
- (a) endoplasmic reticulum
 - (b) Golgi apparatus
 - (c) mitochondria
 - (d) peroxisomes
- 10. Lysosomes arise from**
- (a) endoplasmic reticulum
 - (b) Golgi apparatus
 - (c) nucleus
 - (d) mitochondria
- 11. Amoeba acquires its food through a process termed as**
- (a) exocytosis
 - (b) endocytosis
 - (c) plasmolysis
 - (d) exocytosis and endocytosis both
- 12. Which cell organelle plays a crucial role in detoxifying many poisons and drugs in a cell?**
- (a) Golgi apparatus
 - (b) lysosomes
 - (c) smooth endoplasmic reticulum
 - (d) vacuoles
- 13. Chromosomes are made up of**
- (a) DNA
 - (b) protein
 - (c) DNA and protein
 - (d) RNA
- 14. Organelle other than nucleus, containing DNA is**
- (a) endoplasmic reticulum
 - (b) mitochondria

- (c) Golgi apparatus
- (d) lysosome

15. Find out the false statement

- (a) Golgi apparatus is involved with the formation of lysosomes
- (b) nucleus, mitochondria and plastid have DNA, hence they are able to make their own structural proteins
- (c) mitochondria is said to be the power house of the cell as ATP is generated in them
- (d) cytoplasm is called as protoplasm

16. Cell wall of which one of these is not made up of cellulose ?

- (a) bacteria
- (b) *Hydrilla*
- (c) mango tree
- (d) cactus

17. A cell will swell up if

- (a) the concentration of water molecules in the cell is higher than the concentration of water molecules in surrounding medium
- (b) the concentration of water molecules in surrounding medium is higher than water molecules concentration in the cell
- (c) the concentration of water molecules is same in the cell and in the surrounding medium
- (d) concentration of water molecules does not matter

18. Plasmolysis in a plant cell is defined as

- (a) break down (lysis) of plasma membrane in hypotonic medium
- (b) shrinkage of cytoplasm in hypertonic medium
- (c) shrinkage of nucleoplasm
- (d) none of them

19. Which of these is not related to endoplasmic reticulum ?

- (a) it behaves as transport channel for proteins between nucleus and cytoplasm
- (b) it transports materials between various regions in cytoplasm
- (c) it can be the site of energy generation
- (d) it can be the site for some biochemical activities of the cell

20. Select the odd one out

- (a) the movement of water across a semipermeable membrane is affected by the amount of substances dissolved in it.

- (b) membranes are made of organic molecules such as proteins and lipids.
 - (c) molecules soluble in organic solvents can easily pass through the membrane.
 - (d) plasma membranes contain chitin sugar in plants.
- 21. Following are a few definitions of osmosis. Read carefully and select the correct definition.**
- (a) movement of water molecules from a region of higher concentration to a region of lower concentration through a semipermeable membrane.
 - (b) movement of solvent molecules from its higher concentration to lower concentration.
 - (c) movement of solvent molecules from higher concentration to lower concentration of solution through permeable memberane.
 - (d) movement of solute molecules from lower concentration to higher concentration of solution through a semipermeable membrane.

ANSWERS

Type I MCQs

1. (a);
2. (a);
3. (d)
4. (c);
5. (c);
6. (b);
7. (c);
8. (c);
9. (b);
10. (d);
11. (a);
12. (d).

Type II MCQs

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

Type III MCQs

1. (d);
2. (b);
3. (a);
4. (b);
5. (b);
6. (a);
7. (b);
8. (a);
9. (a);
10. (b);
11. (b);
12. (c);
13. (c);
14. (b);
15. (d);
16. (c);
17. (b);
18. (b);
19. (c);
20. (d);
21. (a).

NCERT TEXTBOOK QUESTIONS AND EXERCISES WITH ANSWERS

NCERT Text Book Questions

Q.1. Who discovered cells and how?

Ans. **Robert Hooke** in 1665 discovered the cells. He examined a thin slice of cork under a self-designed crude microscope and observed that the cork resembled the structure of a honey comb. The latter consisted of many tiny compartments. Hooke called them **cellulae** (singular **cellula**), now termed cells. Cellula is a Latin name which means ‘a little room’. Such rooms were also present in monasteries.

Q.2. Why is the cell called the structural and functional unit of life?

All living organisms are made up of cells. Thus, cell is the structural unit of life. Each living cell has the capacity to perform certain basic functions that are characteristics of all living forms. Each cell acquired distinct structure and function due to the organization of its membrane and cytoplasmic organelles in specific way. Each kind of cell organelle performs a special function, such as making new materials in the cell (*e.g.*, chloroplast, ribosomes), clearing up the waste materials from the cells (*e.g.*, lysosomes), utilisation of oxygen in oxidation of food and energy production (*e.g.*, mitochondria), movement (microtubules containing spindle, cilia, flagella), etc. A cell is able to live and perform all its functions because of these organelles. These organelles together constitute the basic unit of structure and function called the cell.

Q.3. How do substances like CO₂ and water move in and out of the cell?

Ans. Carbon dioxide (CO₂) moves in and out of the cells by the process of diffusion. Diffusion involves movement of molecules from higher concentration to lower concentration across the plasma membrane.

Water moves in and out of the cells by **osmosis**. Osmosis is the movement of water or solvent through a semipermeable membrane from a solution of lower concentration of solutes to a solution of higher concentration of solutes to which the membrane is relatively impermeable.

Both diffusion and osmosis are physical or mechanical processes and do not require spending of energy for their performance by the cells.

Q.4. Why is plasma membrane called a selectively permeable membrane?

Plasma membrane is called selectively permeable membrane because it allows the movement of only selected molecules across it and not all of them.

Q.5. Fill in the gaps in the following table illustrating differences between prokaryotic and eukaryotic cells.

<i>Prokaryotic cell</i>	<i>Eukaryotic cell</i>
1. Size: generally small (1 – 10 μm); $1\mu\text{m} = 10^{-6} \text{ m}$	1. Size: generally large (5 – 100 Mm)
2. Nuclear region: and known as	2. Nuclear region: well defined and surrounded by a nuclear membrane
3. Chromosome: single	3. Chromosome : more than one
4. Membrane – bound organelles: absent	4.

Ans. 2. It lies in the cytoplasm and not covered with a nuclear membrane, nucleoid.
4. Membrane-bound cell organelles such as mitochondria, plastids, Golgi apparatus, lysosomes, etc., are present in the cytoplasm.

Q.6. Can you name the two organelles we have studied that contain their own genetic material?

Ans. (a) Mitochondria;
(b) Chloroplasts (plastids).

Q.7. If the organization of a cell is destroyed due to some physical and chemical influence, what will happen?

A well organized cell maintains **homeostasis**, i.e., constant internal chemical composition. It is, therefore, able to perform basic functions such as respiration, obtaining nutrition, clearing of waste, forming new proteins, etc. If the organization of a cell is destroyed, it will not be able to maintain homeostasis and thus will not be able to perform above said basic functions and such a cell will ultimately die.

Q.8. Why are lysosomes known as suicide bags?

Lysosomes contain digestive enzymes for almost all types of organic

Ans. materials. If their covering membrane breaks as it happens during injury to cell, the digestive enzymes will spill over the cell contents and digest the same. As lysosomes are organelles which on bursting can kill cells possessing them, they are called **suicide bags**.

Q.9. Where are proteins synthesized inside the cell?

Ans. Proteins are synthesized in the ribosomes.

NCERT Exercises

Q.1. Make a comparison and write down ways in which plant cells are different from animal cells.

Ans. Refer to [Table 2.17](#).

Q.2. How is a prokaryotic cell different from a eukaryotic cell?

Ans. Refer to [Table 2.3](#).

Q.3. What would happen if the plasma membrane ruptures or break down?

Plasma membrane is a selectively permeable membrane of the cell that maintains its homeostasis, *i.e.*, constant internal composition of the cell.

Ans. If it ruptures or breakdown the constant internal chemical composition of the cell will be lost and it will not be able to perform its basic functions. Such a cell with ruptured plasma membrane is killed.

Q.4. What would happen to the life of a cell if there was no Golgi apparatus?

There would not be any lysosome for intracellular digestion and **Ans.** cleansing, not complexing of molecules, no exocytosis and no formation of new plasma membrane.

Q.5. Which organelle is known as the powerhouse of the cell? Why?

Mitochondrion is known as the powerhouse of the cell because it contains enzymes that are needed for stepwise oxidation of food stuffs (carbohydrate, fats or lipids and proteins) present in the cells to CO_2 and water. Oxidation of food releases energy which is used to form

Ans. high-energy ATP (adenosine triphosphate) molecules. ATP is known as **energy currency** of the cell and it is used as cellular fuel. Energy stored in ATP is used to bring about energy requiring activities of cell such as photosynthesis, protein synthesis and muscle contraction.

Q.6. Where do the lipids and proteins constituting the cell membrane get synthesized?

Ans. Proteins are synthesized in ribosomes of rough ER while lipids are synthesized over smooth ER.

Q.7. How does an Amoeba obtain its food?

Amoeba is unicellular animal. It acquires its food by the process of endocytosis. Plasma membrane of *Amoeba* is flexible with its help *Amoeba* engulfs food particles. The engulfed food particle passes into the body of organism as a phagosome. Phagosome combines with lysosome to produce **digestive** or **food vacuole**. Digestion occurs in food vacuole. The digested food passes into surrounding cytoplasm. The undigested matter is thrown out of the cell.

Q.8. What is osmosis?

Osmosis is diffusion of water from the region of its higher concentration (pure water or dilute solution) to the region of its lower concentration (strong solution) through a semipermeable membrane.

Q.9. Carry out the following osmosis experiment:

Take four peeled potato halves and scoop each one out to make potato cups. One of these potato cups should be made from a boiled potato. Put each potato cup into a trough containing water.

Now

- (a) keep cup A empty;
- (b) put one teaspoon sugar in cup B;
- (c) put one teaspoon salt in cup C;
- (d) put one teaspoon sugar in the boiled potato cup D;

Keep these for 2 hours. Then observe the four potato cups and answer the following:

- (i) Explain why water gathers in the hollowed portion of B and C.
- (ii) Why is potato A necessary for this experiment?
- (iii) Explain why water does not gather in the hollow out portion of A and D?

When unboiled potato cups B and C were put into a trough containing water, the cells of potatoes gained water by **endosmosis**. When a teaspoon of sugar and salt were added later in the hollowed portion of B and C cups respectively, water movement occurred through the plasma membranes of the cells

- Ans.** (i) from within the cells of potato into the hollowed portion of both B and C cups because of **exosmosis** (*i.e.*, exit of water molecules through permeable plasma membranes from within the cells of unboiled potatoes into the hollowed portions having hypertonic sugar and salt, respectively).
- (ii) Potato cup A is necessary in the experiment as a ‘control’ for providing comparison with situations created in potato cups B, C and D. It indicates that the potato cavity alone does not induce movement of water.
- (iii) Water does not gather in the hollowed portion of potato cup A because it does not possess higher osmotic concentration than the cells of potato.
- Potato cup D is boiled potato cup. On boiling, potato cells die and the membranes of the potato cells lost their permeability. As a result, when teaspoon of sugar is added into the hollowed portion of boiled potato cup D, water does not come out from within the potato cells into the hollowed portion.

Questions Based on NCERT Question Bank (Exemplar Problems in Science)

Q. 1. Why are lysosomes known as “suicide bags” of a cell ?

Ans. See [Q.8](#). In NCERT Text book Questions.

Q. 2. Do you agree that “A cell is a building unit of an organism” ?

Yes, cell is a building unit of every living organism as every living being is made up of one or more cells. For example, in **unicellular** or **acellular organisms**, the single cell performs all the functions of life. In **multicellular organisms** all the cells have a similar basic structure and perform a similar basic life activities. However, they become specialised to form components of different structures that perform different functions. Cells are first organised into **tissues**,

Ans. each with a specific function, *e.g.*, contraction by the muscular tissue. Tissues are organised to form **organs** with each organ performing a specific task, *e.g.*, heart, kidney, lung, stomach, eyes. Organs are grouped into **organ systems**, each with a major function, *e.g.*, circulatory system, excretory system, respiratory

system, digestive system, skeletal system. A living organism has a number of organ systems. Thus, in all such organisational complexity, cell remains the basic building unit of the organism.

Q.3. Why does the skin of your fingers shrink when you wash clothes for a long time ?

Clothes are washed with soap or detergent solution. This solution is **hypertonic** as compared to osmotic concentration of our skin cells.

Ans. The washing solution, therefore, results in **exosmosis** in the skin cells that come in contact with it for some time. Due to this reason, the skin over the fingers shrinks while washing clothes for a long time.

Q. 4. Why is endocytosis found in animals only ?

Endocytosis is swallowing up of food and other substances (bacteria, viruses) from external medium by the plasma membrane.

Ans. This is possible only when plasma membrane is in direct contact with external medium. It occurs only in animal cells. In plant cells, a cell wall is present over the plasma membrane. Therefore, their plasma membrane cannot perform endocytosis.

Q. 5. A person takes concentrated solution of salt. After some time he starts vomiting. What is the phenomenon responsible for such a situation ? Explain.

Concentrated salt solution is a **hypertonic solution** so causes irritation and excessive dehydration in the wall of alimentary canal

Ans. due to **exosmosis**. There is uncomfortable stretching which causes reverse movements and hence vomiting.

Q. 6. Name any cell organelle which is nonmembranous.

Ans. Ribosome.

We eat food composed of all the nutrients such as carbohydrates, proteins, fats, vitamins, minerals and water.

Q. 7. After digestion, they are absorbed in the form of glucose, amino acids, fatty acids, glycerol, etc. What mechanisms are involved in the absorption of digested food and water ?

Ans. Digested food is taken in the intestinal cells by the following process:

- (i) Glucose, amino acids and some ions—Active transport.
- (ii) Fatty acids, glycerol—Diffusion (Passive transport)
- (iii) Water—Osmosis.

If you are provided with some vegetables to cook, you generally

Q. 8. add salt into vegetables during cooking process. After adding salt, vegetables release water. What mechanism is responsible for this?

On adding salt, vegetables release water due to **exosmosis**.

Ans. Exosmosis occurs whenever the external medium is hypertonic as compared to the osmotic concentration inside living cells.

Q. 9. If cells of onion peel and RBC are separately kept in hypotonic solution what among the following will take place ? Explain the reason for your answer. (a) Both the cells will swell (b) RBC will burst easily while cells of onion peel will resist the bursting to some extent. (c) a and b both are correct (d) RBC and onion peel cells will behave similarly.

(b) RBC will burst as there is no mechanism to resist entry of water into them. Onion peel cells do not burst. **Endosmosis** causes some

Ans. initial swelling in such onion peel cells but cell wall puts a mechanical barrier to promote entry of water. Therefore, these cells do not burst.

Bacteria do not have chloroplasts but some bacteria are
Q. 10. photoautotrophic in nature and perform photosynthesis. Which part of bacterial cell perform this ?

Ans. Photoautotrophic bacteria posses photosynthetic pigments inside small vesicles which may be attached to the plasma membrane.

Q. 11. Match the items of A and B.

A	B	
(a) Smooth reticulum	endoplasmic	(i) <i>Amoeba</i>
(b) Lysosome		(ii) Nucleus
(c) Nucleoid		(iii) Bacteria
(d) Food vacuoles		(iv) Detoxification
(e) Chromatin material and nucleolus		(v) Suicidal bag

a - iv;

b-v;

Ans. c-iii;

d-i;
e-ii.

Q. 12. Write the name of different plant parts in which chloroplast, chromoplast and leucoplasts are present.

- Ans.** 1. Chromoplast: Flower (petals) and fruits.
2. Chloroplast : Green leaves and green parts.
3. Leucoplast : Root and underground stem.

Q. 13. Name the organelles which show analogy written as under

- (a) Transporting channels of the cell
 - (b) Power house of the cell
 - (c) Packaging and dispatching unit of the cell
 - (d) Digestive bag of the cell
 - (e) Storage sac of the cell
 - (f) Kitchen of the cell
 - (g) Control room of the cell
- (a) Endoplasmic reticulum;
 - (b) Mitochondria;
 - (c) Golgi apparatus;
- Ans.** (d) Lysosome;
(e) Vacuole;
(f) Chloroplasts;
(g) Nucleus.

Q. 14. How is bacterial cell different from an onion peel cell ?

Ans. See differences between prokaryotic (bacterial cell) and eukaryotic (onion peel cells; [Table 1.3](#)).

Q. 15. How do substances such as carbon dioxide and water move in and out of the cell ?

Ans. By diffusion and osmosis respectively.

Q. 16. How does Amoeba obtain its food ?

Ans. See NCERT Exercise [Q. 7](#).

Q. 17. Name two organelles in plant cell that contain their own genetic materials and ribosomes.

Ans. (i) Plastids;
(ii) Mitochondria.

Q. 18. Why are lysosomes also known as “scavengers of the cell”.

Lysosomes are called scavengers of the cell because they remove cell

Ans. debris consisting of dead and worn out cell organelle by digesting the same. Rather they nourish the cells by sending out digesting nutrients into the cytoplasm.

Q. 19. Which cell organelle control most of the activities of the cell ?

Nucleus, by controlling metabolism and cell activities. Genes express

Ans. their effect through RNAs. RNAs control synthesis of proteins and enzymes.

Q. 20. Which kind of plastid is more common in (a) Root of the plant, (b) Leaves of the plant, (c) Flowers and fruits.

(a) Leucoplasts in roots;

Ans. (b) Chloroplasts in leaves;

(c) Chromoplasts in flowers and fruits.

Q. 21. Why do plant cells possess large sized vacuole ?

Ans. Vacuole of plant cells is large in size because it has to take part in following activities:

1. It stores salts, sugar, amino acids, organic acids and some proteins.
2. Metabolic wastes of the cell are dumped in the vacuole.
3. Lysosomal enzymes occur in the vacuole of plant cell.
4. The vacuole contains cell sap and helps in maintaining turgidity of the cell.
5. Plant cell vacuole contains an osmotic concentration which is required for the process of osmosis through plasma membrane.

Q. 22. How are chromatin, chromatid and chromosome related to each other.

Chromatin is intertwined mass of fine thread-like structures made of DNA and protein. During cell division (mitosis or meiosis), chromatin condenses to form thicker rod-like structures called *chromosomes*.

Ans. Each chromosome consists of two similar halves called *chromatids*. Formation of chromosomes having two similar halves or chromatids is meant for equitable distribution of chromatin which is hereditary material.

Q. 23. What are consequences of the following conditions ?

(a) **A cell having higher water concentration than the surrounding medium.**

A cell containing low water concentration than the

- (b) surrounding medium.
- (c) A cell having equal water concentration to its surrounding medium.

Ans. High water concentration occurs in hypotonic solution, low water concentration in hypertonic solution while equal water concentration in isotonic solution.

- (a) A cell having higher water content or hypotonic cell sap will undergo exosmosis and, therefore, lose water. It may undergo plasmolysis.
- (b) A cell having low water concentration or hypertonic cell sap will undergo endosmosis and absorb water from outside. It would become turgid.
- (c) A cell having isotonic cell sap will neither gain nor lose water to the external medium.

Q. 24. Draw a plant cell and label the parts which

- (a) Determine function and development of the cell.
- (b) Provides resistance to microbes and to withstand hypotonic external medium without injury.
- (c) Packages materials coming from the endoplasmic reticulum.
- (d) Is a fluid contained inside the nucleus.
- (e) Is site for many biochemical reaction necessary to sustain life.

Ans. Draw figure of a plant cell as in [Figure. 2.15](#), and label (a) Nucleus; (b) Cell wall, (c) Golgi bodies; (d) Nucleoplasm; (e) Cytoplasm.

Q. 25. Illustrate only a plant cell as seen under electron microscope. How is it different from animal cell ?

Ans. (a) Draw [Figure 2.13](#).
(b) For differences between plant and animal cells see [Table 2.17](#).

Q. 26. Draw a neat labelled diagram of an animal cell.

Ans. Draw [Figure 2.12](#).

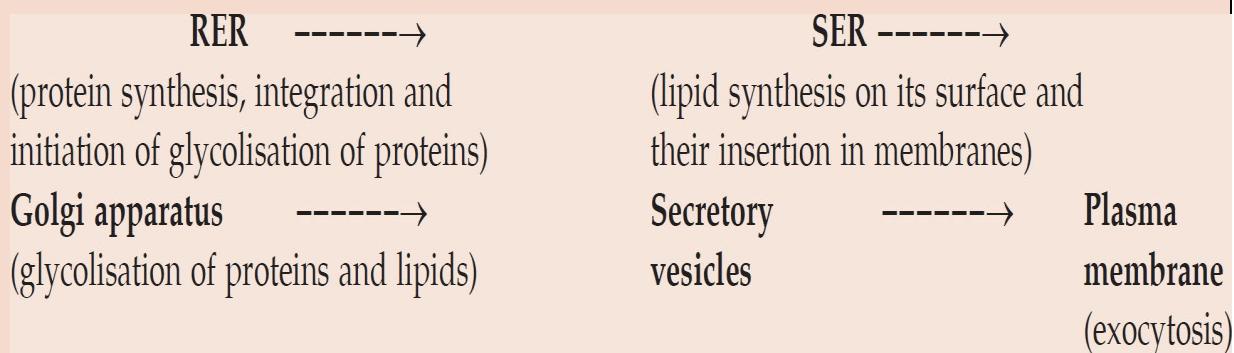
Q. 27. Draw a well labelled diagram of eukaryotic nucleus. How is it different from nucleoid?

Ans. (a) Draw [Fig. 2.27](#).
(b) See [Table 2.4](#) for differences between nucleus and nucleoid.

Differentiate between rough and smooth endoplasmic reticulum.

Q. 28. How is endoplasmic reticulum important for membrane biosynthesis ?

Ans. (a) For differences in rough ER and smooth ER see [Table 2.13](#). Membranes grow as newly synthesized proteins and lipids are inserted into existing membrane in endoplasmic reticulum (ER). Glycolisation of proteins of the membrane is started in RER but completed in Golgi apparatus. Glycolisation of lipids of the membrane occurs in Golgi apparatus. Flow of membrane occurs in the following manner.



Q. 29. In brief state what happen when

- (a) Dry apricot are left for some time in pure water and later transferred to sugar solution.
 - (b) A red blood cell is kept in concentrated salt solution.
 - (c) The plasma membrane of a cell breaks down.
 - (d) Rheo leaves are boiled in water first and then a drop of sugar syrup is put on it.
 - (e) Golgi apparatus is removed from the cell.
- Ans.** (a) When placed in pure water, dry apricots swell up due to endosmosis. On being transferred to sugar solution, they shrink due to exosmosis.
- (b) In concentrated salt solution, red blood cells shrink and give a shrivelled appearance (crenation).
 - (c) Breakdown of plasma membrane will result in death of the cell as protoplasmic structures will get dispersed.
 - (d) Boiling shall kill the leaves. The dead leaves and their cells do not undergo plasmolysis.
 - (e) Formation of lysosomes, secretory vesicles will stop. Glycolisation of lipids and proteins synthesized by ER for membrane biosynthesis will not occur.

Q. 30. Draw a neat diagram of plant cell and label any three parts which differentiate it from animal cell.

Ans. Draw [Figure 2.13](#) showing chloroplast, large vacuole and cell wall. These three structures do not occur in the animal cell.

Questions of CBSE Sample Paper

Q.1. What happens to an animal cell when it is placed in a very dilute external medium? Why?

(2 marks ; 2010)

Ans. Endosmosis. As the external solution is very dilute or hypotonic, water passes into animal cell due to endosmosis the animal cell continues to swell up for some time but ultimately bursts up.

Reason. Bursting of animal cell with endosmosis is due to absence of rigid cell wall as found in plant cells.

Q.2. (a) Draw a plant cell and name seven important organelles found in it.

(b) Name one organelle that can make some of its protein in a plant cell and also mention one function of such organelle.

(5 marks ; 2010)

Ans. (a) Draw [Fig 2.13](#).

(b) Mitochondrion is a cell organelle that makes some of its own proteins with the help of its own DNA and ribosomes. It performs Krebs cycle part of (aerobic) respiration (*i.e.*, uses O₂ molecules during final oxidation of food and manufactures energy rich ATP molecules).

Q.3. (a) Name and draw a cell which does not have a well defined nuclear region. Label any four parts.

(b) Mention two ways by which a photosynthesizing cell belonging to this group differs from a cell of your body.

(5 marks ; 2010)

Ans. (a) Prokaryotic cell (*e.g.* bacterium, blue green algae), Draw [figure 2.7](#).

(b) Differences

<i>Photosynthetic prokaryotic cell</i>	<i>Human cell</i>
1. The cell possesses photosynthetic	

<p>pigments in bag like membranous sacs.</p> <p>2. A cell wall occurs around the cell.</p> <p>3. A nucleus is absent. Instead nucleoid occurs embedded in the cytoplasm.</p>	<p>1. Photosynthetic pigments are absent.</p> <p>2. Cell wall is absent.</p> <p>3. A nucleus is present.</p>
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SOME TYPICAL OR ILLUSTRATIVE QUESTIONS

Q.1. What is functional unit of life ?

Cell is the functional unit of life. It is defined as a tiny mass of protoplasm covered by plasma membrane which is capable of performing all functions of life.

Q.2. What is the difference between plasma membrane and cell wall ? Give the functions of each one.

Plasma membrane is an elastic living membrane made up of lipids and proteins, whereas cell wall is a rigid non-living covering made up of cellulose.

Plasma membrane acts as semipermeable membrane which allows only selective substances to pass through it. Cell wall provides rigidity and protection to cell. It is permeable.

Q.3. Main cellular site of ATP generation is

Ans. Mitochondrion.

Q.4. Which cellular organelle uses molecular oxygen like mitochondria but protects the cell from toxic metabolic by products ?

Ans. Peroxisome.

Q.5. Differentiate between RER and SER.

Ans. See [Table 2.13](#).

Q.6. Differentiate between chromatin and chromosome.

Ans. Chromatin is the nucleoprotein (DNA +protein) fibrous mass which stains strongly with basic dyes and is present inside nucleus.

Chromosome is a thread -like, stainable, condensed chromatin unit, visible at cell division.

Both chromatin and chromosomes contain hereditary information in the form of genes.

Q.7. Which molecules are present in chromatin.

Ans. DNA, histone proteins and acids proteins.

Q.8. Which types of ribosomes are found in prokaryotes and eukaryotes ?

Prokaryotes have 70S ribosomes and eukaryotes have 80S ribosomes.

(**Note.** The S value is called **Svedberg unit**. It refers to the

Ans. sedimentation coefficient of the RNA; the larger the number, the more rapidly the molecule moves through a field of force during centrifugation.)

Q.9. Which structure is called little nucleus ?

Ans. Nucleolus.

Q.10. Why is nucleus called director of the cell ?

Ans. Nucleus controls and coordinates all the metabolic functions of the cell.

QUESTIONS BASED ON HIGH ORDER THINKING SKILLS (HOTS)

1. Cell inclusions are

- (a) non-living materials present in the cytoplasm
- (b) another name of cell organelles
- (c) cytoskeletal framework of cell
- (d) combined name for cell wall and plasma membrane

2. Which of these is wrongly matched ?

- (a) chloroplasts – chlorophyll
- (b) elaioplasts – starch
- (c) amyloplasts – carbohydrates

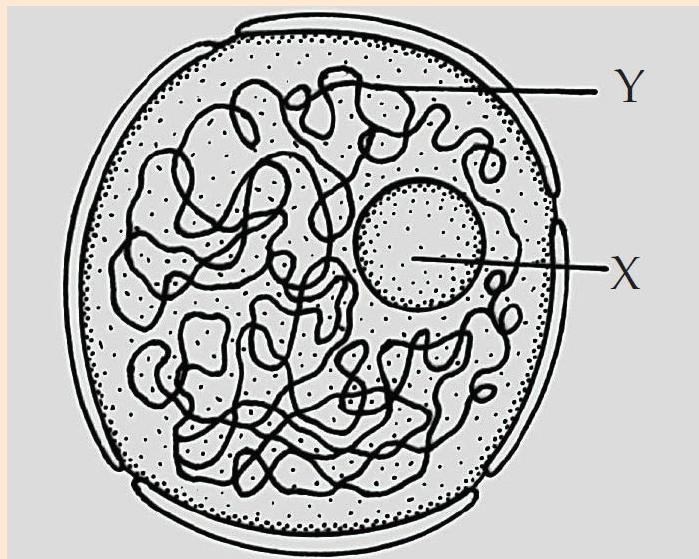
Ans. 1. a;
2. b.

3. What will happen if chloroplast is taken out of the cell and illuminated ?

Chloroplast is a semiautonomous cell organelle of plant cells which on illumination can perform its function of photosynthesis and perform its

Ans. function of photosynthesis and release oxygen even outside the cell provided it is kept in isotonic medium and receives raw material of carbon dioxide.

4.



(a) Identify the above figure

(b) Label X and Y

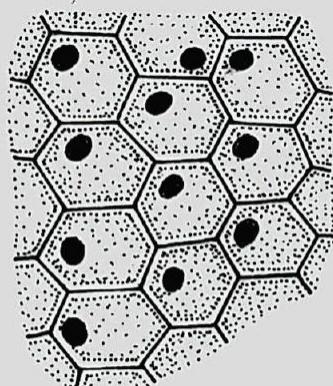
(c) What is the function of X ?

Ans. (a) It is figure of nucleus of an eukaryotic cell.

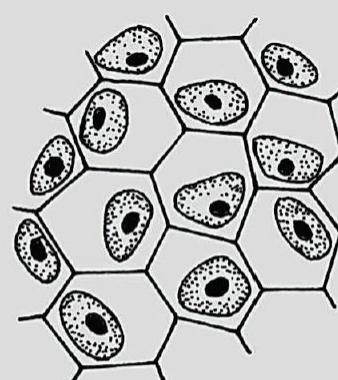
(b) X-nucleolus; Y-chromatin.

(c) Function of X (*i.e.*, nucleolus)-synthesis of ribosomes.

5.



A cells



B cells

- (a) Identify A - and B-cells.
- (b) What will happen if B-cells are kept in hypotonic solution.
- (c) What will happen if A cells are kept in hypertonic solution ?

Ans. (a) A cells – Turgid cells; B–cells–Plasmolysed cells.
(b) If B cells kept in hypotonic solution they will become deplasmolysed if done so immediately after plasmolysis.
(c) A cells kept in hypertonic solution will become plasmolysed.

6. What will happen if

- (a) Excess amount of fertilizer is added to a green lawn ?

- (b) Salt is added to cut pieces of raw mango.

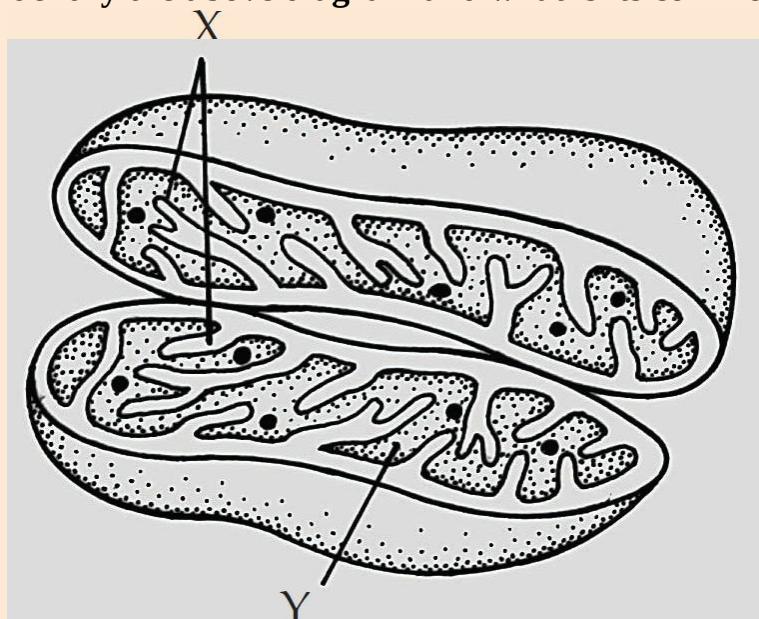
Ans. (a) Application of excess fertilizer (*i.e.*, urea) in green grass lawn will kill grass plants due to exosmosis and plasmolysis.
(b) Application of salt to mango pieces will release water (sap) due to exosmosis. Consequent less moisture in fruit protects the cut pieces of mango from bacterial and fungal attack (*i.e.*, it helps in the process of food preservation).

7. (a) Label X and Y.

- (b) What is the function of X ?

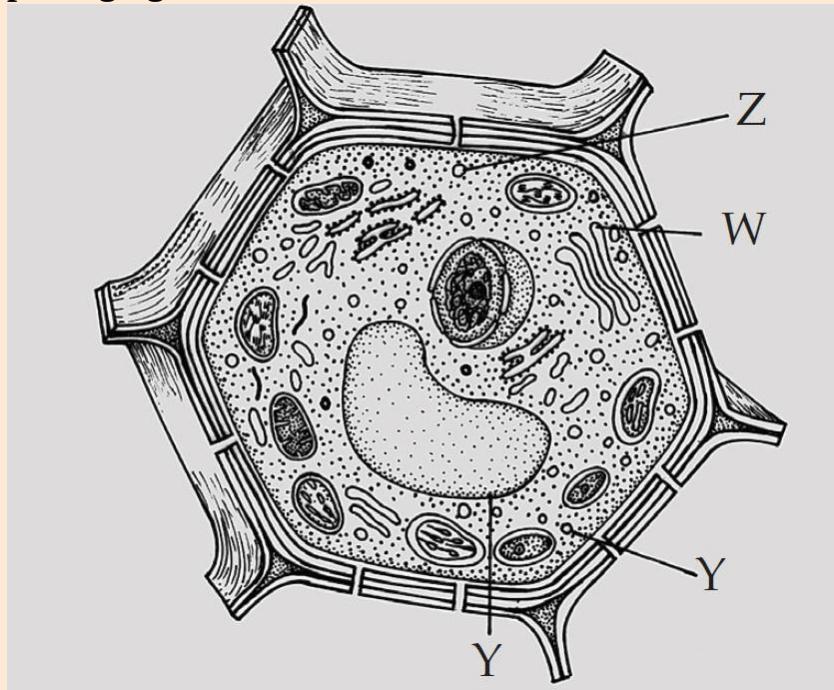
- (c) What is the composition of Y ?

- (d) Identify the above diagram and what is its common name ?



Ans. (a) X — Cristae
(b) Y — Matrix

- (c) Matrix is rich in ions, proteins, enzymes of Krebs cycles, DNA, RNAs and ribosomes.
 - (d) Mitochondrion (cut lengthwise). Its common name is power house of cell.
- 8. (a) Label W, X, Y, and Z.**
- (b) What is the covering membrane of X known as ?
 - (c) Which of them contain hydrolytic enzymes ?
 - (d) Which one of them takes part in storage modification and packaging of various chemicals?



- Ans.** (a) W-Dictyosome (*i.e.*, Golgi apparatus); X-Vacuole; Y-Ribosome; Z-Lysosome.
- (b) Covering membrane of X is called **tonoplast**.
- (c) Lysosome contains the hydrolytic enzymes.
- (d) Golgi apparatus takes part in storage, modification and packaging.
- 9.** (a) Name the phenomenon which helps fresh water unicellular organisms (*e.g.*, Amoeba) continuously gain water in their bodies. Also name the mechanisms by which these organisms throw out excess of water from their bodies.
- (b) Give at least two examples in plants where similar phenomenon is used to gain water.

Ans. 1. Amoeba is a freshwater unicellular organism. It continuously gain water in its body due to **osmosis**. It contains contractile vacuoles to

- throw out excess of water from its body.
2. (i) Absorption of water by the plant root hairs occurs due to osmosis.
- (ii) In plants, cells, tissues and soft organs such as leaves, buds, young shoots, flowers, fruits maintain turgidity due to osmotic absorption of water.

REVISION QUESTIONS

Very Short Answer Questions (Carrying 1 mark each)

1. What is cell ?

Ans. Cell is the structural and functional unit of life.

2. What is prokaryotic cell ?

In a cell of bacteria and blue green algae (=cyanobacteria), a well organised nucleus is absent (*i.e.*, there is no nuclear envelope and nucleolus) and membrane-bound organelles are lacking. Such cells are called **prokaryotic cells**.

3. What is eukaryotic cell ?

In a cell of plants, animals, fungi and protists, a well organised nucleus is present (*i.e.*, such a nucleus is bounded by an envelope and has nucleolus) and membrane-bound organelles such as endoplasmic reticulum, mitochondria, chloroplasts and Golgi apparatus are present. Such cells are called **eukaryotic cells**.

4. Who coined the term cell ?

Ans. Robert Hooke.

5. Name the book in which Robert Hooke published his work.

Ans. Micrographia (1665).

6. Name the scientist who first studied living cell?

Ans. A.V. Leeuwenhoek (1674).

7. Name two factors on which shape of the cell depends.

Ans. Shape of the cell depends upon functional adaptations and viscosity of the protoplasm.

8. Name the smallest and the largest cell.

Ans. The smallest cell is PPLO and largest cell is ostrich egg.

9. Name the longest cell in the human body.

Ans. Nerve cell.

10. How many cells are present in human body ?

Ans. 100 trillion cells (10^{14}).

11. Name the structure from which all multicellular organisms develop.

Ans. Zygote (= fertilized egg).

12. Give two examples of prokaryotic cell.

Ans. Bacteria and cyanobacteria (= blue green algae).

13. Give one example each of unicellular and multicellular organism.

Ans. Amoeba and Margosa/Human being respectively.

14. Who proposed the cell theory ?

M.J. Schleiden and T.Schwann proposed the cell theory. Rudolf

Ans. Virchow modified the cell theory and stated that every cell arises from pre-existing cell.

15. What is light microscope ?

Ans. An instrument consisting of a source of visible light and a system of glass lenses that allow an enlarged image of a specimen to be viewed.

16. What is electron microscope ?

An instrument that uses a beam of electrons to visualise cellular

Ans. structures and thereby examine cellular architecture; the resolution is much greater than that of light microscope, allowing detailed ultra-structural examination.

17. Is plasma membrane living or dead ?

Ans. Living.

18. What is plasma membrane ?

Plasma membrane or cell membrane is a thin delicate living elastic

Ans. membranous covering of the cell that separates the cell contents from the external environment.

19. Define the cell.

Ans. Cell is a unit mass of protoplasm which is covered by the plasma membrane and is capable of performing different functions of life.

20. What is protoplasm ?

Protoplasm or living matter is a complex semifluid mass of various

Ans. biochemicals that are often compartmentalized to perform different

functions of life.

21. Name the biomolecules present in plasma membrane.

Ans. Lipids (phospholipids, cholesterol), proteins and small quantity of carbohydrates (sugars and polysaccharides).

22. What is meant by selectively permeable membrane ?

Selectively permeable membrane is the one which allows entry of certain substances, exit of some substances but prevents the passage of other substances, through it.

23. What type of organization is found in the plasma membrane ?

Ans. Fluid mosaic organization.

24. Define Diffusion.

The process of movement of a substance (solid, liquid or gas) from the region of higher concentration to the region of lower concentration so as to spread uniformly is called diffusion.

25. What is osmosis ?

Diffusion of water through a semipermeable membrane from the region of its higher concentration (*i.e.*, dilute solution) to the region of its lower concentration (*i.e.*, concentrated solution) is known as **osmosis**.

26. What would happen if plasma membrane ruptures ?

Ruptured plasma membrane generally heals within no time but if rupturing does not heal, the cell contents will spill over and the cell is killed.

27. What is the main function of plasma membrane?

Ans. Plasma membrane defines the boundary of the cell and regulates the flow of materials into and out of the cell.

28. What is endosmosis ?

Ans. **Endosmosis** is the osmotic entry of water into a cell or system due to presence of hypotonic solution on the outside.

29. What is exosmosis ?

Ans. **Exosmosis** is the osmotic exit of water from a cell or system due to presence of hypertonic solution on the outside.

30. Define: (i) Hypertonic solution; (ii) Hypotonic solution, (iii) Isotonic solution.

(i) Hypertonic solution is the one which has higher osmotic concentration and less solvent concentration as compared to another solution.

Ans. (ii) Hypotonic solution is the solution that possesses lower osmotic concentration and higher solvent concentration as compared to another solution.

(iii) Isotonic solution is the solution that has the same concentration, osmotic as well as solvent, as that of another solution.

31. What is endocytosis ?

Ans. **Endocytosis** is the bulk transfer of materials from inside to the outside of a cell with the help of special vesicles formed by plasma membrane.

32. What is exocytosis ?

Exocytosis is the bulk expulsion of materials from inside to the outside

Ans. of a cell with the help of special vesicles (which ultimately get fused with the plasma membrane and turn out their contents).

33. Write down names of three types of endocytosis.

Ans. 1. Phagocytosis, 2. Potocytosis (= pinocytosis) and 3. Receptor mediated endocytosis.

34. What is active transport ?

Membrane protein-mediated movement of a substance across a

Ans. membrane against a concentration gradient. It is an energy-requiring process.

35. Is the plant cell wall living or dead?

Ans. Cell wall is dead.

36. Name two cell organelles, which contain their own genetic material.

Ans. Mitochondria and plastids.

37. Name the following :

(a) Kitchen of a cell; (b) Power house of cell.

Ans. (a) Chloroplast;
(b) Mitochondrion.

38. What is the chemical composition of cell wall in plants and fungi respectively ?

Ans. In plants cell wall is made up of cellulose, whereas, in fungi it is made up of chitin.

39. What is the main function of each of the following organelles ?

(a) Ribosome; (b) Cell wall

Ans. (a) Ribosome. It is site of protein synthesis in the cell.

(b) Cell Wall. It provides shape, rigidity and protection to the cell.

Name the cell organelle in which following structures are present :

- 40.** (a) Cristae;
(b) Stroma;
(c) Centriole;
(d) Chromosome.

(a) Mitochondrion;

- Ans.** (b) Chloroplast;
(c) Centrosome;
(d) Nucleus.

- 41.** **What is the main function of each of the following organelles? (a) Golgi bodies; (b) Vacuole.**

(a) Golgi bodies help in the formation of cell plate (during cell division

- Ans.** of plant cells) and synthesis of lysosomes and secretory vesicles.

(b) Vacuoles are involved in the maintenance of water balance.

- 42. What cell organelle is responsible for release of energy as ATP ?**

- Ans.** Mitochondria.

- 43. What for ATP stand ?**

- Ans.** Adenosine triphosphate.

- 44. Name the nucleic acids that are present in an animal cell.**

- Ans.** DNA and RNA.

- 45. Do the plant cells contain centriole ?**

- Ans.** No.

- 46. Write two differences between plant cell and animal cell.**

- Ans.** (i) Plant cells have cell wall which is absent in animal cell.

(ii) Plant cells lack centrioles whereas animal cells have centrioles.

Short Answer Questions (Carrying 2 marks each)

1. Distinguish between prokaryotic and eukaryotic cells.
2. Write down differences between organ and organelle.
3. Write down differences between nucleus and nucleoid.
4. Mention differences between light microscope and electron microscope.
5. Give a brief account of discovery of the cell.
6. Describe the proteins of plasma membrane.

- 7.** Enumerate functions of plasma membrane.
- 8.** Give an example of diffusion across plasma membrane.
- 9.** Set up an experiment to demonstrate osmosis.
- 10.** Write down the differences between diffusion and osmosis.
- 11.** Write a note on endocytosis.
- 12.** What would happen when eukaryotic cells are placed in hypotonic, hypertonic and isotonic solutions?
- 13.** Name the following :
 - (a) Smallest cell organelle
 - (b) Largest cell organelle;
 - (c) ER studded with ribosomes
 - (d) Functional segments of the DNA molecule.
- 14.** Distinguish between the following
 - (a) Chromoplast and chloroplast
 - (b) Ribosome and centrosome.
- 15.** Write main differences between plant and animal cells.
- 16.** What will happen in a cell if its nucleus is removed? Give reasons in support of your answer.
- 17.** Explain why do spinach look green, papaya yellow and edible part of water melon red ?
- 18.** Write down two main functions of
 - (a) Endoplasmic reticulum
 - (b) Lysosome.
- 19.** Name the following
 - (a) The cell organelle which synthesizes protein.
 - (b) The type of plastid which stores food.
- 20.** “Lysosomes are known as suicide bags”. Why?
- 21.** Define the following terms :
 - (a) Cell inclusions
 - (b) Cytosol
 - (c) Protoplasm
 - (d) Nucleoplasm.
- 22.** Where do the ribosomes get synthesized ?
- 23.** Write short notes on
 - (a) Mitochondria;
 - (b) Plastids.

24. Write names of cell organelles.
25. What are three main functional regions of the cell ?
26. What is the location of following in the cell:
 - (a) Chromatin
 - (b) Chromosome
 - (c) Tonoplast
 - (d) Nucleolus
27. What are the genes ? Where are they located in the cell ?
28. Lysosomes are also called digestive bags. Why?
29. Which organelle is the “power plant” of eukaryotic cell. Write in brief its functions.
30. What are centrioles? Write about their function.
31. Where do lipids and proteins constituting the plasma membrane get synthesised ?
32. Draw a well labelled diagram of typical prokaryotic cell ?
33. What does the term plasmolysed mean when used to describe a cell ?

Long Answer Questions (Carrying 5 marks each)

1. Describe with a diagram the fluid mosaic organisation of the plasma membrane.
2. Draw a well labelled diagram of animal cell and mention one function of the main cell organelles.
3. Give an illustrated account of nucleus.
4. Write short note on the following :
 - (a) Golgi apparatus
 - (b) Mitochondria

VALUE BASED QUESTIONS

Q. 1. How does a cell show division of labour ? Is there any parallelism

between working of the cell and our society?

A cell has a number of organelles such as plasma membrane, chloroplasts, mitochondria, endoplasmic reticulum, Golgi apparatus lysosomes, ribosomes, nucleus, vacuoles, etc. Every cellular organelle perform its specific function such as regulation of entry and exit of vital molecules by the plasma membrane, food (carbohydrate) synthesis by chloroplasts: they are one type of **transducers** of cells, converting energy of sunlight into chemical energy of carbohydrates (glucose, sugar and starch); energy liberation by mitochondria (mitochondria are other types of transducers of the cells, converting glucose's energy into ATP molecules); protein synthesis by ribosomes; lipid synthesis by smooth endoplasmic reticulum, transport of manufactured products to Golgi apparatus or to lysosomes; packaging of synthetic and finished items (glycoproteins, proteins, lipids, carbohydrates) for export; scavenging or digestion and utilisation of wornout organelles and imported items (via endocytosis) by lysosomes; in plant cell vacuoles act as the pool or storage tank; control by nucleus (DNA of chromosomes regulate all the activities of all cellular organelles by manufacturing various types of RNA molecules which ultimately synthesize specific proteins both structural and functional, which are the key of diversity of cells and species.

Ans. Human society can be compared with a cell. Police and security persons check entry and exit of persons of a city; city planners develop infrastructure of a city such as residential areas, colleges, schools, hospitals, markets, malls, roads, flyovers, railways, sewers; power engineers ensure regular supply of electricity to various establishments/industries and to produce vital products of daily use of human beings such as bread, milk, butter, tea, eggs, clothes, furniture, building materials, soaps, detergents. In this way masons, electricians, carpenters, plumbers, transporters, scavengers, traffic controllers, teachers, doctors, farmers, shopkeepers, managers, security persons, all have some specialised job/task to do for the human society. Activities of all sections of the human society are well coordinated according to some written/unwritten laws.

Q. 2. **Khushi wanted to eat rice and kidney bean (rajmah). She requested her mother to cook the same for lunch tomorrow. At night her mother took a cup of kidney bean and put them in a container having some water. She kept the container covered overnight. Next morning, she cooked rice and kidney beans for**

lunch. Khushi inquired her mother the following questions:

- (i) Why did she soak kidney beans in water overnight ?
- (ii) Name the scientific phenomenon involved in above process.
- (iii) Name atleast one more food item that is cooked in this way.

Kidney beans are seed and each cell of it is covered with porous cell wall and semipermeable plasma membrane. By

- Ans.** (i) the process of endosmosis, water is diffused in kidney beans upon soaking overnight and they get swollen and become palatable after cooking.
- (ii) Endosmosis.
- (iii) White grams (Kabul chana or choley or chicken pea (gram or chana).

Q. 3. One day Muskan saw her mother making pickle. Her mother cut the carrots, turnips and cauliflowers into small pieces, washed them and put them in the sun for few hours. Thereafter, she mixed common salt, oil, paste of onion, ginger and garlic, gur, red chilli, turmeric powder, acetic acid, etc., as per requirement with the cut vegetables and heated them. After cooling, she put the contents in the air tight jar and kept it in the sun for many days.

- (i) Why did Muskan's mother cut the vegetables into small pieces and put them in the sun for few hours ?
- (ii) Why did she mix common salt in the cut vegetables and heated it ? Name the process involved.
- (iii) Why did she mix acetic acid ?

Muskan's mother cut the vegetables into small pieces and put them into the sun (to get sunlight) for few hours so that they lose water by diffusion and evaporation and become dry.

She mixed common salt to the cut vegetables so that the cells of cut vegetables lose further water by exosmosis. Heating was done to evaporate the water. This is done to check the growth of microorganisms such as bacteria and fungi on the vegetables.

- (iii) Acetic acid is used as preservative; it kills the microorganisms.

Q. 4. What is the basis of long life of pickles and jams ? What lesson one gets from this fact ?

Pickles and jams have high concentration of osmotically active substances (such as salt in pickles, sugar in jams). They do not allow the microbial spores to germinate over them. Even on contamination, a microorganism cannot survive in them as it will undergo exosmosis and die.

Ans. Turmeric and acetic acid (or any preservative) too kills the microbes. Because of being microbe/germ free, pickles and jams do not get easily spoiled. Further life of pickles and jams is enhanced by keeping them in dry and cool places and handling of them by the neat and moisture - free (*i.e.*, dry) spoons.

An active and long life can also occur in human beings if they live in hygienic environment, avoid coming in contact with contaminated articles and visiting crowded places.

Q. 5. Arvind sometimes go for late evening walk with his father who has a background of biology. While walking in the colony park, he observed many plants having colour flowers. He also saw few plants having white flowers. Most of these flowers emit pleasant fragrance (= aroma). Out of curiosities, Arvind asked his father the following questions:

(i) Why do plants have variously coloured flowers ? Give two reasons.

(ii) Why do certain flowers emit fragrance ? How does fragrance of flowers spread in the environment ?

Which scientific phenomenon is involved when
(iii) (a) fragrance spreads in the house at the time of cooking of food in the kitchen; (b) exchange of gases occurs across the respiratory surface.

(a) Plants have variously coloured flowers to attract insects and other animals for pollination. Coloured flowers attract

Ans. (i) diurnal insects such as honeybees and butterflies, while white flowers attract nocturnal insects such as moths.

(b) The flowers are meant for sexual reproduction in plants.

Flowers contain nectar and spread fragrance in the environment to attract insects and other animals for

(ii) pollination.

Scent/fragrance spreads from flowers into surrounding environment through diffusion.

(iii) (a) Diffusion

(b) Diffusion.

Q. 6. What are the functions of plasma membrane ? How is the plasma membrane able to perform diverse functions. Give an example of diversity in functioning in any segment of human society.

Plasma membrane of the cell is a living motile (fluid) structure having lipids, proteins and externally attached sugars. It has a number of functions such as providing shape to cell, acting as mechanical barrier between cell contents and environment, selective permeability, endocytosis (e.g., paenocytosis, phagocytosis), recognition, flow of information, passage of water, flow of external fluids by cilia or absorption of nutrients by its microvilli.

Ans. The diverse functions of the plasma membrane are possible due to adaptation of proteins to form channels, enzymes, carriers, receptors and their attachment to small carbohydrates (oligosaccharides).

Like proteins, every human being has to perform different functions in the human society. For example, Muskan is daughter of her parents, sister of her brother, student of her school, a table tennis player, a friend to several class fellows, a companion of her pet, a gardner in home garden, a helper to her mother, a caretaker of her grand parents, an active social worker, etc.

Q. 7. (i) A fruit is green when unripe but become beautifully coloured when ripe. How does this change occur ?

(ii) What is the importance of this change ?

(iii) What is mutualism involved ?

(iv) Give an example of such a mutualism in human society.

An unripe fruit is green because it contains chloroplasts in its skin. Towards ripening of the fruit, the chloroplasts are

Ans. (i) changed into chromoplasts which give the fruit an attractive non-green colour such as yellow, orange, reddish, pink, purple, brownish, etc.

The colour of ripe fruits attracts animals. The coloured fruits

(ii) are often sweet and fleshy. Animals such as birds, monkeys, come to feed over the fruits.

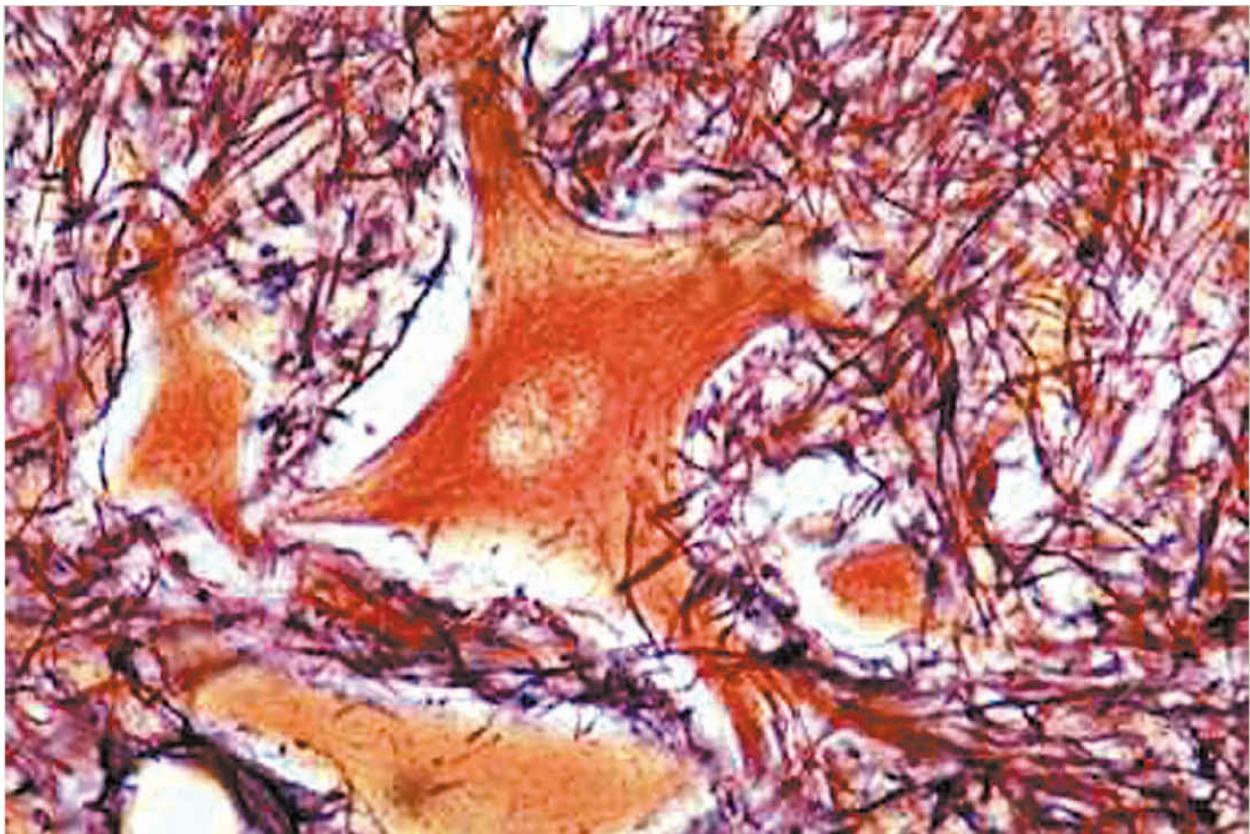
While eating the flesh of fruits, the animals pick up the seeds (iii) and take them to different places visited by them. This helps in the dispersal of seeds. Therefore by this action both the animals and the plants are benefitted. It is mutualism.

Mutualism or mutual dependence is the law of human

(iv) society. No body can live and work alone. Every body is dependent on somebody else for most of his/her activities. For example, household workers such as cook, utensil cleaner, washerman, gardner, driver, scavenger, hair dresser, tailor, etc., work for you for which you pay so that the worker is able to run his/her family.

CHAPTER 3

Tissues



3.1. DIVISION OF LABOUR

In [chapter 3](#), it has been described, that all living organisms are made of the cells. A unicellular organism (*e.g.*, *Amoeba*, *Paramecium*, etc.) has a single cell in its body, *i.e.*, a single cell

performs all basic life activities. For example, in *Amoeba*, movement of a cell, intake of food and respiratory gases (O_2), intracellular digestion, metabolism, respiration, osmoregulation and excretion are all done by the same cell. However, in multicellular organisms (e.g., human beings) there are millions of cells. Most of these cells are specialised to carry out only a few functions efficiently. These functions are taken up by different groups of cells. Thus, we can say that there is a **division of labour** in the multicellular organisms. For example, in human beings, muscle cells contract and relax to cause movement of a body part, nerve cells or neurons carry messages, blood flows to transport oxygen, food, hormones and waste materials (CO_2 , urea) and so on. Likewise, in plants, cells of phloem conducts food from leaves to other parts of the plant. Thus, we see that cells, which specialize in a function, are grouped together and form a tissue (Fr. *tissue-woven*). Blood, phloem, muscle are all examples of tissues.

The term tissue was coined by **Bichat** in 1792. Study of tissues is called **histology** (Gk. *histos* = tissue; *logos* = study; [Box 3.1](#)).

Box 3.1

1. **Marie Francois Xavier Bichat** (1771-1802) was a french anatomist and pathologist, the **father of histology**. Although working without the microscope, Bichat distinguished 21 types of elementary tissues from which the organs of the human body are composed.
2. **Marcello Malpighi** (1628-1694) is considered as **founder of histology**.
3. The term histology was coined by **Mayer** in 1819.

A group of cells similar in structure that work together to

perform a particular function forms a **tissue**. All cells of a tissue have common origin. For example, human nervous tissue (present in brain, spinal cord and nerves) has nerve cells or neurons ([Fig. 3.1](#)) which are basically same structurally and functionally. All nerve cells basically have a **cell body** or **soma** (the nucleus-containing central part of a neuron) which has two types of branches, namely **dendrites** (to receive messages) and an **axon** (to convey messages away from the soma). All neurons of nervous tissue originated from the same germinal layer called **ectoderm** (more aptly the neural ectoderm).

Importance of tissues. 1. Formation of tissues has brought about a division of labour in multicellular organisms. 2. Tissues become organised to form **organs** and **organs** into **organ systems**. 3. Workload of individual cell has decreased due to origin of tissues. 4. As a result of improved organisation and higher efficiency, multicellular organisms have higher survival.

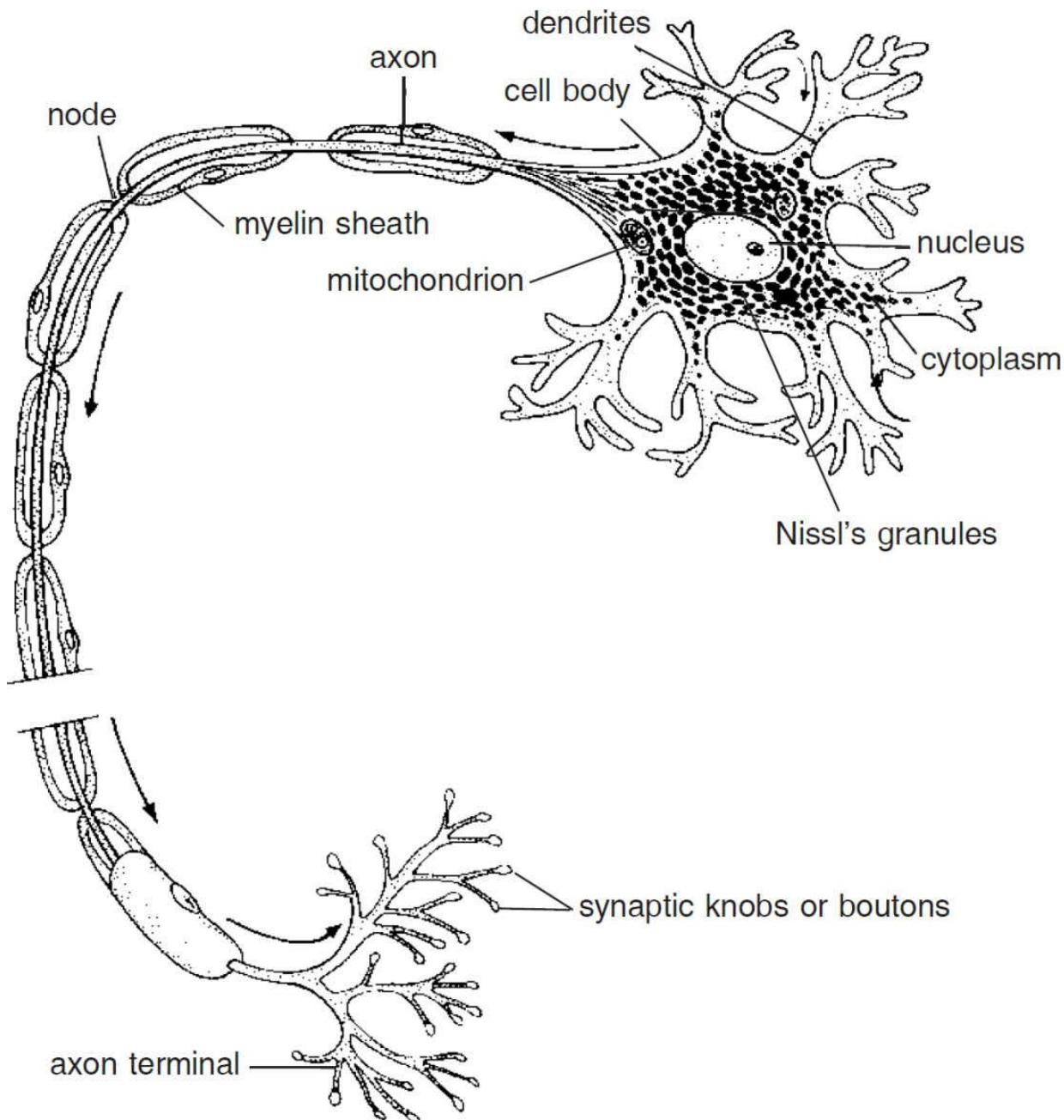


Figure 3.1. A neuron.

Why plants and animals are made of different types of tissues ?

Plants and animals are two different types of organisms. Plants are autotrophic organisms, so prepare their own food by photosynthesis. Moreover, plants are stationary or fixed organisms; they do not have to move from place to place in the search of their

food. Since they do not consume or need much energy, so most of the plant tissues are supportive, which provide them with structural strength. Most of these tissues such as xylem, phloem, sclerenchyma and cork are dead tissues ; they do not contain living protoplasm.

Animals on the other hand, are heterotrophic organisms. They have to move in search of food, mate and find shelter, so they need more energy as compared to plants. Most of the tissues they contain, are living (*i.e.*, they have living protoplasm).

Table 3.1. Differences between plant and animal tissues.

<i>Plant tissues</i>	<i>Animal tissues</i>
1. In plants, dead supportive tissues are more abundant as compared to living tissues.	1. In multicellular animals living tissues are more common as compared to dead tissues.
2. They require less maintenance energy.	2. They require more maintenance energy.
3. There is a differentiation of meristematic and permanent tissues.	3. Such a differentiation is absent in them.
4. Due to activity of meristematic tissues plants continue to grow throughout life.	4. Animals do not show growth after reaching maturity. Reparative growth is, however, present.
5. Organisation of plant tissues is simple.	5. Organisation of animal tissues is complex with the development of more specialised and localised organs and organ systems.
6. Tissues organisation is meant for stationary habit of plants.	6. Tissues organisation is targeted towards high mobility of animals.

Further, there are some tissues in plants which divide throughout life. They divide for the growth and reproduction of the plants. Such ever-dividing tissues are localised in certain regions of the plant body. Thus, based on the dividing capacity of the tissues,

various plant tissues can be classified as **meristematic** and **permanent tissues** ([Fig. 3.2](#)).

In contrast to plants, growth in animals is uniform. So there is no such demarcation of dividing and non-dividing regions in animals.

3.2. PLANT TISSUES

Plant tissues are of two types, meristematic and permanent. Permanent plant tissues are of two subtypes, simple and complex ([Fig. 3.2](#)).

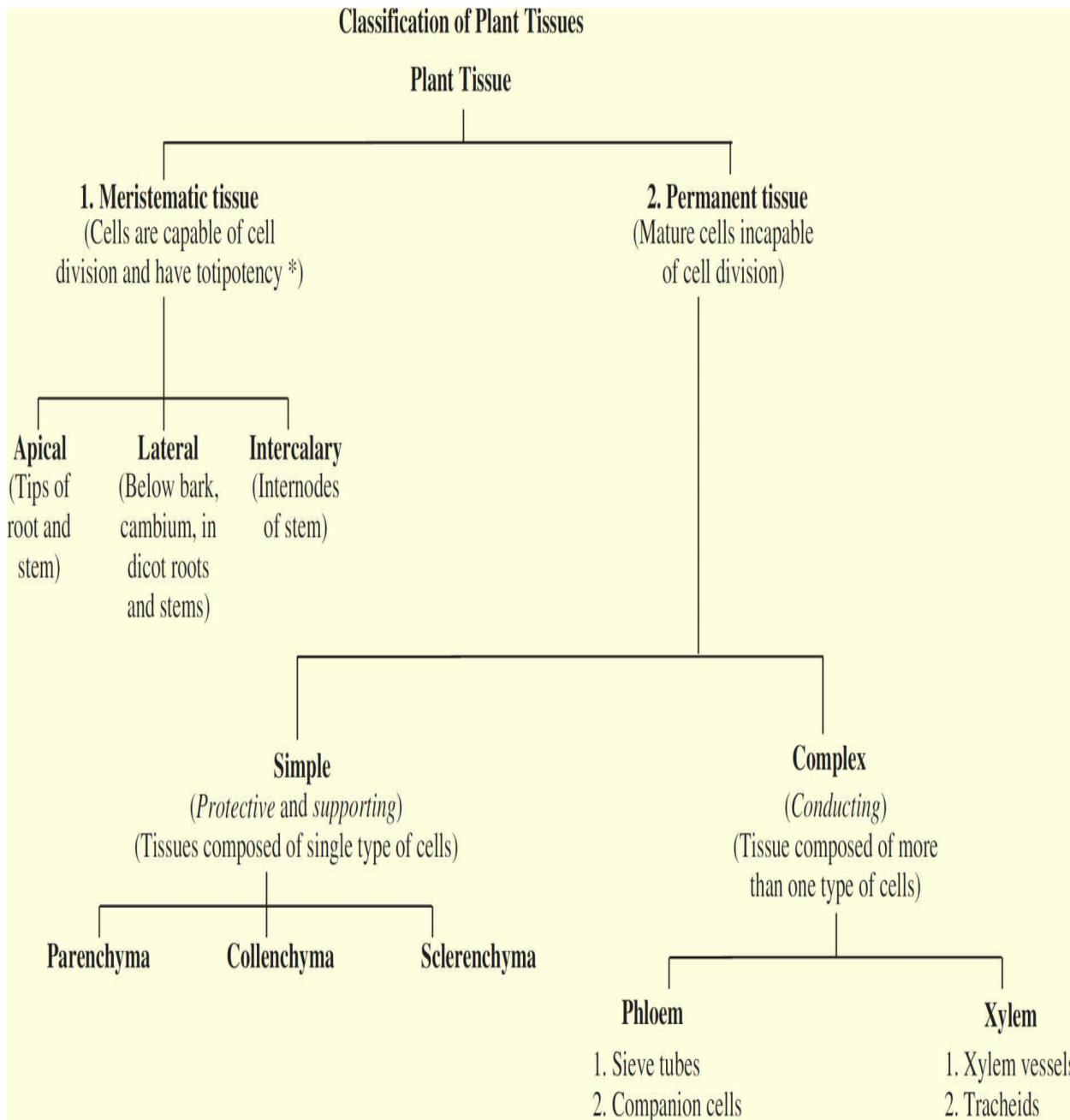


Figure 3.2. Different plant tissues.

* *Totipotent cells* are capable of giving rise to all the various cell types of the body of an organism.

1. Meristematic Tissues (Meristems)

Nature. Cells of meristems divide continuously and help in increasing the length and girth of the plant. These cells show the

following characteristics :

1. The cells of meristematic tissue are similar in structure and have thin cellulose cell walls.
2. The meristematic cells may be spherical, oval, polygonal or rectangular in shape.
3. The meristematic cells are compactly arranged and do not contain any intercellular space between them.
4. Each meristematic cell contains dense or abundant cytoplasm and a single large nucleus ([Fig. 3.3](#)).
5. The meristematic cells contain few vacuoles or no vacuoles at all.

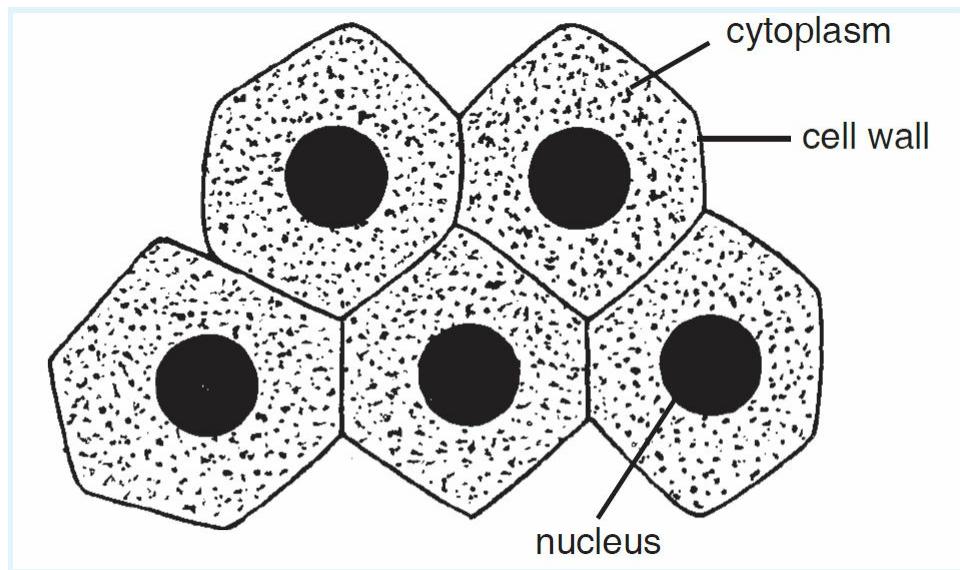


Figure 3.3. Meristematic tissue as seen in cross section.

Occurrence. Meristematic tissues are growth tissues and are found in the growing regions of the plant. According to their position in the plant, meristems are apical, lateral and intercalary.

1. Apical meristems. These are situated at the growing tip of stems and roots, *i.e.*, at shoot apex ([Fig. 3.4](#)) and root apex ([Fig. 3.5](#)). Apical meristems are also found at apices of the leaves.

2. Lateral meristems. These are found beneath the bark (called

cork cambium) and in vascular bundles of dicot roots and stems (called **vascular cambium**). They occur in thin layers. Cambium is the region which is responsible for growth in thickness.



3. Intercalary meristems. They are located at the base of leaves or internode, *e.g.*, stems of grasses and other monocots. Such tissues also occur below the nodes (*e.g.*, mint).

Functions.

1. Meristematic tissue acts as a parent tissue from which other tissues develop.
2. These tissues take part in growth by formation of new cells.
3. With the help of meristems, plants continue to produce new leaves, branches of stem and root, flowers, fruits and root hairs.
4. The place of injury in plants is healed up by the formation of new cells by meristems.
5. The plant shoots lodged or bent by wind are made to grow upright by activity of intercalary meristem. Different types of meristems have the following functions :

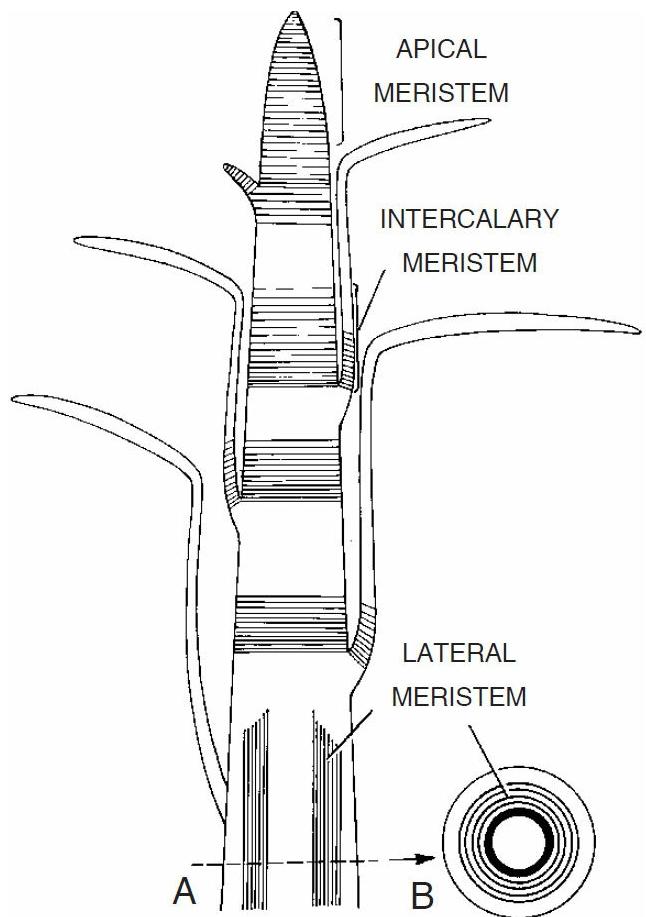


Figure 3.4. Longitudinal section of shoot apex showing location of meristem and young leaves.

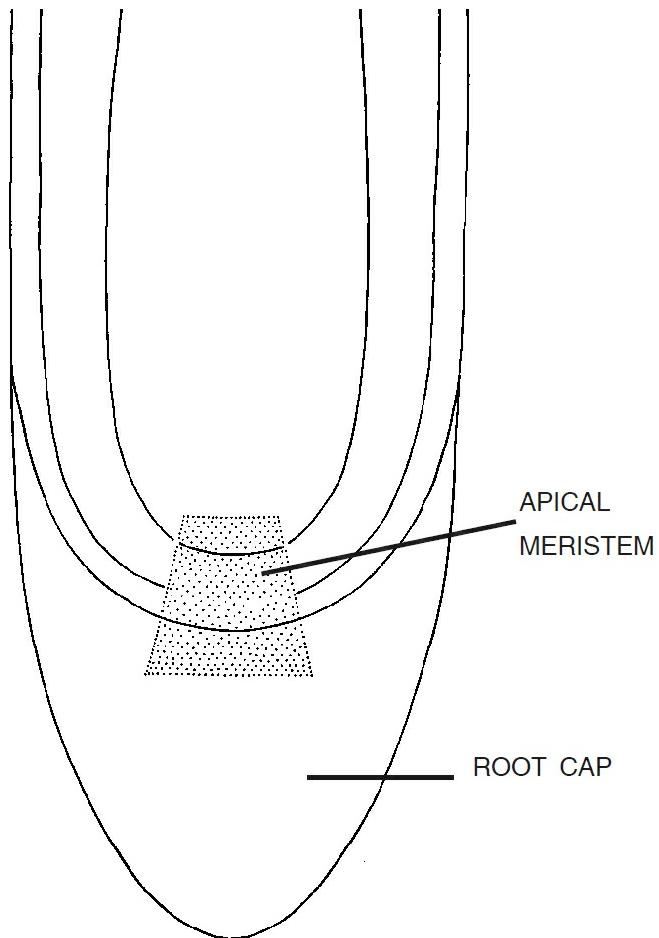


Figure 3.5. Longitudinal section of root apex showing the position of meristem.

1. Apical meristem. It brings about the elongation of the root and stem. It results in an increase in the height of the plant, which is called **primary growth**.

2. Lateral meristem. It causes the organ (stem or root) to increase in diameter and girth. This is called **secondary growth**.

For example, cork cambium or **phellogen** produces a protective cork on the outside and secondary cortex tissue inside.

3. Intercalary meristem. It produces an increase in the length of an organ such as leaves and internodes.

ACTIVITY 3.1

Apical meristem causes growth in length

Take two glass jars and fill them with water. In next step, take two onion bulbs and place one on each jar. Placement of the onion bulbs on the mouth of each jar should be in such a way that the stem and root parts of each onion remain in contact with water ([Fig. 3.6](#)). Observe the growth of roots in both the onion bulbs. Measure the length of roots on day 1, day 2 and day 3. However, on day 4 cut the root tips (i.e., up to 1 cm) in jar B. Observe the growth of roots in both jars for a few more days and record your observation in the following table :

Length of root	Day 1	Day 2	Day 3	Day 4	Day 5
1. Jar A					
2. Jar B					

From the above observations, answer the following questions :

1. Which of the jars has longer roots ?
2. Do the roots continue growing even after you have removed their tips ?
3. Why do the root tips stop growing in jar B after you have cut them ?

You may answer Q.1 that roots of jar are longer, since they have dividing cells at the root tip. In jar B, there will be no growth of roots, since they lack the dividing cells. Cut roots stop growing since there is no dividing tissue present.

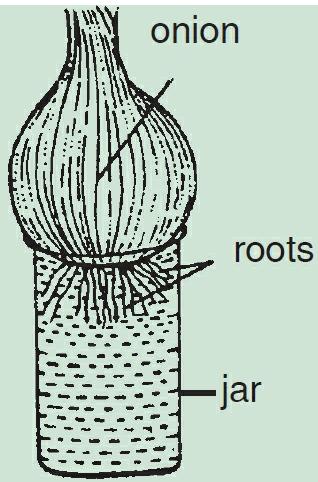


Figure 3.6. Method of putting onion bulb in a jar.

2. Permanent Tissues

What happens to the cells formed by meristematic tissue? Cells derived from division of meristematic tissue take up specific role and lose the ability to divide. They, thus, form, a type of permanent tissue. The developmental process by which cells derived from meristematic tissue, take up a permanent shape, size and function is called **differentiation**. In this way, cells of meristematic tissue differentiate to form cells of permanent tissues.

Different types of permanent tissues are formed due to differences in their specialization. Permanent tissues may be simple or complex. Their cells may be living or dead, thin-walled or thick-walled. Thickening may be regular or irregular ([Table 3.2](#)).

Table 3.2. Differences between meristematic and permanent tissue.

<i>Meristematic tissue</i>	<i>Permanent tissue</i>
1. Its component cells are small, spherical or polygonal and undifferentiated.	1. Its component cells are large, differentiated with different shapes.
2. Cytoplasm is dense. Vacuoles are nearly absent.	2. Large central vacuole occurs in living permanent cells.

3. Intercellular spaces are absent.	3. Intercellular spaces are often present.
4. Cell wall of its cells is thin and elastic.	4. Cell wall of its cells is thin or thick.
5. Nucleus of each cell of this tissue is large and prominent.	5. Nucleus of each cell of this tissue is less conspicuous.
6. Its cells grow and divide regularly.	6. Its cells do not normally divide.
7. It is a simple tissue.	7. It can be simple, complex or specialized.
8. Its cells are metabolically active.	8. Metabolic rate of cells of this tissue is slow.
9. Cell organelles of its cells are simple.	9. Cell organelles of its cells are well developed.
10. Cells of this tissue do not contain crystals and other inclusions.	10. Cells of this tissue possess crystals and other inclusions.
11. Its cells are living.	11. Its cells may be living or dead.
12. It provides growth to the plant.	12. It provides protection, support, conduction photosynthesis, storage, etc.

ACTIVITY 3.2

To understand the structure and function of various types of permanent plant tissues you have to study **anatomy** of plant organs such as root, stem, leaves, flowers, etc. For studying the plant anatomy, you have to cut thin transverse sections or slices of internode of young and old stems ; stain them with safranin stain, mount the stained section in glycerine and study the slide, under the compound microscope. For this exercise, you should take help of your teacher. This anatomical exercise is called **section cutting** ([Activity 3.3](#)).

Box 3.2

Study of gross internal structure of an organ, as observed in a section, is called **anatomy** (Greek *ana* = up ; *temnein* = to cut). In other words, anatomy is the study of the way in which tissues and organs are arranged in organisms.

ACTIVITY 3.3

Section Cutting. It involves the following steps :

1. Select a piece of stem (monocot or dicot) having 1–2 mm diameter, and keep it in water in a watch glass.
2. Cut a cylindrical piece of potato, carrot or radish and make a vertical slit in it. This is known as **pith** and it keeps delicate cutting material erect and gives a firm hold.

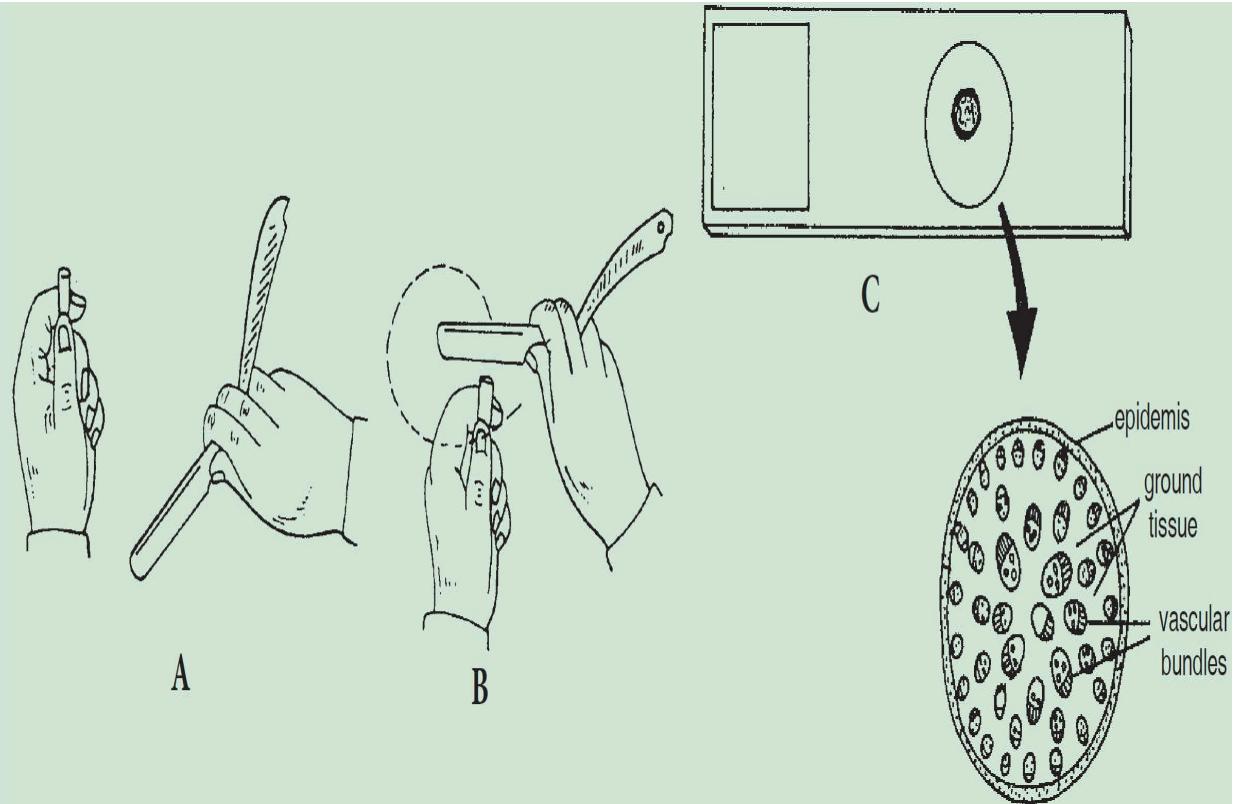


Figure 3.7. Method of section cutting and slide preparation.

3. Insert the material for section cutting, into slit made in pith. Keep the pith holding the material in your left hand.
4. Hold the razor in your right hand with blade facing you and handle at right angle to it. Start cutting transverse sections with uniform but fast motion from outside facing you.
5. Collect the sections cut on the edge of the blade with the help of a fine drawing/painting brush, and put them in clean water in a watch glass to avoid drying.
6. Select a thin section of uniform thickness and stain it with safranin.
7. Mount this stained section on a clean slide in glycerine. Cover it with a cover slip and study under the compound microscope.

1. Simple permanent tissues. These tissues are composed of cells which are structurally and functionally similar. Thus, these tissues are all made of one type of cells.

(i) **Parenchyma**

Nature. Parenchyma (Gr., *para* = beside; *enchyma* = in-filling) forms the bulk of the plant body. Parenchyma cells are living and possess the power of division. The cells are rounded or **isodiametric**, i.e., equally expanded on all sides ([Fig. 3.8](#)). The parenchymatous cells are oval, round, polygonal or elongated in shape. The cell wall is thin and encloses a dense cytoplasm which contains a small nucleus and surrounds a large central vacuole. In other words, parenchyma cells have living protoplasm. Inter-cellular spaces are abundant (i.e., parenchyma has loosely-packed cells).

Occurrence. The parenchyma is widely distributed in plant bodies such as stem, roots, leaves, flowers and fruits. Thus, the parenchyma tissue is found in the soft parts of the plant such as cortex of roots, ground tissues in stems and mesophyll of leaves. It is also distributed in pith, medullary rays and packing tissue in xylem and phloem.

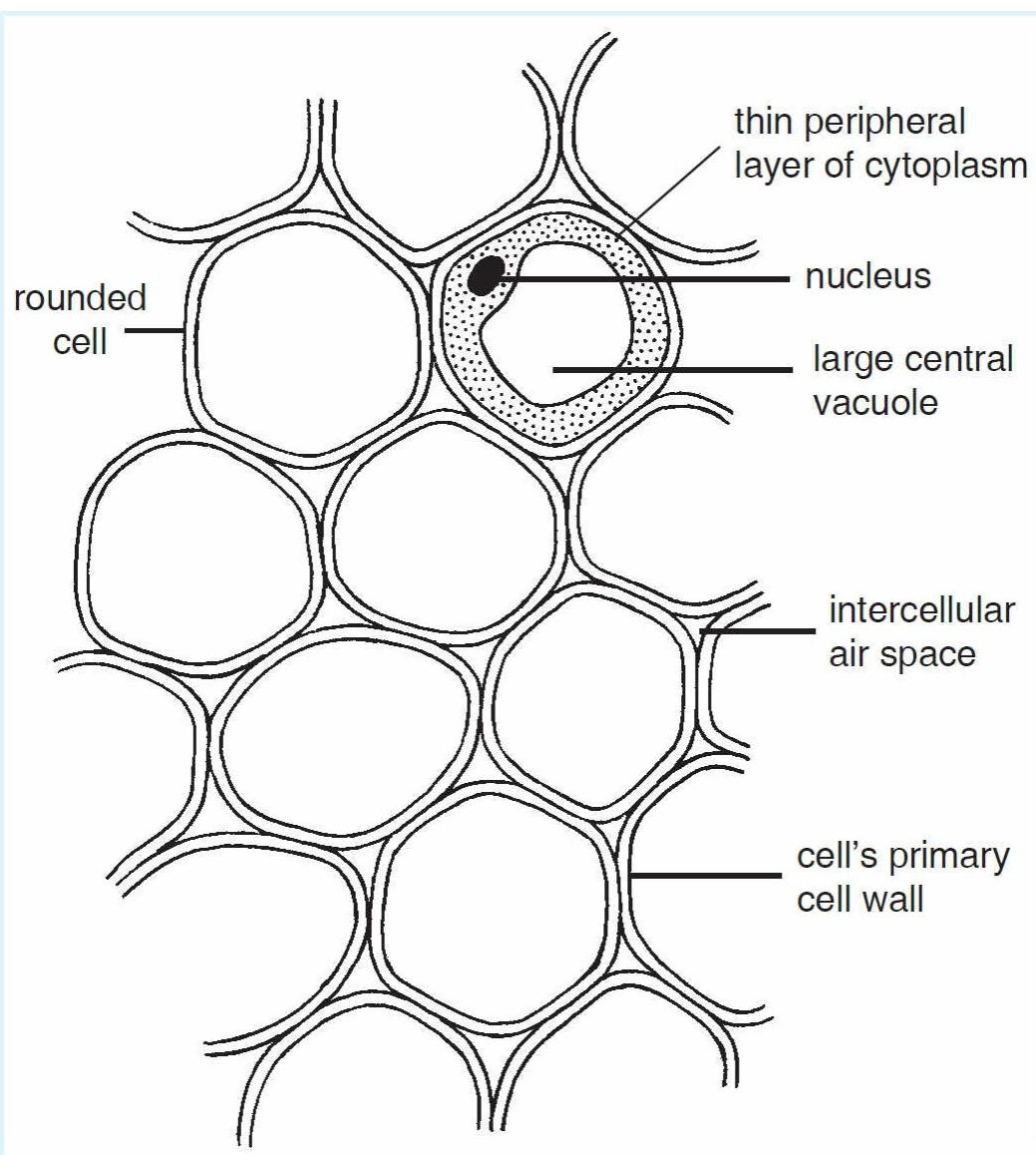


Figure 3.8. Parenchyma tissue.

Functions :

1. Parenchyma serves as a packing tissue, to fill the spaces between other tissues and maintain the shape and firmness of the plant due to its turgid cells.
2. Due to turgidity (osmotic) property, parenchyma acts as a primary support to the stem of herbaceous plants.
3. The main function of parenchyma is to store and assimilate food. Parenchyma serves as **food storage tissue**, e.g., starch

(present in amyloplasts) in the parenchyma of cortex of potato tuber.

4. Transport of materials occurs through cells or cell walls of parenchyma cells.
5. Parenchyma cells are metabolically active; their intercellular air spaces allow gaseous exchange.
6. Parenchymatous tissue stores waste products of plants such as tannin, gum, crystals, resins or inorganic waste, etc.
7. If chloroplast is present, the parenchyma tissue is called **chlorenchyma** and it performs photosynthesis, e.g., the mesophyll of leaves.
8. In hydrophytes (aquatic plants) such as water hyacinth, *Hydrilla* ([Fig. 3.9](#)), large air cavities are present in parenchyma to give buoyancy to the plants. Such a type of parenchyma is called **aerenchyma**.
9. In xerophytes (arid plants), e.g., succulents (plants having fleshy parts) parenchyma acts as a water storage tissue.

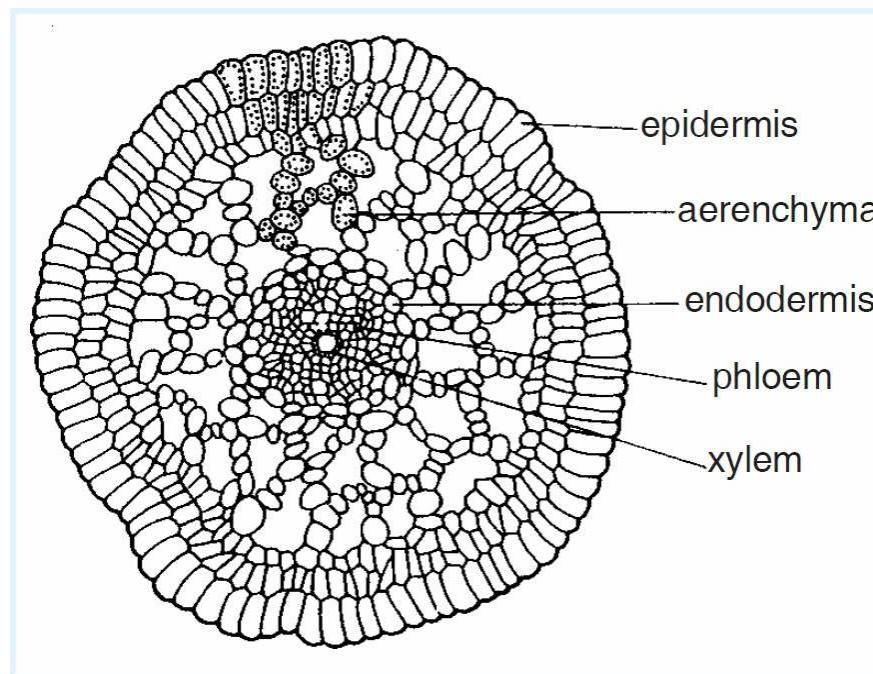


Figure 3.9. T.S. of *Hydrilla* stem.

(ii) Collenchyma

Nature. Collenchyma (Gr., *kolla* – glue) tissue also consists of living cells. It shows many features of parenchyma, but is characterised by the deposition of extra cellulose at the corners of the cells ([Fig. 3.10](#)). In collenchyma, intercellular spaces are generally absent. Collenchyma cells are elongated in shape. They often contain a few chloroplasts.

Occurrence. The cells of collenchyma are located below the epidermis (*i.e.*, hypodermis) of dicotyledon stem and petiole (leaf stalk) (*i.e.*, in outer region of cortex). These cells also occur in the midribs of dicot leaves. Collenchyma is absent in monocot stems, roots and leaves.

Functions :

Collenchyma is a **mechanical tissue** in young dicotyledonous stems and provides mechanical support and elasticity. Thus, collenchyma provides tensile strength with flexibility to those organs in which it is found. It allows easy bending in various parts of a plant (leaf, stem) without actually breaking it. When cells of collenchyma contain some chloroplasts, they manufacture sugar and starch.

Table 3.3. Differences between parenchyma and collenchyma.

Parenchyma	Collenchyma
1. The tissue consists of thin-walled living cells.	1. The tissue consists of cells having localised thickening in their cell walls.
2. It is distributed in almost all the parts of the plant body.	2. It occurs mostly in the aerial parts of the plants and is restricted to the other layers.
3. The living cells of parenchyma	3. Collenchyma is the chief mechanical tissue in parts of a

assimilate and store food. They also store waste products.

young plant particularly in the young dicotyledonous stems.

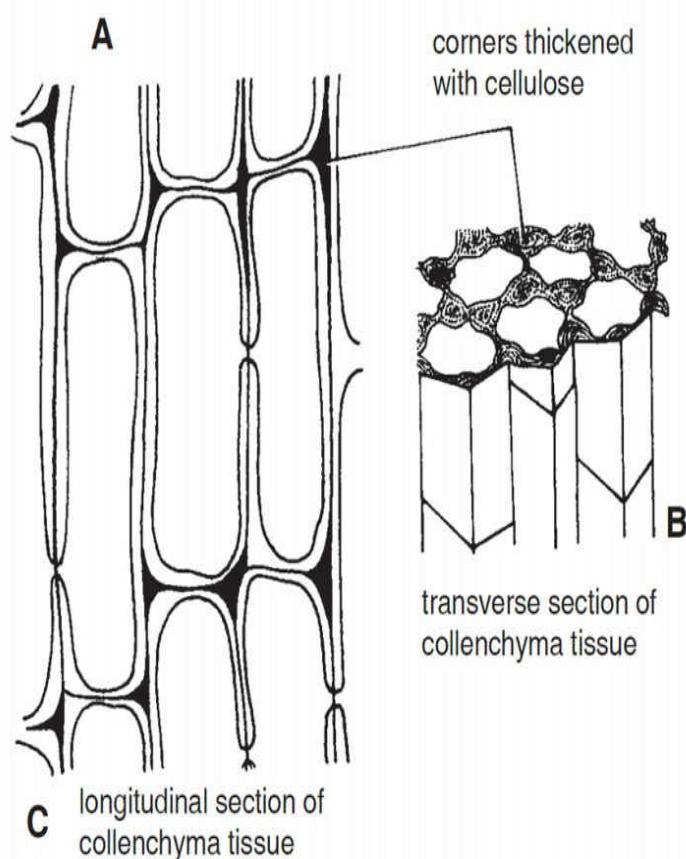
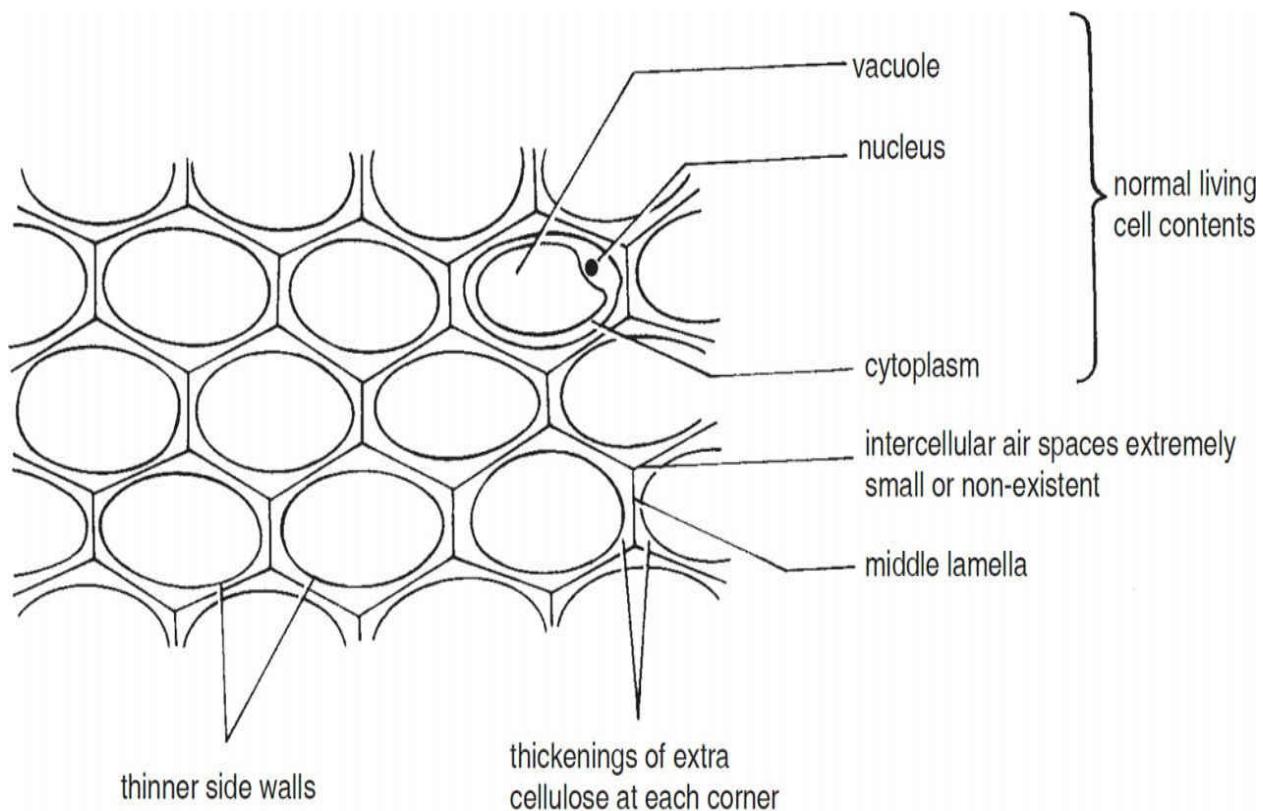


Figure 3.10. Collenchyma. A–T.S. cells ; B–T.S. cells showing deposition of cellulose at corners; C–L.S. cells.



(iii) Sclerenchyma

Sclerenchyma cells (Gr. *sclerous* – hard) are dead cells and they are devoid of protoplasm. The cell walls of sclerenchyma are greatly thickened of **lignin** ([Box 3.3](#)). Such cell wall, walls are called **lignified**. Due to excessive thickening of a sclerenchyma cell wall, its cell cavity or lumen becomes nearly absent. The cells of sclerenchyma are closely packed without intercellular spaces. Thus, these cells are fitted together like tiles in a mosaic floor. A conspicuous **middle lamella** exists between two sclerenchymatous cells. Middle lamella is a thin layer of cementing substance containing pectin, lignin and protein; it occurs between cell walls of two adjacent plant cells.

Box 3.3

Lignin is a complex polymer which acts as a cement and hardens cell wall. It provides flexibility and great tensile and compressional strength. A high **tensile strength** means that it does not break easily on stretching, and a high **compressional strength** means that it does not buckle easily.

Lignin makes the cell wall impermeable, so important

substances are unable to pass through it. As a result, cells that are heavily lignified do not have living content (= protoplasm).

Cells of sclerenchyma are of two types : fibres and sclereids. **Fibres** consist of very long, narrow, thick and lignified cells. The length of sclerenchymatous cells varies from 1 mm to 550 mm in different plants. Fibres are usually pointed at both ends and are clustered into strands and look polygonal in transverse section. In contrast to fibres, **sclereids** (also called **grit cells** or **stone cells**) are irregular-shaped. (e.g., sclereids may be spherical, oval, cylindrical, T-shaped, dumbbell- shaped or stellate). They are dead and develop in various parts of the plants such as cortex, pith, phloem, hard seeds, etc. Often oblique thin areas are found in the thick walls of both fibres and sclereids. These are called **pits** ([Fig. 3.11](#)).

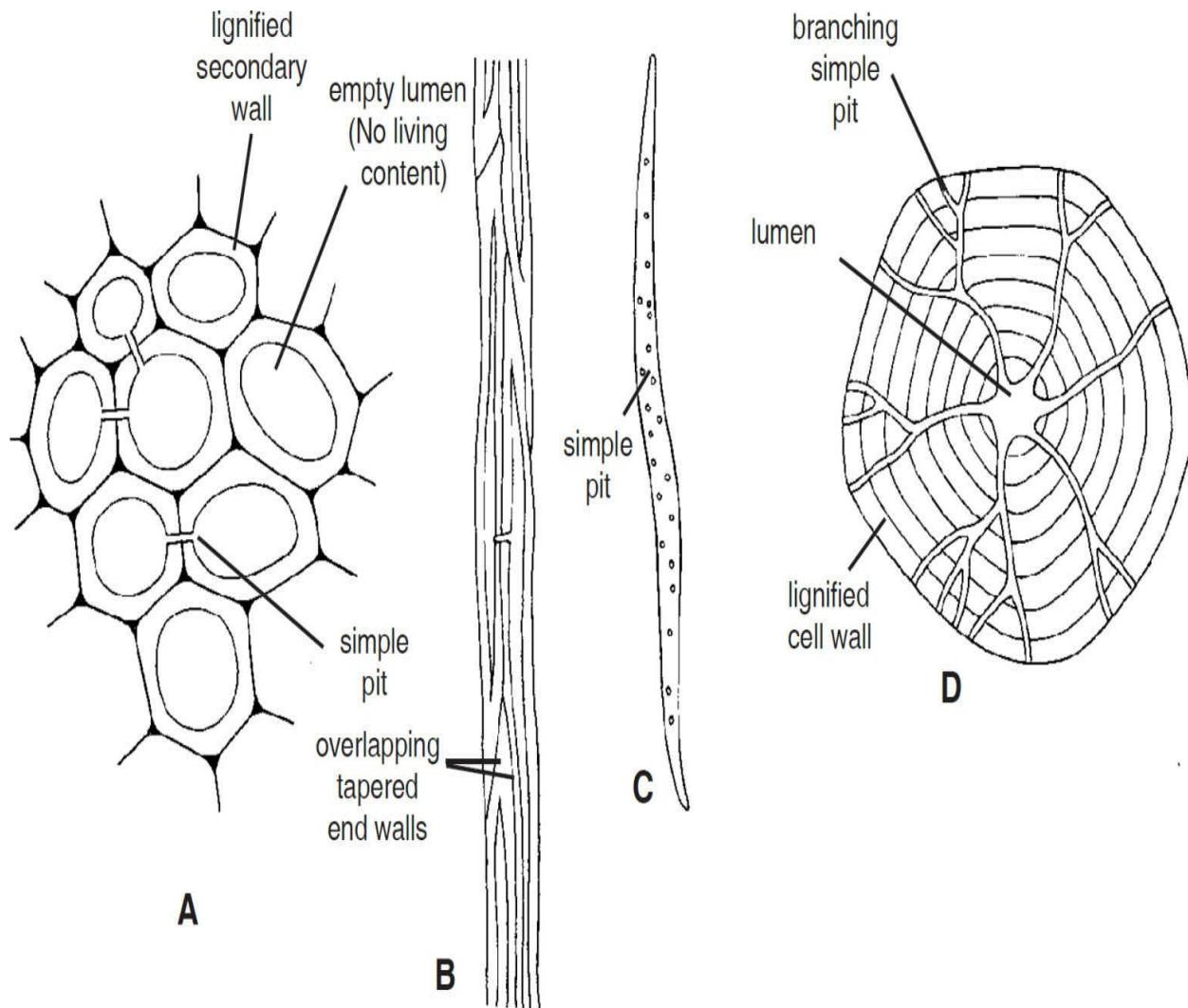


Figure 3.11. Structure of sclerenchyma cells. A–T.S. cells are polygonal in outline; B–L.S. cells are elongated; C–Three-dimensional appearance; D–Sclereid.

Occurrence. The sclerenchyma occurs in abundance either in patches or definite layers. They are found in stems (around the vascular bundle), roots, veins of leaves, hard coverings of seeds and nuts. Sclereids form the gritty part of most of the ripe fruits and contribute hardness to the seed coat and nutshells.

Husk of coconut is made of sclerenchymatous tissue. It is present in mesocarp of fruit of coconut (*Nariyal*) and yield *coir* a well known fibre used for mats, cordage (ropes and cords), brushes,

etc.

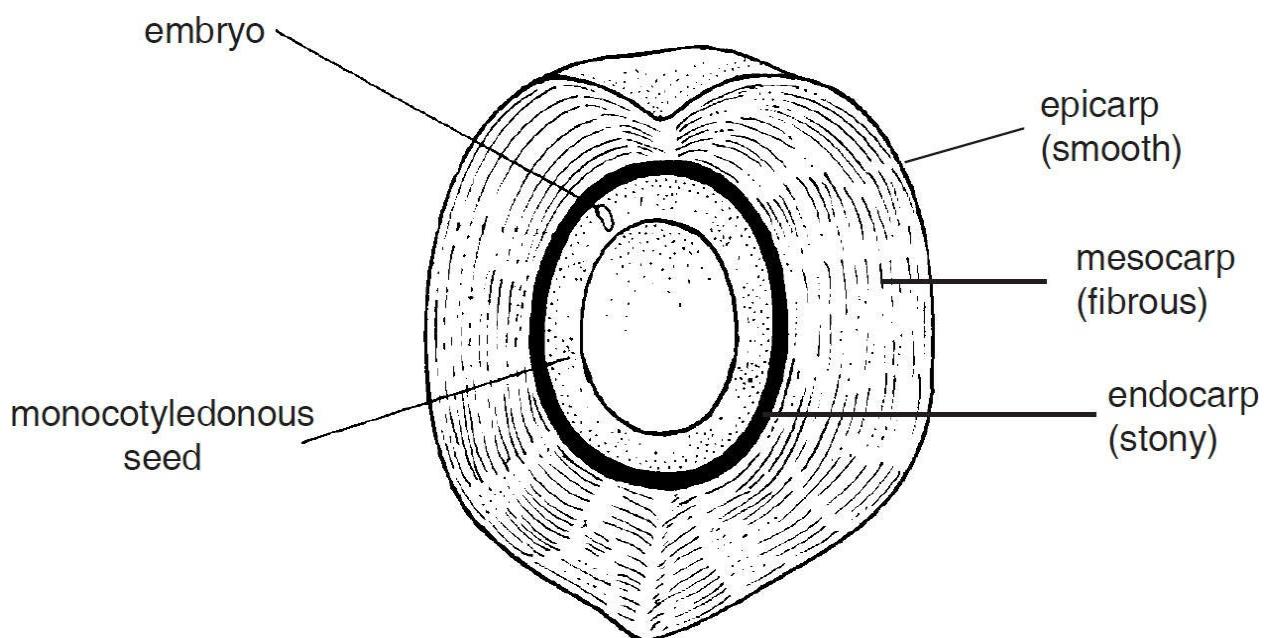


Figure 3.12. T.S. of coconut fruit.

Table 3.4. Differences between sclerenchyma fibres and sclereids.

<i>Sclerenchyma fibres</i>	<i>Sclereids</i>
1. They are elongated, spindle-shaped, thick-walled dead cells.	1. They are broad thick-walled dead cells.
2. They are arranged in bundles, nets and cylinders.	2. They occur singularly or in small groups.
3. They do not form covering of any plant organ.	3. They form hard covering of nuts and seeds.
4. They provide mechanical strength.	4. They provide stiffness.

Functions. The sclerenchyma is mainly mechanical and protective in function. It gives strength, rigidity, flexibility and elasticity to the plant body and, thus, enables it to withstand various strains.

Table 3.5. Differences between collenchyma and sclerenchyma.

<i>Collenchyma</i>	<i>Sclerenchyma</i>

1. It consists of living cells.	1. It consists of dead cells.
2. Its cells contain cytoplasm.	2. Its cells are empty.
3. Its cell walls are cellulosic.	3. Its cell walls are lignified.
4. The thickening of cell wall is not uniform.	4. Cell wall thickening is uniform.
5. Lumen of the cell is wide.	5. Lumen of the cell is narrow.
6. It provides mechanical support and elasticity to the plant body.	6. It is chiefly mechanical tissue.

Study of Stem Tissues

Under the microscope, observe the various types of cells and their arrangement. Compare it with [figure 3.13](#).

On the basis of your observation, try to answer the following questions :

1. Are all cells similar in structure ? How many types of cells can be seen ?
2. Can you think of a reason as to why there are so many types of cells ?

You will find that sections of sunflower stems (*Helianthus annus*) have different types of cells in it. Together they have 7 types of cells : epidermal cells, collenchyma, parenchyma, sclerenchyma, xylem, phloem and cambium (= lateral meristematic cells). All of these cells perform different functions; such as conduction of water (xylem), transport of food (phloem), protection (epidermis), support (collenchyma, sclerenchyma), food storage (parenchyma) and growth (cambium). Thus, from this activity you have learnt that different groups of tissue cells present in a plant organ help the organisms to perform different functions efficiently.

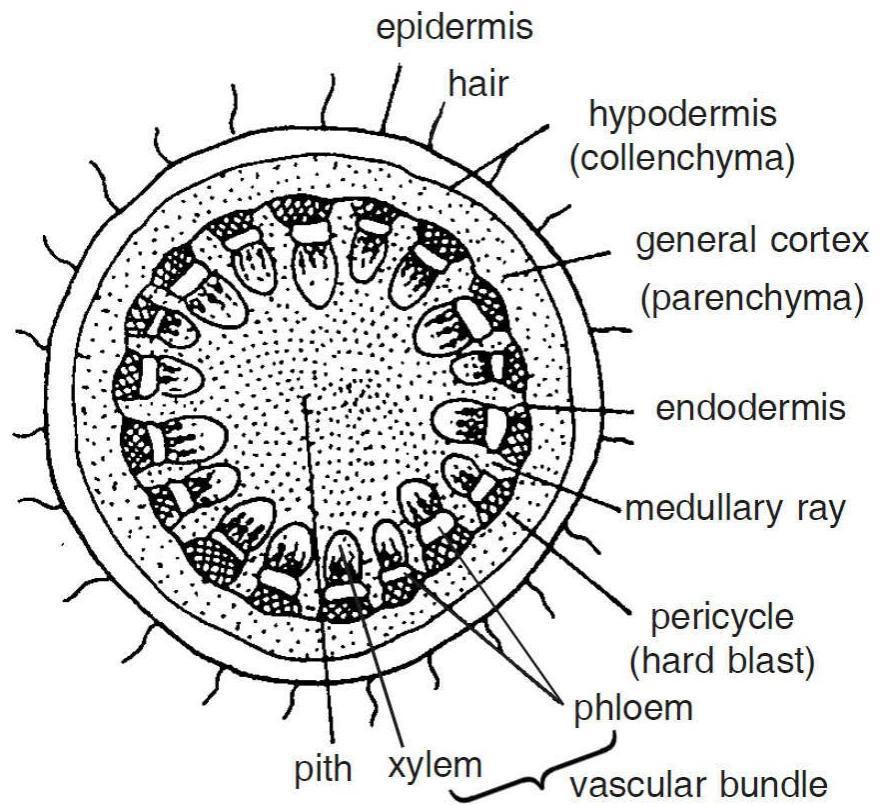


Figure 3.13A. Transverse section of a dicot stem (*e.g.*, sunflower).

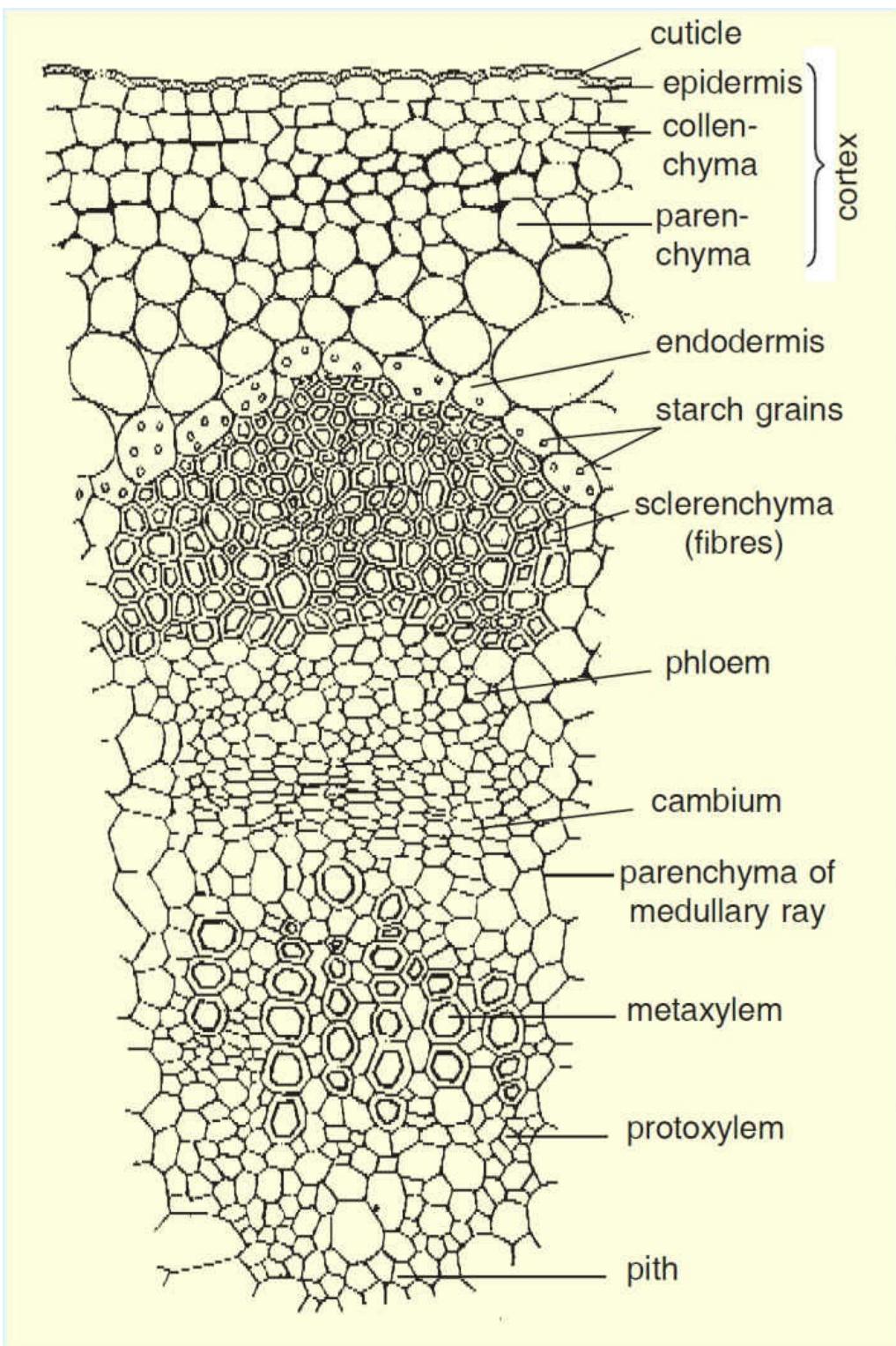


Figure 3.13B. T.S. of stem of sunflower showing different tissues.

You can try to cut sections of stems and roots of different plants

(monocots and dicots) and study them.

Protective Tissue

Protective tissues include *epidermis* and *cork* (or **phellem**).

ACTIVITY 3.4

(i) Take a freshly plucked leaf of *Rhoe* plant. Stretch it from its upper side and break it by applying pressure. While breaking it, stretch gently so that peel or skin projects out. Place this peel in petridish filled with water. Add a few drops of safranine stain to it. Observe it under a microscope.

This outermost layer of cells in leaves is single layered. It forms the peel of an organ, the epidermis.

(ii) Boil a small piece of stem of *Cucurbita*/sunflower/castor/*Coleus* in water containing few drops of nitric acid and a pinch of potassium chlorate. Wash the boiled material gently. Stain it with 1% aqueous safranin and tease the tissues apart on a glass slide with the help of needles. Draw tracheids, vessel elements, fibres, sieve elements and companion cells.

1. Epidermis. The epidermis (Gr. *epi* = upon, *derma* = skin) is usually present in the outermost layer of the plant body such as leaves, flowers, stem and roots. Epidermis is one cell thick and is covered with **cuticle**. Cuticle is a water proof layer of a waxy substance called **cutin** which is secreted by epidermal cells. Cuticle possesses variable thickness in plants, for instance it is more thicker in xerophytic (or desert) plants. Cells of epidermis are elongated and flattened and do not contain any intercellular space between them ([Fig. 3.14](#)). Their inner contents are similar to parenchyma cells (they are living cells).

The main function of epidermis is to protect the plant from desiccation and infection. In fact, cuticle of epidermis helps to reduce water loss by evaporation from the plant surface and also helps in preventing the entry of pathogen (bacteria, fungi etc.).

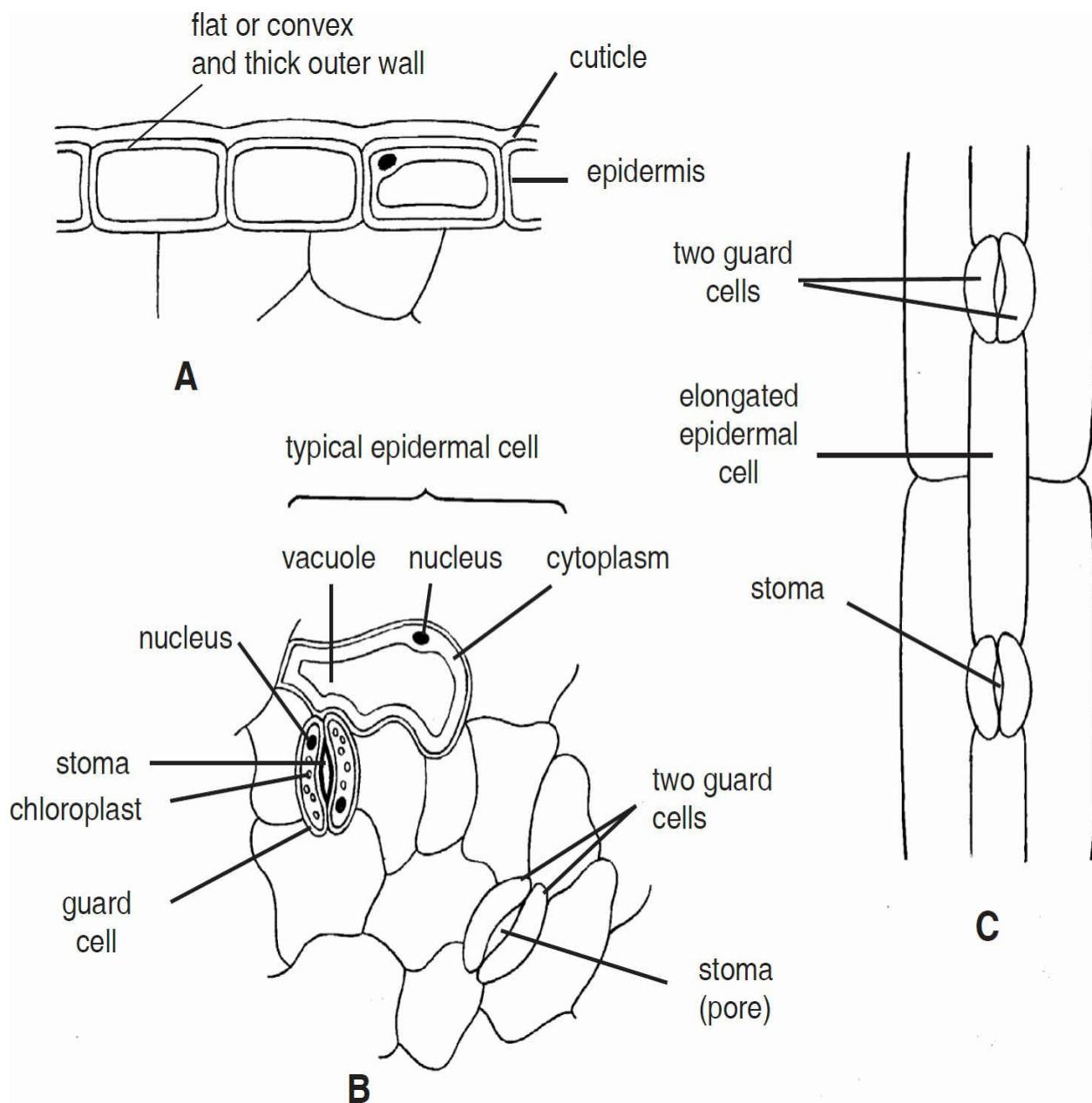


Figure 3.14. Structure of epidermal cells. A– Epidermal cells in transverse section (T.S.); B–Epidermis of a dicot leaf in surface view; C–Epidermis of a monocot leaf in surface view.

The aerial surfaces of many plants bear cutinised hair ([Fig. 3.13A](#)) over their epidermis. They are called *trichomes*. They reduce the rate of transpiration. The seeds of cotton contain numerous long unicellular hairs which form the husk of cotton. In roots, the younger parts are covered with uncutinised layer of epidermis called **epiblema**. Some of the epiblema cells give rise to tubular outgrowths called **root hairs**. These long unicellular root hairs increase the absorptive surface area of the root. They pass into the soil interspaces to absorb water and minerals.

2. Cork. As plants grow older, the outer protective tissue (*i.e.*, epidermis) undergoes certain changes. A strip of secondary meristem, called **phellogen** or **cork cambium** replaces epidermis of stem. Cork cambium is a simple tissue having only one type of cells. The cells of cork cambium are rectangular and their protoplasts are vacuolated and contain tannins and chloroplasts. Cork cambium gives off new cells on its both sides, thus, forming cork (phellem) on the outer side and the **secondary cortex** or **phellogerm** on the inner side. The layer of cells which is cut by cork cambium on the outer side ultimately becomes several layered thick **cork** (bark) of trees. Cells of cork are dead and compactly arranged without intercellular spaces. The walls of cork cells are heavily thickened with an organic substance (a fatty substance), called **suberin** deposits. Suberin makes these cells impermeable to water and gases. The cork cells do not contain protoplasm but are filled with resin or tannins. In case of an onion bulb too, in the skin of onion the cell walls become thick and water proof due to addition of suberin.

Box 3.4

Cork and bark are not the same structures. While cork

includes outer products of cork cambium, the bark includes the outer products of cambium such as secondary phloem and also cork cambium and cork.

Cork is protective in function. Cork cells prevent desiccation (loss of water from plant body), infection and mechanical injury. Cork is light and does not catch fire easily. Due to these properties, cork is used as insulators, shock - absorbers, linoleum (used as flooring) and sports goods (in making of shuttle cocks, cricket balls, wooden paddles of table tennis, etc.) Commercial cork is obtained from the stem surface of cork oak tree (*Quercus suber*) found in Southern Europe and North Africa.

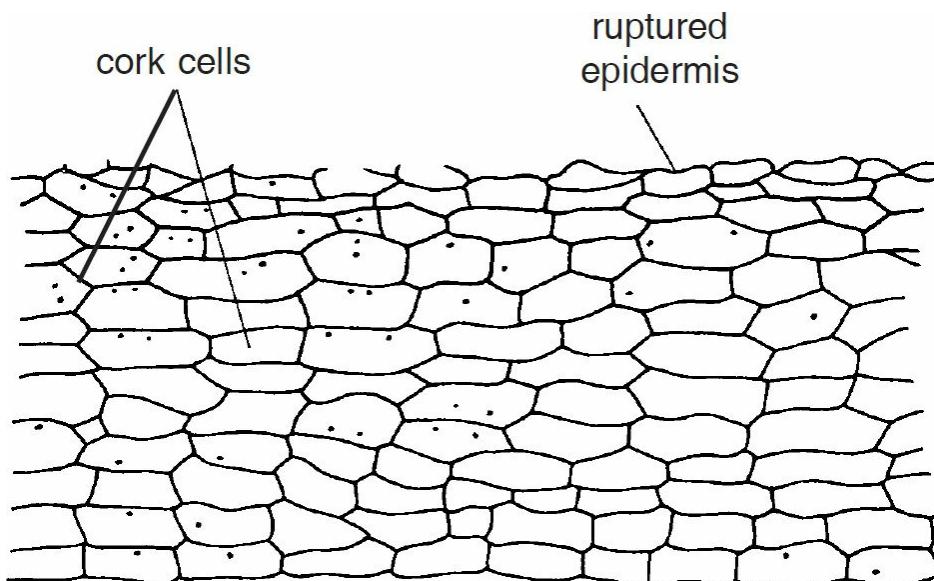


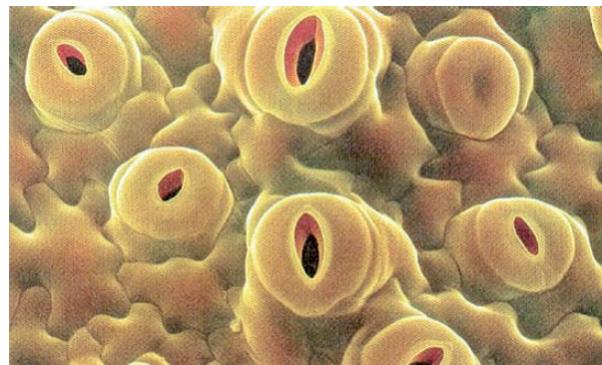
Figure 3.15. Transverse or cross section of a cork piece showing dead cells.

Stomata

Epidermis of a leaf is not continuous at some places due to the presence of small pores, called **stomata**. Each stoma is bounded by a pair of specialised epidermal cells or two kidney-shaped cells called **guard cells**. The concave sides of these guard cells face each

other and have a space forming stomatal opening ([Fig. 3.14 B, C](#)). Guard cells are the only epidermal cells which contain chloroplasts, the rest being colourless.

The stoma allows gaseous exchange to occur during photosynthesis and respiration. During transpiration too, water vapour also escapes through stomata ([Box 3.5](#)).



Stomata.

Box 3.5

During photosynthesis, carbon dioxide gas is taken in by the stomata from the atmosphere and oxygen gas is released (*i.e.* O₂ is a byproduct of photosynthesis). However, during respiration of plants, oxygen is taken in and carbon dioxide is released via stomata. Photosynthesis takes place during day time (in light), but respiration occurs both in the day and night time.

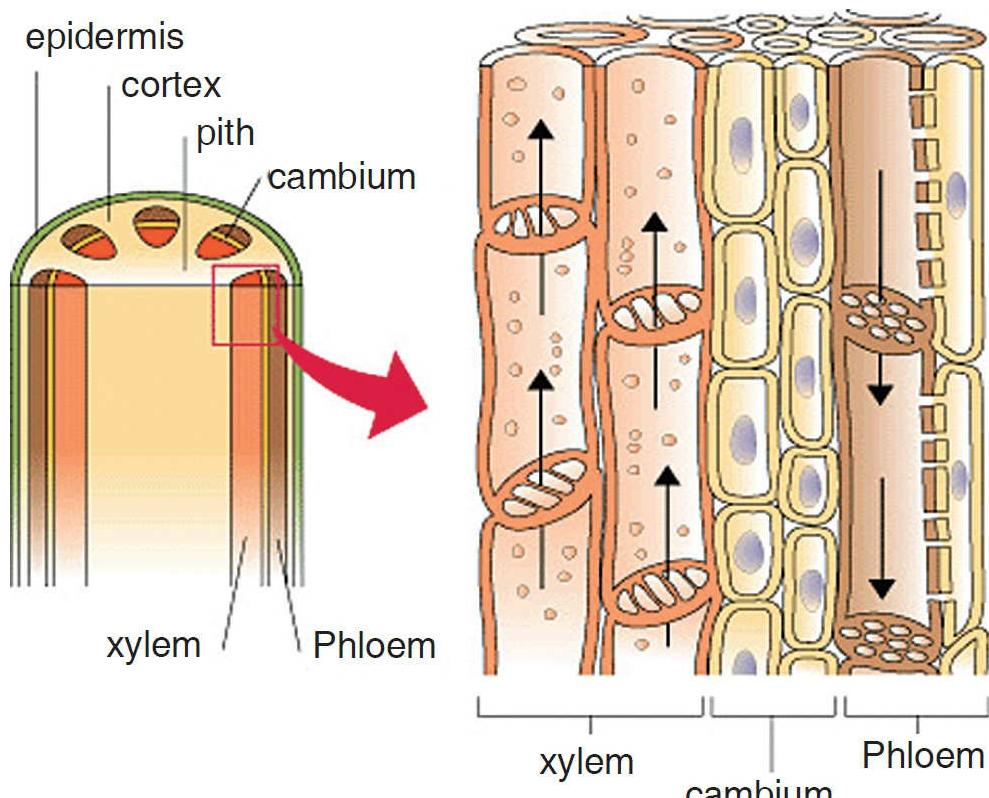
The process of transpiration helps the xylem tissue in the conduction of water and dissolved mineral salts by mass flow mechanism.

2. complex permanent tissues. The complex tissues consist of more than one type of cells having a common origin. All these cells coordinate to perform a common function. Complex tissues

transport water, mineral salts (nutrients) and food material to various parts of plant body. Complex tissues are of following two types :

1. Xylem or wood;
2. Phloem or bast

Xylem and phloem are both conducting tissues and also known as **vascular tissues**; together both of them constitute **vascular bundles**.



Complex permanent tissues.

(i) Xylem

Nature. Xylem (Gr. *xylos* = wood) is a vascular and mechanical tissue. In other words, it is a **conducting tissue**. Xylem is composed of cells (called **elements**) of four different types: 1. **Tracheids**; 2. **Vessels or tracheae**; 3. **Xylem parenchyma** and 4.

Xylem sclerenchyma (or fibre). Except xylem parenchyma, all other xylem elements are dead and bounded by thick lignified walls ([Box 3.6](#)). Of these four types of cells of xylem, most important cells are vessels. Vessels are shorter and wider than tracheids ([Fig. 3.16](#)). **Vessels** are very long tube-like structures formed by a row of cells placed end to end. The transverse walls between the vessel elements are partially or completely dissolved to form continuous channels or water-pipes. **Tracheids** are elongated cells with tapering ends. They also conduct water. Since tracheids do not have open ends like the vessels, so that water has to pass from cell to cell via the pits. Xylem parenchyma stores food and helps in lateral conduction of water.

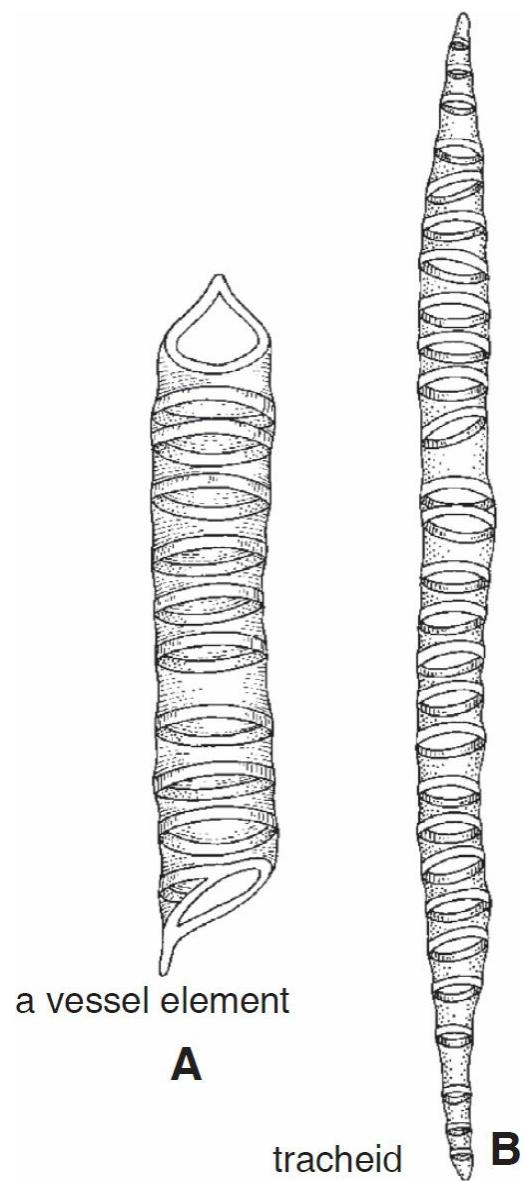


Figure 3.16. Xylem. A – Vessel element ; B – Tracheid.

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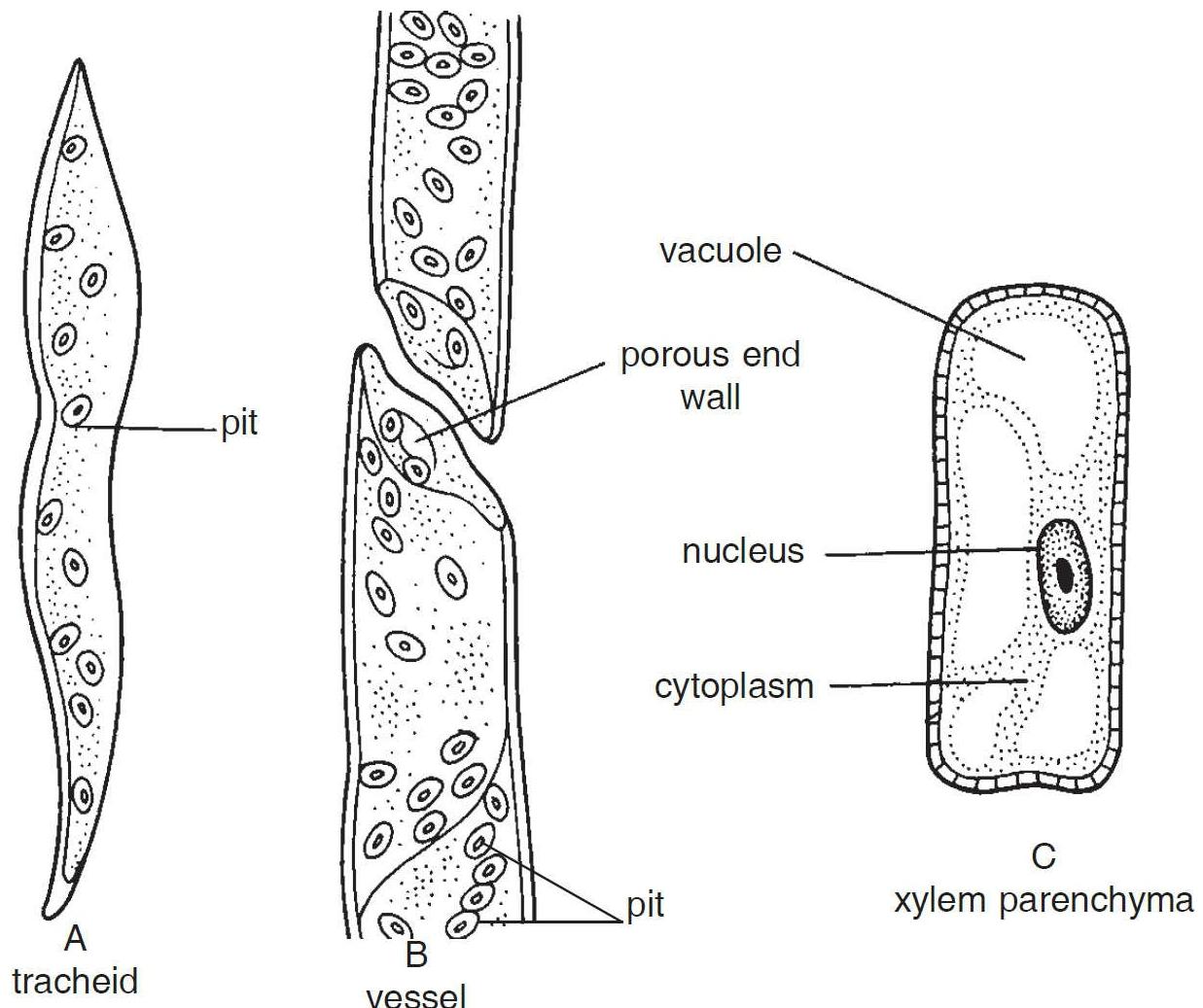


Figure 3.17. Different xylem elements.

Table 3.6. Differences between tracheids and vessels.

<i>Tracheids</i>	<i>Vessels</i>
1. Single celled.	Made up of a row of cells.
2. The end walls remain intact.	End (= transverse) walls gets dissolved and become perforated.
3. The walls of tracheids are very thick with a narrow lumen.	The walls of vessels are less thick and they have a wider lumen.

Box 3.6

How pits are formed in vessels ?

No lignin is laid down where plasmodesmata were present in the original cell walls. These non-lignified areas are known as **pits** and they allow water to pass sideways between one xylem vessel and the next.

As vessels and tracheids of xylem have the lignified cell walls, so, this simply mean that these cells are hollow and there are no cell contents to restrict the flow of water.

Functions. 1. The main function of xylem is to carry water and mineral salts upward from the root to different parts of shoots.

2. Since walls of tracheids, vessels and sclerenchyma of xylem are lignified, they give mechanical strength to the plant body.



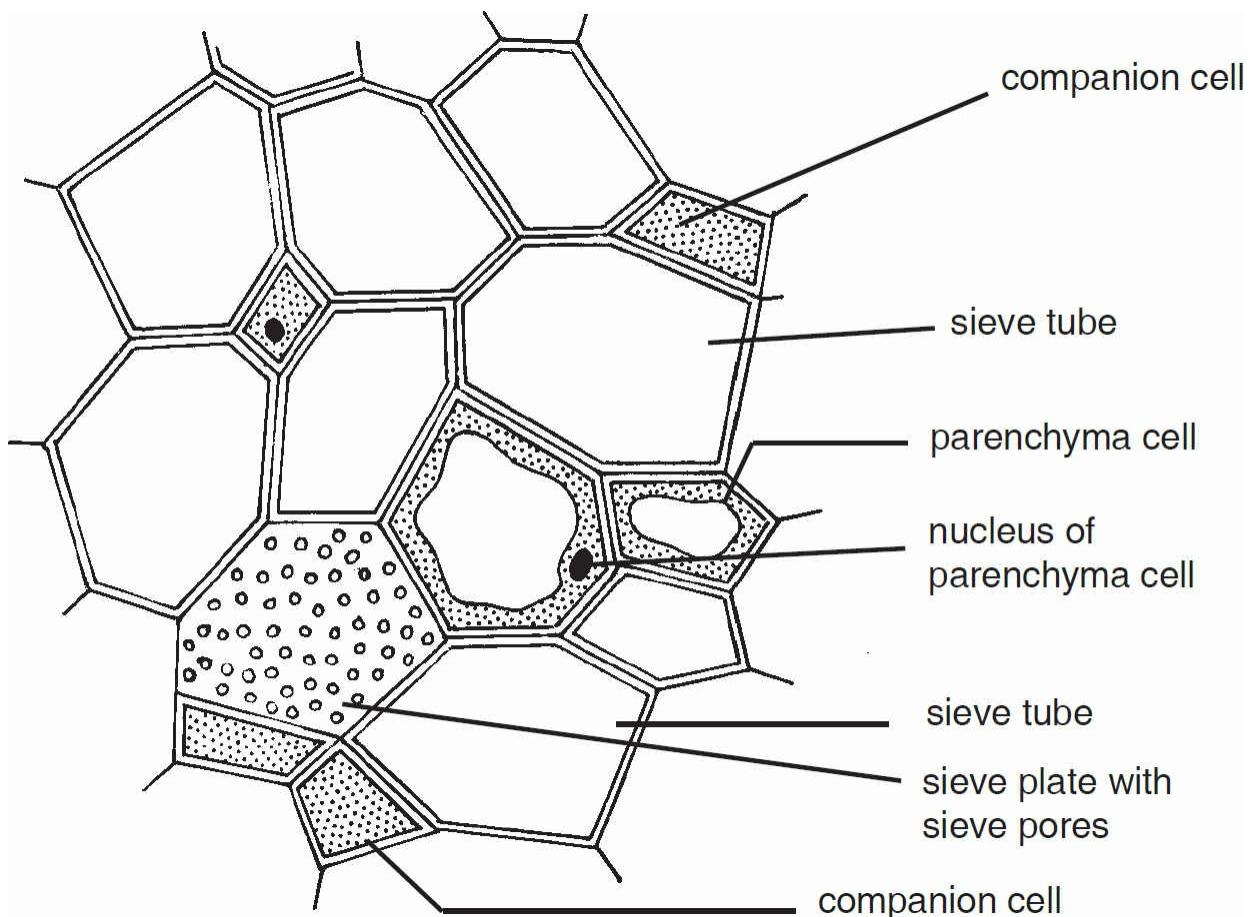


Figure 3.18. T.S. of phloem tissue.

(ii) Phloem

Nature. Like xylem, phloem (Gk. *phloos* = bark) contains tubes but performs no mechanical function. Phloem is composed of following four elements or cells. 1. **Sieve tubes**, 2. **companion cells**; 3. **Phloem parenchyma** and 4. **Phloem fibres** ([Fig. 3.18](#) and [Fig. 3.19](#)). Except for phloem fibres, phloem cells are living cells.

Table 3.7. Differences between xylem and phloem

Xylem	Phloem
1. It conducts water and minerals.	1. It conducts organic solutes or food materials.
2. Conduction is mostly	2. In it conduction may be bidirectional, i.e., from leaves to

unidirectional, <i>i.e.</i> , from roots to apical parts of the plant.	storage organs or growing parts or from storage organs to growing parts of plants.
3. Conducting channels or tracheary elements are tracheids and vessels.	3. Conducting channels are sieve tubes.
4. Components of xylem include tracheids, vessels, xylem parenchyma and xylem fibres.	4. Components of phloem include sieve tubes, companion cells, phloem parenchyma and phloem fibres.
5. Three of the four elements of xylem are dead (<i>i.e.</i> , tracheids, vessels and fibres). Only xylem parenchyma is living.	5. Three of four elements are living (<i>i.e.</i> , sieve tubes, companion cells and phloem parenchyma) only phloem fibres are dead.
6. In addition to conduction, xylem provides mechanical strength to the plant.	6. Phloem performs no mechanical function for the plants.

Box 3.7

Although sieve tube elements do not have nuclei, but *they still remain living*. It is so because they are dependent on adjacent companion cells, which develop from the same original meristematic cell. The two cells, together form a functional unit. Companion cells have extra number of mitochondria and ribosomes.

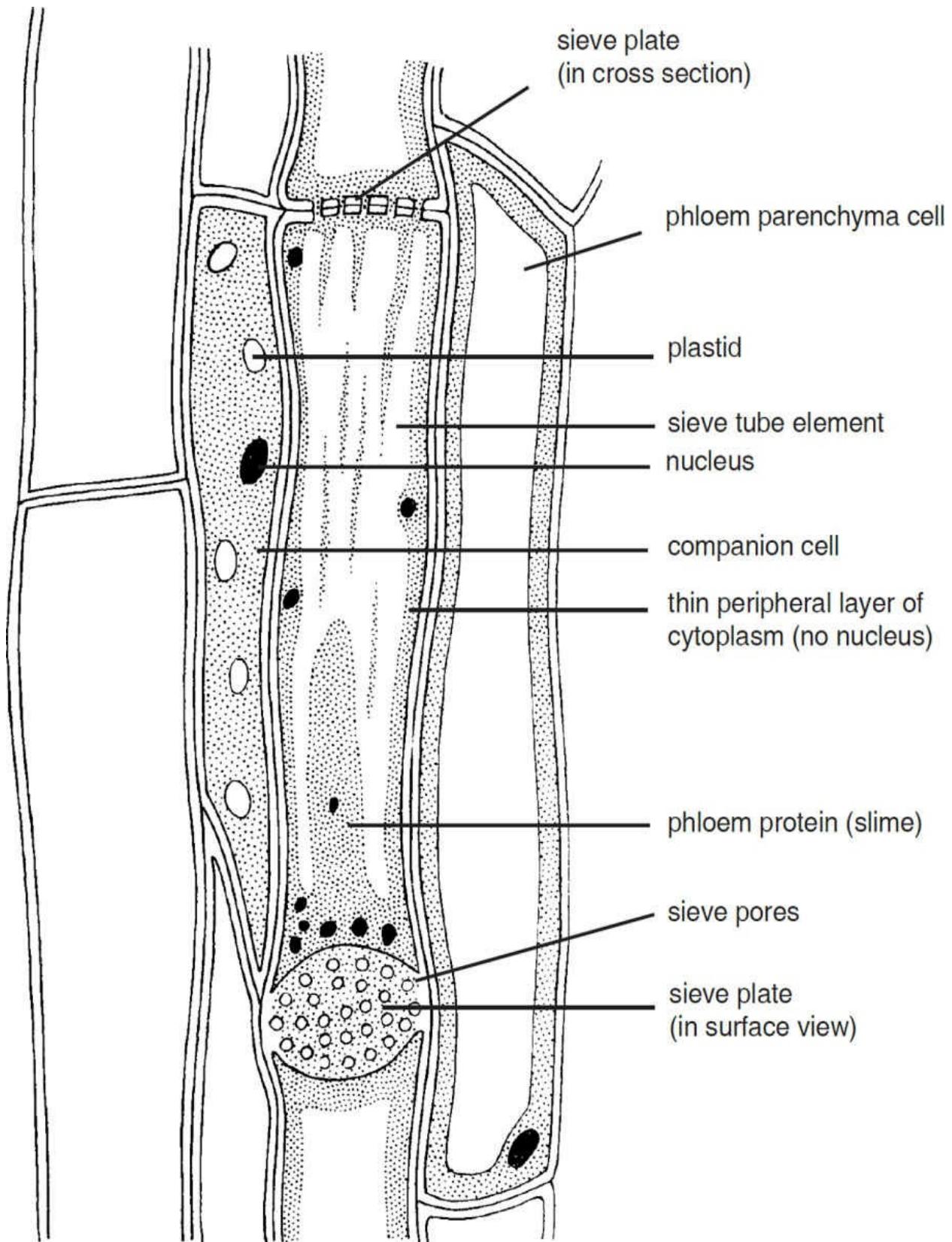


Figure 3.19. L.S. of phloem tissue (showing living elements only).

1. Sieve tubes. Sieve tubes are slender, tube-like structures composed of elongated thin-walled cells, placed end to end. Their end walls are perforated by numerous pores and are called **sieve plates** ([Fig. 3.18](#), [Fig. 3.19](#)). Walls of sieve tubes are perforated. The nucleus of each sieve cell degenerates at maturity, however, cytoplasm persists in the mature cell. Thus, nuclei are absent in mature sieve tube elements. The cytoplasm of one sieve tube element is continuous with those of other sieve elements above and below due to cytoplasmic connections passing through the pores of the sieve plate.

2. Companion cells. Generally associated with the sieve tube is a small thin-walled cell containing dense and very active cytoplasm and large elongated nucleus. It is called a **companion cell** and it is connected to the sieve tube with numerous plasmodesmata ([Box 3.7](#)).

3. Phloem parenchyma. These are thin-walled, living cells of parenchyma of phloem. They have two functions, storage and slow lateral conduction of food.

4. Phloem fibres or bast fibres. These are thick-walled, elongated spindle-shaped dead cells which possess narrow lumen. They provide mechanical strength to the tissue. Bast fibres obtained from some plants such as jute, hemp, flax has commercial or economic value.

Functions. Phloem transports (conducts) photosynthetically prepared food materials from the leaves to the storage organs and later from storage organs to the growing regions of the plant body.

3.3. ANIMAL TISSUES

Breathing is one of the most vital activity for humans. When we breathe, we can, in fact, feel the movement of our lungs and

diaphragm. How do these parts move inside our body ? For breathing, we have specialized cells in our bodies, called muscle cells. The contraction and relaxation of these muscle cells result in movement.

During breathing, we inhale oxygen gas (along with air). Where does this oxygen go ? It goes to our two lungs and then is transported to all cells of our body through the blood. So, why do cells need oxygen? Mitochondria present in each and every cell of our body, utilises oxygen to generate energy in the form of ATP molecules. These ATP molecules provide energy for all sorts of activities performed by our body cells.

Blood is a *fluid connective tissue*. It flows and connects different parts of body. It carries oxygen and food to all cells and in return collects metabolic wastes (*e.g.*, carbon dioxide) from them.

Thus, muscles and blood, both are examples of tissues found in our body. On the basis of the functions they perform in the body of multicellular animals, the animal tissues are classified as 1. Epithelial tissue; 2. Muscle or muscular tissue; 3. Connective tissue and 4. Nervous tissue. Muscle forms the muscular tissue and blood is a type of connective tissue.

These tissues are further differentiated as shown in the following chart :

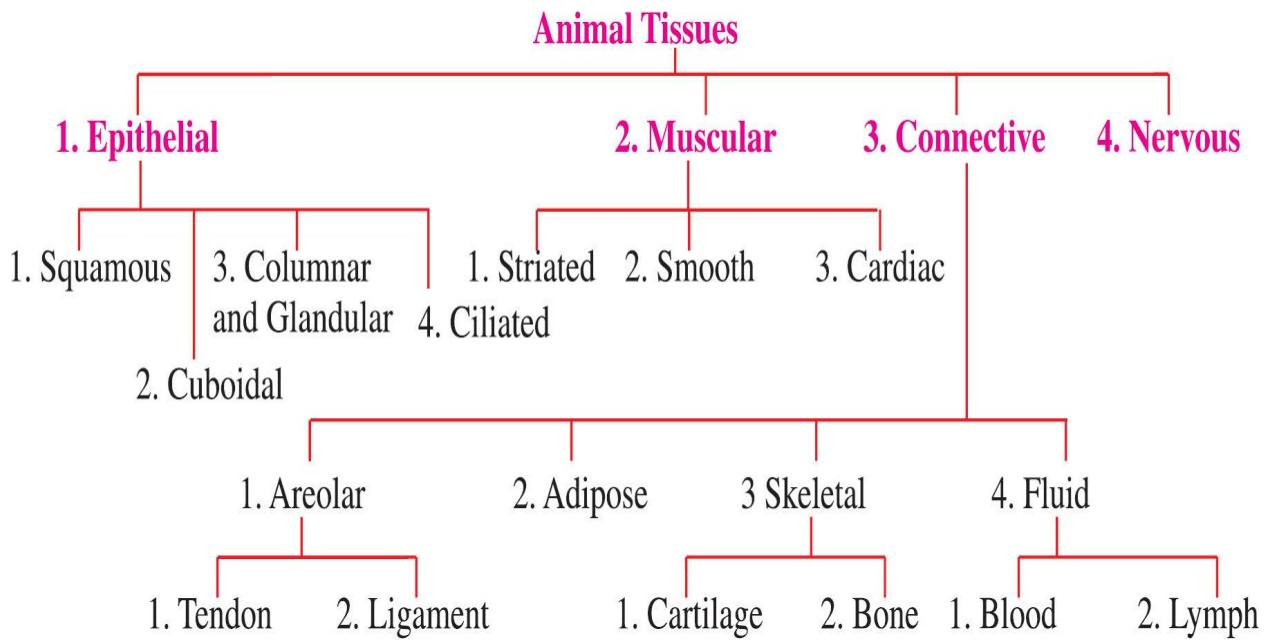


Figure 3.20. Different types of animal tissues.

1. Epithelial Tissue (Epithelium)

Nature. Epithelial tissue is the **simplest tissue**. It is the protective tissue of the animal body (as epidermis of plants). The cells of this tissue are tightly packed and they form a continuous sheet. Cells of epithelium contain very little or no intercellular matrix. The tissue covers most organs and cavities within the body. It also forms a barrier to keep different body systems separate. The skin and lining of buccal cavity, blood vessels, alveoli (of lungs) and kidney tubules are made of epithelial tissue. Epithelial cells lie on a delicate non-cellular **basement membrane** which contains a special form of matrix protein, called **collagen**.

Epithelial tissue may be **simple**, i.e., composed of a single layer of cells, or **stratified**, i.e., made up of several layers of cells.

Functions :

1. The cells of the body surface (i.e., epidermis) form the outer layer of skin. These cells protect the underlying cells from drying, injury, and chemical effects. They also protect the

body from viral or bacterial infection.

2. Inside the body, epithelial cells form lining of mouth and alimentary canal and protect these organs.
3. Epithelial tissues help in absorption of water and nutrients.
4. Epithelial tissues help in elimination of waste products.
5. Some epithelial tissues perform secretory function. They secrete a variety of substances such as sweat, saliva (mucus), enzymes, etc.

Types of epithelial tissue. Depending upon the shape and function of the cells, the epithelial tissues are classified as follows :



- (i) Squamous epithelium;
- (ii) Cuboidal epithelium;
- (iii) Columnar epithelium;
- (iv) Glandular epithelium;
- (v) Ciliated epithelium.

(i) Squamous Epithelium

Nature. Squamous epithelium is made up of thin, flat, irregular-shaped cells which fit together like floor tiles to form a compact tissue ([Fig. 3.21](#)). Squamous epithelium is also known as **tesselated** and **pavement epithelium**.

Occurrence. It forms the delicate *lining* of cavities (mouth,

oesophagus, nose, pericardium, alveoli, etc.) and of blood vessels and *covering* of the tongue and skin.

Functions :

This epithelium protects the underlying parts of body from mechanical injury, entry of germs, chemicals and drying. It also forms a selectively permable surface through which filtration occurs.

(ii) Stratified Keratinized Squamous Epithelium

This is found in skin and covers the external dry surface of the skin ([Fig. 3.22](#)). Cells of this tissue are arranged in many layers. Cells forming different layers of this epithelium are not similar. Deeper layers of the tissue have cuboidal cells which become polygonal and finally flattened (squamous) towards the free surface. The flattened cells of superficial layer contain a fibrous protein, the **keratin** and become dead cells. Horny, scale-like remains of dead squamous cells, ultimately flakes away. This epithelium is water-proof and highly resistant to mechanical injury.

(iii) Cuboidal Epithelium

Nature. It consists of cube-like (cubical) cells which are square in section but the free surface appear hexagonal. ([Fig. 3.23](#)).

Occurrence. The cuboidal epithelium is found in kidney tubules, thyroid vesicles and in glands (*e.g.*, salivary glands, sweat glands and exocrine pancreas). It forms germinal epithelium of gonads (testes and ovaries).

Functions :

It helps in absorption, excretion and secretion. It also provides mechanical support.

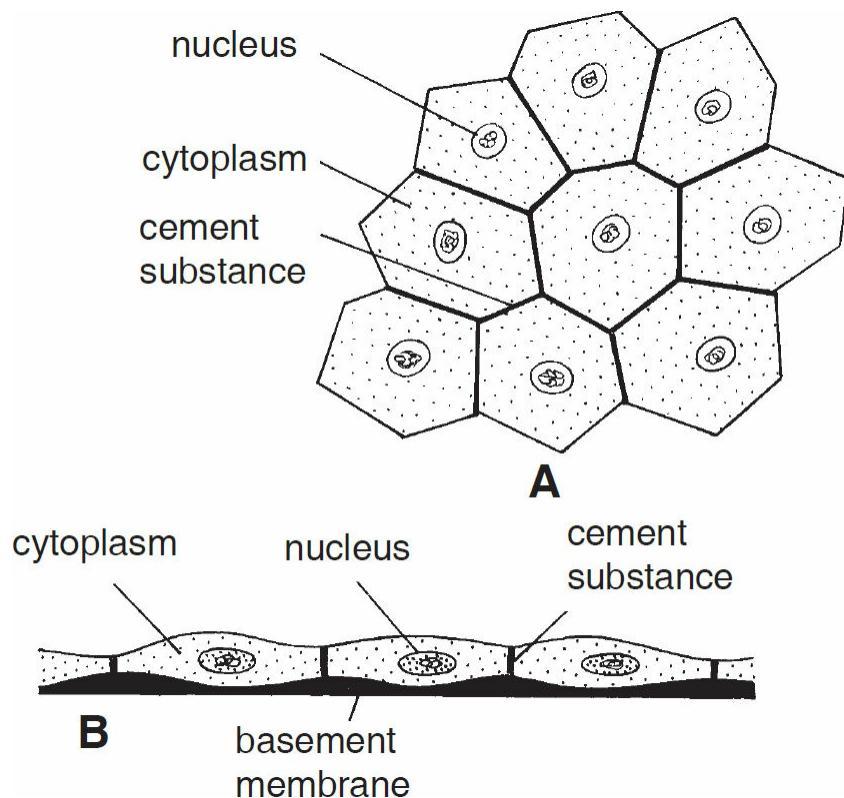


Figure 3.21. Squamous epithelium.

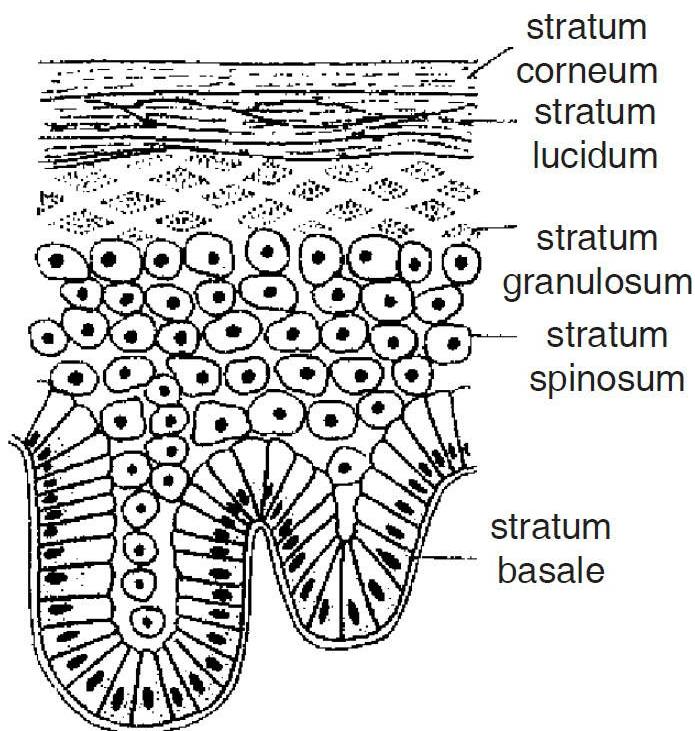


Figure 3.22. Epidermis of mammalian skin showing four layers of stratified

keratinized squamous epithelium.

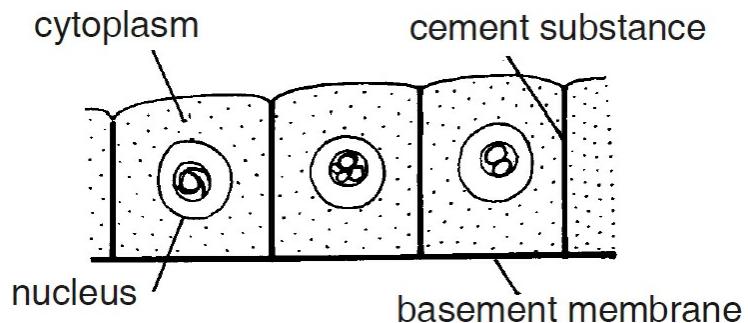


Figure 3.23. Cuboidal epithelium.

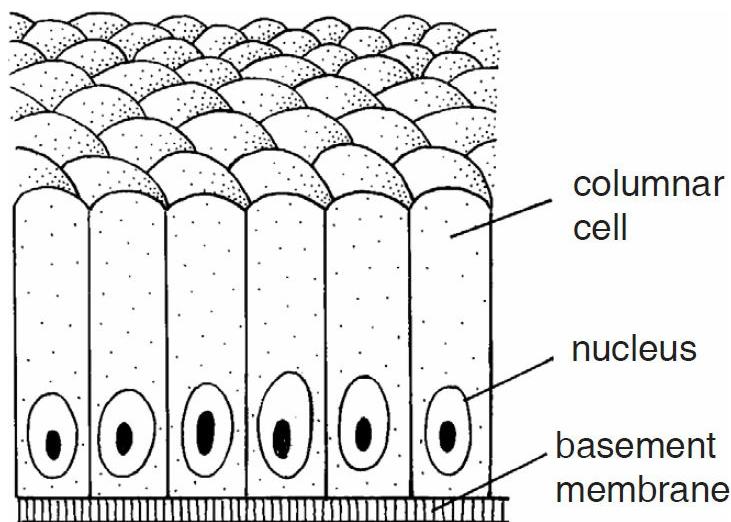


Figure 3.24. Columnar epithelium.

(iv) Columnar Epithelium

Nature. The columnar epithelium consists of cells which are taller than broader (*i.e.*, pillar-like). The nuclei are towards the base and sometimes the free ends of cells have a brush border containing microvilli ([Fig. 3.24](#)).

Occurrence. It forms the lining of stomach, small intestine and colon, forming **mucous membrane**. It also forms lining of gall bladder and oviducts and facilitates movement across the cells.

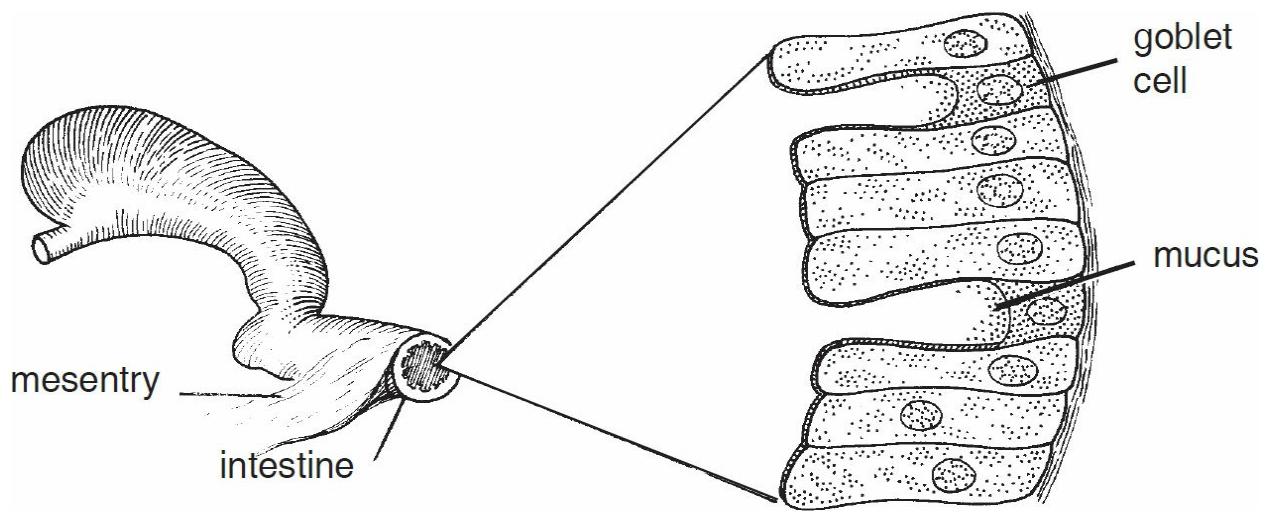


Figure 3.25. Goblet cells in mucous epithelium of intestine.



Functions :

Its main functions include *absorption* (e.g., stomach, intestine) and *secretion* (e.g., mucus by goblet cells or mucous membrane; [Fig. 3.25](#)).

Table 3.8. Difference between squamous epithelium and columnar epithelium

<i>Squamous epithelium</i>	<i>Columnar epithelium</i>
1. The component cells are thin and flat.	The component cells are pillar-like.
2. The nucleus lies in the centre of the cell which generally bulged out.	The nuleus is located near the base of the cell.
3. This tissue occurs in lung alveoli, blood capillaries, Bowman's	It occurs with in the layer of stomach and intestine, their glands and the

capsule, buccal cavity, skin, etc.	covering of epiglottis.
4. It functions as a selectively permeable barrier, in ultrafiltration and wear and tear.	It takes part in absorption, secretion and protective covering.

(v) Glandular Epithelium

The columnar epithelium is often modified to form glands which secrete chemicals.

(vi) Ciliated Epithelium

Nature. Certain cuboidal or columnar cells have a free border which bear thread-like cytoplasmic outgrowths, called **cilia** ([Fig. 3.26](#)). Such cells form the ciliated epithelium.

Occurrence. Ciliated cuboidal epithelium is found in the sperm ducts. The ciliated columnar epithelium ([Fig. 3.26](#)) lines the trachea (wind-pipe), bronchi (lungs), kidney tubules and oviducts (Fallopian tubes).

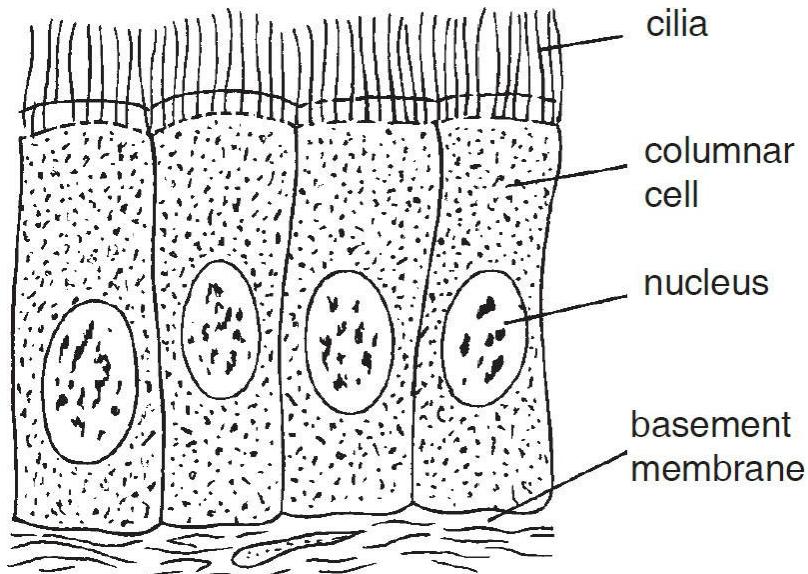


Figure 3.26. Ciliated columnar epithelium.

Functions :

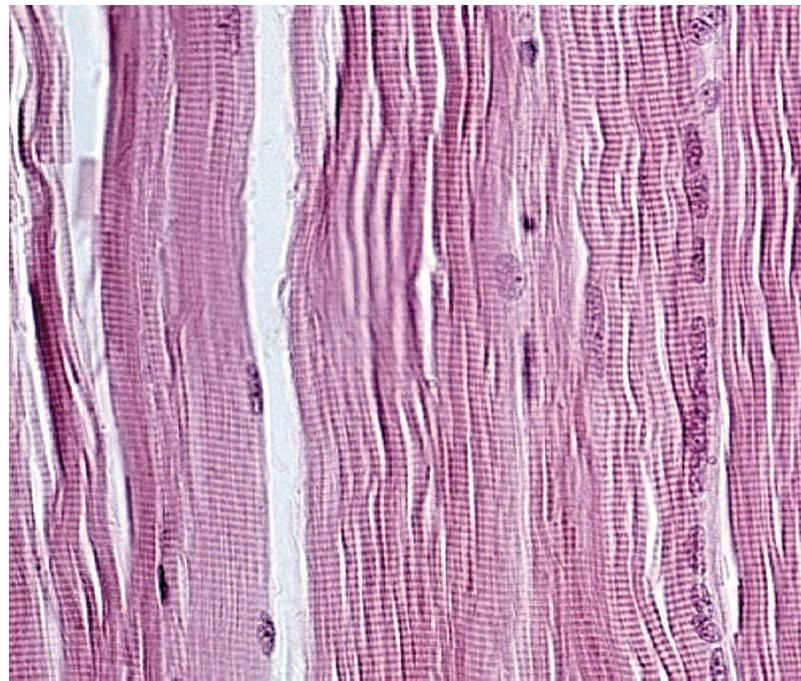
The rhythmic, concerted beating of the cilia moves solid particles (*e.g.*, mucus) in one direction through the ducts.

2. Muscle Tissues (or Muscular Tissues)

The muscle tissues or muscles of the body form the contractile tissue and are made of muscle cells. Muscle cells are elongated and large-sized, so they are also called **muscle fibres**. The movements of the body or limbs are brought about by contraction and the relaxation of contractile proteins which are present in muscle cells. The movements of the internal organs such as heart and alimentary canal, are all caused by muscle tissues. Muscle cells are typically arranged in parallel arrangement allowing them to work together effectively.

On the basis of their location, structure and function, there are following three types of muscle fibres:

- (i) Striated muscles ;
- (ii) Smooth muscles ;
- (iii) Cardiac muscles.



Muscular tissue.

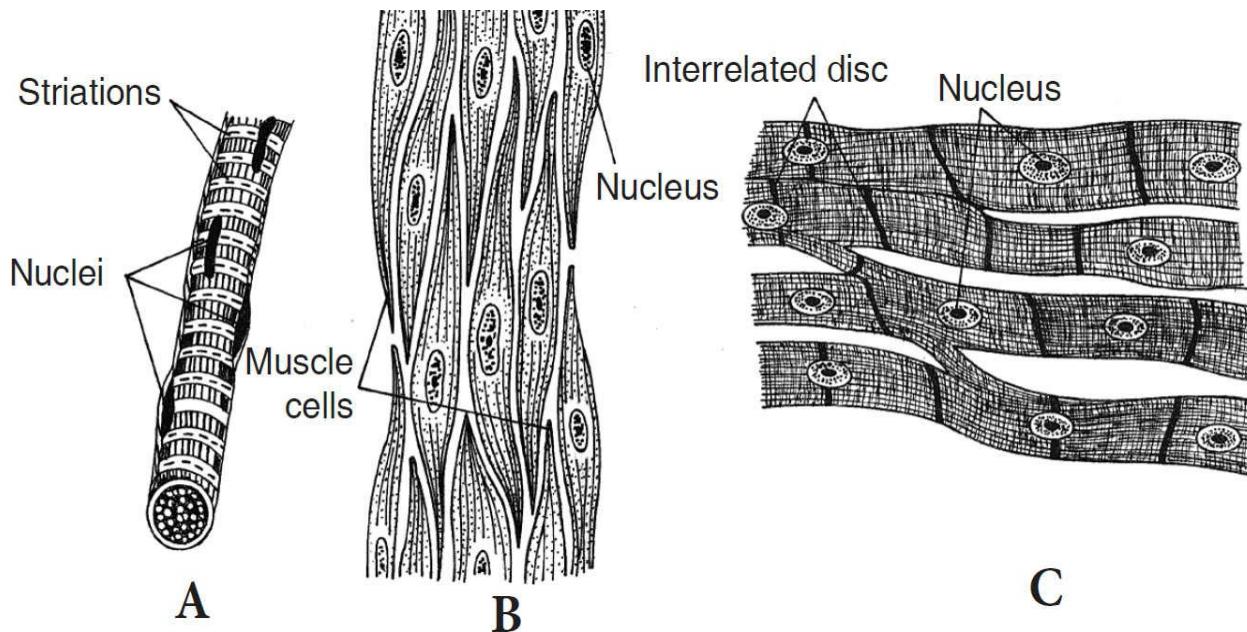


Figure 3.27. Types of muscle fibres A—Striated muscle; B – Smooth muscle; C — Cardiac muscle.

(i) Striated Muscles

Nature. Striated muscles are also known as **striped**, **skeletal** or

voluntary muscles. Since the entire muscle fibres show alternate dark and light stripes (striations or bands), they are called **striped muscles**. Since they are attached to the bones and are responsible for body movements, they are called **skeletal muscles**. And lastly since these muscles work according to our will, they are also called **voluntary muscles** ([Fig. 3.27A](#)).

The striated muscle fibres (cells) are long or elongated, non-tapering, cylindrical and unbranched. These cells have a number of nuclei (*i.e.*, each muscle cell is **multinucleated**). Each muscle cell is enclosed in a thin but distinct plasma membrane, called **sarcolemma**.

Its nuclei are peripheral in position, *i.e*, nuclei are located just beneath the sarcolemma. In the sarcoplasm (cytoplasm) of the muscle cell are embedded large number of contractile elements, called **sarcostyles** or **myofibrils**.

Occurrence. Striated muscles occur in the muscles of limbs (*e.g.*, biceps and triceps of arms), body wall, face, neck, etc. Striated muscles present in tongue, pharynx, diaphragm and upper part of oesophagus are called **visceral striated muscles**.

Functions :

1. Striated muscles are powerful and undergo rapid contraction. These muscles can get tired and may need rest.
2. Striated muscles provide the force for locomotion and all other voluntary movements of the body.

(ii) Smooth Muscles

Nature. Smooth smooth muscles are also known as **unstriated**, **visceral** or **involuntary muscles**. Smooth muscles occur as bundles or sheets of elongated fusiform or spindle-shaped (pointed

at both ends) cells or fibres. These are held together by loose connective tissue. Each muscle cell is enclosed in a plasma membrane ([Fig. 3.27B](#)). There is a single centrally located cigar-shaped nucleus in the centre of the cytoplasm or **sarcoplasm (uninucleate cell)**. Delicate, contractile threads called **myofibrils** run longitudinally through out the cell. These fibrils do not bear any bands, stripes or striations across the muscle hence, called **smooth or unstriated muscles** ([Fig. 3.27B](#)).

Occurrence. Smooth muscles are found in the walls of the hollow (tubular) visceral organs except that of the heart, and so are called **visceral muscles**. Thus, they occur in the wall of alimentary canal and internal organs, ducts of glands, urogenital ducts and blood vessels. Smooth muscles are found in stomach, intestine, ureter, bronchi, iris of eye, etc.

Functions :

1. Smooth muscles do not work (contract) according to our will, so they are also called *involuntary muscles*. Movement of food in the alimentary canal, opening and closing of tubes are involuntary movements.
2. Smooth muscle contracts slowly but can remain contracted for long periods of time. Due to this fact, smooth muscles cause the characteristic **peristaltic movements** in the tubes. Peristaltic movements are the rhythmic progressive waves of muscular contraction and relaxation. Such wave-like peristaltic movements occur in the gastrointestinal tract and male genital tract.
3. In some organs, smooth muscles contract throughout the organ to produce **extrusive movements** as in the urinary bladder, the gall bladder and the uterus.

(iii) Cardiac Muscles

Nature. Cardiac muscles show characteristics of both smooth and striated muscles. Cardiac muscles are composed of branched fibres and the branches join to form a network ([Fig. 3.27C](#)). Each fibre or cell is surrounded by *sarcolemma*, a cytoplasm (sarcoplasm) with longitudinal *myofibrils* and a centrally located nucleus (*i.e.*, each cell is uninucleate). The intercellular spaces of cardiac muscles are filled with abundant loose connective tissue supplied with blood capillaries.

Cardiac muscles have stripes of light and dark bands. In addition, these muscle fibres show densely stained cross-bands called **intercalated impulse (Act as impulse boosters)**. These are regions of interdigitations of plasma membranes (sarcolemmas) consisting of adjacent muscle cells or fibres (*i.e.*, each fibre of cardiac muscle is formed due to joining of an individual uninucleate muscle cell to one another in a linear arrangement).

Occurrence. The cardiac muscles occur in the heart (*i.e.*, in the walls of heart).



Functions :

1. Cardiac muscles contract and relax rapidly, rhythmically and tirelessly throughout a life time. They contract endlessly from early embryonic stage until death.
2. The contraction and relaxation of the heart muscles help to pump and distribute blood to various parts of body.

ACTIVITY 3.5

Observe and compare the structures of different types of muscle tissues. Note their shape, number of nuclei and position of nuclei within the cell.

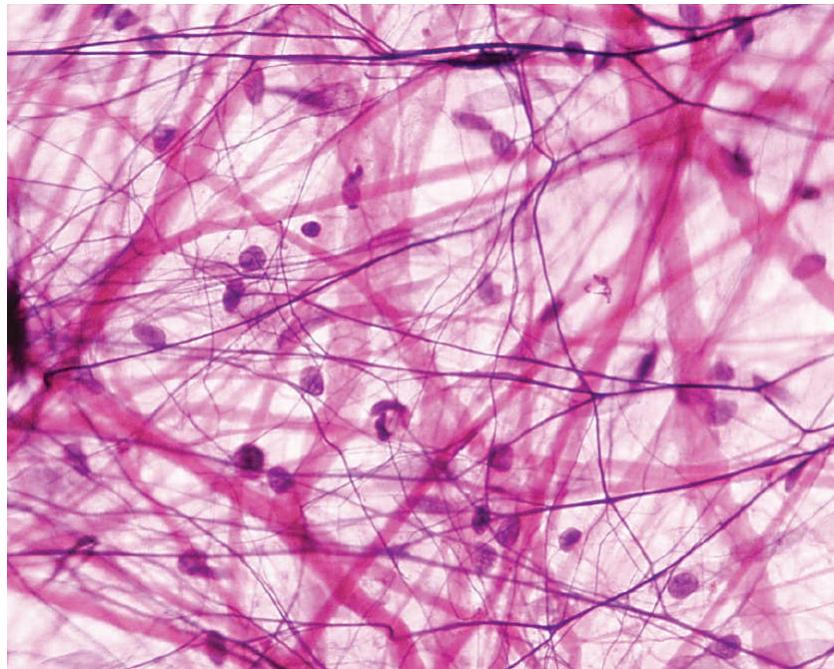
Table 3.9. Comparison of Smooth, Skeletal and Cardiac muscles.

<i>Smooth muscle</i>	<i>Skeletal muscle</i>	<i>Cardiac muscle</i>
1. Not striated	Striated	Striated
2. Spindle-shaped	Cylindrical	Cylindrical
3. Not branched	Not branched	Branched
4. Nucleus-central	Nuclei-peripheral	Nuclei-central
5. No discs	No discs	Intercalated discs
6. Involuntary	Voluntary	Involuntary
7. Slow	Fast	Fast
8. Contraction not inherent	Contraction not inherent	Contraction inherent

3. Connective Tissue

The connective tissue is specialised to connect and anchor various body organs. The tissues can connect bones to each other, muscles to bones, bind tissues and can also give support to various parts of body by creating a *packing* around organs. The packing would prevent the organs from getting displaced by body movements. Thus, the main functions of connective tissue are **binding**, **supporting**, and **packing** together different organs of the body.

The cells of connective tissue ([Box 3.8](#)) are *living*, separated from each other (*i.e.*, loosely spaced) and low in number. Homogeneous, gel-like intercellular substance called medium or **matrix** forms the main bulk of the connective tissue. Connective tissue.



Connective tissue.

Thus, space between cells is filled with a non-living matrix which may be solid as in bone and cartilage and **fluid** as in the blood.

Matrix is fibrous in nature ([Box 3.9](#)) and **binds** other tissues. In fact, the nature of matrix decides the function of connective tissue.

Box 3.8

Cells of connective tissue

Connective tissue contains the following types of cells :

1. **Fibroblasts.** They form ground substance and fibres (*e.g.*,

collagen).

2. **Adipose cells.** They store fats (lipids) in their vacuoles.

3. **Macrophages.** These may be free-moving or fixed phagocytes (leucocytes or WBCs). They are involved in the destruction and removal of invading bacteria, foreign bodies and damaged cells from tissues.

4. **Mast cells.** They secrete substances such as **heparin** (anticoagulant), **histamine** (vasodilator) and **serotonin** (vasoconstrictor). They promote inflammation of the infected area.

5. **Immunocytes.** These include cells such as **lymphocytes** and **plasma cells** both producing antibodies for the immune response.

Box 3.9

Protein fibres of matrix

Matrix of connective tissue is secreted by the component cells. It chemically contains **GAGs** (*i.e.*, glycosaminoglycans or mucopolysaccharides). The matrix also contains the following *three* main types of protein fibres:

1. White fibres of collagen;
2. Yellow fibres of elastin;
3. Reticular fibres of reticulin.

Types of connective tissue. In animals, there are following *five* types of connective tissues :

1. Areolar (or loose) connective tissue;
2. Dense regular connective tissue;
3. Adipose tissue;

4. Skeletal tissue;
5. Fluid connective tissue.

(i) Areolar or Loose Connective Tissue

Nature. As the name suggests, this tissue is a loose and cellular connective tissue ([Fig. 3.28](#)). Its matrix consists of two kinds of fibres: 1. **White collagen fibres** (which changes into **gelatin** on boiling in water) and 2. **Yellow elastic fibres** or **elastin**. Also scattered in matrix are several kinds of irregular cells (*e.g.*, fibroblasts; [Box 3.8](#)), some of which can engulf bacteria and prevent infection (*e.g.*, macrophages).

Occurrence. It is the simplest and most widely distributed connective tissue. It joins skin to muscles, fills spaces inside organs and is found around muscles, blood vessels and nerves.

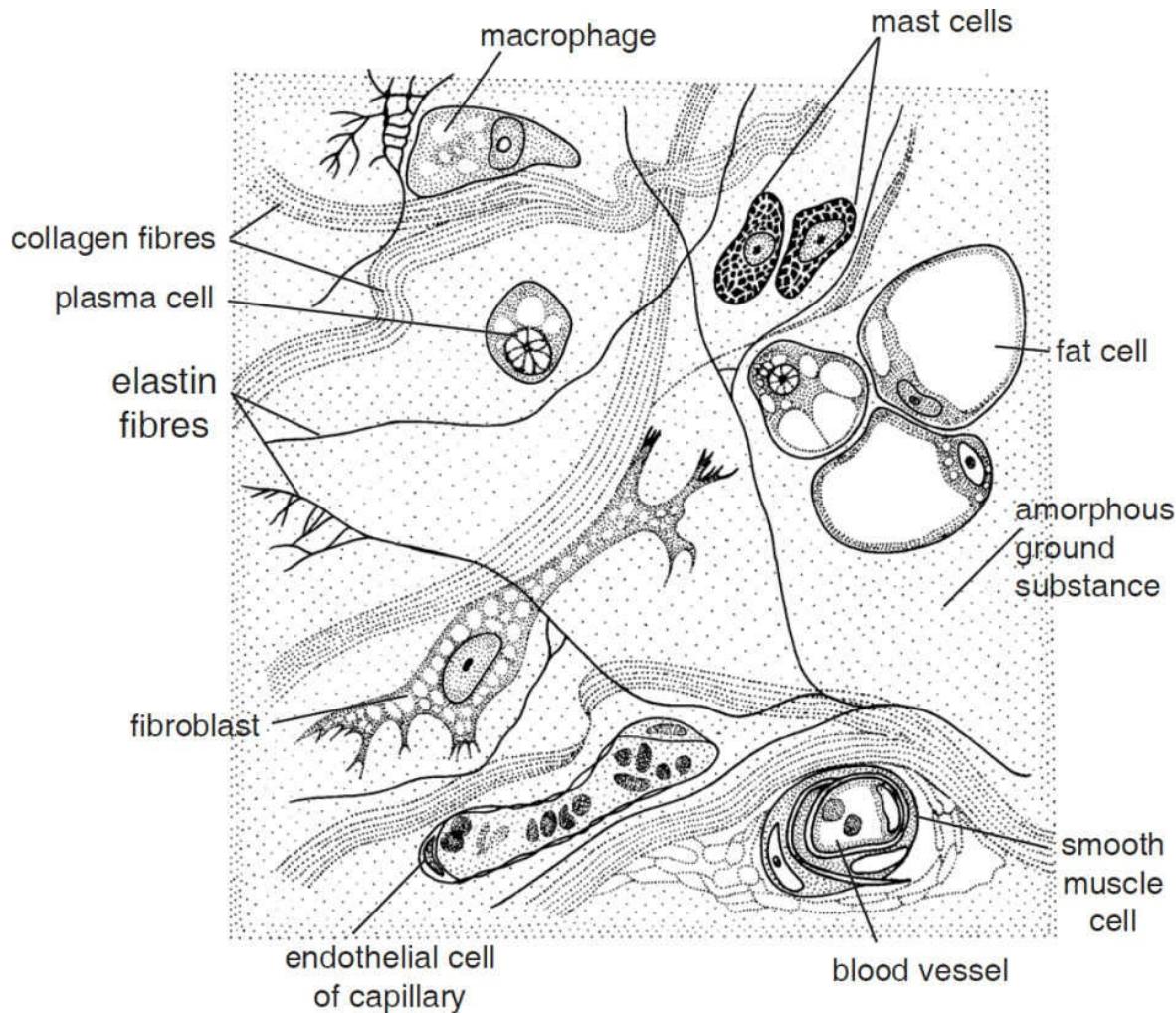


Figure 3.28. Areolar connective tissue.

Functions :

1. It acts as a supporting and packing tissue between organs lying in the body cavity. Matrix of this tissue is important in *diffusion* of oxygen and nutrients from small blood vessels.
2. It helps in repair of tissues after an injury.
3. It also helps in combating foreign toxins.
4. It fixes skin to underlying muscles.

(ii) Dense Regular Connective Tissue

It is a fibrous connective tissue. It is characterized by ordered

and densely packed collection of fibres and cells ([Fig. 3.29](#)). Dense regular connective tissue is the principal component of tendons and ligaments and aponeuroses.

Tendons. Tendons are cord-like, strong, inelastic, structures that *join skeletal muscles to bones*. A tendon is a white fibrous tissue

- (i) which has great strength but limited flexibility. It consists of parallel bundles of collagen fibres, between which are present, rows of fibroblasts (called **tendinocytes**). Collagen fibres are bounded by areolar connecting tissue.

Ligaments. They are elastic structures which *connect bones to bones*. A ligament is highly elastic and has great strength but contains very little matrix. In ligament, some elastic and many

- (ii) collagen fibres are bound together by areolar connective tissue. Fibroblasts are compressed in between regular rows of fibres ([Fig. 3.30](#)).

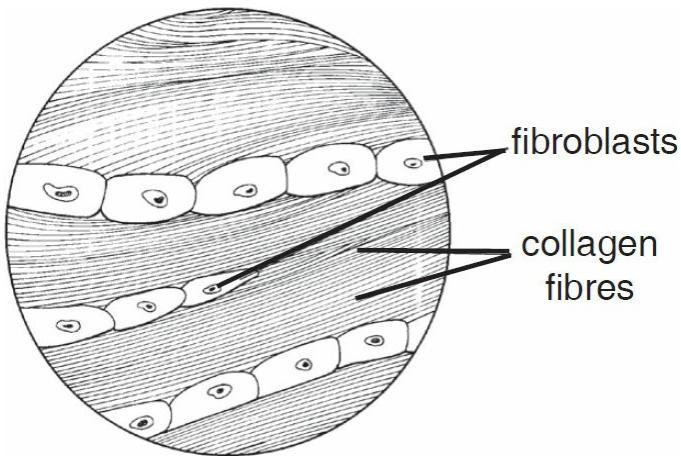


Figure 3.29. Dense regular connective tissue.

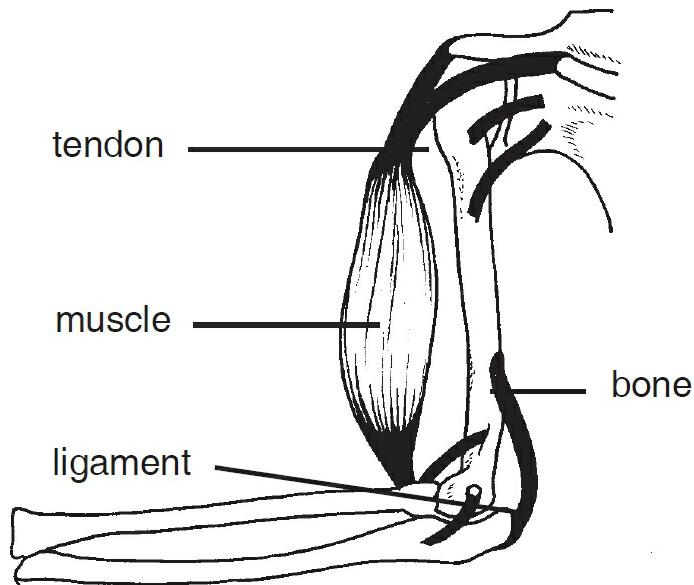


Figure 3.30. Attachment of tendons and ligaments.

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Ligaments strengthen the joint and permit normal movement but prevent over-flexing or over-extension. **Sprain** is caused by excessive pulling (stretching) of ligaments.

Table 3.10. Differences between tendon and ligament.

<i>Tendons</i>	<i>Ligaments</i>
1. Inelastic.	1. Elastic.
2. Join muscles to bone.	2. Connect bones to bones.
3. Made up of white fibres.	3. Made up of white as well as yellow fibres.

Aponeuroses. These are broad sheets of dense, fibrous, (iii) collagenous connective tissues that cover, invest and form the

terminations and attachments of various muscles.

(iii) Adipose Tissue

Nature. Adipose tissue is basically an aggregation of fat cells or **adipocytes**. Each fat cell is rounded or oval in shape and contains a large droplet of fat that almost fills it. The fat cells are arranged into lobules separated by partitions of *collagen* and *elastin* fibres. These partitions carry blood vessels of lobules ([Fig. 3.31](#)).

Occurrence. The adipose tissue is abundant below the skin, between the internal organs (e.g., around the kidneys) and in yellow bone marrow.

Functions :

1. Serves as a fat reservoir.
2. Provides shape to the limbs and the body.
3. Keeps visceral organs in position. It forms shock-absorbing cushions around kidneys and eye balls.
4. Acts as an insulator.. Being a poor conductor of heat, it reduces heat loss from body, i.e., it regulates body temperature.

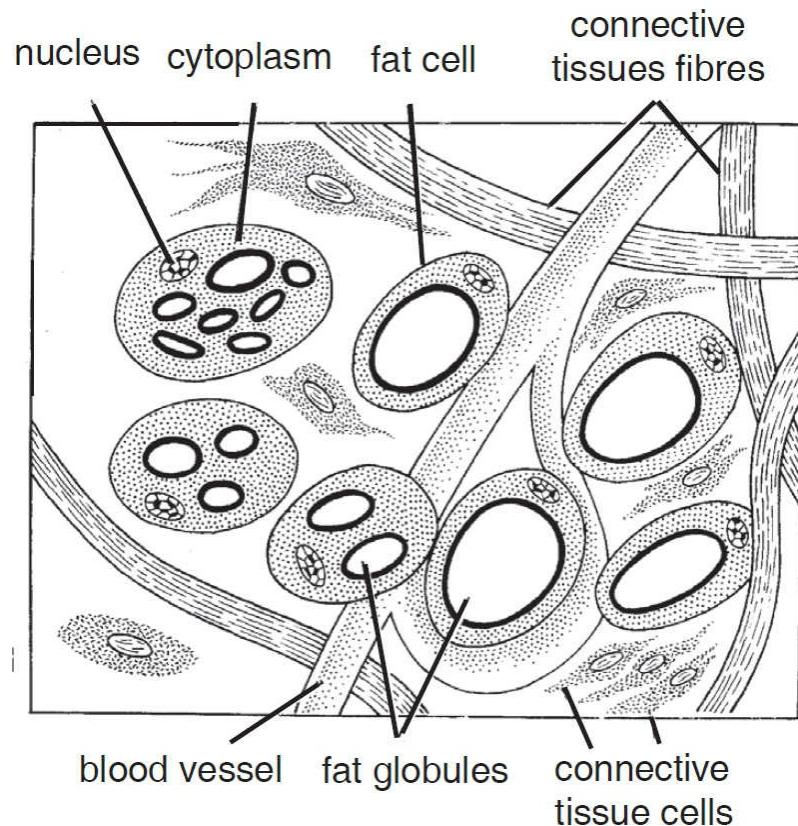


Figure 3.31. Adipose tissue.

(iv) Skeletal Tissue

The skeletal or supporting tissue includes **cartilage** and **bone** which form the endoskeleton of a vertebrate body.

(a) Cartilage

Nature. The cartilage is a specialised connective tissue which is compact and less vascular. It has widely spaced out cells. Its extensive **matrix** is composed of proteins, and is slightly hardened by calcium salts. Its matrix is produced, and maintained by the **chondrocytes**. Matrix is solid, cheese-like and firm but also slightly elastic. This accounts for its flexible nature ([Fig. 3.32](#)).

The matrix of cartilage has a delicate network of collagen fibres and living cells, chondrocytes. Chondrocytes are present in fluid-filled spaces known as **lacunae**. Blood vessels are absent in the

matrix. Chondrocytes multiply by mitosis and help in internal growth of cartilage. Thus, cartilage is capable of continuous and rapid growth.

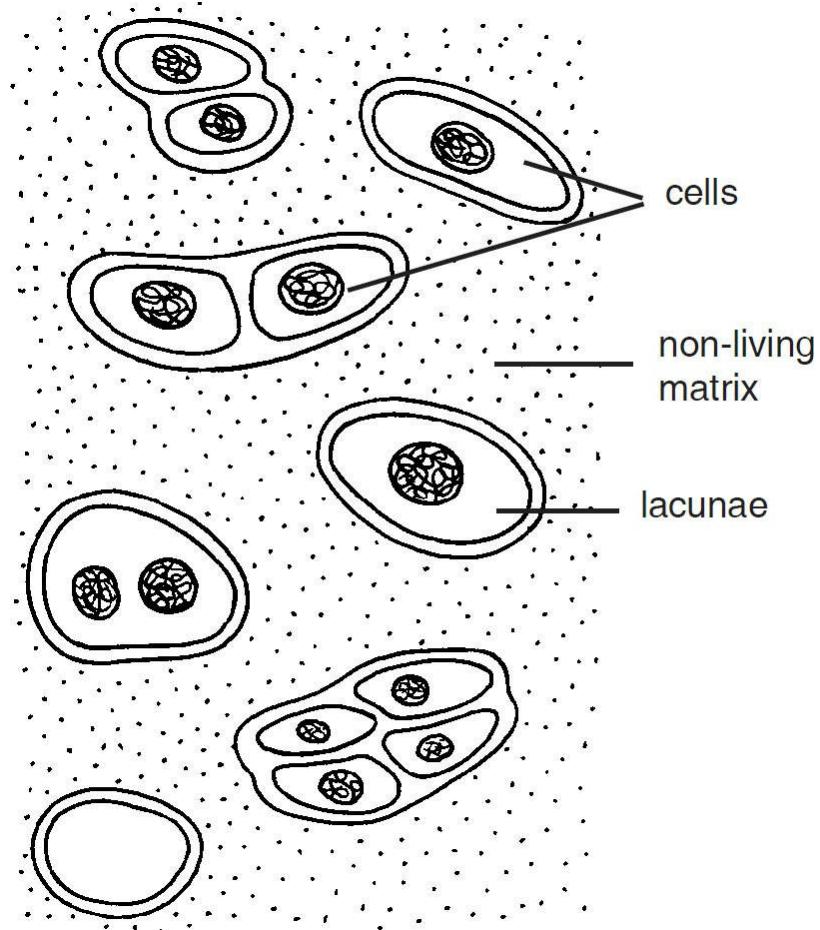


Figure 3.32. Cartilage.

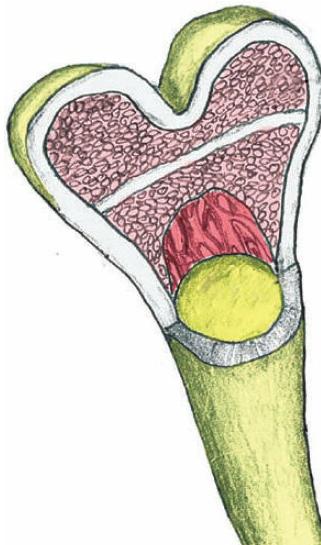
Occurrence. Cartilage is located in the following body parts : ear pinna, nose tip, epiglottis, intervertebral discs, end of long bones, lower ends of ribs and rings of trachea (wind-pipe).

Functions :

It provides support and flexibility to the body parts. It smoothens surface at joints.

(b) Bone

Nature. Bone is a very strong and non-flexible tissue. Like cartilage, bone is a specialised connective tissue. It is porous, highly vascular, mineralised, hard and rigid. Its matrix is made up of proteins (*e.g.*, osteonectin, osteocalcin, proteoglycan and collagen). Matrix of bone is rich in salts of calcium and magnesium such as phosphates and carbonates of calcium and magnesium (*e.g.*, hydroxyapatite). These minerals are responsible for the hardness of the bone. The matrix of bone is in the form of thin concentric rings, called **lamellae**. Bone cells, called **osteoblasts** or **osteocytes**, are present between the lamellae in fluid-filled spaces called **lacunae** ([Fig. 3.33](#)). All lacunae of the bone communicate with each other by a network of fine canals, called **canalliculi**. Each canalculus is filled with delicate cytoplasmic process of the bone cell. Through canalliculi, each bone cell of each lacuna receives food and oxygen and eliminates waste.



Skeletal tissue (bone).

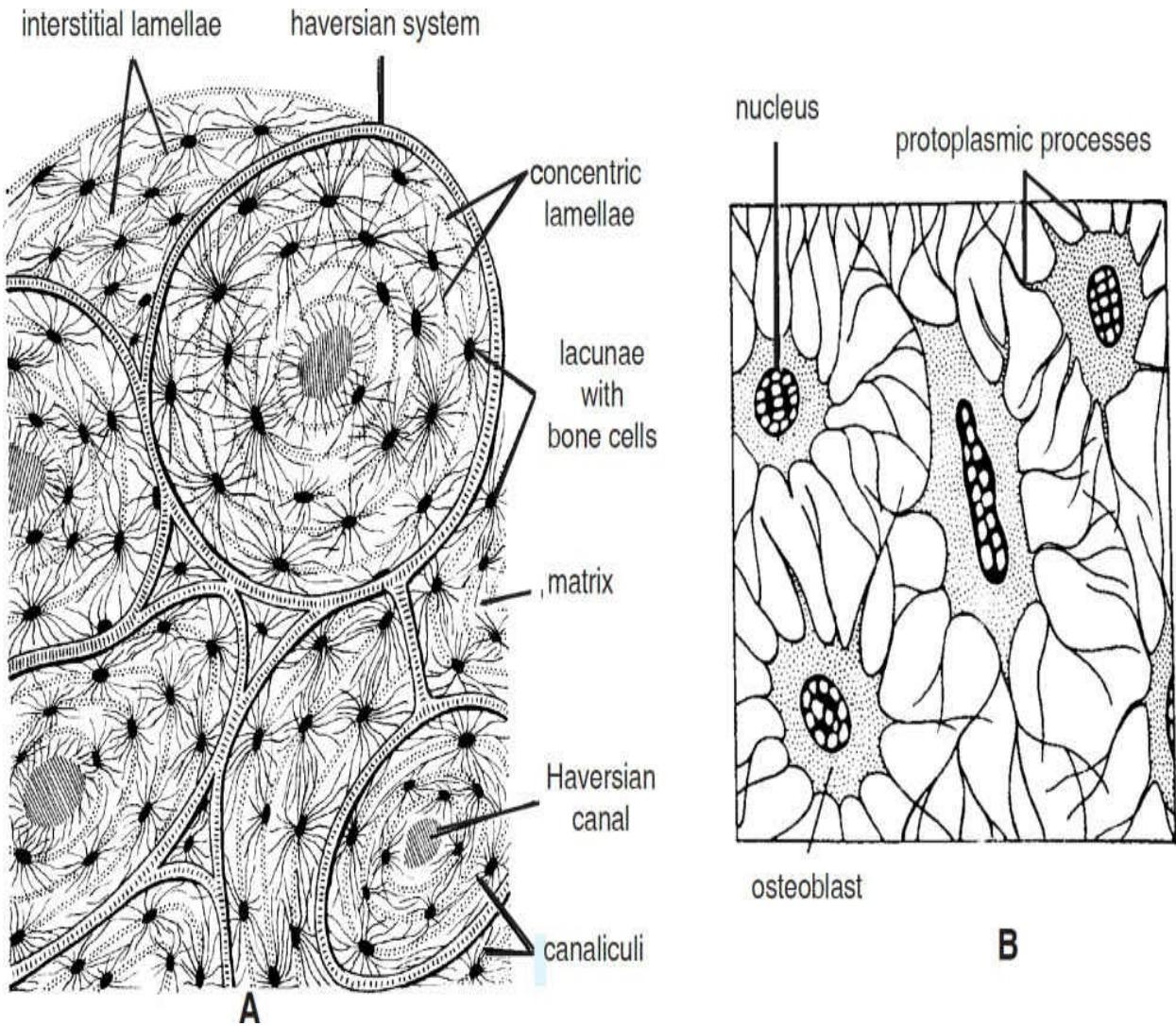


Figure 3.33. A—T.S. of long bone showing Haversian system; B—Osteoblasts and their processes.

Functions :

Bone forms the endoskeleton in human beings and other vertebrates except the sharks. It serves the following functions :

1. Provides shape to the body.
2. Provides skeletal support to body.
3. Protects vital body organs such as brain, lungs, etc.
4. Serves as a storage site of calcium and phosphate.
5. Anchors the muscles.

Table 3.11. Differences between bone and cartilage.

Bone	Cartilage
1. Hard and inflexible.	1. Flexible.
2. Porous.	2. Non-porous.
3. Blood vessels present.	3. Blood vessels absent.
4. Matrix made up of protein and mineral salts (<i>e.g.</i> , calcium phosphate).	4. Matrix made up of protein.

(v) Fluid Connective Tissue

Fluid connective tissue links the different parts of the body and maintains a continuity in the body. It includes blood and lymph.

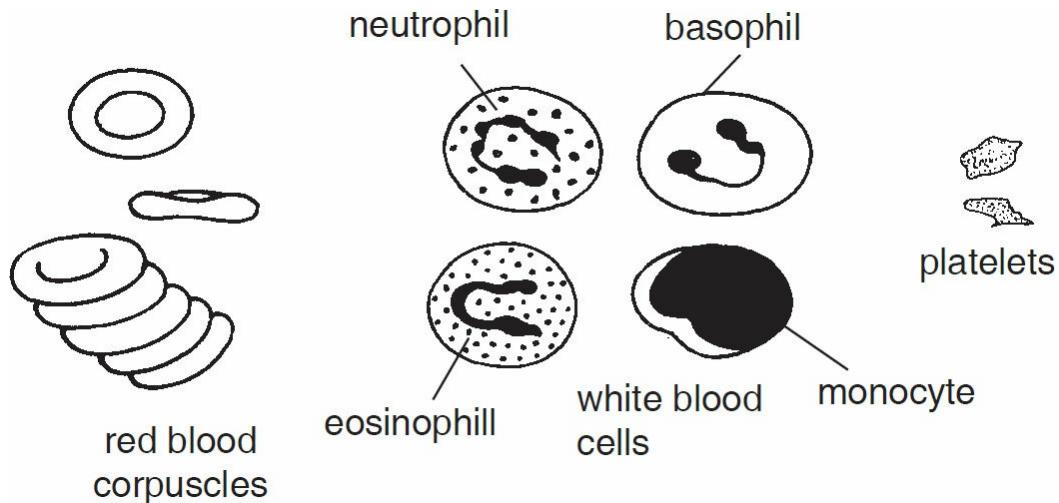


Figure 3.34. Various types of blood cells.

(a) Blood

Blood is a fluid connective tissue. In this tissue, cells (or corpuscles) move in a fluid or liquid matrix or a medium called **blood plasma**. The blood plasma does not contain protein fibres but contains cells called **blood corpuscles** or **blood cells** ([Fig. 3.34](#)). These blood corpuscles or cells are :

1. Red blood corpuscles (RBCs) or erythrocytes;

2. White blood cells (WBCs) or leucocytes;
3. Platelets.

RBCs and WBCs are living, while plasma and platelets are non-living.

Plasma forms 55 per cent of the total volume of blood. It is a complex fluid and contains inorganic salts and organic compounds. Organic substances of plasma are soluble proteins such as **albumins** (maintain osmotic pressure of blood), **globulins** (some act as antibodies), **fibrinogen** (used in blood clotting); and glucose, amino acids, lipids, vitamins, enzymes, hormones and waste materials (urea, uric acid).



Red blood corpuscles (RBCs) are large in number ([Table 3.13](#)) and have iron-containing red respiratory pigment, the **haemoglobin**. The erythrocytes of most vertebrates are oval-shaped, nucleated and biconvex. However, erythrocytes of mammals are circular, biconcave, disc-like and lack nuclei. In this way, mammalian erythrocytes have the increased surface area for gaseous exchange and they accommodate much more haemoglobin in them than RBCs of other animals. Erythrocytes play a vital role in the transport of oxygen.



Human blood showing erythrocytes.

White blood cells (WBCs) are of two main kinds: phagocytes and immunocytes. **Phagocytes** are capable of phagocytosis and they carry out the function of body defence by engulfing bacteria and other foreign substances. Phagocytes are of two types : 1. **Granulocytes** which have irregular-shaped nuclei and cytoplasmic granules with specific staining properties. They include **neutrophils, basophils** and **eosinophils** ([Fig. 3.34](#)). 2. **Agranular leucocytes** have no cytoplasmic granules and include the **monocytes**. Monocytes have a large nucleus indented on one side and large amount of cytoplasm. They ultimately migrate to body tissues and transform into **macrophages** and **histiocytes**. **Immunocytes** produce antibodies and are involved in the immune response. They include **lymphocytes** which have a nearly spherical nucleus and little cytoplasm with no granules. Some lymphocytes later on transform into **plasma cells**.

Blood platelets are minute, anucleated, fragile fragments of

giant bone marrow cells, called **megakaryocytes**.

Table 3.12. Formed elements of blood.

<i>Formed element</i>	<i>Number or percentage</i>
1. Erythrocytes (Red blood corpuscles)	4-6 million/mm ³
2. Leucocytes (White blood cells)	6000-9000/mm ³
A. Agranulocytes	
(i) Lymphocytes	30-35%*
(ii) Monocytes	3-7%
B. Granulocytes	
(i) Neutrophils	55-60%
(ii) Eosinophils	2-5%
(iii) Basophils	0-1%
3. Platelets	200,000-400,000/mm ³

*Percentage of white blood cells.

Table 3.13. Difference between Red blood corpuscles (erythrocytes) and White blood cells (leucocytes).

<i>Red blood corpuscles (RBCs)</i>	<i>White blood cells (WBCs)</i>
1. They are red in colour.	They are colourless.
2. Size of each RBC is about 7.2 micrometer.	Size of WBCs varies between 10 to 20 micrometer.
3. Their number is 4 to 6 million/mm ³ .	Their number is 6000-9000/mm ³ .
4. They are biconcave rounded in shape.	The shape of WBCs is rounded to amoeboid.
5. Nucleus is absent. (That is why they are called corpuscles).	Nucleus is present.
6. The cells contain haemoglobin.	The cells do not contain haemoglobin.
7. Most of the cell organelles are	

absent in these cells.	Cell organelles are present in these cells.
8. They are of only one type.	They are of five types.
9. Life span of each RBC is 120 days.	Life span of each WBC is generally shorter (few hours to four days).
10. They transport oxygen and to some extent carbon dioxide.	They function in defence and immunity.

Occurrence. Blood occurs in blood vessels called **arteries**, **veins**, and **capillaries** which are connected together to form the circulatory system. The extensive branching network of vessels enables blood to reach every part of the body.

Functions :

1. Blood transports nutrients, hormones and vitamins to the tissues and transports excretory products from the tissues to the liver and kidney.
2. The red blood corpuscles (RBCs) carry oxygen to the tissues for the oxidation of food stuff.
3. The white blood cells (WBCs) fight disease either by engulfing and destroying foreign bodies or by producing antitoxins and antibodies that neutralise the harmful effects of germs.
4. Blood platelets disintegrate at the site of injury and help in the clotting of blood.

ACTIVITY 3.6

Take a drop of human blood on a slide and observe different cells present in it.

(b) Lymph

Nature. Lymph is a colourless fluid that is filtered out of the

blood capillaries. Since it is a part of blood, its composition is similar to that of blood except that red blood corpuscles and some blood proteins are absent in it. In the lymph, white blood cells are found in abundance.

Functions :

1. Lymph transports the nutrients (oxygen, glucose) that may have been filtered out of the blood capillaries back into the heart to be recirculated in the body.
2. It brings CO₂ and nitrogenous wastes from tissue fluid to blood.
3. Being loaded with WBCs such as lymphocytes, the lymph protects the body against infection. It forms the defence or immune system of the body.

4. Nervous Tissue

Nature. Nervous tissue is a tissue which is specialized to transmit messages within our body. Brain, spinal cord and nerves are all composed of nervous tissue. Nervous tissue contains highly specialised unit cells called **nerve cells** or **neurons**. Neurons have the ability to receive stimuli from within or outside the body and to conduct (send) impulses (signals) to different parts of the body. The impulse travels from one neuron to another neuron.

Each neuron has following three parts ([Fig. 3.1](#); [Fig. 3.35](#)):

1. The **cyton** or **cell body** which contains a central nucleus and cytoplasm with characteristic deeply stained particles, called **Nissl's granules** (*i.e.*, clumps of ribosomes).
2. The **dendrons** which are short processes arising from the cyton and further branching into **dendrites**; and
3. The **axon** which is a single, long cylindrical process of uniform diameter. It forms fine branches terminally. Each such twig-like branch of axon ends in a swollen structure,

called **synaptic knob** or **bouton**. Bouton contains acetylcholine-filled vesicles. **Acetylcholine (ACh)** is an important **neurotransmitter** (*i.e.*, a substance that plays an important role in the transmission of nerve impulses within the nervous system).

Axon is also called **nerve fibre**.

Functions :

The dendrites receive impulses and the axon takes impulses away from the cell body.



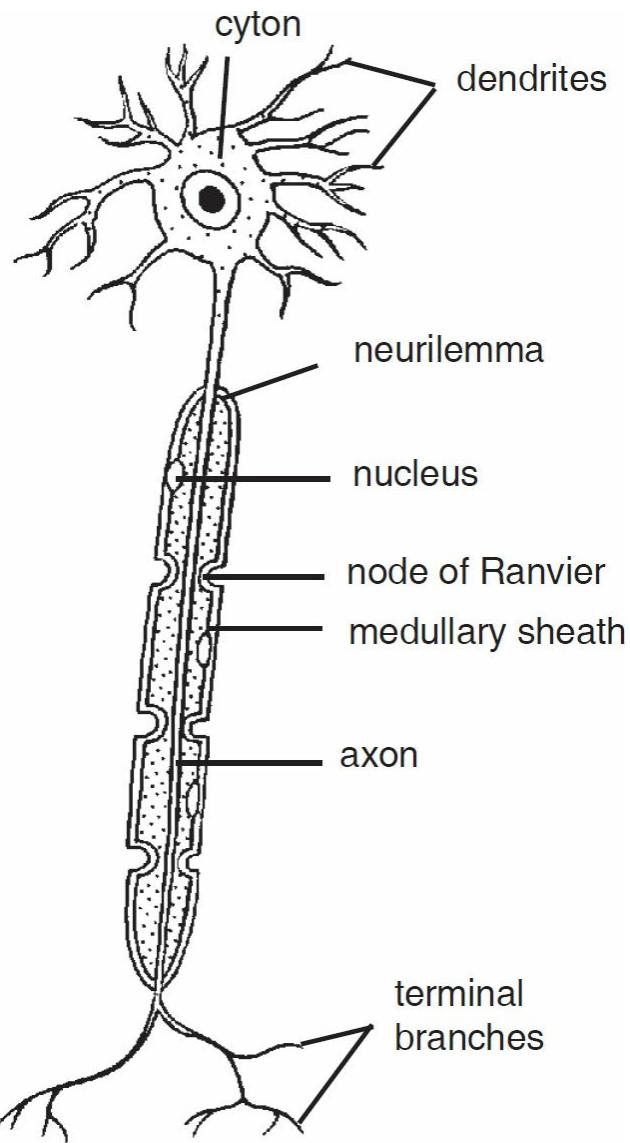


Figure 3.35. A neuron—a unit of nervous tissue.

Table 3.14. Difference between axon and dendrite.

Axon	Dendrite
1. It is long uniformly thickened fibre-like process of a neuron.	It is a short tapering process of a neuron.
2. It is always covered with a sheath (e.g., medullary sheath).	A sheath is absent.
3. Nissl's granules are absent. Neurofibrils are, however, present.	Both Nissl's granules and neurofibrils are present.

4. It carries impulses away from the cell body.

It carries impulses towards the cell body.

SUMMARY

- Cells of multicellular organisms show division of labour. Various metabolic activities are performed by different group of cells. Each such group of cells forms a tissue.
- Plant tissues are of two main types – meristematic and permanent.
- Meristematic tissue is the dividing tissue present at the growing regions of plants. They are meant for growth of an organ.
- Permanent tissues are derived from meristematic tissue till they lose the ability to divide. They are classified as simple and complex tissue.
- Parenchyma, collenchyma and sclerenchyma are three types of simple tissues. Xylem and phloem are two types of complex tissues.
- Animal tissues are epithelial, muscular, connective and nervous tissue.
- Depending on shape and function, epithelial tissue is classified as squamous, cuboidal, columnar and glandular. Epithelium acts as a protective tissue in animals as it does in plants.
- Striated, smooth and cardiac muscles are three types of muscular tissues. They perform movement by contraction and relaxation.
- The different types of connective tissues in our body include areolar tissue, adipose tissue, bone, cartilage, tendon, ligament and blood.
- Connective tissues have widely spaced cells (fibroblasts) embedded in a matrix having a variety of proteins, polysaccharides, mineral salts and protein fibres such as collagen and elastin. They bind or connect other tissues together, e.g., muscle to bone (tendon), bone to bone (ligament) or various body parts (blood).
- Nervous tissue is made of neurons that receive and conduct impulses.
- Impulse is the passage of electrical activity along the axon of a nerve cell.

FORMATIVE ASSESSMENT

A. CLASS ASSIGNMENT

I. True or False Questions

1. Totipotency exists in meristematic cells.
2. Cambium has the apical meristem.
3. In monocot stems, intercalary meristem is located at the base of inter-node.
4. Parenchyma contains isometric cells.
5. Intercellular spaces occur in collenchyma.
6. Sclereids form gritty part of ripe fruits.
7. Cuboidal epithelium is located in salivary glands.
8. Collagen occurs in yellow elastic fibre.
9. Vacuoles are absent in meristematic plant cell.
10. Cells of cork are dead, suberized and compactly arranged.
11. Cells of sclerenchyma has irregularly thickened cell walls.
12. Absorptive surface area of roots are increased by the presence of root hair.
13. Cells of connective tissue are compactly packed with no intercellular spaces.
14. Cardiac muscles undergo rhythmic contraction and relaxation throughout life.
15. Areolar connective tissue binds muscles with bones.
16. Voluntary muscles control the movement of iris of eye.

ANSWERS

True and False Questions

1. T
2. F
3. T
4. T
5. F

- 6.** T
- 7.** T
- 8.** F
- 9.** T
- 10.** T
- 11.** F
- 12.** T
- 13.** F
- 14.** T
- 15.** F
- 16.** F

II. Fill in the Blanks

1. Water and minerals are conducted by
2. In higher plants food is conducted by
3. Blood is a tissue.
4. Bone consists of cells.
5. Cartilage consists of cells.
6. Fibres are absent in a type of connective tissue.
7. A nerve impulse passes from one neuron to another across a
.....
8. Animals move around in search of, mate and shelter.
9. A thick waterproof coating of occurs over the epidermis in desert plants.
10. consists of tracheids, vessels, parenchyma and fibres.
11. epithelium occurs in the lining of renal tubules and ducts of salivary glands.
12. Tendons connect muscles with

ANSWERS

Fill in the Blanks

1. Xylem
2. Phloem
3. Connective
4. Osteocyte
5. Chondrocyte
6. Blood
7. Synapse
8. Food
9. Cutin
10. Xylem
11. Cuboidal
12. Bones

III. Match the Columns

1. Single Matching

Match the contents of the column I and II

<i>Column I</i>	<i>Column II</i>
1. Photosynthetic tissue	a. Transport
2. Epithelial tissue	b. Protection
3. Connective tissue	c. Message
4. Blood tissue	d. Feeding
5. Nervous tissue	e. Strength
6. Collenchyma	f. Division
7. Bone	g. Flexibility
8. Meristem	h. Calcium and phosphorus

2. Double matching questions

Match the contents of column I, II and III

<i>Column I</i>	<i>Column II</i>	<i>Column III</i>
(A) Columnar epithelium	(a) Absorption	(i) Anchoring of muscles
(B) Bones	(b) Axon	(ii) Flexibility
(C) Neuron	(c) Strength	(iii) Dendrites
(D) Collenchyma	(d) Body framework	(iv) Secretion
(E) Tongue	(e) Ground substance	(v) Ciliated
(F) Areolar connective tissue	(f) Trachea	(vi) Fibroblasts
(G) Epithelium	(g) Striated muscle	(vii) Visceral

3. Match the stimulus with appropriate response.

<i>Tissue</i>	<i>Strength A</i>	<i>Exchange B</i>	<i>Mobility C</i>
(i) Stomata
(ii) Squamous epithelium
(iii) Sclerenchyma
(iv) Muscle

4. Key or check list items

which one of the following tissues are involved in absorption (A), transportation (T), growth (G)

<i>Tissue</i>	<i>Function</i>
(i) Xylem
(ii) Root hair
(iii) Meristem
(iv) Blood

ANSWERS

1. Single matching

1. d
2. b
3. e

4. a
5. c
6. g
7. h
8. f.

2. Double Matching

- (A) (a) (iv)
- (B) (d) (i)
- (C) (b) (iii)
- (D) (c) (ii)
- (E) (g) (VII)
- (F) (e) (VI)
- (G) (f) (v)

3. (i) B

- (ii) B*
- (iii) A*
- (iv) C*

4. (i) T

- (ii) A*
- (iii) G*
- (iv) T.*

IV. Multiple Choice Questions (MCQs)

- 1. Presence of tissues in a multicellular organisms ensures**
 - (a) faster development*
 - (b) division of labour*
 - (c) higher reproductive potential*
 - (d) body strength*
- 2. A group of cells alike in form, function and origin are called**

 - (a) tissue*
 - (b) organ*
 - (c) organelle*

- (d) none of these
3. Which of the following statements given below is correct about meristematic tissue ?
- (a) is made of cells that are incapable of cell division
 - (b) is made of cells that are capable of cell division
 - (c) is composed of single type of cells
 - (d) is composed of more than one type of cell
4. The nuclei of meristematic cells are
- (a) small
 - (b) large
 - (c) medium sized
 - (d) none of these
5. The cell wall of meristematic cell is made of
- (a) protein
 - (b) amino acid
 - (c) peptidoglycan
 - (d) cellulose
6. Parenchyma which contains chlorophyll is called:
- (a) collenchyma
 - (b) sclerenchyma
 - (c) chlorenchyma
 - (d) none of these
7. Parenchyma is a type of
- (a) complex tissue
 - (b) simple tissue
 - (c) xylem
 - (d) phloem
8. Parenchyma: Simple: Phloem :
- (a) simple
 - (b) collenchyma
 - (c) complex
 - (d) xylem
9. Phloem in the plant perform the function of
- (a) conduction of food
 - (b) conduction of water
 - (c) providing support

- (d) photosynthesis
- 10.** Collenchyma mainly forms
- (a) hypodermis
 - (b) epidermis
 - (c) phloem
 - (d) inner cortex
- 11.** Permanent tissues differ from meristematic tissue in
- (a) inability to divide
 - (b) attainment of definite shape and size
 - (c) performing a distinct function
 - (d) all the above
- 12.** Tissue that is absent in monocots is
- (a) chlorenchyma
 - (b) sclerenchyma
 - (b) areenchyma
 - (d) collenchyma
- 13.** Grit of pear is formed of
- (a) sclereids
 - (b) sclerenchyma fibres
 - (c) tracheids
 - (d) companion cells
- 14.** Which one is made of dead cells ?
- (a) sclerenchyma
 - (b) tracheids
 - (c) vessel
 - (d) all the above
- 15.** Xylem is made of
- (a) tracheids
 - (b) vessels
 - (c) both of these
 - (d) none of these
- 16.** Phloem is made of
- (a) sieve tubes
 - (b) companion cells
 - (b) both of these
 - (d) none of these

- 17.** Which of the following is not an example of simple tissue in plants ?
- (a) parenchyma
 - (b) collenchyma
 - (c) xylem
 - (d) sclerenchyma
- 18.** Which of the following components of xylem is living
- (a) tracheids
 - (b) vessels
 - (c) xylem parenchyma
 - (d) xylem sclerenchyma
- 19.** Which of the following components of phloem is absent in monocot stem
- (a) sieve tubes
 - (b) companion cells
 - (c) bast fibers
 - (d) phloem parenchyma
- 20.** Of the following components of phloem is non-living
- (a) sieve Tubes
 - (b) companion cells
 - (c) bast Fibers
 - (d) phloem parenchyma
- 21.** Which of the following tissues are composed of mainly dead cells?
- (a) phloem
 - (b) epidermis
 - (c) xylem
 - (d) endodermis
- 22.** Father of histology is
- (a) Malpighi
 - (b) Bichat
 - (c) Mayer
 - (d) none of them
- 23.** The term tissue was given by
- (a) Robert Hooke
 - (b) Mayer

- (c) Bichat
 - (d) Leeuwenhoek
- 24.** Epithelial tissue always has an exposed outer surface and an inner surface anchored to connective tissue by a thin, non-cellular structure called the
- (a) nonstratified layer
 - (b) stratified layer
 - (c) basement membrane
 - (d) fibroblast
- 25.** Which type of tissue forms the inner lining of a blood vessel?
- (a) epithelial
 - (b) connective
 - (c) nervous
 - (c) muscle
- 26.** Which type of tissue forms glands?
- (a) connective
 - (b) epithelial
 - (c) nervous
 - (d) muscle
- 27.** The covering tissue of external and internal surfaces of animals is :
- (a) connective
 - (b) muscular
 - (c) nervous
 - (d) epithelial
- 28.** Trapped dust particles are pushed out of respiratory tract by
- (a) ciliated epithelium
 - (b) stratified epithelium
 - (c) sensory epithelium
 - (d) glandular epithelium
- 29.** Nasal and genital tracts are lined by
- (a) simple columnar
 - (b) stratified columnar epithelium
 - (c) pseudostratified epithelium
 - (d) stratified cuboidal epithelium
- 30.** Tissue found in area of regular wear and tear is

- (a) simple squamous epithelium
 - (b) stratified squamous epithelium
 - (c) simple cuboidal epithelium
 - (d) stratified cuboidal epithelium
- 31.** Cardiac muscle fibres are
- (a) branched
 - (b) striated
 - (c) involuntary
 - (d) all the above
- 32.** Cylindrical muscle fibres which show alternate light and dark bands are
- (a) smooth muscle
 - (b) cardiac muscle fibres
 - (c) tendons
 - (d) striated muscle fibres
- 33.** Most abundant animal tissue is
- (a) epithelium
 - (b) muscular
 - (c) connective
 - (d) blood
- 34.** Matrix of connective tissue is produced by
- (a) plasma cells
 - (b) mast cell
 - (c) fibroblasts
 - (d) both (b) and (c)
- 35.** Tendons and ligaments are
- (a) dense connective tissue
 - (b) loose connective tissue
 - (c) muscular tissue
 - (d) vascular tissue
- 36.** Ligament connects a bone with
- (a) skin
 - (b) muscle
 - (c) bone
 - (d) both (b) and (c)
- 37.** Matrix of cartilage is made of

- (a) collagen
 - (b) chondrin
 - (c) ossein
 - (d) elastin
- 38.** Plasma content of blood is
- (a) 35%
 - (b) 55%
 - (c) 65%
 - (d) 80%
- 39.** Largest blood cells are
- (a) monocytes
 - (b) neutrophils
 - (c) lymphocytes
 - (d) basophils
- 40.** Short branched process coming out of a soma of neuron are
- (a) dendrites
 - (b) axons
 - (c) neutrophils
 - (d) boutons
- 41.** Fluid part of blood after removal of corpuscles is _____
- (a) plasma
 - (b) lymph
 - (c) serum
 - (d) vaccine
- 42.** Tendon is a structure which connects _____
- (a) a bone with another bone
 - (b) a muscle with a bone
 - (c) a nerve with a muscle
 - (d) a muscle with a muscle

ANSWERS

1. b
2. a
3. b

4. *b*
5. *d*
6. *c*
7. *b*
8. *c*
9. *a*
10. *a*
11. *d*
12. *d*
13. *a*
14. *d*
15. *c*
16. *c*
17. *c*
18. *c*
19. *d*
20. *c*
21. *c*
22. *b*
23. *c*
24. *c*
25. *a*
26. *b*
27. *d*
28. *a*
29. *c*
30. *b*
31. *d*
32. *d*
33. *c*
34. *d*
35. *a*
36. *c*
37. *b*
38. *b*
39. *a*

40. a
41. a
42. b.

B. CLASS RESPONSE

V. Oral Questions

1. What type of tissues are more abundant in plants?
2. What is apical meristem?
3. What is the function of lateral meristem?
4. What is differentiation?
5. Name seven types of cells found in stem of sun flower.
6. In which type of plants arenchyma is found? Give example.
7. What type of thickening of cell wall does occur in collenchyma?
8. Which one is main mechanical tissue of the plants?
9. What is epiblema?
10. Name the plant from which commercial cork is obtained.
11. What are conducting elements of xylem?
12. Name the conducting elements of phloem
13. What is location and function of companion cells?
14. Root hair is extension of which type of cell?
15. Which one is called pavement epithelium?
16. Which mineral is present in bone?
17. What is function of tendon?
18. Name the type of muscles that accomplish peristalsis.
19. What is the name of contractile elements of muscles?
20. What is RBC count of normal humans?
21. What is leucocyte count of normal humans?
22. What is the number of blood platelets?
23. What is cyton?
24. What is the name of sheath of nerve fibre?
25. What are medullated nerve fibres?

VI. Quiz

1. What is relation between division of labour and various types of tissues?
2. Lodged shoots become upright due to activity of
3. Name two lateral meristems which help in secondary growth of stem and root.
4. What is mesophyll?
5. What is stomata?
6. What is name of simple tissue that provides flexibility to soft aerial plant parts ?
7. What is other name of cork cambium?
8. What is another name of cork?
9. Which chemical compound does make cork impermeable for liquid and gases?
10. How many types of conducting tissues are found in plants?
11. Is sieve tubes unicellular or multicellular?
12. What is economic use of sclerenchyma?
13. What is tracheid?
14. What are guard cells?
15. Which are soldiers of the body in offence and defence?
16. Name the leucocytes that increase in number during worm infestations.
17. Where do bone and cartilage cells reside?
18. Which tissue forms blubber of whale and hump of camel?
19. What type of tissue is tendon?
20. Which epithelium has pillar -like cells?
21. Nodes of Ranvier occur in
22. What are boutons?
23. Connective tissue cells forming neurolemma are called
24. Cardiac muscles seldom get fatigues because

C. HOME ASSIGNMENT

VII. Answer the following Questions

1. What are tissues ? Give importance of tissue.
2. Why are plant and animal tissues different ?

3. Define meristematic tissue ? Write down characteristics of meristematic cells.
4. What are permanent tissues of the plants ? Give their characteristics.
5. Write down about location, structure and functions of parenchyma.
6. Write a note on collenchyma.
7. What is sclerenchyma ? Describe location, structure and economic importance of this tissue.
8. Give an account of structure and function of xylem.
9. Describe components of phloem. Define translocation.
10. What is epithelial tissue? Give its characteristics and functions.
11. Write a note on squamous epithelium.
12. Describe structure, location and functions of cuboidal epithelium.
13. Describe columnar epithelium.
14. What is muscular tissue? Describe structure and function of striated muscle fibres.
15. (a) Write about structure and function of smooth muscle fibres.
(b) Briefly describe cardiac muscle fibres.
16. Define connective tissue. Write down functions of connective tissue.
17. Write a note on areolar tissue.
18. Give a short account of structure and function of adipose tissue.
19. What are tendons and ligaments? Differentiate between the two.
20. Give a brief account of cartilage.
21. Describe structure and functions of bone.
22. Describe the composition of human blood.
23. Enumerate the functions of blood.
24. What is lymph? Describe its function.
25. Describe the structure of a nerve cell.

D. GROUP DISCUSSION

VIII. Organise a group discussion on each of the following topics

1. Functions of xylem and phloem in a green plant.
2. What will happen if all RBCs are removed from the blood?
3. The role of blood platelets in human body.

E. SEMINAR / SYMPOSIUM

IX. Organise a seminar / symposium on each of the following topics

1. Significance of meristems in plants.
2. Epithelium — The natural cover of animal body.

F. GROUP ACTIVITY

X. Investigatory Projects

1. List the locations of connective tissue in human body.
2. Study of significance of tissue culture in horticulture.

XI. Experimental Projects

1. Perform an activity to find the blood groups of given samples of blood.
2. Perform an activity to study water movements in plants.

XII. Survey

1. Visit a pathology lab and find out how various tests of blood help to diagnose a disease.
2. Collect some plants from different habitats and have comparative study of their external and internal structures.

SUMMATIVE ASSESSMENT

Some Typical or Illustrative Questions

(i) Open-ended Questions

Q.1. Which plant tissue provides both mechanical strength as well as flexibility?

Ans. Collenchyma provides both mechanical strength as well as flexibility.

Q.2. What chemical substance is deposited in the secondary wall of sclerenchyma?

Ans. The chemical that is deposited in the secondary wall of sclerenchyma is lignin.

Q.3. Name the plant tissue which show the following features?

(a) made up of living cells showing thickening; provide mechanical support to the plant.

(b) made up of dead cells showing thickening: provide mechanical support to the plant; are made of one type of cells.

(c) made up of living cells containing green coloured chloroplasts, possesses intercellular space.

(a) Collenchyma

(b) Sclerenchyma

(c) Parenchyma.

Q.4. What is skeletal connective tissue? Give its functions.

Skeletal connective tissue is the tissue which forms the endoskeleton of the body of vertebrates. It includes bones and cartilage.

Ans. The function of skeletal connective tissue is to give support to the body musculature, give a definite shape to the body and protect the vital organs of the body such as brain, ear, heart, lungs, etc. It anchors the muscles and provide movement to animal body.

Q.5. What is a synapse? Explain.

Ans. The junction between the terminal part of one axon and the dendrite of the adjacent neuron is called a **synapse**. Synapses helps in the transmission of impulses from one neuron to another.

Q.6. Name the protein is found in white fibre and yellow fibre.

Ans. Collagen protein is found in white fibres whereas elastin protein is found in yellow fibres.

Q.7. State the function of microvilli.

Microvilli have the following main functions: (a) They increase the

Ans. absorptive surface of the intestinal cell (enterocyte) and (b) They increase the surface area available for reactions.

Q.8. **What is medullary sheath? Mention its significance**

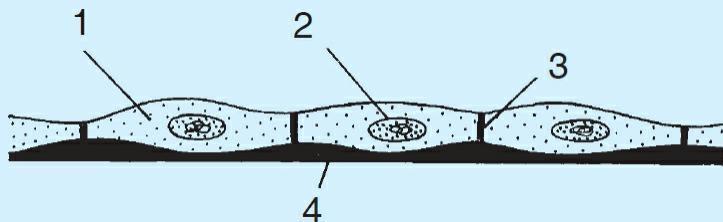
Ans. Medullary (myelin)- Sheath is the covering of nerve fibres. It insulates the nerve fibre (axon) and prevents leakage of ions.

Q.9. **Which tissue is called middleman between tissues cells and blood?**

Ans. Lymph is called the middleman between tissues cells and blood.

(ii) Illustration Based Questions

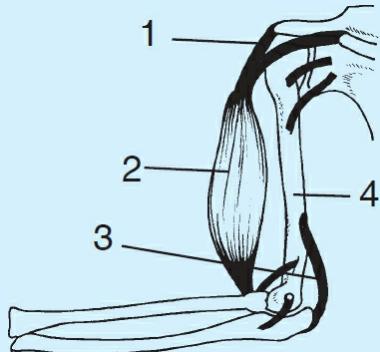
- Q.10.**
- (a) Identify the animal tissue represented alongside
 - (b) Label the parts 1 to 4
 - (c) Mention the function of this tissue.



Ans.

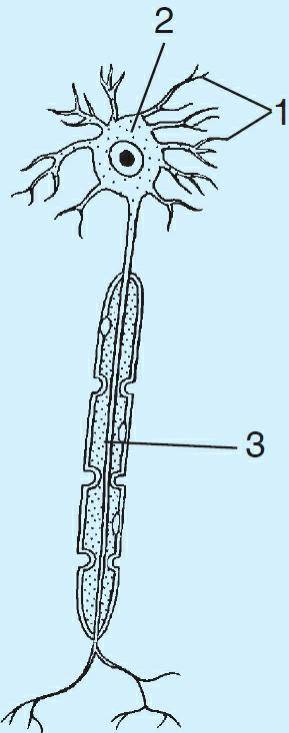
- (a) Squamous epithelium
- (b) 1. Cytoplasm, 2 Nucleus, 3. Cement substance, 4. Basement membrane.
- (c) It protects the underlying body parts such as mouth cavity, skin, nose, alveoli, etc.

- Q.11.**
- (a) Label the parts marked 1 to 4 in figure.
 - (b) Mention difference between 1 and 3.



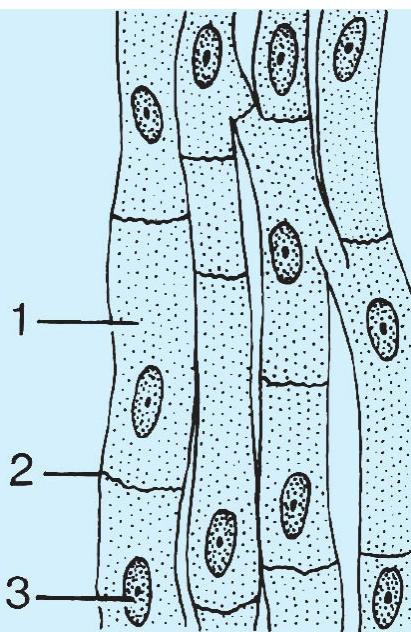
Ans. (a) 1. Tendon, 2. Muscle, 3. Ligament, 4. Bone.
(b) See [Table 3.10](#).

Q.12. (a) Identify the tissue.
(b) Label the parts marked 1, 2 and 3.
(c) What is the location of this tissue ?

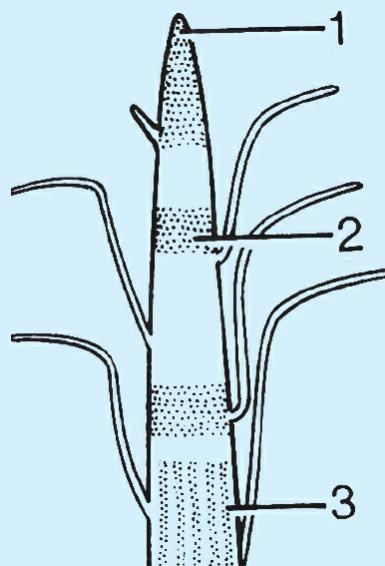


Ans. (a) It is neuron of vertebrate nervous tissue.
(b) 1. Dendrite, 2. Cyton or cell body, 3. Axon.
(c) It is located in brain and spinal cord.

Q.13. (a) Identify the tissue.
(b) Labels the parts marked 1, 2 and 3.
(c) What type of this tissue and where it occurs in body

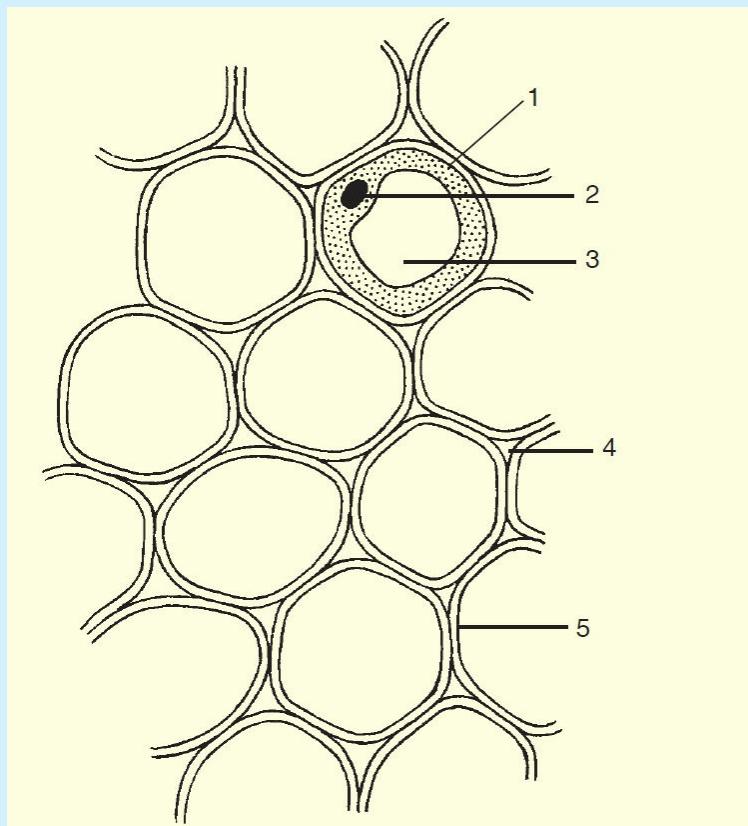


- Ans.**
- (a) It is a muscular tissue.
 (b) 1. Sarcoplasm 2. Intercalated disc 3. Nucleus.
 (c) This tissue is cardiac muscle which is involuntary in nature.
 (d) It is found in the wall of heart of vertebrate (human).
- Q.14.**
- (a) Identify the figure.
 (b) Labels the parts marked 1 to 3.
 (c) Write the functions of parts marked 1 and 3.



- Ans.**
- (a) The figure illustrates the location of meristematic tissue in plants.
 (b) 1. Apical meristem; 2. Intercalary meristem; 3. Lateral

- meristem.
- (c) Part 1 (apical meristem) is responsible for the growth of roots, shoots, branches and leaves.
Part 3 (lateral meristem) is responsible for increase in girth of stem and roots.
- Q.15.**
- (a) Identify the plant tissue given in figure alongside.
 - (b) Label the parts marked 1 to 5.
 - (c) Mention the function of this tissue.



- Ans.**
- (a) It is parenchyma which is a simple and living plant tissue.
 - (b) 1. Cytoplasm; 2. Nucleus, 3. Vacuole, 4. Intercellular space, 5. Cell wall.
 - (c) The main function of parenchyma is the storage of food.

(iii) Communication Skill-Based Questions

- Q.16.** Why is blood considered to be connective tissue?

- Ans.** Blood is considered as mobile connective tissue because, during circulation, it passes through all the organs of the body and in doing so, it connects different tissues and organs of the body.
- Q.17. What will happen if apical meristem is damaged or cut?**
- Ans.** Apical meristems are present at the tips of roots, shoots, branches and leaves. They form the growing parts of the roots and stems. If they are damaged or cut, the growth in length of that part will cease to occur.
- Q.18. What will happen if bone marrow is destroyed.**
- Ans.** Bone marrow produces blood cells. If bone marrow is destroyed, white blood cells (WBCs), red blood corpuscles (RBCs) and platelets will not be formed.
- Q.19. What will happen if all blood platelets are removed from blood?**
- Ans.** Blood platelets are responsible for the release of thromboplastin necessary for blood clotting at the site of injury. In the absence of blood platelets, blood clotting will not occur after injury and bleeding will continue from the wound. This will finally cause the death of the injured person.

Questions Based on NCERT Question Bank (Exemplar Problems in Science)

- Which structure protects the plant body against the invasion of parasites?**
- Q.1.** **Ans.** Epidermis is the outer protective layer of plant body which does not allow the parasites to gain entry into plant's internal tissues due to (i) absence of intercellular spaces; (ii) thick outer walls; (iii) deposition of cutin and wax in the cuticle covering the epidermis; (iv) silica and other depositions.
- Animals of colder region and fishes of cold water have thicker layer of subcutaneous fat. Describe why?**
- Q.2.** **Ans.** In animals, subcutaneous fat functions as an insulating layer that prevents heat loss from the body in cold environment. So animals in cold areas and fishes of cold water possess thicker layer of subcutaneous fat. Fat also functions as reserve food during periods of food scarcity.

Q.3. Match the items of column A and column B

<i>Column A</i>	<i>Column B</i>
(a) Stratified squamous epithelium	(i) Subcutaneous layer
(b) Striated muscle	(ii) Cartilage
(c) Fluid connective tissue	(iii) Skeletal muscle
(d) Filling the space inside the organs	(iv) Alveolar tissue
(e) Adipose tissue	(v) Blood
(f) Surface of joints	(vi) Skin

Ans. (a) (vi)
(b) (iii)
(c) (v)
(d) (iv)
(e) (i)
(f) (ii).

Q.4. Match the column A with column B

<i>Column A</i>	<i>Column B</i>
(a) Aerenchyma	(i) Thin walled packing cells
(b) Collenchyma	(ii) Carbon fixation
(c) Parenchyma	(iii) Localised thickening
(d) Permanent tissue	(iv) Buoyancy
(e) Photosynthesis	(v) Sclerenchyma

Ans. (a) (iv)
(b) (iii)
(c) (i)
(d) (v)
(e) (ii).

Q.5. Name the different components of xylem and draw a living component.

Ans. Xylem is made up of four components—tracheids, vessels (trachae), xylem fibres and xylem parenchyma. Only xylem parenchyma is the living component. Draw xylem parenchyma from [Figure. 3.17](#).

Q.6. Draw and identify different elements of phloem.

Ans. Draw [Fig. 3.19](#). It does not show phloem fibres. The other three components are phloem parenchyma, sieve tubes and companion cells.

Write true (T) and false (F).

- (a) Epithelial tissue is protective tissue in animal body.
- (b) The lining of blood vessels, lung alveoli and kidney tubules are all made up of epithelial tissue.
- (c) Epithelial cells have a lot of intercellular spaces.
- (d) Epithelial layer is permeable layer.
- (e) Epithelial layer does not allow regulation of materials, between body and external environment.

(a) T

(b) T

Ans. (c) F

(d) T

(e) F.

Q.8. Differentiate between voluntary and involuntary muscles. Give an example of each type.

Ans.

<i>Voluntary muscles</i>	<i>Involuntary muscles</i>
<ul style="list-style-type: none">1. These muscles function as per the directions of a conscious will.2. Brain can stop or start them.3. They get fatigued after some time. Example: Skeletal (striated) muscles.	<p>These muscles function on their own independent of conscious will.</p> <p>Brain cannot stop or start them.</p> <p>They do not get fatigued.</p> <p>Example: Unstriated (smooth) and cardiac muscles</p>

Differentiate the following activities on the basis of voluntary (v) or involuntary (iv) muscles

Q.9.

- (a) Jumping of frog
- (b) pumping of heart
- (c) writing with hand
- (d) movement of chocolate in your intestine

(a) v

(b) iv

Ans. (c) v

(d) iv

Fill in the blanks

Q.10.

- (a) Lining of blood vessels is made up of
- (b) Lining of small intestine is made up of
- (c) Lining of kidney tubules is made up of
- (d) Epithelial cells with cilia are found in of body.

Ans.

- (a) Squamous epithelium
- (b) Columnar epithelium
- (c) Cuboidal epithelium
- (d) Respiratory tract

Fill in the blanks

Q.11.

- (a) Cork cells possess on their walls that makes them impervious to gases and water.
- (b) have tubular cells with perforated walls and are living in nature.
- (c) Bone posses a hard matrix composed of and

Ans.

- (a) Suberin
- (b) Sieve tubes
- (c) Calcium, phosphorus

Q.12.

Why is epidermis important for the plants.

Ans.

See text.

Fill in the blanks:

Q.13.

- (a) are forms of complex tissue.
- (b) have guard cells.
- (c) Cells of cork contain a chemical called..... .
- (d) Husk of coconut is made of tissue.
- (e) and both conducting tissues.
- (f) gives flexibility in plants.
- (g) Xylem transports and from soil.
- (h) Phloem transports from to other parts of the plant.

Ans.

- (a) Xylem and phloem
- (b) Stomata
- (c) Suberin
- (d) Sclerenchyma
- (e) Xylem, phloem
- (f) Collenchyma
- (g) Water, minerals
- (h) Food, leaves

Q.14. Water hyacinth floats on water surface. Explain.

Water hyacinth (*Eichornia crassipes*) has spongy petioles which enclose a lot of air in its aerenchyma. Air makes the plant lighter than water so that it is able to float on surface of water.

Q.15. Differentiate between sclerenchyma and parenchyma tissue. Draw well labelled diagrams.

Ans. Draw [Fig. 3.11](#) and [Fig. 3.8](#).

Table : Difference between sclerenchyma and parenchyma tissues.

<i>Sclerenchyma</i>	<i>Parenchyma</i>
1. It is a dead tissue.	It is a living tissue.
2. The cells are thick walled.	The cells are thin walled.
3. The cells have a deposition of lignin.	The cells are generally unlignified.
4. Intercellular spaces are absent in between the cells.	Intercellular spaces are abundant so that the tissue cells are loosely packed.
5. The cells are generally elongated and spindle-shaped.	The cells are generally isodiametric.
6. Cell cavity is narrow.	Cell cavity is wide.
7. It provides mechanical strength.	It stores nutrients and water especially in the stems and roots.
8. Sclerenchyma occurs over vascular bundles, hypodermis of monocot stems, veins of leaves and hard covering of seeds and nuts.	Parenchyma occurs as chlorenchyma in leaves and young stems, ground tissue (cortex, pith) in stems and roots and as aerenchyma in aquatic plants.

Q.16. Describe the structure and function of different types of epithelial tissues. Draw well labelled diagram.

Ans. See text. Draw [Figs. 3.21, 3.23, 3.24](#) and [3.26](#).

Q.17. Draw well labelled diagrams of various types of muscles found in human body

Ans. Draw [Fig. 3.27](#).

Give reasons for

(a) Meristematic cells have a prominent nucleus and dense cytoplasm but they lack vacuoles

Q.18. (b) Intercellular spaces are absent in sclerencymatous tissue

- (c) We get a crunchy and granular feeling when we chew pear fruit
- (d) Branches of a tree move and bend freely in high wind velocity
- (e) It is difficult to pull out the husk of coconut.

Ans. (a) They are undergoing divisions (by mitosis) and do not store food.

- (b) They have lignified walls and form bundles for mechanical function.
- (c) It has stone cells or sclereids.
- (d) Collenchyma provides them flexibility.
- (e) Sclerenchyma fibres are tightly packed.

Q.19. **List the characteristics of cork. How is it formed? Mention its role.**

Ans. **A. Characteristics of cork**

- (i) Cork is the outer protective tissue of older stems and roots.
- (ii) The mature cork cells become dead and filled with tannins, resins and air.
- (iii) Intercellular spaces are absent. Cork is a compact tissue.
- (iv) Cork cells are impermeable due to deposition of suberin in their walls.
- (v) Cork consists of several layers of cells.
- (vi) Cork cells are rectangular in outline.
- (vii) At places, the cork bears aerating pores called lenticels.

B. **Formation of cork :** As plants grow old, cork is formed from a secondary lateral meristem called **phellogen** or **cork cambium**. It develops subepidermally in older stems and roots. Cells cut out on the outer side by cork cambium form cork or **phellem** while cell cut out on the inner side give rise to secondary cortex or **phelloderm**. The whole tissue (cork, cork cambium and secondary cortex) is called **periderm**.

C. Functions of cork. See text.

Q.20. **Why are xylem and phloem called complex tissues? How are they different from one another?**

Xylem and phloem are vascular or conducting tissues of the plants. They are called complex tissues because each of them is made of more than

Ans. one type of cells which coordinate their activities to perform a common function.

Differences between xylem and phloem. See [Table 3.7](#).

- Q.21.**
- (a) **Differentiate between meristematic and permanent tissues in plants.**
 - (b) **Define the process of differentiation.**
 - (c) **Name any two simple and two complex permanent tissues in plants.**
- Ans.**
- (a) Differences between Meristematic and Permanent tissues. See [Table 3.2](#).
 - (b) The process of loss of ability to divide and taking up a permanent shape, size, structure and function by newly formed cells is called **differentiation**.
 - (c) (i) **Simple permanent tissues.** Parenchyma, collenchyma, sclerenchyma.
(ii) **Complex permanent tissue.** Xylem, phloem.

NCERT TEXTBOOK QUESTIONS AND EXERCISES WITH ANSWERS

NCERT Textbook Questions

Q.1. What is a tissue?

Ans. A tissue is a group or collection of similar cells which work together to achieve a particular function and have common origin. Blood, phloem and muscles are all examples of tissues.

Q.2. What is the utility of tissues in multicellular organisms?

In multicellular organisms there are millions of cells. Most of these cells are specialised to carry out a few functions. Each specialized function is taken up by a different group of cells or tissues. Since these cells of a tissue carry out only a particular function, they do it very efficiently. For example, in human beings, muscle cells contract and relax to cause movement, nerve cells carry messages and blood flows to transport oxygen, food, hormones and waste materials and so on. Likewise, in plants, vascular tissues (xylem, phloem) conduct water and food from one part of the plant to other parts. So, multicellular organisms show division of labour.

Q.3. Name three types of simple tissues.

Ans. *Three* types of simple tissues of plants are:

1. Parenchyma; 2. Collenchyma; and 3. Sclerenchyma.

Q.4. Where is apical meristem found?

Ans. Apical meristem is found in shoot apex and root apex of an angiospermic plant.

Q.5. Which tissue makes up the husk of coconut?

Ans. Sclerenchymatous fibres.

Q.6. What are constituents of phloem?

Ans. Phloem is a complex tissue of the angiosperm plants. It serves as a conducting tissue and is made up of four types of elements: (i) Sieve tube; (ii) Companion cells; (iii) Phloem fibres (bast fibres), and (iv) Phloem parenchyma.

Q.7. Name the tissue responsible for the movement in our body.

Ans. Muscular tissue.

Q.8. What does a neuron look like?

Ans. Neuron or nerve cell is a unit of nervous tissue (brain, spinal cord and nerves) which serves to transmit messages in our body. A neuron consists of **cell body** with a nucleus and cytoplasm, from which long thin hair-like parts arise. Usually, each neuron has a single long part called the **axon**, and many short branched processes (parts) called **dendrites**.

Q.9. Give three features of cardiac muscle.

Ans. (i) Cardiac muscles are involuntary.
(ii) Cardiac muscle cells are cylindrical, branched and uninucleate.
(iii) Cardiac muscles show rhythmic contraction and relaxation throughout the life.

Q.10. What are functions of areolar tissue?

Ans. Areolar tissue is a connective tissue. It fills the space inside the organs, supports internal organs and helps in repair of tissues.

NCERT Exercises

Q.1. Define the term “tissue”.

Ans. A tissue is a group or collection of similar or dissimilar cells which work together to achieve a particular function. Cells of a tissue have common origin.

Q.2. How many types of elements together make up the xylem tissue? Name them.

Ans. Xylem is a complex tissue. It is made up of following four kinds of cells (= elements): (i) Tracheids; (ii) Vessels; (iii) Xylem parenchyma; (iv) Xylem fibres.

Q.3. How are simple tissue different from complex tissue in plants?

Ans. A simple tissue is made up of only one type of cells whereas complex tissue is made up of different types of cells.

Q.4. Differentiate between parenchyma, collenchyma and sclerenchyma on the basis of their cell wall.

Ans. The differences between cell walls of parenchyma, collenchyma and sclerenchyma are given in following table:

<i>Parenchyma</i>	<i>Collenchyma</i>	<i>Sclerenchyma</i>
1. Cell wall is primary. 2. Cell wall is thin and made up of cellulose.	1. Cell wall is primary. 2. Cell wall has localised thickening of cellulose.	1. Cell wall is secondary. 2. Cell wall is very thick obliterating internal cellular space. Cell wall is thickened due to deposition of lignin.

Q.5. What are the functions of the stomata?

The important functions of stomata are:

Ans. (i) Exchange of gases with atmosphere, e.g., entry of carbon dioxide for photosynthesis and of oxygen for respiration.
(ii) Transpiration, i.e., loss of water in the form of water vapour.

Q.6. Diagrammatically show the difference in three types of muscle fibres.

Ans. Refer to [Fig. 3.27 A, B](#) and [C](#).

Q.7. What is the specific function of the cardiac muscle?

Ans. Cardiac muscle is present in the heart. It contracts and relaxes rapidly and continuously with a rhythm, but it never gets fatigued.

Q.8. Differentiate between striated, unstriated and cardiac muscles on the basis of their structure and site/location in the body.

Ans. Differences between striated, unstriated and cardiac muscles are as follows:

<i>Striated muscle</i>	<i>Unstriated muscle</i>	<i>Cardiac muscle</i>
1. The cells of striated muscles are long, cylindrical unbranched and multinucleated. 2. Striated muscles are present in our limbs and join the bones.	1. The cells of unstriated muscles are long, pointed at the ends and uninucleated. 2. These muscles are present in alimentary canal, blood vessels, iris of the eye, ureter and bronchi.	1. The cells of cardiac muscles are cylindrical, branched and uninucleated. 2. Cardiac muscles are present in the heart (<i>i.e.</i> in the wall of heart).

Q.9. Draw a labelled diagram of a neuron.

Ans. Refer to [Fig. 3.35](#).

Name the following:

- (a) Tissue that forms inner lining of our mouth.
- (b) Tissue that connects muscle to bone in humans. (c) Tissue that transports food in plants.

- Q.10.**
- (d) Tissue that stores fat in our body.
 - (e) Connective tissue with a fluid matrix.
 - (f) Tissue present in the brain.
- (a) Squamous epithelium;
 - (b) Tendon;
 - (c) Phloem;

Ans.

- (d) Adipose tissue;
- (e) Vascular tissue (Blood and lymph);
- (f) Nervous tissue.

Q.11. Identify the type of tissue in the following: skin, bark of tree, bone, lining of kidney tubule, vascular bundle.

Skin: Epithelial tissue (squamous epithelium);

Bark of tree: Cork (protective tissue);

Ans. **Bone:** Skeletal tissue (connective tissue);

Lining of kidney tubules: Cuboidal epithelial tissue;

Vascular bundle: Complex permanent tissue — xylem and phloem.

Q.12. Name the regions in which parenchyma tissue is present.

Ans. Parenchyma is a simple permanent tissue of angiospermic plants. It is present in cortex and pith of stem and roots. It is also present in the mesophyll of leaves.

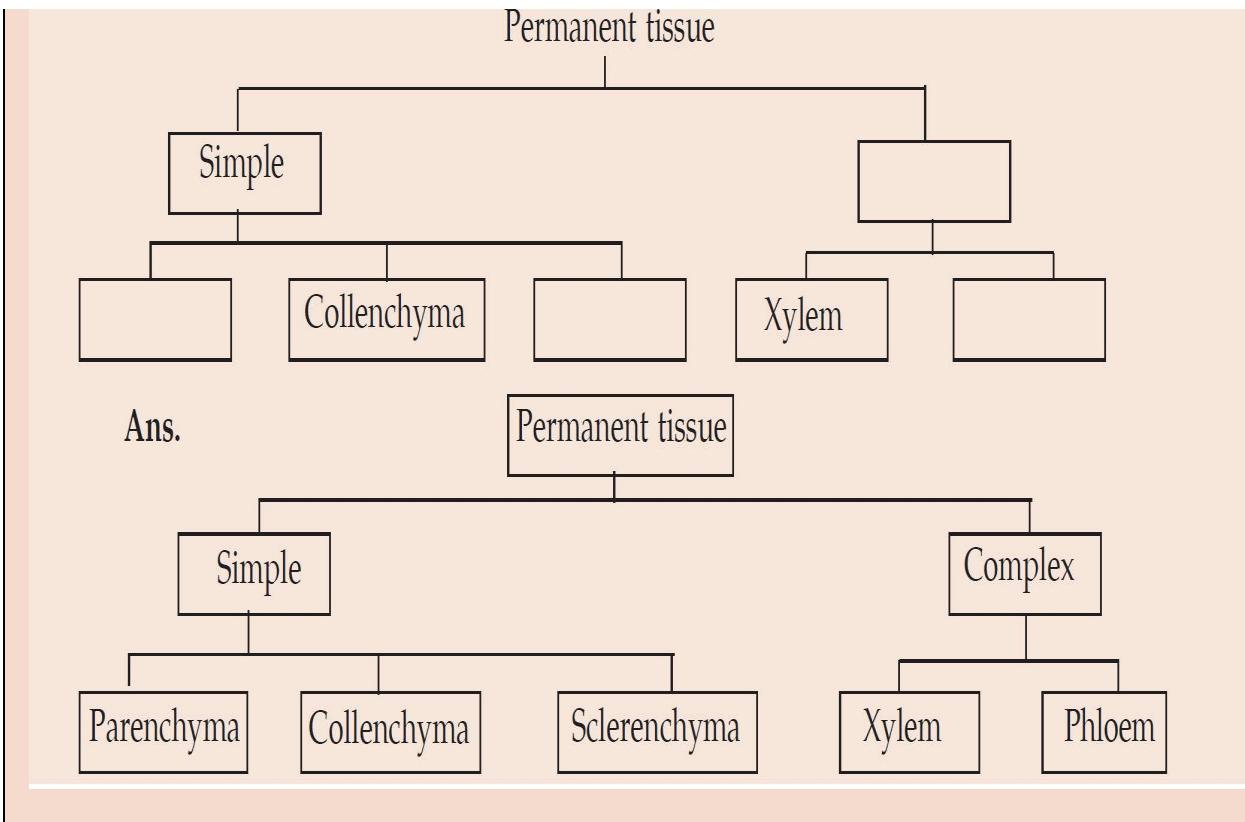
Q.13. What is the role of epidermis in plants?

Ans. Epidermis is a protective tissue of angiospermic plants. It provides protection to underlying tissues. Epidermis forms outer covering of various plant organs such as roots, stem, leaves and flowers and remains in direct contact with the environment. Any substance, whether solid, liquid or gas can enter into the plant or move outside only after passing through this layer. Epidermis helps in absorption, secretion, excretion, gaseous exchange and transpiration. It helps in preventing the entry of pathogens.

Q.14. How does cork act as a protective tissue?

Ans. The cork cells are dead and do not have any intercellular spaces. The cell walls of the cork cells are coated with suberin (a waxy substance). Suberin makes these cells impermeable to water and gases. Cork is protective in function; it protects underlying tissues from desiccation (loss of water from plant body), infection and mechanical injury.

Q.15. Complete the table:



QUESTIONS OF CBSE SAMPLE PAPER

- Q.1. (a) Name the plant tissue found in the husk of coconut and also identify the chemical which is responsible for its stiffness.**
(b) Give one way in which it differs from parenchymatous cells

(2 marks; 2010)

- Ans. (a)** Plant tissue in husk of coconut is sclerenchyma fibres.
Reason for stiffness of sclerenchyma is deposition of lignin in cell walls of its cells.
- (b)** Sclerenchyma fibres are thick walled dead cells while parenchyma cells are thin walled living cells.

- Q.2. (a) Name the living components common to both the complex permanent tissues found in plants. What is its function?**
(b) Give any two ways in which these tissues differ functionally from each other

(3 marks; 2010)

Parenchyma is the common living component of two complex

- Ans.** (a) permanent tissues, xylem and phloem. It takes part in storage of nutrients and slow lateral conduction (water in xylem and nutrients in phloem).
- (b) Function differences.

<i>Xylem</i>	<i>Phloem</i>
<p>1. Xylem conducts sap (water and minerals).</p> <p>2. Conduction is often bidirectional from leaves to roots and from roots to stem tips.</p>	<p>1. Phloem conducts solutes or nutrients.</p> <p>2. Conduction is mostly unidirectional, upwardly from roots to stem tips and leaves.</p>

MCQs (1 mark each; 2010)

1. Multinucleate conditions is seen in
 - (a) only smooth muscle cells
 - (b) only skeletal muscle cells
 - (c) both smooth and skeletal muscle cells
 - (d) neither smooth nor skeletal muscle cells
2. The features that best describe the cells of parenchyma cells are
 - (a) dead cells, thick walled, no inter cellular
 - (b) living cells, thin-walled, no intercellular spaces
 - (c) dead cells, thin-walled, large inter cellular spaces
 - (d) living cells, thin-walled, large intercellular spaces
3. The correct order of the parts of nerve cells through which the nerve impulse is transmitted is
 - (a) nerve endings, dendrites, nerve endings
 - (b) cell body, axon, dendrites, nerve endings
 - (c) dendrites, nerve endings, cell body, axon
 - (d) dendrites, cell body, axon, nerve endings
4. A coverslip must always be placed very gently while mounting in order to
 - (a) avoid the entry of air bubbles
 - (b) stop the stain from oozing out
 - (c) avoid crushing of the material
 - (d) stop the material from drying

- Ans. 1.** (b);
2. (d);
3. (d);
4. (a)x

QUESTIONS BASED ON HIGH ORDER THINKING SKILLS (HOTS)

Q.1. What will happen if (a) Bone is dipped in hydrochloric acid (HCl); (b) Bone is dried ?

- Ans.** (a) When a bone is dipped in HCl, its mineral matter dissolves. Only organic matter is left.
(b) When a bone is dried, its organic matter gets destroyed. Only mineral matter is left.

Q.2. What will happen if

- (a) **Ligament gets over stretched ?**
(b) **Heparin is absent in blood.**
(c) **Striated muscles contract rapidly for longer duration.**

- Ans.** (a) Overstretching of ligament results in sprain.
(b) Absence of heparin in blood result in coagulation of blood inside the blood vessels.
(c) When striated muscles contract rapidly for longer duration, they get fatigued due to accumulation of lactic acid in them.

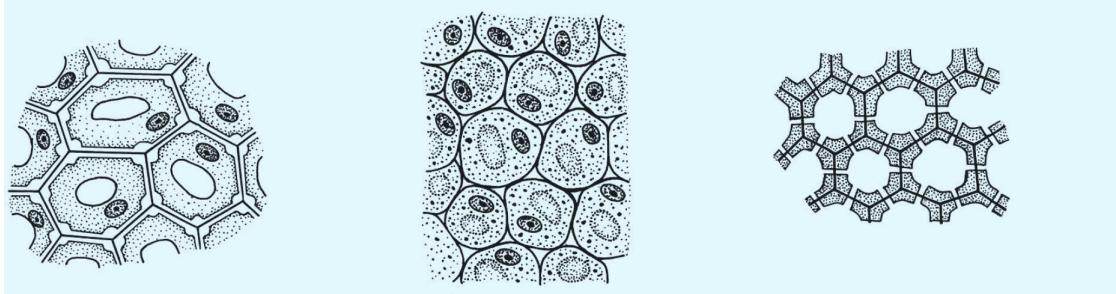
Q.3. What will happen if

- (a) **Apical meristem is damaged or cut ?**
(b) **Cork is not formed in older stems and roots.**
(c) **Lymph is not returned to blood ?**

- Ans.** (a) If apical meristem is damaged or cut, then growth in length of the plant will stop.
(b) If cork is not formed in older stems or roots, the outer tissues will rupture due to increase in girth (secondary growth) which expose the interior to dessication and infection.
If lymph is not returned to blood, the blood volume will decrease and

- (c) while passage of materials from tissues to blood and vice versa would be disturbed.

Q.4.



A

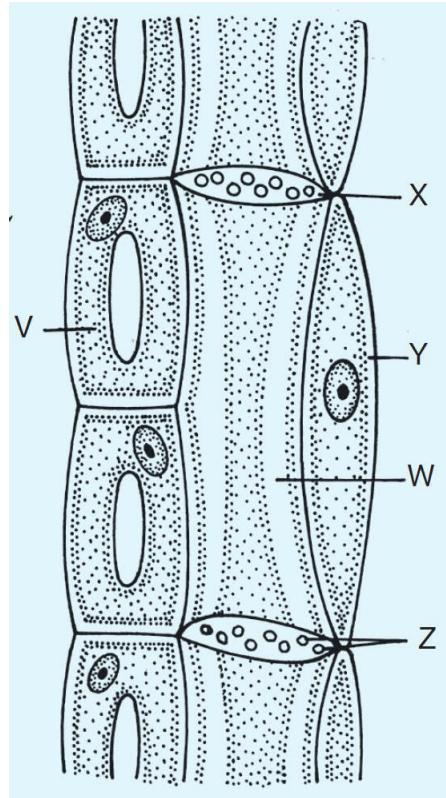
B

C

- (a) **Identify Figures A, B and C.**
- (b) **Which one of them has heavy deposition of lignin ?**
- (c) **Which one of them provides both mechanical strength as well as flexibility ?**
- (d) **Which one of them can be modified to form air cavities in aquatic plants ?**
- (e) **Which one of them is commercially exploited to obtain Hemp and Jute ?**

- Ans.** (a) Figure A — T.S. collenchyma;
Figure B — T.S. parenchyma ;
Figure C — T.S. sclerenchyma fibres.
- (b) Tissue which has heavy deposition of lignin is sclerenchyma.
- (c) Tissue which provides both mechanical strength and flexibility is collenchyma.
- (d) Parenchyma is modified to arenchyma having air cavities in the aquatic plants.
- (e) Fibres of Hemp and Jute are obtained from the sclerenchyma fibres.

- Q.5. (a) Identify the figure. What is its function ?**
- (b) Label V and W.**
- (c) Label X, Y and Z.**
- (d) W loses its nucleus in the mature state, still it remains alive. Explain how ?**

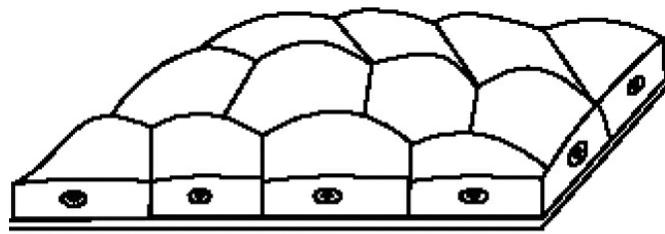


Ans. (a) It is a phloem tissue of the angiospermic plant. Function of phloem is conduction of organic food.

- (b) V — Phloem parenchyma; W — Sieve tube cell.
- (c) X — Sieve plate; Y — Companion Cell;
- Z — Sieve pores.

Living state of the mature sieve tube cells is regulated by nucleated companion cells with which they are connected by plasmodesmata.
 (d) Both sieve tube cell and companion cells tend to be originated from the same mother.

Q.6. (a) Identify figures A and B.



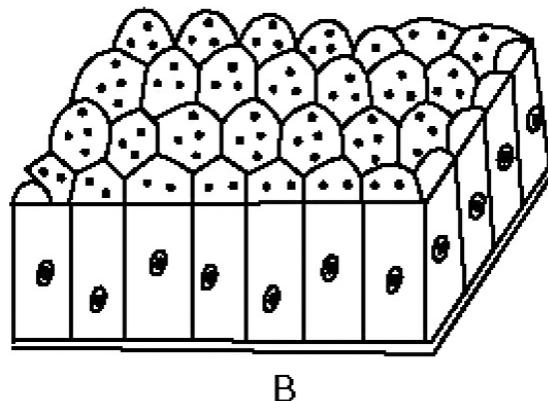
A

- (b) Which is called tessellated and pavement epithelium ?
- (c) Which one lines the gastrointestinal tract and epiglottis ?

(d) Which one allows diffusion of substances ?

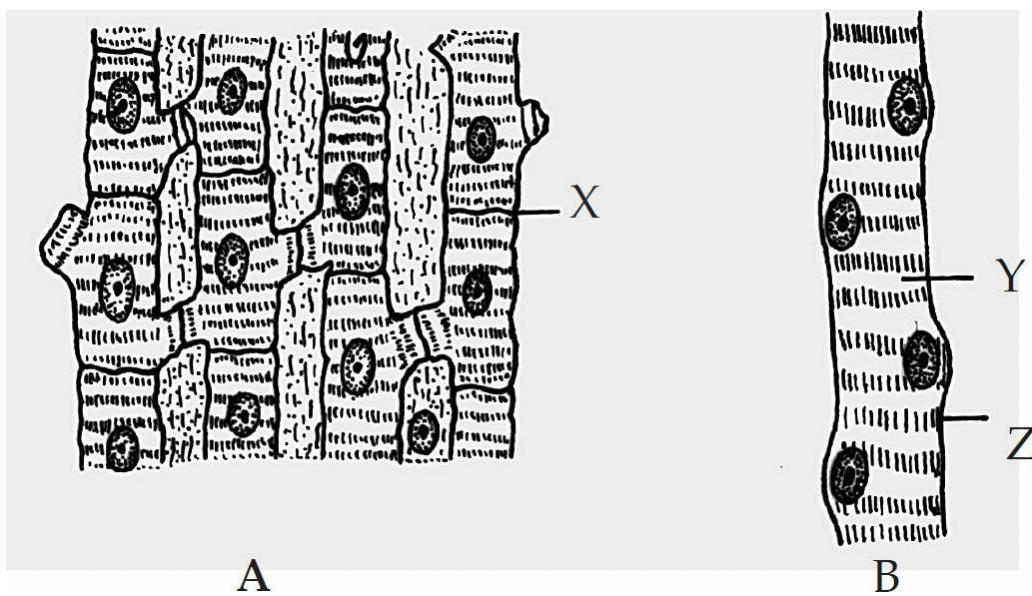
Ans. (a) Figure A is squamous epithelium;
Figure B is columnar epithelium.

(b) Tesselated epithelium is another name for the squamous epithelium.
(c) Pavement epithelium is also one of the name of squamous epithelium.



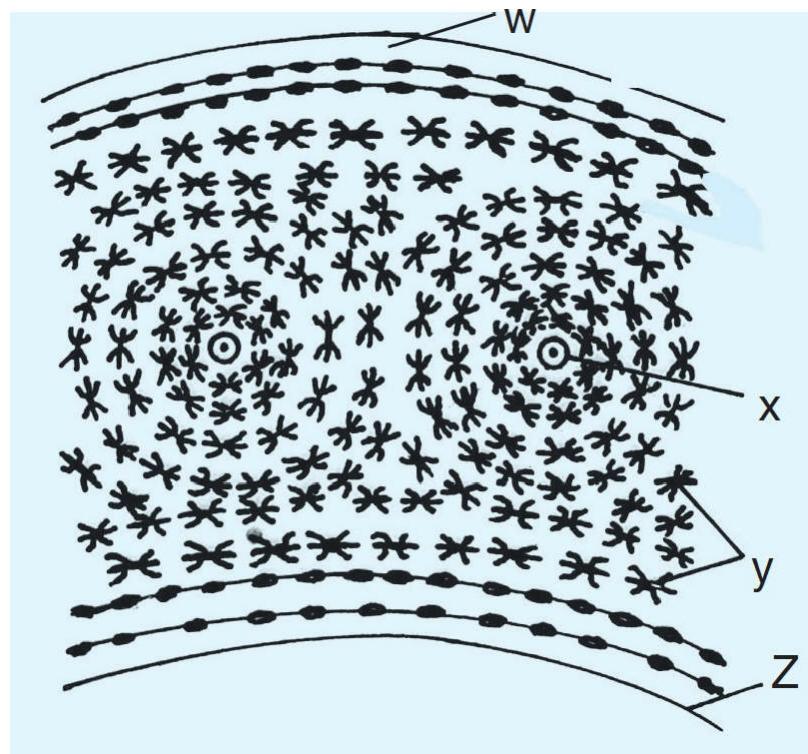
- (c) Gastrointestinal tract is lined by simple columnar epithelium.
Epiglottis is lined by simple columnar epithelium.
(d) Simple epithelium such as squamous epithelium allows diffusion of substances through it.

Q.7.



- (a) Identify figures A and B.
(b) Label X, Y and Z.
(c) Which one act as impulse booster ?
(d) Which one is under control our will ?

- Ans.** (a) Figure A is cardiac muscle fibres.
 Figure B is skeletal or striated muscle fibre.
 (b) X-Intercalated disc; Y-Light band; Z-Dark band
 (c) Intercalated disc act as an impulse booster.
 (d) Skeletal or striated muscle is under control of our will.



- Q.8. (a) Identify the figure.
 (b) Label W, X, Y and Z.
 (c) What is chemical composition of material of the figure.
 (d) What is the function of X ?**

- Ans.** (a) It is section of a bone.
 (b) W-Periosteum; X-Haversian canal; Y-Canaliculus (plural canaliculi);
 Z-Endosteum.
 Composition of material of bone includes
 (c) (i) Ossein (30-40%), (ii) Mineral matter (60-70%) of calcium and magnesium carbonate and phosphate.
 (d) Haversian canal tends to carry nutrients to the interior of the bone.

PAPER-PEN TEST

Time 30 minutes

Maximum marks 17

MCQ

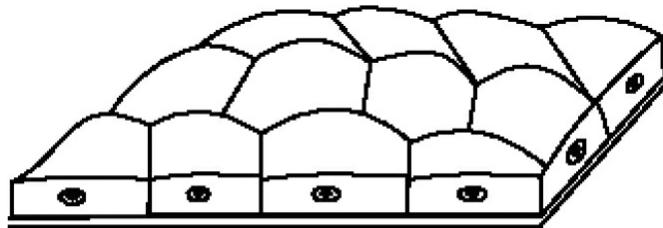
1

1. Cuboidal: Epithelial :: Cardiac: _____
 - (a) nervous
 - (b) connective
 - (c) epithelia
 - (d) muscular

Blanks

1

2. Cork cells are dead cells so have no spaces and the cell walls are heavily thickened by the deposition of



A

1

T/F

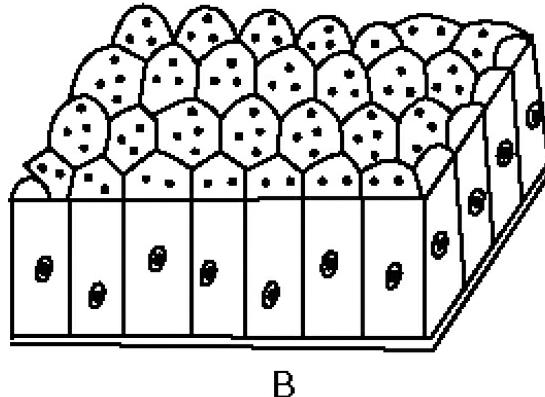
3. Xylem consists of mainly dead elements.

2

Matching

4. Match the following

- | | |
|--------------------------|--------------------------------|
| 1. Blood and Lymph | (a) Epithelial tissue |
| 2. Bone and Cartilage | (b) Areolar connective tissue |
| 3. Tendon and Ligament | (c) Skeletal connective tissue |
| 4. Ciliated and Cuboidal | (d) Fluid connective tissue |



2

HOTS

5.

- (a) Identify figures A and B.
- (b) epithelium forms the outer layer of the skin and lines cavities and ducts.
- (c) epithelium consist of cells that are tall and pillar-like
- (d) Which one allows diffusion of substances ?

S.A.I.

6. Name the various cells found in connective tissue.

2

S.A.II

7. Give on illustrative account of any type of complex permanent tissues of the plants.

3

L.A.B.

8. Classify connective tissues. Give one example of each type.

5

ANSWERS

1. (d)
2. Intercellular, lignin;
3. F;
4. 1-d.,
2. c,

3. b,
4. a

Multiple Choice Questions

Type 1: Interpretation Type Questions

1. **The efferent part of neuron is**
 - (a) axon
 - (b) dendrite
 - (c) cyton
 - (d) both (a) and (b)
2. **Blubber of whale and hump of camel are**
 - (a) areolar tissue
 - (b) muscular tissue
 - (c) tendon
 - (d) adipose tissue
3. **Cuboidal tissue takes part in**
 - (a) absorption
 - (b) secretion
 - (c) excretion
 - (d) all the above
4. **Heart muscles are**
 - (a) voluntary and striated
 - (b) involuntary and striated
 - (c) voluntary and multinucleate
 - (d) involuntary, striated and uninucleate
5. **Simple tissues are these**
 - (a) parenchyma, xylem and collenchyma
 - (b) parenchyma, collenchyma and sclerenchyma
 - (c) parenchyma, xylem and sclerenchyma
 - (d) parenchyma, xylem and phloem
6. **The most common type of ground tissue is**
 - (a) epidermis

- (b) collenchyma
- (c) sclerenchyma
- (d) parenchyma

7. Collenchyma mainly forms

- (a) hypodermis
- (b) epidermis
- (c) phloem
- (d) inner cortex

8. Whose living cells provide tensile and mechanical strength?

- (a) collenchyma
- (b) sclerenchyma
- (c) phloem
- (d) sclereids

9. Lignified elongated dead cells are

- (a) parenchyma
- (b) collenchyma
- (c) sclerenchyma
- (d) none of the above

10. Simple epithelium is a tissue in which cells are

- (a) hardened and provide support to organs
- (b) continuously dividing to provide to form an organ
- (c) cemented directly to one another to form a single layer
- (d) loosely connected to one another to form an irregular layer

11. Pavement epithelium is the name of

- (a) squamous epithelium
- (b) cuboidal epithelium
- (c) ciliated epithelium
- (d) columnar epithelium

12. Brush-bordered epithelium is found in

- (a) stomach
- (b) small intestine
- (c) fallopian tube
- (d) trachea

13. Phloem in the plants perform the function of

- (a) conduction of food
- (b) conduction of water

- (c) providing support
 - (d) photosynthesis
- 14. Tendon is a structure which connects**
- (a) a bone with another bone
 - (b) a muscle with a bone
 - (c) a nerve with a muscle
 - (d) a muscle with a muscle
- 15. Smooth muscles occur in**
- (a) uterus
 - (b) artery
 - (c) vein
 - (d) all the above
- 16. Which are not true cells in the blood?**
- (a) platelets
 - (b) monocytes
 - (b) basophils
 - (d) neutrophils
- 17. The end of a long bone is connected to another bone by**
- (a) ligament
 - (b) tendon
 - (c) cartilage
 - (d) connective tissue
- 18. Ligaments and tendons are formed of**
- (a) epithelial tissue
 - (b) muscular tissue
 - (c) cartilage
 - (d) connective tissue

Type 2 : Identity : Relationship Type Questions

- 1. Haversian canals are present in**
- (a) cartilage
 - (b) ligament
 - (c) bone
 - (d) tendon

2. Intercalated disc is present in

- (a) striated muscle
- (b) smooth muscle
- (c) cardiac muscle
- (d) both b and c

3. Plant length is increased by

- (a) apical meristems
- (b) lateral meristems
- (c) periblem
- (d) parenchyma

4. The cell division is restricted to

- (a) meristematic cells
- (b) permanent cells
- (c) secretory cells
- (d) all the above

5. Active divisions take place in the cells of

- (a) xylem
- (b) phloem
- (c) sclerenchyma
- (d) cambium

6. Grass stem elongates by the activity of

- (a) primary meristem
- (b) secondary meristem
- (c) intercalary meristem
- (d) apical meristem

7. Which one of the following tissue gives mechanical support to young dicotyledonous stem?

- (a) parenchyma
- (b) collenchyma
- (c) sclerenchyma
- (d) chlorenchyma

8. Areolar connective tissue is found between

- (a) blood vessels and nerves
- (b) skin and muscles
- (c) in the bone marrow
- (d) all the three

- 9. Husk of coconut is made of**
 - (a) sclerenchymatous tissue
 - (b) parenchyma
 - (c) collenchyma
 - (d) chlorenchyma
- 10. Guard cells are present in**
 - (a) cork
 - (b) cortex
 - (c) stomata
 - (d) vascular bundle
- 11. White fibres of connective tissue are made up of**
 - (a) elastin
 - (b) reticular fibre
 - (c) collagen
 - (d) myosin
- 12. The hardness of the bone tissue is due to the phosphates and carbonates of**
 - (a) calcium and sodium
 - (b) calcium and magnesium
 - (c) magnesium and sodium
 - (d) magnesium and potassium

Questions Based on NCERT Question Bank (Exemplar Problems)

- 1. Meristematic tissues in plants are**
 - (a) growing in volume
 - (b) localised and permanent
 - (c) localised and dividing cells
 - (d) not limited in certain regions
- 2. Girth of stem increases due to**
 - (a) apical meristem
 - (b) lateral meristem
 - (c) intercalary meristem

(d) vertical meristem

3. Find out incorrect sentence

- (a) parenchymatous tissues have intercellular spaces
- (b) collenchymatous tissues are irregularly thickened at corners
- (c) apical and intercalary meristems are permanent tissues
- (d) meristematic tissues, in its early stage, lack vacuoles

4. Which cell does not have perforated cell wall?

- (a) tracheids
- (b) companion cells
- (c) sieve tubes
- (d) vessels

5. Parenchyma cells are

- (a) relatively unspecified and thin walled
- (b) lignified
- (c) thick-walled and specialised
- (d) none of these

6. The water conducting tissue generally present in gymnosperms is

- (a) xylem fibres
- (b) sieve tube
- (c) vessels
- (d) tracheids

7. The dead elements present in the phloem is

- (a) companion cells
- (b) phloem fibres
- (c) phloem parenchyma
- (d) sieve tube cells

8. If the tip of sugarcane plant is removed from the field, even then it keeps on growing in length. It is due to the presence of

- (a) cambium
- (b) apical meristem
- (c) lateral meristem
- (d) intercalary meristem

9. Which of the following does not lose their nucleus at maturity?

- (a) vessel

- (b) companion cells
 - (c) red blood cells
 - (d) sieve tube cells
- 10. Cork cells are made impervious to water and gases by the presence of**
- (a) cellulose
 - (b) lipids
 - (c) lignin
 - (d) suberin
- 11. Intestine absorbs the digested food materials. What type of epithelial cells are responsible for that?**
- (a) stratified squamous epithelium
 - (b) columnar epithelium
 - (c) spinal fibres
 - (d) cuboidal epithelium
- 12. Which is not a function of epidermis?**
- (a) protection from adverse condition
 - (b) gaseous exchange
 - (c) conduction of water
 - (d) transpiration
- 13. Which muscles act involuntarily?**
- (i) striated muscles
 - (ii) smooth muscles
 - (iii) cardiac muscles
 - (iv) skeletal muscles
- (a) (i) and (ii)
 - (b) (ii) and (iii)
 - (c) (iii) and (iv)
 - (d) (i) and (iv)
- 14. The muscular tissue which function throughout the life continuously without fatigue is**
- (a) skeletal muscle
 - (b) cardiac muscle
 - (c) smooth muscle
 - (d) voluntary muscle
- 15. While doing work and running, you move your organs such as**

hands, legs, etc., which among the following is correct?

- (a) smooth muscles contract and pull the ligament to move the bones
- (b) smooth muscles contract and pull the tendons to move the bones
- (c) skeletal muscles contract and pull the ligament to move the bones
- (d) skeletal muscles contract and pull the tendon to move the bones

16. Voluntary muscles are found in

- (a) alimentary canal
- (b) limbs
- (c) iris of the eye
- (d) bronchi of lungs

17. A person met with an accident in which two long bones of hand were dislocated. Which among the following may be the possible reason?

- (a) tendon break
- (b) break of skeletal muscles tissue
- (c) ligament break
- (d) areolar tissue break

18. Select the incorrect sentence

- (a) blood has matrix containing proteins, salts and hormones
- (b) two bones are connected with ligament
- (c) tendons are non-fibrous tissue and fragile
- (d) cartilage is a form of connective tissue

19. Bone matrix is rich in

- (a) fluoride and calcium
- (b) calcium and phosphorus
- (c) phosphorus and potassium
- (d) calcium and potassium

20. Contractile proteins are found in

- (a) bones
- (b) blood
- (c) muscles
- (d) cartilage

- 21. Which of the following helps in repair of tissue and fills up the space inside the organ?**
- (a) tendon
 - (b) adipose tissue
 - (c) areolar
 - (d) cartilage
- 22. Fats are stored in human body as**
- (a) cuboidal epithelium
 - (b) adipose tissue
 - (c) bones
 - (d) cartilage
- 23. Cartilage is not found in**
- (a) nose
 - (b) ear
 - (c) kidney
 - (d) larynx
- 24. Nervous tissue is not found in**
- (a) brain
 - (b) spinal cord
 - (c) tendons
 - (d) nerves
- 25. Nerve cell does not contain**
- (a) axon
 - (b) nerve endings
 - (c) tendons
 - (d) dendrite
- 26. Which of the following cell is found in the cartilaginous tissue of the body?**
- (a) basophils
 - (b) mast cells
 - (c) osteocytes
 - (d) chondrocytes
- 27. In desert plants, rate of water loss gets reduced due to the presence of**
- (a) cuticle
 - (b) stomata

- (c) lignin
(d) suberin
- 28. A long tree has several branches. The tissue that helps in the side ways conduction of water in the branches is**
- (a) collenchyma
(b) xylem parenchyma
(c) parenchyma
(d) xylem vessels
- 29. Flexibility in plants is due to**
- (a) collenchyma
(b) sclerenchyma
(c) parenchyma
(d) chlorenchyma
- 30. Survival of plants in terrestrial environment has been made possible by the presence of**
- (a) intercalary meristem
(b) conducting tissue
(c) apical meristem
(d) parenchymatous tissue
- 31. A nail is inserted in the trunk of a tree at a height of 1 metre from the ground level. After 3 years the nail will**
- (a) move downwards
(b) move upwards
(c) remain at the same position
(d) move sideways
- 32. Choose the wrong statement**
- (a) cells of striated muscles are multinucleate and unbranched
(b) fats are stored below the skin and in between internal organs
(c) the nature of matrix differs according to function of tissue
(d) epithelial tissue have intercellular spaces between them.

ANSWERS

Type I MCQs

1. (a);
2. (d);
3. (d)
4. (d);
5. (b);
6. (d);
7. (a);
8. (a);
9. (c);
10. (c);
11. (a);
12. (b)
13. (a)
14. (b);
15. (d);
16. (a);
17. (a)
18. (d).

Type II MCQs.

1. (c);
2. (c);
3. (a)
4. (a);
5. (d);
6. (c);
7. (b);
8. (d);
9. (a);
10. (c)
11. (c);
12. (b).

Type III MCQs

1. (c);

2. (b);
3. (c);
4. (b);
5. (a);
6. (d);
7. (b);
8. (d);
9. (b);
10. (d);
11. (b);
12. (c);
13. (b);
14. (b);
15. (d);
16. (b);
17. (c);
18. (c);
19. (b);
20. (c);
21. (c);
22. (b);
23. (c);
24. (c);
25. (c);
26. (d);
27. (a)
28. (d);
29. (a);
30. (b);
31. (c);
32. (d).

REVISION QUESTIONS

Very Short Answer Questions (Carrying 1 marks each)

- 1. What types of functions does the single cell of unicellular organism such as *Amoeba* perform?**

Ans. The single cell of unicellular organism such as *Amoeba* perform both vital life activities (e.g., respiration, metabolism, repair, assimilation) and organismic level activities (e.g., intake of food, exchange of respiratory gases, excretion, reproduction).

- 2. What types of functions does the single cell of multicellular organism perform ?**

Ans. All vital life activities and one specific function as a component of tissues.

- 3. Define the tissues.**

Ans. A tissue is a group of cells of the same type or mixed type having a common origin and performing a common function.

- 4. Name the two basic types of tissues found in plants.**

Ans. Meristematic and permanent.

- 5. Name a basic tissue which is present in plants but absent in animals.**

Ans. Meristematic.

- 6. What is division of labour ?**

Ans. Division of labour is adaptation of different parts of an organism to carry out different funtions.

- 7. Which types of tissues are more common in plants.**

Ans. Tissues with dead cells.

- 8. Why do animals consume more energy as compared to plants ?**

Ans. Animals require more energy as they have to move from place to place and possess living tissues for their activity.

- 9. What contribute more to the difference in organ system design of plants and animals ?**

Ans. Active movement (e.g., locomotion) in animals and sedentary habit of plants.

Give one example of (i) apical meristem and (ii) lateral meristem.

10.

- Ans.** (i) Shoot apex;
(ii) Cambium.

11. Where can one find meristematic tissues in plants?

- Ans.** In apical, intercalary and lateral positions in plants.

12. What is permanent tissue ?

- Ans.** A permanent tissue is a group of plant cells which have lost their ability to divide and have assumed a definite form and size.

13. Define simple tissue.

- Ans.** A simple tissue of the plant is a collection of similar cells that carry out the same function.

14. Name three types of simple tissues of plants.

- Ans.** Parenchyma, collenchyma and sclerenchyma.

15. What is the main function of parenchyma ?

- Ans.** The main function of parenchyma is to store food and provide turgidity to organ where it is found.

16. Which chemical is deposited at the corner of cells in collenchyma ?

- Ans.** Pectin and cellulose are deposited at the corner of cells in collenchyma.

17. Which chemical is deposited in the cell wall of sclerenchyma ?

- Ans.** Lignin is deposited in the cell wall of sclerenchyma.

18. Give one main function of collenchyma ?

- Ans.** Collenchyma provides mechanical strength as well as flexibility to the plant organs.

19. Define complex tissue.

- Ans.** A complex tissue of the plants consists of more than one type of cells which work together to perform a particular function.

Name the complex tissue which helps in :

**20. (a) Conduction of water and minerals.
(b) Conduction/transport of food.**

- Ans.** (a) Xylem ;
(b) Phloem.

- 21. What is common name of :**
- (a) Xylem
(b) Phloem ?
- Ans.** (a) Wood.
(a) Bast.
- 22. Name the plant cell which is attached to the lateral side of sieve tube.**
- Ans.** Companion cell is attached to the lateral side of sieve tube.
- 23. Which type of simple tissue of plants is used for making ropes ?**
- Ans.** Sclerenchyma is used for making ropes.
- 24. Give one example of protective tissue in plants.**
- Ans.** Cork is the protective tissue in the plants.
- 25. What is function of stomata ?**
- Ans.** Stomata allows gaseous exchange to occur during photosynthesis and respiration
- 26. What is the function of lateral meristem?**
- Ans.** Secondary growth.
- 27. Enumerate four main types of animal tissues.**
- Ans.** Epithelial tissues, Muscular tissues, Connective tissues, Nervous tissue.
- 28. Describe functions of squamous epithelial tissue.**
- Ans.** Squamous epithelium protects the underlying parts of body from mechanical injury, entry of germ, chemicals and drying.
- 29. Where is squamous epithelium found?**
- Ans.** Squamous epithelium forms delicate lining of cavities (mouth, oesophagus, nose, pericardium and alveoli), and of blood vessels and covering of tongue and skin.
- 30. What is goblet cell?**
- Ans.** Goblet cell is a mucus - secreting epithelial cell (as of columnar epithelium) that is distended with secretion at the free end.
- 31. What is the function of ciliated epithelium?**
- Ans.** The rhythmic, concerted beating of the cilia of ciliated epithelium moves solid particles (e.g., mucus) in one direction through the ducts.
- 32. Define connective tissue.**

- Ans.** Connective tissue is a tissue which is rich in intercellular substances (matrix) or interlacing processes with little tendency for the cells to come together in sheets or masses. This tissue pervades, supports and binds together other tissues and forms ligaments, tendons and aponeuroses.
- 33. Enumerate protein fibres of connective tissue.**
- Ans.** White fibres of collagen, yellow fibres of elastin and reticular fibres of reticulin.
- 34. Enumerate various cells of connective tissue.**
- Ans.** Fibroblasts, adipose cells, macrophages, mast cells and lymphocytes.
- 35. Define the following : tendon, ligament and cartilage.**
- (i) Tendons are cord-like, strong inelastic structures that join skeletal muscles to bones.
- (ii) Ligaments are elastic structures which connect bones to bones.
- Ans.** (iii) Cartilage is a tough, flexible connective tissue found in all vertebrates consisting of cartilage cells (chondrocyte) in a matrix of collagen fibres and a rubbery protein gel (containing molecules such as chondrin).
- 36. What is the name of bone cell?**
- Ans.** Osteocyte (or osteoblast).
- 37. Write the name of various types of white blood cells (WBCs).**
- Ans.** (i) Eosinophils; (ii) Basophils; (iii) Neutrophils; (iv) Monocytes; (v) Lymphocytes (e.g., plasma cells).
- 38. What is blood platelet?**
- Ans.** Blood platelets are minute, anucleated, fragile fragments of giant bone marrow cells, the megakaryocytes. They help in clotting of blood at the site of injury.
- 39. How many types of muscles occur in animals?**
- Ans.** Three namely striated muscles, smooth muscles and cardiac muscles.
- 40. What is neuron? Define it.**
- Ans.** Neuron is one of the unit cell that constitutes nervous tissues that has the property of transmitting and receiving nervous impulses. It has a nucleus containing cell body or soma, dendrites and axon.
- 41. Which tissue protects entire animal body?**

- Ans.** Epithelial tissue protects the entire animal body.
- 42. Classify epithelial tissues on the basis of arrangements of layers.**
- Ans.** Epithelial tissue is classified into two types, on the basis of arrangement of layers simple epithelium and stratified epithelium.
- Give one example each of**
- 43.** (a) **Squamous epithelium;**
(b) **Columnar epithelium.**
- Ans.** (a) Lung alveoli; canal.
(b) Alimentary
- Which type of epithelium (on the basis of function) is present in:**
- 44.** (a) **Sweat gland;**
(b) **Testis ?**
- Ans.** (a) Glandular epithelium;
(b) Germinal epithelium.
- 45. Which type of epithelium is present in the organs where exchange of substances takes place ?**
- Ans.** Squamous epithelium is present in the organs where exchange of substances takes place.
- 46. Which type of tissue is most abundant in animals ?**
- Ans.** Connective tissue is most abundant tissue in animals.
- 47. Give one example of connective tissue in which matrix is solid.**
- Ans.** In bone, the matrix is solid.
- 48. Which type of connective tissue is present in hump of camel and blubber of whale ?**
- Ans.** Adipose tissue is present in hump of camel and blubber of whale.
- 49. Which tissue is commonly known as “packaging tissue” ?**
- Ans.** Areolar tissue is commonly known as packaging tissue.
- 50. Which connective tissue connects bone to another bone?**
- Ans.** Ligament connects bone to another bone.
- 51. Give two examples of cartilage.**
- Ans.** Tip of the nose and external ear (pinna) are two examples of cartilage.
- 52. Which type of skeletal tissue contain chondrin and ossein**

respectively ?

Ans. Chondrin is present in cartilage whereas ossein is present in bone.

53. Which type of connective tissue has fibreless matrix ?

Ans. Blood has fibreless matrix.

54. What is serum ?

Ans. Plasma of blood after removal of fibrinogen is known as serum.

55. What is the function of WBC ?

Ans. WBC provides immunity to the body by protecting the body against infection.

56. What is the function of RBC ?

Ans. RBC contains haemoglobin, which helps in transport of respiratory gases such as oxygen and carbon dioxide.

57. What is the function of blood platelets ?

Ans. Blood platelets help in clotting of blood at the site of injury.

58. Mention two differences between blood and lymph ?

Ans. (i) Blood contains blood cells (RBCs, WBCs) or their pieces (platelets) as well as plasma, whereas lymph contains plasma and leucocytes (WBCs such as lymphocytes).
(ii) Blood has more proteins, calcium and phosphorus, whereas lymph has fewer proteins with lesser calcium and phosphorus.

59. Which type of WBC is most abundant in lymph ?

Ans. Lymphocytes are WBCs which are most abundant in lymph.

60. Name any one structure in our body which bears ciliated epithelium.

Ans. Respiratory (= breathing) tract bears ciliated epithelium.

Name the following :

**61. (a) Multinucleate muscle fibre ;
(b) Spindle shape muscle fibre.**

Ans. (a) skeletal muscle fibre;
(b) smooth muscle fibre.

62. Name the muscle which gets fatigued soon.

Ans. Skeletal muscle gets fatigued very soon.

63. Name the muscle of heart.

Ans. Cardiac muscle is the muscle of heart.

64. What are the two types of striated muscle fibres ?

Ans. Skeletal and cardiac muscles are two types of striated muscle fibres.

65. Name the muscle which is commonly found in visceral organs.

Ans. Smooth muscle.

66. Name the muscle fibre which contains intercalated discs.

Ans. In cardiac muscle, intercalated disc is present.

Name the following :

67. (a) Neurons which carry impulses towards brain.

(b) Process of neuron which carries impulses away from cyton.

Ans. (a) Sensory neuron; (b) Axon.

Short Answer Questions (Carrying 2 marks each)

- 1. What is the importance of tissues ?**
- 2. Why do plants and animals possess different types of tissues ?**
- 3. Tabulate differences between plants and animal tissues.**
- 4. Write a short note on intercalary meristem.**
- 5. Write one main function of**
 - (a) Apical meristem**
 - (b) Lateral meristem.**
- 6. What are simple tissues ? Explain their three different types.**
- 7. Draw a well labelled diagram of parenchyma and collenchyma.**
- 8. Draw a well labelled diagram of phloem**
- 9. Draw a well labelled diagram of xylem.**
- 10. Give two functions of collenchyma.**
- 11. Write a short note on sclerenchyma.**
- 12. Distinguish between xylem and phloem.**
- 13. Distinguish between tracheids and vessels.**

Short Answer Questions (Carrying 3 marks each)

1. Explain different types of elements present in phloem.
2. What are tracheary elements ? Describe their functions.
3. Write the functions of parenchyma, collenchyma and sclerenchyma.
4. What is the difference between parenchyma and collenchyma ?
5. What is the difference between collenchyma and sclerenchyma ?
6. Name the different types of elements found in the xylem.
7. What are the functions of xylem ?
8. What are the functions of phloem ?
9. Write down names of different types of plant tissues.
10. Explain how sieve tubes manage to be living ?
11. Give four important functions of epithelial tissue. Name one specific place in the body where each function is carried out.
12. Enlist three types of muscles with their locations.
13. In which tissue is found anyone of the following structures : neuron, dendrite, cilia, collagen fibres, elastin fibre.
14. List one function for each of following : osteoblast, chondroblast, goblet cell, neuron, muscle cell.
15. State two characteristics of nerve cells.
16. What is the function of bone, cartilage and ligament ?
17. Name the following :
 - (a) Tissue which stores fat ;
 - (b) Epithelium which lines lung alveoli.
18. Give three functions of blood.
19. What are the different tissues in animals.
20. Draw and label a neuron.
21. Diagrammatically show the difference in three types of muscle fibres.

Long Answer Questions (Carrying 5 marks each)

1. What are different types of tissues in plants ? Describe simple

tissues.

2. What are meristematic tissues? Explain with the help of suitable diagram. Give their classification on the basis of their position in the plant body.
3. What is simple tissue ? Classify and explain its different types with suitable diagram.
4. What do you know about complex tissue ? Classify and explain its different types in plants with suitable diagrams.
5. Distinguish between the following pairs in one or two sentences for each
 - (a) RBCs and WBCs;
 - (b) bone and cartilage;
 - (c) blood and lymph;
 - (d) striated and unstriated muscles;
 - (e) tendon and ligament;
 - (f) axon and dendrite.
6. Describe the structure and functions of epithelium.
7. Classify connective tissue and give one example of each type.
8. Describe the composition and functions of blood.
9. Define muscular tissue. Classify and explain different types of muscles with the help of suitable diagrams.
10. Explain the structure of neuron with the help of a labelled diagram.

VALUE BASED QUESTIONS

Q.1. What is bark ? Give its importance. Why are certain barks used in medicines ?

Ans. **Bark** is the outer protective covering of stems and roots of woody plants. It is mostly made up of **cork** that consists of several layers of compactly arranged dead rectangular cells. The cork cells are impermeable due to deposition of suberin. They contain air, tannins, resins and alkaloids. **Importance of bark.**

(i) **Protection against water loss** due to impermeable nature

- of cell walls.
- (ii) **Protection against invasion of microorganisms** due to bark's impervious nature.
- (iii) **Insulation** from extremes of temperature, mechanical injury and browsing by animals.
- (iv) Bark provides cork which is used commercially in stoppers of bottles, insulation boards, shock absorbers, linolium and sports goods.
- (v) **Tannin** rich bark is used in dyes.
- (vi) Inner bark of cinnamon tree (*Cinnamomum zeylanicum*) is a common aromatic spice and is also used to lace certain beverages and candies/chocolates.

Bark in medicines

- (i) **Quinine**, an antimalaria drug is obtained from the bark of *Cinchona* tree. (Note. Quinine is a bitter toxic alkaloid which is formerly used as a tonic. Now this drug is not used in the treatment of malaria.)
- (ii) **Taxol**, an expensive anti-cancer drug, is obtained from bark of yew tree ([Box 3.10](#)). Medicinal barks contain alkaloids.

Box 3.10

Taxol

Taxol is a wonder drug for treating cancers other than blood cancer. It is used mainly against ovarian cancers. US cell biologist found in 1979 that taxol killed cancer cells by stabilizing the spindle fibres (*i.e.*, by stopping cell division).

Taxol drug is obtained originally from bark of Pacific Yew tree (*Taxus brevifolia*) and discovered by Indian born biochemist **M.C. Wani** and **M. Wall** in 1964. The coniferous tree *T. brevifolia* is the only source of this anti-cancer drug and this plant is not found outside America. A kilogram of bark of yew tree yields only 50 - 150 milligrams of taxol. This most expensive (2 to 3 lac US dollar per kg) anti-cancer drug has also been artificially synthesized in the laboratory (**Jain et al., 2012**).

Q.2. Fibres are obtained from various parts of plants such as stem, leaves, fruit walls and seed walls. Fibres obtained from plants are economically used in making fabric, paper, ropes and gunny bags, etc.

- (i) Why only some parts of plants are used for making ropes ?
- (ii) Cotton fibres are obtained from which part of cotton plant ?
- (iii) From which part of coconut fruit coir (fibre) is obtained ?
- (iv) In which state of our country, jute growing is a major source of income.

Sclerenchymatous tissue of plants consists of thick-walled dead cells and it is located in parts where strength, rigidity, flexibility and elasticity is required. Sclerenchyma fibres are

- Ans.**
- (i) elongated (long and narrow) spindle - shaped, lignified dead cells. Only sclerenchymatous fibre containing parts of the plant such as stems, fruits and seeds can be used for making ropes.
 - (ii) From seed coat epidermis of cotton plant.
 - (iii) Mesocarp of coconut fruit yield husk which provides coir fiber used for making mats and cordage (ropes and cords).
 - (iv) West Bengal.

Q.3. Name five economically important plant fibres derived from sclerenchyma. Why they differ in softness and durability ?

Five plant fibres. Cotton, coconut, jute, flax and hemp.

In cotton, the fibres are obtained from epidermis of seed. In coconut, the fibres (sclerenchymatous coir) are obtained from husk (mesocarp) of the fruit. Jute, flax and hemp are obtained from stems, being bast or phloem fibres.

Ans. Plant fibres differ in their hardness and strength. Hardness is due to excessive deposition of lignin to the cell wall as in coconut and jute. Because of it, they are prone to degeneration on wetting. Coconut fibres are used in the preparation of mats and ropes while jute fibres are used in preparing gunny bags (sacks) and ropes. Flax yield high quality cloth called **linen** which is used in preparing durable clothing. Fibres which are obtained from the stems of hemp plants are used in

manufacture of rope and coarse cloth.

Q.4. While walking through garden, Kapil plucked the tips of some flowering plants. Gardner saw him doing this and persuaded him not to do so as it is not good for plant growth.

- (i) What happens to the plants if their tips are removed ?
- (ii) What are meristems ?
- (iii) How meristems are classified ?
- (iv) What value was displayed by the gardner ?

Ans. In flowering plants, apical meristems are present at tips of branches of the plants and their removal will stop the further longitudinal growth of the plants.

(i) Meristems are tissues present in plants and are composed of rapidly dividing cells with dense cytoplasm.

Meristems are growth tissues and are classified on the basis of their position in the plant body. They are of three main types:

(ii) *apical meristem* (at growing ends of stems and roots), *lateral meristems* (i.e., cambium for secondary growth) and *intercalary meristems* (at base of leaves or at internodes of grasses).

Q.5. Obesity is a common health problem now a days which results due to deposition of fat in various parts of the body. It may lead to other health problems such as diabetes, high blood pressure and heart attacks.

- (i) Which tissue is responsible for storage of fat in the body ?
- (ii) How we can control obesity ?
- (iii) What are the effects of morning walk and regular physical exercise on obesity.

Ans. (i) Adipose tissue.

We can control obesity by having balanced diet, by increasing the amount of fibre rich food and decreasing (ii) saturated fat and high caloric products in our diet, and above all through regular exercise ([Box 3.11](#)).

Currently doctors have found that there is virtue in working standing up. Constant low-level activity is recommended to save us from suffering of obesity, diabetes and cardiovascular disease.

Light - to - moderate exercise, such as standing up, walking around and like, is something qualitatively better from an energetic, high-intensive workout (see **S.R. Sashikumar**, Indian Express, 15th August 2013).

- (iii) Morning walk and regular physical exercise help in burning calories and thereby help in reducing fat deposition in the body.

Q.6. What is Cartilage ? What is its importance to bones?

Cartilage is flexible soft supportive connective tissue having non-vascularized (and without any nerve supply solid) matrix of chondrin with fluid filled lacunae containing 1 - 4 living cells called **chondrocytes** or **chromocytes** (or cartilage cells). **Importance of cartilage to bones.**

Ans. (i) Cartilage occurs over articular surfaces of bones where it protects them from frictional damage during movement against one another. (ii) It lies at sternal ends of ribs to give them flexibility in movement during breathing. (iii) It occurs at inter vertebral discs to function as cushions in the vertebral column.

Q.7. Why are medullated nerve fibres more efficient than non-medullated nerve fibers ?

Medullated nerve fibres are those axons which have a covering of fat rich medullary sheath below the neurilemma ([Fig. 3.35](#)). During impulse conduction, they are more efficient than non-medullated nerve fibres due to following two reasons: (i) Such nerves fibres being well insulated do not meet any interference in impulse conduction. (ii) An impulse does not travel all along the axon but jumps from one node of Ranvier to the next. By this saltation (jumping process) medullated nerve fibres are some fifty times (50 X) more efficient in impulse transmission as compared to non-medullated nerve fibres.

CHAPTER 4

Diversity in Living Organisms



4.1. BIODIVERSITY : DIVERSITY OF PLANTS AND ANIMALS

Each organism in this world, whether it is a plant, an animal or

a microorganism (viruses, bacteria, unicellular eukaryotes), is unique in itself. This uniqueness of individuals forms the basis of the **diversity** (L. *diversitas* = *variety*) among the living organisms.

The term “**biodiversity**” is a concise form of “**Biological Diversity**”. It was coined by **Walter G. Rosen** in 1986. Biodiversity refers to the diverse or varied forms of living beings which differ from one another in external appearance, size, colour pattern, internal structure, nutrition, behaviour, habitat, etc. Currently, there are 1.7-1.8 million organisms, all of which are different from one another. They range in size from microscopic bacteria, hardly a few micrometers in size, to Blue whales (about 30m in length) and Redwood trees (*Sequoia*) of California (about 100m in height). Some pine trees (e.g., *Pinus*) live for thousands of years while many insects such as mosquitoes have a life span of a few days. The diversity extends to habitat, habits, nutrition, forms, etc., of different organisms. A few of the present day living forms are, evolved versions of living beings that have existed on Earth for the past 3.5 billion years. We are familiar with most of the commonly known animals and plants, but the fauna and flora (biota) of inaccessible areas of forests, mountains, deserts, depths of oceans, etc., are largely unexplored. In fact, it has been calculated that about 92 per cent biota of the world is still unexplored.



Biodiversity.

Box 4.1

Types of Species Diversity

Each community has a variety of species, some of which are rare, while others are common. Thus, no community consists of species which are present in equal abundance. The following types of species diversity can be described :

1. **Point diversity.** This is a diversity present on the smallest scale, *i.e.*, the diversity of micro-habitat.
2. **Alpha diversity.** Also known as **local diversity** and includes variety of organisms local to a particular habitat.
3. **Gamma diversity.** It represents the diversity of a larger unit such as an island or a landscape.
4. **Epsilon diversity.** It is also called **regional diversity** and includes total diversity of a group of gamma diversity

areas.



Alpha diversity.



Point diversity.



Gamma diversity.



Epsilon diversity.

For example, a single plant may be considered as a unit of *alpha diversity*; a leaf as an area of *point diversity*; a group of plants occurring together as an area of *gamma diversity* and the forest within which the plants are located as an area of *epsilon diversity*.

Uniqueness of Indian biodiversity. India is one of the 12 megabiodiversity countries in the world ([Box 4.2](#)). The country is divided into 10 biogeographical regions. The wide variety in

physical features and climatic conditions have resulted in a wide diversity of ecological habitats such as forests, grasslands, rivers and wetlands, coastal and marine ecosystems and deserts which harbour and sustain immense biodiversity.

Box 4.2

Earth's Regions of Megadiversity

The variety of life forms found in a particular region forms the **biodiversity**. Diverse life forms tend to share a common environment and are also affected by each other. Due to these interactions, a stable biotic community comprising of different species comes into existence. In recent times, human activities (*e.g.*, deforestation, hunting, pollution), have played a crucial role in changing the balance of such communities. Indeed, the diversity in such communities is affected by the changing characteristics of land, water, climate and so on. For example, legs of Asian bullfrog is regarded as a delicacy in Europe (especially France) and the United States. To fulfil their growing demand, bullfrogs are exported from India and Bangladesh (about 80 million frogs are collected each year from rice fields in Bangladesh alone). With so many insect-eating frogs removed from the ecosystem, rice production is threatened due to uncontrolled flourishing of insect populations. Further, various consumers of frog in the wild such as snake, prey birds, etc., are also affected.

A rough estimate shows that there are about ten million species on the planet earth, and at present we are aware of only one or two millions of them. The warm and humid tropical regions of the Earth, between the tropic of Cancer and the tropic of Capricorn, have a rich diversity of life, *i.e.*, plants, animals

and microorganisms. This is called the region of megadiversity. Of the biodiversity of the planet Earth, more than half is concentrated in 12 countries, namely, 1. Brazil; 2. Colombia ; 3. Ecuador ; 4. Peru ; 5. Mexico ; 6. Zaire ; 7. Madagascar ; 8. Australia ; 9. China ; 10. India ; 11. Indonesia and 12. Malaysia.



Hotspots of biodiversity.

4.2. BASIC ISSUES IN SCIENTIFIC NAMING

Taxonomy is a biological science which deals with the identification, nomenclature and classification of organisms. One of the functions of a taxonomist or systematist is to provide a **scientific name** for every living creature. The need for a uniform international system of naming is obvious. **Common vernacular names** for the same plant or animal vary from region to region. For example, the bird that we know as *Gauraiya* in Hindi in India and Pakistan is known by different names in other countries—*house*

sparrow in England, *Pardal* in Spain, *Musch* in Holland, *Suzune* in Japan, and so on. Similarly, a dog is called ‘kutta’ in Hindi, Kukur in Bangla and ‘Naai’ in Tamil. These names are not understood elsewhere. Moreover, the same common name may be used for different kinds of animals. For example, the name *Kenchua* is used both for the earthworm and *Ascaris*. It is, therefore, important to have a single scientific name to be followed all over the world.

ACTIVITY 4.1

Find out the names of the following animals and plants in as many languages as you can :

1. Rat
2. Cat
3. Bat
4. Tiger
5. Lion
6. Dog
7. Wolf
8. Peacock
9. Ant
10. House fly
11. Honey bee
12. Lotus
13. Potato
14. Neem
15. Mango.

Note down that these names are not related with the names you normally use to identify them.

Binomial Nomenclature: In biology, every organism is given two **proper names**. First is the name of the **genus** to which an organism belongs. This genus name can be shared among a number of other closely related organisms. A genus name is similar to a person's surname. The organism shares this name with other members of its genus, just as we share our surname with other members of our family.

An organism's second name is the name of the **species** to which it belongs. This name is specific to the organism in question and the name is not shared with any other organism in that particular genus.

The scientific names are unique, understood and followed all over the world. They are not changed easily. They are guided by a set of rules in the **International Code of Biological Nomenclature**.

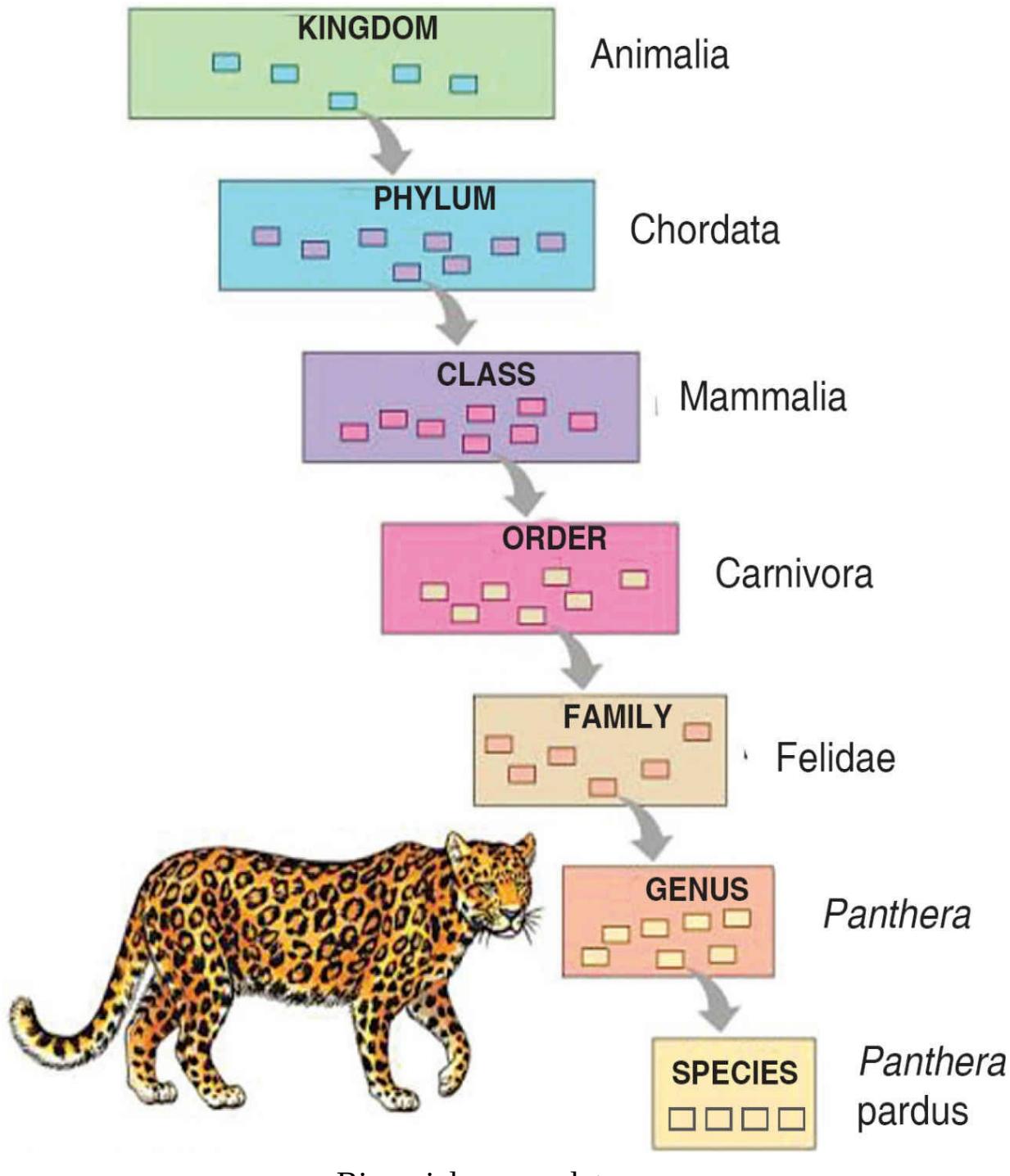
As per the convention, the **genus name** (generic name) is always written first with its first letter capitalised. **Species name** (specific name) is written after the genus name and its first letter is always in small case. Both names of an individual are printed in italics. When hand written, both the names are underlined, *e.g.*,

Rana tigrina = Frog
(Genus) (species)

Both names are usually Latin names or have Latin endings. One may question that why is it necessary to use a "dead" language to refer to an organism? Why not use everyday English, Hindi, French, Spanish or Russian? for one thing, Latin is a hold over from the

times when scholars communicated in this tongue. (**hold over** means to remain beyond the expected time). In order to distinguish each kind of organism in language that is precise, uniform and understandable to investigators throughout the world, a formal system of Latin nomenclature is used.





Binomial nomenclature.

Thus, according to the binomial nomenclature system, the lion's full name is *Panthera leo*: *Panthera* is the genus name and *leo* is its species name. However, the genus *Panthera* also includes several animals such as tiger and leopard. The tiger's proper name is

Panthera tigris, leopard's is *Panthera pardus* and snow leopard's *Panthera uncia*. The scientific name of human species is *Homo sapiens*, where *Homo* is a generic name and *sapiens* is a specific name.

Since this system of naming involves giving organisms two names, it is known as the **binomial nomenclature**. It was developed and first of all used in naming plants and animals by **Linnaeus** in his book entitled *Species Plantarum*, which was published in 1753. **Linnaeus** has been considered as the “**father of taxonomy**”, since he developed the binomial system of nomenclature and a system of classification.



Linnaeus.

ACTIVITY 4.2

Find out the scientific names of any five common animals and

plants. Do these names have anything in common with the names you normally use to identify them. For example, margosa tree in Hindi is called Neem, in Bangla Neem, in Marathi *Limba* and in Tamil *Vembu*.

4.3. BASIS OF CLASSIFICATION

The diversity shown among present day living organisms is an outcome of the past 3.5 billion years of organic evolution. During this time a great number of new species originated and many more became extinct. Science of **palaeontology** studies evidences of the past life, in the form of **fossils**. With such a huge repository of organisms, it would be almost impossible to study each and every living form separately at an individual level. So, to study the diversity among living organisms in an effective way, we need to arrange various kinds of organisms in an orderly or systematic manner. **The method of arranging organisms into groups or sets on the basis of similarities and differences is called classification.** Similarities and differences of organisms show their relationships. In fact, to understand the living world, there is no need to know every detail about all living organisms. Studying only a few representatives from each group would give an idea of all the members of that group.

Importance of Classification

The science of classification is known as **taxonomy**. It is an important branch of biological science ([Box 4.3](#)). Classification of living organisms has the following advantages :

1. Classification makes the study of a wide variety of organisms easy.
2. Classification projects before us a picture of all life forms at a

glance.

3. Classification is essential to understand the interrelationships among different groups of organisms.
4. Classification forms a base for the development of other biological sciences. For example **biogeography** which is the study of geographical distribution of plants and animals totally dependent on the information supplied by classification.

Box 4.3

The **taxonomy** or **systematics** is the study of the diversity and kind of organisms and the evolutionary relationships among them. It includes naming and arrangement of organisms into a classification and an examination of their origin and history. The systematic biologist (or taxonomist) tend to deal with informations that can be obtained from the museum specimens and also from life-history studies, cytology, biochemistry and physiology of the organisms.

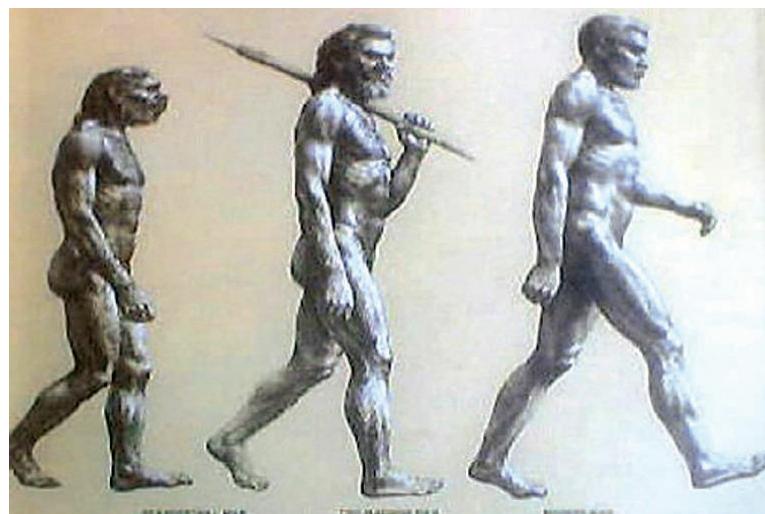
The method of systematically arranging the different species of living organism into closely related groups according to the some scheme of likeness and differences is called **classification**.

CLASSIFICATION AND EVOLUTION

Living things are identified and categorised on the basis of their body design in relation to their form and function. Some characteristics are likely to make more wide-ranging changes in body design than the others. There is a role of time (for evolution) in this as well. In other words, characteristics that came into existence earlier are likely to be more fundamental than

characteristics that have come into existence later.

So, the classification of life forms is closely related to their evolution. What is evolution ? Most life forms that we see today have arisen by an accumulation of changes in its body design that allow the organism possessing them to survive better ([Box 4.4](#)). **Charles Darwin** (1809-1882) first described this idea of evolution in his book '*The Origin of Species*', published in 1839.



Evolution.



Charles Darwin.

Box 4.4

In 1985, Professor **Ernst Mayr** of Harvard University

argued, that Darwinism should be viewed as *five* major theories :
1. Perpetual change, 2. Common descent, 3. Multiplication of species, 4. Gradualism, and 5. Natural selection.

1. Perpetual change. This is the basic theory of evolution on which the other theories are based. It states that *the living world is neither constant nor perpetually cycling, but it always changes*. The properties of organisms undergo transformation across generation, throughout time.

2. Common descent. The second Darwinian theory, “common descent”, states that *all forms of life descended from a common ancestor through a branching of lineages*.

3. Multiplication of species. Darwin’s third theory states that *the evolutionary process produces new species by the splitting and transformation of older ones*.

4. Gradualism. Gradualism states that the large differences in anatomical traits that characterizes different species originate through the accumulation of many small incremental changes over very long periods of time.

5. Natural selection. Natural selection is Darwin’s most famous theory. It rests on three propositions. (i) There is variation among organisms (within populations) for anatomical, behavioral and physiological traits. (ii) The variation is at least partly heritable so that offspring tend to resemble their parents. (iii) Organisms with different variant forms leave different numbers of offspring to future generations.

If the idea of evolution is connected to classification, it becomes apparent that some groups or organisms with ancient body designs, have not changed much. There are other groups of organisms that have evolved their current body designs, relatively recently. Those

in the first group (*i.e.*, with ancient body designs) are commonly referred to as “**primitive**” or “**lower**” organisms, while those in the second group (*i.e.*, with recent body designs) are called “**advanced**” or “**higher**” organisms. In other words, it can be said that first formed (ancient, older) organisms are simpler, while younger organisms (later formed, modern) are more complex, *i.e.*, complexity in design of simpler forms has increased over evolutionary time, so that they have ultimately become more complex.

Artificial and Natural System of Classification

Biological classification goes back to **Aristotle** (384–322 B.C.) and **Theophrastus** (372–287 B.C.) in Greek times. Early systems of classification were **artificial**, *i.e.*, they were based on a few arbitrarily chosen criteria such as size, colour, or nature of the organism. **Aristotle** classified living organisms based on their nature. He divided animals according to whether they lived on land, sea or air. Likewise, **Theophrastus** categorised all known plants on the basis of their form, life-span, and habitat. He grouped plants into four categories: trees, shrubs, undershrubs and herbs.

A Swedish scientist **Carl von Linnaeus** (1707 – 1778) published a book in 1735, called *Systema Naturae* (Classification of Nature). In this book, he classified, described and named plants, animals and minerals. He based his classification scheme on the sexual characters of living organisms (*i.e.*, number and arrangement of stamens and carpels in the flower). Thus, his classification was also an *artificial* one.

In the 19th century, the artificial system of classification was replaced by **natural systems** of classification. The new system was based on natural affinities between living organisms and indicated the overall similarities and differences between the organisms.

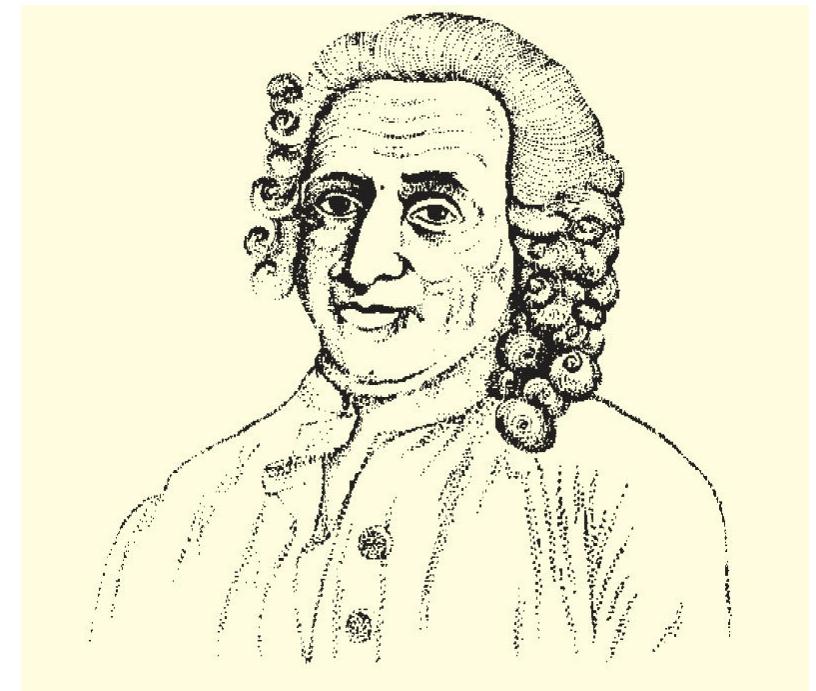


Figure 4.1. Carl von Linnaeus.

Box 4.5

Carolus Linnaeus (Carl von Linne) was born on May, 23, 1707, in Rashult, Sweden and was a doctor by profession. He was also naturalist and botanist attached to university of Uppsala. He died on January, 1778. He had a great talent for collecting and classifying objects, especially flowers. At the age of 22, he published his first paper on sexuality of plants. While serving as a personal physician of a banker **George Clifford**, he studied the diversity of plants in his employer's garden. Later he published 14 papers and also brought about three important books. First book *Systema Naturae* was released in 1735 and from it all fundamental taxonomical research has taken off. He used morphology, *i.e.*, the comparative study of organismal forms. His system of classification was a simple scheme for arranging plants so as to be able to identify them again. In 10th edition of this book (1758), binomial system was applied to the

animals.

Linnaeus introduced the binomial system of biological nomenclature, in which organisms are classified as species, grouped into genera, rather than concise Latin descriptions, the methods used earlier. His system facilitated the identification and cataloging of plants and animals and proved very popular, though it was based on superficial features rather than evolutionary relationships and so was unnatural.

His second book, *Genera Plantarum* was published in 1737, in which descriptions of several genera were given. His third book, *Species Plantarum* (1753) in two volumes is still the official starting point for botanical nomenclature and many of his names are still used. Because his knowledge of animals was limited, his lower categories, such as genera, were very broad and included animals that are very distantly related. Much of his classification has been drastically altered now, but the basic principles in his scheme are still followed.

Classification Systems

Living organisms have been classified variously according to different criteria, however, the following two systems are most in use:

A. Two-kingdom system of classification. The differences between plants and animals are very clear. Plants are stationary (fixed), trap radiant energy of sun to make their food and some plants even grow indefinitely. *Animals* generally move, eat plants or animals as food, and their bodies stop growing after attaining a certain size. In fact, plant cells are surrounded by a cell wall and contain chloroplasts to prepare their own food (photosynthesis). Animal cells neither have a cell wall nor chloroplasts. Because of

these basic differences, plants and animals are divided into two groups – Plants kingdom and Animal kingdom. This system of classification was first suggested by Carolus Linnaeus in 1758.

Later taxonomic studies indicated that certain organisms did not strictly fit either under Plant kingdom or Animal kingdom. Accordingly, a German Zoologist, **E.H. Haeckel** (1866) raised a third kingdom, Protista, for unicellular organisms. When significant differences became evident among the protists, an American ecologist, **Robert H. Whittaker** (1959) proposed a fourth kingdom, Monera, for the bacteria which are prokaryotes and fifth, kingdom Fungi for the fungi which lack chlorophyll, and obtain their food through absorption.

Here it is clear that *classification of organisms* is a progressive (ongoing) process. As more and more data on life forms becomes available, classification becomes more and more refined. In this chapter, we will follow two-kingdom system of classification.

B. Five-kingdom system of classification. **Whittaker (1959)** has classified the living organisms into following five kingdoms (= broad categories) :

- 1. Kingdom Monera** (Prokaryotic bacteria and blue green algae).
- 2. Kingdom Protista** (Unicellular eukaryotic organisms– protozoans, fungi and algae).
- 3. Kingdom Fungi** (Multinucleate higher fungi).
- 4. Kingdom Plantae** (Multicellular green plants and advanced algae).
- 5. Kingdom Animalia** (Multicellular animals).

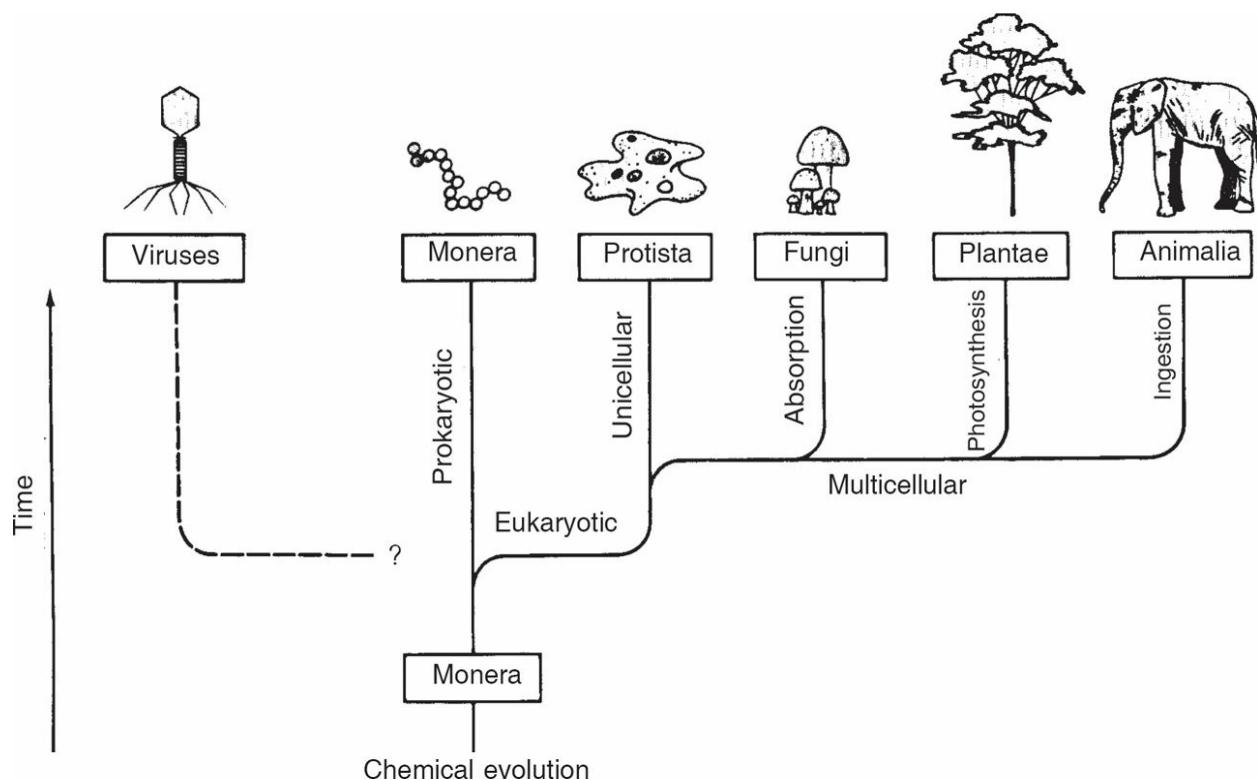


Figure 4.2. Family tree showing the relationships among the five kingdoms.

Whittaker had based his classification scheme on the following three levels of organisation: 1. The prokaryotic versus eukaryotic structure of cells, 2. The unicellular versus multicellular or multinucleate organisation, and 3. The three different modes of nutrition: photosynthesis (plants), absorption from the environment (fungi) and ingestion (animals). **Carl Woese (1977)** further divided Kingdom Monera into **Archaeabacteria** (or **Archaea**) and **Eubacteria** (or **Bacteria**).

Modern Scheme of Five-Kingdom Classification

In 1982, **Margulis** and **Schwartz** revised the five kingdom classification. It includes one prokaryotic kingdom – the **Prokaryotae** and four eukaryotic kingdoms – the **Protocista**, the **Fungi**, the **Plantae** and the **Animalia**. This scheme is widely accepted one. The eukaryotes can be regarded as belonging to a **super kingdom** the **Eukaryotae**.

The kingdom Protoctista is a collection of all the eukaryotic organisms that do not fit neatly into the other three eukaryotic kingdoms. Many of these organisms are unicellular. The Protocista contains eukaryotes that are generally regarded as being identical or similar to early plants (**Algae**), early animals (**Protozoa**) and early fungi (**Oomycota** or water molds). The kingdom also includes a group known as **slime molds** which have spores like fungi but can creep slowly over surfaces and are therefore motile like the animals.

One group of ‘organisms’ that does not fit neatly into any classification scheme is the **viruses**. Viruses are extremely small particles consisting of only a piece of genetic material (DNA or RNA) in a protective coat of protein. They do not have a cellular structure, unlike all other organisms, and can only reproduce by invading living cells.

The smallest organisms are often collectively known as **microorganisms**. These include the archaea and bacteria (prokaryotes), viruses, fungi and protists. These groupings are useful for practical reasons because the techniques used in their study are often similar. For example, a microscope is needed to view them and sterile (*i.e.*, aseptic) techniques are needed to culture them. The study of microorganisms forms a branch of biology, celled **microbiology**.



Microbiology.

4.4. HIERARCHY OF CATEGORIES OR GROUPS

The main aim of a taxonomic study is to assign organism an appropriate place within the systematic framework of classification. This framework is called **taxonomic hierarchy** ([Box 4.6](#)) by which the taxonomic groups are arranged in a definite order, from higher to lower categories. A category is called **taxon** (plural **taxa**). The taxa or categories used in the classification of plants or animals are kingdom, phylum, class, order, family, genus and species. However, in case of plants, term division is used as a category in place of phylum, while the remaining categories have the same terminology. All the members of a taxon show similar characteristics, which are different from those of other taxa.

Box 4.6

Linnaeus's scheme of arranging organisms into an ascending series of groups of ever-increasing inclusiveness forms the **hierarchical system of classification**.

Both in animal and plant kingdoms, the lowest category is a species and highest is a kingdom; rest of the categories lie within this framework. The categories in the hierarchy are placed in ascending order ([Fig. 4.3](#)). As we go upwards from the species towards the kingdom, the number of similar characters decreases.

1. Species. It is a basic unit for understanding taxonomy as well as evolution. Species is a group of individuals with similar morphological characters, which are able to breed among themselves and produce fertile offsprings of their own kind. Individuals of the same species resemble each other closely both structurally and functionally.

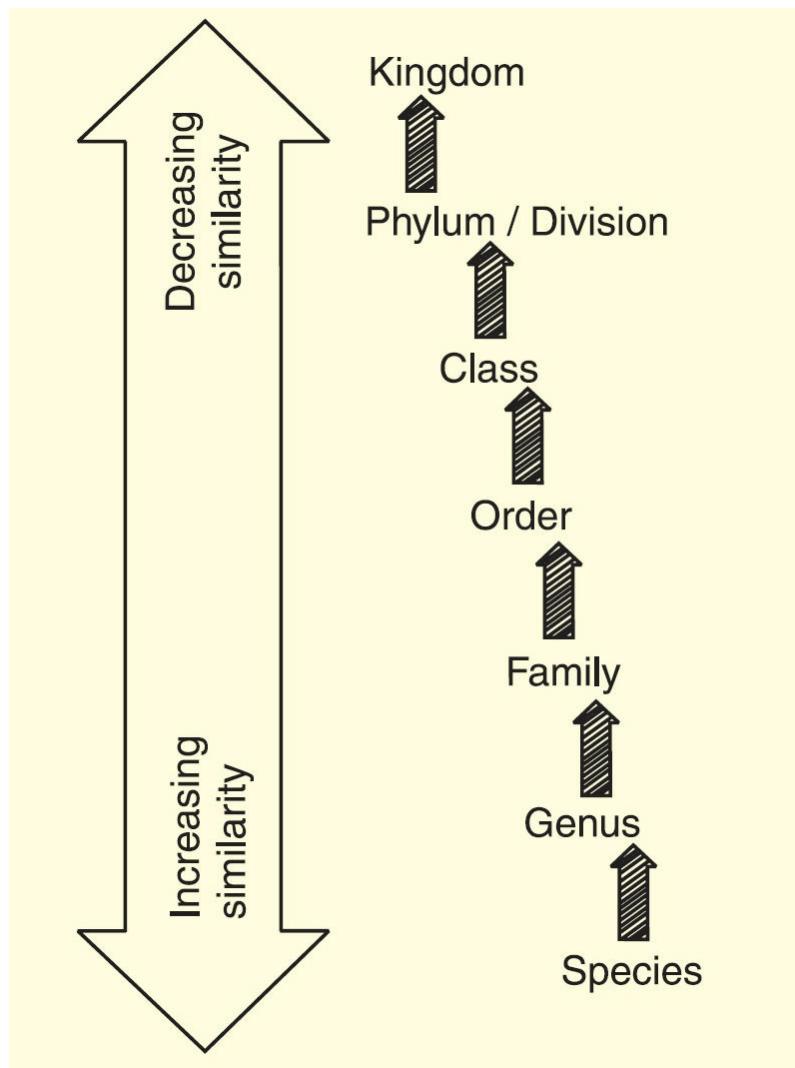


Figure 4.3. Hierarchy of taxonomic categories or taxa.

Box 4.7

Linnaeus recognised only five hierarchic levels within the animal kingdom. These were Class, Order, Genus, Species and Variety. Later on, ‘variety’ was discarded and two new taxonomic categories, namely, Phylum and Family were added to Linnaean hierarchy. Thus, six taxonomic categories, namely, Phylum, Class, Order, Family, Genus and Species form the basic taxonomic hierarchy of animals. Any given animals must belong to one of these six categories.

Example. Horse and ass belong to the same genera (*Equus*) but both have different species, i.e., Horse – *E. cabalus* and Ass – *E. asinus*.



Equus cabalus.



Equus asinus.

Box 4.8

Mule does not form a distinct species!

It is important to note that the species is the basic level for all modern classification. The **species** is an isolated reproductive unit which does not mate with members of other reproductive isolates. Thus, species is most unambiguous of all taxa in the hierarchy. A **species** is a group of similar organisms that are able to breed together and produce fertile offspring. For example, human beings, dogs, cats, etc., form distinct species. But when a horse (*Equus cabalus*) and an ass (*Equus asinus*) belonging to different species interbreed, the product is a **mule** which is sterile, i.e., incapable of reproducing.

2. Genus. It is a group of species which are related and have less characters in common as compared to species. Members of a genus have identical reproductive organs.

Example. Banyan and fig trees differ from each other in vegetative characters such as shape, size and surface of leaf, but resemble in their reproductive organs such as inflorescence, flower, fruit and seed. Thus, they belong to the same genus *Ficus*.

3. Family. It is represented by a group of related genera that are more similar to each other than with the genera of other families.

Example. A cat (*Felis domestica*) and a lion (*Panthera leo*) belong to the “cat” family **Felidae**. They both possess similar structure and have retractile claws.

4. Order. It is an assemblage of families resembling one another in a few characters.

Example. A tiger (*Panthera tigris*) and a wolf (*Cannis lupus*) share the common characteristics such as jaws with powerful incisors and large, sharp canines, adapted for flesh-eating. Hence, both are placed in the same order **Carnivora**.

5. Class. It represents organisms of related orders.

Example. Chordates such as rats, dogs, bats, dolphins, camel, rhinoceros, kangaroo and monkeys belong to the **Mammalia** class as they have a characteristic hairy exoskeleton, mammary (milk) glands, external ear, etc.

6. Phylum. It includes all organisms belonging to different classes having a few common characters.

Example. All animals which have a notochord present in the embryo belong to the phylum **Chordata**.

7. Kingdom. It includes all organisms who share a set of distinguishing common characters.

Example. Plant kingdom, Animal kingdom, etc.

Table 4.1. Classification of some organisms.

Taxa	Potato	Wheat	Paramecium	Human being
Scientific name	<i>Solanum tuberosum</i>	<i>Triticum aestivum</i>	<i>Paramecium caudatum</i>	<i>Homo sapiens</i>
Kingdom	Plantae	Plantae	Protista	Animalia
Phylum/Division	Angiospermae	Angiospermae	Protozoa	Chordata
Subphylum/	—	—	Ciliophora	Vertebrata
Subdivision				
Class	Dicotyledonae	Monocotyledonae	Ciliata	Mammalia
Order	Polemoniales	Gerinales	Holotricha	Primates
Family	Solanaceae	Gramineae	—	Hominidae
Genus	<i>Solanum</i>	<i>Triticum</i>	<i>Paramecium</i>	<i>Homo</i>
Species	<i>tuberosum</i>	<i>aestivum</i>	<i>caudatum</i>	<i>sapiens</i>

4.5. CHARACTERISTICS OF FIVE KINGDOMS

1. Kingdom Monera (Prokaryotae)

The kingdom prokaryotae is divided into two sub-kingdoms : **Archaeabacteria (Archaea)** and **Eubacteria (Bacteria)**. Of the two sub-kingdoms, the Archaeabacteria is more ancient.

(i) Archaeabacteria

Most archaeabacteria are autotrophs and only a few, photosynthesize. Archaeabacteria derive the energy for their metabolic activities, from the oxidation of chemical energy sources, such as the reduced gases — ammonia (NH_3), methane (CH_4) or hydrogen sulphide (H_2S). In the presence of one of these

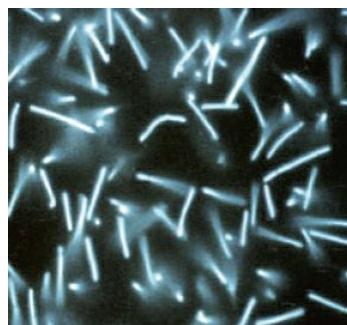
chemicals, archaebacteria can manufacture their own amino acids and proteins.

The environments where these chemical energy sources are found, are often harsh for most other kinds of organisms.

Archaeabacteria are divided into following *three* groups:

(1) Methanogens. As their name implies, methanogens manufacture **methane** as the result of their metabolic activities. Methanogens die in the presence of oxygen. Thus, they are found in swamps and marshes, in which all the oxygen has been consumed by the other organisms living in those environments. The methane smell characteristic of swamps and marshes is courtesy of the methanogens.

(2) Thermoacidophiles. These archaea favour extremely hot and acidic environments, such as hot springs. Many thermoacidophiles use hydrogen sulphide as their energy source.



Methanogens.



Thermoacidophiles.



Halophiles.

(3) Halophiles. These archaea grow in very salty environments, such as Great Salt Lake and the Dead Sea. These environments are extremely alkaline.

(ii) Eubacteria

Prokaryotic cells of bacteria have an outer **cell wall** that surrounds the **plasma membrane**, which in turn surrounds a non-compartmentalised **cytoplasm** dotted with **ribosomes** ([Fig. 4.4](#)). They generally lack membrane-enclosed organelles such as nucleus, chloroplasts and mitochondria. A circular strand of DNA, usually coiled into one region of the cell, the **nucleoid**, serves as a single chromosome. Metabolic activities, such as electron transport (a function of mitochondria) and photosynthesis, take place on the plasma membrane, which sometimes folds inwards into the cell's interior.

Nearly all bacteria are encased in a porous but rigid **cell wall** that protects them from osmotic rupture in watery environments and gives different types of bacteria their characteristic shapes. The most common bacterial shapes are rodlike **bacilli** (singular, **bacillus**), spheres called **cocci** (singular, **coccus**) and the corkscrew shaped **spirilla** (singular, **spirillum**) ([Fig. 4.5](#).) The cell wall of bacteria contains a unique material called **peptidoglycan**. Peptidoglycan is composed of chains of sugars cross-linked by peptides (short chains of amino acids).

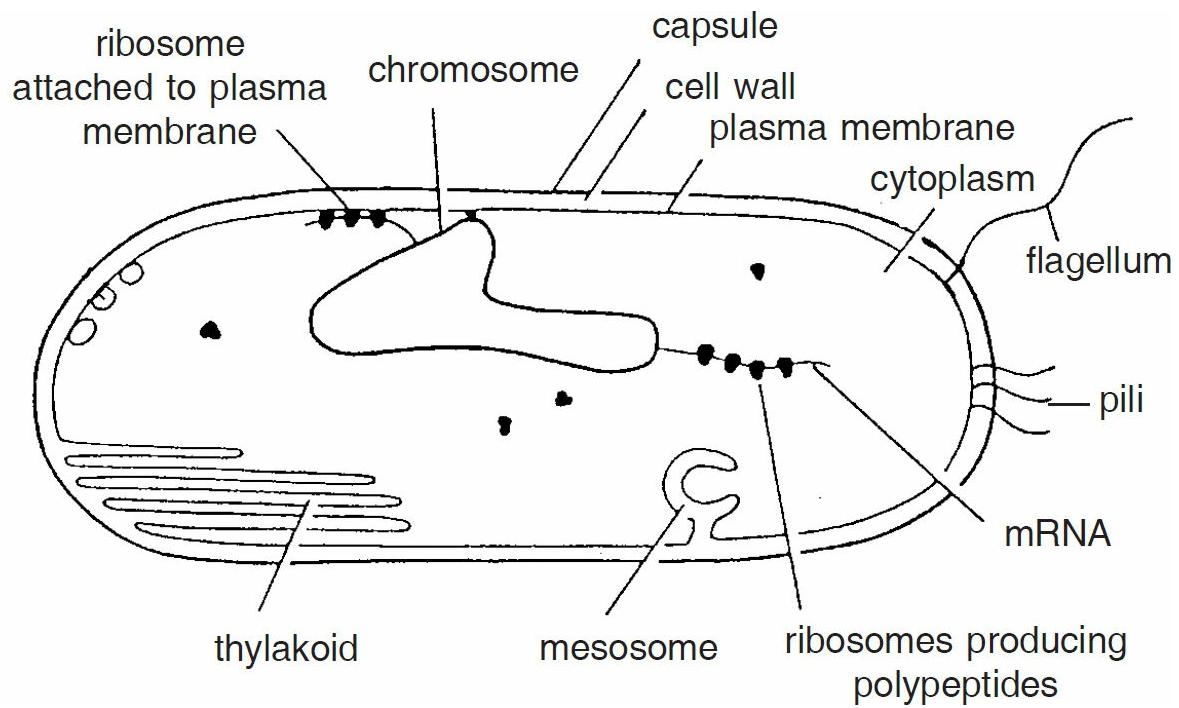


Figure 4.4. Cellular structure of a typical bacterium.

 mystudygear



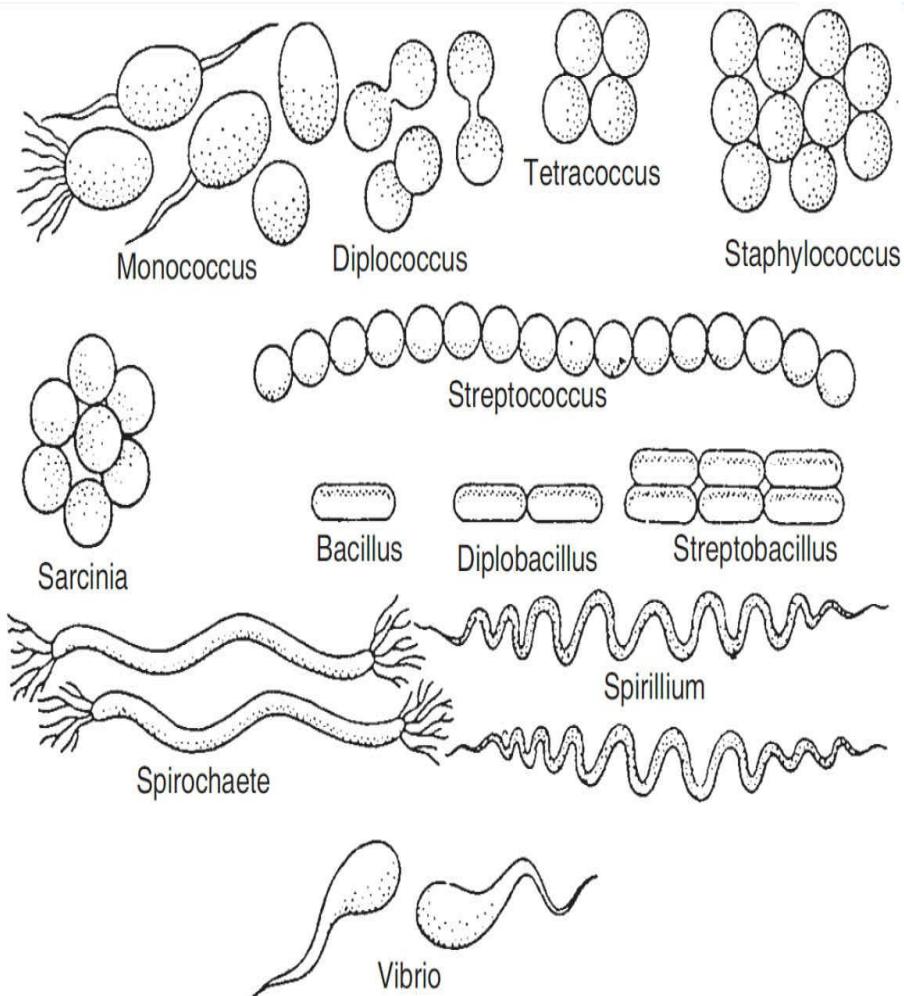


Figure 4.5. Different forms of bacteria.

The **Gram-staining** technique distinguishes two types of cell-wall construction in bacteria, enabling us to classify them as **gram-positive** or **gram-negative**. Gram stain causes gram-positive bacteria to stain red. The cell wall of gram-negative bacteria contains an additional outer membrane resembling a plasma membrane in structure. The antibiotic penicillin works best on gram-positive bacteria. Another antibiotic streptomycin works best on gram-negative bacteria ([Box 4.9](#)).

Box 4.9

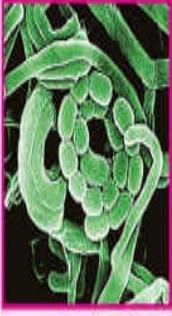
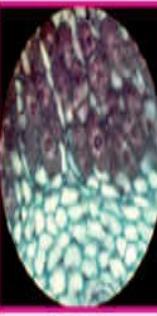
Gram staining technique is one of the first procedures a microbiologist will perform on a newly found or unfamiliar bacterial species ; it is important because it suggests the types of antibiotics that might be effective in fighting a pathogenic (disease-producing) bacterium. An **antibiotic** is a chemical made by one microorganism (e.g., fungi, bacteria) that can slow the growth or kill another microorganism.

Many bacteria are motile (e.g., *Escherichia coli*) and contain one or more **flagella**. The flagella are made of a protein, called **flagellin** and tend to rotate like the propeller of a ship. Some bacteria also contain very fine, short appendages on the cell surface. They are called **pili** and help in sexual reproduction of bacteria and in attachment of pathogenic bacteria to their hosts.

The eight groups of eubacteria with their typical examples and key characteristics have been tabulated in the [Table 4.2](#).

Table 4.2. Main groups of eubacteria

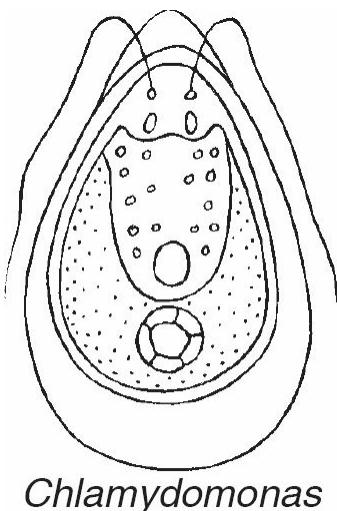
Major Group	Typical Examples	Key Characteristics
1. Actinomyces	1. <i>Streptomyces</i> 2. <i>Actinomyces</i>	Gram positive soil bacteria, form branching filaments and produce spores; often mistaken for fungi; produce many commonly used antibiotics, including streptomycin and tetracycline.
2. Chemoauto-trophs	1. Sulphur bacteria 2. <i>Nitrobacter</i> 3. <i>Nitrosomonas</i> 4. <i>Rhizobium</i> (nitrogen-fixing bacteria of root nodules)	Bacteria able to obtain their energy from inorganic chemicals ; most extract chemical energy from reduced gases such as H ₂ S or SH ₂ (hydrogen sulphide), NH ₃ (ammonia) and CH ₄ (methane) ; play a key role in the nitrogen cycle (nitrogen fixation).

Major Group	Typical Examples	Key Characteristics			
3. Cyanobacteria (Blue-green algae)	1. <i>Oscillatoria</i> 2. <i>Anabaena</i> 3. <i>Spirulina</i> 4. <i>Nostoc</i>	A form of photosynthetic bacteria common to both marine and freshwater environments ; deeply pigmented ; often responsible for "blooms" in polluted waters. Heterocyst cells of <i>Anabaena</i> are involved in nitrogen fixation.			
4. Enterobacteria	1. <i>Escherichia coli</i> 2. <i>Salmonella</i> 3. <i>Vibrio cholerae</i>	Gram-negative rod-shaped bacteria; do not form spores; usually aerobic heterotrophs ; pathogenic causing bubonic plague and cholera.			
5. Gliding and budding bacteria	1. <i>Myxobacteria</i> 2. <i>Chondromyces</i>	Gram-negative bacteria ; exhibit gliding mobility.			
 <i>Streptomyces.</i>	 <i>Rhizobium.</i>	 <i>Nostoc.</i>	 <i>E.coli.</i>	 <i>Myxobacteria.</i>	 <i>Pseudomonas.</i>
6. Pseudomonas	<i>Pseudomonas</i>	Gram-negative heterotrophic rods with polar flagella; very common form of soil bacteria ; some are pathogens of plants.			
7. Rickettsias and Chlamydias	1. <i>Rickettsia</i> 2. <i>Chlamydia</i>	Small gram-negative intracellular parasites ; pathogens of human.			
8. Spirochaetes	<i>Treponema</i>	Long, coil-shaped cells with flagella at both ends; common in aquatic environments ; pathogen.			

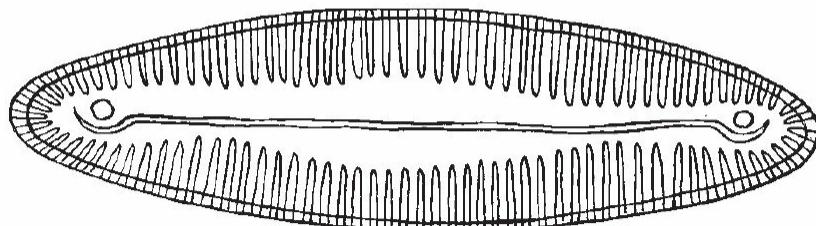
2. Kingdom Protista (or Protocista)

This group includes many kinds of unicellular eukaryotic organisms such as unicellular algae, protozoans and unicellular fungi (Oomycota and slime molds). Some of these organisms use appendages, such as hair-like cilia (e.g., *Paramecium*) or whip-like flagellum (e.g., *Euglena*). Their mode of nutrition can be **autotrophic** (e.g., unicellular algae, diatoms) or **heterotrophic** (e.g., protozoans).

Examples. Unicellular algae ; *Chlorella*, *Chlamydomonas* ; diatoms ([Fig. 4.6](#)) and protozoans.



Chlamydomonas



Diatom

Figure 4.6. Some unicellular algae.

Phylum Protozoa (Gr., *proto*— first; *zoon*— animals; early animals)

1. Unicellular (one-celled or single-celled), mostly aquatic (fresh water or marine) animals.
2. Solitary or colonial, free living or parasitic or symbiotic.
3. Body naked or covered by pellicle or hard shells.
4. Body shape may be irregular, spherical, oval, elongated or flattened.
5. Cytoplasm differentiated into outer **ectoplasm** and inner **endoplasm**.
6. Uninucleate, binucleate or multinucleate.
7. Locomotion using finger-like pseudopodia, flagella or cilia.
8. Nutrition is mostly heterotrophic.
9. Asexual reproduction by binary fission, multiple fission, and sexual reproduction by conjugation.

Phylum Protozoa is divided into the following *five* classes:

Class 1. Mastigophora. 1. Locomotory organs are flagella.

Examples: *Euglena*, *Noctiluca*, *Trypanosoma* (causes sleeping sickness), *Giardia* (causes dysentery), *Leishmania* (causes kala azar), *Volvox* ([Fig. 4.7](#)).

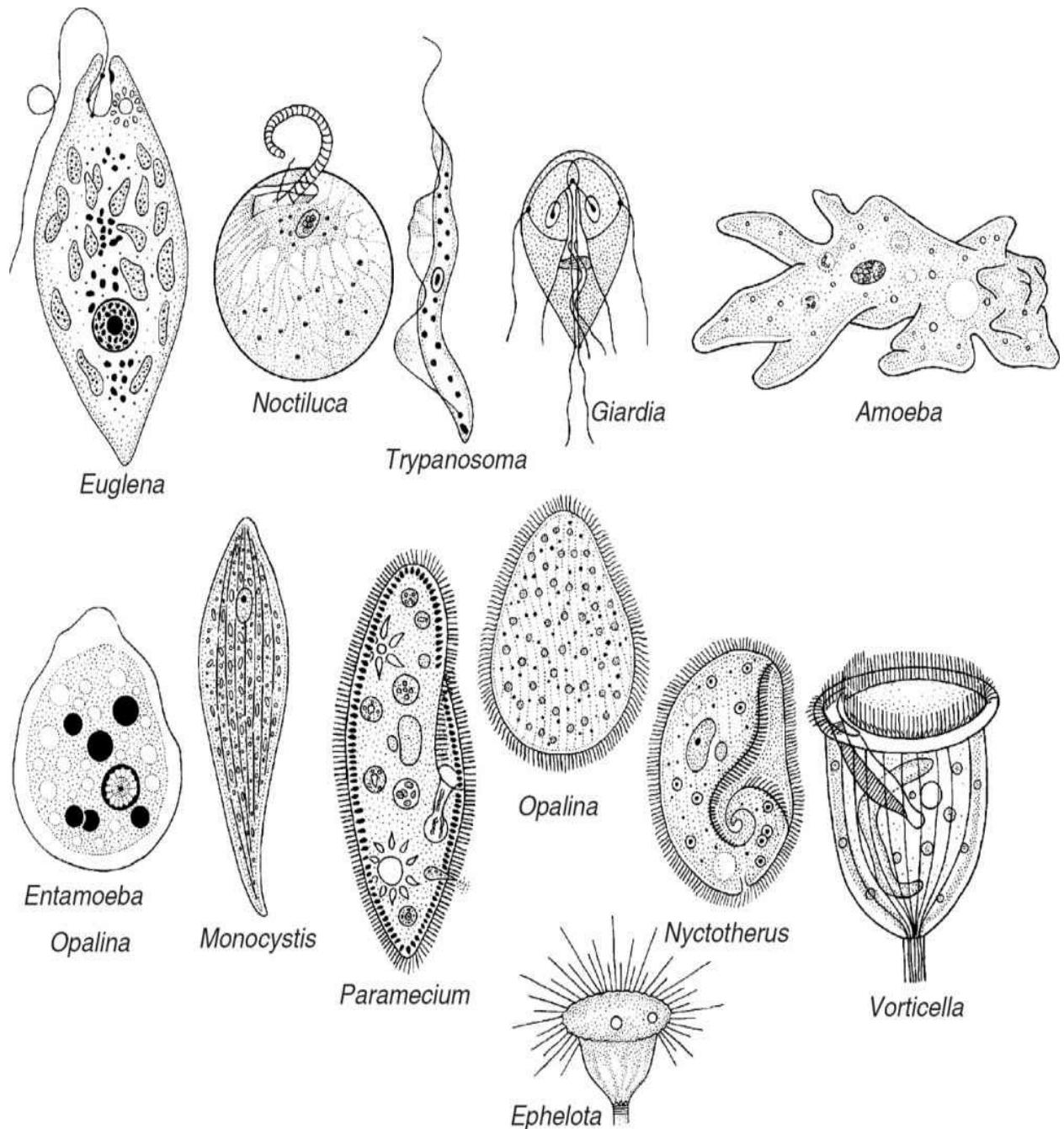


Figure 4.7. Some examples of Protozoa.

Class 2. Sarcodina (Rhizopoda). Pseudopodia are chief organelles of locomotion and food catching.

Examples: *Amoeba*, *Entamoeba* (causes dysentery), *Polystomella*, *Arcella* ([Fig. 4.7](#)).

Class 3. Sporozoa. 1. Lack locomotory organelles.

2. All are parasites.

Examples: *Plasmodium* (causes malaria), *Monocystis* ([Fig. 4.7](#)).

Class 4. Ciliata. Cilia chief locomotory and food catching organelles.

Examples : *Paramecium* ([Fig. 4.8](#)), *Opalina*, *Nyctotherus*, *Vorticella* ([Fig. 4.7](#)).

Class 5. Suctoria. Adult without any locomotory organelles.

Example: *Ephelota* ([Fig. 4.7](#)).

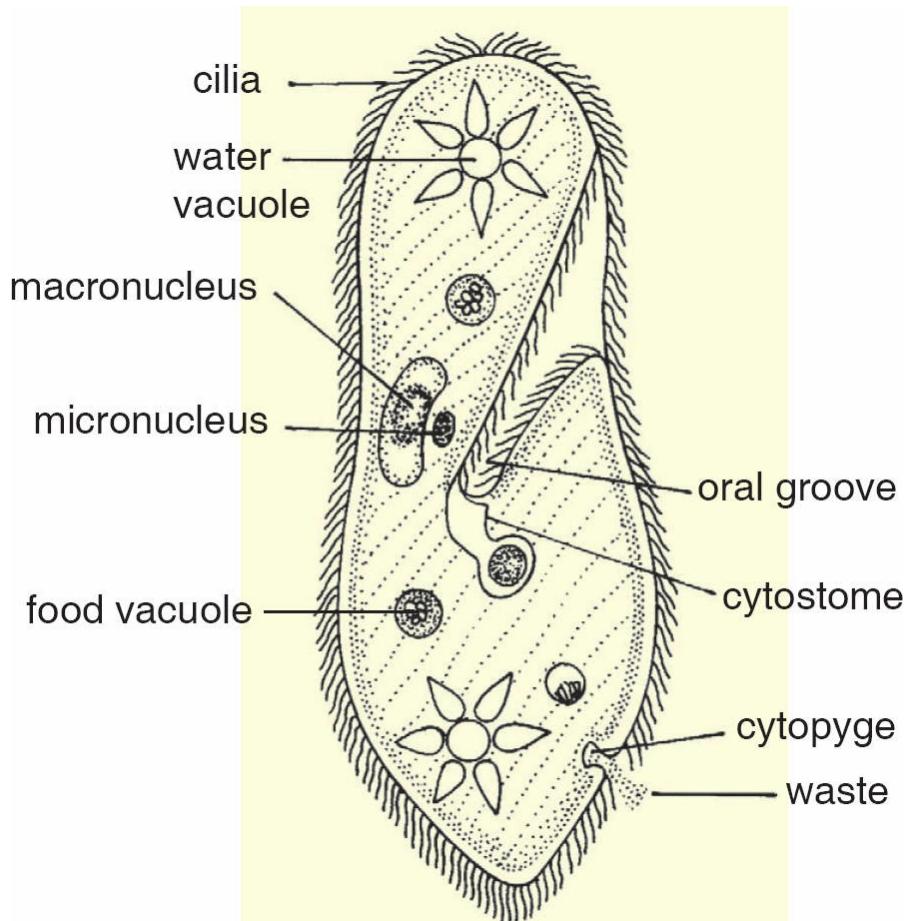


Figure 4.8. *Paramecium*.

3. Kingdom Fungi

Fungi (L., *fungus* – a mushroom). 1. Simple non-green plants which are not photosynthetic. They are **heterotrophic** and **eukaryotic organisms**. Some fungi, such as *Puccinia*, *Albugo*, *Ustilago*, etc., are **parasites** and draw their nutrients from the living cells of their host-plants. Some fungi, such as *Mucor*, *Rhizopus*, *Penicillium* and *Agaricus*, are **decomposers** (hence fungi form a kingdom of multicellular decomposers), **saprophytes** or **saprobionts**, deriving their nourishment from the dead remains of plants and animals.



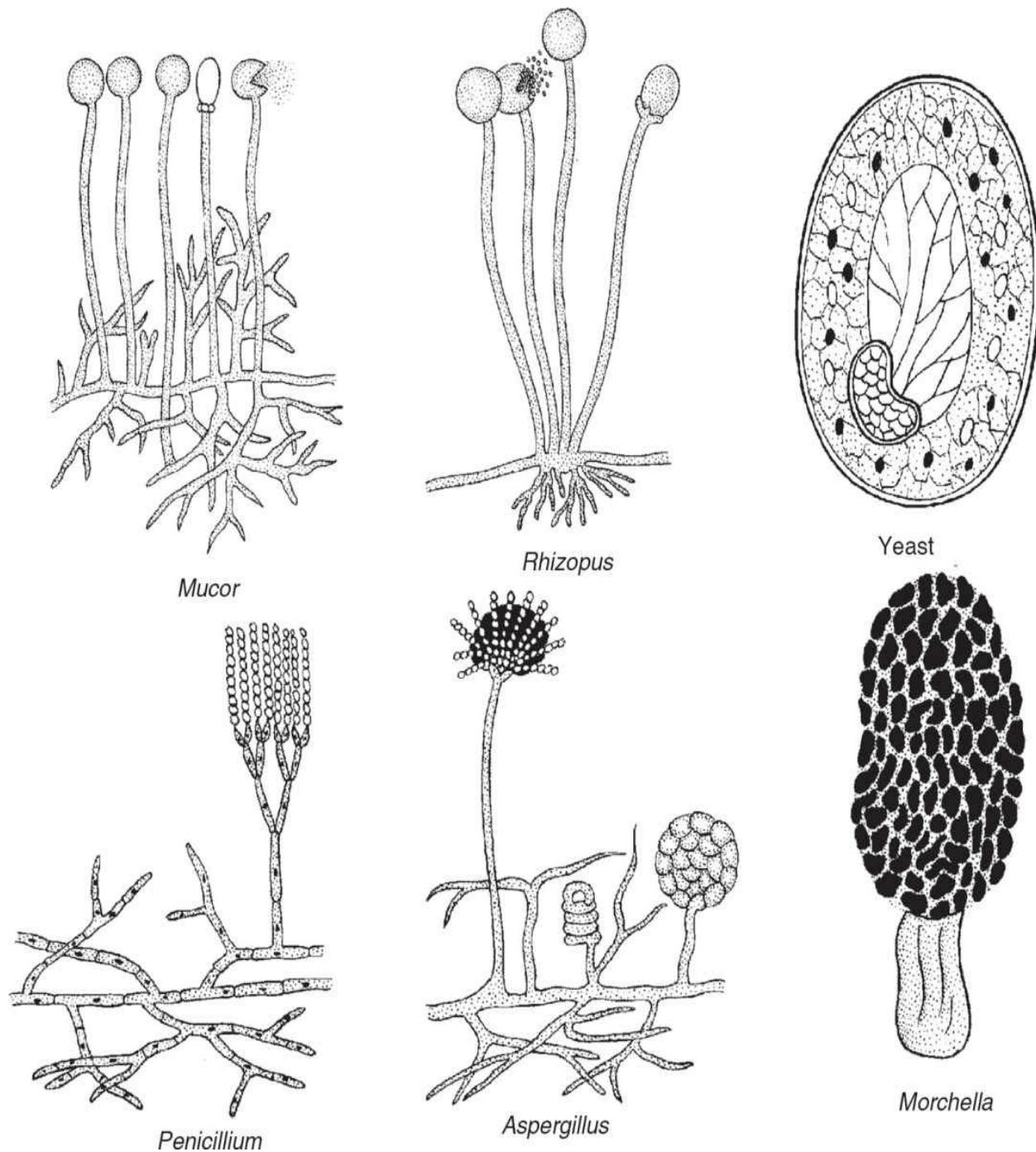


Figure 4.9. Some examples of fungi.

2. They may be unicellular (yeast) or filamentous (most fungi). The body of a multicellular and filamentous fungus is called a **mycelium** and is composed of several thread-like structures, termed **hyphae**.

3. Fungi have a cell wall containing a mixture of chitin and cellulose. Chitin is a tough complex sugar.

4. The reserve food is glycogen.

Examples : Bread mold (*Rhizopus*, *Mucor*); yeast (*Saccharomyces*); pink bread mold (*Neurospora*); green mould (*Penicillium*); cup fungus (*Peziza*); morel, guchi or sponge fungus or gill fungus (*Morchella*); mushroom or gill fungus (*Agaricus*); rust (*Puccinia*); smut (*Ustilago*) and *Aspergillus* ([Fig. 4.9](#)).

(c) Lichens

1. Lichens grow as the slow-growing coloured patches on rocks, bark of tree-trunks, and even on the ground. They are very hardy.
2. In lichens, blue-green algae or cyanobacteria and fungi live in symbiosis (*mutualism*), i.e., they co-exist for mutual benefit.
3. The algal component of the lichen is known as **phycobiont** and the fungal component as **mycobiont**.

Box 4.10

Lichens can tolerate prolonged drought and drastic variations in temperature. They occur in hostile habitats such as barren rocks, walls, tree trunks and icy regions where they can be seen as slow growing large coloured patches. *Lichens are sensitive to air pollution*. They are a source of essences, *dhup* and *havan samagri*, some medicines and dyes (e.g., orcein (a biological stain), orchil (violet dye) and litmus).

4. The fungus absorbs water and mineral matter and supplies it to the algae. The algae, in turn, prepares food and supplies it to the fungus.

Examples. **Crustose lichens** (e.g., *Rhizocarbon*, *Graphic*); **foliose lichens** (e.g., *Parmelia*, *Collema*) and **fruticose lichens** (e.g., *Alectoria*, *Usnea*) ([Fig. 4.10](#)).

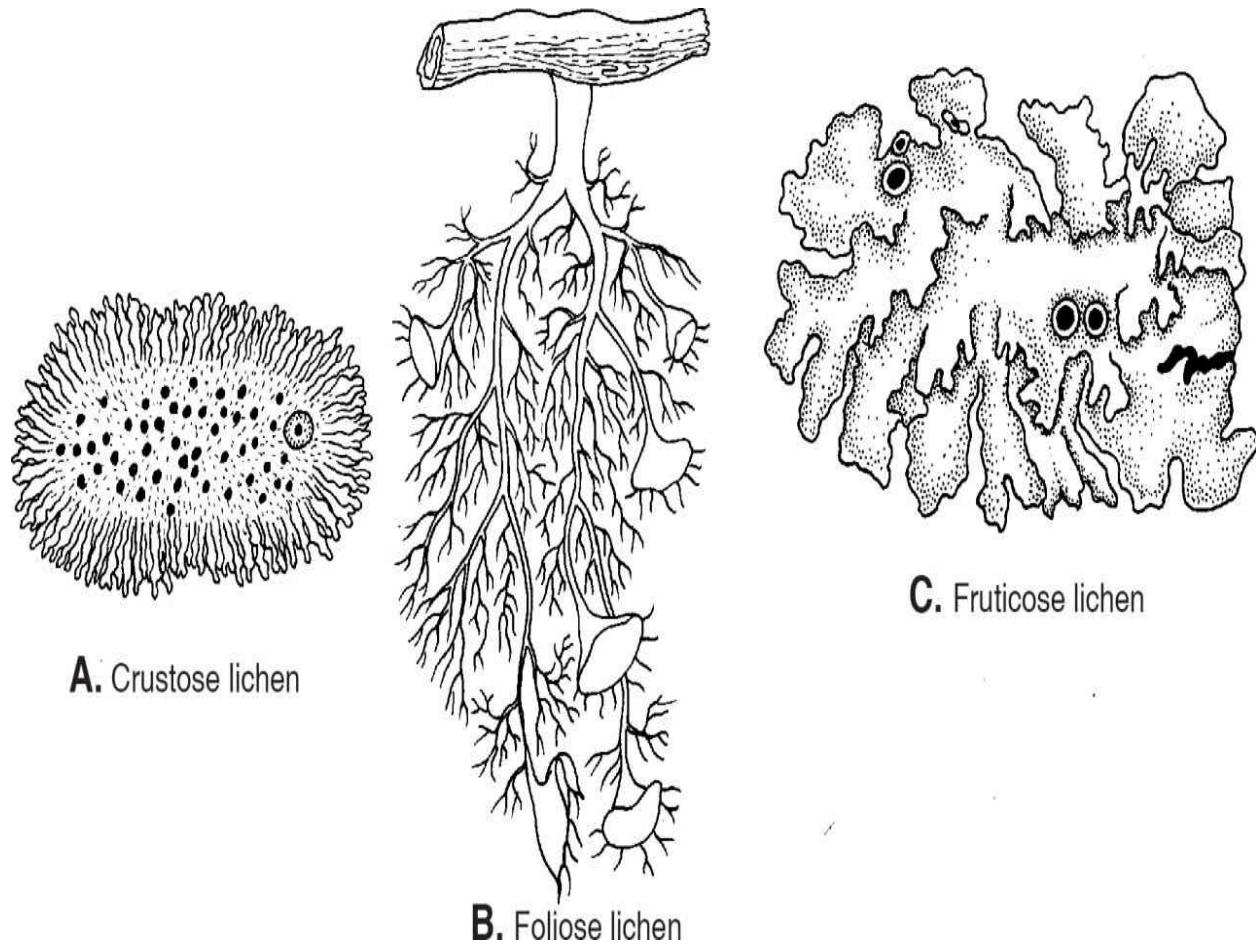


Figure 4.10. Lichens. A—Crustose lichen; B—Foliose lichen ; C— Fruticose lichen.

4. Kingdom Plantae

1. Plantae includes multicellular organisms except for some primitive relatives of algae.
2. They are eukaryotes, that is, their each cell has a nucleus and membrane bound cellular organelles.
3. Cellulose – containing cell wall occurs around the cell.
4. A mature plant commonly possesses a single large central

vacuole bound by tonoplast (membrane).

5. Reserve food of plants is starch and lipids (oil/fat).
6. In all plant cells occur double membrane covered cell organelles, called **plastids**. Some plastids possess photosynthetic pigments (chlorophylls). They are called chloroplasts.
7. Nutrition of plants is autotrophic type with the help of chlorophyll present in chloroplasts, plants are able to perform photosynthesis.
8. Growth in plants is generally indefinite due to presence of growing points.
9. Body form of the plants is irregular due to presence of branches.

5. Kingdom Animalia

1. Animals have wall-less eukaryotic cells.
2. Animals' heterotrophic nutrition is of holozoic (= ingestive) type. An internal alimentary canal is present for extra-cellular or intracellular digestion and absorption of food in most animals. Digestion is intracellular in primitive animals. The undigested matter is thrown out.
3. Growth of animals is limited and stops after reaching maturity.
4. Animals generally possess a definite shape, size and symmetry. Exceptions occur in some lower forms.
5. Most animals are mobile (locomotory). Locomotion is required for obtaining food and other necessities (e.g., dwelling, mate). Sponges and cnidarians (e.g., *Hydra*, *Obelia*, corals), however, are mobile (e.g., tentacles in *Hydra* and flagella of choanocytes in sponges).
6. Movements occur in animals with the help of a muscular

system. Information is conveyed to different parts of the body by nervous system which also provides stimulus to muscles for contraction.

7. Animals have organisation of cellular, tissue, organs and organ system level.

Classification of animals will be dealt within [section 4.7](#).

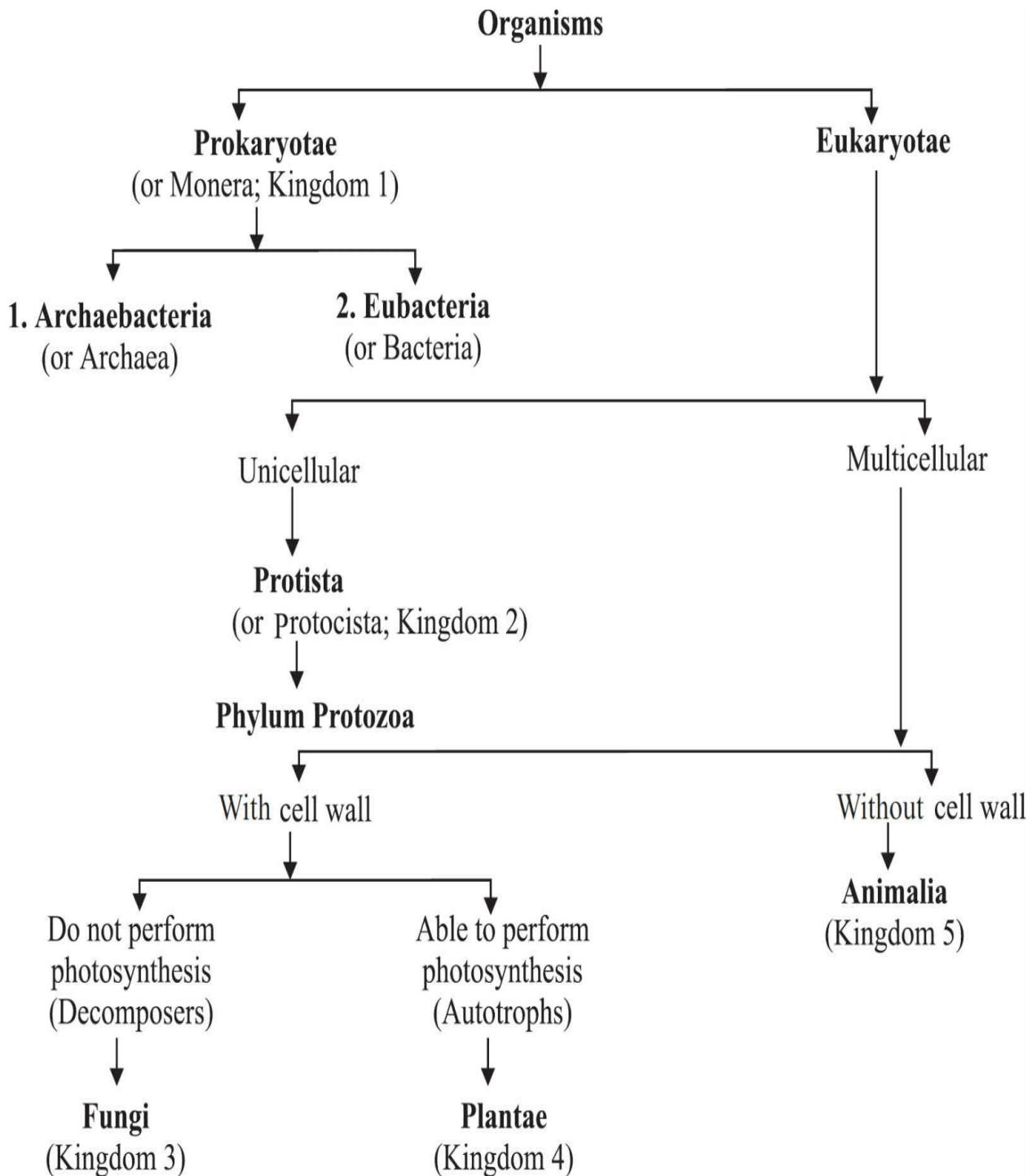


Figure 4.11. The five-kingdom classification.

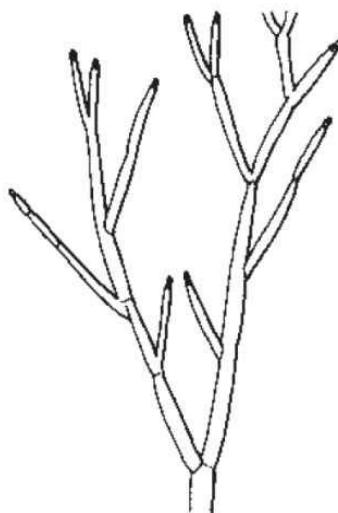
4.6. DETAILED CLASSIFICATION OF KINGDOM PLANTAE

Kingdom plantae is further divided into various divisions based on various criteria. The first level of classification among plants depends on whether or not the plant body has well-differentiated, distinct components. The next level of classification is based on whether the differentiated plant body has special tissues (vascular tissues—the xylem and phloem) for transport of water and other substances within the plant body. Further classification of plants involves criteria, such as, ability to bear seeds and whether the seeds are enclosed within fruits.

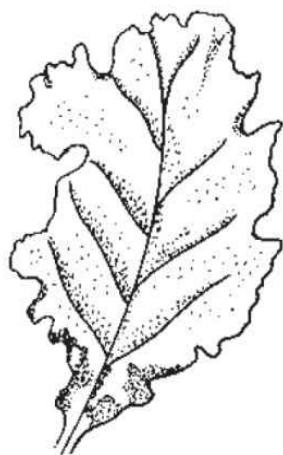




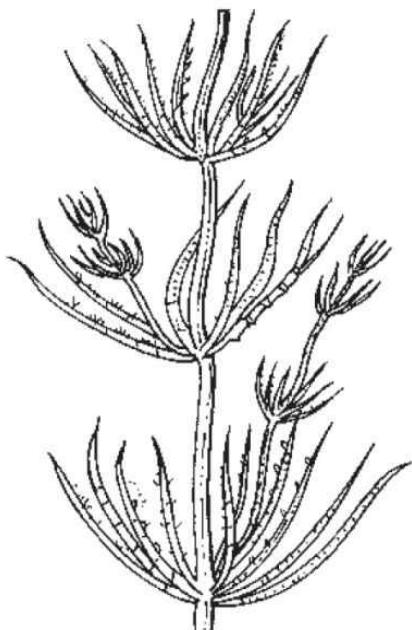
Ulothrix



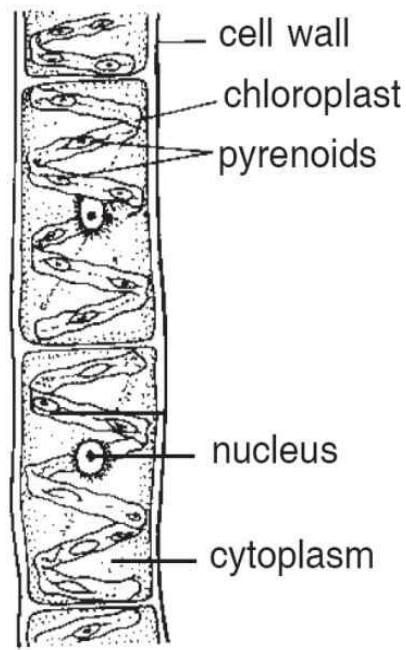
Cladophora



Ulva



Chara



Spirogyra

Figure 4.12. Some examples of thallophyta (algae).

1. Division Algae (*L. alga* = sea weed)

1. Most primitive and simple plants. The plant body is not differentiated into stem, root and leaves, but it is in the form of an

undivided **thallus**.

2. Most algae are water-growing or aquatic, (both marine and fresh water); some are terrestrial, *i.e.*, live on land near moist places.
3. Usually contain green pigment for photosynthesis; some algae have other photosynthetic pigments such as red, brown, and purple. These pigments form the basis of further classification of algae.
4. They are **autotrophic**, *i.e.*, manufacture their own food. Reserve food is generally starch.
5. They have a cellulose cell wall around their cells.
6. Mechanical and conducting tissues are absent (*i.e.*, there is no vascular system).
7. Asexual reproduction generally takes place by spores.
8. Sex organs are simple, single-celled and there is no embryo formation after fertilization.
9. In their life-cycle, the gamete-producing haploid phase, called **gametophytic phase** is dominant. The short spore-bearing diploid phase, the **sporophytic phase**, does not remain attached to the gametophyte.

Example: Green algae — *Ulothrix*, *Cladophora*, *Spirogyra*, *Ulva* and *Chara* ([Fig. 4.12](#)); red algae—*Batra*, *Polysiphonia* ; brown algae (*Laminaria*, *Fucus*, *Sargassum*).

2. Division Bryophyta (Gr., *bryon*— a moss, a liverwort)

1. Bryophytes are small multicellular green land plants. These simple land plants are confined to shady damp places. They are also called **amphibians of the plant kingdom**.

2. Their plant body is a flat, green thallus in liverworts (*Riccia*, *Marchantia*, [Fig. 4.13](#)) and leafy, erect structures in mosses (*Funaria*, [Fig. 4.13](#); *Sphagnum*). They lack real roots, stems and leaves and have no flower.
3. A true vascular system is absent in them.
4. Gametophyte is attached to a substratum by means of hair-like outgrowths, the **rhizoids**, which absorb water and minerals from the substratum. Sporophyte live as a parasite over gametophyte.
5. The sex organs, are multicellular.
6. An embryo is formed upon fertilisation.

Examples: *Riccia*, *Marchantia*, *Anthoceros*, *Funaria*, *Barbula*.

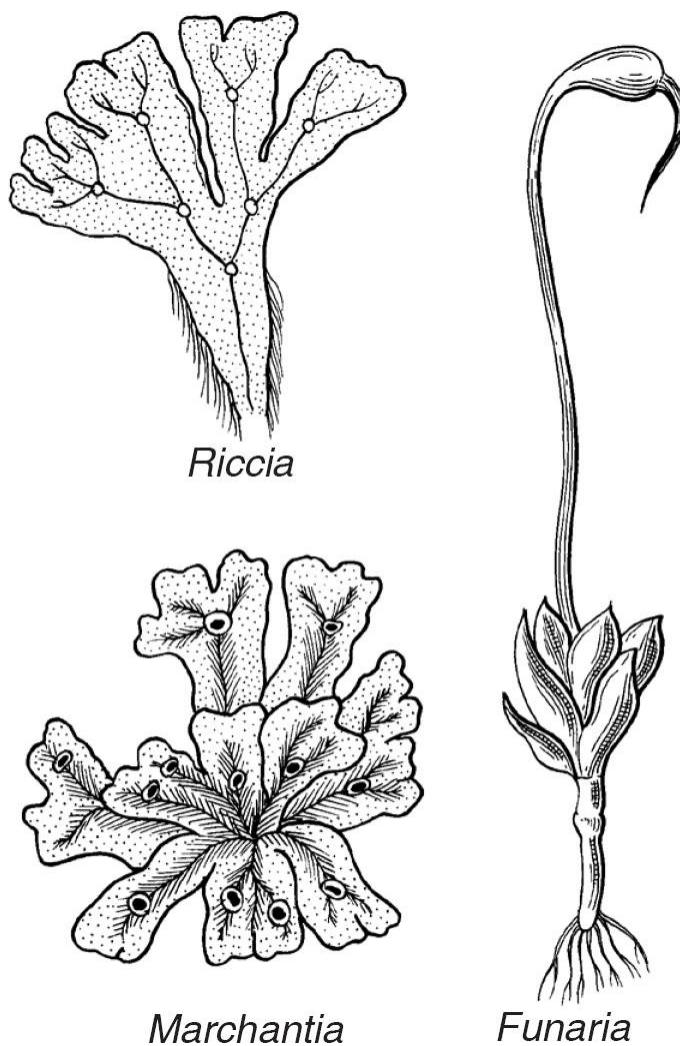


Figure 4.13. Some examples of Bryophyta.

Table 4.3. Differences between Bryophyta and Pteridophyta.

Bryophyta	Pteridophyta
1. Plant body is gametophytic.	1. Plant body is sporophytic.
2. Plant body is either thallose and/or folliose. However, real stem and leaves are always absent.	2. Real stem and leaves are present.
3. Fixation of plant body is carried out by rhizoids.	3. Fixation of plant body is carried out by roots.
4. Sporophyte is parasitic over the gametophytic plant body throughout its life.	4. The gametophyte is small and independent.

- | | |
|---|---------------------------------------|
| 5. Bryophytes are non-vascular in nature. | 5. Pteridophytes are vascular plants. |
|---|---------------------------------------|

Table 4.4. Differences between pteridophytes and phanaerogams (spermatophytes).

<i>Pteridophytes</i>	<i>Phanaerogams / Spermatophytes</i>
1. They are seedless plants.	1. They are seed-bearing plants.
2. Gametophytes are small but independent.	2. Gametophytes are nutritionally dependent on the sporophyte.
3. Their reproductive organs are inconspicuous.	3. Their reproductive organs are quite conspicuous.
4. An external water source is required for fertilization.	4. Fertilization does not require an external water source.

3. Division Pteridophyta (Gr., *pteris*, – idos – fern)

1. They are found mainly in shady or damp places.

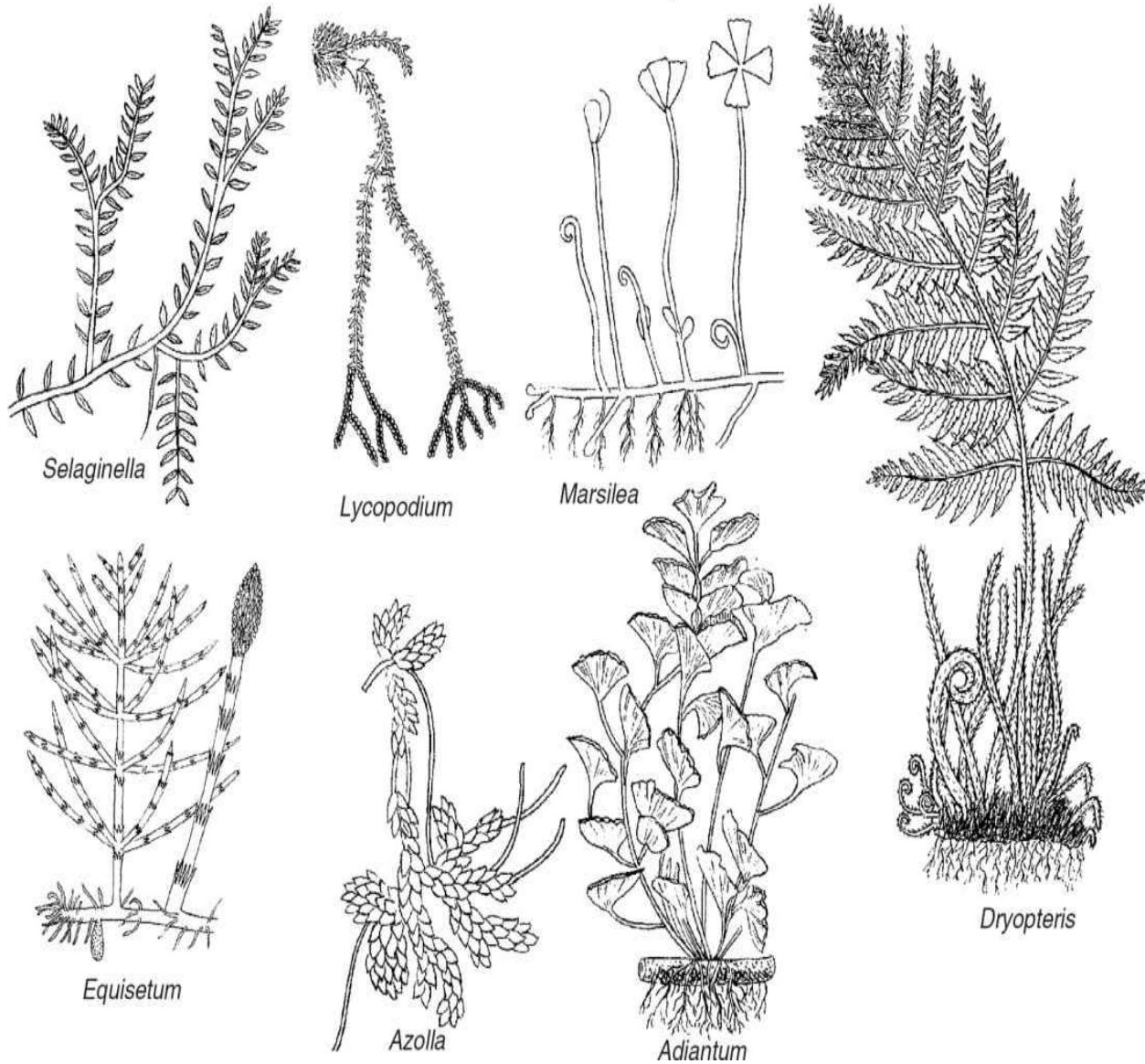


Figure 4.14. Some examples of Pteridophyta.

2. The plant body is made up of root, stem and leaves.
3. They have well developed vascular system (xylem and phloem) for the conduction of water and other substances, from one part of the plant body to another.
4. These plants have no flowers and do not produce seeds.
5. Sex organs are multicellular and jacketed by sterile cells.
6. Fertilised egg develops into embryo.

Examples: Club mosses—*Selaginella*, *Lycopodium* (“ground pine”); horsetails—*Equisetum*; and ferns—*Marsilea*, *Azolla*, *Adiantum*, *Dryopteris*, *Pteris* and *Pteridium* ([Fig. 4.14](#)).

Box 4.11

Cryptogamae and Phanerogamae

(Two subkingdoms of kingdom Plantae according to old classification system)

The plant kingdom, according to **Eichler** (1883), includes all those organisms which possess clearly defined cell walls. This kingdom is subdivided into two sub-kingdoms.

1. Subkingdom Cryptogamae (Gr., *Crypto*-hidden; *gamous*-marriage).

This subkingdom includes those plants which do not produce external flowers or seeds. Thus, they are considered to bear hidden reproductive organs. The common means of reproduction of cryptogam is by spores. The cryptogams are, therefore, also known as **flowerless plants, seedless plants** or **lower plants**. The subkingdom cryptogamae is further divided into three divisions: Thallophyta, Bryophyta and Pteridophyta.

1. Division Thallophyta (Gr. *thallus*-plant-body without root, stem and leaves; *phyton* a plant).

1. This division includes most simple, prokaryotic or simple eukaryotic plants.

2. The plant body is in the form of undivided **thallus** i.e., the plant body is not differentiated into stem, root and true leaves.

3. The vascular tissues (xylem and phloem) are absent i.e., there is no vascular system.

4. The reproductive organs are simple one-celled (unicellular).

5. There is no embryo formation after fertilization.

The division thallophyta is divided into three distinct subdivisions: *algae* (including cyanobacteria or blue green algae), *fungi* (including bacteria, slime moulds and true fungi) and lichens.

2. Subkingdom Phanerogamae

1. Phanerogamae includes higher plants that bear flowers and seeds. Seeds are the result of the reproductive process. They contain an **embryo** along with stored food, which serves for the initial growth of the embryo during germination.

2. The plant body is sporophytic and differentiated into root, stem and leaves.

3. Vascular system (xylem and phloem) are well developed.

4. Sex organs are multicellular.

5. An embryo develops from a fertilized egg.

On the basis of absence or presence of fruits, the group of seed bearing plants is further divided into two subgroups: Gymnospermae and Angiospermae.

On the basis of naked or protected (covered) ovules and absence or presence of fruits, the subkingdom phanerogamae is further divided into subdivisions: Gymnospermae and Angiospermae (Both sub-divisions belong to division spermophyta).

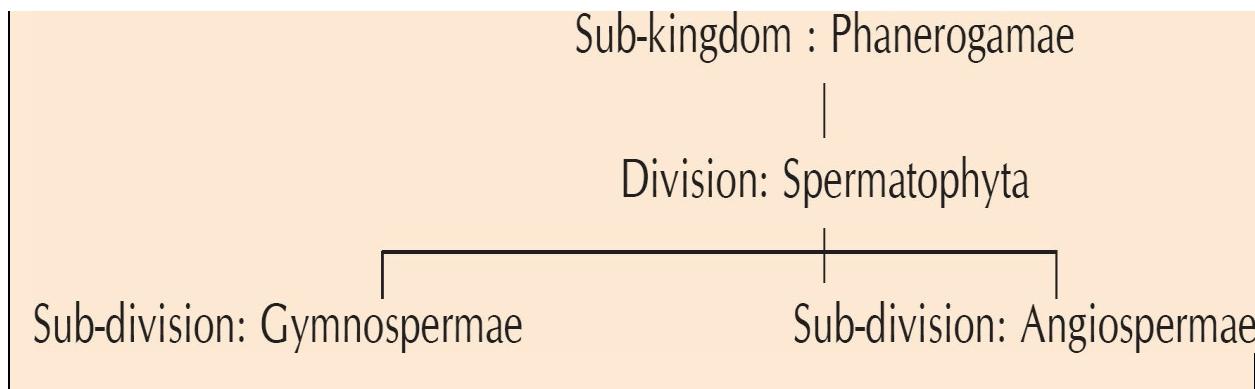


Table 4.5. Differences between cryptogamae and phanaerogamae.

Cryptogamae	Phanaerogamae
1. It contains seedless plants.	1. It contains plants with seeds.
2. It includes both vascular and non-vascular plants.	2. It includes only vascular plants.
3. An external water (source) is required for fertilization.	3. An external water (source) is not required for fertilization.

Table 4.6. Differences between algae and fungi.

Algae	Fungi
1. They contain photosynthetic pigments.	1. Photosynthetic pigments are absent in them.
2. Algae are autotrophic.	2. Fungi are heterotrophic.
3. Most of the algae are aquatic in habitat.	3. Most of the fungi are terrestrial in habitat.
4. The cell wall is made of cellulose.	4. The cell wall is made of chitin.
5. Algae contain starch as a stored food material.	5. Fungi contain glycogen and oil as the stored food materials.

4. Division Gymnospermae (Gr., *gymno*—naked; *sperma*—seed).

1. They are most primitive and simple seed plants.
2. The seeds produced by these plants are naked and are not enclosed within fruits.

3. Usually perennial, evergreen and woody plants.
 4. Sporophylls are aggregated to form cones. There are separate male and female cones.
 5. Xylem lacks vessels and phloem lacks companion cells.
- Gymnospermae includes the following two groups :
- (a) **Cycadae.** e.g., *Cycas*, etc.
 - (b) **Coniferae.** e.g., *Pinus* (pines), *Cedrus* (deodar), *Ginkgo*, etc.

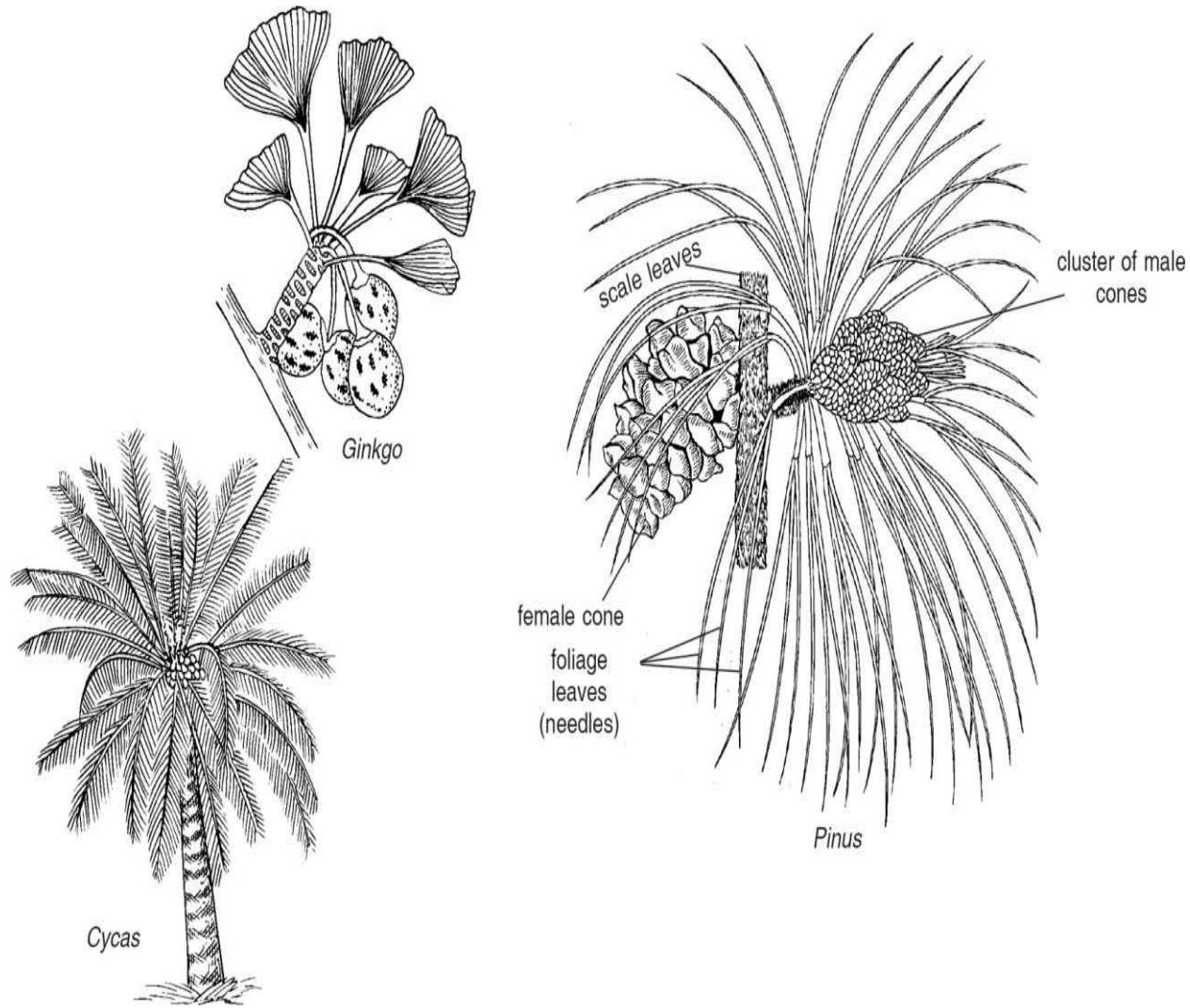


Figure 4.15. Some examples of gymnosperms.

Table 4.7. Differences between gymnosperms and angiosperms.

<i>Gymnosperms</i>	<i>Angiosperms</i>
1. Sporophylls are aggregated to form cones.	1. Sporophylls are aggregated to form flowers.
2. The seeds are naked.	2. The seeds are enclosed by a fruit wall.
3. The microspores and megasporangia are produced by male and female cones.	3. Microspores and megasporangia are produced in the same or two different types of flowers.
4. Vascular tissues such as xylem lacks vessels and phloem lacks companion cells.	4. Vascular tissues such as xylem contain vessels and phloem contains companion cells.
5. The ovules are not contained within an ovary.	5. The ovules are enclosed within an ovary.
6. Endosperm cells are haploid.	6. Endosperm cells are triploid.

5. Division Angiospermae (Gr., *angeion*—case; *sperma*—seed).

1. Angiosperms are highly evolved plants and they produce seeds that are enclosed within the fruit.
2. The reproductive organs (sporophylls) are aggregated in a flower. Since these plants have flowers, they are called **flowering plants**.
3. Plant embryos in seeds have structures, called **cotyledons**. Cotyledons are called '**seed leaves**' because in many cases they emerge and become green when the seed germinates. Thus, cotyledons represent a bit of pre-designed plant in the seed.



Monocotyledon



Dicotyledon

Figure 4.16. Some examples of angiosperms.

4. Endosperm has triploid cells. It supplies nutrients for the developing embryo in the seed.

On the basis of the number of **cotyledons** (fleshy embryonic leaves), the angiosperms are divided into two groups : dicotyledons and monocotyledons ([Fig. 4.17](#)).

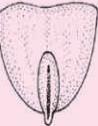
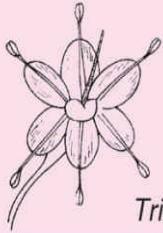
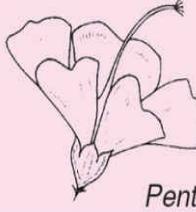
<i>Monocotyledon</i>	<i>Dicotyledon</i>
1. Seed  One cotyledon	 Two cotyledons
2. Root  Fibrous root	 Prominent primary root
3. Stem  Hollow e.g. Reduced to a disc bamboo e.g. onion, garlic False (pseudo) stem e.g. banana	 Strong stem
4. Leaf  Radical i.e. arises directly from soil Sessile i.e. without petiole Parallel venation e.g. banana	 A petiolate dorsiventral leaf Reticulate venation e.g. Hibiscus
5. Flower  Trimerous	 Pentamerous

Figure 4.17. Difference between monocots and dicots.

(a) **Dicotyledonae (Dicots).**

1. The seeds produced by these plants have embryos with two fleshy leaves, the **cotyledons**.
2. Their leaves have reticulate venation, with a network of veins.

3. The root system has a prominent tap root.
4. The flowers have five or multiple of five petals.
5. The vascular bundles are arranged in a ring. They are open (*i.e.*, have cambium) and undergo secondary growth.

Examples: Pea (*Pisum sativum*), potato (*Solanum tuberosum*), sunflower (*Helianthus annuus*), rose (*Rosa indica*), banyan (*Ficus religiosa*), margosa or neem (*Azadirachta indica*), apple (*Malus silvestris*), mustard, mango, etc.

(b) Monocotyledonae (Monocots). 1. The seeds of these plants have only one cotyledon.

2. Their leaves have parallel venation.
3. The root system consists of similar fibrous roots.
4. The flowers are **trimerous**, *i.e.*, have three or multiple of three petals.
5. The vascular bundles are scattered and closed (*i.e.*, lack cambium). Secondary growth does not occur.

Examples: Maize (*Zea mays*), wheat (*Triticum vulgare*), rice (*Oryza sativa*), onion (*Allium cepa*), sugarcane (*Saccharum officinarum*), barley (*Hordeum vulgare*), banana (*Musa paradisiaca*), Coconut (*Cocos nucifera*), bamboo and grasses.

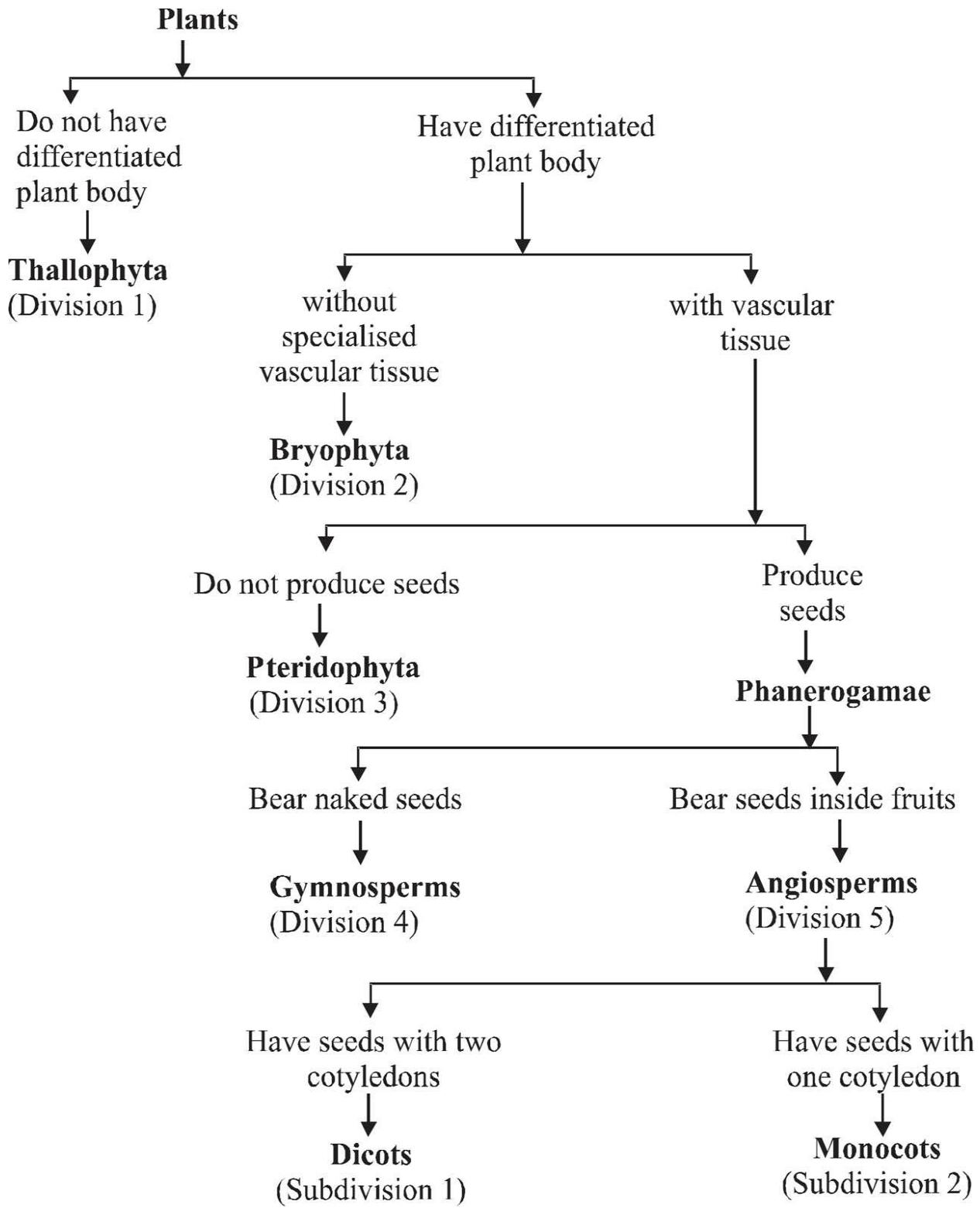


Figure 4.18. Classification of Plants.

ACTIVITY 4.3

1. Take some seeds of green gram, wheat, maize, peas and tamarind and soak them in water. Once they become tender, try to split apart the seed. Do all the seeds break into two nearly equal halves?

You will find, that every seed of green gram, pea and tamarind has two cotyledons. However, the seeds of wheat and maize do not split into equal halves since each of them contain only one cotyledon.

2. The seeds that split open into two equal halves are the dicot seeds and the seeds that do not split in equal halves are the monocot seeds.

3. Now observe the roots, leaves and flowers of these plants. Try to answer the following questions :

(i) Are the roots tap-roots or fibrous ?

(ii) Do the leaves have parallel or reticulate venation ?

(iii) How many petals are found in the flowers of these plants ?

(iv) Try to write down few more characteristics of monocots and dicots on the basis of your above observations.

Table 4.8. Differences between Dicotyledonae and Monocotyledonae.

<i>Dicotyledonae</i>	<i>Monocotyledonae</i>
1. In the seed, the embryo bears two cotyledons.	1. In the seeds, the embryo bears one cotyledon.
2. Leaves of these plants have reticulate venation.	2. Leaves of these plants have parallel venation.

3. Vascular bundles of the stem are open and arranged in a ring.	3. Vascular bundles of the stem are closed and scattered in the ground tissue.
4. Secondary growth occurs.	4. Secondary growth does not occur.
5. The plants have tap root system.	5. The plants have adventitious root system.
6. Flowers are pentamerous (have five of each floral part) or tetramerous.	6. Flowers are trimerous (have three of each floral part).

Table 4.9. Differences between plants and animals.

<i>Plants</i>	<i>Animals</i>
1. They have less definite shape and size.	1. They have definite shape and size.
2. They are usually branched.	2. They are unbranched except for the sponges.
3. Plant organs are generally external, <i>e.g.</i> , root, stem, leaf, flower, etc.	3. Animal organs are generally internal, <i>e.g.</i> , liver, heart, kidney, lungs, brain, stomach, etc.
4. The growth of the plant body is often unlimited and continues till death. The growth regions are localised at the tips.	4. The growth of animal's body is limited and it stops long before death. The growth regions are not localised.
5. Plants are fixed and cannot perform locomotion. (Exceptions include Chlamydomonas, Volvox, etc.)	5. They can move bodily from one place to another. (Exceptions are sponges and corals (which remain fixed but can move their body parts <i>e.g.</i> , tentacles in corals)).
6. They have autotrophic mode of nutrition (<i>i.e.</i> , photosynthesis), because they have green pigment, the chlorophyll.	6. They lack chlorophyll and are heterotrophic in their mode of nutrition.
7. Reserve food of plants is starch and oil.	7. Reserve food of animals is glycogen and fat.
8. Plants do not contain sense organs	8. Animals have sense organs and

and nervous system.	nervous system.
9. Response to external stimuli is slow.	9. Response to external stimuli is quick.
10. Each plant cell typically has a cell wall, plastids and large sized vacuoles. It lacks the centrosome.	10. Each animal cell typically has no cell wall and plastids. It contains centrosome.
11. Plants do not contain excretory organs.	11. Animals have distinct excretory organs.
12. The asexual reproduction or vegetative reproduction is common in the plants.	12. The asexual reproduction occurs only in the lower animals.

4.7. DETAILED CLASSIFICATION OF KINGDOM ANIMALIA

Animals are those organisms which are eukaryotic, multicellular and heterotrophic in their mode of nutrition. Animal cells do not have cell walls. Except a few, most animals are mobile. Multicellular animals are often called **metazoa** which have been divided into two branches: Parazoa and Eumetazoa. In the flow chart ([Fig. 4.41.](#)), animals are arranged progressively from simple parazoa to highly complex animals.

In **Parazoa**, the animal body is formed of loosely aggregated cells. These animals have poorly differentiated tissues and have no organ or digestive cavity (*e.g.*, sponges). However, in **Eumetazoa**, the cells are properly arranged into tissues and organs. Their digestive tract is the mouth but with or without an anus.

The **Eumetazoa** is further classified on the basis of (a) the number of germ layers present in the embryo; (b) the symmetry of the body of the organism; and (c) mode of origin of mouth. Those animals which have two germ layers in the embryo, are called **diploblastic** animals and those having three germ layers are called

triploblastic animals. In diploblastic animals, the outer cell layer is called **ectoderm**, while the inner layer is termed as **endoderm**; and both of these germ layers enclose a non-cellular jelly-like layer, the **mesoglea**. The triploblastic animals have three germ layers, namely **ectoderm**, **mesoderm** and **endoderm**, in their bodies.

Most animals including humans have symmetrical right and left sides. In other words, the two sides of the body are mirror images of one another. Such body symmetry type is called a **bilateral symmetry**. Some animals have **radial body symmetry** which can be defined as an arrangement of usually similar parts in a regular pattern around a central axis.

On the basis of mouth origin two types of animals have been recognised: **Protostomia** (mouth arising from or near the blastopore of gastrula; gastrula is an embryonic stage) and **Deuterostomia** (mouth arising anteriorly at some distance from the blastopore).

Further, based on the presence or absence of body cavity or **coelom**, animals are grouped into acoelomata, pseudocoelomata and coelomata. The **acoelomates** do not have a body cavity, because in them the space between the body wall and digestive tract is filled with parenchymatous tissue. Although the **pseudocoelomates** have a cavity between the body wall and digestive tract, but this cavity does not arise from the mesoderm and is not lined by epithelial cells. The **coelomates** have a true body cavity or coelom which originates from the mesoderm and is lined by epithelial cells of mesodermal origin.

The salient features and common examples of certain main phyla of kingdom Animalia are as follows:

Phylum 1. Porifera (Gr., *porus*—pore; *ferre*— to bear; ‘organisms

with holes')

1. Sessile (stalk-less), sedentary (attached to the substratum), and marine except one group that lives in fresh water. These are non-motile animals attached to some solid support. They are commonly called **sponges**.
2. Simplest multicellular, diploblastic animals.
3. The body design involves minimal differentiation and division into tissues. The cells are loosely held together in a gelatinous matrix, **mesoglea** or **mesohyl** and do not form tissues.
4. Asymmetrical or radially symmetrical. Sponges may be vase-like, rounded, sac-like or branched.



Porifera.

Table 4.10. Differences between bilateral symmetry and radial symmetry of animals.

<i>Bilateral Symmetry</i>	<i>Radial Symmetry</i>
1. Limbs and organs are paired.	1. Limbs and organs occur all around the central axis.
2. Cephalization is present.	2. Cephalization is absent.

3. The animal's body can be divided into two equal halves (*i.e.*, mirror images) by one plane called mid-sagittal plane.

Examples. Earthworm, fish, frog, human being, etc.

3. The animal's body can be divided into two equal halves by any vertical plane passing through the central axis.

Examples. *Hydra*, starfish, etc.

5. Body is perforated with numerous pores. The **ostia**, that open into a **canal system** having canals and chambers lined with collared flagellated cells or **choanocytes**. It also has one or more large-sized outlets for water, called **oscula** (singular osculum). The canal system is a filter-feeding system of sponges. It helps in circulating water throughout the body to bring food, oxygen and water.

6. Mouth, digestive cavity and anus absent.

7. Skeleton is made up of minute calcareous or silicious **spicules** or **spongin fibre (collagen)** or both.

8. Reproduction is both asexual by budding and gemmules and sexual through fertilization. Possess great power of regeneration.

Phylum Porifera is divided into the following three classes :

Class 1. Calcarea. 1. Marine.

Examples: *Leucosolenia*, *Sycon* (*Scypha*) ([Fig. 4.19](#)).

Class 2. Hexactinellida. 1. Marine

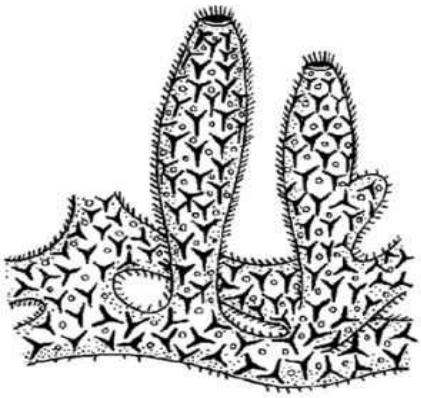
Example : *Euplectella* (Venus's flower basket), *Hyalonema* (rope sponge) ([Fig. 4.19](#)).

Class 3. Demospongiae. Mostly marine and a few fresh water solitary or colonial form.

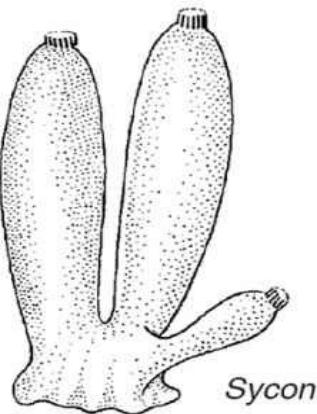
Examples. *Cliona* (boring sponge), *Spongilla*, *Euspongia* (bath sponge) ([Fig. 4.19](#)).

Phylum 2. Cnidaria or Coelenterata. (Gr., *koiros*— hollow; *enteron* – gut)

1. Aquatic (living in water), mostly marine, a few such as *Hydra* are fresh water. Some of these species live in colonies (corals, *Physalia*), while others live solitary (*Hydra*).
2. Cnidarians or coelenterates are multicellular, diploblastic animals with tissue grade of organisation. A gelatinous layer called **mesoglea** or **mesohyl** persists between the ectoderm (epidermis) and endoderm (gastrodermis).
3. Body shows radial symmetry.
4. A central gastrovascular cavity **coelenteron** is present which lacks anus but has a mouth which is surrounded with short and slender tentacles ([Fig. 4.20](#)).
5. Possess specialized sting cells (cnidoblasts) bearing stinging cell organelles called **nematocysts**. Nematocysts serve the functions of paralysing the prey by injecting poison or holding the prey.
6. Respiratory, circulatory and excretory organs are absent.
7. Nervous system is primitive, has only network of nerve cells.
8. Exhibit the phenomenon of **polymorphism** (Gr., *poly*-many; *morphe*-shape) which is the specialisation of individuals of colonial species for the division of labour. For example, hydrozoans have feeding individuals or zooids, the **gastrozooids**, protective zooids, the **dactylozooids** and reproductive zooids, the **gonozooids** producing sexual medusae.

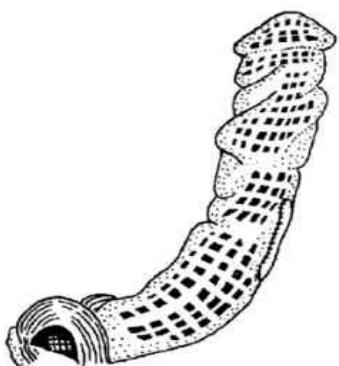


Leucosolenia

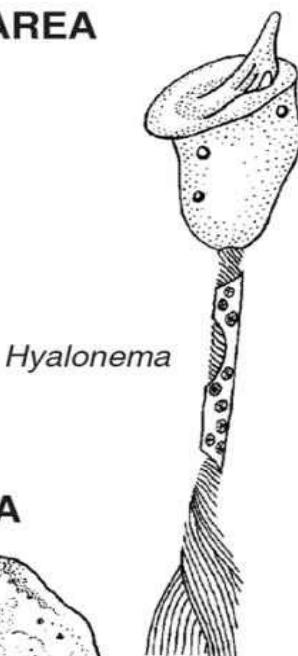


Sycon

CLASS — CALCAREA



Euplectella

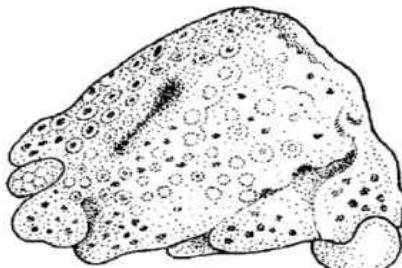


Hyalonema

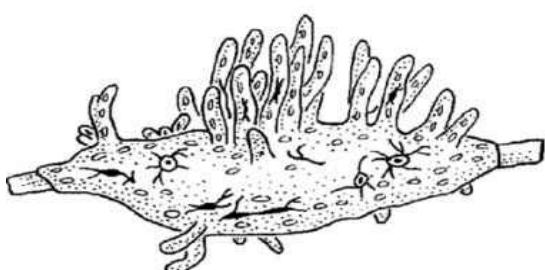
CLASS — HEXACTINELLIDA



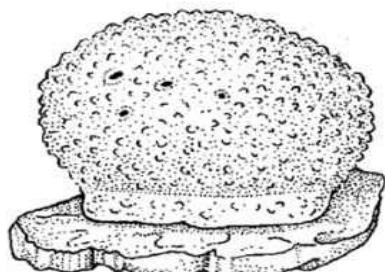
Oscarella



Cliona



Spongilla



Euspongia

CLASS — DEMOSPONGIAE

Figure 4.19. Some examples of Porifera.



Coelenterates.

9. Body shows two main forms, the **polyps** and the **medusae**. The polyp is diploid, cylindrical and sedentary. It is either solitary or colonial and reproduces asexually. The medusa is diploid, umbrella-like and free-swimming sexual phase of the animal.

10. Asexual reproduction by budding and sexual reproduction by gametes formed by medusae.

11. Many forms possess a hard exoskeleton of lime to form corals.

Phylum Coelenterata is divided into the following *three* classes:

Class 1. Hydrozoa. 1. Their life history includes both polypoid and medusoid forms.

Examples: *Hydra*, *Obelia*, *Millepora* (coral), *Physalia* (Portuguese man-of war), *Porpita* ([Fig. 4.21](#)).

Class 2. Scyphozoa. 1. Their life history lacks polypoid phase and has only medusoid form.

Examples : *Aurelia* (jelly-fish), *Rhizostoma* ([Fig. 4.21](#)).

Class 3. Anthozoa. Their life history has only polypoid form, the medusoid forms are absent.

Examples: *Pennatula* (sea-pen), *Tubipora* (organ pipe coral), *Gorgonia* (sea-fan), *Corallium* (red coral), *Metridium* (sea anemone), *Fungia* (mushroom coral) ([Fig. 4.21](#)).

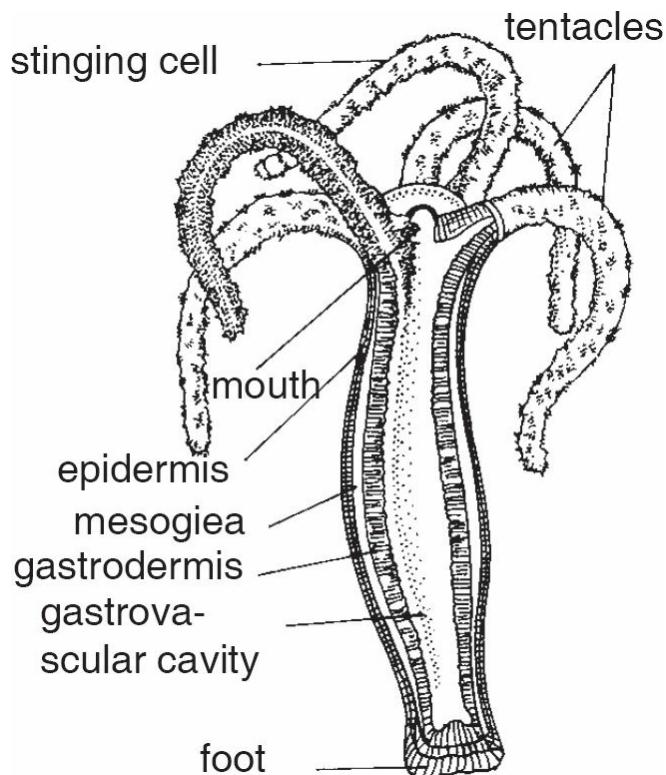


Figure 4.20. L.S. of *Hydra*.



Table 4.11. Differences between Porifera and Coelenterata.

<i>Porifera</i>	<i>Coelenterata (Cnidaria)</i>
1. They have a cellular level of organisation.	1. They have a tissue level of organisation.
2. Their bodies have a number of inhalent (incurrent) pores or ostia and a single exhalant (excurrent) pore or osculum.	2. Their bodies have only a single opening.
3. Digestion is intracellular.	3. Digestion is both extracellular and intracellular.
4. Muscle and nerve cells are absent.	4. Muscle and nerve cells appear for the first time in coelenterates.
5. Appendages are absent in poriferans.	5. Coelenterates have appendages in the form of tentacles.
6. Poriferans contain the special cells called collar cells or choanocytes.	6. Coelenterates contain the special cells called cnidoblasts which contain nematocysts.

Phylum 3. Ctenophora (Gr., *ktenos* – comb; *phora* – carrying)

1. Transparent body with biradial symmetry. Triploblastic.
2. Two tentacles and eight longitudinal rows of ciliary comb-plates for locomotion are present.
3. Marine, solitary and free-swimming.
4. Nematocysts are absent but **colloblasts** (adhesive cells) are

present.

5. No polymorphism or dimorphism occurs.

Examples: *Pleurobrachia* (comb jelly), *Cestum* (Venus's girdle), *Ctenoplana*, *Beroe* (sea mitres), ([Fig. 4.22](#)).



Ctenophora.

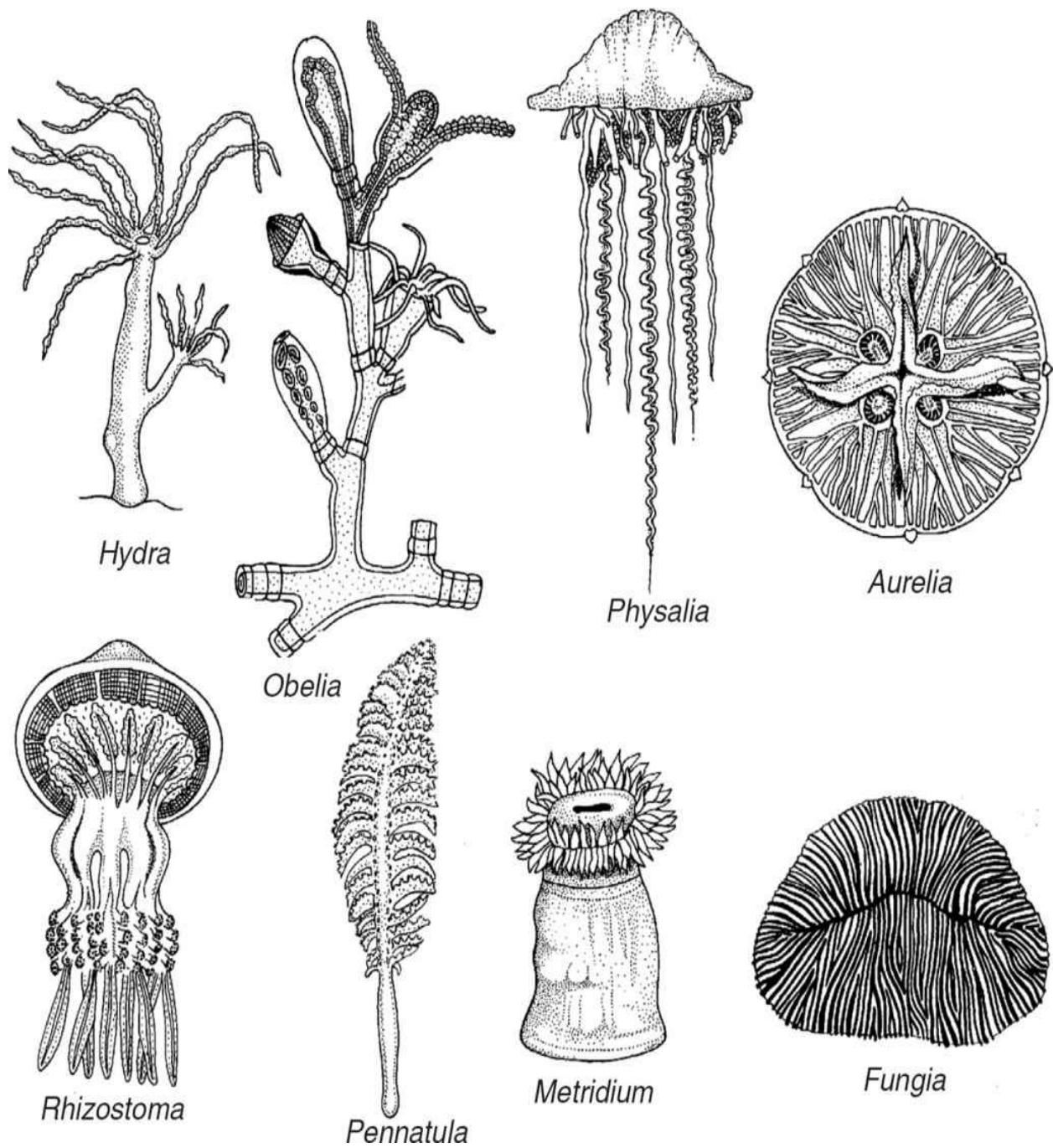


Figure 4.21. Some examples of Coelenterata (Cnidaria).

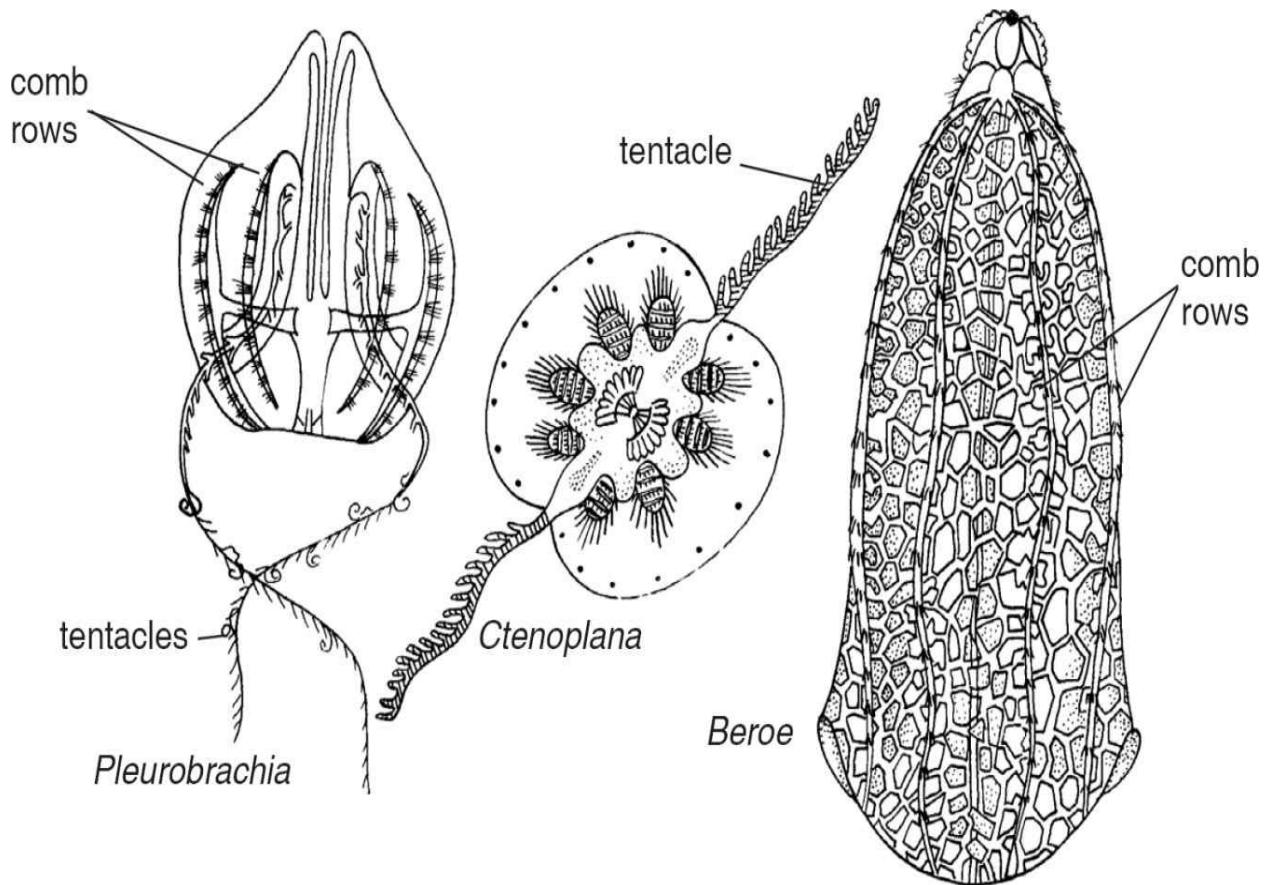


Figure 4.22. Some examples of Ctenophora.

Phylum 4. Platyhelminthes (Gr., *platys* – flat; *helmins* – worm; Flatworms)

1. Bilaterally symmetrical (*i.e.*, the left and right halves of the body have the same design) and dorsoventrally flattened animals.
2. Body thin, soft, leaf-like or ribbon-like.
3. They are triploblastic animals implying that their tissues differentiate from three embryonic germ layers. They are without a body cavity (acoelomate animals).
4. Digestive cavity (when present) with a single opening, the mouth (anus is absent).
5. Suckers and hooks are usually present.

6. Circulatory and respiratory systems and skeleton are absent.

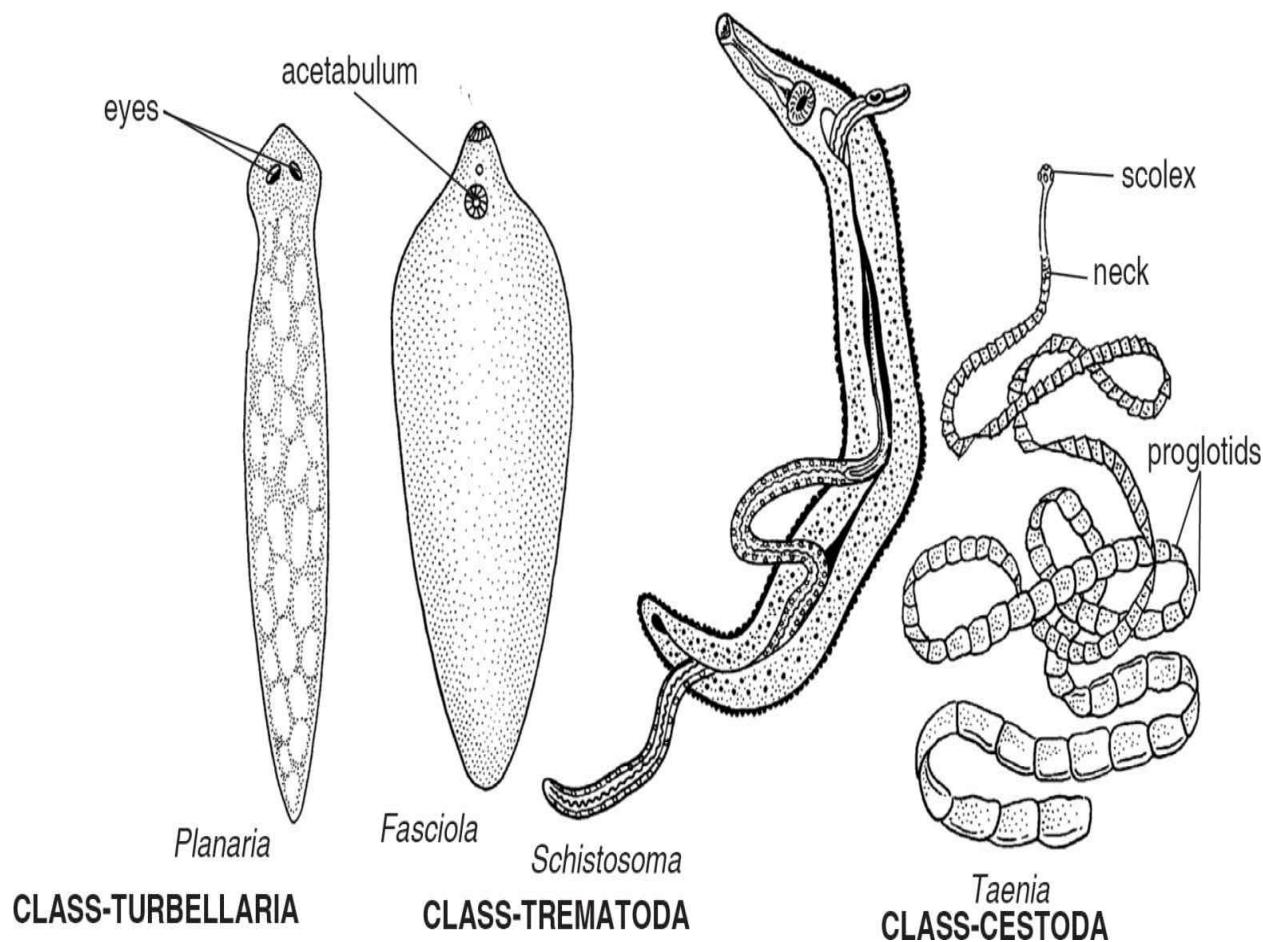


Figure 4.23. Some examples of Platyhelminthes.

7. Excretory system consists of blind tubules called **protonephridia**. Blind end of a tubule bears a tuft of cilia or a flagellum and is called a **flame bulb** or **flame cell**.

8. Hermaphrodite, i.e., both male and female reproductive organs occur in the same individual.

9. The turbellarians are free-living, aquatic, both marine and fresh water and a few are terrestrial. Trematodes and cestodes are parasitic.

Examples: **Class 1. Turbellaria**—*Dugesia*, *Planaria*; **Class 2. Trematoda**—, *Fasciola* (liver-fluke), *Schistosoma* (blood-fluke);

Class 3. Cestoda—*Taenia solium* (pork tape-worm), ([Fig. 4.23](#)).

Phylum 5. Nematoda

1. Bilaterally symmetrical, triploblastic, pseudocoelomate and unsegmented animals.
2. Body is worm-like (*i.e.*, round, slender and tapering at the two ends), cylindrical or flattened.
3. Body is covered with a tough, resistant cuticle; cilia absent.
4. Alimentary canal straight and complete with mouth and anus; pharynx muscular.
5. Sexes are separate.
6. Most forms are parasitic but some are free-living in soil or water.
7. Parasitic nematodes are pathogenic, meaning they produce diseases in the hosts. For example, **elephantiasis** in which enlargement of limbs, scrotum and mammae of humans takes place due to infection of *Wuchereria bancrofti*. This disease spreads through mosquito bites. Likewise, *Ascaris* and *Enterobius* live in human intestine and cause **ascariasis** and **enterobiasis** respectively in humans.

Examples : *Ascaris* (round-worm), *Ancylostoma* (hook-worm), *Wuchereria bancrofti* (filarial worm), *Enterobius* (pinworm of human), ([Fig. 4.24](#)).

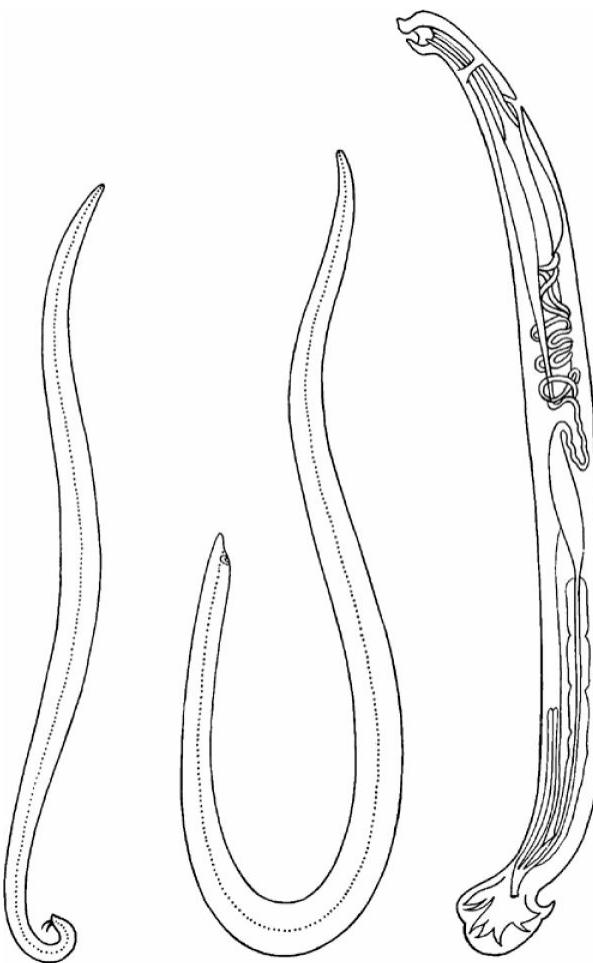


Figure 4.24. Some examples of Nematoda.

Table 4.12. Differences between Platyhelminthes and Nemathelminthes (=Nematoda).

<i>Platyhelminthes</i>	<i>Nemathelminthes</i>
1. They are flatworms.	1. They are cylindrical in form and are called roundworms.
2. They are acoelomate.	2. They are pseudocoelomate.
3. They have an incomplete digestive system.	3. They have a complete digestive system.
4. They are hermaphrodites (i.e., an individual has both types of sex organs).	4. They are unisexual (i.e., males and females are present).
Examples. Liver fluke, pork tape-	5. Examples. <i>Ascaris</i> .

worm.

Phylum 6. Annelida (L., *annelus*— a ring; segmented worms)

1. Body triploblastic, bilaterally symmetrical, soft, elongated, vermiform and cylindrical or dorsoventrally flattened.
2. Body is metamerically segmented externally by transverse grooves and internally by septa. Some of the anterior body segments concentrate to form head.
3. Exoskeleton absent; body is covered by a thin cuticle.
4. Locomotory organs are segmentally arranged paired lateral **appendages**, parapodia or chitinous **setae** or **chaete**.
5. Alimentary canal is tube-like, complete and extends straight from mouth to anus.
6. True coelomate animals (first animals with true body cavity) with closed blood vascular system. Coelom allows true organs to be packaged in the body structure. There is thus, extensive organ ‘differentiation’.
7. Excretion by paired segmental nephridia which removes wastes from coelom and blood stream directly to the exterior.
8. The nervous system consists of a dorsal “brain” and a ventral nerve cord having ganglia and lateral nerves in each body segment.
9. Reproduction is by sexual means. Sexes may be united (hermaphroditic) or separate.
10. They live in a variety of habitats. Mostly aquatic, marine or fresh water; some are terrestrial (in moist soil), burrowing in tubes, some free-living forms.

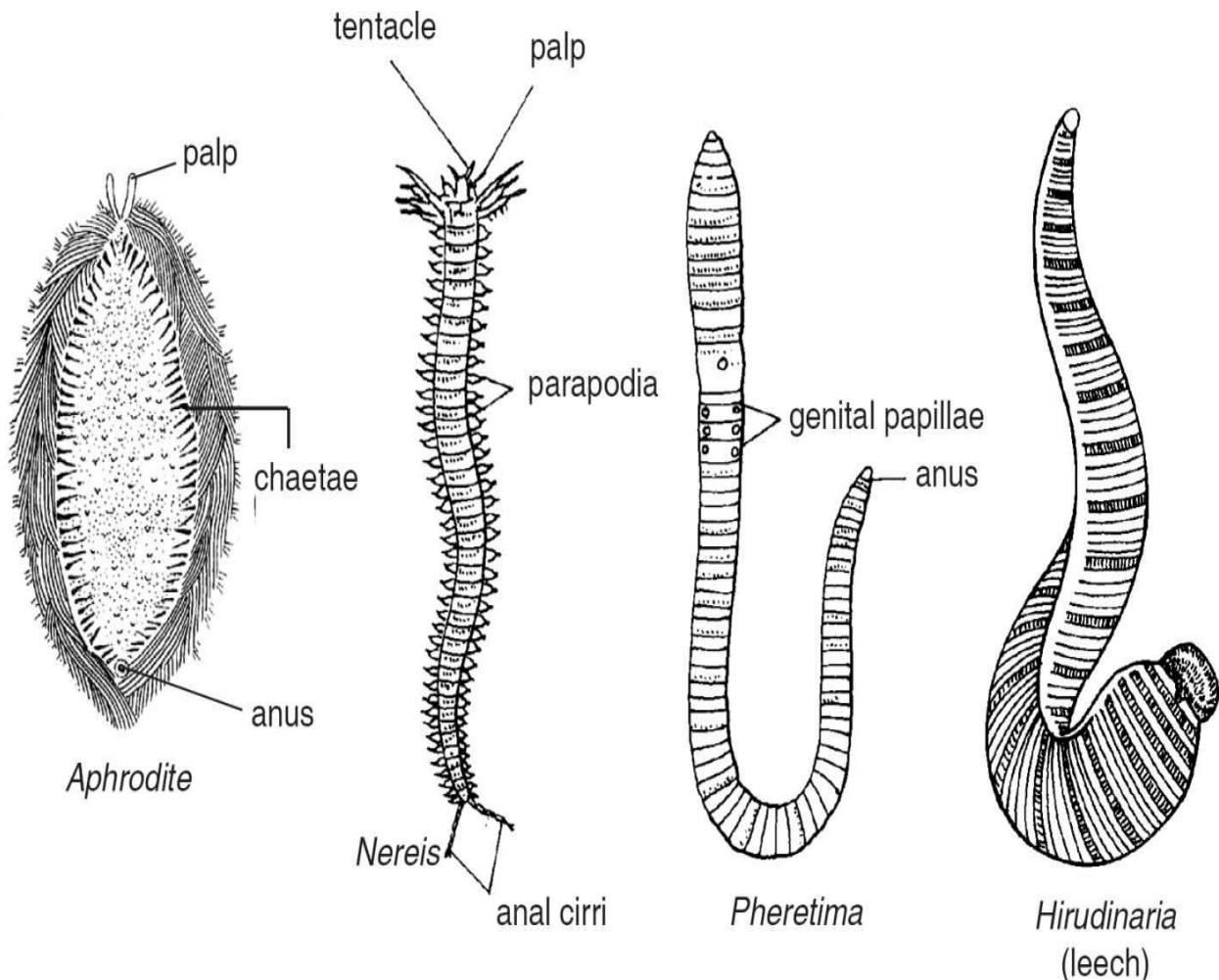


Figure 4.25. Some examples of Annelida.

Phylum Annelida includes the following *three* classes:

Class 1. Polychaeta.

Locomotion by segmentally arranged parapodia having numerous setae.

Examples: *Nereis* (clam worm or sand worm), *Aphrodite* (sea mouse) ([Fig. 4.25](#)).

Class 2. Oligochaeta. Body without distinct head and lacks eyes, tentacles and parapodia.

Examples: *Pheretima* (earthworm), *Eutypheus*, ([Fig. 4.25](#)).

Class 3. Hirudinea. 1. Body with anterior and posterior suckers.

2. Parapodia and setae are absent.

Examples: *Hirudinaria* (Indian cattle leech).

Phylum 7. Arthropoda (Gr., *arthros*—jointed; *podos*—foot; jointed-legged animals)

1. Triploblastic, bilaterally symmetrical and metamerically segmented animals.

2. Body segments are grouped into two regions— cephalothorax (head and thorax together) and abdomen, or three regions – head, thorax and abdomen. Anterior part of body forms a distinct head, bearing sense organs and brain.

3. **Exoskeleton** of cuticle, containing protein, lipid, chitin, and often calcium carbonate is secreted by underlying **epidermis** and shed (moulted) at intervals.

4. They have **complex muscular system**, with exoskeleton for attachment, **striated muscles** for rapid actions and **smooth muscles** for visceral organs. Cilia are absent.

5. Each body segment (somite) usually bears paired lateral and jointed legs or appendages.

6. Body cavity is haemocoel (*i.e.*, filled with blood). The coeloms are reduced to the spaces of the genital and excretory organs.

7. Alimentary canal is complete, mouth and anus lie at opposite ends of the body.

8. Respiration through general body surface, by gills, air tubes (tracheae) or book-lungs.

9. Circulatory system is open with dorsal heart, arteries and haemocoel (blood sinues) but without capillaries and veins. It means that blood does not flow in well-defined blood vessels.

10. True nephridia absent. Excretion by coelomoducts, Malpighian tubules or green or coxal glands.

11. Sexes are usually separate; sexual dimorphism is well marked in several forms.

12. Fertilization is usually internal, oviparous or ovoviviparous and often with **metamorphosis**.

13. Terrestrial or aquatic (fresh water and marine), free-living, commensal or parasitic (on other animals and plants) forms.

14. Arthropoda forms the largest phylum of Animal kingdom. About 900,000 species are known.

Phylum Arthropoda is divided into the following *five* classes:

Class 1. Onychophora. Body is elongated, segmented and is covered with thin cuticle.

Example: *Peripatus*.

Class 2. Crustacea. 1. Head and thorax are fused together to form cephalothorax.

2. Respiration by gills.

Examples : *Palaemon* (prawn), *Daphnia* (water flea), *Cyclops* (one-eyed gian), *Cancer* (True crab) ([Fig. 4.26.](#))

Class 3. Myriapoda. 1. Body is elongated, metamerically segmented with each segment having one or two pairs of legs.

2. Respiration by tracheae.

Examples : *Scolopendra* (centipede), *Julus* (millepede) ([Fig. 4.26.](#)).

Class 4. Insecta. 1. Body is divisible into distinct head, thorax and abdomen.

2. Abdomen lacks appendages, head has a pair of antennae and mouth parts and thorax has three pairs of legs and two pairs of wings.

3. Respiration by tracheae.

Examples: *Lepisma* (silver fish), *Melanopus* (grasshopper), *Gryllus* (house cricket), *Periplaneta* (cockroach), *Musca* (house fly), *Apis* (honey bee), *Anopheles* (mosquito), *Culex* (mosquito), *Pieries* (butterfly), *Cimex* (bed bug) ([Fig. 4.26](#) and [Fig. 4.27](#)).

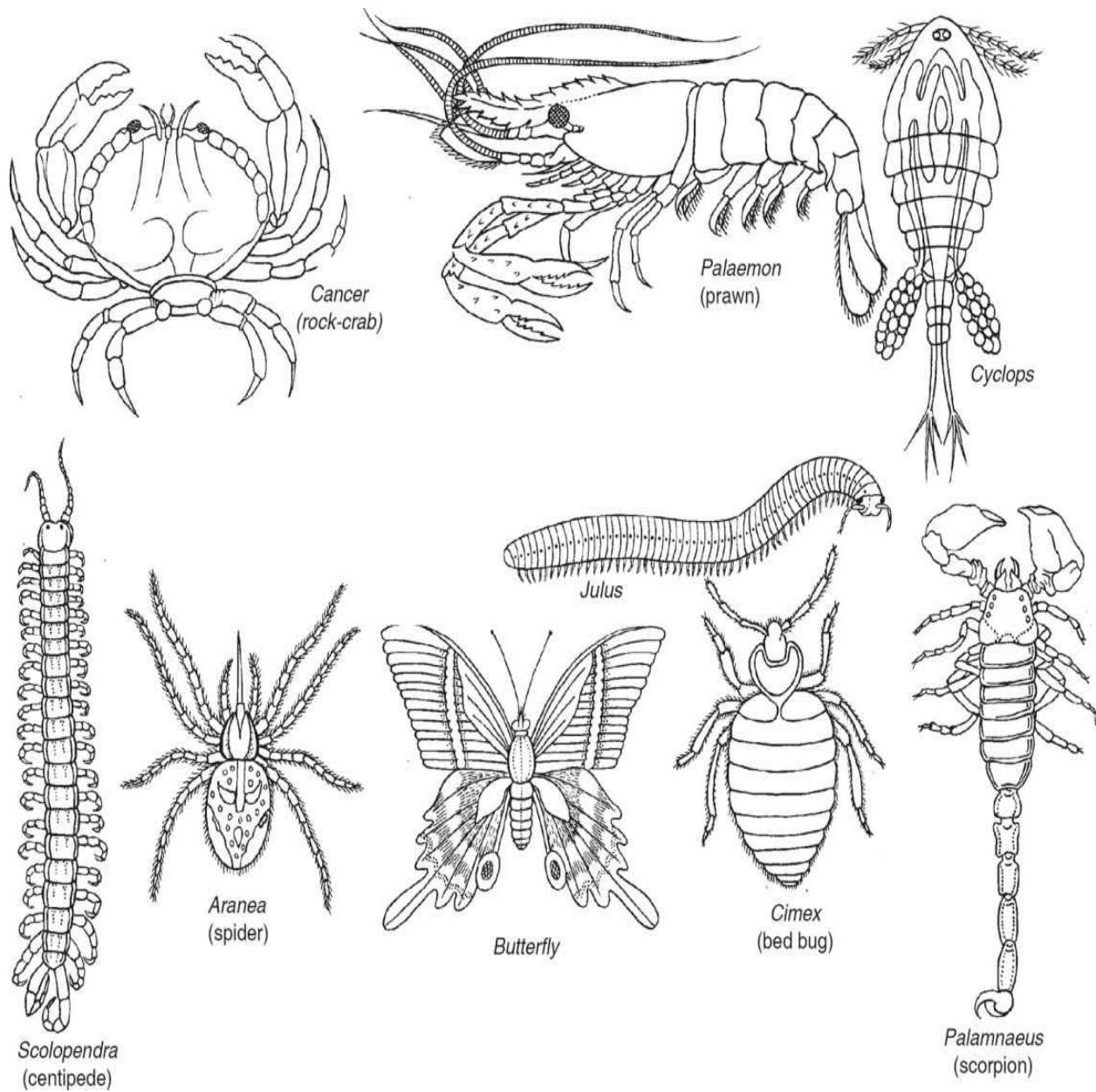


Figure 4.26. Some examples of Arthropoda.

Class 5. Arachnida. 1. Body divisible into cephalothorax and abdomen.

2. Antennae and true jaws are absent.
3. Respiration by tracheae, book-lungs or book-gills.

Examples: *Limulus* (king-crab), *Palamnaeus* (scorpion); *Aranea* (spider), *Sarcoptes* (itch-mites), *Argus* (tick) ([Fig. 4.26](#)).

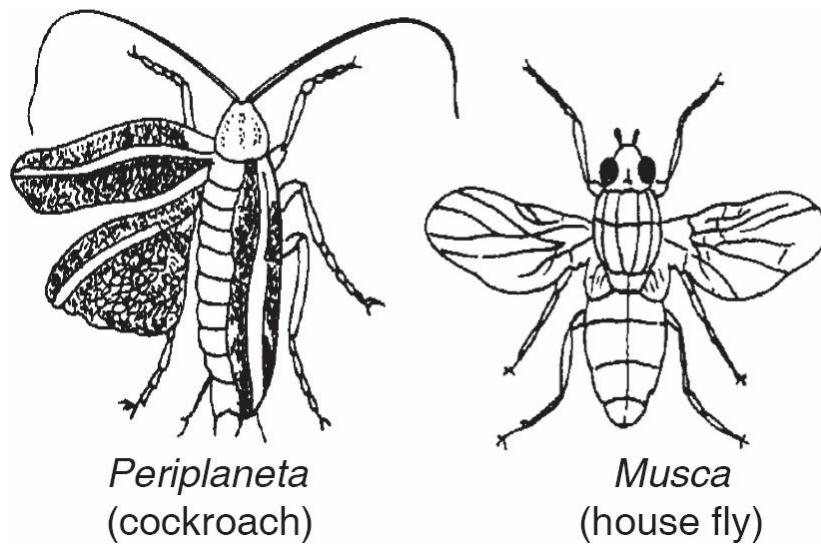


Figure 4.27. Some examples of Insecta.

Table 4.13. Differences between annelids and arthropods.

<i>Annelids</i>	<i>Arthropods</i>
1. Their appendages are unjointed.	1. Their appendages are jointed.
2. They have a closed circulatory system, i.e., their blood flows inside blood vessels.	2. They have a open circulatory system, i.e., their blood flows through large sinuses or spaces.
3. They have a well developed true coelom.	3. They have a small coelom. Instead they have blood filled body cavities called haemocoel.
4. A chitinous exoskeleton is absent in them.	4. A chitinous exoskeleton is present in them.
5. Their excretory organs are nephridia.	5. Their excretory organs are green glands and Malpighian tubules.

6. Their sensory system is less developed.	6. Their sensory system is well developed.
7. Their locomotory organs include parapodia and chaetae.	7. Their locomotory organs are legs and wings.
Examples. Earthworm, <i>Nereis</i> .	Examples. Centipede, crab, cockroach.

Phylum 8. Mollusca (L., *molluscus*— soft)

1. Body is soft, bilaterally symmetrical, with little segmentation and without appendages. The size of body varies from a microscopic to a giant form such as *Octopus* of up to 50 feet.
2. Body is divisible into an anterior **head**, a ventral muscular **foot**, a hard dorsal **visceral mass**. The entire body is covered by a fold of thin skin, called **mantle** which secretes a hard calcareous shell of one or more pieces. Foot is mainly used in locomotion.
3. Body cavity is haemocoel. True coelom is reduced and restricted to the pericardial cavity and the lumen of the gonads and nephridia.
4. Digestive tract has a simple structure.
5. Respiration through gills (called **ctenidia**), mantle or a “lung” of the mantle.
6. Circulatory system is open except in cephalopods.
7. Excretion by a pair of metanephridia or kidneys ([Box 4.12](#)).
8. Sexes are usually separate.
9. Sensory organs of touch, smell, taste, equilibrium, and vision (in some).
10. Aquatic, mostly marine, few fresh water and some terrestrial forms.

Box 4.12

Osmoregulatory organs known as nephridia occur in many invertebrates. When they are closed at the inner end, they are called **protonephridia**, but when they open into a coelomic space at their inner end, they are called **metanephridia**.

The phylum Mollusca is divided into the following *five* main classes :

Class 1. Polyplacophora. 1. Shell composed of eight calcareous pieces.

Example: *Chiton* ([Fig. 4.28](#)).

Class 2. Gastropoda. Univalve shell and visceral mass are spirally coiled (torsion).

Examples: *Pila* (apple snail), *Aplysia* (sea hare), *Helix* (garden snail), *Limax* (gray slug) ([Fig. 4.28](#)).

Class 3. Scaphopoda. Tusk-like tubular shell opens at both ends.

Examples: *Dentalium* (tusk shell) ([Fig. 4.28](#)).

Class 4. Pelecypoda (Bivalvia). Shell consists of two lateral valves hinged together mid-dorsally.

Examples: *Unio* (fresh water mussel), *Mytilus* (sea mussel); *Pinctada* (Indian pearl oyster), *Teredo* (ship worm) ([Fig. 4.28](#)).

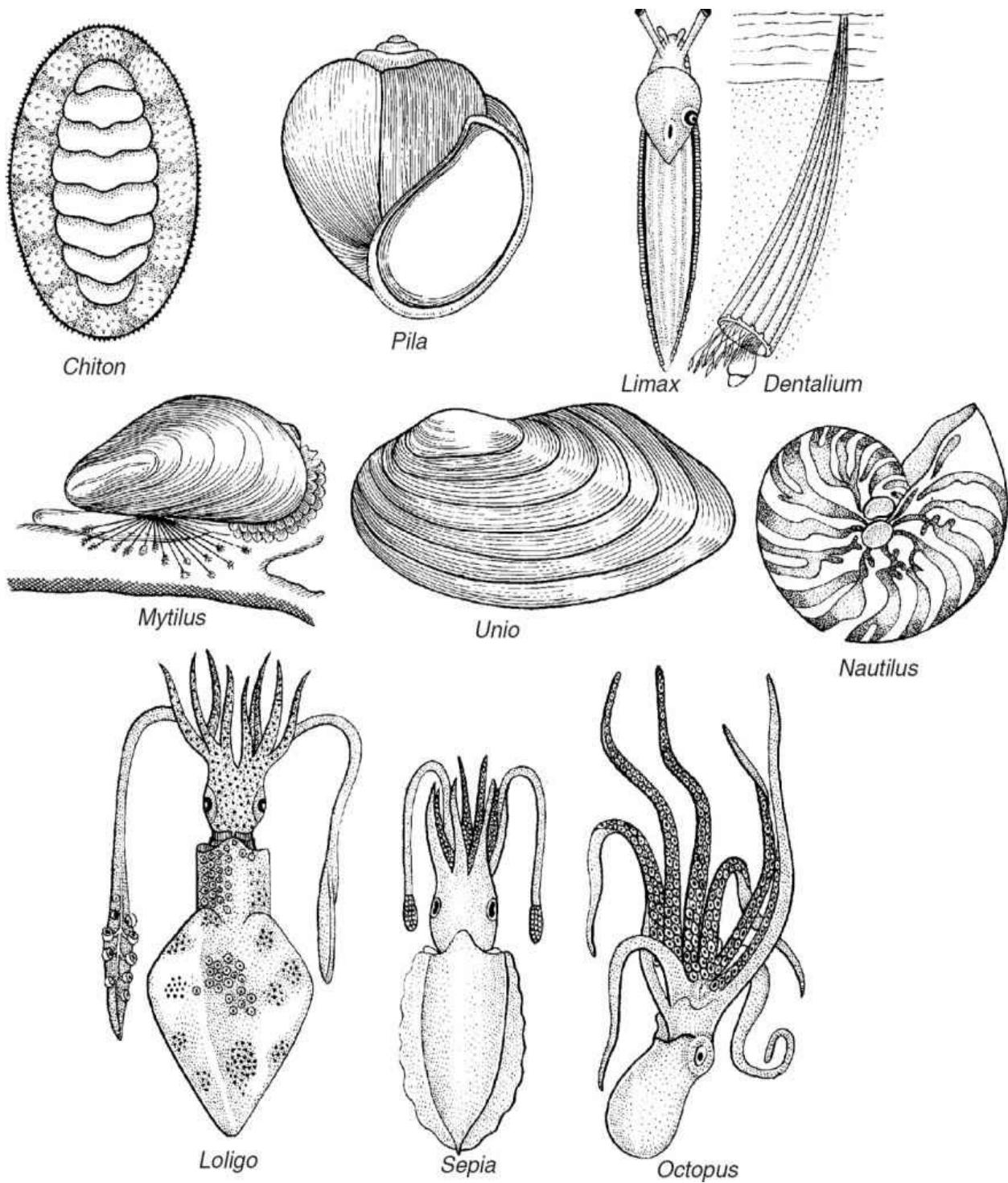


Figure 4.28. Some examples of Mollusca.

- Class 5. Cephalopoda.** 1. Shell external, internal or absent.
2. Foot altered into a series of sucker-bearing arms or tentacles.

3. Eyes are highly developed.

Examples: *Nautilus*, *Loligo* (squid), *Sepia* (cuttle-fish), *Octopus* (devil-fish) ([Fig. 4.28](#)).

Phylum 9. Echinodermata (Gr., *echinos*—spiny or hedge hog; *derma*—skin ; spiny skinned animals)

1. Simple animals may be star-like, spherical or elongate.
2. Body triploblastic, coelomate, unsegmented (nonmetameric) and radially symmetrical (larva bilaterally symmetrical). i.e., pentamerous symmetry in adults.
3. Body lacks head, but has oral and aboral surfaces. Oral surface of body has five radial areas called **ambulacra**.
4. Body wall is covered with spiny hard calcareous (calcium carbonate) plates (ossicles) that forms a rigid or flexible endoskeleton.
5. Body cavity is modified into a unique **water vascular system** which moves respiratory and locomotory organs, the **tube feet** or **podia**.
6. Digestive system is usually complete. Anus is absent in ophiuroids.
7. Excretory organs absent.
8. Reproduction sexual, asexual or by regeneration. Sexes are separate.
9. Exclusively marine, free-living and gregarious (live in groups) animals.

Phylum Echinodermata includes the following *five* classes:

Class 1. Crinoidea. The oral surface is directed upward.

Example : *Antedon* (feather star) ([Fig. 4.29](#)).

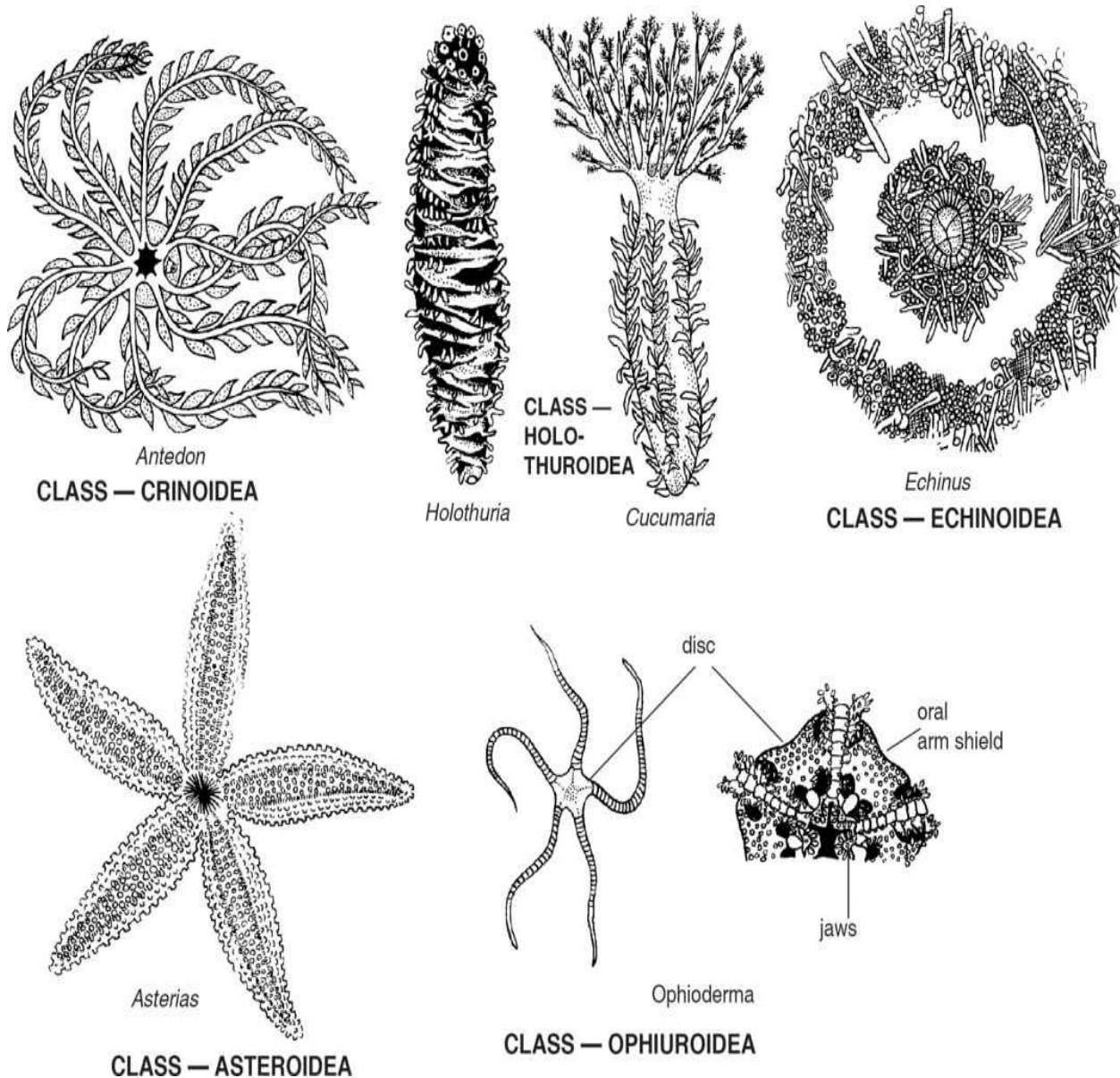


Figure 4.29. Some examples of Echinodermata.

Class 2. Holothuroidea. 1. Worm-like body without arms and spines.

2. Mouth surrounded by tentacles.

Example : *Holothuria*, *Cucumaria* (sea cucumber) ([Fig. 4.29](#)).

Class 3. Echinoidea. 1. Spherical or discoidal body lacking

arms.

2. Body enclosed in an endoskeletal shell or test of closely fitted calcareous plates covered with movable spines.

Examples: *Echinus* (sea urchin) ([Fig. 4.29](#)).

Class 4. Asteroidea. Flattened, pentagonal or star-shaped body with flexible endoskeleton.

Examples: *Pentaceros* (sea pentagon), *Asterias* (star fish or sea star) ([Fig. 4.29](#)).

Class 5. Ophiuroidea. Asteroids-like body is flat and composed of long arms and a central disc.

Examples: *Ophioderma* (brittle star), *Ophiura* (brittle star) ([Fig. 4.29](#)).

Phylum 10. Hemichordata (Gr., *hemi*—half)

1. Body is soft, unsegmented worm-like and bilaterally symmetrical. These animals possess a combination of invertebrate (nonchordate) and chordate characters.

2. Body is divided into proboscis, collar (collarette) and trunk.

3. These animals resemble chordates only in having pharyngeal gill-clefts or gill slits and they lack notochord and true dorsal nerve cord. Gill slits form the respiratory system and connects the pharynx with outside.

4. ‘Buccal diverticulum’, earlier regarded as “notochord” is present in proboscis.

5. No nephridia. Single **glomerulus** connected to blood vessels has a excretory function.

6. Exclusively marine, solitary or colonial, mostly tubicolous and detritus feeders like the earthworms.

Examples: *Balanoglossus* (acorn worm or tongue worm; [Fig. 4.30](#)), *Cephalodiscus* ([Fig. 4.31](#)).

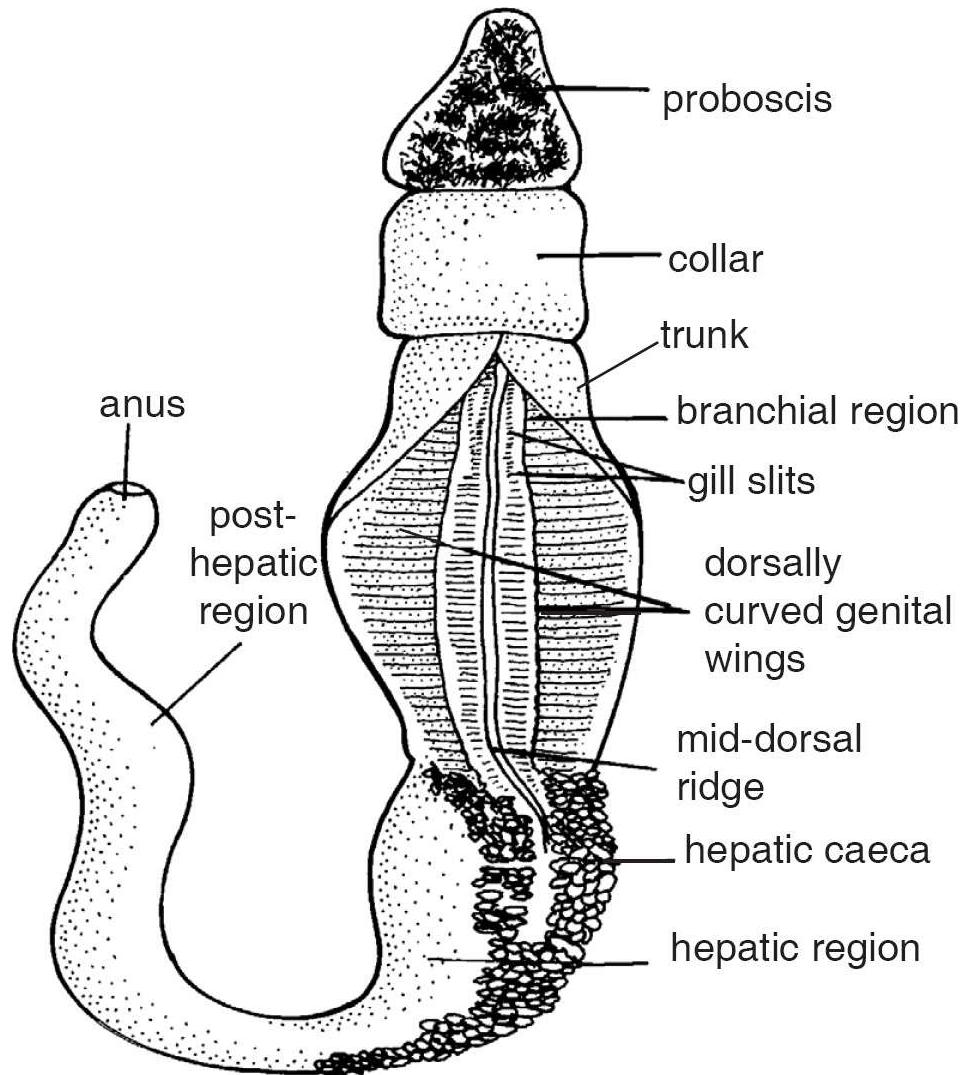


Figure 4.30. *Balanoglossus* (Belongs to Hemichordata; once belonged to Protochordata).

Table 4.14. Differences between non-chordates and chordates

<i>Nonchordates</i>	<i>Chordates</i>
1. Notochord is absent in them	1. Notochord is present in them at some of their developmental stage.
2. Their central nervous system is solid and ventral	2. Their central nervous system is hollow and dorsal.

3. Heart, if present in them, is dorsal in position.	3. Heart is always present and it is ventral in position.
4. Their circulatory system is of open or closed type.	4. Their circulatory system is of closed type.
5. Respiratory pigment, the haemoglobin, if present, is dissolved in plasma of blood.	5. Haemoglobin is present in their red blood cells or corpuscles.
6. Pharyngeal gill slits are absent in them.	6. Pharyngeal gill-slits are present in them.
7. They contain anus at posterior end of body, so post-anal tail is not present.	7. Their anus is not located at posterior tip of body, so contain a post-anal tail.

Phylum 11. Chordata (Gr., *chorda*—string)

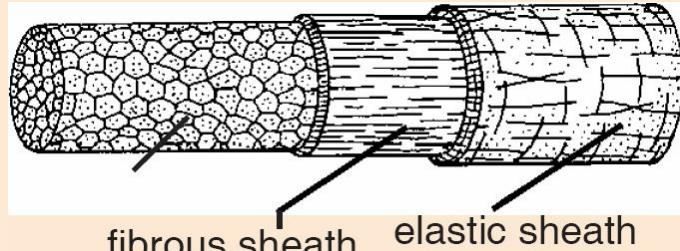
1. Chordates are characterized by the following three features: (a) a dorsal, hollow, tubular nerve cord; (b) a pliable rod called **notochord** that occurs ventral to nerve cord and is replaced by a bone or cartilage to form a vertebral column in vertebrates; and (c) paired gill-slits in the pharynx. These three characters are always present at some stage in development or throughout a life time.

The notochord (Gr. *noton* = back + L. *chorda* = cord) is a long rod-like support structure that runs along the back of an animal and separates the nervous tissue from the gut. It provides a space for muscles to attach for ease of movement.

Box 4.13

Notochord is a primitive type of endoskeleton which is characteristic among all chordates, at some stage of life cycle. The notochord provides longitudinal stiffening of the main body axis, a base for trunk muscles and an axis around which the vertebral column develops. Histologically, cells of the notochord

proper are thick walled, pressed together closely, and filled with semifluid. Stiffness is caused mainly by turgidity of fluid-filled cells and surrounding connective sheaths.



Structure of notochord and its surrounding sheaths.

2. Body bilaterally symmetrically, metamerically segmented, triploblastic and coelomate.

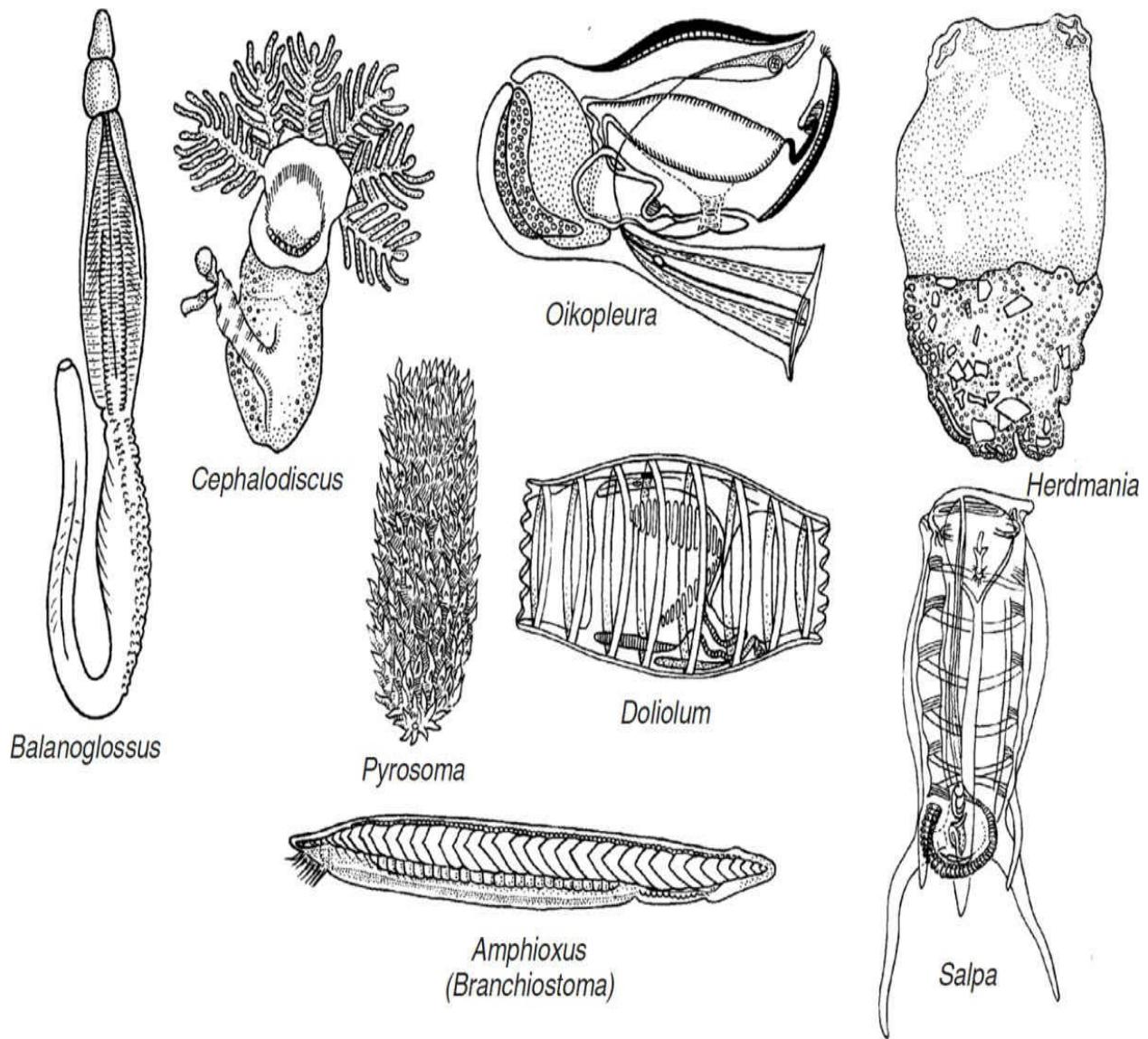


Figure 4.31. Examples of Hemichordata, Urochordata and Cephalochordata.

3. A post-anal tail present at some stage of life.
4. **Segmental muscles** in an unsegmented trunk.
5. **Ventral heart**, with dorsal and ventral blood vessels and closed blood vascular system.
6. Complete digestive system.
7. A cartilaginous or bony **endoskeleton** present in majority of members (Vertebrates).

Chordata is the most advanced group of animals. Phylum Chordata is divided into two groups, viz., Protochordata (Acrania) and Vertebrata (Craniata). Protochordates may not have a proper notochord present during all stages of their lives. Protochordata includes two subphyla, Urochordata and Cephalochordata. Group Vertebrata is divided into two subphyla, viz., Agnatha and Gnathostomata. Agnatha includes a single class Cyclostomata, while Gnathostomata is divided into six classes : Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves and Mammalia. Chondrichthyes and Osteichthyes, both are commonly known as (fishes).

A. Protochordata

Subphylum 1. Urochordata (Gr., *oura*— tail), or **Tunicata**. 1. They are bag-like, sessile, soft-bodied, nonmetameric animals.

2. Adult body is covered with a tunic or test containing cellulose.
3. Notochord is present only in the tail of free-living tadpole-like larva. Sessile adult has no notochord.
4. Dorsal tubular nerve cord is present in the larval form and it degenerates in the form of small ganglion in the adult.
5. The only chordate character present in the adult animal is the presence of numerous gill-slits in the pharynx.
6. Hermaphrodites.
7. Exclusively marine, solitary and colonial.

Examples: *Oikopleura*, *Herdmania*, *Pyrosoma*, *Doliolum*, *Salpa* ([Fig. 4.31](#)).

Subphylum 2. Cephalochordata (Gr., *kephale*— head). 1. Fish-like, metamerically segmented, headless coelomate animals which

retain notochord, dorsal tubular nerve cord and pharyngeal gill-slits throughout life.

2. Notochord and nerve cord (without a distinct brain) extend throughout the entire length of body. Possesses post anal tail.
3. Exoskeleton, head, jaws and paired fins are absent.
4. Pharynx large and perforated by numerous gill-slits.
5. Sexes separate.
6. Marine, burrow in the sand of shallow sea water.

Examples: *Amphioxus* or *Branchiostoma* (lancelet) ([Fig. 4.31](#)).

B. Vertebrata

Subphylum 1. Agnatha (Gr., *a-* without; *gnathos* -jaws).

1. Animals have vertebral column and cranium. They are the most primitive vertebrates known to humans.
2. Without true jaws; but possess a suctorial mouth.
3. Without paired appendages or fins.

Agnatha includes the following single class :

Class Cyclostomata (Gr., *kyklos*—circle, *stoma*—mouth).

1. Body is long, elongated and eel-like.
2. Skin is soft, slimy, smooth and scaleless.
3. Mouth is round, suctorial and without jaws. They are ectoparasites and use their mouth to stick to the back of other fishes.
4. Single and median nostril is present.
5. Respiration is through gills contained in pouches (which are 5 to 15 pairs in hagfishes and 7 pairs in lampreys).

6. Endoskeleton is cartilaginous and the notochord is in the form of cylindrical rod and persists throughout life.
7. Heart is two chambered.
8. Gonad is single and fertilization is external. Development is direct or indirect. *Petromyzon* has ammocoete larva in its life cycle.
9. Aquatic, marine and fresh water.
10. Free-living and ectoparasites of fishes.

Examples: *Petromyzon* (lamprey), *Myxine* (hagfish), *Bdellostoma* (hagfish) ([Fig. 4.32](#)).

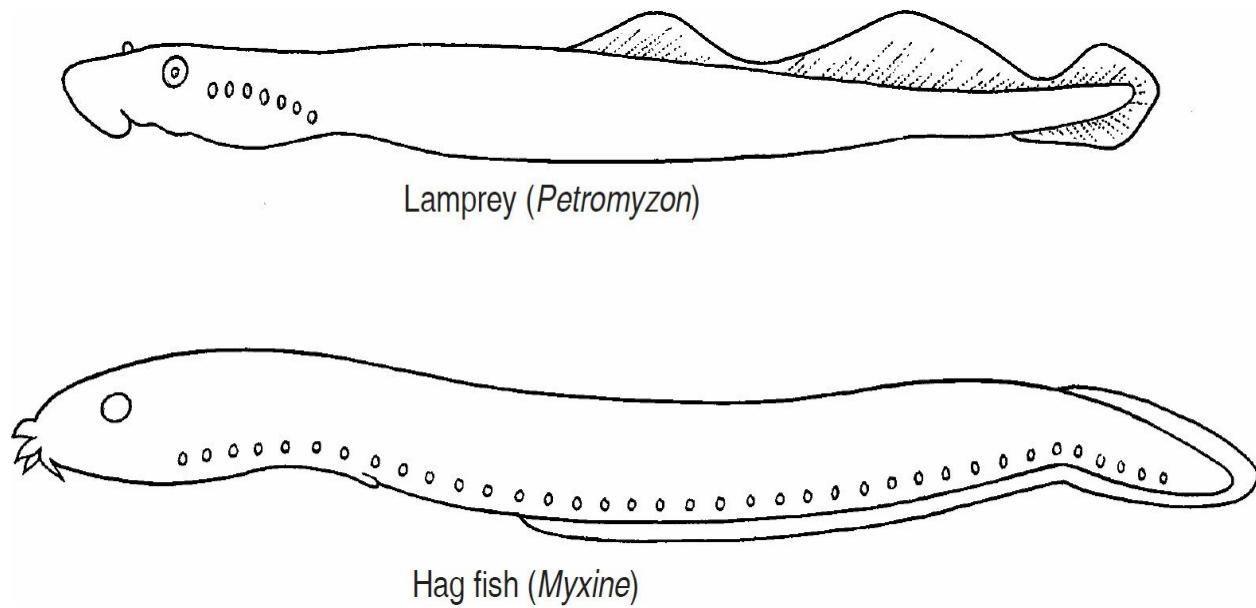


Figure 4.32. Examples of Cyclostomata.

Subphylum 2. Gnathostomata (Gr., *gnathos*— jaws; *stoma*— mouth). 1. Vertebrates with jaws and paired appendages.

2. This subphylum is divided into the following six classes: class Chondrichthyes and class Osteichthyes, (both are combined together to form a superclass, called **Pisces**.)

Class 1. Chondrichthyes (Gr. *chondros* = cartilage + *ichthys* = a fish ; cartilaginous fishes).

1. Marine fishes with completely cartilaginous endoskeleton. They are generally large in size (up to 10 – 20 metres long).
2. Streamlined body is either laterally compressed and spindle-shaped or dorsoventrally flattened and disc shaped.
3. Mouth is ventral in position.
4. Skin is tough and covered with minute **placoid scales**.
5. Respiration through gills. Five or seven pairs of gills open outside by means of gill-slits. The gill-slits are not covered by gill-cover or operculum. Without a swim bladder or lungs.
6. They have **fins** for locomotion (swimming) and balance. Fins may be paired (pectoral fins, pelvic fins) or median (dorsal fin, caudal fin and anal fin).
7. Tail or caudal fin is heterocercal. Muscular tail is used for movement.
8. Heart is two chambered.



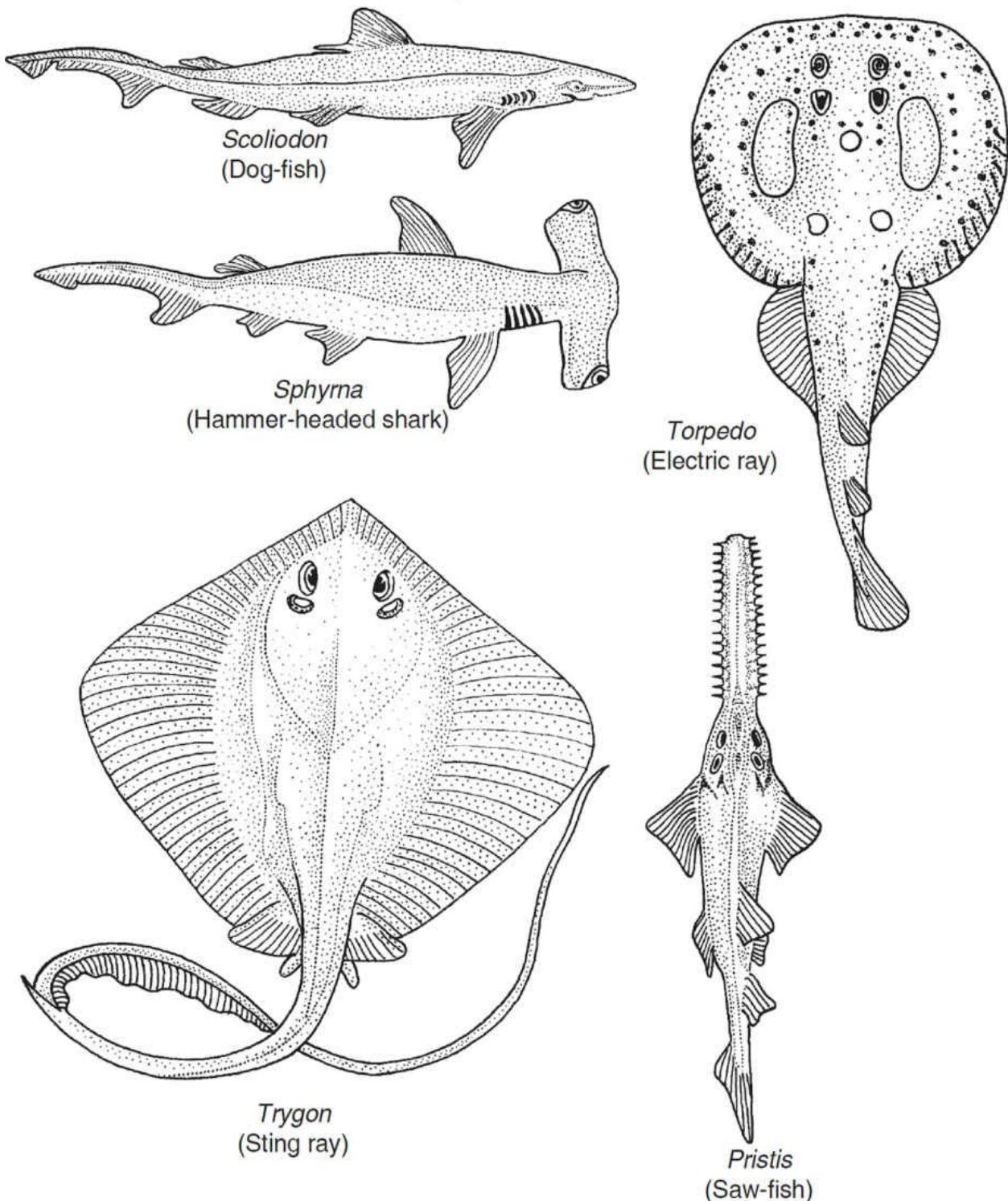


Figure 4.33. Few cartilaginous fishes.

9. Digestive system has a J-shaped stomach (stomach absent in chimaeras) and intestine has **spiral valves**.

10. Sense of smell, vibration reception (lateral line system) and electro reception are well developed.

11. Alimentary canal and urinogenital ducts open into a common aperture, called **cloaca**.

12. Excrete urea (ureotelic animals).

Examples: *Scoliodon* (dog-fish, Indian shark), *Sphyrna* (hammer-headed shark), *Torpedo* (electric ray), *Trygon* (sting ray), *Pristis* (saw-fish), *Chimaera* (rat fish; Hickman *et al.* 1996), ([Fig. 4.33](#)).

Class 2. Osteichthyes (*Gr. Osteon* = bone + *ichthys* = a fish ; Bony fishes). 1. Marine and fresh-water fishes with partly or whole bony endoskeleton.

2. Size varies from 10 mm to 4 metres.

3. Body is generally spindle-shaped.

4. Skin is either naked or covered with **cycloid** or **ctenoid** scales.

5. Mouth is usually terminal (anterior) in position.

6. Four pairs of gills are present and they are covered by operculum. Gills are filamentous. Fish obtain oxygen dissolved in water by using gills.

7. Tail or caudal fin is homocercal.

8. Cloaca is absent. Anus and urinogenital apertures are distinct.

9. Excrete ammonia (ammonotelic animals).

10. Heart is two chambered containing one auricle and one ventricle.

11. They are cold-blooded (ectothermic) animals.

12. They lay eggs and fertilization is external.

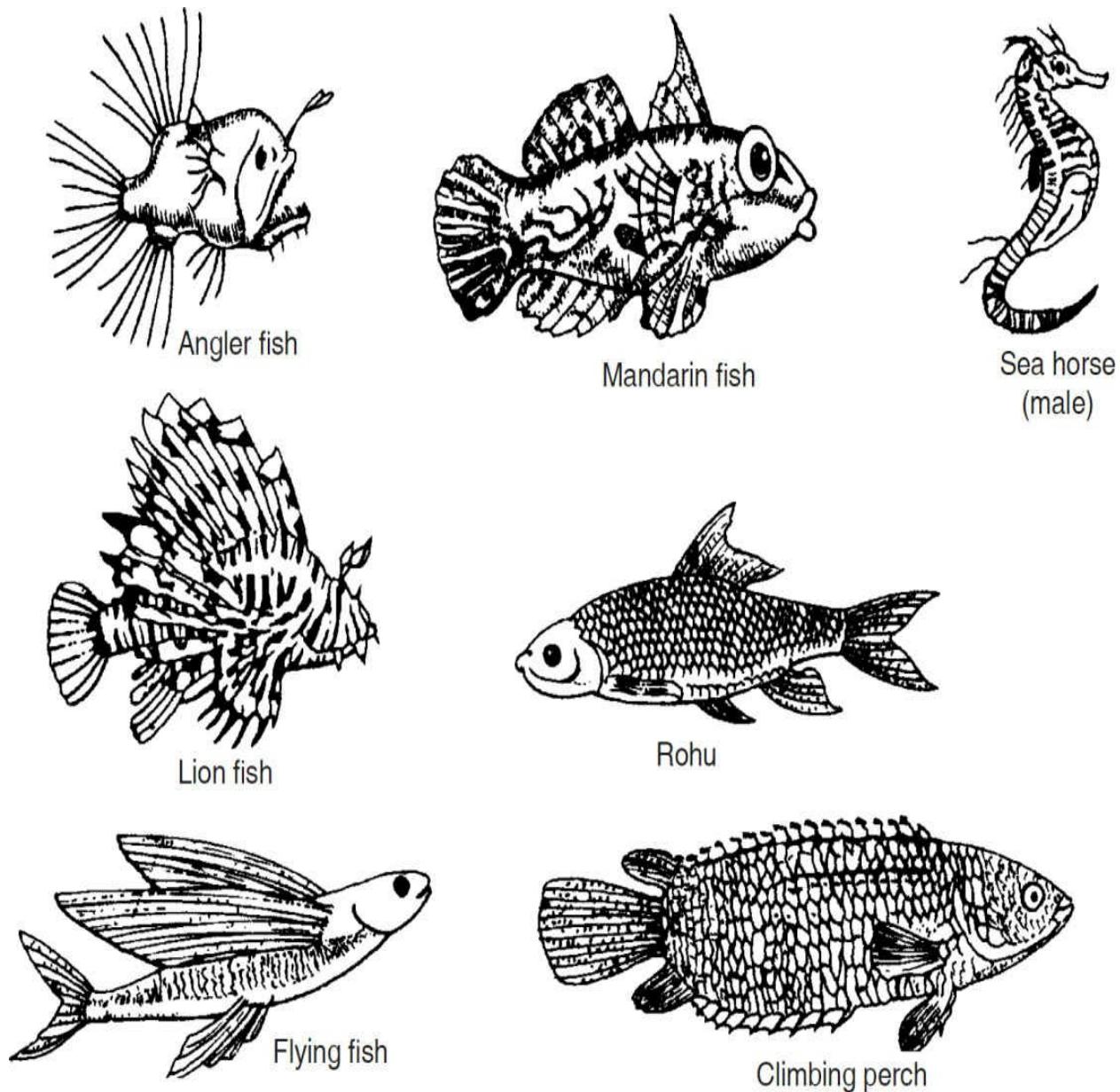


Figure 4.34. Some bony fishes.

Examples: *Labeo* (rohu, carp), *Synchiropus splendidus* (mandarin fish), *Caulophryne jordani* (angler fish), *Pterois volitans* (lion fish), *Hippocampus* (sea horse), *Exocoetus* (flying fish), *Anabas* (climbing perch), *Protopterus* (lung fish) ([Fig. 4.34](#)).

Table 4.15. Differences between bony fishes and cartilaginous fishes.

<i>Bony fishes</i>	<i>Cartilaginous fishes</i>
1. They have a bony endoskeleton.	1. They have a cartilaginous endoskeleton.
2. They contain four pairs of gill slits.	2. They contain 5-7 pairs of gill slits.
3. Their gill slits are covered with an operculum.	3. An operculum is absent in them.
4. Their mouth is terminal in position.	4. Their mouth is ventral in position.
5. Their caudal fin is homocercal.	5. Their caudal fin is heterocercal.
6. Air bladder is usually present in them.	6. Swim bladder is absent in them.
<i>Example.</i> Carp, sea horse, etc.	<i>Example.</i> Indian shark, electric ray, etc.

Class 3. Amphibia (Gr., *amphi*— double; *bios*— life). It includes frogs, toads, newts and salamanders.

1. In evolutionary terms, amphibians form the first group among the chordates to live outside water and comprise of first four-legged (tetrapod) land vertebrates. They live on land but lay their eggs in water. Amphibians are vertebrates that lead two lives.
2. These animals live partly in fresh water and partly on land (moist places).
3. Skin is smooth or rough, moist, slimy, glandular and mostly without scales. Skin has mucus glands.
4. Body has a distinct head and trunk and has no neck. Mouth is usually large.
5. Two pairs of pentadactyl (five digit) limbs are present. Digits or toes are without claws. Limbs may be absent in some cases.
6. Three-chambered heart has two auricles and one ventricle. Double circulation through the heart.
7. Respiration either by gills, lungs, skin or the mouth lining.

8. Excrete either ammonia (tadpole larva) or urea.
9. Oviparous, lay yolk-laden eggs with gelatinous covering usually in water. Fertilization is external in frogs and toads, but internal in salamanders and apoda. Metamorphosis is present.
10. Ectothermal (= cold blooded animals).

Examples: 1. **Apoda:** *Ichthyophis*; 2. **Urodela:** *Amphiuma*, *Salamandra*, *Ambystoma*, *Necturus*; 3. **Anura:** *Rana* (bull frog), *Bufo* (toad), *Hyla* (tree-frog), *Xenopus laevis* (african clawed frog) ([Fig. 4.35](#)).



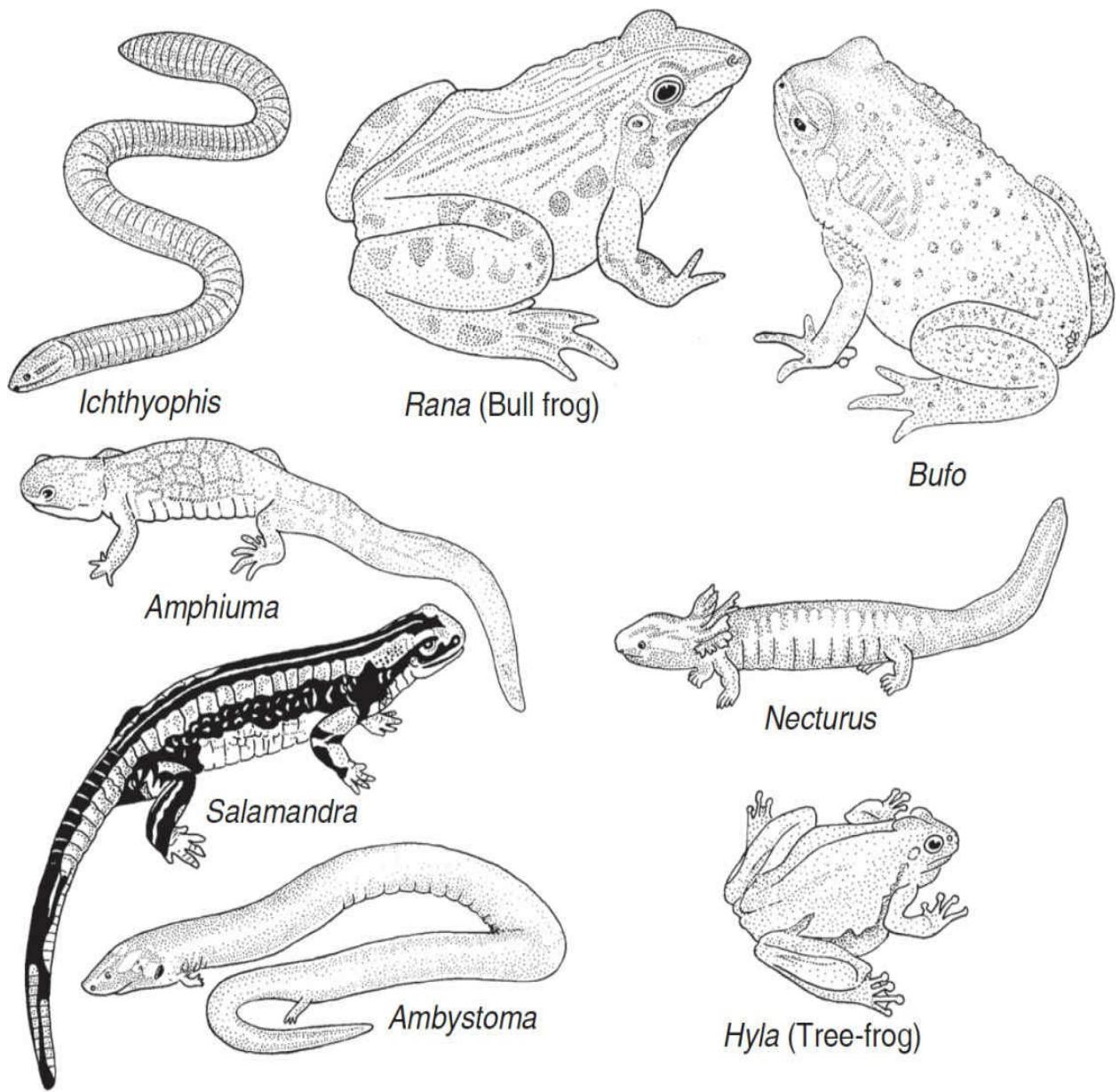


Figure 4.35. Some examples of Amphibia.

Class 4. Reptilia (L., *repre* – to crawl; creeping vertebrates). (Includes lizards, snakes, crocodiles and tortoises.) 1. Ectothermic or cold-blooded, terrestrial or aquatic vertebrates with a body covered with dry water-proof skin having horny epidermal scales or dermal scute plates.

2. Body varies in form and is usually divided into head, neck, trunk and tail.

3. Limbs are tetrapodous pentadacytle (five-toed) type, with clawed digits (limbs are absent in snakes and some lizards).
4. Tympanum is small and depressed.
5. Teeth are present in all reptiles except in tortoises and turtles.
6. Respiration is through lungs only. No gills are present.
7. Heart is three chambered and is divided into two auricles and an incompletely divided ventricle. Only crocodiles have four-chambered heart.
8. Terrestrial reptiles such as snakes and lizards excrete uric acid (uricotelic animals).
9. Fertilization is internal.
10. Most reptiles are oviparous and lay their eggs with tough covering and do not need to lay their eggs in water. A few reptiles are viviparous (e.g., lizards and snakes). No aquatic larval stage.

Examples: *Kachuga* (roofed-terrapin), *Testudo* (land-tortoise), *Chelone* (green turtle), *Uromastix* (sand-lizard). *Hemidactylus* (house wall-lizard), *Calotes* (garden-lizard), *Draco* (flying-lizard), *Chamaeleon*, *Varanus* (Indian monitor), *Python* (ajgar), *Naja* (cobra), *Crocodilus* (muggar), *Gavialis* (gharial) ([Fig. 4.36](#)).

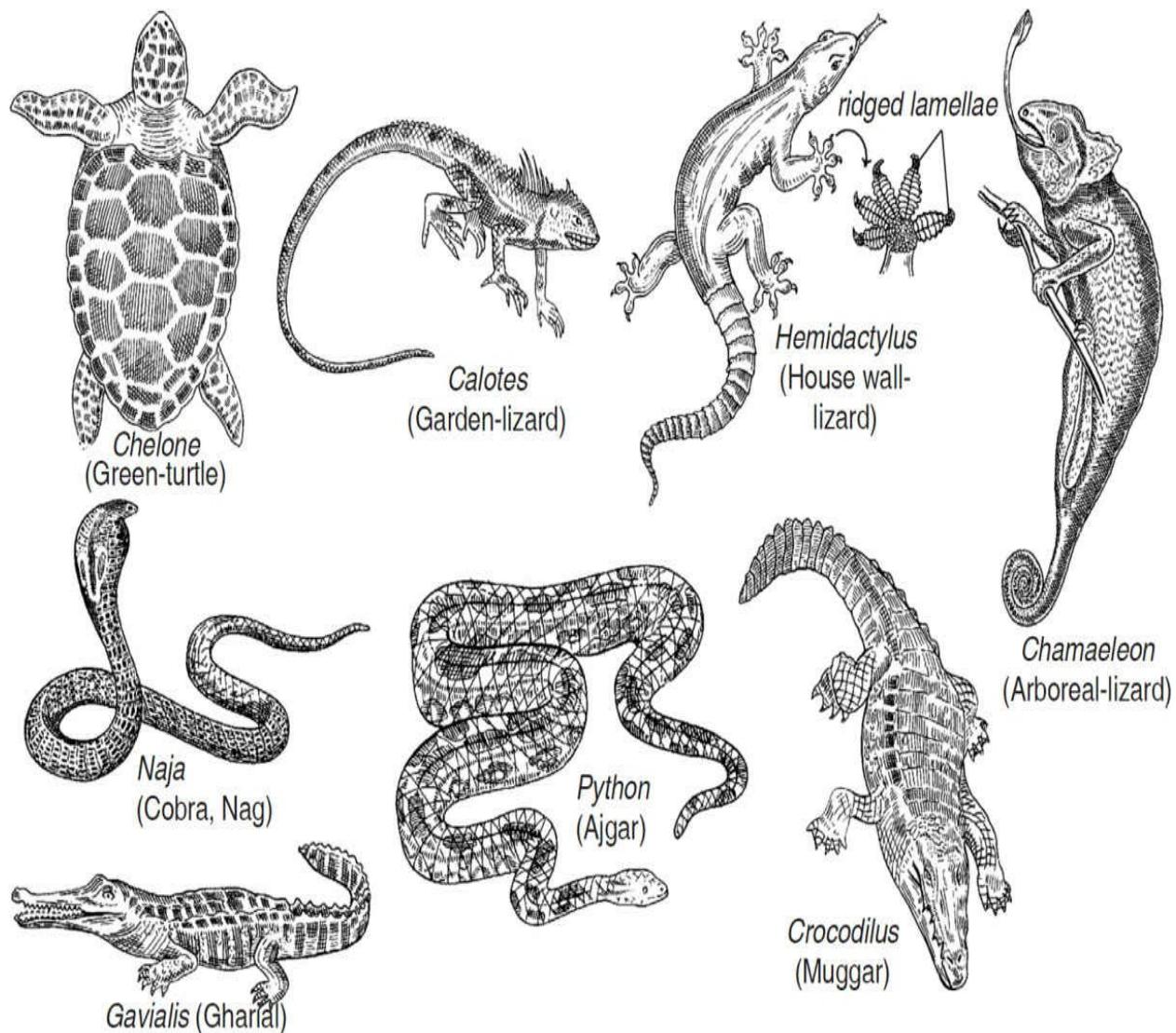


Figure 4.36. Some examples of Reptilia.

Table 4.16. Differences between Amphibia and Reptilia

Amphibia	Reptilia
1. Their skin is glandular, smooth and moist.	1. Their skin is non-glandular, dry and keratinised.
2. Scales are not present in them.	2. Horny scales are present over their body surface.
3. Their digits do not possess claws.	3. Their digits end in claws.
4. They have a three-chambered heart.	4. Their heart is incompletely four chambered.

5. Fertilization is external.	5. Fertilization is internal.
6. Extra-embryonic membranes (e.g. , amnion, allantois and chorion) are absent.	6. Extra-embryonic membranes are present in them.
7. Their eggs have a soft covering.	7. Their eggs have a hard covering or shell.
<i>Example.</i> Frog, toad.	<i>Example.</i> Lizard, snake, tortoise, dinosaurs (extinct).

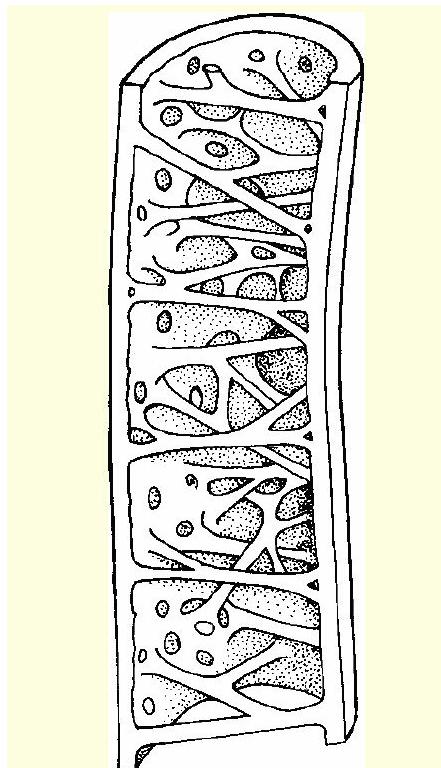


Figure 4.37. Hollow wing bones of a songbird.

- Class 5. Aves** (L., *avis*— bird). 1. Warm-blooded, tetrapodous vertebrates (birds) with various flight adaptations.
2. Size ranges from smallest humming bird to largest ostrich.
 3. Horny scales persist on the feet but **feathers** cover most of the body. Cutaneous glands are absent.
 4. Spindle-or boat-shaped body is divisible into head, neck,

trunk and tail.

5. Fore-limbs modified into wings for flight. Kiwis have vestigial wings.

6. Hind-limbs bear four clawed digits and are adapted for walking, perching, or swimming.

7. Narrow jaws form a horny beak, which is modified for different purpose. Teeth are absent.

8. Bones of endoskeleton are light and spongy due to the presence of air cavities ([Fig. 4.37](#)).

9. They breathe through lungs.

10. Four-chambered heart with two auricles and two ventricles.

11. Cloaca is present.

12. Excrete semisolid urine having uric acid (uricotelic animals). No bladder.

13. Birds have highly developed voice, hearing and vision. They also have specialised sense for nest building and care for the young (parental care).

14. Fertilization is internal. They are oviparous and lay large, yolk-laden eggs having hard shell.

Examples: *Gallus* (chicken), *Passer* (house sparrow), *Corvus* (crow), *Columba* (pigeon), *Psittacula* (parrot), *Pavo* (peafowl, peacock), *Eudynamys* (koel), *Bubo* (owl), *Milvus* (kite), *Gyps* (vulture), *Struthio* (ostrich; [Fig. 4.38](#)), *Coracias* (blue jay or Neelkanth), *Apteryx* (kiwi), *Aptenodytes* (emperor penguin) ([Fig. 4.39](#)).

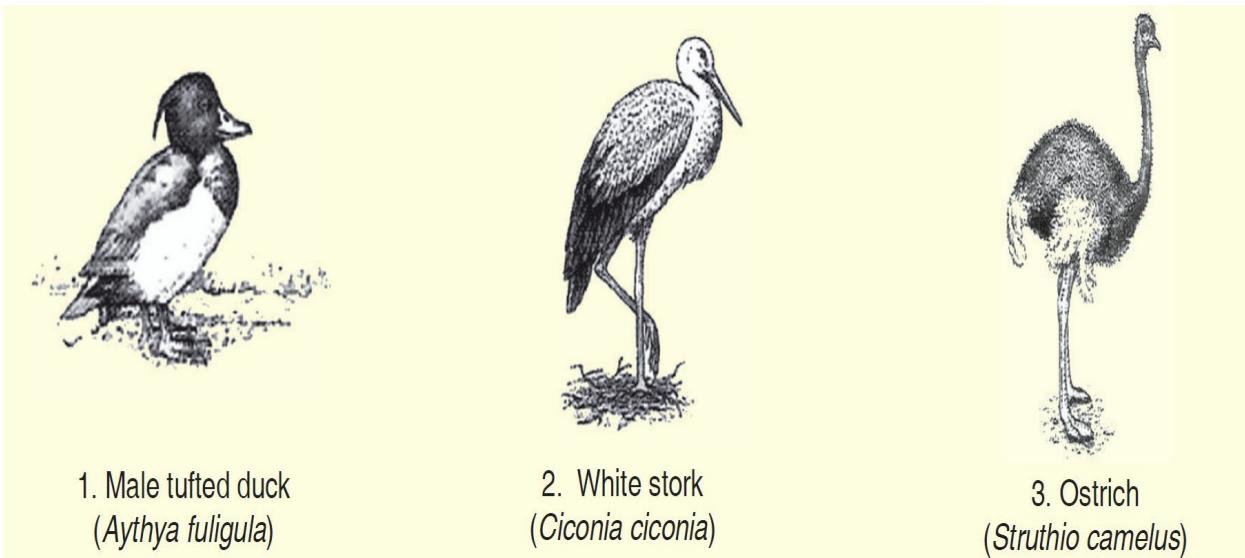


Figure 4.38. Some birds.

Class 6. Mammalia (L., *mamma*— breast). 1. Mammals are warm-blooded (endothermic and homeothermic) and the most evolved animals of Animal Kingdom.

2. **Hairs** and the subcutaneous fat form an insulating layer. Cutaneous glands such as sweat glands, scent glands and sebaceous (oil) glands are present.
3. Body is divisible into head, neck, trunk and tail. Movable eyelids are present.



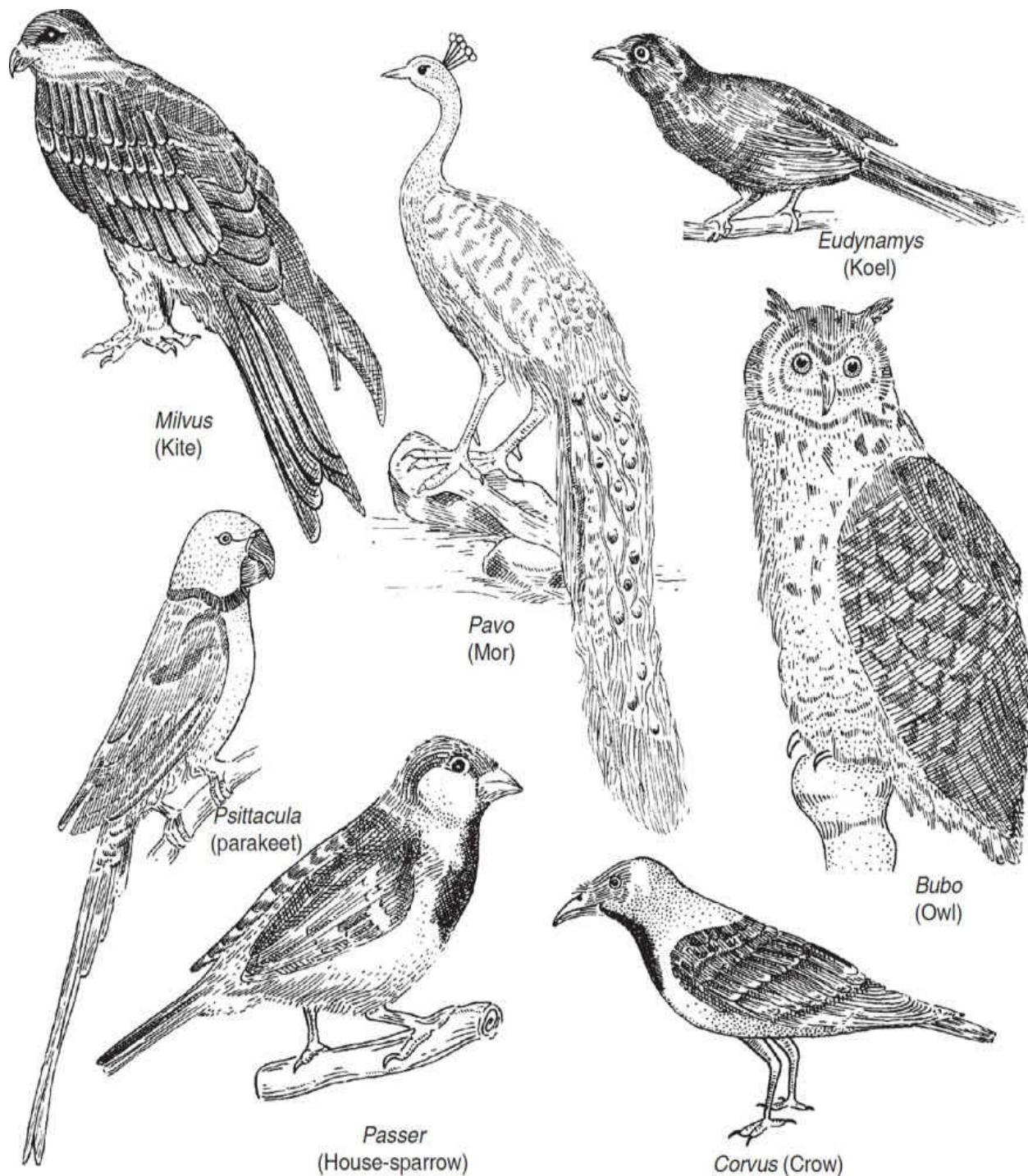


Figure 4.39. Some examples of Aves.

4. Females have milk-producing **mammary glands** which secrete milk for the nourishment of the young.
5. Fleshy external ear (pinnae) present. Middle ear with three

ossicles (malleus, incus and stapes).

6. Teeth are **thecodont** (embedded in sockets in the jaws) and are **heterodont** (differentiated into incisors, canines, premolars and molars).
7. Two pairs of pentadactyl limbs are present. Digits in the fore-limbs and hind-limbs are never more than five and end in claws, nails or hoofs. Limbs are variously adapted for walking, running, climbing, burrowing, swimming or flying.
8. A muscular diaphragm separates thoracic and abdominal cavities.
9. Respiration is through lungs only.

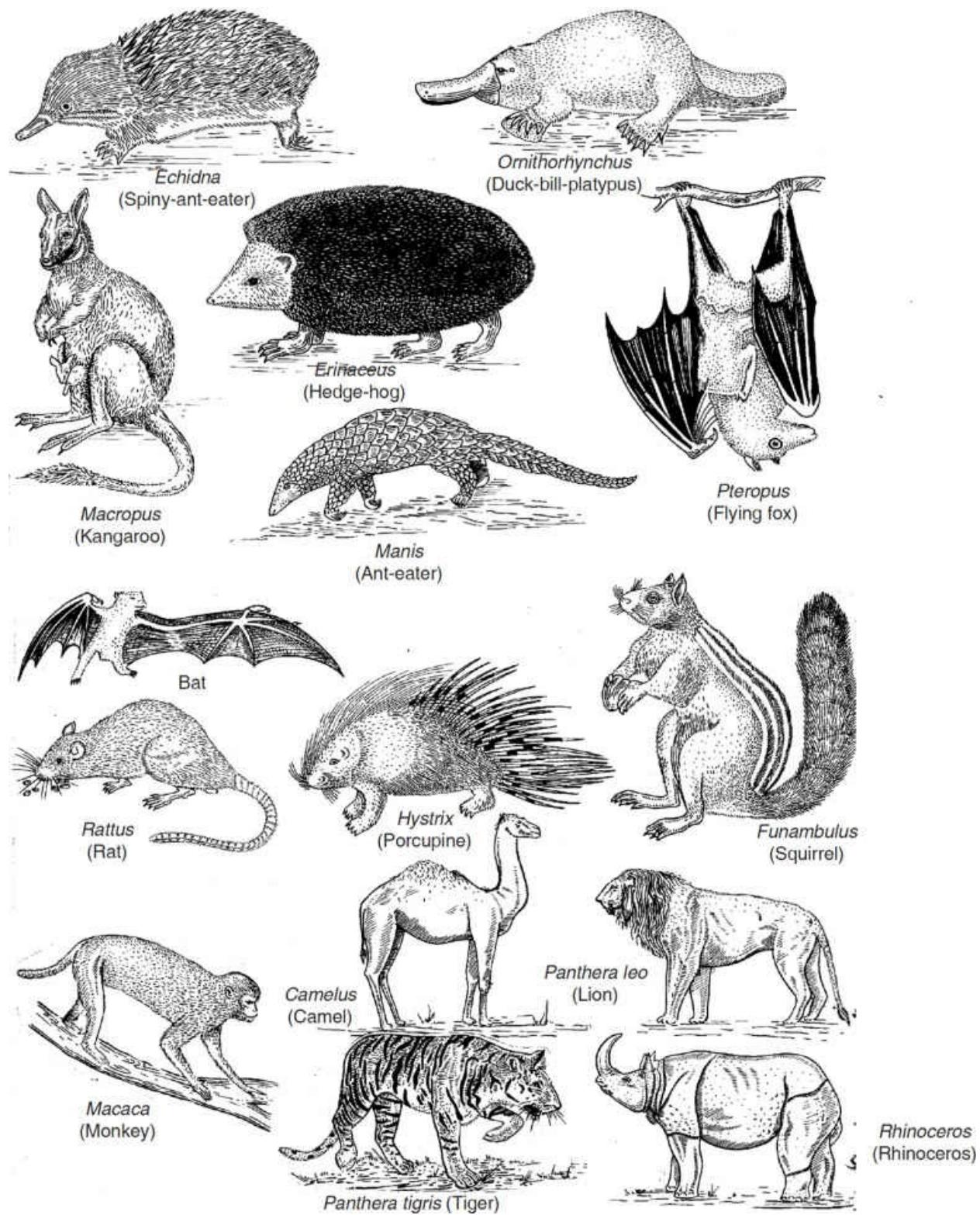


Figure 4.40. Some examples of Mammalia.

Table 4.17. Differences between Aves and Mammalia

<i>Aves</i>	<i>Mammalia</i>
1. Forelimbs are modified into wings.	1. Wings are absent except in bats.
2. The body is covered with feathers and scales.	2. Feathers and scales are absent. Hair are present.
3. Skin is dry only a single preen gland is present.	3. Skin bears a number of sweat and oil glands.
4. Mammary glands are absent.	4. Females have mammary glands for feeding the young.
5. A diaphragm is absent.	5. A muscular partition called diaphragm is present between thorax and abdomen.
6. A toothless beak is present.	6. Jaws do not form beak. Teeth are present.
7. Bones of birds are hollow or pneumatic.	7. Bones of mammals do not possess air cavities.
8. Larynx of birds is non-functional. Instead syrinx is present.	8. Larynx of mammals is functional. Syrinx is absent.
9. Lungs contain external air sacs.	9. External air sacs do not occur in lungs.
10. Eggs possess great amount of yolk. They are called macrolecithal eggs.	10. Eggs have no or tiny amount of yolk, such eggs are called microlecithal eggs.
11. Birds are oviparous.	11. Mammals are viviparous with the exception of prototherians.



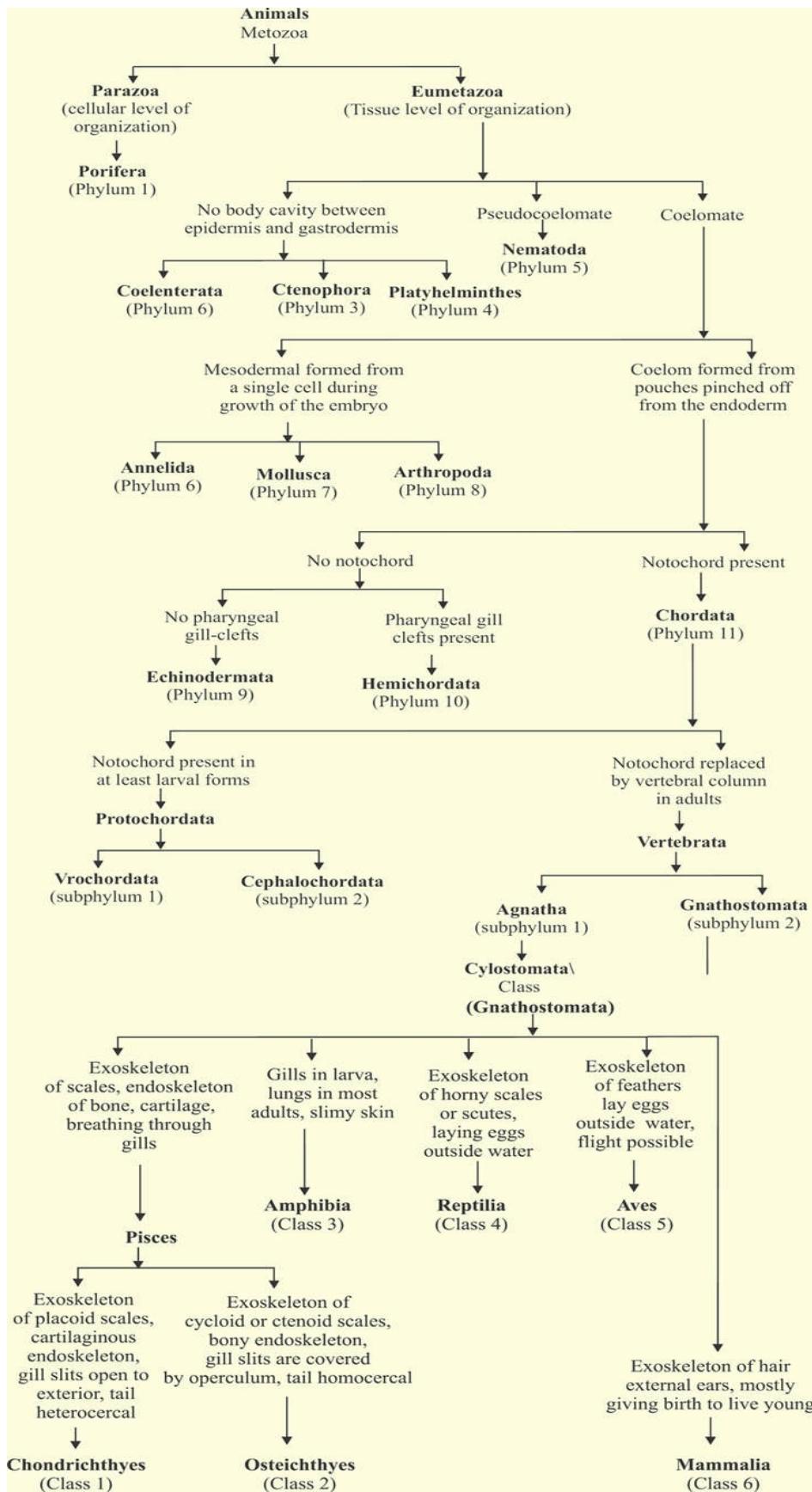


Figure 4.41. Classification of animals.

10. Heart is four-chambered. Nonnucleated biconcave red blood corpuscles are present.
11. Excrete urea (ureotelic animals).
12. Penis is always present. Fertilization is internal.
13. Most mammals familiar to us, produce live young, i.e., they are **viviparous**. In them, the young develops in the uterus of mother for some time, receiving its nourishment and oxygen through placenta and disposing its wastes by way of the maternal circulation. However, a few of them (such as the platypus and the echidna) lay eggs, i.e., they are oviparous. Still some other, such as kangaroos, give birth to very poorly developed youngs.
14. Parental care is highly developed.
15. Mammals live in all kinds of habitats. They are primarily terrestrial animals.

Examples: *Macropus* (kangaroo), *Erinaceus* (hedgehog), *Talpa* (mole), *Sorex* (shrew), *Pteropus* (flying fox), Bat, *Manis* (scaly ant-eater), *Hystrix* (porcupine), *Funambulus* (squirrel), *Rattus* (rat), *Oryctolagus* (rabbit), *Felis* (cat), *Panthera* (lion, tiger, leopard), *Canis* (dog), *Camelus* (camel), *Rhinoceros*, *Elephas* (elephant), *Ursus* (bear), *Balaena* (whale), *Macaca* (monkey), *Homo* (human being) ([Fig. 4.40](#)).

SOME CURIOUS FACTS

- Among all the prevailing organisms in the world, the degree of diversity is more in the animals than in plants.
- In lichens, there exists a ‘*master and slave symbiotic*

relationship' between algae and fungi. This is called **helotism**. Here the partnership is evidently at the expense of the algae.

- *Sphagnum* (peat moss) had been used to replace absorbent cotton for dressing wound in second world war, so it is also called **cotton moss**.
- 75 per cent of the existing animal life is contributed to by insects, (arthropods) including about 6,75,000 species.
- **Sea-wasp** (*Chironex fleckeri*) belong to **Cubozoa** (a new, i.e., fourth class created from class Scyphozoa of phylum Coelenterata). Stings of this cubomedusa are quite dangerous and fatal. This animal exists at sea beaches of tropical Australia.

SUMMARY

- Biological diversity or biodiversity means the variability among living organisms from all sources including terrestrial, aquatic and other ecosystems.
- India is one country with megadiversity among total 12 countries of the planet Earth.
- Classification helps us in exploring the diversity of life forms.
- The binomial nomenclature makes for uniform way of identification of vast diversity of life around us.
- The binomial nomenclature is made up of two words — a generic and a specific name.
- The key characteristics considered for classifying all organisms into *five* major kingdom are :
 1. Whether they are made of prokaryotic or eukaryotic cells;

2. Whether the cells are living singly or organised into multicellular and thus complex organism;
 3. Whether the cells have a cell wall and whether they prepare their own food;
 4. Whether the cells have a cell wall of cellulose and chitin and whether they absorb predigested food (decomposers);
 5. Whether the cells lack cell wall but are heterotrophic (holozoic).
- All living organisms are divided on above bases into five kingdoms, namely, 1. Monera (Prokaryotae); 2. Protista (Protocista); 3. Fungi ; 4. Plantae ; 5. Animalia.
 - The classification of life forms is related to their evolution.
 - Monera are further divided into archaebacteria and eubacteria.
 - Plantae and Animalia are further divided into subdivision (*e.g.*, divisions in plants and phyla in animals) on the basis of increasing complexity of body organization.
 - Plants are divided into *five* divisions : 1. Algae; 2. Bryophyta (liverworts and mosses) ; 3. Pteridophyta (ferns) ; 4. Gymnosperms (pines and cycases) ; and 5. Angiosperms (flowering plants).
 - On the basis of number of cotyledons in the seed, angiosperms are divided into two subgroups : Monocots (wheat, maize, *bajra*) and Dicots (gram, mango and moong).
 - Animals are usually divided into 12 phyla : 1. Porifera (sponges) ; 2. Coelenterata (*Hydra*, corals) ; 3. Ctenophora (comb jellies); 4. Platyhelminthes (liver fluke, tapeworm), 5. Nematoda (*Ascaris*) ; 6. Annelida (earthworm); 7. Arthropoda (prawn, crab, house fly); 8. Mollusca (*Pila*, *Octopus*), 9. Echinodermata (sea star); 10. Hemichordata

(*Balanoglossus*) ; 11. Protochordata (*Herdmania, Amphioxus*) ; 12. Vertebrata (hag fishes, lampreys, dog fish, bony fish, frog, snake, lizards, sparrow, dog, elephant, humans, etc.).

- Vertebrata includes those animals in which notochord is replaced by vertebral column. It is divided into following 7 classes : Cyclostomata (no paired jaws or fins), Chondrichthyes (fishes with cartilaginous endoskeleton), Osteichthyes (fishes with almost bony endoskeleton), Amphibia (scaleless glandular skin), Reptilia (horny scales, oviparous); Aves (feathers) and Mammalia (hair, sweat glands).

FORMATIVE ASSESSMENT

A. CLASS ASSIGNMENT

I. Fill in the Blanks

1. Eumetazonas have proper differentiation into tissues and
2. In Thallophyta sex organs are simple and celled.
3. Tube feet are the organs of echinoderms.
4. Skeleton of sponges is made up of and
5. Skin of reptiles is covered by
6. Scales, feathers and hairs form of vertebrates.
7. Fungi are
8. is a phylum of spiny skinned marine nonchordates.
9. of birds are modified fore limbs.
10. *Ascaris* has a symmetry.
11. has naked seeds.
12. Ferns are example of

II. Matching Type Questions

1. Single Matching

Match the contents of the column I and II

Column I	Column II
1. <i>Cestum</i>	(a) Flightless
2. <i>Amphioxus</i>	(b) Mollusca
3. Sting ray	(c) Osteichthyes
4. Ctenidia	(d) <i>Bufo</i>
5. <i>Anabas</i>	(e) Mammals
6. Toad	(f) Ctenophora
7. Kiwi	(g) Lancelet
8. <i>Hemidactylus</i>	(h) Chondrichthyes
9. Pinnae	(i) House wall lizard

2. Double Matching

Match the contents of column I, II and III

Column I	Column II	Column III
1. Notochord	(a) Urochordata	(i) <i>Hirudinaria</i>
2. <i>Hydra</i>	(b) Fresh water	(ii) Acoelomata
3. Choanocytes	(c) Liver-fluke	(iii) Tail of larva
4. Acorn worm	(d) Hemichordata	(iv) Nematocyst
5. Flame cell	(e) Porifera	(v) Mesohyl
6. Leech	(f) Suckers	(vi) <i>Balanoglossus</i>
7. Flower	(g) Placoid scale	(vii) Prokaryote
8. Nucleoid	(h) Eubacteria	(viii) Shark
9. Ventral mouth	(i) Angiosperm	(ix) Seed in fruit

Key or Check-list Items

Which type of nutrition – autotrophic (A), decomposer (D), detritivore (Dt) and holozoic (H) – occurs in the organisms listed below.

<i>Organisms</i>	<i>Nutrition</i>
1. <i>Pheretima</i>
2. <i>Rhizopus</i>
3. <i>Paramecium</i>
4. <i>Pisum</i>
5. <i>Myxine</i>

Stimulus - Response Items

Match the stimulus with appropriate response

<i>Animals</i>	<i>Acoelomata</i> (A)	<i>Pseudocoelomata</i> (P)	<i>Coelomata</i> (C)
1. <i>Ascaris</i>
2. <i>Fasciola</i>
3. <i>Pavo</i>
4. <i>Homo</i>
5. <i>Sycon</i>
6. <i>Hydra</i>

ANSWERS

Fill in the Blanks

1. organs;
2. single;
3. locomotary;
4. spicules, spongin;
5. scales;
6. exoskeleton
7. Decomposers;
8. Echinodermata;
9. Wings;
10. Bilateral;

11. Gymnosperms;
12. Pteridophytes.

ANSWERS

Matching Type Questions (Single Matching)

1. (f);
2. (g);
3. (h);
4. (b);
5. (c);
6. (d);
7. (a);
8. (i);
9. (e).

ANSWERS

Matching Type Questions (Double Matching)

1. (a) (iii);
2. (b) (iv);
3. (e) (v);
4. (d) (vi);
5. (c) (ii);
6. (b) (i);
7. (i) (ix);
8. (h) (vii);
9. (g) (viii).

ANSWERS

Key or Check-list Items

1. Dt;

2. D;
3. H;
4. A;
5. H.

ANSWERS

Stimulus – Response Items

1. P;
2. A;
3. C;
4. C;
5. A;
6. A.

III. Question - Answer

1. Who coined the term biodiversity ?
2. Why is India called a megadiversity centre ?
3. The task of studying the diversity of living organisms can be made easier and more effective if the various organisms are arranged in an manner.
4. What are common names ? Write down their disadvantages.
5. What is binomial nomenclature ? Give its advantages.
6. Write down conventions and rules of binomial nomenclature.
7. What is the procedure of providing distinct and proper names to organisms ?
8. Local names used for recognising objects are called
9. How is a common name misleading ?
10. Why is scientific name latinised ?
11. Linnaeus proposed what sort of classification of organisms ?
12. Why Darwin is linked with natural system of classification ?
13. Who proposed two-kingdom system of classification ?
14. Which group are included in kingdom Protista?
15. Name that group of organisms which does not fit neatly into any

scheme of classification.

16. Who classified organisms into five kingdoms ?
17. Name structures used in locomotion in protozoa.
18. Name the protozoan which moves by pseudopodia.
19. Explain why mule is not considered as species ?
20. Why are plants and animals so different ?
21. Name the amphibians of plant kingdom.
22. An embryonic stage is absent in which group of plantae ?
23. What is gametophyte ?
24. What is sporophyte ?
25. Name the hair-like structures with which gametophytic plant body of bryophytes is fixed to soil.
26. Which plant group has jacketed sex organs ?
27. Which ones are called seeded plants ?
28. What is nature of vascular bundles in dicot stem ?
29. Vascular bundles are scattered and closed in which group of angiosperms ?
30. Comb jellies belong to which phylum ?
31. Which type of nutrition is found in animals ?
32. Which type of animals occur in Porifera?
33. In which animal phylum does tissue level of organisation occur ?
34. What is the name of the phylum to which round worm belong ?
35. Which triploblastic group of animals lacks a coelom ?
36. Canal system is characteristic of which phylum of kingdom Animalia ?
37. Give an example of a freshwater cnidarian.
38. What is the name of excretory structure of flatworms?
39. Name the annelid which sucks blood from cattle and human beings.
40. Name the largest phylum of Animalia.
41. Which mollusc does produce pearls ?
42. Tube feet occur in which types of animals.
43. What are the organs of locomotion in insects ?
44. *Balanoglossus* is member of which group of animals.
45. To which group does sea horse (*Hippocampus*) belong?
46. Name a reptile which does not possess limbs.

- 47.** How many teeth are present in the beak of a bird ?
- 48.** What is the diaphragm of the mammals ?

IV. Multiple Choice Questions (MCQs)

- 1.** Redwood tree of California reaches a height of
 - (a) 25m
 - (b) 50m
 - (c) 75m
 - (d) 100m
- 2.** Hotspots of biodiversity means
 - (a) areas of the Earth that contain many endemic species
 - (b) species serve as proxy for entire communities in particular areas
 - (c) species in particular niche/area
 - (d) species diversity at particular areas
- 3.** The total number of species, that are known and described, range between
 - (a) 0.5-1.0 million
 - (b) 1.1-1.2 million
 - (c) 1.7-1.8 million
 - (d) 2.5-3.0 million
- 4.** The science of naming organism is called
 - (a) identification
 - (b) nomenclature
 - (c) classification
 - (d) taxonomy
- 5.** The system of nomenclature evolved by Linnaeus is
 - (a) monomial
 - (b) vernacular
 - (c) binomial
 - (d) polynomial
- 6.** Binomial nomenclature consists of two words
 - (a) genus and species
 - (b) order and family
 - (c) family and genus
 - (d) species and variety

- 7.** In binomial name, which is written in capital ?
- (a) first alphabet of generic name
 - (b) all alphabets of generic word
 - (c) first alphabet of specific word
 - (d) all alphabets of specific word
- 8.** *Homo*: generic name :: *Sapines* :
- (a) species name
 - (b) human name
 - (c) division name
 - (d) organism name
- 9.** Who has divided Prokaryota (Monera) into Archaea and Eubacteria ?
- (a) Haeckel
 - (b) Copeland
 - (c) Woese
 - (d) Whittaker
- 10.** The eukaryotic kingdom Protocista was created by
- (a) Whittaker
 - (b) Woese
 - (c) Margulis and Schwartz
 - (d) Haeckel
- 11.** Who proposed the concept of evolution ?
- (a) Aristotle
 - (b) Theophrastus
 - (c) Darwin
 - (d) Linnaeus
- 12.** Phylogeny is study of
- (a) development of an individual
 - (b) evolution of species
 - (c) embryonic development of an organ
 - (d) ecological adaptation of an organisms
- 13.** The science of classification is called
- (a) demography
 - (b) taxonomy
 - (c) biology
 - (d) none of the above

- 14.** Class is a category between
- (a) phylum and order
 - (b) kingdom and phylum
 - (c) order and family
 - (d) family and genes
- 15.** ‘Taxa’ differs from “taxon” due to
- (a) this being a higher taxonomic category than taxon
 - (b) this being the lower taxonomic category than taxon
 - (c) this being the singular of taxon
 - (d) this being the singular of taxon.
- 16.** The basic unit of classification is
- (a) variety
 - (b) species
 - (c) genus
 - (d) family
- 17.** A group of similar freely inter-breeding organisms constitutes a
- (a) species
 - (b) genera
 - (c) family
 - (d) class
- 18.** A group of related genera, with still less number of similarities as compared to the genus and species, constitutes.
- (a) order
 - (b) class
 - (c) family
 - (d) division
- 19.** Genetic material of prokaryotes is called
- (a) nucleoid
 - (b) nucleolus
 - (c) plasmid
 - (d) mesosome
- 20.** The ability of nitrogen fixation is found in
- (a) monerans only
 - (b) both monerans and protistans
 - (c) protistans only
 - (d) fungi only

- 21.** *Amoeba* belongs to kingdom
(a) Monera
(b) Protista
(c) Fungi
(d) Animalia
- 22.** Fungi resemble animals in having
(a) mycelium
(b) chitin
(c) glycogen
(d) both (b) and (c)
- 23.** A plant body not differentiated into root, stem and leaves is termed as
(a) thallus
(b) mycelium
(c) hyphae
(d) herb
- 24.** Chlorophyll containing, autotrophic thallophytes are called
(a) algae
(b) lichens
(c) fungi
(d) bryophytes
- 25.** The compound plants composed of algae and fungi are called
(a) algae
(b) bryophytes
(c) pteridophytes
(d) lichens
- 26.** Which of the following group of plants is called vascular cryptogams ?
(a) thallophyta
(b) bryophyta
(c) pteridophyta
(d) angiospermae
- 27.** Which of the following plant group bears naked seeds ?
(a) Pteridophyta
(b) Bryophyta
(c) Gymnospermae

- (d) Angiospermae
28. Reproductive structure are flowers in
(a) gymnosperms
(b) pteridophytes
(c) angiosperms
(d) both (a) and (b)
29. Phylum mollusca can be distinguished from other nonchordates by the presence of
(a) bilateral symmetry and exoskeleton
(b) a mantle and gills
(c) shell and non-segmented body
(d) a mantle and a non-segmented body
30. The phylum of sedentary animals is
(a) Mollusca
(b) Echinodermata
(c) Porifera
(d) both (a) and (b)
31. Choanocytes are unique to
(a) Protozoa
(b) Porifera
(c) Mollusca
(d) Echinodermata
32. Cnidaria is characterised by
(a) Nematoblasts
(b) Coelenteron
(c) Tissue level of organisation
(d) all the above
33. Tapeworm is member of phylum
(a) Annelida
(b) Porifera
(c) Nematoda
(d) Platyhelminthes
34. Elephantiasis disease of human beings is caused by
(a) *Wuchereria*
(b) *Ascaris*
(c) *Enterobius*

- (d) *Ancylostoma*
35. True coelom appeared for the first time in
(a) Mollusca
(b) Nematoda
(c) Annelida
(d) Arthropoda
36. Arthropods are characterised by
(a) jointed legs
(b) jointed appendages
(c) chitinous exoskeleton
(d) all the above
37. In the *Pila*, the gastropod mollusc, the organ of the locomotion is
(a) mantle
(b) foot
(c) tentacles
(d) legs
38. Starfish belongs to phylum
(a) Mollusca
(b) Coelenterata
(c) Arthropoda
(d) Echinodermata
39. Echinoderms have
(a) water vascular system
(b) canal system
(c) jet propulsion
(d) book lungs
40. Phylum Chordata is named after the occurrence of
(a) notochord
(b) dorsal hollow nerve cord
(b) occurrence of postnatal tail
(d) presence of gill slits
41. In higher chordates, notochord is transformed into
(a) cranium
(b) limbs
(c) vertebral column
(d) both (b) and (c)

- 42.** *Balanoglossus* belongs to Hemichordata which forms a connecting link between
- (a) urochordates and cephalochordates
 - (b) urochordates and vertebrates
 - (c) cephalochordates and vertebrates
 - (d) nonchordates and chordates
- 43.** Lateral line sense organs occur in
- (a) fishes
 - (b) amphibian larva
 - (c) reptiles
 - (d) both (a) and (b)
- 44.** In the lung fishes, the heart is
- (a) single chambered
 - (b) two chambered
 - (b) three chambered
 - (d) four chambered
- 45.** The skin is devoid of scales in
- (a) cartilaginous fish
 - (b) bony fishes
 - (b) reptiles
 - (d) amphibians
- 46.** A very long sticky tongue and ability to change colour occurs in
- (a) garden lizard
 - (b) chameleon
 - (b) python
 - (d) king cobra
- 47.** Duck-billed platypus and echidna are
- (a) reptiles
 - (b) egg-laying mammals
 - (b) marsupial mammals
 - (d) eutherian mammals

ANSWERS

1. d

2. *a*
3. *c*
4. *b*
5. *c*
6. *a*
7. *a*
8. *a*
9. *c*
10. *c*
11. *c*
12. *b*
13. *b*
14. *a*
15. *c*
16. *b*
17. *a*
18. *c*
19. *a*
20. *a*
21. *b*
22. *d*
23. *a*
24. *a*
25. *d*
26. *c*
27. *c*
28. *c*
29. *d*
30. *c*
31. *b*
32. *d*
33. *d*
34. *a*
35. *c*
36. *d*
37. *b*

38. d
39. a
40. a
41. c
42. d
43. d
44. b
45. d
46. b
47. b.

CLASS ASSIGNMENT

V. True or False Questions

1. During classification, species are distinguished, named and grouped into genera based on correlated characteristics.
2. In binomial nomenclature, the name of an organism consists of two words in Latin; the first word denotes specific name and the second name the generic name.
3. The taxonomic term taxon can substitute for any rank in the classification.
4. Order is an assemblage of related classes.
5. *Plasmodium* is a pathogenic human parasite.
6. Monocots have parallel venation in their leaves, while dicots have netted venation.
7. The red and brown algae do not contain any chlorophyll.
8. Bryophytes are amphibians of plant kingdom.
9. Echinoderms are exclusively found in sea water.
10. Cartilaginous fish have gill covers.
11. Blue whale is the largest known fish.
12. Prokaryotes lack true nucleus but possess all other types of organelles.
13. *Paramecium* has cilia for locomotion.
14. Lichen is formed by symbiotic association between an alga and a

- fungus.
- 15. Platypus and Echidna are reptiles that lay eggs.
 - 16. The largest bird is ostrich.
 - 17. Chameleon is an amphibian
 - 18. As mammals have hair, similarly reptiles have scales and feathers.

ANSWERS

True/False, Right/Wrong, Yes/No.

- 1. T;
- 2. F;
- 3. T;
- 4. F;
- 5. T;
- 6. T;
- 7. F;
- 8. T;
- 9. T;
- 10. F;
- 11. F;
- 12. F;
- 13. T;
- 14. T;
- 15. F;
- 16. T;
- 17. F;
- 18. F

CLASS RESPONSE

VI. Oral Questions

- 1. Give one-word Answer
 - 1. Which kingdom do bacteria belong to?

2. Who gave five-kingdom system of classification?
3. Who is known as father of taxonomy?
4. Name the locomotory organs of *Amoeba*?
5. Which division does lichens belong to?
6. Which division do ferns belongs to?
7. Which mode of nutrition is found in algae?
8. What is botanical name of wheat?
9. Which plant group is called 'amphibians' of the plant world?
10. Which sub-kingdom do seedless and fruitless plants belong to?
11. Which type of leaf venation is found in monocotyledonous plants?

VII. Quiz

1. During the course of evolution several species vanished from the surface of the Earth. (True/False)
2. The diversity we see today is the result of 3.5 billion years of organic evolution. (True/False)
3. Every organism whether plant, animal or microorganism is unique in itself. (True/False)
4. Which is written first, generic or specific name.
5. Binomial system of nomenclature was given by (Fill in the blanks).
6. No two organism can have the same combination of genus and spceies (True or False)
7. In which year Robert H. Whittaker proposed five kingdom classification ?
8. Who had divided kingdom Monera into Archaebacteria and Eubacteria ?
9. What is the contribution of Margulis and Schwartz?
10. Name the book of Linnaeus which was released in 1735.
11. In which book Linnaeus first of all described botanical nomenclature ?
12. Define classification.
13. Who had proposed the theory of natural selection?
14. Common characters found in all members of a category higher than species are called ?

15. What is the reserve food of algae.
16. To which division of plantae does belong the deodar trees of Himalayan region ?
17. What is the venation in monocots ?
18. What is common name of *Funaria* ?
19. Name the characters in which seed plants differ from pteridophytes.
20. In which group of plants is the sporophyte parasitic over gametophyte ?
21. In which group of plants seeds are protected by fruits?
22. Why do algae live in well lighted areas ?
23. Give an example of unicellular fungi.
24. What is botanical name of mushroom?
25. Give an example of Gram-negative eubacteria.
26. Whittaker classified organisms into five kingdoms of plantae, animalia, fungi, monera and
27. What is the other name of cyanobacteria ?
28. What is the name of nitrogen fixing bacterium found in the root nodules of legumes ?
29. Name the cyanobacterial cell specialised for nitrogen fixation.
30. What type of nutrition is found in *Euglena* ?
31. Which one is the kingdom of multicellular decomposers ?
32. Which organisms are sensitive to air pollution ?
33. What type of nutrition is found in fungi ?
34. What is peculiarity of bilateral symmetry ?
35. What are triploblastic animals ?
36. What is present between ectoderm and endoderm of diploblastic animals ?
37. Name the germinal layer that exists in between ectoderm and endoderm of triploblastic animals.
38. Animals in which phylum have numerous pores in their body.
39. What is Portuguese-man-of-war ?
40. In which phylum pseudocoelom occurs ?
41. What is metameric segmentation ?
42. Write the scientific name of pearl oyster ?
43. What are locomotory organs of a fish ?

44. Give the generic name of *hag* fish ?
45. What is popular name of *Torpedo* fish ?
46. What is the popular name of *Trygon* fish ?
47. What is use of swim bladder of bony fishes ?
48. To which group does crocodile belong ?
49. What is the characteristic of avian bones ?
50. Give an example of flightless birds ?
51. What is the name of voice box of birds ?
52. What is the major characteristic of mammals ?

VIII. GROUP DISCUSSION

Organise a group discussion of each of the following topics

1. Bryophytes – The amphibians of plant kingdom.
2. Lichens – The symbiotic association of fungus and algae.
3. Merits and demerits of various systems of classification.
4. Discuss the reason of placing a whale and mouse in the same class.
5. Aquatic adaptations of fishes.
6. Aerial adaptations of birds.

IX. SEMINAR / SYMPOSIUM

Organise a Seminar/Symposium on each of the following topics.

1. How classification and evolution are interrelated to each other?
2. Basis of classification of living organisms.
3. Five kingdom classification
4. Need and advantages of nomenclature and scientific names of living organisms.
5. Basis of animal classification

X. GROUP ACTIVITY

Investigatory Projects

1. Record the contributions made by various zoologists and botanists and taxonomists in the field of classification.

2. Study some specimens such as moss, fern, pinus, earthworm, cockroach, frog, lizard, sparrow, etc., in school worm, cockroach, frog, lizard, sparrow, etc., in school lab and study their identifying features related to their class.
3. Make a list of extinct animals of the Animal Kingdom and classify them on the basis of various systems of classification.
4. List some organisms having common features of plants and animals and justify their position in classification.

XI. Experimental Projects

1. Find out scientific names of common plants and animals and classify them on the basis of their form, shape, etc.

XII. Survey

1. To study biodiversity, visit a nearby pond, field, orchard, forest, zoological park or wildlife sanctuary, etc. and collect information and pictures of animals and plants you find there.
2. Collect some fallen parts of plants and animals and classify them on the basis of their form, shape, etc.

NCERT TEXTBOOK QUESTIONS AND EXERCISES WITH ANSWERS

NCERT Textbook Questions

Q.1. Why do we classify organisms?

There is vast number of living organisms in this biosphere and they have a great diversity in shape, size and form. It is practically not

Ans. possible to examine and study each and every organism separately at individual level. It is therefore, advisable to study the diversity of organisms by classify them in a orderly manner.

Q.2. Give three examples of the range of variations that you see in life forms around you.

1. The living organisms vary in size from a few micrometers (e.g., microscopic bacteria) to more than 30 metres long (e.g., blue

Ans. whale) and more than 100 meters tall (e.g., red wood trees of California).

2. The living organisms vary in longevity from a few days (e.g., mosquitoes) to several thousand years e.g. pine trees.
3. The living organisms range from colourless or transparent to brightly coloured birds and flowers.

Where do you think is more basic characteristic for classifying

Q.3. organism?

(a) the place where they live

(b) the kind of cells they are made of, why?

Ans. The more basic characteristic for classifying organisms is – (b) the kind of cells they are made of.

It is erroneous to classify organisms on the basis of the place where they live (such as aquatic, terrestrial, aerial, etc.) because many different kinds of organisms may live in the same habitat but they do not belong to the same group. For example, sponges, corals, whales, octopuses, starfishes, fishes (sharks), etc., live in sea but they differ with each other.

Q.4. What is the primary characteristic on which the first division of organism is made?

Ans. The primary characteristic used for making the broadest division of organism is that whether the organisms are prokaryotic or eukaryotic.

Q.5. On what basis are plants and animals put into different categories?

Ans. Plants and animals are both eukaryotic organisms. Both are put into different groups on the basis of their mode of nutrition as well as their body designs. Plants are autotrophic and perform photosynthesis whereas animals are heterotrophic and get food from the outside. Plant cells have cell wall (of cellulose) whereas animal cells do not have any cell wall.

Q.6. Which organisms are called primitive and how are they different from so-called advanced organisms?

The organisms having characteristics that came into existence earlier are referred to as “primitive” and the organisms having characteristic that have come into existence later on are called,

Ans. ‘advanced’. For example, unicellular prokaryotic bacteria are primitive and multicellular eukaryotic Mammalia are advanced. Likewise, algae are primitive plants and angiosperms are advanced plants. Fishes are primitive vertebrates and birds are advanced vertebrates.

Q.7. Will advanced organisms be the same as complex organisms? Why?

Yes. The complex organisms are comparatively more advanced as compared to simple organisms. It is because the complexity in organisation of organisms has increased over evolutionary time.

Q.8. What is the criterion for classification of organisms as belonging to kingdom Monera or Protista?

The organisms which do not possess well defined nucleus, organelles and multicellular body design are grouped under the kingdom Monera, *e.g.*, Archaebacteria and Bacteria organisms of both groups (= subkingdoms) have prokaryotic organisation. The organisms which are unicellular and eukaryotic are grouped under the kingdom Protista.

Q.9. In which kingdom will you place an organism which is single-called, eukaryotic and photosynthetic?

Ans. Kingdom Protista.

Q.10. In the hierarchy of classification, which grouping will have the smallest number of organisms with a maximum of characteristics in common and which will have the largest number of organisms?

In the hierarchy of classification, **species** will have the smallest number of organisms with a maximum number of characteristics in common and **kingdom** will have the largest number of organisms.

Q.11. Which division among plants has the simplest organisms?

Ans. The organisms belonging to division Algae are the simplest among the plants.

Q.12. How are pteridophytes different from the phanerogams?

Ans. The plants belonging to pteridophytes do not produce seeds whereas those belonging to phanerogams produce seeds.

Q.13. How do gymnosperms and angiosperms differ from each other?

The gymnosperms have naked seeds (*i.e.*, seeds are not enclosed

Ans. within the fruits) whereas the angiosperms have seeds inside the fruits.

Q.14. How do poriferan animals differ from coelenterate animals?

Ans. Porifers differ from Coelenterata in following characters:

<i>Porifera</i>	<i>Coelenterata</i>
<ol style="list-style-type: none"> 1. Cellular level of organisation. 2. Have a canal system. 3. Digestion by choanocytes. 4. Do not have nematocysts. 5. Do not exhibit the phenomenon polymorphism. 	<ol style="list-style-type: none"> 1. Tissue level of organization. 2. Do not have a canal system. 3. Choanocytes are absent. 4. Have nematocysts. 5. Exhibit the phenomenon of polymorphism.

Q.15. How do annelid animals differ from arthropod animals?

Ans. Annelid animals differ from Arthropod animals in following respects:

<i>Annelida</i>	<i>Arthropoda</i>
<ol style="list-style-type: none"> 1. Animals are metamerically segmented both externally as well as internally. 2. Exoskeleton absent 3. Appendages are not jointed. 4. Excretion by nephridia. 	<ol style="list-style-type: none"> 1. Animals are segmented both internally as well as externally. 2. Exoskeleton present. 3. Appendages are jointed. 4. Nephridia are absent. Excretion by coelomoducts, Malpighian tubules or green glands.

Q.16. What are the differences between amphibians and reptiles?

Ans. Amphibians differ from reptiles in the following respects:

<i>Amphibia</i>	<i>Reptilia</i>
<ol style="list-style-type: none"> 1. Skin is moist and slimy. 2. Lay eggs inside the water. 3. Their larvae have gills. 	<ol style="list-style-type: none"> 1. Skin is dry and covered by scales of scute plates. 2 Lay eggs outside the water. 3. No larva is produced.

Q.17. What are the differences between animals belonging the Aves group and those in the Mammalia group.

Ans. Aves includes the birds which have the following differences with mammals.

<i>Aves</i>	<i>Mammalia</i>
1. They are oviparous, <i>i.e.</i> , lay eggs. 2. Do not have mammary glands. 3. Their bodies are covered with feathers. 4. Cutaneous glands are absents. 5. Teeth are absent. 6. Diaphragm is absent.	1. Most of them are viviparous, <i>i.e.</i> , lay young babies. 2. Have mammary glands for the production of milk to nourish their young. 3. Their bodies are covered with hairs. 4. Cutaneous glands such as sweat glands, scent glands and sebaceous (oil) glands are present in skin. 5. Teeth are present. 6. A muscular diaphragm separates thoracic and abdominal cavities.

NCERT Exercises

Q.1. What are the advantages of classifying organisms?

Ans. The classification of organisms have the following advantages:

1. Classification of organisms according to a definite plan facilitates their identification and makes their study convenient.
2. There is a vast number of organisms in this world. It is not possible by the individual human being to know about all individuals. Thus, the study of a few representatives from each group gives a broad idea of the life as a whole.
3. Classification gives information about the organisms which do not occur in one's locality.
4. Classification reveals evolution trends by showing gradually increasing complexity of structure in various groups of organisms.

Q.2. How would you choose between two characteristics to be used for developing a hierarchy in classification?

Before developing a hierarchy in classification, we need to decide which characteristics should be used as the basis for making the broadest divisions. Then we should pick up next set of characteristics for making subgroups. This process must continue and each time new characteristics should be used. The **Ans.** characteristics that decide the broadest divisions among living organisms should be independent of any other characteristics. For example, nature of cell and form of the body is considered to classify organisms into broad divisions (*e.g.*, Prokaryotes and Eukaryotes). The characteristics of the next level should be dependent on the previous one that will decide the subsequent divisions of the groups.

Q.3. Explain the basis for groupings into five kingdoms.

Whittaker (1959) has based his scheme of classification of living **Ans.** organisms into five kingdoms (namely Monera, Protista, Fungi, Plantae and Animalia) on following four bases :

1. Complexity of cell structure. There are two broad categories of cell structure: Prokaryotic and Eukaryotic. Thus, two broad groups can be formed — one having prokaryotic cell structure and the other having eukaryotic cell structure. Presence or absence of cell wall is another important characteristic.

2. Unicellular and multicellular organisms. This characteristic makes a very basic distinction in the body designs of organisms and helps in their broad categorizations.

3. Mode of nutrition. Organisms basically have two types of nutritions — autotrophic (they can manufacture their own food) and heterotrophic (they obtain their food from external environment, *i.e.*, from other organisms). Thus, organisms can be broadly classified into different groups on the basis of their mode of nutrition.

4. Phylogenetic relationship. Phylogeny is the evolutionary history or ancestry of an organism. It is believed that the simple organisms are primitive and complex organisms are advanced. Thus, primitive and advance nature of organisms also helps in their classification into broad groups. For example, the Monera are believed to have given rise to Protista, from which the remaining three kingdom of multicellular organisms have evolved.

Q.4. What are the major divisions in the Plantae? What is the basis of this division?

Kingdom Plantae includes the following five divisions: 1. Thallophyta (Algae); 2. Bryophyta; 3. Pteridophyta; 4. Gymnospermae; 5. Angiospermae.

The first level of classification of plants is based on the presence and absence of well - differentiated distinct components in the body. Algae are separated from rest of the plants in having simple and less differentiated thalloid plant body. The next level of classification is based on the presence and absence of vascular tissues (*i.e.*, xylem and phloem). This character separates the bryophyta from the rest of the plants. Further classification is based on the ability to bear seeds. Pteridophytes do not bear seeds. Finally, the groups are formed on the basis of seeds naked or enclosed within fruits. The gymnosperms have naked seeds whereas Angiosperms bear seeds enclosed within the fruits.

Q.5. How are the criteria for deciding divisions in plants different from the criteria for deciding the subgroups among animals ?

The criteria (norms) for deciding divisions in plants are different from the criteria for deciding the subgroups among animals because the basic designs of their body is different. This is mainly due to the fact that plants are autotrophic and often remain fixed to substratum, while animals are heterotrophic and they can move. Thus, the body design of the two groups is based on the need to make their own food in case of plants and to acquire it from external source in case of animals. The other characteristics such as presence or absence of skeleton, etc., are used to make subgroups among animals.

Q.6. Explain how animals in Vertebrata are classified into further subgroups ?

The major characteristics used to classify animals in Vertebrata are : 1. The kind of exoskeleton or endoskeleton. 2. The kind of respiratory organs. 3. The method of reproduction and giving birth to young ones. On the basis of above mentioned characters the vertebrata is divided into following classes.

1. Exoskeleton of scales : Endoskeleton of cartilage or bones ; breathing through gills – **Pisces** (fishes).
2. Breathing through gills only in larva ; skin slimy – **Amphibia**.
3. Exoskeleton of scales or scutes ; laying eggs outside the water

– **Reptilia.**

4. Exoskeleton of feathers; lays eggs ; flight possible – **Aves** (birds).
5. Exoskeleton of hair ; external ears, ; give birth to young ones – **Mammalia.**

Questions Based on NCERT Question Bank (Exemplar Problems in Science)

Q.1. Write (T) or False (F)

- (a) Whittaker proposed five kingdom classification.
- (b) All prokaryotes are classified under Monera.
- (c) Starting from class, species comes before genus.
- (d) Monera is divided into Archaebacteria and Eubacteria.
- (e) *Anabaena* belongs to kingdom Monera.
- (f) Blue-green algae belong to kingdom protista.

- Ans.** (a) T;
(b) T;
(c) F;
(d) T;
(e) T;
(f) F.

Q.2. Fill in Blanks:

- (a) has smallest number of organisms with maximum number of similar characters.
- (b) Fungi show mode of nutrition.
- (c) Cell wall of fungi is made up of
- (d) Chemical nature of chitin is
- (e) are called amphibians of plant kingdom.
- (f) Association between blue-green algae and fungi is called as

- Ans.** (a) Species;
(b) Saprophytic;
(c) Chitin;

- (d) Carbohydrate;
- (e) Bryophyta;
- (f) Lichen.

Q.3. You are provided with seeds of Gram, Wheat, Rice, Pumpkin, Maize and Pea. Classify them whether they are monocot or dicot.

Ans. Dicot seeds, e.g., Gram, Pumpkin, Pea Monocot seeds, e.g., Wheat, Rice, Maize.

Q.4. Match the items of Column A with items of Column B

<i>Column A</i>	<i>Column B</i>
(a) <i>Marsilea</i>	(i) Angiosperms
(b) <i>Penicillium</i>	(ii) Gymnosperms
(c) Flagella	(iii) Pteridophyta
(d) Naked seed	(iv) Bryophyta
(e) Covered seed	(v) Thallophyta
(f) <i>Cladophora</i>	(vi) Fungi
(g) <i>Marchantia</i>	(vii) <i>Euglena</i>

- Ans.** (a) (iii);
 (b) (vi);
 (c) (vii);
 (d) (ii);
 (e) (i);
 (f) (v);
 (g) (iv).

Q.5. Match the articles of Column A with those of Column B

<i>Column A</i>	<i>Column B</i>
(a) Jointed legs	(i) Mollusca
(b) Soft bodied animals	(ii) Echinodermata
(c) Diploblastic	(iii) Arthropoda
(d) Spiny skinned animals	(iv) Coelenterata
(e) Pore bearing animals	(v) Annelida
(f) Metamerism	(vi) Porifera

- Ans.** (a) (iii);
(b) (i);
(c) (iv);
(d) (ii);
(e) (vi);
(f) (v).

Q.6. **Classify the following organisms based on absence or presence of true coelom as acelomate, pseudocoelomate, and coelomate:** *Spongilla*, *Sea anemone*, *Planaria*, *Liver fluke*, *Wuchereria*, *Ascaris*, *Nereis*, *Earthworm*, *Scorpion*, *Birds*, *Fishes* and *Horse*.

Ans. 1. **Acelomata.** *Spongilla*, *Sea anemone*, *Planaria*, *Liver fluke*.

2. **Pseudocoelomata.** *Wuchereria*, *Ascaris*.

3. **Coelomata.** *Nereis*, *Earthworm*, *Scorpion*, *Birds*, *Fishes*, *Horse*.

Q.7. **Endoskeleton of fishes are made up of cartilage and bone. Classify the following fishes as cartilaginous or bony :** *Torpedo*, *Sting ray*, *Dog fish*, *Rohu*, *Angler fish*, *Exocoetus*.

Ans. (i) **Cartilaginous endoskeleton, e.g.,** *Torpedo*, *Sting ray*, *Dog fish*.
(ii) **Bony endoskeleton, e.g.,** *Rohu*, *Angler fish*, *Exocoetus*.

Q.8. **Classify the following based on number of chambers in their heart:** *Rohu*, *Scoliodon*, *Frog*, *Salamander*, *Flying lizard*, *King cobra*, *Crocodile*, *Ostrich*, *Pigeon*, *Bat*, *Whale*.

Ans. 1. **Two-chambered heart, e.g.,** *Rohu*, *Scoliodon*.

2. **Three-chambered heart, e.g.,** *Frog*, *Salamander*, *Flying lizard*, *King cobra*.

3. **Four-chambered heart, e.g.,** *Crocodile*, *Ostrich*, *Pigeon*, *Bat*, *Whale*.

Q.9. **Classify Rohu, Scoliodon, Flying lizard, King cobra, Frog, Salamander, Ostrich, Pigeon, Bat, Crocodile and Whale into cold blooded and warm blooded animals.**

Ans. 1. **Cold Blooded Animals.** *Rohu*, *Scoliodon*, *Frog*, *Salamander*, *Flying lizard*, *King cobra*, *Crocodile*.

2. **Warm Blooded Animals.** *Ostrich*, *Pigeon*, *Bat*, *Whale*.

Q.10. **Name two egg laying mammals.**

Ans. (i) *Duck-Bill Platypus*; (ii) *Echidna*.

Q.11. **Fill in the Blanks**

- (a) Five kingdom classification of living organisms is given by
- (b) Basic smallest unit of classification is
- (c) Prokaryotes are grouped in kingdom
- (d) *Paramecium* is a protistan because of its
- (e) Fungi do not contain
- (f) A fungus can be seen without microscope.
- (g) Common fungus used in preparing the bread is
- (h) Algae and fungi form symbiotic association called

Ans. (a) Whittaker;

- (b) Species;

- (c) Monera;

- (d) Unicellular eukaryotic nature;

- (e) Chloroplasts;

- (f) Mushroom;

- (g) Yeast;

- (h) Lichen.

Q.12. Give True (T) and False (F):

- (a) *Funaria* is a moss.

- (b) Bryophytes have conducting tissue.

- (c) Non-flowering plants are called cryptogamae.

- (d) Compound leaves are found in many ferns.

- (e) Seeds contain embryo.

- (f) Gymnosperms differ from angiosperms in having covered seeds

Ans. (a) T;

- (b) F;

- (c) T;

- (d) T;

- (e) T;

- (f) F.

Q.13. Give examples for the following :

- (a) are known to have pseudocoelom.

- (b) Worm causing elephantiasis is

- (c) Bilateral, dorsiventral symmetry is found in

(d) Open circulatory system is found in

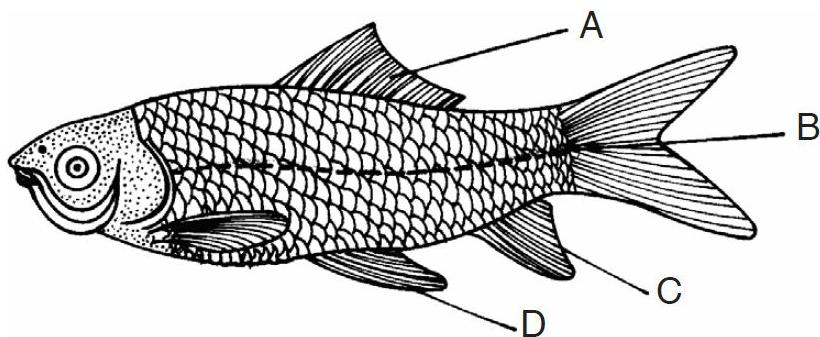
Ans. (a) nematodes or roundworms;

(b) *Wuchereria* or Filaria;

(c) Liver fluke / Frog/Lizard;

(d) Arthropoda.

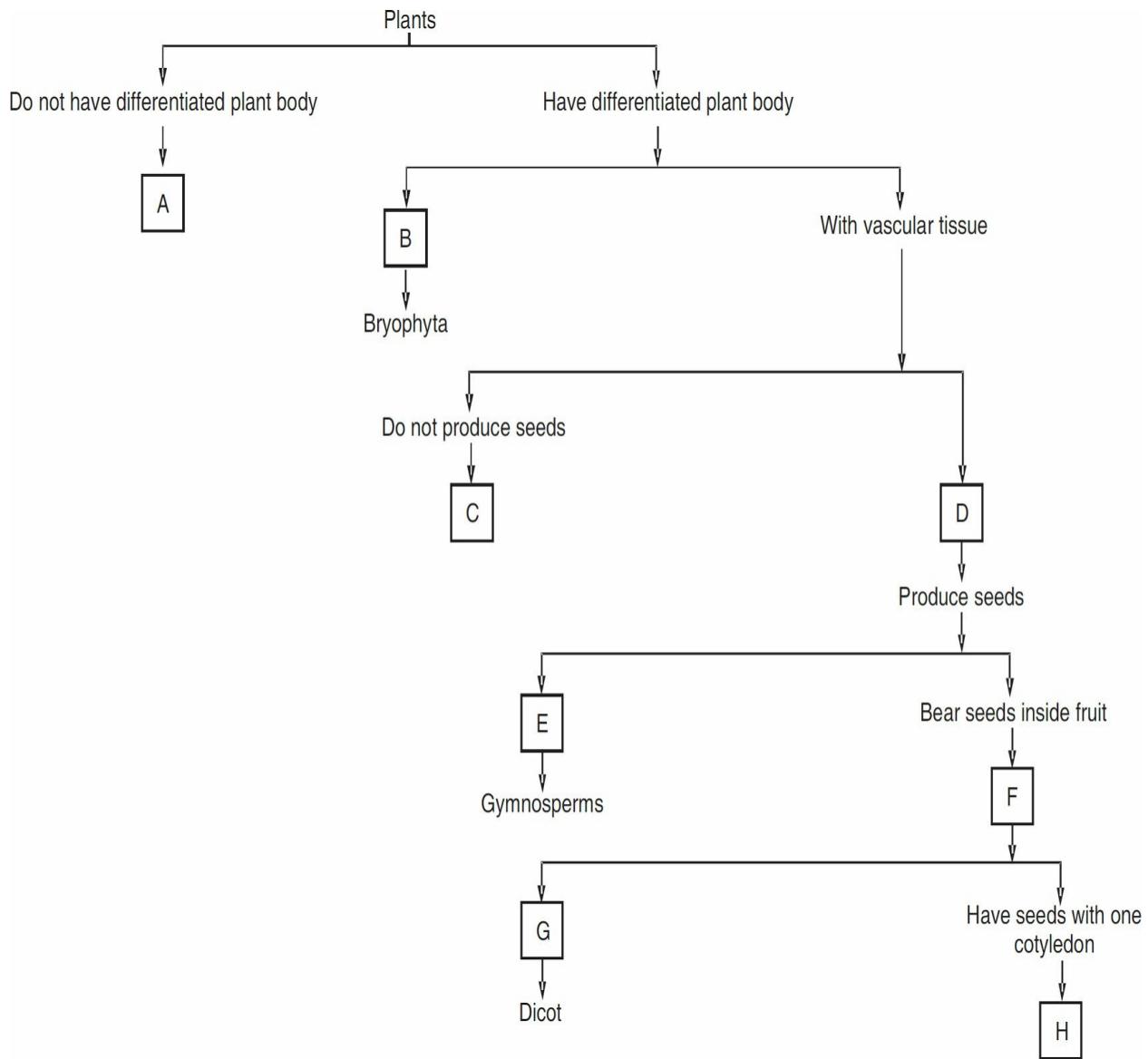
Q.14. Label A, B, C, and D in the given figure. Give the function of B.



Ans. 1. A-Dorsal fin; B-Caudal fin; C-Anal fin or Ventral fin, D-Pelvic fin.

2. Caudal fins of the bony fishes are chief locomotory organs and are used in swimming. Muscular tail of fish provides main propulsive force.

Q.15. Fill the boxes with appropriate characteristics/plant groups.



A-Thallophyta; B-Without specialised vascular tissue (non vascular); C-

Ans. Pteridophyta; D-Phanerogamae E-Bear naked seeds; F-Angiosperms; G-Have seeds with two cotyledons; H-Monocots.

Q.16. Write name of a few thallophytes. Draw a labelled diagram of *Spirogyra*.

Ans. Algae such as blue green algae and *Ulothrix*, *Spirogyra*, *Fucus*; fungi; bacteria; lichens.

Thallophyta, Bryophyta and Pteridophyta are called “cryptogams”.

Q.17. Gymnosperms and angiosperms are called “Phanerogams”. Discuss why? Draw one example of gymnosperm.

(a) Thallophyta, Bryophyta and Pteridophyta are called **cryptogams**

Ans. because they are seedless and possess inconspicuous or hidden

reproductive organs. They reproduce by the spores.

(b) Gymnosperms and angiosperms are called **phanerogams** as they have conspicuous reproductive organs with seeds containing an embryo and reserve food.

(c) Draw Figure of *Cycas* or *Pinus*.

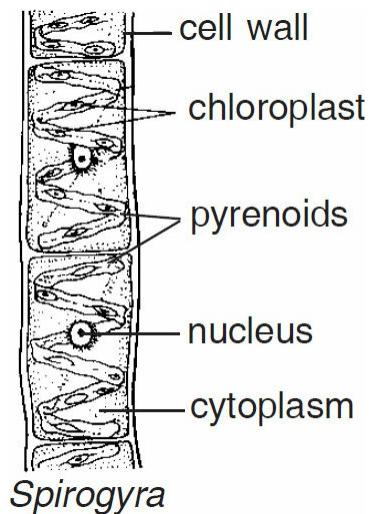
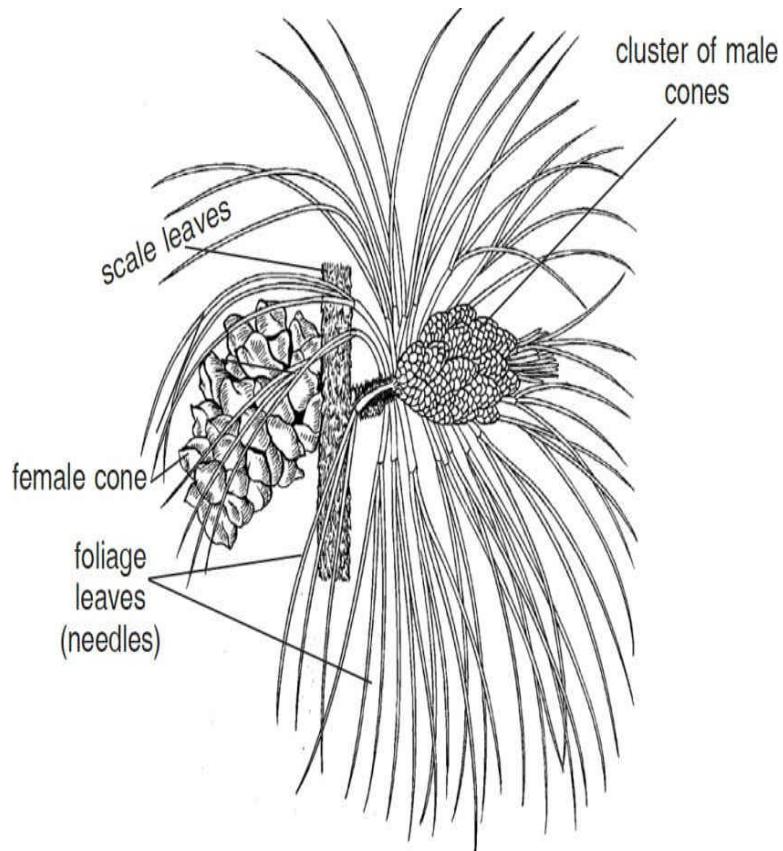
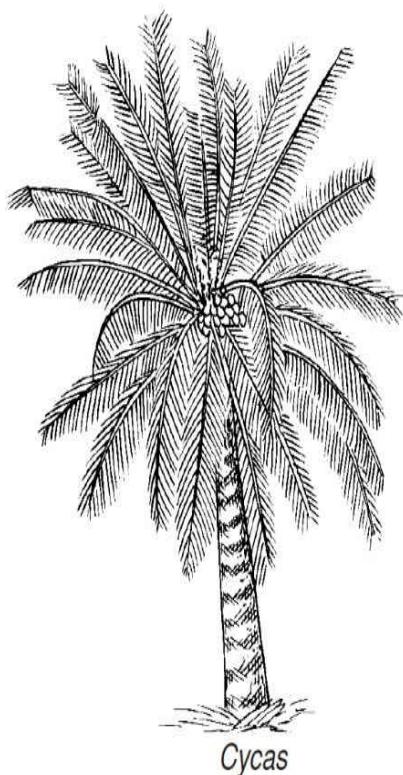


Figure of Q.16



Q.18. Define terms and one example of each (a) Bilateral symmetry, (b) Coelom, (c) Triploblastic.

Ans. (a) **Bilateral symmetry.** It is a type of body symmetry in which appendages and organs of the body are paired with one of each pair being present in right and left halves of the body. It is an adaptation of motile life style, e.g., Frog/Lizards/Sparrow/Human being.

(b) **Coelom.** It is a mesoderm lined, fluid-filled internal body cavity that provides a shock proof environment to the contained body organs, e.g., annelids, chordates.

(c) **Triploblastic.** They are animals having three germinal layers - outer **ectoderm**, middle **mesoderm** and inner **endoderm**, e.g., liver fluke/*Ascaris/Pheretima*/house fly/star fish/*Amphioxus*/ cat.

Q.19. You are given Leech, *Nereis*, *Scolopendra*; Prawn and Scorpion. All have segmented body organisation. Will you classify them in one group ? If not give the important characters based on which you will separate these into different groups.

Ans. No (i) Leech and *Nereis* have metamerism (i.e., external segmentation of body corresponding to internal segmentation), closed circulatory system and unjointed appendages. They belong to phylum Annelida.

(ii) *Scolopendra* (centipede), Prawn and Scorpion also have segmented body but they have open circulatory system, jointed appendages and chitinous exoskeleton. They belong to phylum Arthropoda.

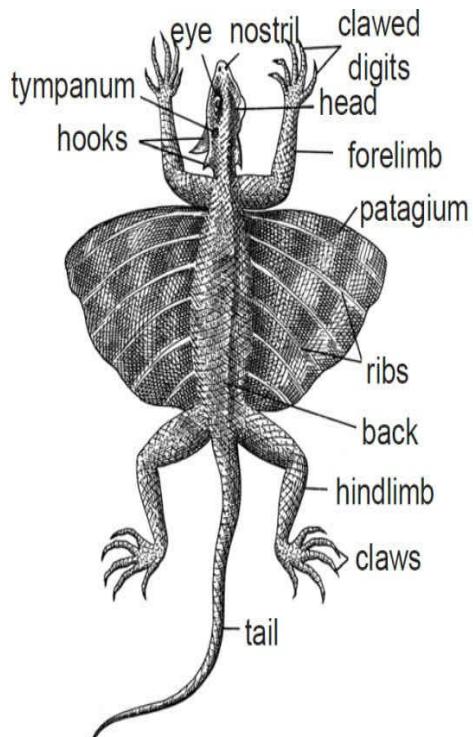
Q.20. Which organism is more complex and evolved among Bacteria, Mushroom and Mango tree, Give reason.

Ans. Mango tree is more complex and evolved among bacteria, mushroom and mango tree because of the following characters:

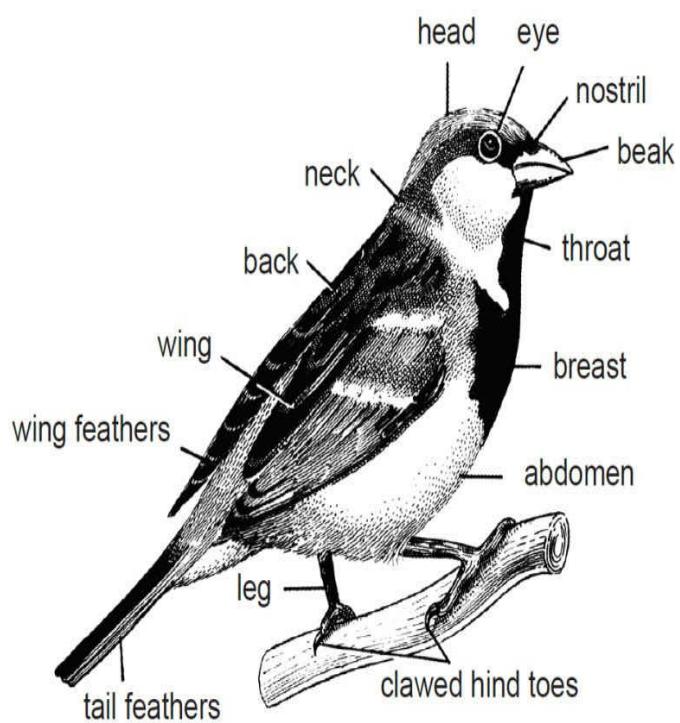
1. Differentiated sporophyte; 2. Vascular tissues (xylem and phloem); 3. Embryo stage in life cycle; 4. Seeds present inside fruit. Bacteria are prokaryotic. Mushroom is eukaryotic (fungus) but without any differentiation in body of stem, leaves, roots, absence of vascular tissues and embryonic stage.

Q.21. Differentiate between flying lizard and Bird. Draw the diagram.

Ans. Draw diagram of flying lizard and of bird according to following figures:



Flying lizard (*Draco volans*)



House sparrow (*Passer domesticus*)

Table: Differences between flying lizard and bird.

<i>Flying lizard</i>	<i>Bird</i>
1. It belongs to class Reptilia of phylum Chordata.	1. It belongs to class Aves of phylum Chordata.
2. The animal is cold blooded.	2. The animal is warm blooded.
3. Its heart is three chambered.	3. Its heart is four-chambered.
4. Feathers are absent.	4. Feathers are present.
5. Jaws have teeth.	5. Jaws are modified into beak. Teeth are absent.
6. It has normal fore limbs.	6. Its forelimbs are modified into wings.
7. A patagium is present for helping in gliding (Patagium is a fold of skin extending between the forelimbs and hindlimbs of an arboreal animal).	7. A patagium is absent.

8. Body is covered by scales.

8. Scales are restricted to hindlimbs.

Q.22. List out some common features in Cat, Rat and Bat.

Cat, Rat and Bat belong to same class Mammalia, phylum Chordata. The common characters of these animals are (i) Hair; (ii) Mammary glands;

Ans. (iii) Integumentary glands, e.g., sweat glands; (iv) Seven cervical vertebrae; (v) Diaphragm; (vi) Four chambered heart, (vii) External pinnae; (viii) Viviparity.

Q.23. Why do we keep both snake and turtle in the same class ?

Both snake and turtle have been placed by taxonomists in class Reptilia of phylum Chordata. This is done because of following features; (i) skin

Ans. without glands; (ii) three-chambered (infact incompletely four chambered) heart; (iii) respiration through lungs; (iv) cold blooded; (v) hard shelled eggs; (vi) embryo protected by extra embryonic membranes.

QUESTIONS OF CBSE SAMPLE PAPERS

1. What is symbiosis? Name a symbiotic life form. Mention specific organisms which display the symbiotic relationship in this life form.

(2 Marks; 2011)

2. (a) Identify two features possessed by all chordates.
(b) In which class would you place any organism which has

- (i) a scaly exoskeleton and a bony endoskeleton
(ii) a scaly exoskeleton and lay eggs outside water?

(2 Marks; 2011)

List three groups of plants. Which plants are referred to as vascular plants?

3. Out of these which group is further classified on the basis of number of cotyledon? State its two characteristics.

(3 Marks; 2011)

4. List in the tabular form any three differences between the Aves and Mammalia group.

(3 Marks; 2011)

Identify the plant bodies, which are commonly named as “cryptogamae”.

5. State and explain two characteristics which are exhibited by each category of these plant bodies.

(3 Marks; 2011)

6. (i) Draw a neat diagram of *Hydra*.
(ii) Label mesoglea and gastrovascular cavity.
(iii) Name the group of animals it belongs to.
(iv) Name one species of this group that lives in colonies.

(3 Marks; 2011)

7. Define the terms and give one example of each

- (i) Bilateral symmetry;
(ii) Coelom;
(iii) Triploblastic.

(3 Marks; 2011)

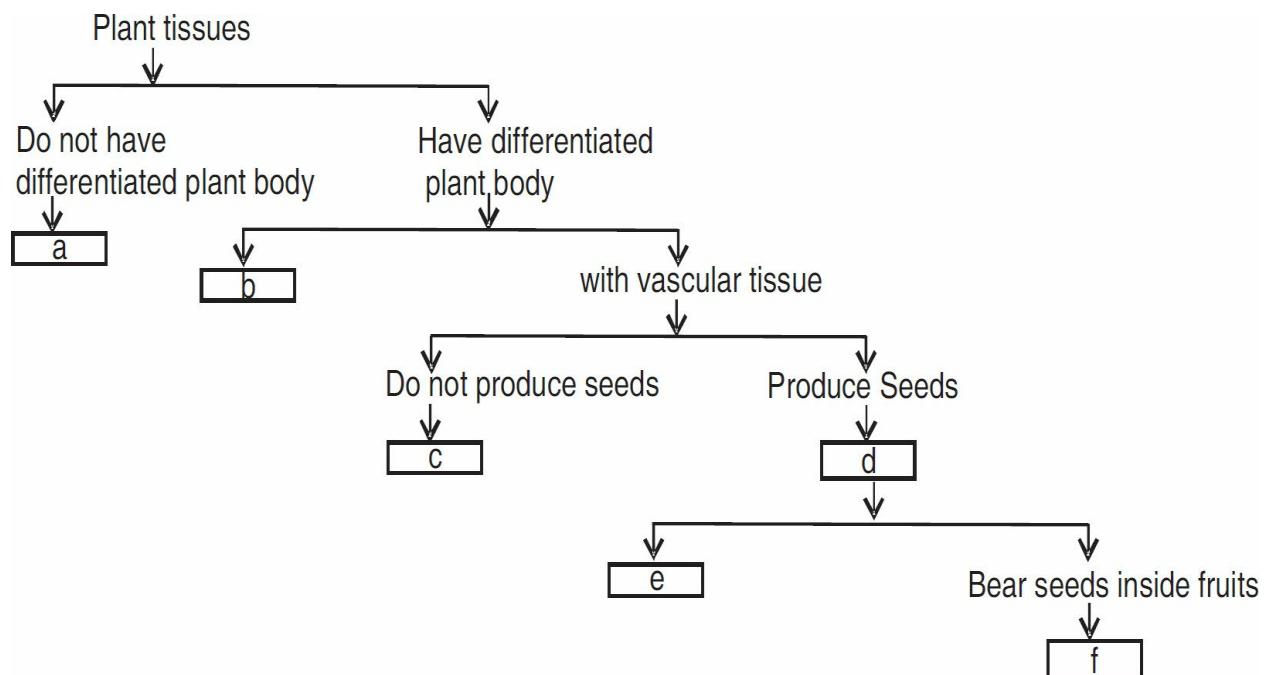
8. Write any three differences between Amphibia and Mammalia belonging to kingdom Animalia.

9. Pick the odd one out and justify your choice by giving reasons.

(3 Marks; 2011)

- (a) Moss, Fern, *Pinus*, *Spirogyra*.
(b) Sea cucumber, Octopus, Feather star, Star fish

10. In the given classification scheme fill in the boxes with appropriate plant groups:



Multiple Choice Questions

Type 1. Interpretation Type Questions

1. A branch of biology which deals with the identification, nomenclature and classification of organisms is called
 - (a) morphology
 - (b) ecology
 - (c) taxonomy
 - (d) phytogeography
2. Basic taxonomic category is
 - (a) population
 - (b) species
 - (c) variety
 - (d) breed
3. Natural system of classification employs
 - (a) complexity of cell structure
 - (b) complexity of body structure
 - (c) organisation
 - (d) all the above
4. Who has proposed two kingdom classification?
 - (a) R.Whittaker
 - (b) Carolus Linnaeus
 - (c) Schimper
 - (d) Eichler
5. What is true in a scientific name ?
 - (a) specific name is written first
 - (b) generic name starts with small letter
 - (c) generic name starts with capital letter while specific name starts with small letter
 - (d) it is written in English
6. Sex organs are unicellular and non-jacketed in
 - (a) algae
 - (b) bryophytes
 - (c) pteridophytes

- (d) gymnosperms
7. *Amoeba* has a contractile vacuole for
- (a) osmoregulation
 - (b) storage
 - (c) turgidity
 - (d) gaseous exchange
8. Male *Ascaris* can be distinguished from female ones by
- (a) curved posterior
 - (b) round shape end
 - (c) presence of penial setae
 - (d) both (a) and (c)
9. In angiosperms
- (a) xylem possess vessels
 - (b) phloem has sieve tubes and companion
 - (c) flowers are reproductive structures
 - (d) all the above
10. Which of the following is the largest phylum ?
- (a) Arthropoda
 - (b) Annelida
 - (c) Mollusca
 - (d) Cnidaria
11. Mammals
- (a) lay eggs
 - (b) possess body hair
 - (c) have a skin with scales
 - (d) all the above.
12. Find the incorrect pair
- (a) Leech – phylum Annelida
 - (b) *Octopus* – Phylum Mollusca
 - (c) *Fasciola* – phylum Platyhelminthes
 - (d) starfish – phylum Chordata

Type 2: Identify – Relationship Type Questions

1. Which taxonomic term may be substituted for any rank in the classification ?

- (a) class
 - (b) genus
 - (c) species
 - (d) taxon
- 2.** Algae belong to
- (a) Thallophytes
 - (b) Bryophytes
 - (c) Pteridophytes
 - (d) all of the above
- 3.** Algae are characterized by
- (a) pyrenoids
 - (b) aquatic habit
 - (c) unicellular sex organ
 - (d) all of the above
- 4.** In Whittaker's classification, unicellular organisms are grouped under
- (a) Protista
 - (b) Porifera
 - (c) Fungi
 - (d) Protozoa
- 5.** The mode of nutrition in all fungi is characteristically
- (a) symbiotic
 - (b) autotrophic
 - (c) holozoic
 - (d) saprotrophic
- 6.** The body of organisms has chitinous cell wall and is made up of hyphae and mycelium
- (a) *Spirogyra*
 - (b) *Rhizopus*
 - (c) *Funaria*
 - (d) *Riccia*
- 7.** The algal partner of a lichen is called
- (a) mycobiont
 - (b) phycobiont
 - (c) both above
 - (d) none above

- 8.** Comb jellies belong to
- (a) Scyphozoa
 - (b) Hydrozoa
 - (c) Ctenophora
 - (d) Both (a) and (b)
- 9.** Which one of the following is cold-blooded animal ?
- (a) birds
 - (b) monkey
 - (c) rat
 - (d) lizard
- 10.** Naked seeds are present in
- (a) *Pinus*
 - (b) mango
 - (c) mustard
 - (d) lemon
- 11.** Which of the following is a monocot ?
- (a) carrot
 - (b) wheat
 - (c) mango
 - (d) mustard
- 12.** Which of the following is parasitic protozoan ?
- (a) *Amoeba*
 - (b) *Entamoeba*
 - (c) *Euglena*
 - (d) *Paramecium*
- 13.** Canal system is present in phylum
- (a) Cnidaria
 - (b) Echinodermata
 - (c) Porifera
 - (d) Protozoa
- 14.** Placoid scales are present in
- (a) *Anabas*
 - (b) *Scoliodon*
 - (c) Lizard
 - (d) Crocodile
- 15.** Metamerism is characteristic feature of

- (a) Chordata
 - (b) Annelida
 - (c) Mollusca
 - (d) Nematoda
- 16.** The excretory organs of Annelida are
- (a) nephridia
 - (b) statocysts
 - (c) archeocytes
 - (d) none of the above
- 17.** Respiration in arthropods occurs through
- (a) gills
 - (b) booklungs
 - (c) trachea
 - (d) all of the above
- 18.** Which of the following classes has largest number of animals ?
- (a) mammals
 - (b) pisces
 - (c) insecta
 - (d) reptilia
- 19.** Spiders and scorpions are
- (a) insecta
 - (b) millipedes
 - (c) arachnids
 - (d) crustacea
- 20.** *Amphioxus* belongs to
- (a) Craniata
 - (b) Hemichordata
 - (c) Urochordata
 - (d) Cephalochordata
- 21.** *Herdmania* is a
- (a) Urochordate
 - (b) Cephalochordate
 - (c) Hemichordate
 - (d) Craniate
- 22.** Common between ostrich, penguin and kiwi is that all are birds,

- (a) running
 - (b) migratory
 - (c) flightless
 - (d) four toed
23. Which of the following has two chambered heart ?
- (a) *Labeo*
 - (b) *Hemidactylus*
 - (c) *Bufo*
 - (d) *Columba*
24. Swim bladder is present in
- (a) bony fishes
 - (b) cartilaginous fishes
 - (c) toad
 - (d) duck

Type 3. NCERT Question Bank (Exemplar Problems)

1. Organisms without nucleus and cell organelles belong to
 - (i) Fungi
 - (ii) Protista
 - (iii) Archaebacteria
 - (iv) Cyanobacteria
 - (a) (i) and (ii)
 - (b) (iii) and (iv)
 - (c) (i) and (iv)
 - (d) (ii) and (iii)
2. Karl von Linne was involved with which branch of science ?
 - (a) morphology
 - (b) physiology
 - (c) taxonomy
 - (d) medicine
3. The book *Systema Naturae* was written by
 - (a) Linnaeus
 - (b) Haeckel
 - (c) Whittaker

- (d) Robert Brown
4. The book *Origin of Species* is written by
- (a) Darwin
 - (b) Haeckel
 - (c) Linnaeus
 - (d) Whittaker
5. Five kingdom classification has given by
- (a) Morgan
 - (b) R. Whittaker
 - (c) Linnaeus
 - (d) Haeckel
6. In taxonomic hierarchy family comes between
- (a) division and class
 - (b) class and order
 - (c) genus and species
 - (d) order and genus
7. Well defined nucleus is absent in
- (a) blue green algae
 - (a) diatoms
 - (b) algae
 - (d) Yeast
8. Who introduced the system of scientific nomenclature of organisms?
- (a) Robert Whittaker
 - (b) Carolus Linnaeus
 - (c) Robert Hooke
 - (d) Ernst Haeckel
9. Find out incorrect sentence
- (a) protista includes unicellular eukaryotic organisms
 - (b) both monera and protista may be autotrophic and heterotrophic
 - (c) monerans have well defined nucleus
 - (d) whittaker considered cell structure, mode and source of nutrition for classifying the organisms in five kingdoms.
10. Which among the following produce seeds ?
- (a) Thallophyta

- (b) Bryophyta
 - (c) Pteridophyta
 - (d) Gymnospermae
- 11.** Which among the following has specialised tissue for conduction of water ?
- (i) Thallophyta
 - (ii) Bryophyta
 - (iii) Pteridophyta
 - (iv) Gymnospermae
- (a) (i) and (ii)
 - (b) (ii) and (iii)
 - (c) (iii) and (iv)
 - (d) (i) and (iv)
- 12.** Pteridophytes do not have
- (a) root
 - (b) stem
 - (c) flowers
 - (d) leaves
- 13.** Which one is a true fish ?
- (a) jelly fish
 - (b) starfish
 - (c) dogfish
 - (d) silverfish
- 14.** Which among the following is exclusive marine ?
- (a) Porifera
 - (b) Echinodermata
 - (c) Mollusca
 - (d) Pisces
- 15.** Elephantitis is caused by
- (a) *Wuchereria*
 - (b) pinworm
 - (c) planarians
 - (d) liver fluke
- 16.** In which group of animals, coelom is filled with blood ?
- (a) Arthropoda

- (b) Annelida
(c) Nematoda
(d) Echinodermata
17. Which among the following have open circulatory system ?
- (i) Arthropoda
(ii) Mollusca
(iii) Annelida
(iv) Cnidaria
- (a) (i) and (ii)
(b) (ii) and (iv)
(c) (i) and (iii)
(d) (ii) and (iv)
18. Which of the following is not a criterion for classification of living organisms ?
- (a) body design of the organism
(b) ability to produce one's own food
(c) membrane bound nucleus and cell organelles
(d) height of the plant.
19. Which is not an aquatic animal ?
- (a) *Hydra*
(b) jelly fish
(c) corals
(d) filaria
20. Which one is the most striking (or common) character of chordates ?
- (a) presence of notochord
(b) presence of triploblastic condition
(c) presence of gill pouches
(d) presence of coelom
21. Which among the following have scales ?
- (i) Amphibians
(ii) Pisces
(iii) Reptiles
(iv) Mammals

- (a) (i) and (ii)
 - (b) (iii) and (iv)
 - (c) (ii) and (iii)
 - (d) (i) and (ii)
- 22.** Find out the false statement
- (a) aves are warm blooded, egg laying and have four chambered heart
 - (b) aves have feather covered body, fore limbs are modified as wings
 - (c) most of the mammals are viviparous
 - (d) fishes, amphibians and reptiles are oviparous.
- 23.** Identify a member of porifera
- (a) *Spongilla*
 - (b) *Euglena*
 - (c) *Penicillium*
 - (d) *Hydra*
- 24.** One of the following is not an annelid
- (a) *Nereis*
 - (b) earthworm
 - (c) leech
 - (d) sea urchin
- 25.** Real organs are absent in
- (a) Mollusca
 - (b) Cnidaria
 - (c) Arthropoda
 - (d) Echinodermata
- 26.** Corals are
- (a) poriferans attached to some solid support
 - (b) cnidarians that are solitary living
 - (c) poriferans present at the sea bed
 - (d) cnidarians that live in colonies
- 27.** The locomotory organs of Echinodermata are
- (a) parapodia
 - (b) tube feet
 - (d) muscular feet
 - (d) jointed leg

- 28.** Differentiation in segmental fashion occurs in
- (a) leech
 - (b) starfish
 - (c) snail
 - (d) *Ascaris*
- 29.** Hard calcium carbonate structures are used as skeleton by
- (a) Echinodermata
 - (b) Protochordata
 - (c) Arthropoda
 - (d) Nematoda
- 30.** Two chambered heart occurs in
- (a) crocodiles
 - (b) fish
 - (c) amphibians
 - (d) aves
- 31.** Skeleton is made entirely of cartilage in
- (a) shark
 - (b) tuna
 - (c) rohu
 - (d) none of these
- 32.** Amphibians do not have the following
- (a) three chambered heart
 - (b) gills or lungs
 - (c) scales
 - (d) mucus glands
- 33.** The feature that is not a characteristic of protochordata ?
- (a) presence of notochord
 - (b) bilateral symmetry and coelom
 - (c) jointed leg
 - (d) presence of circulatory system

ANSWERS

Type 1. MCQs.

1. (c);

2. (b);
3. (d);
4. (b);
5. (c);
6. (a);
7. (a);
8. (d);
9. (d);
10. (a);
11. (b);
12. (d).

Type 2. MCQs.

1. (d);
2. (a);
3. (d);
4. (a);
5. (d);
6. (b);
7. (b);
8. (c);
9. (d);
10. (a);
11. (b);
12. (b);
13. (c);
14. (b);
15. (b);
16. (a);
17. (d);
18. (c);
19. (c);
20. (d);
21. (a);
22. (c);
23. (a);

24. (a).

Type 3. MCQs.

1. (b);
2. (c);
3. (a);
4. (a);
5. (b);
6. (d);
7. (a);
8. (b);
9. (c);
10. (d);
11. (c);
12. (c);
13. (c);
14. (b);
15. (a);
16. (a);
17. (a);
18. (d);
19. (d);
20. (a);
21. (c);
22. (c);
23. (a);
24. (d);
25. (b);
26. (d);
27. (b);
28. (a);
29. (a);
30. (b);
31. (a);
32. (c);
33. (c).

SOME TYPICAL (OR ILLUSTRATIVE) QUESTIONS

1. Give one example of each

- (i) Asymmetry, radial symmetry and bilateral symmetry;
- (ii) Acoelomate, pseudocoelomate and haemocoelomate.

Ans. (i) Amoeba, Hydra and Frog.

(ii) Platyhelminths (flatworms), Nematodes (round worms) and Arthropods (crab).

2. Why is *Euglena* is called plant-animal ?

Euglena is called *plant-animal* because it has characteristics of both plants and animals. Like plants, *Euglena* has chloroplasts with the help of which

Ans. it performs autotrophic nutrition by photosynthesis. Like animals, it lacks cell wall, possess pellicle, an anterior invagination, flagellum, eye spot, etc, and capable of obtaining readymade food in dark (heterotrophic).

3. Why are protozoa are called early animals ?

Protozoa are called early animals because like animals they lack cell wall and have holozoic-type heterotrophic nutrition. They have glycogen as the

Ans. reserve food. They have however, unicellular nature and are without an embryonic stage in their life cycle. Protozoa evolved before the origin and evolution of true animals or metazoa.

4. Name the organisms which has (i) Setae and parapodia (ii) Tube feet.

Ans. (i) *Nereis*, (ii) Starfish.

5. What is haemocoel? Which groups of animals have haemocoel ?

Ans. The blood-filled cavity consisting of spaces in between organs is known as haemocoel. Examples. Mollusca and Arthropoda.

6. Give one point of difference between Gymnosperms and Angiosperms.

Ans. Seeds are naked or exposed in gymnosperms but they are covered by fruit wall or pericarp in angiosperms.

7. Define phylogeny.

Ans. Phylogeny is ancestry of an organisms i.e., evolutionary history of an organism.

8. Identify animal groups having

- (a) Soft bodied animals supported by calcareous shells;
- (b) Spiny body has radial body symmetry;

- (c) Bones light and hollow;
- (d) Four pairs of jointed legs and no wings;
- (e) External ear or pinna.

Ans. (a) Mollusca;
(b) Echinodermata;
(c) Aves;
(d) Arachnida;
(e) Mammalia.

9. Give one example of hemichordata, urochordata and cephalochordata.

Ans. (i) Hemichordata - *Balanoglossus*
(ii) Urochordata - *Herdmania*
(iii) Cephalochordata - *Amphioxus (Branchiostoma)*

10. Give one point of difference between notochord and nerve cord.

Notochord is a transient mesodermal rod in the most dorsal portion of the chordate embryo. In other words, notochord is an ensheathed flexible rod of turgid cells located along the back of chordate embryos and some primitive chordates ventral to nerve cord. It provides place for the attachment of muscles. Notochord has given rise to jointed axial skeleton of vertebral column. **Nerve cord** is a collection of nerve fibres that runs throughout the length of an animal. It is hollow and dorsal in chordates where it gets modified into central nervous system of brain and spinal cord. Nerve cord is solid and ventral in nonchordates.

11. In what way, amphibians are advanced than the fishes ?

Ans. Amphibians have three-chambered heart and lungs for respiration, while fishes have two-chambered heart and gills for respiration.

12. Differentiate the nature of skin in four classes of tetrapoda.

Ans. The nature of skin in four classes of tetrapoda are:

- (i) Class Amphibia - Thin, moist, glandular and respiratory skin.
- (ii) Class Reptilia - Dry and non-glandular skin with horny scales or scutes.
- (iii) Class Aves - Dry and non-glandular skin with feathers.
- (iv) Class Mammalia - Glandular skin with hairs.

13. List a few flight adaptations in birds.

Ans. Flight adaptations of the birds are the following:

- (1) Forelimbs are modified into wings.
- (2) Body is covered with exoskeleton of water-proof and light-weight feathers.
- (3) Long bones of endoskeleton are pneumatic having air cavities.
- (4) All birds are toothless; their jaws are modified into horny beaks.
- (5) Body is streamlined to reduce air resistance during its flight.
- (6) Birds have air sacs helping in double respiration.
- (7) Flight muscles are well developed.
- (8) Tail feathers form a steering apparatus.
- (9) Birds have acute vision.

14. Why whales are not grouped in the fishes ?

Whales look like fishes. They can swim in water like them but they are not

Ans. fish as they respire with lungs, have four chambered heart, diaphragm, mammary gland, hairs, etc. Whales are viviparous like any other mammal.

DRAWING/ILLUSTRATION BASED QUESTIONS

Q.1.

- (a) Identify the organism in the following figure.
- (b) Label the parts numbers 1 to 4.
- (c) Name the phylum in which notochord is present.
- (d) Name the subphylum in which notochord is present throughout life.

Ans.

- (a) The figure illustrates *Amphioxus (Branchiostoma)*.
- (b)
 - 1. Nerve Cord ;
 - 2. Notochord ;
 - 3. Atriopore ;
 - 4. Oral hood
- (c) Notochord is present in phylum Chordata.
- (d) Notochord persists throughout the life in subphylum Cephalochordata (Group Acrania or Protochordata).

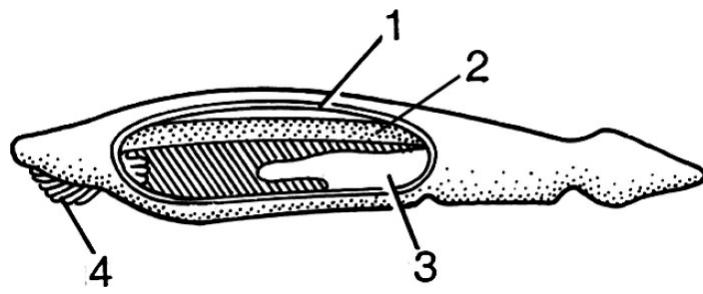


Figure of Q.1

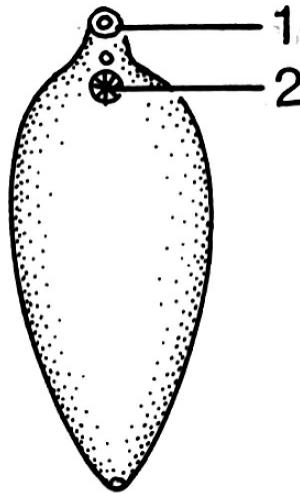


Figure of Q.2 (b)

Q.2. (a) Identify the organism.

(b) Label the part 1 and 2.

(c) Write the mode the nutrition in this animal.

Ans. (a) The figure illustrates liver fluke (*Fasciola hepatica*).

(b) 1. Oral sucker ;

2. Ventral sucker (acetabulum)

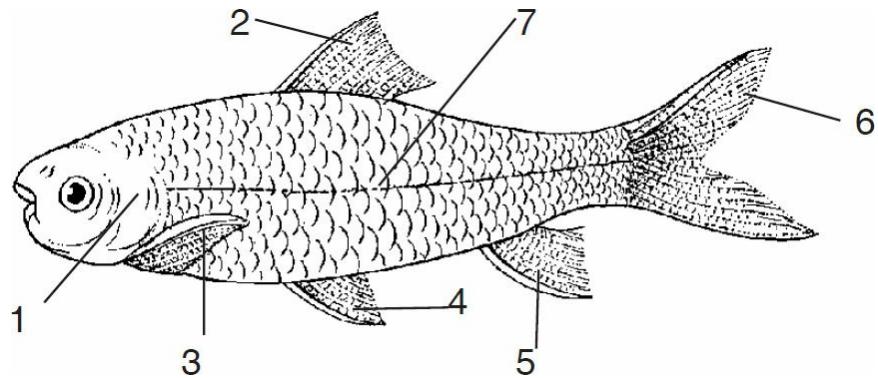
(c) The mode of nutrition of liverfluke is parasitic.

It is a endoparasite living in bile duct of sheep.

Q.3. (a) To which group this organism belongs?

(b) Label the parts marked 1 to 7.

(c) What is the function of part marked 7?



Ans. (a) The organism is a bony fish belonging to class Pisces.

(b)

1. Operculum ;
2. Dorsal fin ;
3. Pectoral fin;
4. Pelvic fin;
- 5 Anal fin ;
6. Caudal fin;
7. Lateral line.

The lateral line system in fish bears neuromast organs which are

(c) rheoreceptors, i.e., they can feel the waves of water and make the fish orient its body accordingly.

COMMUNICATION SKILL- BASED QUESTIONS

Q.1. Wins are absent in bed bug even then it is considered an insect. Why ?

Bed bug (*Cimex*) is an insect because it possesses the basic characteristics

Ans. of class Insecta, such as: (i) Three pairs of jointed thoracic legs. (ii) Its body is divisible into three parts -head, thorax and abdomen. (iii) The exoskeleton of bed bug is made up of chitin.

Q.2. Why are protozoa are regarded as early animals?

Protozoa are regarded as early or primitive animals because: (i) they

Ans. exhibit a cellular level of organisation; (ii) the tissues, organs and organ systems have not developed in them; (iii) they are microscopic and exhibit a primitive mode of reproduction.

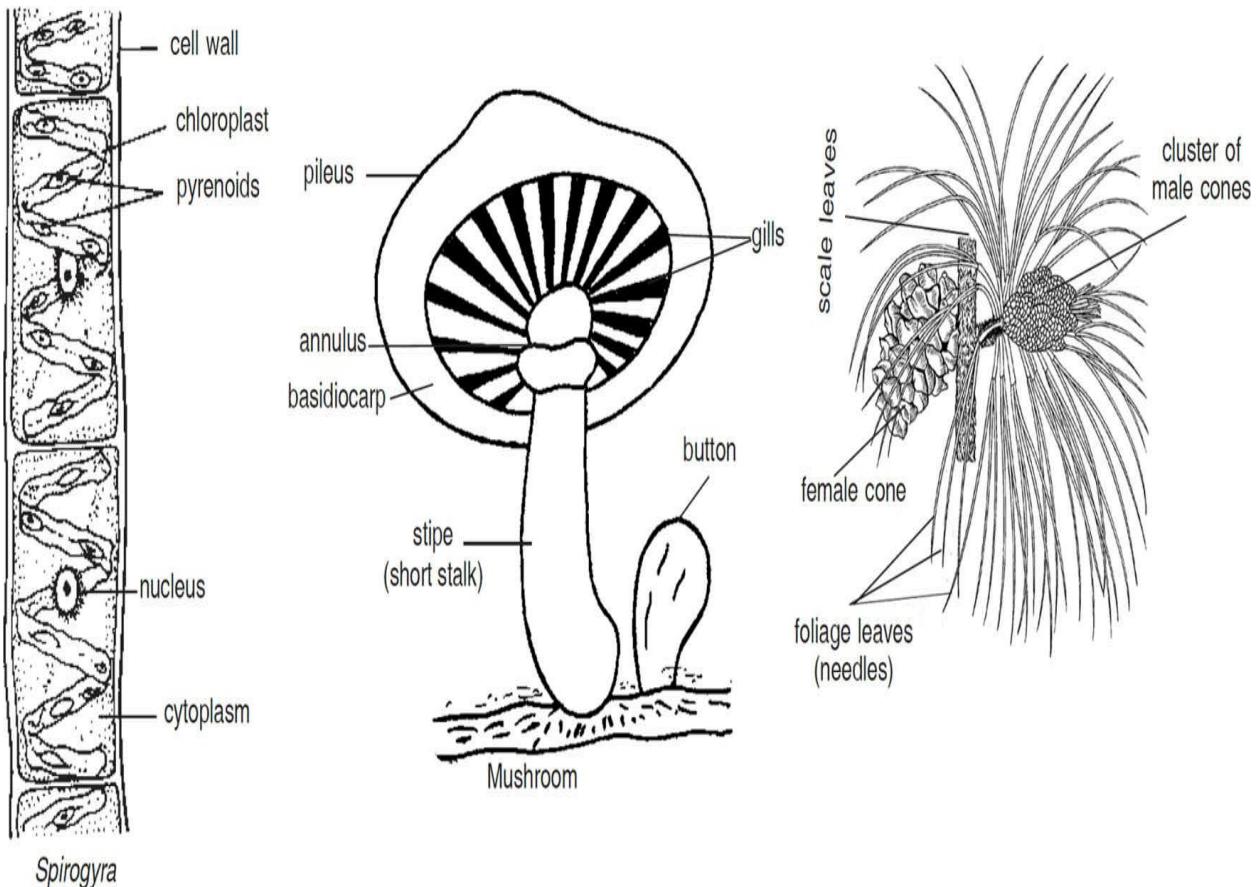
Q.3. Why are whales not grouped in fishes?

Whales belong to class Mammalia while fishes are included in class Pisces. Both are aquatic animals and chordates. However, both differ in several basic characters, such as: (i) Whales are warm-blooded animals

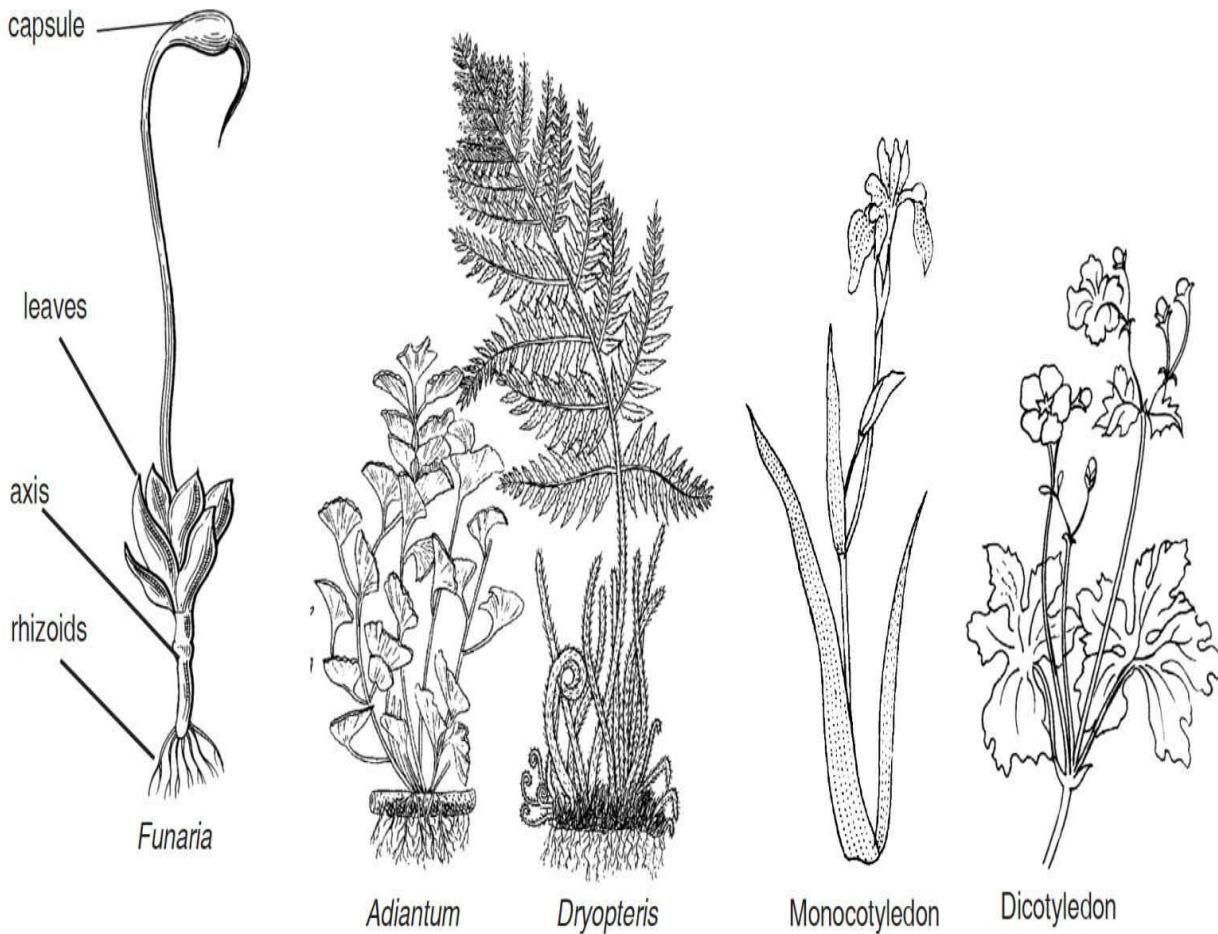
Ans. while fishes are cold-blooded. (ii) Whales respire through lungs while fishes respire through gills. (iii) Whales possess mammary glands which are absent in fishes. (iv) Whales have four chambered heart, while fishes have a two-chambered heart.

PRACTICAL SKILLS BASED MCQs FROM CBSE SAMPLE PAPERS

Refer following figures to answer the forthcoming practical questions.



Pinus : A twig with male and female cones developing on different branches



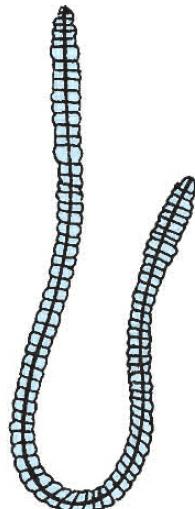
Some Specimens

1. General

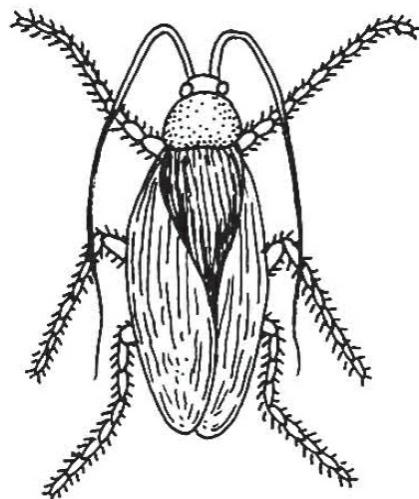
1. Which of the following is common among plants and animals ?
 - (a) Both are prokaryotic
 - (b) Both are eukaryotic
 - (c) Both are heterotrophic
 - (d) Both are autotrophic
2. A group of freely interbreeding organisms constitute
 - (a) family
 - (b) genus
 - (c) species
 - (d) class
3. Cell of bacteria contain
 - (a) cell wall
 - (b) chromatin fibre
 - (c) both (a) and (b)

(d) may be (a) or (b)

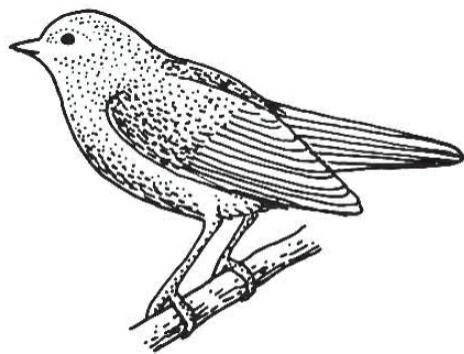
4. Which of the following organisms A, B, C and D have common features that place them in the same phylum ?



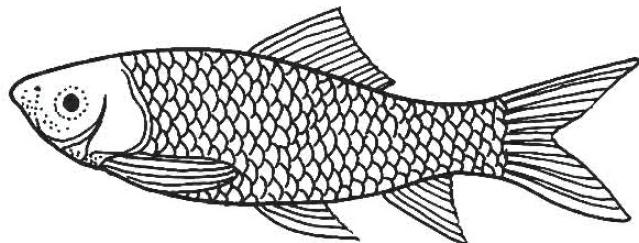
A



B

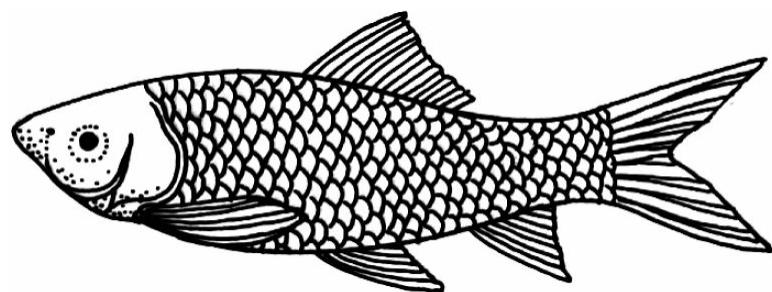


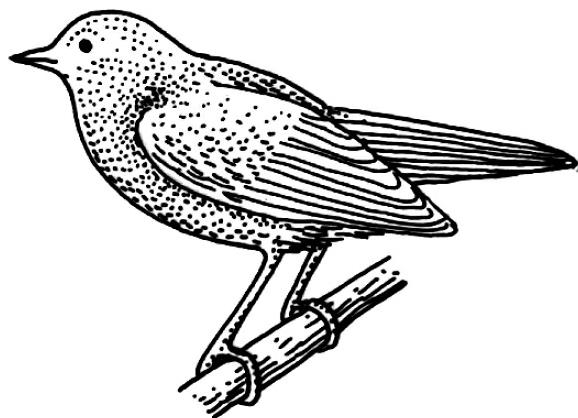
C



D

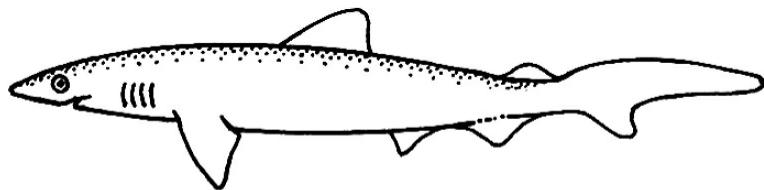
- (a) A and B
 - (b) B and C
 - (c) C and D
 - (d) A and D
5. Observe the pictures of a bird and a bony fish, the feature that places them in the same phylum is:



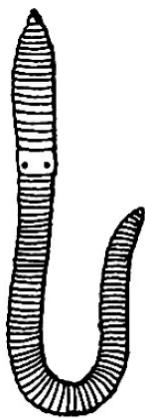


- (a) pointed head
- (b) bulky thorax
- (c) presence of scale
- (d) post anal tail

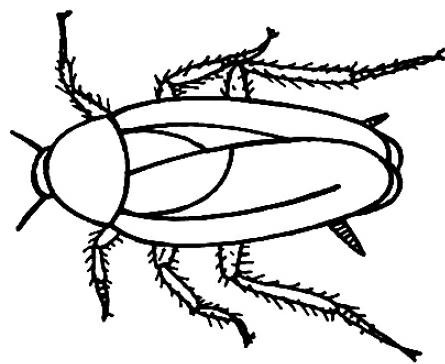
6. Which set of answers classifies the given organisms correctly ?



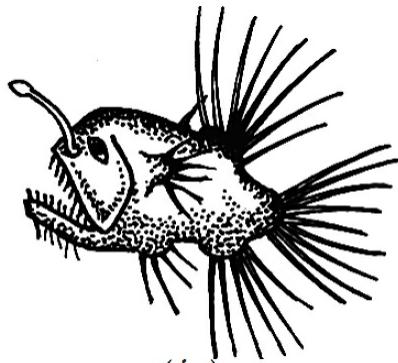
(i)



(ii)



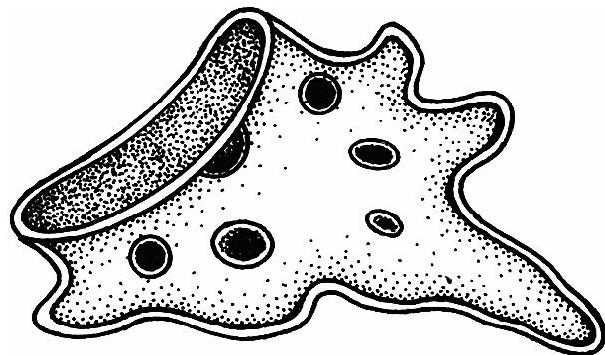
(iii)



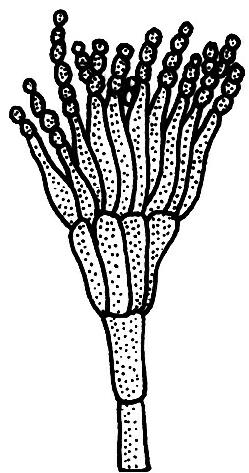
(iv)

- | | | | |
|-----------------------------|------------------|-------------------|-------------------------|
| (a) (i) Cartilaginous fish, | (ii) Annelida, | (iii) Bony fish, | (iv) Arthropoda |
| (b) (i) Cartilaginous fish, | (ii) Annelida, | (iii) Arthropoda, | (iv) Bony fish |
| (c) (i) Bony fish, | (ii) Arthropoda, | (iii) Annelida, | (iv) Cartilaginous fish |
| (d) (i) Bony fish, | (ii) Annelida, | (iii) Arthropoda | (iv) Cartilaginous fish |

7. Which set of answers classifies the given organisms correctly ?



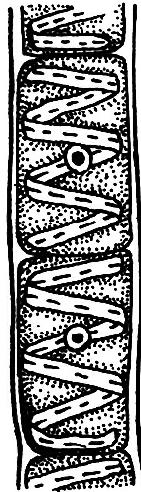
(i)



(ii)



(iii)



(iv)

- | | | | |
|---------------------|-------------------|--------------------|-------------------|
| (a) (i) Protista | (ii) Fungi | (iii) Pteridophyta | (iv) Thallophyta |
| (b) (i) Fungi | (ii) Pteridophyta | (iii) Thallophyta | (iv) Protista |
| (c) (i) Thallophyta | (ii) Fungi | (iii) Protista | (iv) Pteridophyta |
| (d) (i) Protista | (ii) Pteridophyta | (iii) Thallophyta | (iv) Fungi |

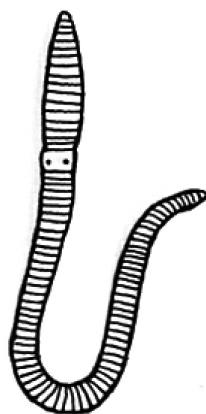
8. The distinguishing characteristic of phylum Chordata are :

- (a) head with a pointed mouth
- (b) dorsal nerve cord
- (c) presence of pseudopodia
- (d) diploblastic

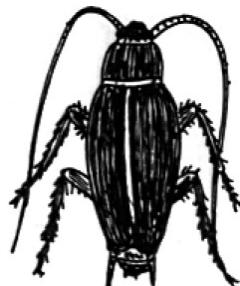
9. Which set of answers classifies the given organisms correctly ?



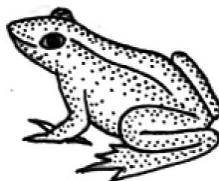
(a)



(b)



(c)



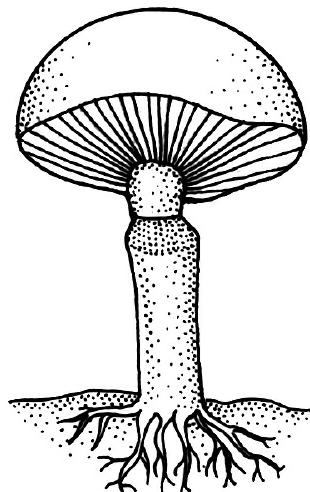
(d)

- (a) Amphibia, Annelida, Nematoda, Arthropoda
- (b) Annelida, Amphibia, Arthropoda, Nematoda
- (c) Arthropoda, Nematoda, Annelida, Amphibia
- (d) Nematoda, Annelida, Arthropoda, Amphibia

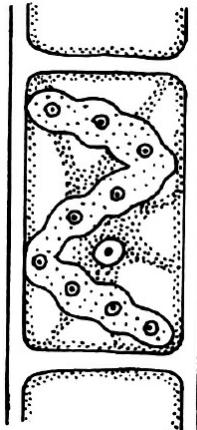
2. *Spirogyra* (Thallophyta)

1. Shyam has observed following parts in the given slide :
(1) Pyrenoids (2) Ribbon like chloroplast (3) Filamentous structure;
Which organisms has he observed ?
(a) *Spirogyra*
(b) Moss

- (c) Fern
 - (d) *Pinus*
2. Thallophyta are group of plants which
- (a) bear flowers
 - (b) have well developed root, stem and leaves
 - (c) do not have well differentiated body design
 - (d) have naked seeds
3. *Spirogyra* is slimy in touch because :
- (a) cell wall is made up of cellulose
 - (b) It is found in dirty pond water
 - (c) pectin layer of the cell wall dissolves in water to give a slimy touch
 - (d) none of these
4. A student observed the permanent slide of spirogyra and labelled the following: cell organelles :
- (a) nucleus, cell wall, plastid and Golgi bodies
 - (b) nucleus, ribbon shaped chloroplast, cell wall and pyrenoids
 - (c) vacuole, cell wall, nucleus and chloroplast
 - (d) cell wall, vacuoles, cell membrane and plastid
5. Figures given below shows an algae and fungus. The reason that both are placed under same division “Thallophyta” are :



Fungus (*Agaricus*)



Algae (*Spirogyra*)

- (a) both are autotrophic
 - (b) both are saprophytic
 - (c) plant body in both is not differentiated into root, stem and leaves
 - (d) both have false roots
6. The starch storing bodies present in the chloroplast of spirogyra are known as
- (a) zygospores
 - (b) pyrenoids
 - (c) zoospores
 - (d) peroxisomes
7. Non-flowering plants belongs to :
- (a) cryptogam
 - (b) phanerogams
 - (c) dicots
 - (d) monocots
8. These structures in spirogyra help to suspend nucleus in the cells :
- (a) chloroplast
 - (b) cell wall
 - (c) vacuole
 - (d) cytoplasm
9. The following diagram illustrates a filament of spirogyra as seen under the microscope. Its parts have been labelled as A, B, C, D. Functions of these parts are stated below randomly:
- (1) performs photosynthesis
 - (2) controls activities of cell

(3) makes the algae slippery to touch

(4) stores starch and protein

The correct matching of the parts and their functions are

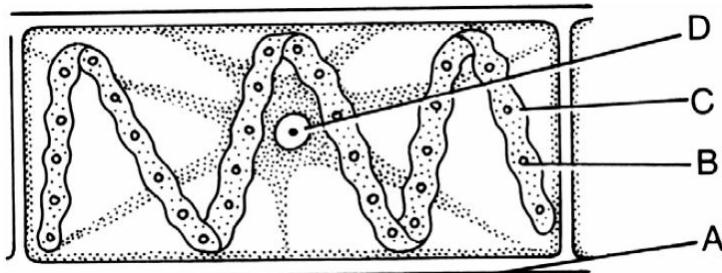


Fig. of Q. 9

(a) A-1; B-2; C-3; D-4

(b) A-2; B-3; C-4; D-1

(c) A-3; B-4; C-1; D-2

(d) A-4; B-1; C-2; D-3

10. The important features that can help a student to identify spirogyra under the microscope are :

(a) filamentous structure

(b) green - coloured cylindrical cells

(c) Spirally -coiled chloroplasts and filament like structure

(d) thick cell wall and large central vacuole

11. What is the shape of chloroplast in *Spirogyra* ?

(a) cup shape

(b) girdle shape

(c) spiral shape

(d) ring shape

12. Which one of the following algae is not found in colonial form ?

(a) *Ulothrix*

(b) *Volvox*

(c) *Pandorina*

(d) *Gonium*

13. Choose the option that best describes the feature of *Spirogyra*.

(a) multicellular, autotrophic, root-like rhizoids

(b) cytoplasmic strands, autotrophic, presence of rhizome

(c) presence of male cones, nonvascular, filaments

- (d) filamentous, presence of cytoplasmic strands, presence of pyrenoids

3. *Agaricus* (*Thallophyta*)

1. Choose the option that best describes the characteristic of the organism of the Kingdom to which the mushroom belongs :
 - (a) unicellular prokaryotic organism
 - (b) saprophytic, eukaryotic, multicellular organism
 - (c) unicellular eukaryotic organism
 - (d) autotrophic eukaryotic organism
2. The mode of nutrition in mushroom is :
 - (a) autotrophic
 - (b) parasitic
 - (c) holozoic
 - (d) saprophytic
3. Fruiting body has chitinous cell wall:
 - (a) *Funaria*
 - (b) *Agaricus*
 - (c) *Spirogyra*
 - (d) *Riccia*
4. Fruiting body in *Agaricus* is called :
 - (a) pseudocarp
 - (b) pericarp
 - (c) basidiocarp
 - (d) mesocarp
5. Sachin identified the specimen displayed as a saprophyte called mushroom. What made him conclude so ?
 - (a) they have an umbrella shaped cap
 - (b) they are heterotrophs
 - (c) they derive food from dead and decaying organic matter
 - (d) they derive food from the soil
6. The feature(s) found in *Agaricus* is/are :
 - (a) an umbrella shaped fleshy structure
 - (b) a mycelial body
 - (c) saprophytic habit
 - (d) all of these
7. To which group *Agaricus* belong :

- (a) algae
 - (b) fungi
 - (c) gymnosperm
 - (d) angiosperm
8. Non-green saprophytic plant is :
- (a) *Marsilea*
 - (b) *Marchantia*
 - (c) *Paramecium*
 - (d) *Rhizopus*
9. In which plant gills are present ?
- (a) *Spirogyra*
 - (b) *Agaricus*
 - (c) moss
 - (d) fern
10. The parts marked A, B and C in the following plants are :

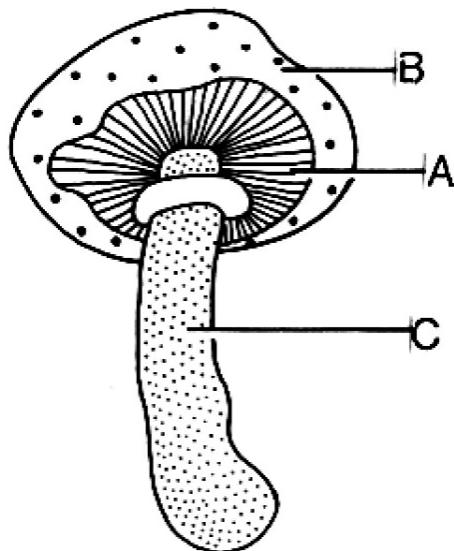


Fig. of Q. 3(10)

- (a) gills, pileus and stipe
 - (b) gills, stipe and pileus
 - (c) pileus, gills and stipe
 - (d) stipe, gills and pileus
11. In a given diagram of MCQ 10. what is marked as B ?
- (a) pileus

- (b) gills
 - (c) annulus
 - (d) stipe
12. Identify the edible fungus from the following :
- (a) Bread mould
 - (b) Penicillium
 - (c) Toad's tool
 - (d) Mushroom

4. *Funaria* (Bryophyta)

1. In the given diagram what is *x* :

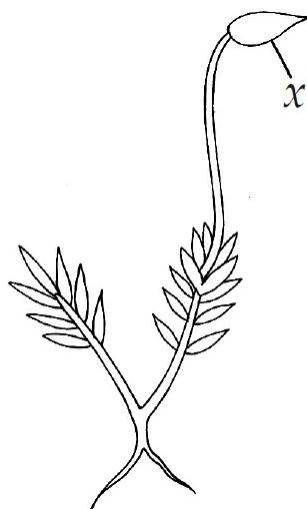


Fig. of Q. 04 (1)

- (a) rhizoids
 - (b) leaves
 - (c) capsule
 - (d) seta
2. Which of the following plant groups is known as amphibians of the plant body?
- (a) Algae
 - (b) Fungi
 - (c) Gymnosperms
 - (d) Bryophyta
3. *Marchantia* is a
- (a) Thallophyta

- (b) Pteridophyta
- (c) Gymnosperm
- (d) Bryophyta

4. The diagram given below illustrates a sporophyte attached to gametophyte in Moss. Its parts have been labelled as A, B, C, D by a student. Correct labelling of parts A, B, C and D are :

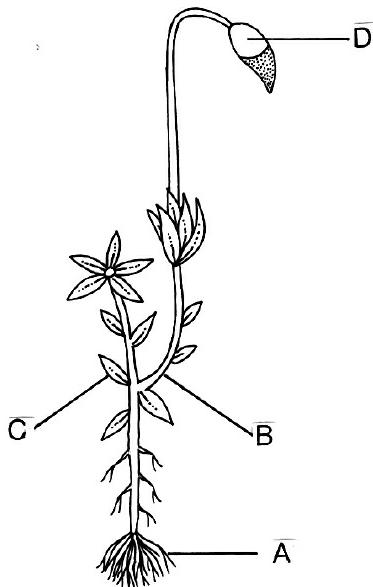


Fig. of Q. 4 (4)

- (a) female branch, male branch, rhizoids, capsule
- (b) male branch, female branch, rhizoids, capsule
- (c) capsule, female branch, rhizoids, capsule
- (d) rhizoids, female branch, male branch, capsule

5. The main plant in moss plant is of :

- (a) gametophyte
- (b) sporophyte
- (c) may be (a) or (b)
- (d) neither (a) nor (b)

6. Bryophytes are more evolved than algae because of the

- (a) presence of sex organs
- (b) unicellular root like structures to absorb some water
- (c) terrestrial habitat
- (d) all of the above

7. The given figure is of *Funaria* - a moss plant. The parts indicated by

the letters A, B, C, D represents, which of the following structures?

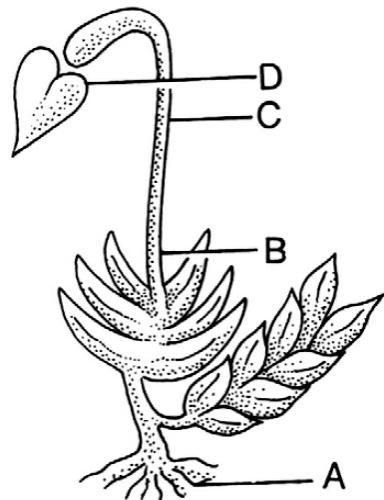


Fig. of Q. 4 (7)

- (a) A → foot : B → rhizoids : C → seta : D → capsule
 - (b) A → rhizoids : B → foot : C → seta : D → capsule
 - (c) A → foot : B → seta : C → rhizoids : D → capsule
 - (d) A → rhizoids : B → seta : C → foot : D → capsule
8. The plant part that bears spores in the following is :

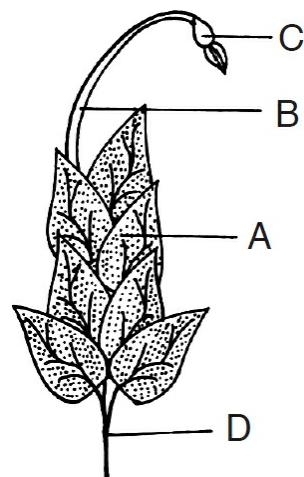


Fig. of Q. 4 (8)

- (a) B
- (b) C
- (c) A
- (d) D

9. *Funaria* is:

- (a) angiospermic plant
- (b) green algae
- (c) a moss
- (d) grass

5. Fern (Pteridophyta)

1. Which of the following characteristics does not belong to the ferns?
 - (a) Body is differentiated to form roots, stems and leaves.
 - (b) Presence of specialised tissues for the conduction of water and other substances.
 - (c) Presence of sporophylls containing spores on the underside of the leaves.
 - (d) Presence of naked seeds.
2. Ravi has observed rhizome and circinate leaves in the given specimen. Which specimen he has observed ?



Fig. of Q. 5 Part (2)

- (a) fern
- (b) *Funaria*
- (c) *Spirogyra*
- (d) mushroom

3. Which of the following is a characteristic feature of ferns?
 - (a) they have male and female cones
 - (b) they have rhizoids
 - (c) they have needle shaped leaves
 - (d) their plant body is differentiated into root, stem and leaves

6. *Pinus* (Gymnosperms)

1. The plants which have naked seeds belong to the group
 - (a) angiosperm
 - (b) gymnosperm
 - (c) algae
 - (d) fungi
2. Kevin found out needle like leaves in :
 - (a) fern
 - (b) moss
 - (c) pinus
 - (d) mustard
3. In *Pinus* the seed is:
 - (a) enclosed within fruit
 - (b) naked
 - (c) both (a) and (b)
 - (d) none of the above
4. The following figures represents :
 - (a) male cone of pinus
 - (b) female cone of pinus
 - (c) rachis of fern
 - (d) annulus of agaricus
5. The plants which have naked seeds belong to the group:
 - (a) angiosperm
 - (b) gymnosperm
 - (c) algae
 - (d) fungi
6. Which of the following produces seeds without fruit?

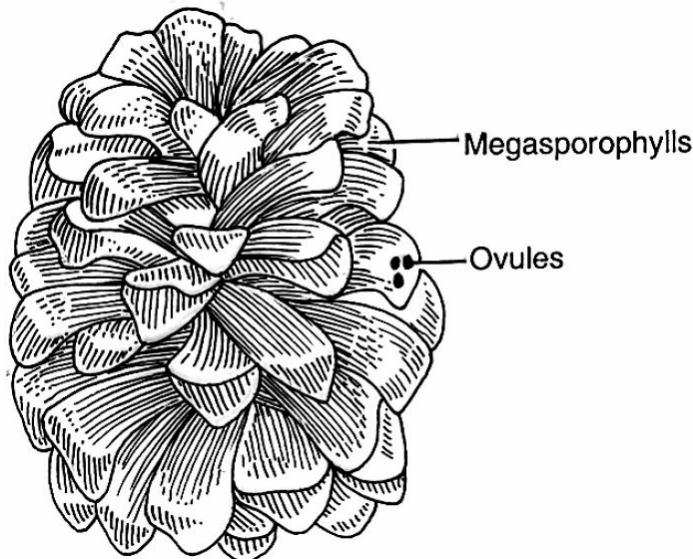


Fig. of Q. 6 Part (4)

- (a) *Cycas*
 - (b) rice
 - (c) fern
 - (d) grapes
7. The pinus is characterised by:
- (a) short tree with heavy branches
 - (b) two types of shoots and two types of cones
 - (c) large scented flowers
 - (d) large fruits bearing seeds

7. Angiosperms

1. An angiosperm plant is characterised by :
 - (a) presence of flower
 - (b) seeds enclosed in fruit
 - (c) fibrous/tap root system
 - (d) all of the above
2. This represents a bit of predesigned plant :
 - (a) cotyledon
 - (b) embryo
 - (c) seedless fruit
 - (d) *Ulothrix*
3. The main characteristic feature of angiosperm is :
 - (a) seeds are naked in fruits

- (b) seeds are covered with coats and are in fruits
 - (c) fruits are without seeds
 - (d) seeds are naked without fruits
4. Tap root system, prominent nodes and internodes, reticulate venation, tetramerous flower and enclosed seeds with two cotyledons as observed in the laboratory are characteristics features of :
- (a) monocot
 - (b) dicot
 - (c) conifers
 - (d) cycadae
5. The highest evolved among the following plant groups are:
- (a) bryophytes
 - (b) angiosperms
 - (c) pteridophytes
 - (d) gymnosperms
6. Monocotyledonous and dicotyledonous are two groups present in :
- (a) angiosperms
 - (b) gymnosperms
 - (c) pteridophyta
 - (d) bryophyta
7. Maize, grass, coconut, banana are the examples of :
- (a) gymnosperms
 - (b) monocots
 - (c) dicots
 - (d) algae
8. Cutin is present as the outermost layer in the leaves of angiosperms.
It is secreted by:
- (a) guard cells
 - (b) epidermal cells
 - (c) mesophyll cells
 - (d) none of these
9. Which of the following is not a feature of monocots?
- (a) trimerous flowers
 - (b) fibrous root system
 - (c) leaf with parallel venation

- (d) secondary growth due to the presence of cambium
10. Which of the following characteristics does not belong to following plants?
- (a) seeds are naked
 - (b) conducting tissue is well developed
 - (c) shows nodes and internodes
 - (d) shows the presence of root hairs

8. Earthworm (Annelida)

1. A student observed a prominent band on 14, 15 and 16 segment of earthworm, what is it known as?

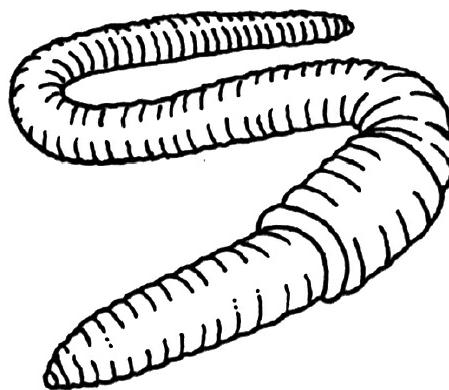


Fig. of Q. 8. (Part 1)

- (a) peristomium
 - (b) prostomium
 - (c) clitellum
 - (d) mouth
2. Which group of animals have segmented body?
- (a) Arthropoda
 - (b) Nematoda
 - (c) Annelida
 - (d) Coelenterata
3. Which animal belongs to Annelida?
- (a) butterfly
 - (b) earthworm
 - (c) cockroach
 - (d) roundworm
4. The horizontal lines on the body of earthworm represent:

- (a) cells of the body
 - (b) cell walls separating the cells of the body
 - (c) vertically arranged muscles of the body
 - (d) septa separating the segments of the body
5. Unlabelled outline diagram of earthworm is drawn below. The important feature to be drawn and labelled for placing the earthworm in its phylum is :

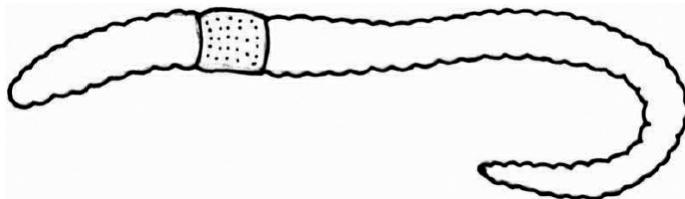


Fig. of Q. 8. (Part 5)

- (a) eye
 - (b) clitellum
 - (c) annuli
 - (d) anus
6. The correct position of clitellum in earthworm is :
- (a) 12, 13, 14 segments
 - (b) 14, 15, 16 segments
 - (c) 24, 25, 26 segments
 - (d) 5, 6, 7 segments
7. The correct identifying feature of the phylum Annelida are:
- (a) true body cavity, dorsoventrally flattened, non-segmented
 - (b) true body cavity, cylindrical, metamerically segmented
 - (c) psuedo-coelom, flat body, no organ differentiation
 - (d) diploblastic, no true body cavity, cylindrical
8. Which of the following feature places earthworm in its phylum?
- (a) segmented body
 - (b) elongated body
 - (c) mouth
 - (d) anus
9. The kind of respiration shown by earthworm is :
- (a) pulmonary
 - (b) buccal

- (c) through gills
 - (d) cutaneous
- 10.** An adaptation of earthworm is :
- (a) aerial
 - (b) burrowing
 - (c) aquatic
 - (d) arboreal
- 9. Mollusca**
- 1.** The phylum in which animals have soft bodies covered with a hard shell is:
 - (a) Mollusca
 - (b) Arthropoda
 - (c) Nematoda
 - (d) Annelida
- 10. Cockroach (Arthropoda)**
- 1.** The presence of the feature which distinguishes a male cockroach from the female cockroach is the presence of:
 - (a) membranous wings
 - (b) presence of jointed legs
 - (c) presence of chitinous exoskeleton
 - (d) presence of a pair of anal style in the 9th abdominal segment
 - 2.** Which of the following characteristic is present in the arthropods?
 - (a) Open circulatory system is present and so the coelomic cavity is filled with blood.
 - (b) Presence of kidney like organs of excretion.
 - (c) Have peculiar water driven tube system that they use it for moving around.
 - (d) The body is bilaterally symmetrical and dorsoventrally flattened.
 - 3.** Jointed appendages and chitinous skeleton are the characteristic features of

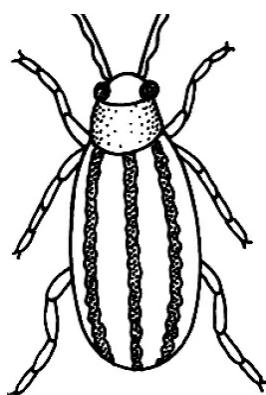
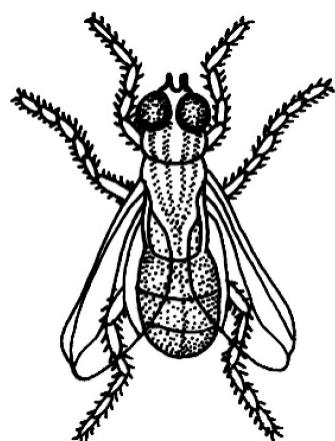
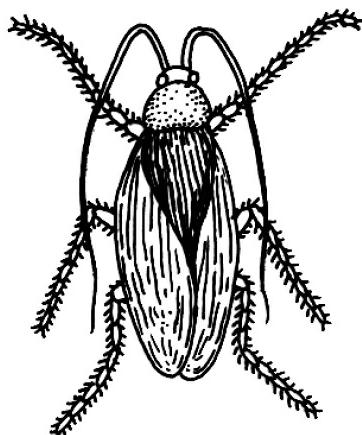


Fig. of Q. 10. (part 3)

- (a) arthropods
 - (b) annelida
 - (c) chordata
 - (d) echinoderm
4. Phylum possessing jointed appendage or legs is:
- (a) Arthropoda
 - (b) Porifera
 - (c) Mammalia
 - (d) Annelida
5. The group of animals having open circulatory system is
- (a) Arthropoda
 - (b) Nematoda
 - (c) Annelida
 - (d) Coelenterata
6. In which group of animals, coelom is filled with blood?
- (a) Nematoda
 - (b) Annelida
 - (c) Echinodermata
 - (d) Arthropoda
7. Legs are jointed for fast running in:
- (a) earthworm
 - (b) cockroach
 - (c) frog
 - (d) birds
8. What is common between silverfish, scorpion, crab and honey bee?
- (a) compound eye

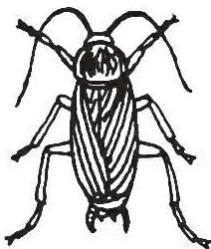
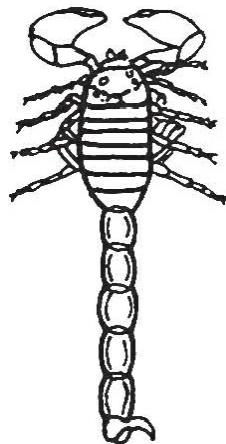
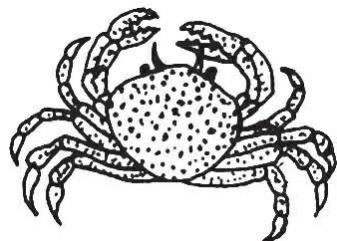
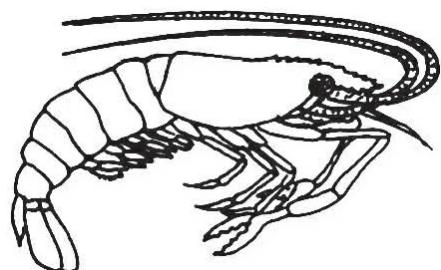
- (b) poison glands
- (c) jointed legs
- (d) metamorphosis

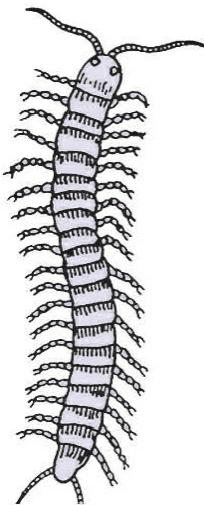
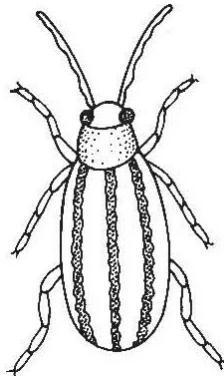
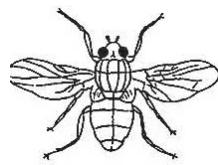
9. The jointed legs are the characteristic feature of the following organisms. They belong to the phylum called :



- (a) Annelida
- (b) Arthropoda

- (c) Vertebrata
(d) Aves
10. Observe the pictures of the following organisms. The common feature that assigns them to same phylum is:





- (a) wings
- (b) three pair of legs
- (c) jointed appendages
- (d) antennae

11. A student observed the posterior part of male cockroach in the lab.
The following sketch was made. The missing part in the sketch is :

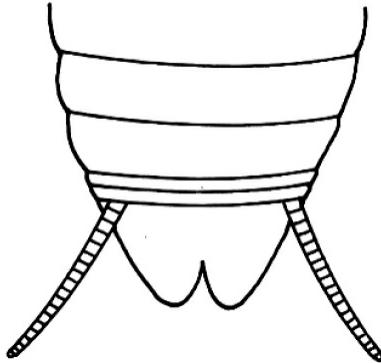


Fig. of Q. 7 (part 11)

- (a) anal cerci
 - (b) anal style
 - (c) brood pouch
 - (d) antennae
12. Which of the following statements is incorrect? A cockroach has
- (a) a pair of antennae
 - (b) three pairs of legs
 - (c) body covered by exoskeleton
 - (d) body divided into 100-120 segments
13. Which is the largest phylum of animal kingdom?
- (a) Mammalia
 - (b) Pisces
 - (c) Annelida
 - (d) Arthropoda
14. The body of cockroach is divided into :
- (a) thorax and abdomen
 - (b) head, wings and legs
 - (c) head, abdomen and tail
 - (d) head, thorax and abdomen
15. Observe the pictures of cockroach and housefly. The common features that assign them the same phylum.

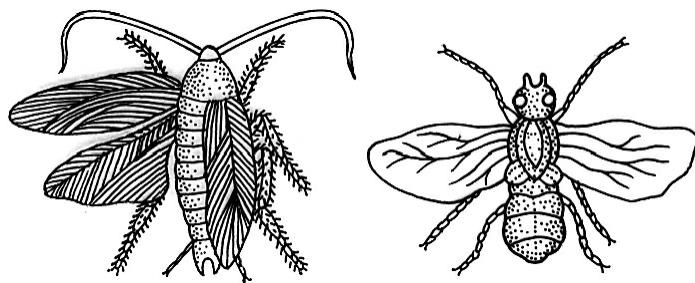


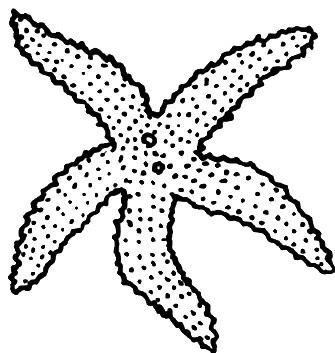
Fig. of Q. 7 (parts 15)

- (a) three pairs of legs
 - (b) antennae
 - (c) wings
 - (d) jointed legs
16. Some features of the body design of an organism are given below.
To which group does it belong ?
- (1) bilaterally symmetrical
 - (2) open circulatory system
 - (3) jointed legs
 - (4) largest group of animals
- (a) Annelida
 - (b) Arthropoda
 - (c) Nematoda
 - (d) Echinodermata
17. Insects have compound eye made up of several units. Each unit is :
- (a) ommatidium
 - (b) retina
 - (c) photoreceptors
 - (d) all of the above
18. The most outstanding feature of arthropods is:
- (a) bilaterally symmetrical body
 - (b) closed circulatory system
 - (c) jointed legs
 - (d) spiny-skinned body
19. Pick the odd one out
- (a) jointed legs
 - (b) scales
 - (c) compound

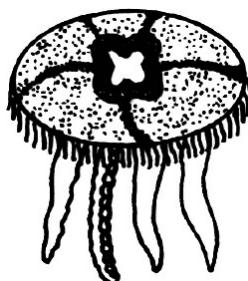
(d) wings

11. Echinodermata

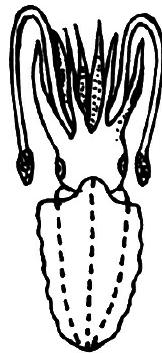
1. Hard calcium carbonate structures are used as skeleton by :
 - (a) Arthropoda
 - (b) Echinodermata
 - (c) Nematoda
 - (d) Protochordata
2. Hard calcium carbonate structures are used as skeleton by :
 - (a) spider
 - (b) *Asterias*
 - (c) *Wuchereria*
 - (d) *Herdmania*
3. Which of the following animals possesses a water vascular system?



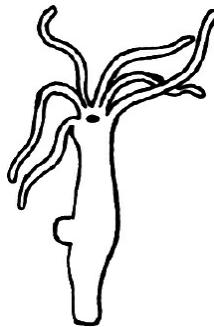
I. star fish



II. Jelly fish



III. cuttle fish



IV. Hydra

- (a) I
- (b) II
- (c) III
- (d) IV

12. Bony fish (Pisces)

1. Which of the following is an aquatic adaptation ?
 - (a) presence of gills
 - (b) presence of feathers
 - (c) hollow bones
 - (d) forelimbs modified into wings
2. Which of the following has two chambered heart?
 - (a) rohu
 - (b) lizard
 - (c) toad
 - (d) ostrich
3. A specimen of a fish was given to identify the externally visible chrodate feature in it. The student would look for :

- (a) operculum
 - (b) notochord
 - (c) dorsal tubular nerve chord
 - (d) post anal tail
4. The gills in which one of the following are covered with operculum?
- (a) starfish
 - (b) bony fish
 - (c) cartilaginous fish
 - (d) none of these
5. Dorsal, pelvic, pectoral and tail fins are for locomotion in
- (a) earthworm
 - (b) cockroach
 - (c) fishes
 - (d) birds
6. Bony fishes are characterised by:
- (a) bony skeleton
 - (b) spindle shaped body with cycloid scales
 - (c) terminal mouth
 - (d) all the above
7. Observe the pictures of fish and a bird. The feature that places them in the same phylum is :

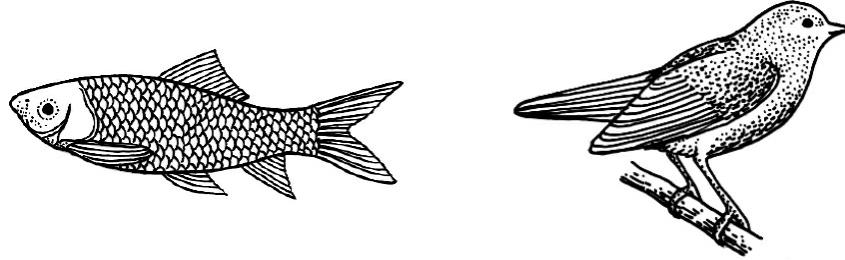


Figure of Q. 12 (Part 7)

- (a) pointed heads
 - (b) presence of scales
 - (c) bulky thorax
 - (d) post anal tails
8. Which of the following show aquatic adaptation ?
- (a) snake

- (b) fish
 - (c) bacteria
 - (d) toad
9. Which of the following adaptation is not found in a fish?
- (a) stream lined body
 - (b) presence of joint appendages
 - (c) presence of fins
 - (d) presence of gills
10. The fish which may have given rise to terrestrial vertebrates is:
- (a) cat fish
 - (b) lion fish
 - (c) lobe finned fish
 - (d) rohu
11. What is the role of the air bladder in fishes?
- (a) acts as a reservoir of fresh air
 - (b) to maintain buoyancy in water
 - (c) reserve food material is stored in it
 - (d) acts as lungs when a fish jumps to the surface of water
12. Choose option which includes the feature that helps the fish to change its direction :
- (a) caudal fin and pelvic fin
 - (b) dorsal fin and anal fin
 - (c) dorsal fin only
 - (d) caudal fin only

13. Frog (Amphibia)

1. Which adaptation of the frog differentiates it from the fish?
 - (a) presence of mucous glands in the skin
 - (b) ability to live in water also
 - (c) lays eggs in water
 - (d) have a streamlined body
2. Which of the following has three chambered heart?
 - (a) toad
 - (b) catla
 - (c) rohu
 - (d) ostrich
3. Which of the following is not an amphibian

- (a) sea-anemone
- (b) frog
- (c) toad
- (d) hyla

4. Scientific name of a frog is :

- (a) *Rana tigrina*
- (b) *Periplaneta americana*
- (c) *Musca domestica*
- (d) *Pheretima posthuma*

14. Reptilia

1. Respiration in reptiles occurs through :

- (a) gills
- (b) moist skin
- (c) lungs
- (d) fins

15. Birds (Aves)

1. Pick the odd one out :

- (a) warm blooded animals with a four chambered heart
- (b) presence of hollow bones
- (c) give birth to young ones
- (d) presence of strong flight muscles

2. Pneumatic bones are the adaptive features of which phylum?

- (a) Osteichthyes
- (b) Chondrichthyes
- (c) Aves
- (d) Reptilia

3. The hind limbs in birds are modified for :

- (a) walking
- (b) perching
- (c) swimming
- (d) all the above

4. Wings of the birds are modified form of :

- (a) hindlimbs
- (b) forelimbs
- (c) chest
- (d) feathers

5. Birds are adaptive to aerial mode of life. Which of the statements is not correct ?
- (a) fore limbs are modified into wings for flying
 - (b) feathers present on the body provide insulation
 - (c) lungs show air sacs attached to it
 - (d) heavy bones are present to reduce the weight of the body and help in flying
6. Features that help the bird to maintain constant body temperature:
- (a) digits
 - (b) pneumatic bones
 - (c) wings
 - (d) feathers
7. In the following figures what is the common feature?

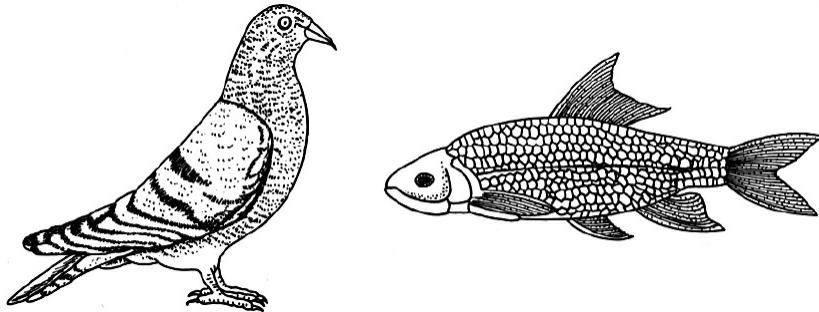


Fig. of Q. 15 (part 7)

- (a) presence of fins
 - (b) presence of scales
 - (c) bulky thorax
 - (d) post anal tail
8. Hollow bones occur in :
- (a) frog
 - (b) tortoise
 - (c) peacock
 - (d) whale
9. Which of the following is not an aerial adaptation ?
- (a) presence of gills
 - (b) presence of feather
 - (c) hollow bones

- (d) fore limbs modified into wings
- 10.** The number of teeth in the beak of birds are :
- (a) 8
 - (b) 16
 - (c) 32
 - (d) none
- 11.** The class Aves have the following features except that their :
- (a) heart is four chamber
 - (b) skeleton is light
 - (c) forelimbs are modified into wings
 - (d) respiration is not through lungs
- 12.** Pneumatic bones are found in :
- (a) whale
 - (b) dolfin
 - (c) pigeon
 - (d) snake
- 13.** Which of the following is not an aerial adaptation of a bird?
- (a) presence of strong flight muscles
 - (b) presence of vertebral column
 - (c) streamlined body
 - (d) forelimbs modified into wings
- 14.** Feathers and beaks are present in the animals of class :
- (a) Aves
 - (b) Reptilia
 - (c) Amphibia
 - (d) Mammalia
- 15.** Birds respire with
- (a) lungs
 - (b) gills
 - (c) skin
 - (d) none of these
- 16.** The characteristic not common between bony fish and pigeon is
- (a) vertebral column
 - (b) streamlined body
 - (c) warm blooded
 - (d) lay eggs

16. Mammals

- 1.** Which one is a warm blooded animal?
 - (a) rat
 - (b) earthworm
 - (c) fish
 - (d) frog
- 2.** Which of the followoing is a warm- blooded animal :
 - (a) liver -fluke
 - (b) human being
 - (c) draco
 - (d) salamander
- 3.** Which one of the following is egg laying mammal :
 - (a) platypus
 - (b) bat
 - (c) whale
 - (d) seal

ANSWERS

1. General

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

2. Spirogyra (Thallophyta)

- 1.** (a)
- 2.** (c)
- 3.** (c)
- 4.** (b)
- 5.** (c)

- 6.** (b)
- 7.** (a)
- 8.** (d)
- 9.** (c)
- 10.** (c)
- 11.** (c)
- 12.** (a)
- 13.** (d).

3. *Agaricus* (Thallophyta)

- 1.** (b)
- 2.** (d)
- 3.** (b)
- 4.** (c)
- 5.** (c)
- 6.** (d)
- 7.** (b)
- 8.** (d)
- 9.** (b)
- 10.** (a)
- 11.** (a)
- 12.** (d).

4. *Funaria* (Bryophyta)

- 1.** (c)
- 2.** (d)
- 3.** (d)
- 4.** (d)
- 5.** (a)
- 6.** (d)
- 7.** (c)
- 8.** (b)
- 9.** (c)
- 10.** (c).

5. Fern (Pteridophyta)

- 1.** (d)
- 2.** (a)

3. (d).

6. *Pinus* (Gymnosperm)

1. (b)

2. (c)

3. (b)

4. (b)

5. (b)

6. (a)

7. (b).

7. Angiosperms

1. (d)

2. (b)

3. (b)

4. (b)

5. (b)

6. (a)

7. (b)

8. (b)

9. (d)

10. (a).

8. Earthworm (Annelida)

1. (c)

2. (c)

3. (b)

4. (d)

5. (b)

6. (b)

7. (b)

8. (a)

9. (d)

10. (b).

9. Mollusca

1. (a).

10. Cockroach (Arthropoda)

- 1.** (d)
- 2.** (a)
- 3.** (a)
- 4.** (a)
- 5.** (a)
- 6.** (d)
- 7.** (b)
- 8.** (c)
- 9.** (b)
- 10.** (c)
- 11.** (b)
- 12.** (d)
- 13.** (d)
- 14.** (d)
- 15.** (a)
- 16.** (b)
- 17.** (a)
- 18.** (c)
- 19.** (b).

11. Echinodermata

- 1.** (b)
- 2.** (b)
- 3.** (a).

12. Bony Fish (Pisces)

- 1.** (a)
- 2.** (a)
- 3.** (a)
- 4.** (b)
- 5.** (c)
- 6.** (d)
- 7.** (d)
- 8.** (b)
- 9.** (b)
- 10.** (c)
- 11.** (b)

12. (d).

13. Frog (Amphibia)

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

14. Reptilia

- 1. (c).

15. Birds (Aves)

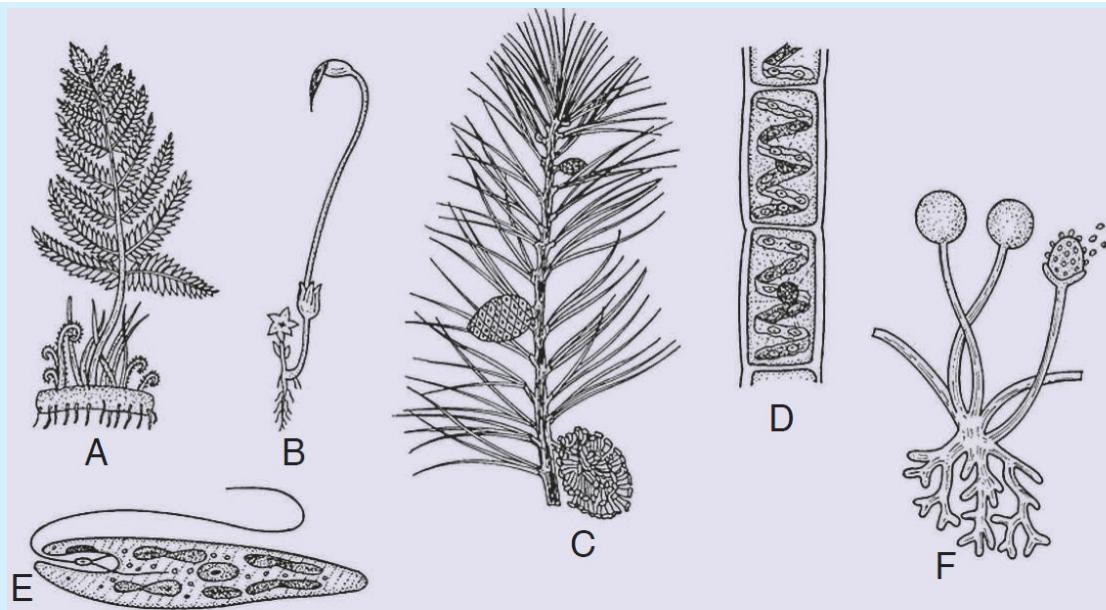
- 1. (c)
- 2. (c)
- 3. (d)
- 4. (b)
- 5. (d)
- 6. (d)
- 7. (d)
- 8. (c)
- 9. (a)
- 10. (d)
- 11. (d)
- 12. (c)
- 13. (b)
- 14. (a)
- 15. (a)
- 16. (c).

16. Mammals

- 1. (a)
- 2. (b)
- 3. (a).

**QUESTIONS BASED ON HIGH ORDER
THINKING SKILLS (HOTS)**

Q.1.

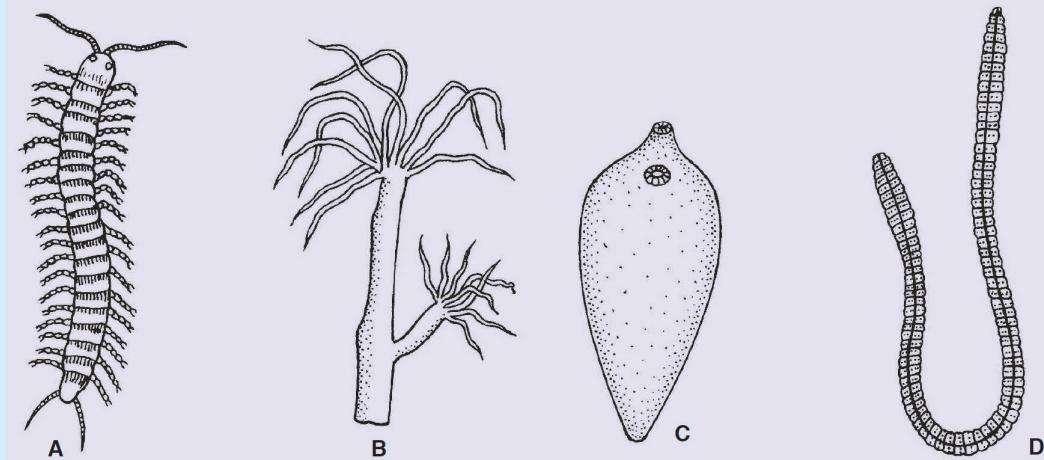


- (a) Identify figures A to F ?
- (b) What is the phylum of D, E and F ?
- (c) What is the division of A, B and C ?
- (d) Which of them is unicellular and eukaryotic organism ?
- (e) Which one of them exhibits (i) Heterotrophic nutrition; (ii) Mixotrophic nutrition.
- (f) Which one of them is multicellular decomposer ?
- (g) Which one amphibian of plant kingdom ?
- (h) In which one of them plant xylem lacks vessels and phloem is without companion cells ?
- (i) What is the scientific name of each of them : (i) Male shield fern ; (ii) Bread mould ?
- (j) In which of them endosperm is haploid ?

- Ans.**
- (a) **Identification.** A - Male shield fern (*Dryopteris*); B - Moss (*Funaria*), C - *Pinus*; D - *Spirogyra* ; E- *Euglena*, F - Bread Mould (*Rhizopus*).
 - (b) **Classification.** D - Algae; E-Protozoa; F-Fungi.
 - (c) **Classification.** A - Pteridophyta; B - Bryophyta; C - Gymnospermae.
 - (d) **Unicelluar Eukaryotic Organism** - *Euglena*.
 - (e) (i) **Heterotrophic nutrition** - *Rhizopus* ; (ii) **Mixotrophic nutrition** - *Euglena*.
 - (f) **Multicellular decomposer** — *Rhizopus*.
 - (g) **Amphibian of plant kigndom** - *Funaria*.
 - (h) *Pinus*

- (i) (i) *Dryopteris*; (ii) *Rhizopus*
(j) *Pinus* has haploid endosperm.

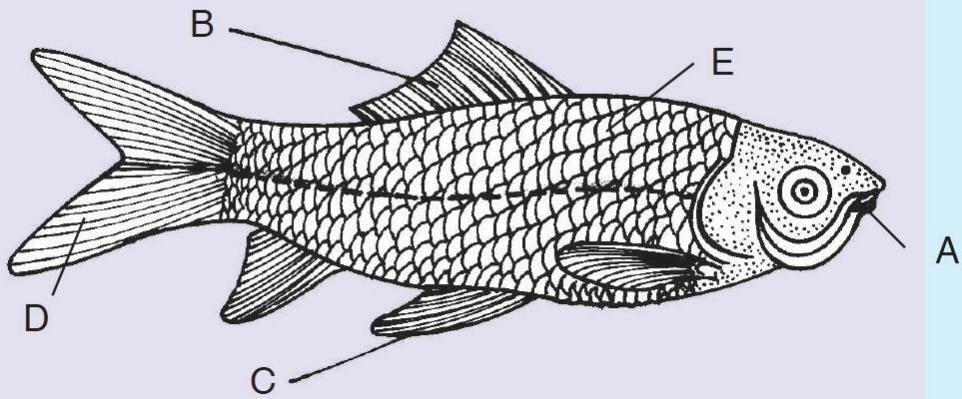
Q.2.



- (a) Identify figure A to D.
(b) Which one of them is (i) diploblastic; (ii) triploblastic ?
(c) Which triploblastic animal is (i) Acoelomate; (ii) Coelomate ?
(d) Which one belong to phylum
(i) Cnidaria; (ii) Platyhelminthes; (iii) Annelids; (iv) Arthropoda ?
(e) Which one of them has
(i) Organ level organisation ;
(ii) Organ-system level organisation ?
(f) Which one of them has excretory organs in the form of (i) Flame cells; (ii) Nephridia ?
(g) Which one of them has tracheae as the respiratory organ ?

- Ans.** (a) Identification. A-Scolopendra (Centipede), (B)-Hydra; C-Fasciola hepatica (liverfluke), D-Pheretima posthuma (earthworm).
(b) (i) Diploblastic. *Hydra*. (ii) Triploblastic. *Fasciola*, *Pheretima*, *Scolopendra*.
(c) (i) Triploblastic acoelmate-*Fasciola*. (ii) Triploblastic coelomate-*Pheretima*, *Scolopendra*.
(d) (i) Cnidaria. *Hydra*; (ii) Platyhelminthes. *Fasciola*; (iii) Annelida. *Pheretima*. (iv) Arthropoda. *Scolopendra*.
(e) (i) Organ level organisation - *Fasciola*; (ii) Organ system level of organisation. *Pheretima*, *Scolopendra*.
(f) (i) Flame cells - *Fasciola*; (ii) Nephridia - *Pheretima*.
(g) Tracheae. *Scolopendra*.

Q. 3.



- (a) Identify the figure and write down its class.
- (b) Label A, B, C and D.
- (c) What is its respiratory organs ?
- (d) What type of adaptation this creature has ?
- (e) What type of endoskeleton it has ?

Ans. Identification and Classification.

- (a) Bonyfish; Class-Osteichthyes (Phylum Chordata).
- (b) **Labelling.** A-Mouth; B-Dorsal fin; C-Pectoral fin; D-Caudal fin; E-Scales.
- (c) **Respiratory organs.** Gills.
Have adaptation to live in water and to swim. (i.e., stream-lined body, fins and tail for swimming, slimy and scale covered body, gills for aquatic breathing; ammonia as the excretory substance, lateral-line sense organs, etc.). It is a freshwater fish.
- (d) aquatic breathing; ammonia as the excretory substance, lateral-line sense organs, etc.). It is a freshwater fish.
- (e) Bony endoskeleton.

SOME ACTIVITY BASED QUESTIONS

1. **What is scientific name of cow ?**

Ans. *Bos indicus*

2. **What is the purpose of bringing exotic breeds of cattle to India. Name one.**

Ans. Purpose of bringing exotic breeds of cattle to India is for improving local breeds of cow, so as to obtain higher milk yield.

Exotic breed of cow = Jersey

(Note. To get more female calves and increased yield of milk from cows, in future, only semen of selected U.S. bulls (Blitz, Oman, Potter, etc.) will be imported for artificial insemination of local breeds in Punjab; see Suckhdeep Kaur, Indian Express, 6th September 2010).

3. A weed is growing on the border of your playing ground. How will you recognise it to be a dicot or monocot?

Ans. A dicot plant has reticulate venation, tap root system and pentamerous or tetramerous flowers. The dicot seeds have two cotyledons.

A monocot plant has parallel venation, fibrous root system and trimerous flowers. The monocot seeds contain only one cotyledon.

- 4. Give local names of one plant or one animal in five languages.**

Ans. See text.

5. Write scientific names of any two plants and any two animals.

Ans. See text.

PAPER - PEN TEST

Time 30 minutes

Maximum marks 17

- ### 1. Birds differ from bats in absence of

(a) homeothermy

MCQ

(b) four-chambered heart

(c) tracheae

(d) diaphragm

1

Blanks

2. Moss and liverworts belong to division -----.

1

T/F

3. *Hemidactylus* is a flying lizard and reptile.

1

Matching

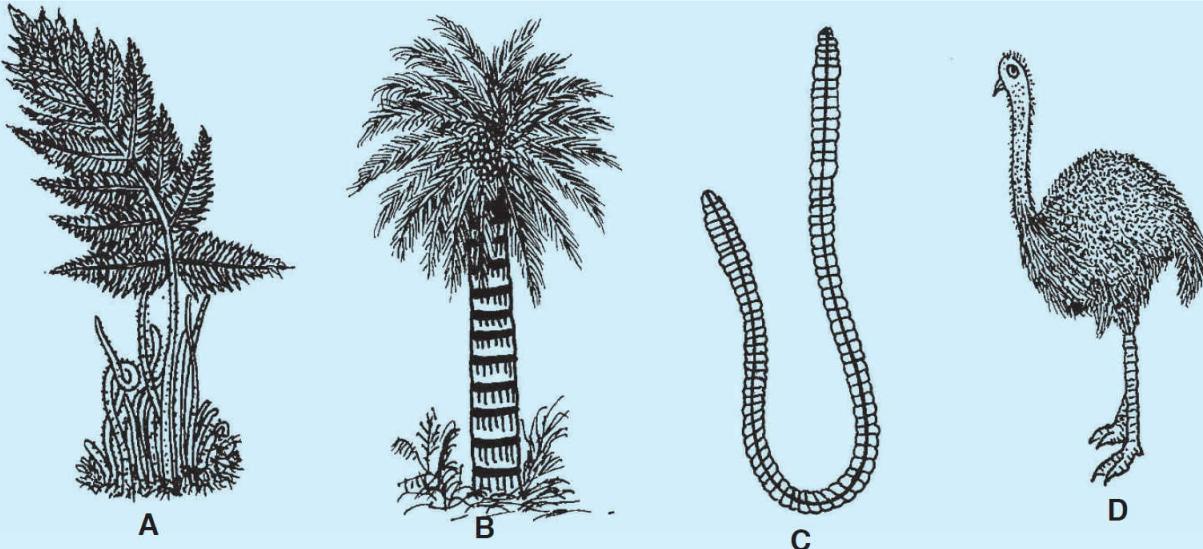
- 4. Match the column I and column II**

<i>Column I</i>	<i>Column II</i>
1. <i>Sycon</i>	(a) Hemichordata
2. <i>Balanoglossus</i>	(b) <i>Myxine</i>
3. <i>Cycas</i>	(c) <i>Monocot</i>

- | | |
|-----------------------|----------------------|
| 4. Hag fish | (d) Carolus Linnaeus |
| 5. Binomial system | (e) Gymnosperm |
| 6. Single cotyledon | (f) Porifera |
| 7. <i>Spirogyra</i> | (g) Two names |
| 8. Father of taxonomy | (h) Algae |

Hots 5. Identify the following.

2



S.A.I. 6. Write four aquatic adaptations of fishes.

2

S.A.II 7. What is binomial nomenclature ? What are its advantages ?

5

L.A. 8. Describe classification of kingdom Plantae. Mention one characteristic and one example of each class.

5

REVISION QUESTIONS

Very Short Answer Questions (Carrying 1 mark each)

1. **What is diversity ?**

Diversity is the occurrence of various types of living beings which

- Ans.** differ from one another in external form and appearance, internal structure, nutrition, behaviour, habitat, etc.
- 2. How many types of organisms are believed to be present on Earth?**
- Ans.** 1.7-1.8 million.
- 3. What is the size of blue whale ?**
- Ans.** 30 meters in length (largest animal).
- 4. What is the height of Redwood tree?**
- Ans.** 100 meters.
- 5. Who is close to us, monkey or cow ?**
- Ans.** Monkey.
- 6. What is megadiversity ?**
- Ans.** Megadiversity is the high degree of richness of different types of forms found in an area.
- 7. What is the region of megadiversity ?**
- Ans.** The area of megadiversity on Earth is humid tropical region lying between tropic of Cancer and tropic of Capricorn.
- 8. Name two countries that are centres of megadiversity.**
- Ans.** India (Western Ghats, North East Himalayas), Malayasia.
- 9. What is nomenclature ?**
- Ans.** Nomenclature is a system of giving distinct and proper names to various objects.
- 10. Define binomial nomenclature.**
- Ans.** Binomial nomenclature is a system of giving distinct and proper names to organisms with each name consisting of two words, generic and specific.
- 11. Who proposed binomial nomenclature ?**
- Ans.** Carolus Linnaeus (Karl von Linne).
- 12. What is common or vernacular name ?**
- Ans.** Common or vernacular name is regional name specific to a language which is given to an organism by local people.
- 13. Rewrite the following scientific names correctly, if incorrect.**

1. Amoeba Histolytica;

- 2. *Atthala rosea* (holly-hock);**
3. *Brassica Campestris*;
4. *brassica capitata* (cabbage).
- Ans.** 1. *Amoeba histolytica* 2. *Athala rosea*
3. *Brassica campestris* 4. *Brassica capitata*.
- 14. What is the scientific name of humans ?**
- Ans.** *Homo sapiens*.
- 15. Write scientific name of one animal and one plant.**
- Ans.** (a) *Azadirachta indica* - Margossa, Neem.;
(b) *Panthera tigris* - Tiger, Bagh.
- 16. What is main advantage of using scientific name ?**
- The scientific names have no resemblance with common names.
Ans. Common names differ from language to language but scientific names are universal, distinct and specific.
- 17. What is classification ?**
- Ans.** It is arranging of living beings in groups and subgroups on the basis of their fundamental similarities and disimilarities.
- 18. What is taxonomy ?**
- Ans.** It is a branch of biology which deals with identification, nomenclature and classification of organism.
- 19. Who is considered father of taxonomy ?**
- Ans.** **Carolus Linnaeus** (Karl von Linne, 1707-1778).
- 20. What is characteristic ?**
- Ans.** It is a particular form or function found in all members of one or more organisms.
- 21. Define artificial system of classification.**
- Ans.** It is a system of classification which uses one or a few characteristics for grouping of organisms.
- 22. What is natural system of classification ?**
- Ans.** A natural system of classification is the one which uses several characteristics from various aspects of organisms to bring out natural relationships amongst them.

- 23. What is the utility of artificial systems of classification ?**
- Ans.** Artificial systems of classification are useful in quick identification of organisms.
- 24. Write down one drawback of artificial system of classification.**
- Ans.** Closely related organisms get separated into different groups while unrelated organisms get grouped together.
- 25. Which characteristic is likely to be more basic?**
- Ans.** The characteristics which came into existence earlier is likely to be more basic.
- 26. Who has described the idea of evolution in book “The origin of species”?**
- Ans.** Charles Darwin (1859).
- 27. What is primitive organism ?**
- Ans.** Primitive organisms is one which has ancient body design that has not changed very much.
- 28. What are advanced organisms ?**
- Ans.** Advanced organisms are the ones which have evolved recently and usually possess more complex and elaborate structure.
- 29. What is taxonomic category ?**
- Ans.** Taxonomic category is a rank or group of organisms developed on the basis of their fundamental characteristics, similarities and dissimilarities.
- 30. What is hierarchy of categories ?**
- Ans.** Hierarchy of categories is a system of arranging taxonomic categories in a descending order on the basis of their relative dimensions.
- 31. What is Linnaean hierarchy ?**
- Ans.** Linnaean hierarchy is the other name of hierarchy of categories as it was developed by Linnaeus.
- 32. What is the basic unit of classification ?**
- Ans.** Species.
- 33. Which is the highest taxonomic category ?**
- Ans.** Kingdom.
- 34. How many categories are there in hierarchy classification ?**

- Ans.** Seven.
- 35. What is species ?**
- Species is a grouping of one or more natural populations of morphologically similar interbreeding individuals which are genetically distinct and reproductively isolated from others.
- 36. Who proposed 5-kingdom classification ?**
- Ans.** Robert H.Whittaker (1959).
- 37. What is contribution of Carl Woese in classification of organisms ?**
- Ans.** Carl Woese (1994) has divided kingdom Monera into Archaebacteria (= Archaea) and Eubacteria.
- 38. What is Monera ?**
- Ans.** Monera is the kingdom of prokaryotic organisms.
- 39. Define prokaryotes ?**
- Ans.** Organisms (archaea and bacteria) containing simple cells that do not have membrane-bounded organelles. Their, genetic material, the chromosome of a cell exists in an area called **nucleoid**, in direct contact with cytoplasm.
- 40. Which special biochemical constitutes the wall in monera ?**
- Ans.** Murein and peptidoglycan.
- 41. Give two examples of Monera.**
- Ans.** Methanogens (Archaea), *Escherichia coli* (Eubacteria) or *Anabaena* (cyanobacteria).
- 42. What is protista ?**
- Ans.** Protista is a kingdom of unicellular eukaryotes such as unicellular algae, fungi and protozoans.
- 43. What are eukaryotes ?**
- Ans.** Organisms (plants, animals, protists and fungi) containing advanced cells, each of which has a true **nucleus** and membrane-bounded organelles. Thus, in eukaryotic cells, the genetic material is isolated from cytoplasm by a nuclear envelope of two membranes.
- 44. What is mixotrophic nutrition ?**
- Ans.** Mixotrophic nutrition is a type of dual nutrition where in light the organisms performs photosynthesis while in dark it switches over to

- saprophytic nutrition, e.g., *Euglena*.
- 45. Give two examples of protozoan protists.**
- Ans.** *Amoeba* and *Paramecium*.
- 46. Give one example of algal protist.**
- Ans.** *Chlamydomonas*.
- 47. Which one is called plant-animal ?**
- Ans.** *Euglena*.
- 48. What are fungi ?**
- Fungi are achlorophyllous, heterotrophic, spore producing, cell wall containing eukaryotes having chitin in their cell wall and glycogen as reserve food.
- 49. What is mycelium ?**
- Ans.** The mass of intermeshed hyphae (*i.e.*, fine threads) that permeate soil, rotting wood, or other substrate and that constitute the ‘body’ of fungus.
- 50. What is chemical characteristics of fungal cell wall.**
- Ans.** Chitin.
- 51. Give two examples of fungi.**
- Ans.** *Agaricus*, *Penicillium*.
- 52. What is lichen ?**
- Ans.** Lichen is a dual organism which is made of a fungus and an alga, associated in a mutually beneficial association.
- 53. Give one use of lichen.**
- Ans.** Lichens are air pollution indicators.
- 54. Define thallus ?**
- Ans.** Thallus is the plant body in which there is no differentiation of root, stem and leaves.
- 55. Write down two important characteristics of algal cell wall ?**
- Ans.** (i) Unicellular non-jacketed sex organs.
(ii) Absence of embryo sac.
- 56. What is the chemical characteristics of algal cell wall ?**
- Ans.** Cellulose.
- 57. To which division of cryptogams do algae belong ?**

- Ans.** Thallophyta.
- 58.** Name the division which is known as “amphibians of plant kingdom”.
- Ans.** Bryophyta.
- 59.** Name the body part which helps in attaching the bryophytes to the substratum.
- Ans.** Rhizoid.
- 60.** What is peculiar about sex organs in bryophytes?
- Ans.** Multicellular and jacketed.
- 61.** Give two examples of bryophytes.
- Ans.** *Riccia* and *Funaria* (Moss).
- 62.** Give two examples of pteridophytes.
- Ans.** *Selaginella* and *Dryopteris*.
- 63.** Name the group of vascular cryptogams.
- Ans.** Pteridophyta.
- 64.** Why bryophytes and pteridophytes grow in moist and shady places?
- Ans.** They grow in moist and shady places because they require water for fertilization.
- 65.** What do you mean by the term spermatophyta?
- Ans.** The group of seed bearing plants is known as spermatophyta.
- 66.** Name the group: (i) in which seeds are naked; (ii) in which reproductive organs are flowers.
- Ans.** (i) Gymnosperms; (ii) Angiosperms.
- 67.** Classify the following seeds into dicot and monocot: wheat, maize, bean, gram.
- Ans.** Dicot seeds. bean, gram. Monocot seeds. wheat, maize.
- 68.** Name the class of angiosperms in which :
- (a) reticular venation is present;
- (b) leaves show parallel venation.
- Ans.** (a) Dicot; (b) Monocot.
- 69.** Name the sex organs of gymnosperms and angiosperms.

- Ans.** In gymnosperms reproductive organ is called **cone** whereas in angiosperms sex organ is known as **flower**.
- 70.** **Name the subdivision in which xylem contains vessels.**
- Ans.** Angiospermae.
- 71.** **What are phanerogams ?**
- Ans.** Phanerogams are seed plants, in which plant body is differentiated into true root, stem and leaves.
- 72.** **What are nonchordates ?**
- Ans.** Nonchordates are those animals in which notochord is not present.
- 73.** **What is cell level organisation ?**
- Ans.** It is a type of body organisation of animals which is based on cells that are not organised into tissues.
- 74.** **What are parazoa ?**
- Ans.** Parazoa are animals whose body consists of loosely aggregated cells, e.g., Porifera.
- 75.** **What is choanocyte ?**
- Ans.** Choanocyte or collar cell is a unique cell type of porifers which contains a flagellum surrounded at its base by a thin cytoplasmic collar. This cell creates current and ingest food particles from water.
- 76.** **What are cnidoblasts ?**
- Ans.** Cnidoblasts or nematoblasts are stinging cells found in cnidaria or coelenterata. Each of them bears a stinging cell organelle called **nematocyst** which is used in offence, defence and attachment of the animal.
- 77.** **Define diploblastic animals.**
- Ans.** They are animals having two germinal layers in the embryo, the outer ectoderm and the inner endoderm, e.g., porifera and cnidaria.
- 78.** **What is pseudocoelom ?**
- Ans.** Pseudocoelom is false body cavity which is generally endodermal in origin and not lined by mesoderm.
- 79.** **Define enterocoelom.**
- Ans.** Enterocoelom is a true coelom which develops as lateral pouches from the embryonic gut (archenteron), e.g., Echinodermata and Chordata.

- This cavity is lined by cells of mesodermal origin.
- 80. What is bilateral symmetry ?**
- Bilateral symmetry is a type of symmetry found in most animals in which appendages and organs of the body are paired and where the body can be divided into two equal halves by a section passing through midsagittal plane, e.g., Fish, Frog, Rat, Human beings, etc. It is an adaptation of motile life style.
- 81. Name a fresh water sponge ?**
- Ans.** *Spongilla.*
- 82. Name the following :**
- (a) Cavity present in the body of sponges.
(b) Cavity present in the body of cnidarians.
- Ans.** (a) Spongocoel; (b) Coelenteron.
- 83. What is the skeleton of sponges made up of ?**
- Ans.** Skeleton of sponges is made of spicules or spongin fibres. Spicules are formed of calcium carbonate and silica.
- 84. Name the following:**
- (a) Simplest sponges;
(b) Commonly known as bath sponge.
- Ans.** (a) *Leucosolenia* ;
(b) *Euspongia*.
- 85. Write down two unique characters of Porifera.**
- Ans.** (i) Presence of canal system and
(ii) Skeleton of spicules.
- 86. What is the name of gelatinous layer existing between two germ layer of Cnidaria ?**
- Ans.** Mesogloea or mesohyl.
- 87. What is the body symmetry of cnidarians or coelenterates ?**
- Ans.** Radial symmetry.
- 88. What type of digestion takes place in cnidarians ?**
- Ans.** Both intercellular and intracellular.
- 89. In which phylum, nervous system develops for the first time ?**

- Ans.** Cnidarians.
- 90.** **Name the organisms in which asexual reproduction takes place by budding.**
- Ans.** *Hydra* and other cnidarians.
- 91.** **To which phylum do sponges belong ?**
- Ans.** Porifera.
- 92.** **What is alternation of generation ?**
- When asexual generation (polypoid generation) and sexual generation (medusoid generation) alternate each other in the life cycle, it is called alternation of generation or metagenesis, e.g. *Obelia* and other cnidarians.
- 93.** **What is common name of following :**
- (a) *Pleurobranchia* and
- (b) *Cestum*.
- Ans.** (a) Comb jelly;
(b) Venus's girdle.
- 94.** **Give an example of ctenophora.**
- Ans.** *Beroe*.
- 95.** **What are colloblasts ?**
- Ans.** Colloblasts are adhesive cells found on the tentacles of Ctenophora.
- 96.** **What types of body symmetry is present in Platyhelminthes ?**
- Ans.** Bilateral symmetry.
- 97.** **Name the excretory organs in Platyhelminthes.**
- Ans.** Flame cells.
- 98.** **Name the following :**
- (a) Free living Platyhelminthes ;
- (b) Scientific name of pork tape worm.
- Ans.** (a) *Planaria*;
(b) *Taenia solium*.
- 99.** **Which type of body organisation is present in Platyhelminthes ?**
- Ans.** Organ system level of organisation.
- 100.** **Give one example of :**

(a) Platyhelminthes ;

(b) Nematoda.

- Ans.** (a) Tapeworm (*Taenia solium*);
(b) Roundworm (*Ascaris lumbricoides*).

101. What is common name of nematoda.

- Ans.** Roundworm.

102. Give the scientific name of the following :

- (a) Roundworm;**
(b) Filarial worm.

- Ans.** (a) *Ascaris lumbricoides*;
(b) *Wuchereria bancrofti*.

103. Name the causal organisms of elephantitis.

- Ans.** *Wuchereria bancrofti*.

104. What is the common name of annelids ?

- Ans.** Segmented worms.

105. Which type of circulatory system is present in annelids ?

- Ans.** Closed circulatory system.

106. Name the excretory organ of annelids.

- Ans.** Nephridia.

107. Give the scientific name of the following:

- (a) Earthworm ;**
(b) Leech

- Ans.** (a) *Pheretima posthuma*
(b) *Hirudinaria*.

108. Name the parasitic annelid.

- Ans.** *Hirudinaria* (Leech).

109. Enumerate locomotory organs of annelids ?

- Ans.** Parapodia and setae.

110. Name the largest phylum of Invertebrata.

- Ans.** Arthropoda.

- 111. Which is second largest phylum of Invertebrata**
- Ans.** Mollusca.
- 112. What is literal meaning of (a) Arthropoda; (b) Mollusca.**
- Ans.** (a) Jointed legs; (b) Soft bodied animals.
- 113. Name those phyla in which circulatory system is open and body cavity is filled with blood.**
- Ans.** Mollusca and Arthropoda.
- 114. Name the excretory organ of (a) Crab; (b) Insect.**
- Ans.** (a) Green gland; (b) Malpighian tubules.
- 115. Which type of eye is present in insects?**
- Ans.** Compound eye.
- 116. Which part of Molluscan's body secrete the shell?**
- Ans.** Mantle.
- 117. Name the organ of locomotion in Mollusca.**
- Ans.** Muscular foot.
- 118. Give two examples of Mollusca.**
- Ans.** *Pila* and *Octopus*.
- 119. Name the locomotory organs in insects.**
- Ans.** Three pairs of walking legs (jointed) and two pairs of wings.
- 120. What is habitat of all echinoderms ?**
- Ans.** Marine habitat.
- 121. What is body symmetry of echinoderms ?**
- Ans.** Radial symmetry (in adults, since their larvae are bilaterally symmetrical).
- 122. Name the organ of echinoderms which helps in respiration and locomotion ?**
- Ans.** Tube feet.
- 123. What is literal meaning of echinoderms ?**
- Ans.** Spiny skinned animals.
- 124. Given one example of Onychophora ?**
- Ans.** *Peripatus*.

- 125.** **Name the phylum in which pharyngeal gill slits are present but notochord is absent.**
- Ans.** Phylum Hemichordata (Now considered as Nonchordata).
- 126.** **Give one example of phylum Hemichordata.**
- Ans.** *Balanoglossus*.
- 127.** **What is common name of *Balanoglossus* ?**
- Ans.** Acorn worm or Tongue worm.
- 128.** **Name the phylum in which dorsal nerve tube, notochord and pharyngeal gill clefts are present.**
- Ans.** Chordata.
- 129.** **Give one example of**
(a) Urochordata; (b) Cephalochordata.
- Ans.** (a) Herdmania; (b) *Branchiostoma (Amphioxus)*.
- 130.** **What do you meant by the term Craniata ?**
- Craniata are animals which have the cranium (brain box) around the brain. They also have the vertebral column, so are also called **Vertebrata**.
- 131.** **What is the position of Notochord in the body of**
(a) Urochordata; (b) Cephalochordata ?
- Ans.** (a) In the tail region of larva of Urochordata.
(b) Notochord extends upto anterior end of the body and persists in larval as well as adult animals.
- 132.** **Give two examples of Cyclostomata.**
- Ans.** Lamprey (*Petromyzon*), Hagfish (*Myxine*).
- 133.** **What do you mean by the term Chondrichthyes ?**
- Ans.** Cartilaginous fishes.
- 134.** **What do you mean by the term Osteichthyes ?**
- Ans.** Bony fishes.
- 135.** **How many chambers are present in the heart of : (i) Fishes; (ii) Frog ?**
- Ans.** (a) Two; (b) Three.
- Name four Chordata classes having cold blooded animals.**

136.

Ans. Chondrichthyes, Osteichthyes, Amphibia and Reptilia.

137. **Name the superclass of Chordata in which lateral line sense organs are found.**

Ans. Pisces.

138. **Identify the following fishes :**

(a) Fish with 5 to 7 pairs of gills ;

(b) Fish with air bladder.

Ans. (a) Cartilaginous fish;

(b) Bony fish.

139. **Give one example of (a) cartilaginous fish; (b) bony fish.**

Ans. (a) *Scoliodon* (dog fish, Indian shark); (b) *Labeo* (rohu, carp).

140. **Give the scientific name of the following:**

(a) Mosquito fish; **(b)** Flying fish.

Ans. (a) *Gambusia*; (b) *Exocoetus*.

141. **Why amphibians are present close to the water bodies ?**

Ans. Water is required for fertilization and also for keeping body surface moist.

142. **What do you understand by the term tetrapoda ? Name two classes belonging to tetrapoda.**

Ans. Animals having four limbs are called *tetrapods*. Tetrapoda group belongs to old system of classification and include classes such as Amphibia and Reptilia.

143. **Name the following**

(a) Organism in which external ear (pinna) is present

(b) Organism in which nictitating membrane is present.

Ans. (a) Human being ; (b) Frog.

144. **Name two classes of chordates in which clawed digits are present.**

Ans. Reptilia and Aves.

145. **Name the first class of terrestrial chordates.**

Ans. Reptilia.

146. **Name the reptile in which heart is four chambered.**

- Ans.** Crocodile.
- 147.** **What is literal meaning of reptiles ?**
- Ans.** Creeping animals.
- 148.** **Name the class in which**
- (a) Syrinx is present;**
- (b) Pneumatic bones are present.**
- Ans.** (a) Aves;
(b) Aves.
- 149.** **Name the national bird and national animal of India.**
- Ans.** Peacock and Tiger.
- 150.** **Name the chordate class of flying worm blooded animals in which teeth are absent.**
- Ans.** Aves.
- 151.** **Name the class in which :**
- (a) digits end up in nail and claws ;**
- (b) hair are present as exoskeleton.**
- Ans.** (a) Mammals;
(b) Mammals.
- 152.** **How many cervical vertebrae are found in mammals ?**
- Ans.** Seven.
- 153.** **Mention one unique feature of mammals.**
- Ans.** Presence of diaphragm.

Short Answer Questions (Carrying 2 marks each)

1. Enlist various types of species diversity.
2. By given the example of a tree explain various types species diversity.
3. What is the need for classification ?
4. What is basis of classification ?

5. How is the complexity of cell structure and their number used in classification ?
6. Mention seven categories of hierarchical classification.
7. Give distinguishing features of plants and animals.
8. Write down two disadvantages of two kingdom classification.
9. With the help of flow chart depict five kingdoms classification.
10. Mention two characteristics of kingdom Protista.
11. Write a note on lichens.
12. Draw a flow chart showing classification of kingdom Plantae
13. Write four general characters of Thallophyta.
14. Distinguish between algae and fungi.
15. Give the four characteristics of algae.
16. Write down differences between dicots and monocots.
17. Write down differences between bryophytes and pteridophytes.
18. Write down four main characters of Bryophyta. Give two examples.
19. Write down four main characters of Pteridophyta. Give two examples.
20. Write down four main characters of gymnosperms.
21. Write down four main characters of angiosperms.
22. Distinguish between Nonchordata and Chordata.
23. How do animals of Porifera differ from animals of Cnidaria?
24. Distinguish between polyp and medusa.
25. Write down four general characters of Porifera. Give two examples.
26. Write down four general characters of cnidarians (coelenterates). Give two examples.
27. What is difference between bilateral symmetry and radial symmetry ?
28. Write down four characteristics of Ctenophora and give two examples.
29. Write down four main characters of Platyhelminthes. Give two examples.
30. Write down four main characters of Nematoda. Give two examples.
31. Write down four main characters of Annelida.

32. Define the term hermaphrodite. Give two examples.
33. What do you mean by the term triploblastic animals ?Give two examples.
34. What do you mean by the term coelomate animals ? Give two examples.
35. Write down four general characters of phylum Arthropoda. Give two examples.
36. Give four general characters of phylum Mollusca. Write down two examples.
37. Write down four general characters of phylum Echinodermata. Give two examples.
38. Write the scientific names of:
 - (a) Prawn; (b) House fly; (c) Star fish; (d) Squid; (e) Apple snail; (f) Fresh water mussel.
39. Name the phylum in which ambulacrual system is present. What is its function?
40. What are adaptations in fishes due to which they are aquatic ?
41. Write down four characters of Chondrichthyes. Give two examples.
42. Write down four characters of Osteichthyes and give two examples.
43. What are differences between the following :
 - (a) Cartilaginous fishes and bony fishes ;
 - (b) Amphibia and Reptilia ;
 - (c) Aves and mammals.
44. Write down four characters of mammals. Give two examples.
45. Describe some flight adaptations of the birds.
46. Write down four main characters of chordates.
47. Write short note on protochordates.
48. Give an example each of Urochordata and Cephalochordata.
49. Give one point of difference between notochord and nerve cord.

Long Answer Questions (Carrying 5 marks each)

1. Describe the characteristics used in hierarchical classification of organisms.
2. Briefly describe the importance of classification.
3. What is hierarchy of categories ? Describe the same.
4. Write a note on kingdom Monera.
5. Describe the characteristics of kingdom Protista. Give two examples.
6. Write a note on kingdom Fungi.
7. Describe general characters, classification and example of old division Spermatophyta.
8. Define pteridophytes. Compare between bryophytes and Pteridophytes.
9. Explain general characteristics of phylum Platyhelminthes and Nematoda. Give two examples of each.
10. Describe general characteristics of phylum Annelida. Give one example each class of Annelida.
11. Explain the general characters of phylum Mollusca. Give one example of following classes of Mollusca; (i) Gastropoda; (ii) Pelecypoda; (iii) Cephalopoda.
12. Explain the general characters of phylum Arthropoda. Give one example of following classes (i) Crustacea; (ii) Myriapoda; (iii) Insecta; (iv) Arachnida.
13. Name major phyla of Animal kingdom. Write down one character and one example of each of them.
14. Describe the important characters of mammals and birds. Give two examples of each.
15. What are fishes ? Classify and explain two different kinds of fishes by the help of suitable examples.

VALUE BASED QUESTIONS

On a rainy day, Vibhuti found small brownish worm - like animals

1. **crawling slowly over the ground of his school. On close examination of these worms, she found that the animal has faintly segmented body.**

- (i) What is the possible identity of the animal ?**
- (ii) Why is it seen only in the rainy season ?**
- (iii) What is its ecological importance ?**

Ans. (i) The identity of the crawling animal is earthworm (*Pheretima*).

Earthworm lives in burrows inside the soil of lawn/fields. In rainy season, the burrows get filled up with rain water. So the earthworms come out of them.

Earthworm feeds on decaying fallen leaves and other organic remains. (iii) It pulverises these food particles. The worm castings are good source of soil nutrients.

Earthworm is regarded as farmer's friend as it ploughs the soil of crop fields by its burrowing habit and converts organic remains into manure containing inorganic nutrients.

Q.2. Seeing a bat flying over the roof of her house, Babita asked her father following questions:

- (i) What is this night flying bird ?**
- (ii) How does it see during night ?**
- (iii) What does it eat and how does it obtain its food ?**

Ans. (i) Bat is not a bird. It is a mammal that has patagia in the forelimbs to function as wings and help in bat's flight.

Bat does not require sharp vision for its flight. It flies through (ii) echolocation or sending echo waves that are interpreted to know the obstacles. Bat thus "sees through its ears".

Bat feeds on nocturnal flying insects such as moths. The insects are located through sound waves produced by them. Feeding on insects (iii) acts as biological control on the population of night flying insects. It is a rule of nature which keeps ecological balance.

"Vasu lives in a coastal village. He is a son of a fisherman. Whenever any unwanted animal comes in the net, instead of killing it, he puts back the same in the sea." Answer the following questions based on above information:

- (i) What would have happened had he killed those animals ?**
- (ii) Give an reason to justify that Vasu's action is environment friendly.**

How can you contribute in the preservation of flora and fauna

(iii) around you ? Mention any three steps.

(Sample Paper 2012-13)

- Ans.** (i) Killing of unwanted animals would have contributed to disturbing ecological balance.
- (ii) Vasu is promoting conservation of biodiversity.
- (iii) (a) Spreading awareness about importance of biodiversity amongst classmates, family members and community members.
- (b) By not using products obtained from the wild animals. For example, by avoiding wastage of paper we can protect our forest covers.
- (c) We can become member of PETA (People for Ethical Treatment of Animals) and developing sympathy and love for all living organisms.

Reema went to the market to buy vegetables along with her mother. He saw that some vegetable vendors were also selling white umbrella-like structures along with other vegetables. He asked his mother about these umbrella - like structures. Failing in getting a convincing reply from her mother she enquired from her science teacher about these structures the next day in the school.

(i) What are umbrella – like structures called ? To which group they belong ? Where are they found ?

(ii) Are all types of these structures edible ?

(iii) What is the nutrient value of these edible structures ?

- These umbrella – like organisms are called **gilled mushrooms** which are edible spore-producing fruiting bodies. These organisms are fungi and they grow on decaying organic matter.

No; all species of mushrooms are not edible as some of these species

(ii) are highly poisonous. *Agaricus compestris* is a common edible mushroom.

(iii) Mushrooms are rich in minerals, vitamins, etc.

After recovering from infection of ringworm, Reena thought that all fungi are harmful for human kind, as these spoil food and cause

Q.5. various diseases. But her elder sister told him that not all fungi are harmful, some are quite useful such as in making bread, vitamins, medicines (antibiotics) and in decomposing organic wastes.

- (i) Name any fungus which is used in bread making.
- (ii) Name any fungus which is the source of some medicine.
- (iii) What ecological benefit is shown by fungi ?

Ans. (i) Yeast (*Saccharomyces*).
(ii) Green mould (*Penicillium*).

Fungi are decomposers (or micro-consumers) of ecosystem. They bring about decomposition of dead organic matter of any ecosystem and help in returning of mineral elements again to the medium and thus keep running the biogeochemical cycles of ecosystems.

Q.6. In rainy season, while walking along road-side, Vivek asked his father, a botanist, whether some small green, non-flowering, leafy and thalloid plants, having little differentiation of body and growing along pavement are of any use to us. Vivek's father answered that these plants are small but they play very important role in maintaining green cover of the land.

- (i) To which group these small thalloid, green, non-flowering plants belong ?
 - (ii) In what way bryophytes are useful to us ?
- Which other groups of plants act as colonizers of barren rocks and make land suitable for growth of higher plants ? Do these plants play some role in pollution monitoring.

Ans. (i) These are amphibians of plant kingdom and are known as Bryophytes.
(ii) These plants bind soil particles and thus prevent soil erosion. They also help in colonization of barren lands.
(iii) Lichens. Lichens are good indicators of atmospheric quality.

Q.7. During monsoon days, a blue green layer was developed on moist soil of village streets making them slippery. On the instruction of science teacher Ghanshyam collected this upper slippery layer of soil from the village street and dried it. Then he added this powder to his crop field. He got very good crop yield without using any fertilizer.

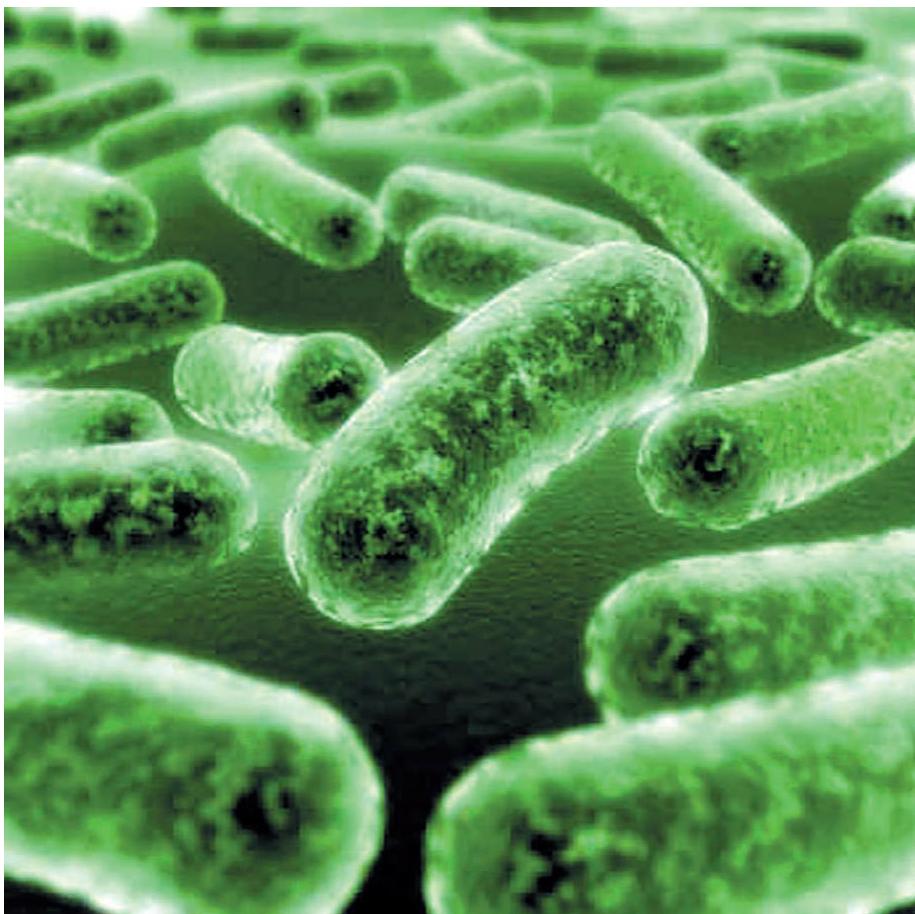
- (i) Which group of organisms is responsible for this blue green layer ?
- (ii) What is the possible reason for increased crop yield after addition of blue green layer to the fields ?
- (iii) Name one blue green alga which do nitrogen fixation.

(iv) Name one blue green alga which is a good source of protein.

- Ans.**
- (i) Blue green algae (Cyanobacteria).
 - (ii) Many blue green algae are known to fix atmospheric nitrogen (called biological nitrogen fixation) and improve the fertility of the soil.
 - (iii) *Anabaena*.
 - (iv) *Spirulina*.

CHAPTER 5

Why Do We Fall Ill ?



As we know, cells are the fundamental units of living organisms. They are made of a variety of chemical substances such as proteins, carbohydrates, fats or lipids and so on. We have also seen that each living cell in itself is a dynamic unit. Things are always happening

there. For instance, cells continuously move from place to place. Even when a cell is immobile, cell repair or formation of new cells and other such functions are continuously being carried out within cells. Similarly, within our body, organs carry various specialised activities at all times *e.g.*, the heart beats to pump blood to all body parts, the lungs breathe to exchange gases, the kidneys filter the blood and make urine and brain thinks. All these activities of various body organs are interconnected. If kidneys, stop filtering the blood, poisonous substances will accumulate in the body. Under such conditions, the brain will not be able to think properly. Anything that prevents proper functioning of the cells and tissues will lead to a lack of proper activities of the body.

ACTIVITY 5.1

Discuss the following question in your class :

- (i) What is health ?
- (ii) What is disease ?

5.1. HEALTH AND ITS FAILURE

1. Significance of Health

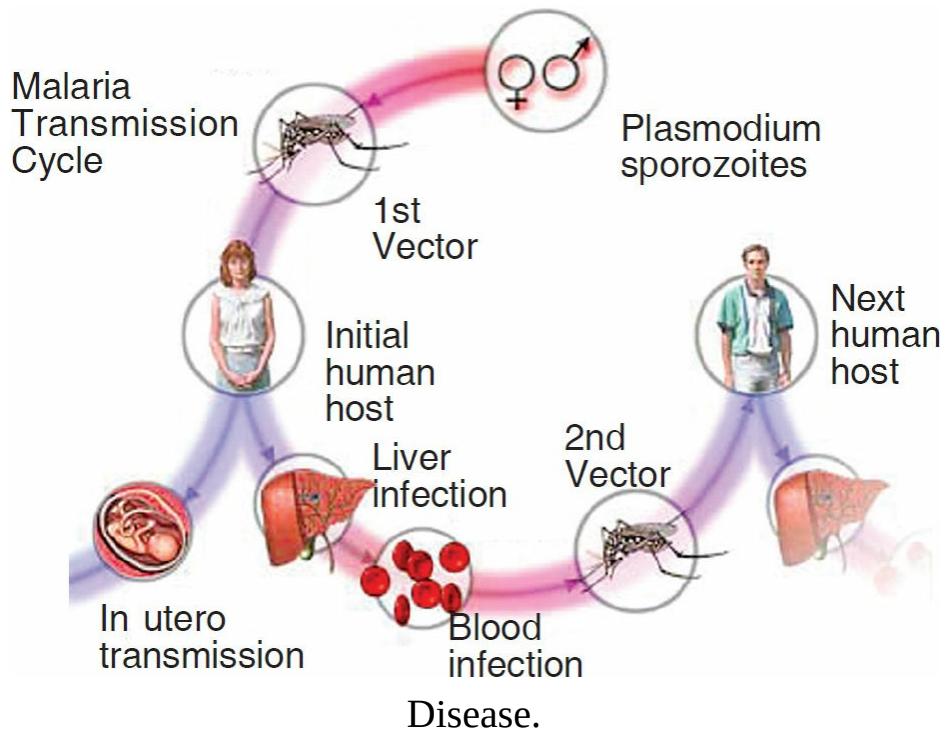
Health is described as the state of complete physical, mental and social well being. Thus, being healthy means that one feels good physically, has a positive outlook and is able to cope with the social and mental pressures without much difficulty. Being healthy is far more than just being free from diseases.

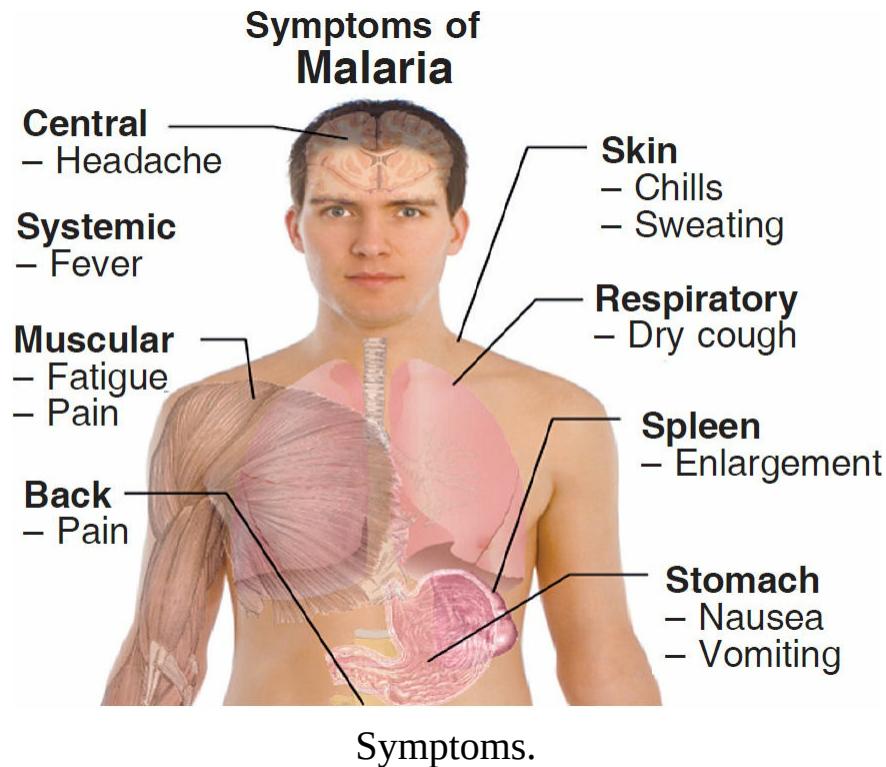
For maintaining a healthy life cycle, a person needs to have a balanced and varied diet, needs to exercise, live regularly in a proper shelter and get enough sleep. Maintaining a good hygiene also reduces the chances of developing an infection.

A disease regularly usually indicates malfunction in the body. A doctor is able to diagnose disease by indentifying the **symptoms**. Symptoms of a disease may be physical, mental or both.

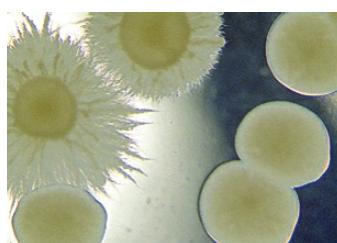


Health.





Our health is affected not only by unbalanced diet but also by disease causing organisms which may be water-borne, air-borne or food-borne. Some diseases are caused by infection through microorganisms, insects and parasites. Infection develops when germs/microbes (*i.e.*, viruses) or some-pathogenic (disease-producing) organisms such as bacteria, fungi, protozoans, helminthes, nematodes, etc., enter human body. Therefore, to prevent the infection of diseases, we need to keep our environment clean and hygienic. Thus, personal hygiene and community hygiene help in the prevention and spreading of the diseases.



Fungi.



Bacteria.



Nematode.



Helminth.

2. Overlap of Personal and Community Issues for Health

Human beings live in societies. Our social environment therefore plays an important part in our individual health. We live in villages, town or cities. In such places, our physical environment is decided by our social environment. For example, just think what would happen if there is no agency to ensure that garbage is collected and disposed ? What would happen if no one takes responsibility for cleaning the drains to ensure that waste water does not get collected in the streets or open spaces ?



If there are heaps of garbage and trash littered here and there, or if there is open drain water lying stagnant around where we live, the possibility of poor health increases. So, public cleanliness is also an important contribution to an individual's health.

ACTIVITY 5.2

Find out what are the provisions make by your local authority (panchayat or municipal corporation) for the supply of clean drinking water. Explain that whether all the people of your locality are able to access to this ?

ACTIVITY 5.3

Find out how your local authority manages the solid waste which is generated in your neighbourhood. Are these methods proper and adequate ?

1. If not, what improvements would you suggest ?
2. What could your family do to reduce the amount of solid waste generated during a day or week ?

Table 5.1. Differences between healthy and disease free.

Healthy	Disease free

1. It is a state of complete physical, mental and social well being.	1. It is a state of absence of discomfort or derangement in any part of body.
2. It depends upon the individual as well as on physical and social environmental factors.	2. It is related to the individual only.
3. A healthy person will be disease free.	3. A disease free person can be healthy or unhealthy.
4. Healthy person is energetic and able to perform as per requirement.	4. Performance of a disease free person depends upon environment and personal attitude.

Social equality and harmonious relationships among our population are necessary for the individual health. Thus, we see that there is a overlap of personal and community issues for health.

The conditions essential for good health are:

- Steps to ensure sanitation, i.e., clean surroundings by providing good sewage and rain water disposal systems and proper garbage disposals.
- Availability of clean drinking water.
- Availability of adequate, nutritious food.
- Social equality and harmony.

5.2. DISEASE AND ITS CAUSES

Occasionally, human health gets negatively affected due to physiological malfunctioning, psychological reasons or pathogenic (disease-causing) organisms. The term disease means Dis-ease or without ease or discomfort.

Disease can also be defined as an impairment (malfunctioning) of the normal state of the living organism that disturbs or modifies the performance of the vital functions. Disease may be a response to 1. environmental factors (as malnutrition, industrial hazards or

climate), 2. specific infective agents (as worms, protozoans, fungi, bacteria or viruses), 3. inherent defects of the organism (as genetic anomalies) 4. combination of these factors.

SOURCES OF DISEASE

Human health is effected by various factors, causes or sources ([Table 5.3](#)). These factors are of following types :

1. Intrinsic or Internal Factors

The disease causing factors which exist within the human body are called **intrinsic factors**. The important intrinsic factors which affect human health are the following :

- (i) Malfunctioning or improper functioning of various body parts such as heart, kidney, liver, etc.;
- (ii) Genetic disorder;
- (iii) Hormonal imbalances ([Table 5.2](#));
- (iv) Malfunctioning of immune system of body, e.g., allergy.

Table 5.2. Few common diseases due to hyposecretion and hypersecretion of hormones.

Disease	Hormone involved	Level of hormone
1. Grave's disease (Exophthalmic goitre)	1. Thyroid hormones	1. Hypersecretion
2. Cretinism (in infants)	2. - do -	2. Hypersecretion
3. Myxoderma (in adults)	3. - do -	3. Hypersecretion
4. Addison's disease	4. Aldosterone	4. Hyposecretion
5. Diabetes mellitus	5. Insulin	5. Hyposecretion

The diseases caused by intrinsic sources are called **organic or metabolic diseases**. Some of the diseases caused by intrinsic sources or factors are : 1. Cardiac failure (Heart attack); 2. Kidney failure; 3. Osteoporosis; 4. Myopia; 5. Cataract; 6. Sickle cell anaemia; 7. Haemophilia; 8. Dwarfism; 9. Gigantism; 10. Cretinism; 11. Diabetes; 12. Allergies (*e.g.*, asthma); 13. Arthritis; 14. Cancer.

Table 5.3. Classification of some common diseases of humans.

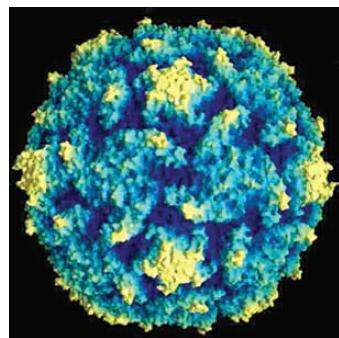
Type of disease	Causes of disease	Example
1. Physical	1. Temporary or permanent damage to body parts.	1. Bone fracture, leprosy.
2. Infectious	2. Invasion of the body by other organisms (viruses, bacteria, fungi, protozoans, nematodes, insects, etc.)	2. Typhoid, diarrhoea, malaria, hepatitis, AIDS, T.B., polio, influenza, cholera.
3. Deficiency	3. Inadequate diet	3. Kwashiorkor, marasmus, scurvy, rickets, anaemia, goitre, xerophthalmia, beri-beri.
4. Inherited	4. Defective genes passed on from parents to offspring.	4. Haemophilia, sickle-cell anaemia, cystic fibrosis.
5. Degenerative	5. Organs and tissues wear away and do not work so well with age.	5. Arthritis, poor sight and hearing defects.
6. Mental	6. Brain damage or psychological.	6. Depression, paranoia.
7. Social	7. Social interactions with family friends and strangers.	7. Drug dependence, alcoholism, smoking, unhealthy life-styles, social isolation.



AIDS.



Malaria.



Polio.



Cholera.

2. Extrinsic or External Factors

The disease causing (pathogenic) external agents which enter the human body from outside are referred to as **extrinsic factors**. The important extrinsic factors which upset human health are the following :

1. Unbalanced diet or inadequate diet ([Table 5.4](#));
2. Disease causing microorganisms such as viruses, bacteria, fungi, protozoans, helminthes, worms, etc.;
3. Environmental pollutants;
4. Tobacco, alcohol and narcotic drugs.

Extrinsic factors affect the health of our body by interfering with the normal functioning of the body system. The most important diseases caused by extrinsic factors are : 1. Kwashiorkor; 2. Marasmus; 3. Obesity; 4. Night-blindness; 5. Beri-beri; 6. Pellagra; 7. Scurvy; 8. Anaemia; 9. Goitre; 10. Rickets; 11. Fluorosis; 12. Food poisoning; 13. Diarrhoea; 14. Malaria; 15. AIDS; 16. Influenza; 17. Cholera; 18. Measles; 19. Chickenpox; 20. Tuberculosis; 21. Pneumonia; 22. Tetanus; 23. Leprosy; 24. Poliomyelitis; 25. Conjunctivitis; 26. Rabies; 27. Dengue; 28. Hepatitis (Jaundice); 29. Kala-azar ; 30. Amoebic dysentery; 31. Giardiasis; and 32. Skin disease (Ring worm).

(i) Disease-causing microorganisms or pathogens. The pathogens include viruses, bacteria, fungi, protozoans, helminths and worms, etc. These pathogens are transferred to the human body through air, contaminated water, food, soil, physical contact, sexual contact and animals.

(ii) Inadequate diet. Absence of nutritional diet makes a person unhealthy. Unhealthy persons are more susceptible to diseases or infections. Deficiency of nutrients in the diet results in number of deficiency diseases in human beings, e.g., night-blindness, beriberi,

scurvy, etc. ([Table 5.4](#)). Unbalanced diet may cause obesity.

Table 5.4. Some common deficiency diseases of human beings.

<i>Deficient Nutrient</i>	<i>Disease</i>
1. Protein	Kwashiorkor
2. Protein and total food calories	Marasmus
3. Vitamin A	Xerophthalmia
4. Vitamin A	Night blindness
5. Vitamin B ₁	Beri-beri
6. Vitamin B ₂	Cheilosis
7. Niacin	Pellagra
8. Vitamin B ₁₂	Pernicious anaemia
9. Iron	Microcytic anaemia
10. Vitamin C	Scurvy
11. Vitamin D	Rickets (in children)
12. Vitamin K	Bleeding disease
14. Fluorine	Dental caries
15. Iodine	Goitre



Scurvy.



Rickets.



Goitre.

(iii) Environment pollutants. Various environmental pollutants such as gases (e.g., oxides of carbon, oxides of nitrogen and oxides of sulphur), particulate matter, industrial chemicals, heavy metals, (e.g., mercury, lead, cadmium and arsenic), pesticides, etc., may contribute to ailments.

(iv) Tobacco, alcohol and narcotic drugs. Continuous use of tobacco, alcohol and narcotic drugs result in harmful effects leading to chronic diseases.

3. Levels of Immediate Causes

There exist various levels of immediate causes. For example, if few babies are suffering from loose motions, we can say that an **immediate cause** of infection or disease is a virus. Such immediate causes of diseases are called **first-level causes**. At this juncture we may ask that from where this virus come? The answer would be that the virus came from unclean (contaminated) drinking water.

We may think why few babies develop loose motions after drinking unclean water in the society. One reason might be that in comparison to others, these few babies are not healthy and, therefore, are likely to get the disease when exposed to risk. Our study may result in question why are these few babies not healthy? The answer would be that perhaps these are under fed (not well nourished). Thus, lack of good nourishment becomes **second level cause** of the disease the babies suffering from. These babies are not properly fed because they belong to poor house hold. Therefore, poor public services providing unclean drinking water in the region where such babies are living in society, and **poverty** becomes the **third level cause** of the disease.

Possibly, some genetic difference in these few babies might be the reason that makes them more likely to suffer from loose motions when exposed to unclean water containing such a virus. Genetic difference or **poor nourishment** are **contributory causes of the diseases**. Contributory causes themselves do not lead to a disease.

5.3. TYPES OF DISEASES

The human diseases are broadly grouped into following *four* categories :

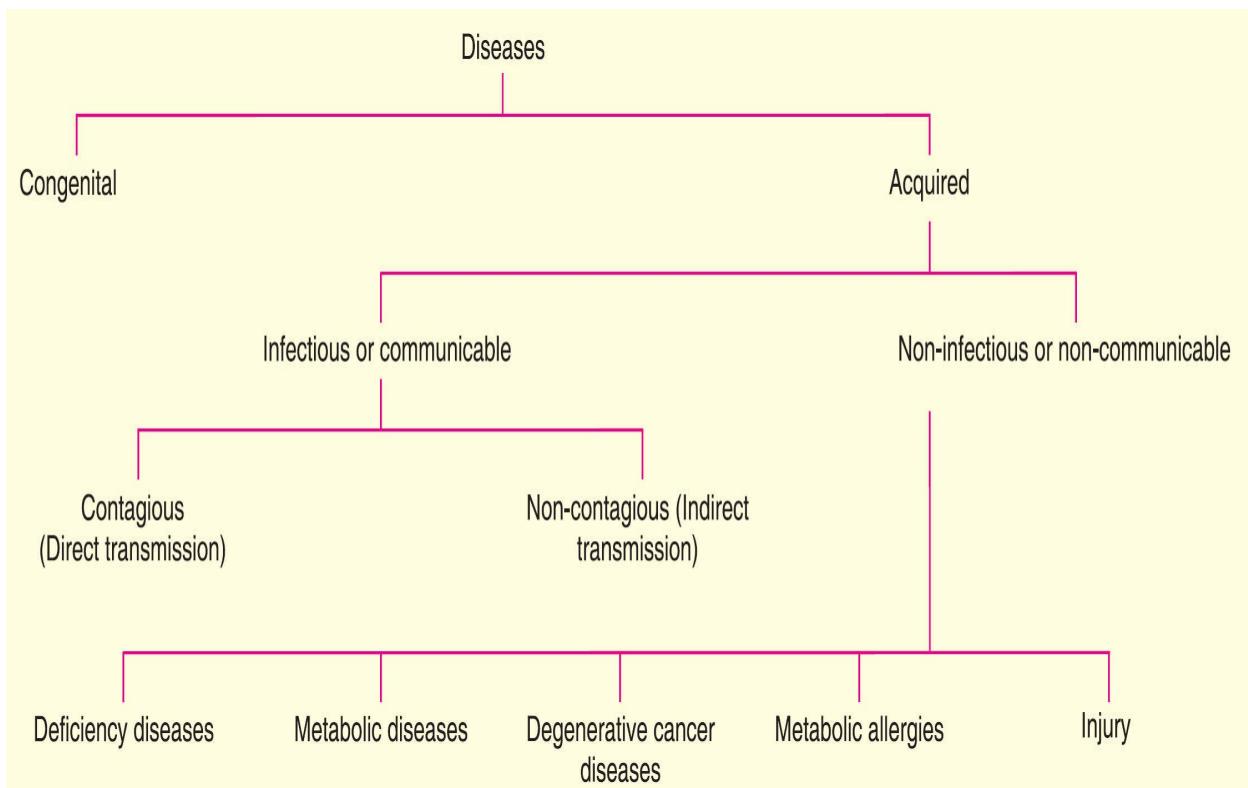


Figure. 5.1. Different types of diseases.

Table 5.5. Differences between infectious and non-infectious diseases.

<i>Infectious or Communicable Diseases</i>	<i>Non-Infectious or Non-Communicable Diseases</i>
1. They are caused by attack of pathogens.	1. They are caused by factors other than living pathogens.
2. The diseases are brought about by extrinsic or external factors.	2. The diseases are mostly brought by intrinsic or internal factors.
3. Infectious diseases can pass from diseased person to healthy person.	3. Non-infectious diseases cannot pass from one person to another.
4. Transmission of infection occurs through direct contact or some medium (air, water, vectors).	4. Transmission is absent. However hereditary diseases are transmitted from parent to offspring.
5. Community hygiene can reduce the incidence of infectious diseases.	5. Community hygiene is ineffective in reducing the incidence of non-infectious diseases.
<i>Examples.</i> <i>Cold,</i> <i>Cholera,</i>	

Tuberculosis (T.B.), Pneumonia, Malaria, Chickenpox.

Examples. Diabetes, Hypertension, Goitre.

- (i) **Acute diseases.** Diseases are described as being acute, when their symptoms are quickly visible in the body e.g., common cold.
- (ii) **Chronic diseases.** These types of diseases are long-term, with the symptoms lasting for months or years. Such diseases are called chronic diseases, e.g., elephantiasis, tuberculosis.

Table 5.6. Differences between acute and chronic disease.

<i>Acute disease</i>	<i>Chronic disease</i>
1. These last for only short period of time.	1. These last for a long time, even as much as a life time.
2. These do not cause long term bad effects on human health.	2. These cause drastic long term effects on human health.
3. Examples include cold, cough, typhoid, cholera, etc.	3. Examples include elephantiasis, cardiovascular diseases, tuberculosis, diabetes, arthritis, cancer, etc.

- (iii) **Congenital diseases.** These diseases are present since birth. They are caused due to genetic abnormalities or due to metabolic disorders or malfunctioning of any organ. They are permanent, generally not easily curable and may be passed on to the children.

- (iv) **Acquired diseases.** These diseases are those which develop after birth. Acquired diseases can be broadly classified into two types : (a) communicable or infectious diseases; (b) non-communicable or non-infectious diseases.

- Infectious diseases.** These diseases are caused by some **biological agents** or **pathogens** such as viruses, bacteria, protozoans, helminthes, nematodes and fungi. Infectious diseases can rapidly spread from one person to another by various means such as by physical contact, water, air, food, and insects (vectors). Since these diseases are communicated from diseased person to healthy person

they are known as **infectious diseases**.

Non-infectious diseases. These include above described organic or metabolic diseases. The non-infectious diseases are restricted only to those persons who are suffering from them. These are not spread from infected person to healthy person. Non-infectious diseases may be caused from : (1) the lack of certain essential substances in (b) our diet, e.g., proteins, vitamins, minerals (**deficiency diseases**); (2) general wearing out or degeneration of tissues as in old age (**degenerative diseases**); (3) uncontrolled growth of tissues in any part of body (**cancer**); (4) defects in the metabolic reactions (**metabolic disorders**); and (5) injury and damage to any part of the body by accidents.

ACTIVITY 5.4.

Survey your neighbourhood to find out the following :

1. How many people suffered from acute diseases during last three months ?
2. How many people developed chronic diseases during the same period ?
3. What is the total number of people suffering from chronic diseases in your neighbourhood ?

Are the answers to questions 1 and 2 above different ? Are the answers to questions 2 and 3 above different ? What do you think could be the reason for these differences?

What do you think would be the effect of these differences on the general health of the population.

5.4. INFECTIOUS DISEASES

I. Infection Agents

Organisms that can cause diseases are classified in a wide range of categories. Some of them are **viruses**, some are **bacteria**, some are **fungi** and some are unicellular animals, the **protozoans**. Some diseases are also caused by multicellular organisms such as different kinds of worms.

Common examples of diseases caused by viruses are the common cold, influenza, dengue, fever and AIDS. Diseases such as tyhpoid fever, cholera, tuberculosis and anthrax are caused by bacteria. Many common skin infections are caused by different kinds of fungi. Protozoans cause many familiar diseases such as malaria and kala-azar. Worms tend to cause a variety of intestinal infections and elephantiasis.

All viruses live inside host cells, whereas bacteria very rarely do. Viruses, bacteria and fungi multiply very quickly, but worms multiply very slowly in comparison. These common traits means that many biochemical processes inside their cells are similar. As a result, drugs that block one of these biochemical mechanisms in one member of the group will be effective against many other members of the group. However, the same drug will not work against a microbe belonging to a different group.

For example, **antibiotics** commonly block biochemical pathways important for bacteria ([Box 5.2](#)). Therefore, most broad spectrum antibiotics work against many species of bacteria, rather than simply working against one.

Since viruses do not use these pathways at all, that is why antibiotics do not work against viral infection. For example, if we have a common cold, taking of antibiotics does not reduce the severity or duration of disease. Instead our body secrete an antiviral protein, celled **interferon** to combat the virus of cold.

However, if we get a bacterial infection along with the viral

cold, then taking antibiotics will help. In that case, too, the antibiotic will work against the bacterial part of infection, not the viral infection.

ACTIVITY 5.5

Find out how many of you had cold/cough/fever recently.

(a) How long were you ill ?

(b) How many of you took antibiotics ? (Ask your parents regarding this).

(c) How long were those who took antibiotics ill ?

(d) How long were those who did not take antibiotics ill ?

(e) Is there a difference between these two groups ?

(f) If yes, why ? If not, why not ?

Table 5.7. Common human disease caused by infectious agents.

<i>Infectious agents</i>	<i>Diseases</i>
1. Viruses	1. Common cold
	2. Influenza
	3. Dengue fever
	4. Poliomyelitis
	5. Hepatitis – B
	6. AIDS (Acquire Immuno Deficiency Syndrome)
	7. Chicken pox
	8. Measles
	9. Mumps
	10. SARS (= Severe Acute Respiratory

	Syndrome; Fig. 5.2)
	11. Small pox
	12. Swine flue (HINI)
	13. Japanese encephalitis
2. Bacteria	1. Typhoid fever 2. Cholera 3. Tuberculosis 4. Anthrax 5. Acne (Fig. 5.3) 6. Tetanus 7. Food poisoning
3. Fungi	Athlete's foot, Ringworm and many other skin infections
4. Protozoa	1. Malaria 2. Kala-azar 3. Amoebic dysentery 4. Sleeping sickness
5. Worm	1. Intestinal worm infections 2. Elephantiasis

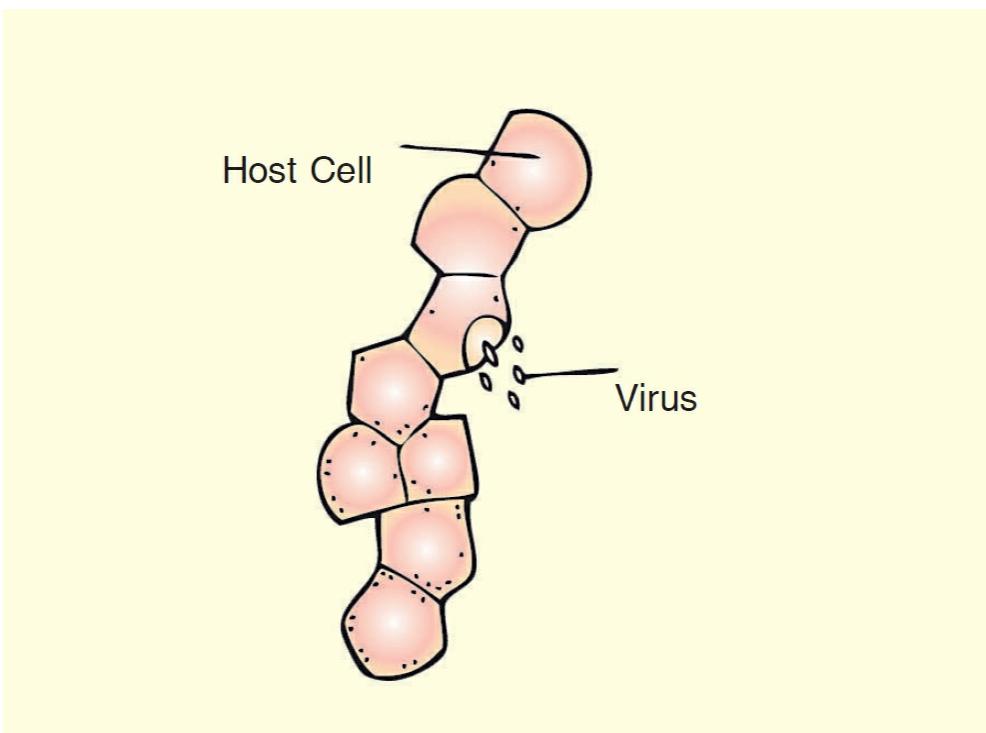


Figure. 5.2. SARS. virus seen coming out of cells.

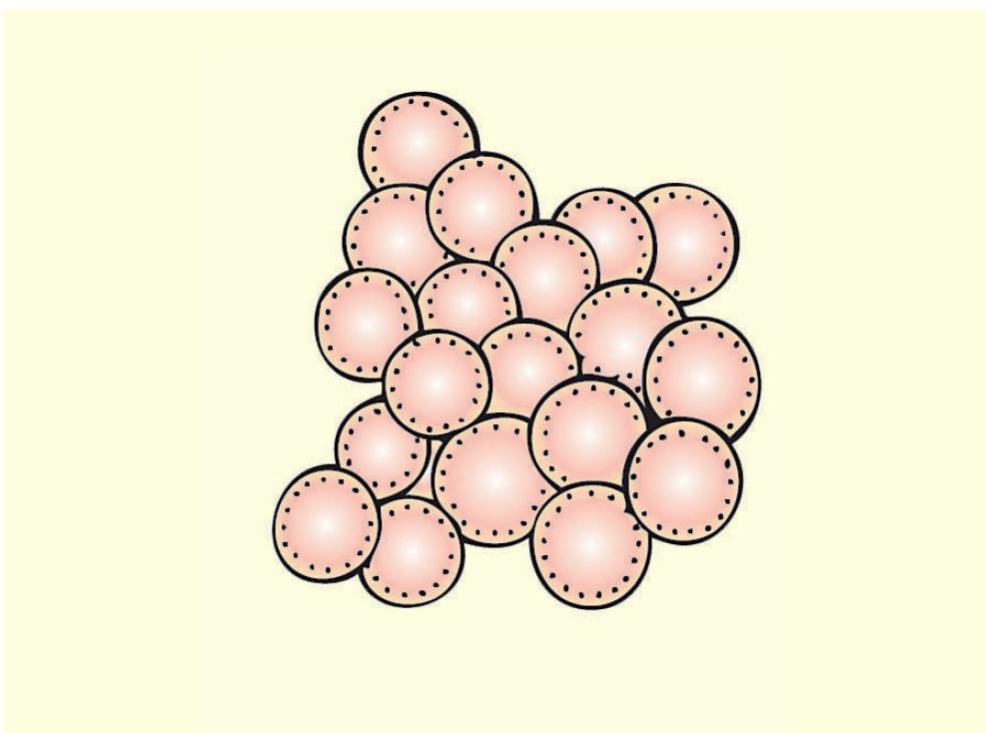


Figure. 5.3. Staphylococcus, the bacterium causing acne.

II. Means of Spread of Infectious Diseases

Infectious diseases spread from one infected person to other normal persons by various methods.

1. Air-borne diseases, e.g., common cold, pneumonia and tuberculosis. Such disease-causing microbes are spread through out the air. The transmission of these microbes occurs through the little droplets coughed out by an infected person who sneezes or coughs ([Fig. 5.4](#)). A person in the vicinity of such a person can inhale these disease causing microbes and may become infected.

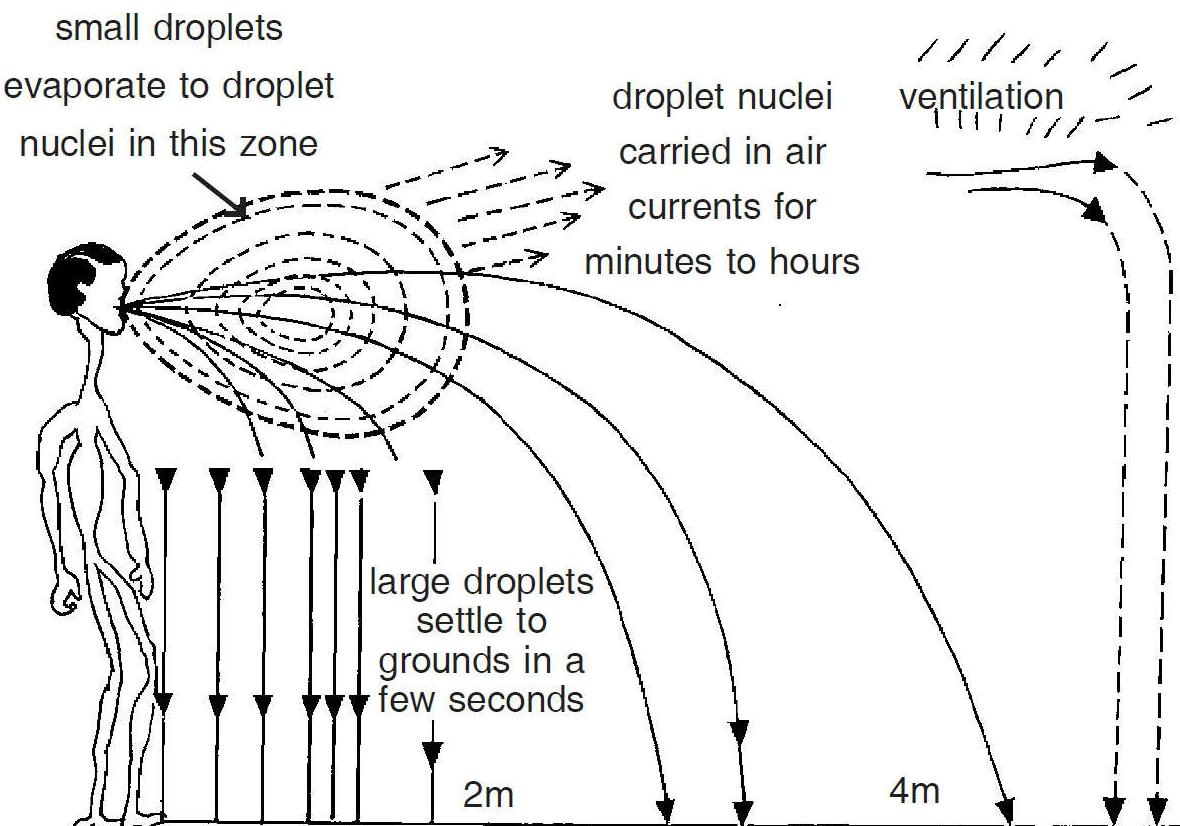


Fig. 5.4. Diagram showing potential risk of getting air-transmitted deseases as we move closer to the infected person. In closed areas, the droplet nuclei recirculate and pose a risk to everybody. Thus, overcrowded and poorly ventilated housing is a major factor in the spread of airborne diseases.

2. Water-borne diseases, e.g., cholera. Infectious diseases can also spread through water. These occur when a stool from someone suffering from an infectious gut disease, such as cholera or

amoebiasis, gets mixed with the drinking water used by people living nearby. The cholera-infested bacteria can enter new hosts through the water they drink and can cause disease in them.

3. Sexually-transmitted diseases, *e.g.*, Syphilis and AIDS. Both of these pathogens are transmitted by sexual contact from one partner to the other. However, such sexually transmitted diseases are not spread by casual physical contact. Casual physical contacts include handshakes, hugs, sports such as wrestling or by any of the other ways in which we touch each other socially.

4. Formite borne diseases. Articles coming in contact with patients act as sources of infection, *e.g.*, door handles, taps, garments, currency, utensils, crockery, etc.

5. Spread of disease through vectors. Many animals which live with us may carry diseases. These animals can transfer infecting agents from a sick person to another potential host. Thus, these animals act as intermediaries or **vectors**. Vectors are carrier of a disease or infection. Mosquitoes (*Anopheles*) are vector of a disease, called **malaria**. In many species of mosquitoes, the females need highly nutritious food in the form of blood in order to be able to lay mature eggs. Hence, they feed on many warm-blooded animals including humans.



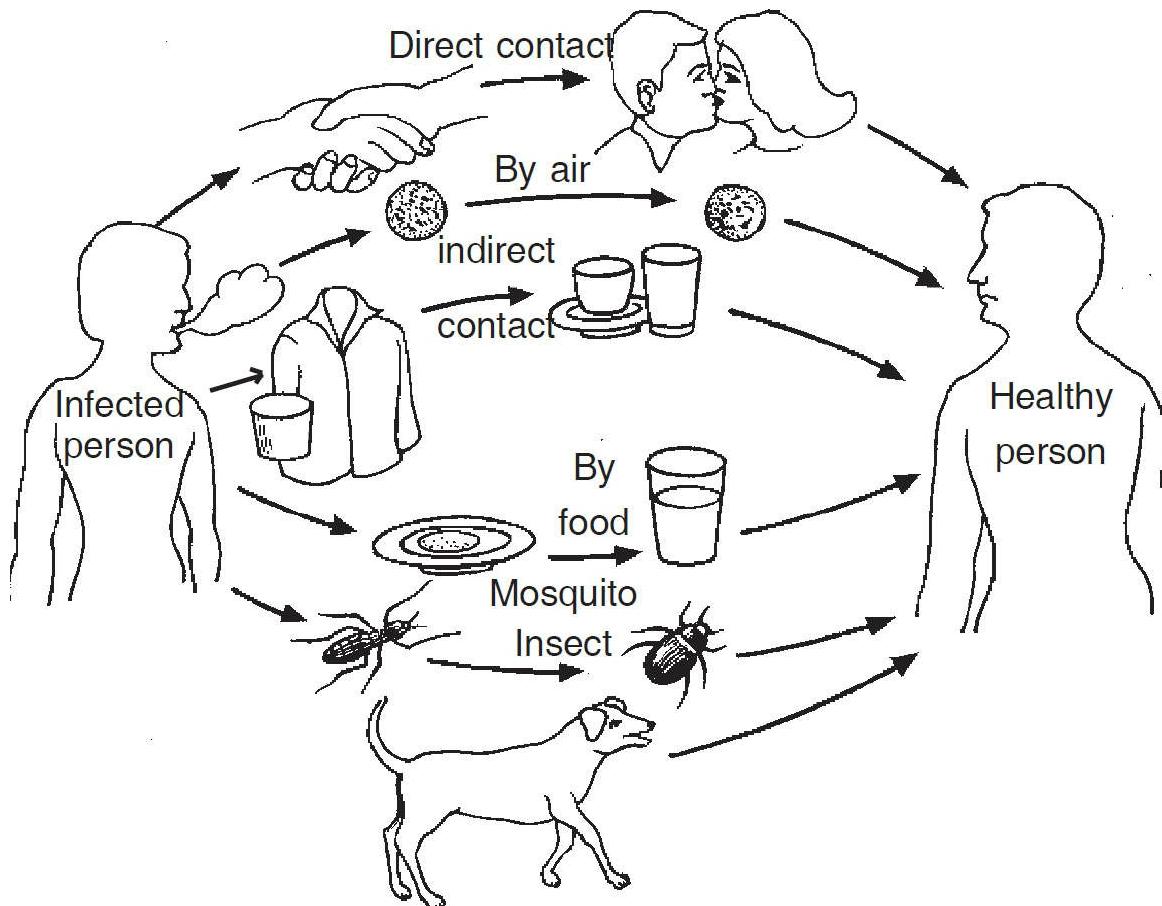


Figure. 5.5. Common methods of transmission of disease.

Table 5.8. Common human diseases transmitted by insects.

Insect vector	Diseases transmitted
1. Mosquitoes	
(i) <i>Anopheles</i> (Female)	Malaria
(ii) <i>Culex</i>	Filariasis
(iii) <i>Aedes</i>	Yellow fever, Dengue, Filariasis
2. Flies	
(i) House fly	Typhoid, Diarrhoea, Dysentery, Cholera, Tuberculosis, Conjunctivitis (an eye disease)
(ii) Sandfly	Kala-azar, oriental sore
(iii) Tse-tse fly	Sleeping sickness

3. Louse	Epidemic typhus
4. Rat flea	Bubonic plague

Thus, means of transmission (spread) of infections diseases may be of two main types: **A. Direct transmission :** 1. Contact with infected person (*e.g.*, AIDS); 1. Contact with soil (*e.g.*, Tetanus); 3. Animal bites (*e.g.*, Rabies), 4. Transplacental (*e.g.*, AIDS, German measles and Syphilis). **B. Indirect transmission:** (i) Through vectors (*e.g.*, Malaria), (ii) Through contaminated food and water (*e.g.*, Amoebiasis, Hepatitis, etc.), (iii) Air transmitted disease (*e.g.*, common cold, T.B., pneumonia), (iv) Formite borne.

III. Symptoms of Disease

(i) Point of entry and place of infection of microbe inside human body. Our body is quite large in comparison to any type of microbe (which is a parasite and pathogen). So there are many possible areas, organs or tissues within our body where microbes may reside. Different species of microbes appear to have evolved to move to different parts of the body. In part, this selection is related to their point of entry. For example, if the microbes enter from the air *via* the nose, they are likely to go to the lungs. This happens in case of bacteria which cause tuberculosis (T.B.) of lungs. If the microbes enter through the mouth, they can stay in the lining of the gut as do typhoid-causing bacteria. These microbes, can also go to the liver, like the viruses that cause jaundice (Hepatitis B). However, this pattern is not followed by all microbes. For example, infection of HIV takes place *via* the sexual organs but it tends to spread to lymph nodes all over the body. Likewise, malaria-causing protozoan enters through a mosquito bite but it first goes to liver cells and then to red blood corpuscles (RBCs). Similarly, the virus causing Japanese encephalitis, or brain fever, enter through a mosquito bite. But it goes to infect the brain.

(ii) Symptoms and signs. **Symptoms** are evidences that point to the presence of diseases. They are visible in the form of structural and functional changes in the body or body parts. They indicate that there is something wrong in the body.

On the basis of symptoms of a disease, physicians search for definite clues or **signs** of the disease. For this, they use certain instruments and conduct laboratory tests (*e.g.*, tests in pathologist's labs) to pinpoint the cause of the disease.

Table 5.9. Differences between symptoms and signs.

<i>Symptoms</i>	<i>Signs</i>
1. They indicate the presence of disease.	1. They provide information about the presence of particular disease.
2. Symptoms are a collective indication of a number of diseases in a particular part or organ.	2. They are distinct for different diseases.

Besides the various tissue-specific effects of the infectious disease, there can be other common effects also. Most of these common effects of a disease depend on the ability of a patient's immune system to become activated in response to an infection. An active immune system recruits many cells to the affected tissue to destroy the disease-causing (*i.e.*, pathogenic) microbes. Such a recruitment process is called **inflammation**. Local effects of an inflammation is shown in the form of swelling and pain. General effect of an inflammation is depicted in the form of fever.

Box 5.1

Inflammation or Oedema

Inflammation is due to the escape of chemicals, including **histamine** and **5'-hydroxytryptamine** from the damaged

tissues. This increases the amount of blood in the wounded area and raises the temperature locally. Leaking from the capillaries is also increased, permitting discharge of plasma and white blood cells into the surrounding tissues. The consequent swelling of the area is called **oedema**. This plasma contains chemicals, which inhibit the growth of bacteria or kill them, and **antibodies** and **phagocytes** (neutrophils, monocytes or macrophages, etc.) combat spread of infection. One of the chemical is **interferon** which is secreted mainly by macrophages and some other white blood cells if they are exposed to foreign antigens. Interferon makes body cells resistant to infection by viruses.

Infection of HIV is found to have multiple dimensional effect. In case of HIV infection, the virus goes to immune system and ultimately damages its function. Thus, many symptoms of HIV-AIDS infection are due to the fact that patients body can no longer fight off many minor infections that he faces everyday. For instance, in an AIDS patient, every small cold can enhance into pneumonia. Similarly, a minor gut infection can produce major diarrhoea with blood loss. Thus, it is these **secondary infections** that kill people suffering from the HIV-AIDS.

One point should also be clear to us that the severity of disease symptoms depends on the number of microbes in the body. For example, if the number of microbes is very small, then the symptoms of disease will be minor or unnoticed. However, if the numbers of same pathogen/microbe are large, the disease can be severe enough to be life-risking. The number of microbe/pathogen is mainly determined by the immune system.

IV. Principle of Treatment

There are two ways to treat an infectious disease. One is to reduce the effects of the disease and the other way is to kill the cause of the disease. For the first requirement, we can provide treatments that will reduce the symptoms. The symptoms are usually a result of **inflammation**. For example, we can take medicines that bring down fever, reduce pain or loose motions. We can take bed rest so that we can conserve our energy. This exercise will enable us to focus on the healing.

However, such a kind of symptom-directed treatment by itself is inadequate. Since it will not make the pathogen to go away, so the disease will not be cured. For that we have to kill the microbe itself.

How to kill microbes? Pathogenic microbes can be killed by two common methods. One way is to use medicines that kill microbes. In fact, we have to choose a drug which may work only on the parasite or pathogen. If that drug affects host's metabolism, then our very purpose of treatment will be defeated.

We have seen earlier that microbes can be classified into different categories. Thus, they are viruses, bacteria, fungi or protozoa. Each of these groups of organisms will have some essential biochemical life processes which are peculiar to that group and not shared with the other groups. These processes may be pathways for the synthesis of new substances(=anabolism) or respiration (=catabolism). For example, our cells may make new substances by a mechanism different from that used by a pathogenic bacteria. We have to find a drug that blocks the bacterial synthetic pathways but does not affect our own cellular pathways. This is what is achieved by **antibiotics** ([Box 5.2](#)). Similarly, there are drugs that kill protozoa such as malarial parasite.

Box 5.2

Antibiotics



1. Antibiotics are chemicals produced by microorganisms (mainly bacteria and fungi) which **at low concentration** levels, have the ability to destroy or inhibit the growth of pathogens. The first antibiotic was **penicillin**, which was developed in the 1940's in response to the need to treat soldiers in the Second World War. There are now about 50 to 100 commercially available antibiotics.
2. Antibiotics are characterised by their range of effectiveness and their mode of action against the pathogens :
 - (i) **Broad spectrum antibiotics** kill a wide range of bacteria.
 - (ii) **Narrow spectrum antibiotics** are effective against only a few types of bacteria.

To kill a specific pathogen, you have to use a narrow spectrum antibiotics which is specific for the disease.



Antibiotics.

3. All antibiotics must have selective **toxicity**. This means they should kill or inhibit the growth of bacteria or fungi, but cause little or no damage to the host.

Box 5.3

The drug **zidovudine** (AZT) stops HIV from replicating itself by binding with reverse transcriptase enzyme and blocking its action. But it has a side effect, *i.e.*, it causes anaemia.

V. Principles of Prevention of Disease

Following *three* limitations are normally confronted while treating an infectious disease :

1. Once someone gets a disease, his or her body functions gets damaged and may never recover completely.
2. Treatment of a disease takes time. This means that if someone is suffering from a disease, he is likely to be bedridden for sometime, even if he is given proper treatment.
3. The person suffering from an infectious disease can serve as

the medium for further spread of infection to other people.

Hence, prevention of diseases is better than their cure.

1. General ways of prevention of infectious diseases. *Public hygiene is one basic key to the prevention of infectious diseases.* Thus, in this method of prevention of diseases, following practices are adopted :

- (i) To avoid exposure to air-borne microbes, adopt living conditions that are not overcrowded.
- (ii) To prevent exposure to water-borne microbes, safe drinking water should be provided.
- (iii) To avoid vector-borne infections, we can provide clean environment as it would not allow mosquito breeding.



Public hygiene.



Immunisation.

2. Specific ways of prevention of infectious diseases. If someone is suffering from a cold and cough in the class, it is likely that the children sitting around will be exposed to the infection. But not all of them will catch the infection. This may be due to a strong immune system.

Immune system and immunisation. Children usually escape cold and cough infection because their immune system (involving certain white blood cells) normally fights off the microbes (pathogenic microorganisms). These cells (*i.e.*, lymphocytes ; see [Box 5.4](#)) become active every time disease causing microbes enter the body.

Box 5.4

Immune Response

An immune response is the way in which a human body responds to invasion by a specific pathogen or antigen. This response involves the production of cells (lymphocytes) and chemicals (antibodies), that are designed to defend the body against the pathogens.

Antigens are substances that can activate an immune response. Antigens trigger the production of **antibodies** (glycoproteins or immunoglobulins) by the immune system. Each type of antibody is specific to a particular antigen and reacts with it to render it harmless.

1. Cell-mediated immunity. There are many different types of white blood cells involved in immunity. Cell-mediated immunity involves **T-lymphocytes** and **macrophages**. Macrophages are phagocytic, *i.e.*, they engulf and digest all types of foreign cells and viruses.

Lymphocytes are white blood cells that recognise and react with antigens. They are of two types : **T- lymphocytes** and **B- lymphocytes**. T-lymphocytes become activated in thymus gland and can be of four types : 1. **Cytotoxic T-cells or killer cells** ; 2. **helper T-cells** ; 3. **memory T-cells** and 4. **suppressor T-cells**.

2. Antibody-mediated immunity. This involves the production of B-lymphocytes which are activated by antigens attached to the macrophage membrane. B-lymphocytes are of *three* types :

(i) Plasma B-cells. They secrete antibodies into the blood circulation.

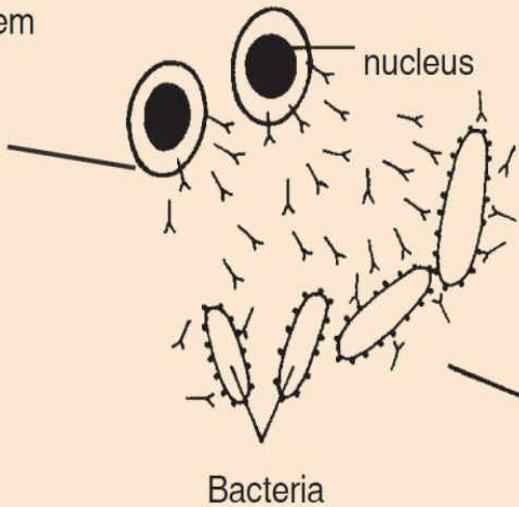
(ii) Memory B-cells. They do not produce antibodies, but become programmed to remember a specific antigen and respond very rapidly to any subsequent infection.

(iii) Dividing B-cells. They produce more B-lymphocyte cells.

Reaction between antibody and antigen. It involves the following three steps ([Fig. 5.6](#)). 1. The antibody becomes attached to the antigen at the antigen-binding sites like a key in a

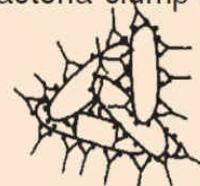
lock. 2. This causes the antibody to change from a T-shape to a Y-shape. 3. Antibody causes the antigen to stick together, a process called **agglutination**, which stimulates phagocytosis by neutrophils.

B-lymphocytes recognise antigens on surface of bacteria as 'foreign' and produce antibodies against them

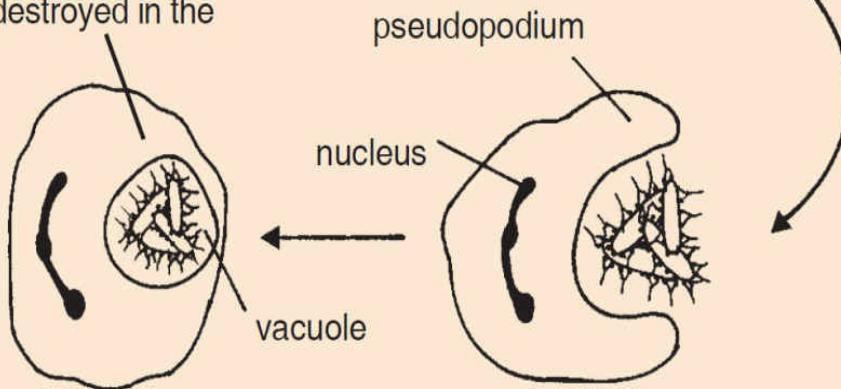


Key
 ↗ antibody
 .. antigens
 ↘ immune complex

antibodies and antigens form immune complexes on surface of bacteria, making the bacteria clump together



engulfment (phagocytosis) is completed and the encircled bacteria are destroyed in the vacuole



neutrophil engulf and destroy bacteria which have been attacked by antibodies

pseudopodia of neutrophil flow round bacteria, beginning the process of engulfment (phagocytosis)

Figure. 5.6. Lymphocytes and neutrophils at work.

1. Active immunity. The pathogen invades the body and the body responds by stimulating the production of T-lymphocytes and B-lymphocytes, both of which are involved in the immune response. Memory cells are formed which provide long-term immunity to an antigen.

This type of immunity if termed as **active immunity** because the lymphocytes get **activated** by antigens present on the surface of the pathogen. Since this activation takes place during the natural course of an infection, this is called **natural active immunity**.

An immune response can also be triggered **artificially**. This involves the injection of antigens into the body. We call this **artificial active immunity**, although it is more commonly referred to as **vaccination** ([Box 5.5](#)).

2. Passive immunity. It occurs when an individual becomes temporarily immune to an antigen by receiving ready-made antibodies from someone else. Passive immunity is of two types :

(a) Natural passive immunity. It occurs when pre-formed antibodies pass naturally from mother to baby across the placenta and in breast milk.

Immunity is only **temporary** since a baby's body does not 'know' how to make more antibodies. But it provides the baby with protection until it develops its **own** immune system.

(b) Artificial passive immunity. It occurs when pre-formed antibodies extracted from one individual, are injected into another as **serum**. This sort of immunity can provide a "quick-fix" and is given to people who for example have been bitten by

poisonous snakes or rabid dog.

Normally, immune cells (WBCs) manage to kill off the infection long before it assumes major proportions. If the spread of the infecting microbes are controlled, the symptoms and effects of a disease will be minor. In other words, exposure to infection or an infectious microbe, does not necessarily imply that symptoms are not noticeable.

So one way of looking at severe infectious disease is that it represents a failure of the immune system. The functioning of the immune system, like any other system in the body, will not be good enough if proper and sufficient nourishment and food is not available. Therefore, *second basic principle of prevention of infectious disease is the availability of proper and sufficient food for everyone.*

ACTIVITY 5.6.

To study the role of food in human's body growth, you have to conduct a survey in your locality. You have to talk to ten families who are well-off (rich) and ten who are very poor.

Both sets of families should have children who are below five years of age. Measure the height of these children. Draw a graph of the height of each child versus its age for both sets of families. Now, try to answer the following questions :

- (i) Is there a difference between the groups ? If yes, why ?
- (ii) If there is no difference, do you think that your finding mean that being well-off or poor does not matter for health.

Vaccination

These days, there is no reported case of smallpox (A highly infectious viral disease) anywhere around the world. But as recent as hundred years ago, smallpox epidemics were quite prevalent. However, it was identified that patients who had contracted smallpox once, developed immunity to that disease for life. So contracting a viral disease once, meant prevention from subsequent attack of the same disease.

When the immune system first encounters an infectious microbe, *it responds against it and then remembers it specifically*. So the next time that particular microbe, or its close relatives enter the body, the immune system responds with greater vigour. This eliminates the infection even more quickly than the first occurrence of the disease. This is the basis of the principle of immunisation.

Box 5.5

1. Derivation of term vaccination



Three centuries ago, an English physician **Edward Jenner** (1749–1823) realised that milkmaids who had cowpox, did not catch smallpox even during epidemics as they had become resistant to the smallpox virus. This was because the smallpox virus is closely related to the cowpox virus. ‘Cow’ is ‘vacca’ in Latin, and a cowpox is ‘vaccinia’. From these roots, the word vaccination came into usage.

2. How are vaccines made ? A vaccine is an antigen that is injected or swallowed. It causes the development of active immunity in the patient. Small quantities of antigen introduced into the person's body stimulate, the production of antibodies as if the body was infected by the disease. This type of immunity is long term since the body develops memory cells in the natural pathway.

Antigens are treated before being introduced to the body of the person, in order to make them relatively harmless. Most vaccines are made in one of the following ways :

(i) Killed virulent organisms, e.g., vaccine for whooping cough-bacteria. In this case, the bacteria is killed by heat or use by chemicals, which denature its enzymes. So the dead pathogen will not cause the disease, but it will possess antigenic sites on its surface that will be recognised by T- and B- lymphocytes, and result in the production of antibodies in the recipient. *But there is no chance of the pathogen replicating and causing infection.*

(ii) Live non-virulent strains, e.g., rubella. Vaccines made in this way are often called **attenuated (= weaken) vaccines**. In such vaccines, the pathogen is deliberately weakened to ensure that it does not cause severe infection. Other examples are **BCG vaccine** used against tuberculosis and the **Sabin vaccine** used against poliomyelitis, which is taken orally.

(iii) Modified toxins, e.g., vaccines used against **diphtheria** and **tetanus**. In this type of vaccine, the **toxoids** (toxic substances) produced by the bacteria are made harmless. Toxoids are used to stimulate antibody production, but there is no risk of infection by the pathogen.

(iv) Isolated antigen, e.g., influenza. Sometime important

antigens are separated from the microorganism, in this case by breaking up the pathogen's structure and obtaining glycoproteins. The “**flu vaccine**” contains a mixture of antigens from various strains of influenza virus, in an attempt to combat the great variations that exists. This **antigenic variation** occurs in microorganisms that have a high mutation rate.

(v) **Genetically engineered antigens**, e.g., hepatitis B. In this most modern type of vaccine, restriction endonuclease enzymes are used to extract from the pathogen the genes that code for a particular antigen. Such genes are inserted in a harmless plasmid vector using a ligase enzyme. The bacterial cells then replicate to produce large amounts of antigen.



Vaccination.



Vaccine.

In this way, we ‘fool’ the immune system into developing a **memory** of a particular infection, by injecting something that mimics the microbe we want it to vaccinate against, into the body. This does not cause the disease but helps prevent any subsequent exposure to the infecting microbe from turning into an actual disease. There are vaccines against 1. Tetanus; 2. Diphtheria; 3. Whooping cough ; 4. Measles ; 5. Polio; 6. Hepatitis-B; 7. Cholera; 8. Tuberculosis; 9. Plague; 10. Mumps; etc. ([Table 5.10](#)).

Table 5.10. Important vaccines for infants and children.

Vaccine	Disease	Age group	Safety level
1. DPT-Hib	Diphtheria (<i>Corynebacterium diphtheriae</i>), Tetanus, Pertussis (whooping cough) and <i>Haemophilus influenzae</i> type B.	To all infants of 1½, 2½ and 3½ month age.	90% - 99%
2. Hepatitis-B	Hepatitis (serum hepatitis)	All infant, children and even adult.	Not yet confirmed.
3. Polio	Poliomyelitis	All infants up to 5 years of age; minimum of three doses at one month interval	Nearly 100%
4. BCG	Tuberculosis	All children between 10 to 14 years.	Nearly 70%

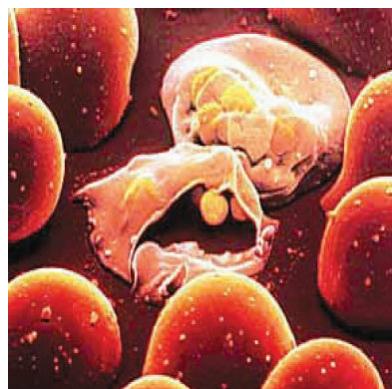
5.5. EXAMPLES OF DISEASES CAUSED DUE TO INFECTION BY MICROORGANISMS

A. Diseases Caused by Protozoa

1. Malaria

Malaria can be a fatal disease for human beings. Approximately 300 million people around the world get infected with malaria every year. More than 2 millions people die every year due to malaria disease.

Malaria is caused by a protozoan parasite *Plasmodium*. This disease spreads through the bite of an insect vector—the **female** *Anopheles* mosquito which feeds on human blood. Male *Anopheles* mosquito feeds upon plant juice.



Plasmodium.

Symptoms. Main symptoms of malaria include headache, nausea, muscular pain and high fever. Each malarial attack is of 6 to 10 hours duration and consists of the three stages : 1. **Cold stage**, feeling of extreme cold and shivers; 2. **Hot stage**, i.e., high fever, faster respiration and heart beat; and 3. **Sweating stage**, i.e., due to profuse sweating, temperature of the body goes down to normal. Even after the patient is cured of malaria, the patient feels weak and becomes anaemic. Malaria may also secondarily cause enlargement of spleen and liver. Presence of malarial parasite can be checked by blood test.

Box 5.6

The name Malaria was proposed by **Macculloch** (1827). **C.L.A. Laveran** (1880), a French physician, discovered the Malarial parasite—*Plasmodium* in the blood of a malaria patient. He received Nobel Prize for this discovery in 1907. **Sir Ronald Ross** (1897), a British physician, confirmed that malaria is caused by malarial parasite and mosquito is the vector. He received Nobel Prize for this discovery in 1902.

Recently **Allan Porter** and his team produced a genetically engineered aquatic bacteria at National Institute of Singapore. When mosquito larvae feed on these bacteria, they get killed by the toxic substance produced by these bacteria. This can prove to be an effective **biological control method** against malaria.

Central Drug Research Institute (CDRI), Lucknow has developed an anti-cerebral malarial drug called—**Arteether**. This drug is extracted from a herbaceous plant *Artemisia annua* belonging to family Asteraceae.

Prevention. Malaria is an infectious disease. It can spread from an infected person to a healthy person (hosts) by the bite of female *Anopheles* mosquitoes (vectors). The only way to prevent malaria is to take precaution against mosquito bites. We can protect ourselves from the bite of mosquitoes by following methods :

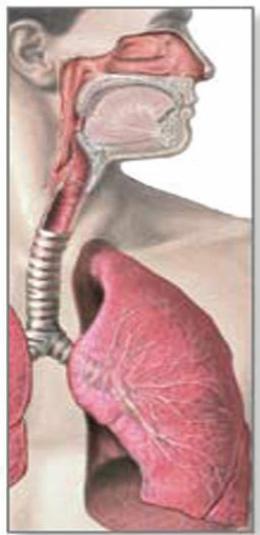


1. Wire-gauze should be used on doors and windows of houses to prevent entry of mosquitoes.
2. Insect-repellents (*e.g.*, Odomos) should be used to prevent mosquito-bite.
3. One should sleep under mosquito nets.
4. Mosquito larvae can be killed by sprinkling kerosene oil on large-sized water bodies. Some larvivorous fishes such as *Gambusia*, minnows or trouts or birds (*e.g.*, ducks) can be introduced in water bodies. These animals feed on mosquito larvae and hence the population of mosquitoes is checked. This is called **biological control** of mosquito.
5. Adult mosquitoes can be killed by spraying insecticides (*e.g.*, BHC, malathion) on the walls of human dwellings. Insecticides are chemical poisons (toxicants), hence, regulation of mosquito population by them is called **chemical control**. The insecticide DDT is not used in the chemical control of mosquitoes, as it persists in the environment for much longer time and can cause toxicity by accumulating in the body of fishes, birds and humans through food chains.
6. The breeding grounds should be destroyed. Thus, the ditches, puddles or swamps around human dwellings should be drained or filled. We should not allow the collection of water in any uncovered container such as water tank, pot, cooler, flower pot, discarded tyres (tires), etc.

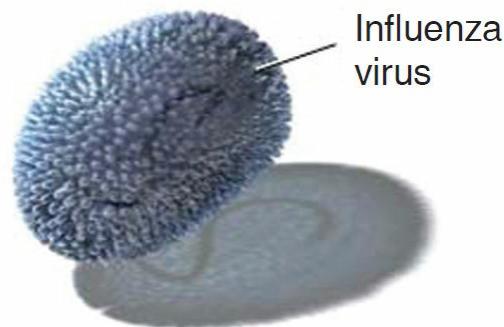
Control. A drug named **quinine**, which is extracted from the bark of *Cinchona* tree, is used to treat a person suffering from malaria. This drug kills most of the stages of malarial parasite. There are certain other drugs (medicines) which should be taken on the advice of doctor. Scientists are trying hard to develop an antimalarial vaccine.

B. Diseases Caused by Viruses

1. Influenza



Influenza is a viral infection of the respiratory tract



Influenza.

Influenza is commonly called **flu**. It is caused by an **influenza virus** (*Myxovirus influenza*). There exist three types of influenza viruses— A, B and C. A and B types of influenza viruses are important because these are responsible for causing of disease epidemics throughout the world. The inhaled virus attacks the epithelial cells in the mucous membrane of nose, throat and upper respiratory tract. Influenza is *spread* mainly from person to person contact and by droplet infection via sneezing, coughing or talking. The common *symptoms* of influenza disease are sudden onset of chills, discharge from the nose, sneezing, fever, headache,

muscular pains, coughing, inflammation of respiratory mucosa and general weakness. Fever lasts for three days in adults. Influenza.

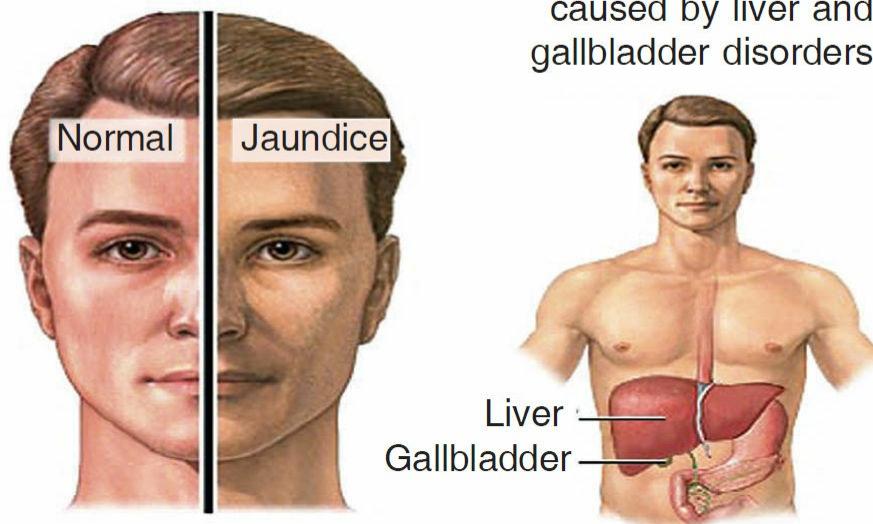
Prevention. We should try to keep away from flu patients.

Control. There is no effective control for influenza. However, vaccines are used for the *control* of infection and antiviral drugs are used for cure. Amantadine and Rimantidine are recommended for the treatment of influenza. Rest speeds up the recovery.

2. Jaundice / Hepatitis

Jaundice or hepatitis is the disease of liver. Since liver is a very important organ in body, so its inflammation due to jaundice affects digestion adversely. Jaundice is caused by viral infection. The types of hepatitis are : Hepatitis A, Hepatitis B, Hepatitis C, Hepatitis D, Hepatitis E or Hepatitis G. Except for type B which is a DNA virus, all the other are RNA viruses. Hepatitis is spread mostly by food and water contaminated with hepatitis virus.

Yellowing is from accumulated bilirubin in the skin, often caused by liver and gallbladder disorders



Jaundice.

Hepatitis A. Hepatitis A (or **infectious hepatitis**) by a RNA-

containing virus) is an acute infectious disease of liver which
(i) affects mainly children and young adults. *Transmission* of hepatitis A virus (HAV) takes place by faecal-oral route, i.e., infection of HAV takes place by ingestion of contaminated water, food or milk.

Symptoms. 1. High temperature, headache, fatigue, general weakness, and joint pains.

2. Loss of appetite (called **anorexia**) with a feeling of nausea and vomiting.

3. Appearance of irritating rashes on body.

4. Dark yellow urine.

5. Light coloured stool after 3 to 10 days of infection.

Prevention. For avoiding infection of hepatitis A following preventive measures should be taken.

1. Use chlorinated, boiled and ozonised water.

2. Proper cleaning of hands after handling bed and vessels of the patient.

3. Hepatitis-A vaccine should be taken to prevent the disease.

Control. 1. Application of **interferon** injection on the advice of the doctor will control the disease.

2. For an early cure, it is essential that a patient of jaundice takes adequate rest.

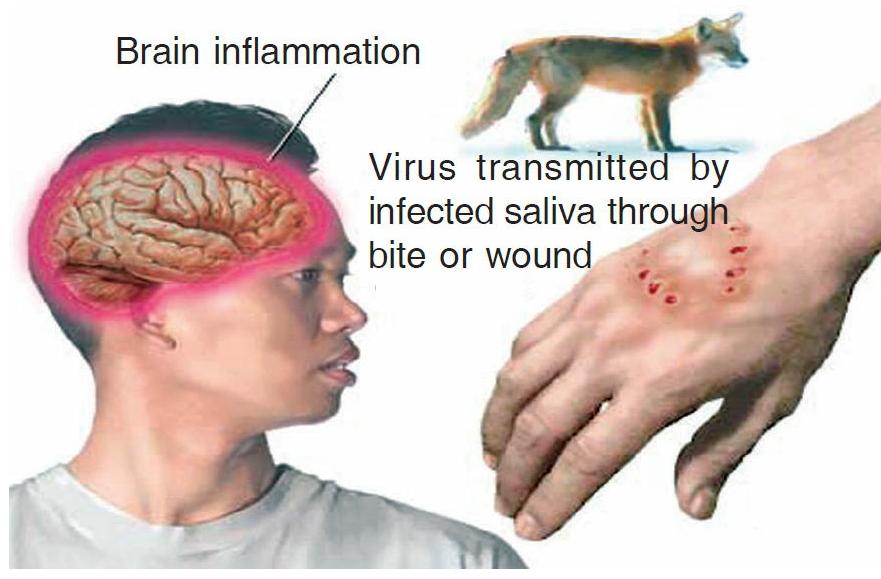
3. Jaundice patient should take high calorie diet such as juice of sugarcane, radish with gur (jaggery).

4. Consumption of protein and fat should be limited.

Hepatitis B. Hepatitis B is also known as **serum hepatitis** or **transfusion hepatitis** (by a double-stranded DNA virus). This is most dangerous and widespread type of viral hepatitis. (Hepatitis B

is regarded more dangerous than AIDS). It occurs due to infection of Hepatitis B virus (HBV). HBV is a blood borne DNA virus. The infection of HBV is transmitted by infected blood, inoculation (Inoculation means the introduction of a vaccine into a living being to give immunity), from mothers to their babies and by sexual route (through the semen, saliva, etc.). Main symptoms of Hepatitis B include progressive liver disease, chronic active hepatitis and hepatocellular carcinoma (*i.e.*, malignant cancer of liver cells). Infection of HBV can be prevented by avoiding risky practices such as free or promiscuous sex (Promiscuous means sexual contact which is not restricted to one sexual partner), injectable drug abuse and direct or indirect contact with blood, semen and other body fluids of patients of Hepatitis B. Hepatitis B vaccine should be taken to prevent disease.

3. Rabies (Hydrophobia)



Rabies.

The bite of a rabid dog (mad dog) and some other rabid mammals such as monkeys, cats or rabbits may cause rabies, which is fatal viral disease caused by a **rabies virus** or **lyssa virus** which is present in the saliva of the infected animals. The viruses are

injected into human blood by the bite of the rabid animal. Disease symptoms are not visible after infection even up to 1 to 3 months. The long period of incubation makes it possible for a rabies vaccination, after a bite, to develop immunity and prevent the appearance of disease.

Symptoms. Rabies is characterised by severe headache, high fever, painful contraction of muscles of throat and chest (due to which there is difficulty in swallowing). The patient feels restless, does excessive salivation, has a choking feeling and finds difficulty in the intake of even liquid food. Since patient develops fear of water, the disease is also called **hydophobia**.

Prevention. 1. Cleaning the wound with carbolic soap and clear water immediately after the dog bite is an important preventive measure. Any antiseptic medicine (*e.g.*, Savalon, Dettol) should be applied to the wound caused by dog bite. A doctor should be immediately consulted for application of anti-rabies vaccine to the patient.

2. Compulsory immunization of stray dogs and cats should be done. Pet dogs should be vaccinated with anti-rabies vaccine.

3. A rabid animal shows excessive salivation and tries to seek isolation after bite. Such mad animals should be killed.

Control. Rabies can be treated with **Pasteur's treatment** (discovered by **Louis Pasteur**), in which a course of 14 vaccines was given. Currently 5 anti-rabies vaccines are prescribed at an interval of 0–3–7–14–30 day of dog bite.

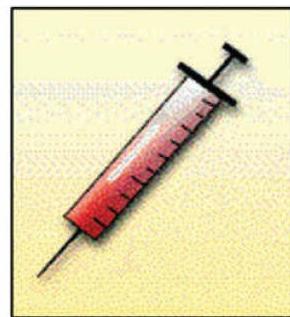
4. AIDS



Unprotected
sexual intercourse
with an infected partner



Vertical
transmission
(from mother to child)
• in utero
• during delivery
• breastmilk



Injection drug use
(rare : infected blood/
blood products)

HIV INFECTION

AIDS stands for Acquired Immuno Deficiency Syndrome. It is a fatal disease. The disease of AIDS is caused by retrovirus (a RNA virus) known as **Human Immunodeficiency Virus (HIV)** ([Fig. 5.7](#)). AIDS virus attacks white blood cells (WBCs) or lymphocytes (T₄ helper cells) of human beings and *weakens the human body's immunity or self- defence mechanism*. Since AIDS virus reduces the natural immunity of the human body, therefore, the patients suffering from AIDS becomes prone to many other infections or diseases. In fact, the patients suffering from AIDS die from other infections (called **secondary infections**). Death occurs because the patient's body cannot resist the attack of pathogens of secondary infections since patient's natural defence mechanism gets destroyed by an AIDS virus.

Transmission. AIDS disease spreads among human beings by the following ways :

1. The AIDS disease usually spreads through unprotected (*i.e.,* without the use of condom; **condom** is a membranous

penile sheath of rubber having an anti-veneral or contraceptive function) sexual contact with an infected person carrying AIDS virus. Thus, AIDS is a sexually transmitted viral disease.

2. The AIDS disease also spreads through the transfusion of blood contaminated with an AIDS virus.
3. The AIDS disease also spreads through the use of infected needles for injections (*i.e.*, sharing of infected injection needles which have not been sterilised).
4. An AIDS infected mother can transmit the virus to her child during pregnancy or during birth (*i.e.*, by mother's blood). This is called **vertical transmission**.

AIDS was first detected in USA in 1981 and in India, first confirmed evidence of AIDS infection came in April 1986 from Tamil Nadu. The AIDS disease has spread in epidemic form in Africa and western countries. This is because of the undesirable sexual practices, polygamy and polyandry. Recently alarmingly increasing cases of AIDS have been reported from different parts of India.



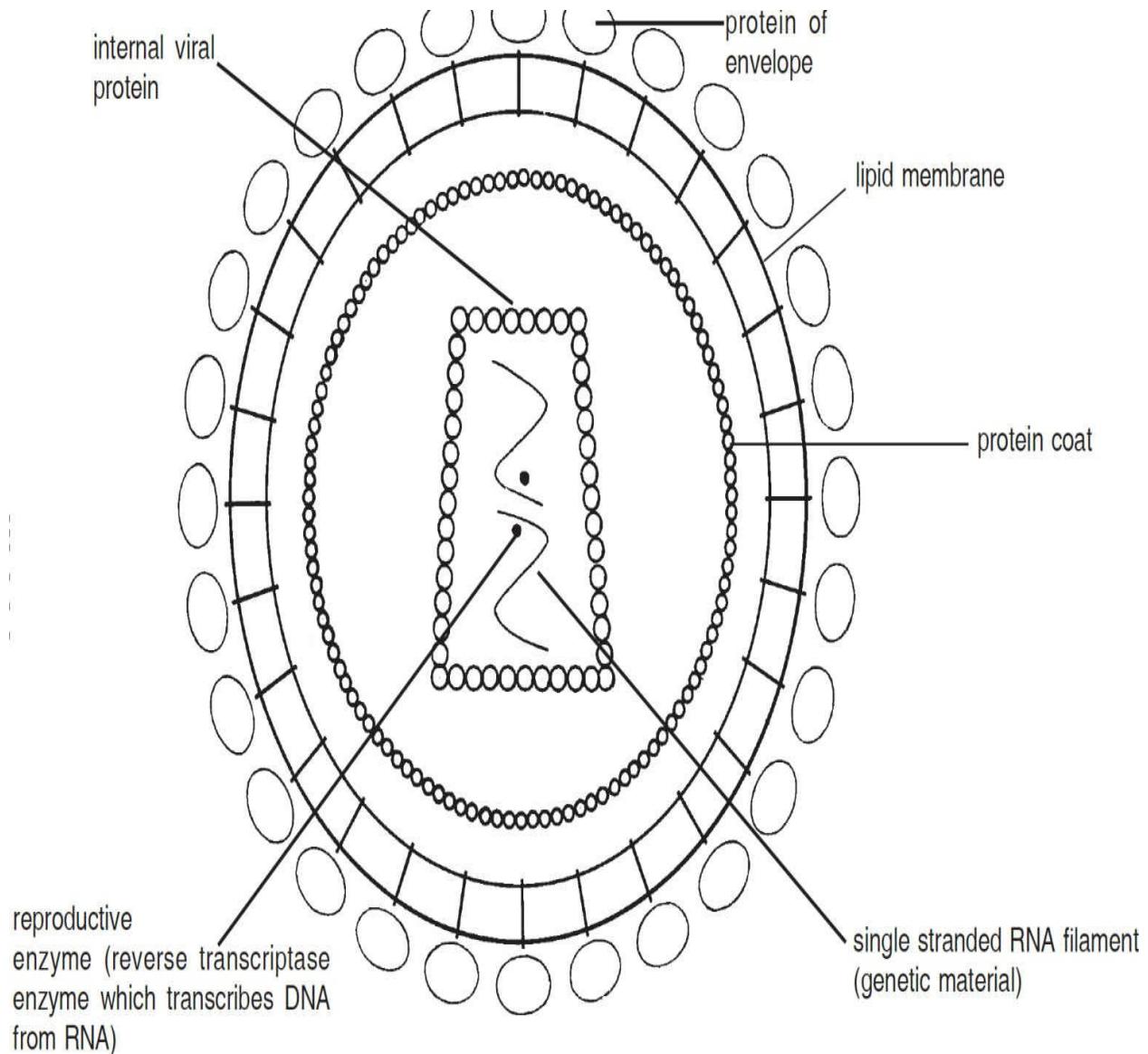


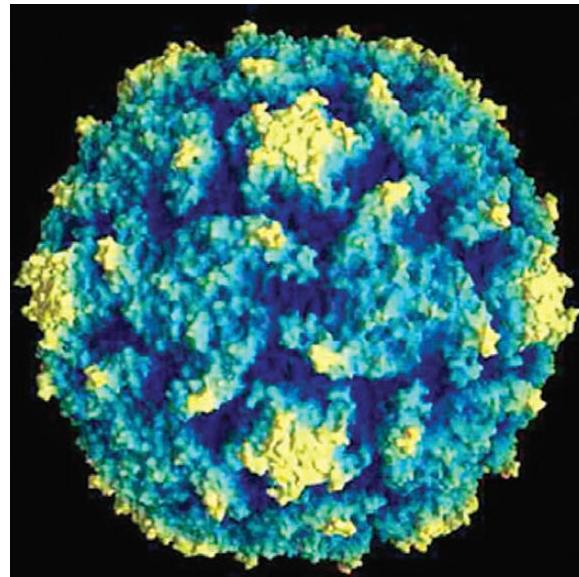
Figure 5.7. Structure of HIV or AIDS virus.

Symptoms. Some important symptoms of AIDS are the following : swollen lymph nodes; regular fever; sweating at night and weight loss. AIDS virus causes severe damage to brain and may lead to loss of memory, ability to speak and of clear thinking.

Prevention and control. So far no medicine or vaccine has been developed to cure AIDS, so, once a person gets AIDS, he is sure to die in a short span of time. The following steps may help in controlling infection of this dreaded disease :

1. People should be educated about AIDS transmission.
2. Disposable syringes and needles should be used for injection.
3. Sexual contact with unknown people should be avoided.
4. High risk groups should refrain from donating blood.
5. Sterilised needles may be provided to drug addicts.
6. Before receiving blood for transfusion, one should ensure that it has been screened for HIV.
7. The common razor at the barber's shop should not be used.

5. Polio



Polio virus.

Poliomyelitis or polio is a disease of the nervous system caused by one of the smallest known viruses, called **polio virus**. The virus enters the body through the food and water and reaches the intestine and from there it enters the CNS or central nervous system (brain and spinal cord) via blood stream and lymphatic systems. In CNS, the virus destroys the motor nerve cells of spinal cord that are responsible for the muscular control. Therefore, the muscles of polio-infected person becomes incapable of carrying out the normal

functions. Polio is a kind of paralysis and mostly affects the legs. Children between the age of 6 months and 3 years are most prone to polio infection. Polio is transmitted among children by the faeco-oral route and through the direct contact, dirty hands, contaminated food or milk and flies. **Faeco-oral route** of infection of a disease includes transmission of an infection *via* food/water that is contaminated by stool of a patient.

Symptoms. The early symptoms of the polio disease are sore throat and headache. If the infection persists, the patient suffers from fever, vomiting, muscular pain, stiffness in the neck, tingling sensation in limbs and ultimately paralysis. Sooner or later polio results in atrophy of skeletal muscles and results in deformity of affected limb.

Prevention. Complete rest and physiotherapy is helpful in the begining of polio virus attack. Exercising of legs is done to reduce the paralytic effect. Maintenance of hygiene by proper sanitary disposal of waste is an essential step for prevention of polio. Now-a-days **Oral Polio Vaccine (OPV)** is given orally to the children as per National Immunisation Schedule in our country. OPV is a live attenuated (diluted or weakend) viral strain taken by mouth which colonises the gut and induces immunity.

Pulse polio immunisation programme (PPIP). Pulse polio immunisation programme forms the largest single day public health project. Pulse means a dose of a substance (here polio vaccine) especially when applied over a short period of time. It was conducted for the first time in December 1995, in an attempt to eradicate polio from our country. This programme uses oral polio vaccine or OPV. As per the National Immunisation Schedule (NIS), a dose of 3 drops (0.5 ml) is given orally to the child, *i.e.*, one dose each at 1.5, 2.5 and 3.5 month's age. Finally, a **booster**

dose is given at the age of 1.5 years. The vaccine consists of milder forms of polio viral particles. After oral administration, virus particles in the vaccine begin to live in the intestine of the human body and multiply. It leads to production of protective molecules (antibodies) in the intestine and the blood.

The prefixed days, on which pulse polio immunisation is to be carried out throughout the country, are called **National Immunisation Days (NIDS)**. In 1996-1997 the target age group was increase to all children under 5 years of age. From 1999-2000, this programme cover mass immunisation of target groups on 4 occasions (4 NIDS or National Immunisation Days).

The pulse polio immunization campaign seems to be a successful programme. Since the incidence of poliomyelitis in India has decreased dramatically, India recorded 4,791 cases of polio in 1994; 2,489 in 1997; 1600 in 2002; 225 in 2003 and 135 in 2004 (**Renu Verma 2011**).

Aims of Pulse Polio Immunisation Programme (PPIP)

- (i) To immunise those children who are not earlier immunised or are partially immunised.
- (ii) To replace the disease-causing wild virus by harmless vaccine virus in the environment.

Box 5.7

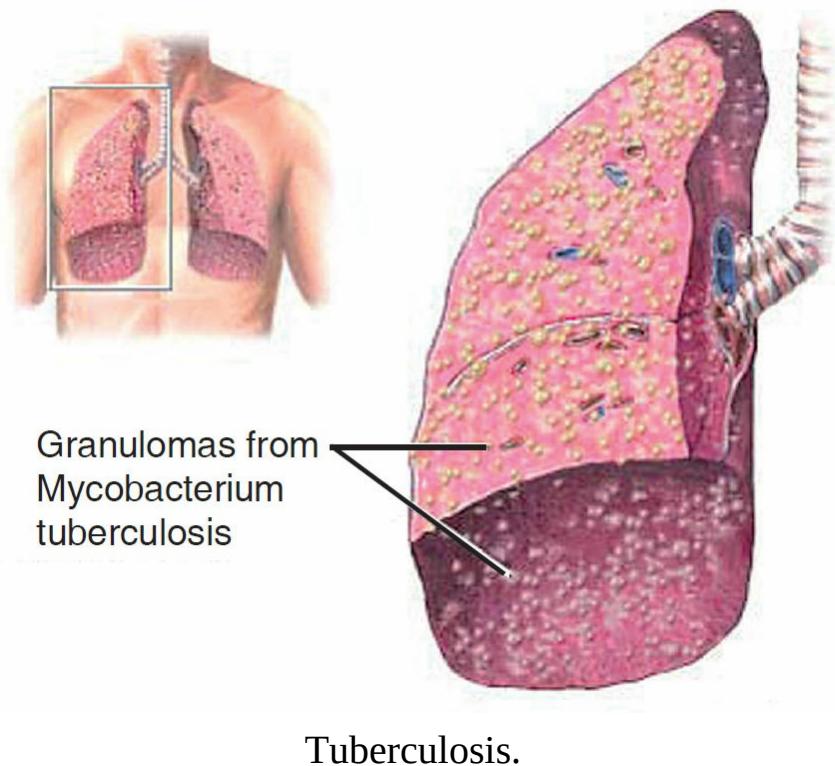
Message to Public Regarding PPIP

- Routing polio vaccination in children at birth, 6 weeks, 10 weeks of age is essential.
- Additional doses of vaccine on National Immunisation Days to boost the immunity of children of target age group.
- No harm to even sick children who are given polio drops.

- Polio drops (vaccine) are completely safe.
- General public should cooperate the Government to achieve the ‘Goal of Polio Eradication, from India’.

C. Diseases Caused by Bacteria

1. Tuberculosis (T.B.)



Tuberculosis was first discovered by German scientist **Robert Koch** in 1882. He was awarded Nobel Prize for this discovery in 1905. *T.B.* is an infectious disease which is communicated from one person to another directly or indirectly. Tuberculosis is also contracted from animals (e.g., cattle). Tuberculosis is caused by a bacterium—called *Mycobacterium tuberculosis*. The bacterium releases a toxin called **tuberculin**. T.B. can affect all parts of body such as lungs, lymph glands, bones, intestine, etc. In human beings, the infection of T.B. spreads by inhaling infected droplets released through coughing, sneezing, talking and spitting by the patient. The

incubation period of T.B. includes a few weeks to a few years.

Symptoms. The patient of tuberculosis feels sick and weak. There is a loss of appetite and weight. Typical fever pattern and night sweats are also common. The symptoms of T.B. vary depending on the site of the infection (disease) in the body. There are following two specific sites of tuberculosis infection.

1. Lung or pulmonary T.B. The person suffers from pulmonary T.B. has continuous fever, persistent cough and produces blood stained sputum. There is loss of weight and weakness. The chest-pain and breathlessness are common features of patients of lung T.B. When the tuberculosis bacteria get into the lungs, they set up a local inflammation and produce an abscess. This usually heals up and leaves a small patch of scar tissue which shows up in X-rays photographs ([Fig. 5.8](#)). In advanced stages of tuberculosis large areas of the lungs are destroyed.

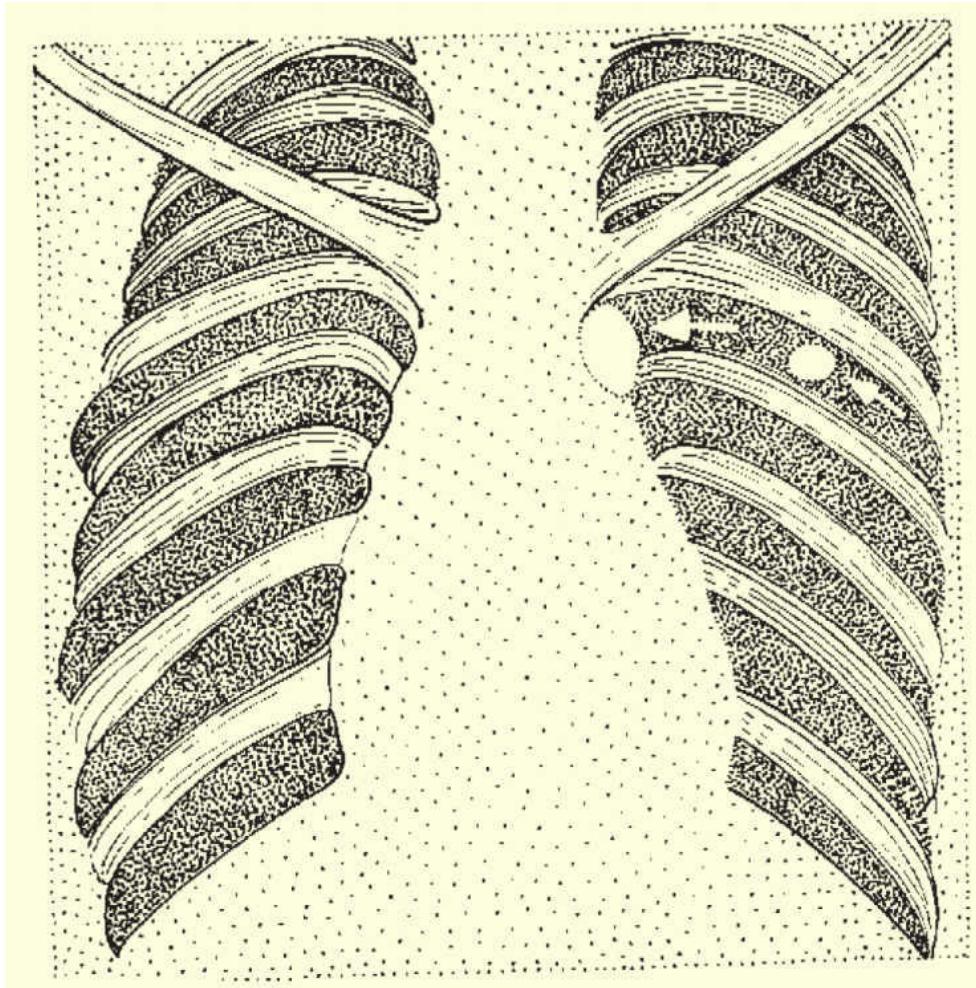


Figure. 5.8. Areas in lungs infected by tuberculosis bacteria.

2. Lymph gland T.B. Symptoms of T.B. of lymph gland include swelling and tenderness of lymph glands, often in the leg which may discharge secretion through the skin.

Prevention. 1. Vigorous public health measures are the best method of prevention. Other preventive measures include isolation and proper rehabilitation of the patient. Avoidance of over-crowding, provision of good ventilation and better nutrition help to reduce the incidence of the disease.

2. Immunisation with BCG or Bacillus–Calmette–Guerin vaccination prevents tuberculosis. BCG vaccine contains weakened Tuberculosis bacillus and it is injected into the skin of a person to

give immunity for 3 to 5 years.

Control. The tuberculosis can be cured by the following **six essential drugs**. 1. Rifampicin (RMP); 2. INH; 3. Streptomycin; 4. Pyrazinamide; 5. Ethambutol; and 6. Thioacetozone. Thus, T.B. can be controlled by the use of antitubercular therapy (ATT) ([Box 5.8](#)).

Box 5.8

The diagnosis of tuberculosis is made on the basis of positive tuberculin test, chest X-rays, positive sputum, gastric analysis, etc. *Tuberculosis is not a hereditary disease.* The modern treatment of tuberculosis is based on the six main factors : namely **rest, diet, drugs, surgery, rehabilitation and health education**. BCG vaccine is injected into the skin for providing considerable protection against the tuberculosis disease.

2. Cholera



Cholera.

Cholera is an acutely infectious, fatal disease and is more

common during overcrowded fairs, festivals and after floods. Sometimes cholera occurs in **epidemic** form (epidemic means wide and destructive in occurrence) spread over large population. Cholera is caused by the bacterium *Vibrio cholerae*. It is transmitted by flies, contaminated water and food. When sanitation is poor, it spreads rapidly. The incubation period of cholera is generally from a few hours to two or three days. When the bacteria of cholera are ingested, they multiply in the small intestine and invade its epithelial cells. When the bacteria die, they release toxins which irritate the intestinal lining and lead to the secretion of large amounts of water and salts.

Symptoms. 1. Watery diarrhoea (*i.e.*, rice-water like stools) which is generally painless.

2. Effortless vomiting without nausea.
3. Loss of several litres of fluid from patient's body takes place within hours. This results in dehydration, muscle cramps and weight loss.
4. Great loss of mineral salts and body fluid leads to kidney failure.
5. Eyes of patient become shrunken.

Prevention. 1. Persons should be immunised by standard cholera vaccine. One dose of immunisation lasts for about six months.

2. In cholera-prone areas, boiled water and cooked food should be taken.
3. Careful personal hygiene and good sanitation in the community are the only certain protection against cholera.

Control. 1. For preventing dehydration therapy with Oral

Rehydration Solution(ORS) should be done immediately. ORS solution contains 3.5 g sodium chloride, 2.5 g sodium bicarbonate, 1.5 g potassium chloride, 20 g glucose, 40 g sucrose in one litre water. Taking small sips of ORS solution at intervals prevents dehydration of the patient.

2. Immediate medical advice should be sought.

Antibiotics such as tetracycline kill the bacteria of cholera ([Box 5.9](#)).

Box 5.9

Antibiotics and interferon

Antibiotics are chemical substances produced by living organisms such as bacteria and fungi, etc., which can kill or stop the growth of some pathogenic (disease producing) microorganisms such as bacteria and fungi. Some of the important antibiotics which are used for the treatment of diseases caused by bacteria and fungi : 1. Penicillin; 2. Tetracycline; 3. Streptomycin; 4. Chloromycetin; 5. Quinocloones; 6. Cephalosporin; 7. Gentamycin; 8. Chloramphenicol and 9. Rifampicin.

The treatment of viral infections is more difficult than that of bacterial infection. For each type of viral infection, human body produces its own antiviral protein, called **interferon** (IFN). Interferon is released from the infected and dying host cells. On reaching the uninfected cells, IFN makes them resistant to the virus infection. Interferons have been proved to be effective in treating influenza and hepatitis.

3. Typhoid

Typhoid is the most common communicable disease in India. Typhoid fever is common in humans of the 1 to 15 years age group. Every year about 2.5 million persons suffer from Typhoid. Typhoid is caused by a rod-shaped and motile bacterium, called *Salmonella typhi* which is commonly found in the intestine of human beings. Human infection is direct.

Infection takes place by the oral route through ingestion of food, milk or water contaminated by contact with faecal matter of the typhoid patient. The bacteria spread through faecal matter by house flies. The symptoms of typhoid often appear 10 to 14 days after the infection.

Symptoms. Symptoms of typhoid are the following :

1. Headache and typhoid fever which rises maximum in the afternoon. The temperature increases each day in the first week.
2. High fever in the second week. Fever gradually declines during 3rd and 4th day.
3. In nutshell symptoms of typhoid include continuous fever often with delirium (disorder of the mind), slow pulse, tender and distended abdomen, diarrhoea with water-green stools and eruption of rosy spots (rash) on the body of the patient.



Typhoid bacteria.

Prevention. 1. Proper sanitation and disposal of faecal matter prevents infection.

2. TAB-vaccination provides immunity for 3 years. (TAB vaccine contains killed typhoid bacilli and paratyphoid organisms-*Salmonella paratyphi* A and B).
3. Typhoral oral vaccine also prevents typhoid.

Control. There are standard drugs (*e.g.*, Chloromycetin) which cure typhoid.

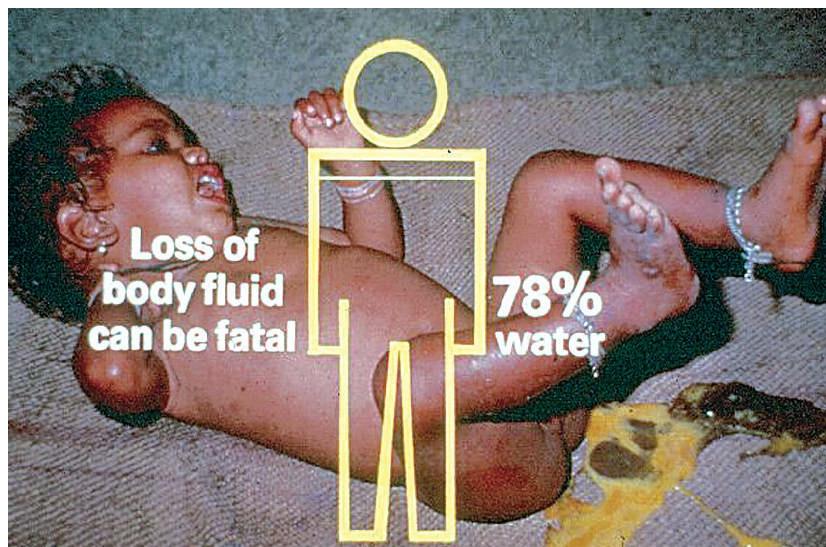
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4. Diarrhoea

Diarrhoeal disease form a group of intestinal infections, including food poisoning. The main *symptom* of all such infections is **diarrhoea**. Diarrhoea is an abnormally frequent discharge of

semisolid or fluid faeces. Other symptoms of diarrhoeal disease include decreased appetite, nausea, vomiting, borborygmus (*i.e.*, gurgling noise produced by movement of gas in the alimentary canal) and abdominal cramps. There may be blood and mucus in the stools. Persistent vomiting and loose stools cause dehydration and shock. Blood pressure may fall, pulse rate increases and temperature rise. Diarrhoea is one of the major causes of infant mortality in India.



Diarrhoea.

The diarrhoea spreads through infection through contaminated food, water, drinks, hands, clothes, bed sheets and utensils. The causative agents of diarrhoea are mainly bacteria such as *Escherichia coli*, *Clostridium botulinum*, *Shigella dysentiriae*, *Campylobacter jejuri* and *Salmonella* ([Box 5.10](#)). The **protozoans** (*Entamoeba histolytica*, *Giardia intestinalis* and *Balantidium coli*), some **viruses** (Rotavirus, Enterovirus, Adenovirus and Norwalk) and **nematodes** (*Ascaris*) also act as causative agents of diarrhoea.

Symptoms. 1. Frequent loose motions and vomiting which lead to dehydration.

2. **Dehydration** (loss of water from body tissues) which makes

the patient dangerously ill in a very short time. Most of the infant deaths due to diarrhoea can be prevented by making sure that dehydration does not take place through stools and vomiting.

3. In cases of dehydration, the patient becomes irritable, eyes appear sunken, nose is pinched and the tongue and the inner side of cheeks appear dry. There is sudden weight loss, weak pulse, deep breathing and fever or fits.

Box 5.10

Salmonellosis

Food poisoning by bacteria *Salmonella* is called **salmonellosis**. Bacteria *Salmonella* is present in the sick farm animals. So the infection of bacteria *Salmonella* which causes food poisoning is contracted from the sick farm animals through their contaminated food products such as milk, eggs and meat. When bacteria *Salmonella* grow and multiply rapidly in our intestines, then food poisoning takes place. Common symptoms include chills, fever, nausea, vomiting, diarrhoea and pain in the abdomen.

Toxins released by *Escherichia coli* cause mild diarrhoea to severe dehydration. **Shigellosis**, caused by *Shigella*, is characterised by frequent passage of stools with blood and mucus and abdominal cramps. *Clostridium botulinum* causes **food poisoning** or **botulism** from taking preserved foods (*dibba-bund* food) which have not been properly sterilised before preservation. Such canned foods contain the toxin, **botulin**, released by the bacterium. Botulin is a potent neurotoxin and causes paralysis.

Prevention

1. Eatables should be covered to prevent their contamination.
2. Fruits and vegetables should be properly washed before use.
3. Proper personal hygiene is important. Hands should be washed with soap and water before eating any food.
4. Stale food should not be consumed.
5. Community hygiene is also important.

Control

1. Complete bed rest should be ensured till the illness is fully controlled.
2. For treating diarrhoea anti-microbial drugs and anti-diarrhoea agents should be used.
3. If there is frequent vomiting, liberal amount of fluids loaded with electrolytes, should be provided orally.
4. Pulp of boiled unripe banana along with required amount of salt, turmeric powder and lime is helpful in controlling the diarrhoea.
5. Husk of isabgol seed (*Plantago ovata*) with water or curd provides relief.
6. Saline drip may be given intravenously to maintain fluid and electrolytes in the body. Alternatively oral rehydration solution (ORS) may be given to the patient periodically.
7. Dilute soups and dals, rice-water and butter-milk can also be given to the child to compensate for the loss of water. Meanwhile, a doctor should be called in who can give some antibiotic treatment. In children, diarrhoea can be prevented by keeping clean surroundings, clean milk and feeding bottles and by following proper feeding habits. There is no vaccine for preventing diarrhoea.

Box 5.11

Anthrax

Anthrax is an acute infectious disease caused by a rod-shaped non-motile bacterium called *Bacillus anthracis*. This disease commonly occurs in wild and domesticated animals such as cattle, sheep, goat, horses and pigs. However, it can affect humans if they are exposed to infected animals. Anthrax can spread by eating under-cooked meat of infected animals. Human beings can also contract infection from animal products such as bones, wool, hide and bristles. *B. anthracis* produces an extra-cellular toxin. Fowls are resistant to anthrax.

Symptoms. Infection of anthrax can occur in following three forms: 1. Cutaneous (skin); 2. Inhalation; and 3. Gastrointestinal.

(i) Cutaneous anthrax. About 20 per cent of untreated cases of cutaneous anthrax will result in death. Cutaneous cases are rare.

(ii) Intestinal anthrax. Its symptoms are nausea, loss of appetite, vomiting, pain and vomiting blood. It results in death of 25 per cent to 60 per cent cases.

(iii) Infection by inhalation. Its initial symptoms may resemble a common cold leading to severe breathing problems. It ultimately results in death of patient.

Prevention. Vaccine of anthrax is found to provide 93 per cent protection against anthrax. Course of four subcutaneous injections of anthrax vaccine is recommended. Mild adverse reaction to the vaccine of anthrax is reported.

Control. Doctor can prescribe effective antibiotic. Treatment should be started early to get good result.

In **food infection**, food merely transfers bacteria into the body. In **food poisoning**, bacteria grow in food and release toxins. When such a food is taken, toxins are absorbed into the blood from the digestive tract. They affect the body quickly, causing gastrointestinal trouble and other effects.

5. Peptic Ulcers

Peptic ulcers are painful bleeding areas within the stomach and the duodenum. They were once considered to be caused by increased gastric acidity due to stress and life style of the afflicted persons. However, **Robin Warren** (born 1937) a Perth based Australian pathologist observed in 1984 that areas of peptic ulcers contained many small curved gram negative bacterium, named *Helicobacter pylori* ([Fig. 5.9](#)). **Barry Marshall** (born 1951), a young clinical fellow of Warren succeeded in culturing the bacteria (1985). **Marshall** and **Warren** (1985) found that **amoxicillin**, an antibiotic effective in killing the bacteria could also cure the peptic ulcers. The finding helped in changing once painful chronic and disabling condition into a short duration treatable disease. For this breakthrough **Marshall and Warren** were awarded Nobel Prize for Physiology and Medicine in 2005.

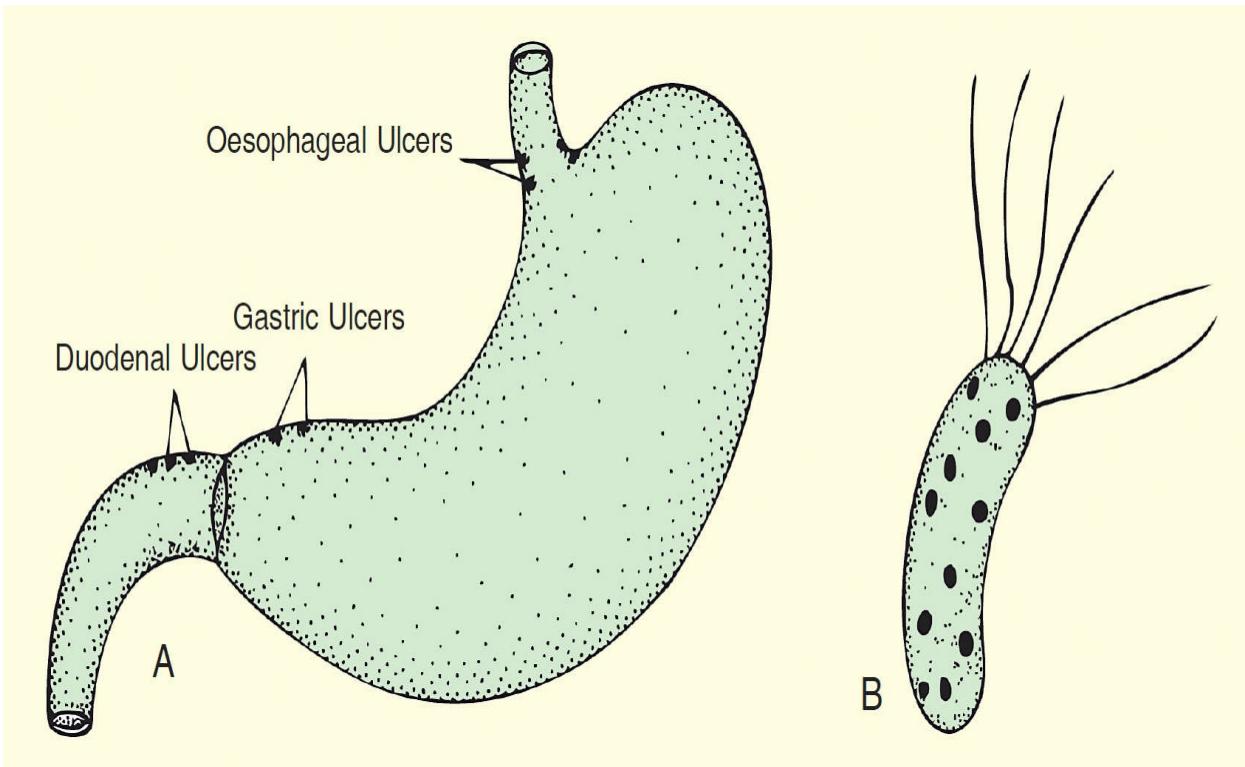


Figure 5.9. A Peptic ulcers; B-*Helicobacter pylori*.

Box 5.12.

Some Vital Facts about Diseases

1. **Dengue fever** is a *viral* disease whose vector is *Aedes aegypti*. It is a daytime biting mosquito.
2. **World T.B. Day :** 24th March.
3. **National T.B. Control Programme** was started in 1962.
4. The **WHO** has announced a new treatment, and management regimen—Directly Observed Treatment Short-course (DOTS) for the control of tuberculosis (TB), also called “White plague” and for reducing the threat of multi drug resistant strains in the next decade. (Regimen = A course of medical treatment, diet or exercise, followed to improve one’s health).
5. The incidence of **tetanus** in India is about 30 to 50 per

- one lakh. Neonatal tetanus carries a mortality type of 90 percent.
6. **Bubonic plague** is commonest type of plague. It is caused by a bacterium of the genus *Yersinia* (*Y. pestis*).
 7. Incidence of **diarrhoeal diseases** is highest in Andhra and Orissa states of India.
 8. **Hepatitis B** is more dangerous than AIDS.
 9. **Malaria Day**. August 20.
 10. The Integrated Child Development Scheme (ICDS) offers a series of services to control nutritional problems. Health centres distribute tablets of iron and folic acid among women and children to prevent anaemia. Vitamin A is also given to children orally under various schemes.
 11. WHO (World Health Organisation, 1978) has defined health to be “A state of complete physical, mental and social well being (and not merely the absence of disease or infirmity) that enables one to lead a socially and economically productive life”.
 12. **World AIDS day** is December 1.
 13. Because of weight loss of AIDS patient, this disease is also called **slim disease**.

SUMMARY

- Anything that prevents proper functioning of cells and tissues lead to a lack of proper activity of the body.
- Health is a state of being well enough to function well physically, mentally and socially. It is a state free from illness or injury.
- Disease is a disorder in a human, animal or plant, caused by infection, diet or by faulty functioning of a process.
- The word ‘disease’ is originated from a old French word *desaise*

meaning ‘lack of ease’.

- Public cleanliness is important for individual health.
- Good economic conditions and jobs are needed for individual health.
- An acute disease is identified as one which comes on rapidly and could be dangerous, *e.g.*, cold and cough.
- A chronic disease is one that lasts for a long time, *e.g.*, tuberculosis.
- Drinking of unclean water is first level of cause of disease. Lack of good nourishment is second level of cause of disease. Lack of public services is third level of cause of disease.
- Diseases which are caused by infectious agents such as microbes (=pathogens) are called infectious diseases, *e.g.*, cholera.
- Diabetes, high blood pressure, cancer, etc., are non-infectious diseases of human beings.
- Antibiotics are chemicals produced by bacteria and fungi to kill the pathogen. They kill microbes by blocking their vital biochemical pathways such as cell wall formation, protein synthesis, etc.
- Infectious diseases can spread by various means such as by air, water or physical contact.
- HIV-AIDS patients die due to various secondary infections. In them the virus tends to destroy the immune system of the patient.
- Antibiotics can not kill viruses. To combat the viruses, microphages of our body secrete interferons.
- The ability of an organism to resist a particular infection is called **immunity**. Specific immune responses function by recognising particular chemicals, called antigens that are present on the surface of the invading cells. These antigen interact with protein molecules produced by the host, the immunoglobulins or antibodies. Once bound, the cell bearing the antigen is more easily ingested by phagocytic cells such as neutrophils and macrophages.
- Vaccines have been developed to combat a variety of bacterial diseases such as tetanus, diphtheria, whooping cough, measles, polio, etc.

FORMATIVE ASSESSMENT

I. CLASS ASSIGNMENT

A. True or False Questions

- 1.** Rickets is caused due to the deficiency of vitamin A.
- 2.** Hepatitis is a non-communicable disease.
- 3.** The process of vaccination was developed by Jenner in the year 1796.
- 4.** HIV virus is a retrovirus.
- 5.** AIDS can be transmitted through blood transfusion.
- 6.** Communicable diseases are non-infectious.
- 7.** An environmental stress upsets the normal physiological functioning of the organism.
- 8.** High blood pressure is an infectious disease.
- 9.** Penicillin is effective against bacteria because it inhibits their wall formation.
- 10.** Personal hygiene is basic to prevent infectious diseases.
- 11.** Interferons are made by our body to fight against the viral infections.
- 12.** Antibiotics are produced by bacteria and fungi.
- 13.** Streptomycin inhibits protein synthesis in pathogenic bacteria.
- 14.** Hepatitis B is more dangerous than Hepatitis A.
- 15.** Ringworm is caused by a nematode worm.
- 16.** Acquire diseases are developed after birth.
- 17.** Cancer is an infectious disease.
- 18.** Botulism can be caused by canned food.

B. Fill in the Blanks

- 1.** Health is state of well being physically, and socially.
- 2.** The two important contributory causes of diseases are and make up.
- 3.** Infectious diseases are caused by
- 4.** Cholera is caused by but malaria is caused by
- 5.** Malaria is spread by which breed in water.

6. Diseases present from the birth are called
7. Interferons are anti-..... proteins.
8. Any organism capable of producing a disease is called
9. The organism which spread the disease from an infected person to a healthy person is called
10. The virus that causes acquired immune deficiency syndrome (AIDS) parasitizes
11. vaccine gives considerable protection against tuberculosis.
12. HIV stands for
13. Diseases are of two main kinds : Congenital and
14. Ability of an organism to resist disease is called a
15. WHO stands for
16. Rabies is also called
17. BCG stands for

C. Matching Type Questions

I. Single Matching

Match the contents of the column I and column II.

<i>Column I</i>	<i>Column II</i>
1. Malaria	(a) <i>Mycobacterium tuberculosis</i>
2. Tuberculosis	(b) Virus
3. AIDS	(c) Protozoa
4. Ringworm	(d) <i>Entamoeba histolytica</i>
5. Amoebiasis	(e) <i>Wuchereria bancrofti</i>
6. Cholera	(f) <i>Vibrio cholerae</i>
7. Elephantiasis	(g) Fungi

II. Double Matching

Match the contents of Column I, II and III.

Column I	Column II	Column III
(a) Chronic disease	(i) Over weight	(A) Debility
(b) Musician	(ii) Good health	(B) Marshal and Warren
(c) High blood pressure	(iii) <i>Helicobacter pylori</i>	(C) Breathing capacity
(d) Peptic ulcer	(iv) Long time	(D) Lack of exercise

III. Key or Check List Items

Which type of pathogen (viral-V, bacterial-B, protozoan-P) cause the following disease.

Disease	Pathogen
(a) Kala-azar
(b) SARS
(c) Acne
(d) Rabies
(e) H ₁ N ₁

IV. Match the Stimulus with Appropriate Responses

Disease	Vector borne A	Droplet B	Contact C	Contaminated food and water D
1. Malaria
2. Cholera
3. Common cold
4. Chicken pox

ANSWERS TO SELECTIVE PROBLEMS

A. True or False Questions

1. False;

2. False;
3. True;
4. True;
5. True;
6. False;
7. True;
8. False;
9. True;
10. False;
11. True;
12. True;
13. True;
14. True;
15. False;
16. True;
17. False;
18. True.

B. Fill in the Blanks

1. Mentally;
2. Under nourishment, genetic;
3. Microorganisms;
4. Bacterium, protozoan;
5. *Anopheles*, stagnant;
6. Congenital;
7. Viral;
8. Pathogen;
9. Vector;
10. Helper T-cells;
11. BCG;
12. Human Immuno-deficiency Virus;
13. Acquired;
14. Immunity
15. World Health Organisation;
16. Hydrophobia;

17. Bacillus-Calmette, Guerin.

C. Matching Type Questions

I. Single Matching

1. (c);
2. (a);
3. (b);
4. (g);
5. (d);
6. (f);
7. (e).

II. Double Matching

- (a) - iv - A;
(b) - ii - C;
(c) - i - D;
(d) - iii - B.

III. Key or Check List Items

- (a). P;
(b). V;
(c). B;
(d). V;
(e) B.

IV. Matching of Stimulus-Response

1. A;
2. D;
3. B;
4. C.

II. Question Answer

1. State the definition of health given by WHO. Write down the traits of a healthy person.
2. (a) Describe significance of good health ?
(b) Discuss how do personal and community issues affect health ?
3. (a) Differentiate between healthy and disease free ?
(b) Distinguish between symptoms and signs of disease.
4. (a) Define the acute and chronic disease.
(b) Describe the various levels of causes of disease.
5. Describe various categories of diseases.
6. Briefly describe (a) Infectious agents; (b) Means of transmission of disease.
7. Discuss (a) Principles of treatment (b) Vaccination.
8. Why does dehydration set in during diarrhoea ? How can the former be prevented?

III. Multiple Choice Questions

- (i) Harelip is a
 - (a) acquired disease
 - (b) infectious disease
 - (c) metabolic disease
 - (d) congenital disease
- (ii) SARS and Swine flue are caused by
 - (a) virus
 - (b) virus and bacterium
 - (c) virus and protozoan
 - (d) virus and helminth
- (iii) Acne are caused by
 - (a) H_1N_1 virus
 - (b) *Trypanosoma*
 - (c) *Staphylococcus*
 - (d) *Leishmania*

(iv) A disease transmitted through sexual contact is

- (a) HIV
- (b) Gonorrhoea
- (c) Syphilis
- (d) all the above

(v) Kala-azar (black fever) is caused by

- (a) protozoan
- (b) fungus
- (c) helminth
- (d) bacterium

(vi) Ascariasis spreads through

- (a) vectors
- (b) contaminated food and water
- (c) formites
- (d) droplets

(vii) A communicable disease is caused by

- (a) metabolic disorder
- (b) allergy
- (c) pathogen
- (d) hormonal balance

(viii) Which one is an acute disease

- (a) diabetes
- (b) tuberculosis
- (c) hypertension
- (d) typhoid

(ix) Clean drinking water is related to

- (a) economic status
- (b) social status
- (c) personal hygiene
- (d) public hygiene

(x) Health deals with

- (a) social well being
- (b) physical fitness
- (c) mental fitness
- (d) all the above

ANSWERS

- (i) d;
- (ii) a;
- (iii) c;
- (iv) d;
- (v) a;
- (vi) b;
- (vii) c;
- (viii) d;
- (ix) d;
- (x) d.

Class Response

IV. Oral Questions

1. What conditions are essential for good health?
2. Name three factors which may be responsible for the disease.
3. Which disease is caused due to hyposecretion of insulin hormone ?
4. Give examples of two degenerative diseases.
5. Give two examples of social diseases.
6. Whether goitre is a inherited or deficiency disease?
7. Name the external factor which is responsible for ring worm disease.
8. Deficiency of which vitamin in human diet may cause pernicious anaemia?
9. Name deficient nutrient for night blindness.

- 10.** Give an example of third level cause of the disease.

V. Quiz

- 1.** Which is T.B. day ?
- 2.** Which is malaria day ?
- 3.** Give scientific name of vector of dengue.
- 4.** When was pulse polio programme started ?
- 5.** How is malaria controlled ?
- 6.** How is typhoid tested ?
- 7.** Which is AIDS day ?
- 8.** What is another name of tuberculosis ?
- 9.** What is another name of rabies ?
- 10.** What is other name of jaundice ?
- 11.** What is ORS ?
- 12.** Name a vaccination which provides life long immunity.

Home Assignment

VI. Answer the following Questions

- 1.** Define communicable disease.
- 2.** Define non-communicable disease.
- 3.** Write the name of the causal organisms of the following disease: malaria, influenza, rabies, tuberculosis and typhoid.
- 4.** Name some diseases caused by Protozoa.
- 5.** Name the disease the child will not suffer from if BCG vaccine is given.
- 6.** Name one disease which spread through direct contact.
- 7.** Name any disease caused by virus in humans.
- 8.** Name a viral disease which suppresses the body's immune mechanism.
- 9.** Name four diseases that are caused by bacteria.
- 10.** Name the viral disease which occurs in human due to the bite of a mad dog.
- 11.** Name the vector and the causal organism of malaria.
- 12.** What are antibodies ?

13. Name two antibiotics.
14. What is lymphocyte ?
15. What is vaccination ?
16. What is TAB vaccine ?
17. How does hepatitis A spread ?
18. How does hepatitis B spread ?
19. Name tow air transmitted diseases ?
20. Name three formites which can be source of infection.
21. Differentiate between personal health and community health
22. What is the difference between symptom and disease.
23. Describe intrinsic factors of disease.

Group Discussion

VII. Organise a group discussion of each of the following topics

1. Discuss the general ways of preventing diseases.
2. Discuss the importance of vitamins in maintaining a healthy life.
3. Factors affecting the community health.

Seminar/Symposium

VIII. Organise a seminar/symposium on each of the following topics

1. AIDS – Its causes and prevention.
2. Heath of Indian people
3. Role of common people in controlling the spread of disease.

Group Projects

IX. Investigatory Projects

1. Investigate the hygiene conditions in and around your school, house, school canteen, near by hospital/nursing home and restaurant.
2. Make a list of infectious and non- infectious diseases and their

causes.

X. Experimental Projects

1. List the human diseases that are caused by microorganisms and their preventive measures.
2. Collect information and compare sanitary conditions of any government and a private hospital.
3. Find out the ways used by local authority to manage the solid waste generated in your locality.

XI. Survey

1. Survey your neighbourhood to collect information about awareness about vitamins, antibiotics and vaccinations.
2. Collect data on the success of pulse polio programme in your city.
3. Collect information if the people of your locality get a supply of clean drinking water at their homes?

STUDY MATERIALS FOR SEMINARS, SYMPOSIA, GROUP DISCUSSIONS, ISSUES OF COMMUNITY AWARENESS AND PROJECTS

A. Seminars

Topic of Seminar :

Diseases and Their causes.

Divide this topic into following subtopics with each subtopic being given to a separate student.

Student 1. Introduction

Student 2. Types of Diseases

Student 3. Spread of Diseases

Student 4. Treatment and Prevention

(a) Methods of Treatment

(b) Prevention and Disease.

B. Symposia

In a symposium, participants also form the audience. They prepare and present papers (by the help of power points, slides) on one or more topics. Students may develop papers on the following topics:

1. Hygiene to ward off Diseases

- (i) Community or Public Hygiene
- (ii) Domestic Hygiene
- (iii) Personal Hygiene

2. Prevention is Better Than Cure

Students may develop the papers on the following lines :

- (i) Proper nutrition
- (ii) Clean Food
- (iii) Pure Drinking Water
- (iv) Clean Surrounding
- (v) Avoiding Overcrowded Places
- (vi) Domestic Hygiene
- (vii) Personal Hygiene
- (viii) Regularity
- (ix) Exercise
- (x) Relaxation
- (xi) Vaccination

C. Group Discussions

A topic for group discussion is given to ten or more students. One student is made group leader, one moderator and one recorder. All students come prepared with the topic thoroughly. They can bring in their notes. **Group leader** is to ensure that each and every student participates in group discussion. **Moderator** conducts the discussion in orderly manner, ensures that there is no cross talk, no two students speak together and listen every one patiently. **Recorder** is to record about the participation of each and every student including one's own.

Discussion can be started by the leader who introduces the subject. The leader can also ask any participant to initiate the same. For example, a topic for group discussion can be prepared on the following lines:

Model Topic for Group Discussion: Global Warming

- (i) Introduction
- (ii) Green House Effect
- (iii) Green House Gases:
 - (a) Carbon dioxide;
 - (b) Methane;
 - (c) Chlorofluorocarbons;
 - (d) Nitrous oxide;
 - (e) Ozone.
- (iv) Effects of Global warming
 - (a) Effect on atmosphere;
 - (b) Effect on weather and climate;
 - (c) Change in sea level;
 - (d) Effect on range of species;
- (v) Strategies to Deal with Global Warming
- (vi) International Efforts
 - (a) Earth summit (1992);
 - (b) Kyoto Protocol (1997);
 - (c) U.N. Convention on Climatic Change (CCC, 2004),
 - (d) Bali conference (2007);
 - (e) Copenhagen conference (2009).

D. Role of Students in Bringing Awareness Among Community Members on Certain Health and Other Issues

Students may campaign for the following issues.

1. Importance of Hygiene

- (a) Personal Hygiene;
- (b) Community and Domestic Hygiene.

2. Saving Power and Water

- 3. Importance of Immunisation**
- 4. Biological Control**
- 5. Organic Farming**

E. Projects

1. Investigatory

- (i) Conservation of resources
- (ii) Spread of diseases caused by mosquito in the locality
- (iii) Soil fertility.

Consult text book and then library for preparing the project.

2. Experimental Projects

- (i) Location of Apical Meristem
- (ii) Vermicomposting

Consult the text book for preliminary understanding the topic of the project. Perform the experiment and then prepare the report giving details about every aspect.

SUMMATIVE ASSESSMENT

NCERT TEXTBOOK QUESTIONS AND EXERCISES WITH ANSWERS

NCERT Textbook Questions

Q.1. State any two conditions essential for good health.

Two conditions essential for good health are

- Ans.** (i) better sanitation or clean surroundings, and
(ii) availability of sufficient and nutritious food.

Q.2. State any two conditions essential for being free of disease.

- Ans.** (i) Living in hygienic environment.

(ii) Getting vaccinated against common infectious diseases.

Are the answers to the above questions necessarily the same or

Q.3. different? Why?

Ans. Answers of above questions (1, 2) are interconnected but different. It is because being disease free does not mean is healthy.

List any three reasons why you would think that you are sick
Q.4. and ought to see a doctor. If only one of these symptoms were present would you still go to the doctor? Why or why not?

The following three symptoms indicate our disease and urge us to go to see doctor:

1. having headache, shivering and body temperature
2. having diarrhoea (loose-motions), and
3. having a wound with pus.

Ans. If only one of the above three symptoms were present, we still would have to consult doctor. It is so because all the three symptoms made us uncomfortable and bed-ridden for sometimes due to attack of some diseases.

Q.5. In which of the following cases do you think the long term effects on your health are likely to be most unpleasant?

- * If you get jaundice;
- * If you get lice;
- * If you get acne. Why?

In case of jaundice, there would be long term effects on our body. Jaundice is the result of a disease called **hepatitis**, caused by a virus. In jaundice, our liver is affected and it takes more time to recover from this disease by taking proper treatment under supervision of doctor. In contrast to jaundice, lice can be removed easily with short treatment and so is the acne. Both of these do not produce long term effects on the body.

Q.6. Why we are normally advised to take bland and nourishing food when we are sick?

Ans. When we fall sick, one or more organ-systems do not function normally. As a result, we lose appetite and do not have proper digestion and absorption of food. Sickness makes us weak. Therefore, we are advised to take bland and nourishing food during sickness. Such a food is easily digested and replenish our lost vitamins, minerals and other nutrients along with energy.

Q.7. What are the different means by which infectious diseases are spread?

Ans. Infectious diseases are generally spread through air, through water, through sexual contact, through vectors (e.g., mosquito), through physical contact with affected person, through articles or formite borne (bedding, utensils, clothes, etc.) of use of affected person.

Q.8. What precautions can you take in your school to reduce the incidence of infectious diseases?

Ans. Following precautions can be taken in the school to reduce the incidence of infectious diseases:

- (i) providing clean drinking water.
- (ii) educating students about causes of infectious diseases such as cholera, hepatitis, flue, AIDS, etc.
- (iii) vaccination of students against common infectious diseases from time to time.
- (iv) proper sanitation or clean environment in school and its surroundings to eradicate vectors (e.g., mosquito) of infectious diseases, and
- (v) by not allowing the affected students (e.g., a student suffering from viral disease, called measles or chicken pox) to attend the classes till they recover from infectious diseases.

Q.9. What is immunisation?

If one person has chicken pox once, there is no chance of suffering from it again. This happens because when the immune system first sees an infectious microbe, it responds against it and then remembers it specifically. So the next time that particular microbe, or its close relatives enter the body, the immune system responds with even greater vigour. This eliminates the infection even more quickly than the first time around. This is the basis of the principle of immunization.

Q.10. What are the immunization programmes available at the nearest health centre in your locality? Which of these diseases are the major health problems in your area?

Ans. At the nearest public health centre in our locality, following childhood immunisation programmes are available:

- (i) for preventing polio;
- (ii) for preventing tetanus, diptiheria and whooping cough;
- (iii) for preventing tuberculosis;
- (iv) for preventing measles.

Occasionally, children suffer from measles in our area.

NCERT Exercises

Q.1. How many times did you fall ill in the last year? What are the illnesses?

- (a) Think of any change you could make in your habits in order to avoid any of most of the above illnesses.
- (b) Think of any change you would wish for in your surroundings in order to avoid any of/most of the above illnesses.

Ans. Only once I fell ill in the last one year. I suffered from sore throat and cough.

- (i) I stopped drinking cold water immediately after taking food.
- (ii) Planting more trees, removing weeds and regular disposal of garbage.

A doctor/nurse/health-worker is exposed to more sick people than

Q.2. others in the community. Find out how she/he avoids getting sick herself/himself.

Ans. A doctor/nurse/health-worker is exposed to more sick people in the community. He avoids getting sick by :

- (i) keeping place of work sterilised by using phenyl, etc.
- (ii) keeping equipments, that are regularly in use, sterilised.
- (iii) washing hands with soap thoroughly after serious examination of patients.
- (iv) wearing clean clothes.

Conduct a survey in your neighbourhood to find out what the three

Q.3. most common diseases are. Suggest three steps that could be taken by your local authorities to bring down the incidence of these diseases.

Ans. The three most common diseases in my neighbourhood are:

- (i) Diarrhoea
- (ii) Cold and cough;
- (iii) Typhoid.

Three steps that should be taken by local authorities are:

- (i) providing clean drinking water regularly.
- providing better sanitation, i.e., clean surroundings through regular

- (ii) disposal of garbage, and
- (iii) arranging immunisation programmes from time to time against common infectious diseases.

Q.4. A baby is not able to tell her/his caretakers that she/he is sick. What would help us to find out

- (a) **that baby is sick?**
- (b) **what is the sickness?**

Ans. (a) An extremely young human child is called baby. Symptoms that help us to find that baby is sick, are

- (i) continuous crying and restlessness in the child.
- (ii) improper intake of food and body temperature;
- (iii) loose motions.

(b) Baby is suffering from diarrhoea.

Q.5. Under which of the following conditions is a person most likely to fall sick?

- (a) **when she is recovering from malaria,**
- (b) **when she has recovered from malaria and is taking care of someone suffering from chicken pox.**
- (c) **when she is on a four-day fast after recovering from malaria and in taking care of someone suffering from chicken-pox. Why?**

Malaria is a very serious fatal disease. It is caused by the toxins produced in the human body by malarial parasite *Plasmodium* which is carried from the infected person to the healthy persons by the bite of the female *Anopheles* mosquito. Malaria results anaemia, enlargement of liver and spleen.

Ans. (c) The possible reason of falling sick of lady is that she has recently suffered from malaria and her body's organ systems are still not functioning normally. Moreover, she is on four days fast which has made her body weak due to improper supply of food. So, she is more prone to infections. Above all, she is taking care of someone who is suffering from most fearful infectious viral disease, i.e., chicken pox, she has more chances of getting an infection due to above mentioned regions.

Questions Based on NCERT Question Bank (Exemplar

Problems in Science)

1. What is disease ? How many types of diseases have you studied ? Give examples.

Disease (Old French *disease* = lack of ease) is a disorder in a human,
Ans. Animal or plant, caused by infection, diet or by faulty functions of a process.

Types of disease. (i) *On the basis of duration.* Acute or chronic diseases.

(ii) *On the basis of period of occurrence.* Congenital and acquired diseases.

On the basis of causal agents. Infectious and non-infectious.

(iii) Infectious or communicable diseases can be contagious or non-contagious. Non-infectious disease may be deficiency disease, metabolic disease, degenerative disease, allergy, cancer and injury.

Example of infectious disease. Influenza, tuberculosis, pneumonia.

Example of non-infectious disease. Cancer, diabetes.

2. Give any four factors necessary for a healthy person.

Ans. (1) **Environment.** (i) A clean physical environment with the help of public health services. (ii) A congenial social environment.

(2) **Personal hygiene.** Personal cleanliness prevents catching up of infectious diseases.

(3) **Nourishment.** Intake of a proper balanced diet keeps the immune system strong.

(4) **Vaccination.** Timely vaccination against major disease (*e.g.*, polio, T.B., chicken pox, etc.) protects one self from catching those diseases.

3. Give two examples for each of the following : (a) Acute diseases ; (b) Chronic diseases ; (c) Infectious diseases ; (d) Non-infectious diseases.

Ans. (a) **Acute diseases.** Typhoid, Malaria, Influenza

(b) **Chronic diseases.** Tuberculosis, Elephantiasis

(c) **Infectious diseases.** Typhoid, Chicken pox

(d) **Non-infectious diseases.** Diabetes, Goitre.

4. Name two diseases caused by protozoans. What are their causal organisms ?

Ans. (a) Sleeping sickness caused by *Trypanosoma gambiense*.

(b) Malaria caused by *Plasmodium vivax*.

5. Which bacterium causes peptic ulcers ? Who discovered the pathogen for the first time ?

Ans. **Bacterium causing peptic ulcers.** *Helicobacter pylori.* **Discovery.** *Warren (1984), Marshal and Warren (1985).*

6. What are antibiotics ? Give two examples.

Ans. **Antibiotics.** An antibiotic is a biochemical produced by a microorganism (e.g., Bacteria or fungi) which kills or block growth of other microorganisms (pathogens) by blocking their life processes without harming human cells, e.g., penicillin, streptomycin.

7. Fill in the blanks

- (a) Pneumonia is an example of disease.
- (b) Many skin diseases are caused by
- (c) Antibiotics commonly block biochemical pathways important for the growth of
- (d) Living organisms carrying the infecting agents from one person to another are called

Ans. (a) Infectious (communicable) disease ;
(b) fungi ;
(c) bacteria ;
(d) vectors.

8. Name the target organs of the following diseases :

- (a) Hepatitis targets
- (b) Fit or unconsciousness targets
- (c) Pneumonia targets
- (d) Fungal disease targets
- (a) liver ;
- (b) Brain ;
- (c) Lungs ;
- (d) Skin.

9. (a) Who discovered “vaccine” for the first time ?
(b) Name two diseases which can be prevented by using vaccines.
Ans. (a) Edward Jenner ;
(b) Tuberculosis (T.B.) and polio or tetanus and diphtheria.

10. Name any two groups of microorganisms from which antibiotics could be extracted.

Ans. Bacteria, Fungi.

11. Name any three diseases transmitted through vectors.

Ans. Malaria (vector female *Anopheles*), Dengue (vector female *Aedes*), kala-azar (vector sandfly *Phlebotomus*).

12. Fill in the blanks :

- (a) disease continues for many days and causes on body.
 - (b) disease continues for a few days and causes no long term effect on body.
 - (c) is defined as physical, mental and social well being and comfort.
 - (d) Common cold is disease.
 - (e) Many skin diseases are caused by
 - (a) Chronic, long term effect ;
 - (b) Acute ;
- Ans.** (c) Health ;
(d) Infectious (communicable) or viral ;
(e) Fungi.

13. Classify the following diseases as infectious and non-infectious :

- (a) AIDS ;
- (b) Tuberculosis ;
- (c) Cholera ;
- (d) High blood pressure ;
- (e) Heart disease ;
- (f) Pneumonia ;
- (g) Cancer.

Ans. (i) **Infectious diseases.** AIDS, Tuberculosis, Cholera.

(ii) **Non-Infectious diseases.** High blood pressure, Heart disease, Pneumonia, Cancer.

14. Explain giving reasons.

- (a) Balanced diet is necessary for maintaining healthy body.
 - (b) Health of an organism depends upon the surrounding environmental conditions.
 - (c) Our surrounding area should be free of stagnant water.
 - (d) Social harmony and good economic conditions are necessary for good health.
- (a) For keeping good health, we should eat a balanced diet containing

adequate (proportionate) amounts of all the essential nutrients such as carbohydrates, proteins, fats (lipids), vitamins, minerals, water and roughage. Unbalanced diet causes malnutrition. Proper nourishment maintains the health of all the body systems including the immune system.

(b) Health of an organism including human beings depend upon the surrounding environmental conditions. **Public Health Services** ensure clean environment around our dwellings and protection from outbreak of diseases. They ensure removal of garbage, drainage and sewage services, proper drinking water, unadulterated food articles, vector and pest control, vaccination and other health care services. If these services are insufficient or faulty, the health of individual citizens is bound to be adversely affected despite taking the best balanced food and keeping the best personal hygiene. It is because, infection is contracted from others and is connected with uncontaminated food.

Ans.

(c) Stagnant water (of pools, ponds) is habitat of larvae of many types of mosquitoes. It is also source of many water borne diseases. Therefore, stagnant water should not be present in and around human habitations.

(d) (i) Social equality and harmony are required for participating in one another's joys and sorrows, helping the others and receiving help at the time of need. There should not be any sort of mistrust, worry and mistreatment of each other. This would make everybody in the community happy and healthy.

(ii) A proper nutrition is essential for good health. Poverty is the root cause of nutritional disorders (*i.e.*, malnutrition and under nourishment) in our country. There should be proper earning in order to provide food to every one in the family. For a good earning there should be opportunity for a proper job for which the bread earner has been trained. Therefore, a proper training for job, a good job and subsequently good economic conditions are needed to maintain health of the individuals.

15. What do you mean by disease symptoms ? Explain giving two examples.

Disease symptoms are evidences of presence of diseases. Symptoms are in the form of structural and functional changes in the body or body parts. They indicate that there is something wrong in the body, *e.g.*, wound with pus, oedema, cough, cold, loose motions, pain in abdomen, headache, fever. However symptoms do not give any exact cause of the disease. For instance, headache may be due to some dozen different diseases. There may be problem of eye sight, blood pressure, some sort of stress (such as of examination, meningitis, pollution, etc.).

16. Why is immune system essential for our health ?

Immune system is body defence system against various types of pathogens. It includes following components of blood-phagocytic cells,

Ans. natural killer cells (NK cells), T-lymphocytes and B-lymphocytes. B-lymphocytes produce antibodies against antigens of pathogens and their toxins. Immune system keeps the body healthy by killing infecting microbes.

17. Why is AIDS considered to be a “syndrome” and not a disease ?

Syndrome is a group of symptoms, signs, physical and physiological disturbances that are due to a common cause. AIDS is also a complex of diseases and symptoms which develop due to failure of the body to fight off even minor infections.

Ans. HIV that causes AIDS damages immune system of the patient by destroying T₄ helper cells (T lymphocytes). As a result, even small cold leads to development of pneumonia, a slight gut infection leads to severe diarrhoea and blood loss, likewise skin rashes develop into ulcers.

18. Why do some children fall ill more frequently than others living in the same locality ?

Children fall ill more frequently due to (i) poor personal hygiene ; (ii) poor

Ans. domestic hygiene ; (iii) unclean food ; (iv) lack of proper nutrition and balanced diet. All these factors make the immune system weak.

What precautions would you take to justify “prevention is better than

19. cure”

Prevention is better than cure as a disease always causes some damage to the body, loss of working days, besides expenditure on medication. The important precautions for preventing occurrence of diseases include (i)

Ans. hygienic environment ; (ii) personal hygiene ; (iii) proper nutrition (balanced diet) ; (iv) clean food ; (v) clean water ; (vi) regular exercise and (vii) adequate relaxation. Every body should also be aware of diseases and their mode of spreading (epidemic). A regular medical checkup is also earnestly required to stay healthy.

20. Why are antibiotics not effective for viral diseases ?

Antibiotics are effective against bacteria and other non-viral pathogens as they block some of their biosynthetic pathways without affecting human beings. However, viruses do not have their own metabolic machinery.

Ans. There are very few biochemical processes that can block viral multiplication. Antibiotics are not effective against them. They can be overpowered only by development of immunity against them, by the body the host. An antiviral product, called **interferon** is produced by the cells

exposed to the action of virus.

21. **Becoming exposed to or infected with a microbe does not necessarily mean developing noticeable disease. Explain.**

An infectious microbe is able to cause a disease only if the immune system of the infected person is unable to put proper defence against it. Many persons have strong immune system or have acquired immunity against the pathogen or the intensity of pathogenic attack is quite mild. As a result, despite exposure to infective microbe, the person will not catch the disease.

QUESTIONS BASED ON HIGH ORDER THINKING SKILLS (HOTS)

- Q.1. Expand the following abbreviations :**

(1) PPIP ; (2) OPV ; (3) NIDS.

(1) PPIP = Pulse polio immunisation programme ;

Ans. (2) OPV = Oral polio vaccine ;

(3) NIDS = National immunisation days, e.g., 4 NIDs for PPIP.

- Q.2. What is correct ?**

(a) A person strolling in the lawn of his/her house is relaxing or doing exercise.

(b) Wearing socks and full sleeves at night will prevent the attack from dengue.

(c) Regular use of ORS cures diarrhoea.

Ans. (a) Strolling is no exercise as a person moves slowly. It is a way of relaxation where stress and strain can be relieved.

(b) No. Dengue is caused by bite of *Aedes aegypti* mosquito which is active during day time only.

(c) Yes. ORS prevents dehydration. Diarrhoea is generally cured automatically after 1 to 2 days because it is mostly viral infection.

- Q.3. Name in which**

(a) Antibiotics has no role.

(b) Kissing does not spread the disease while sexual contact transfer the same.

(c) Mass scale immunisation is going on in India.

- Ans.**
- (d) Virus, bacterium and protozoan can be causal agent.
 (a) Malaria ;
 (b) AIDS ;
 (c) Polio ;
 (d) Diarrhoea.

QUESTIONS OF CBSE SAMPLE PAPER

2 Marks Questions

1. (a) What is an epidemic disease?
 (b) Which organ is affected if a person is suffering from jaundice ?
(2011)

2. Why are we normally advised to take bland and nourishing food when we are sick?
(2011)

3. Why antibiotics effective against bacteria but not against viruses?
(2011)

4. State two consequences, which one has to face while dealing with an infectious diseases?
(2011)

3 Marks Questions

1. (a) It was diagnosed that Preeti suffers from Japanese encephalitis, which organ of Preeti's body is affected?
 (b) How are antibiotics effective in the treatment of some diseases?
 (c) Will they help in curing Preeti's disease? Why?
(2010)

- Ans.**
- (a) **Organ affected in Japanese Encephalitis** — Brain.
 - (b) **Antibiotics** — They block biochemical pathways of bacteria such as synthesis of cell wall and proteins. Therefore bacteria die due to antibiotic's action.
 - (c) **Antibiotic Effect in Japanese Encephalitis** — Nil. Japanese encephalitis is a viral disease while antibiotics are effective against bacteria.
 2. (a) Discuss briefly the principle of immunization.
 (b) Mention any two diseases that can be prevented by immunization.

(2010)

(a) **Immunization** is the development of resistance against a pathogen. It is carried out through vaccination.

Principle of vaccination. Vaccination introduces a harmless antigen of a pathogen into the body. Our immune system develops some antibodies and

Ans. memory lymphocytes against the pathogen. When the actual pathogen happens to enter the body, the immune system recognises its antigen through memory cells. The memory cells induce large scale synthesis of cytotoxic and antibody producing lymphocytes to eliminate the pathogen.

(b) Polio, Diphtheria.

3. **Discuss with the help of suitable examples three ways in which microorganisms can find entry into human body.**

(2010)

- Ans.** (a) **Contaminated food and water.** Cholera, Typhoid.
(b) **By Mosquitoes.** Malaria by bite of female Anopheles, dengue by bite of Aedes.
(c) **Sexual contact.** Syphilis, AIDS.
4. (a) Which of the following disease are protozoan in origin?
Dengue, Malaria, Kala-azar and HIV- AIDS.
(b) Suggest any two ways to prevent being infected by protozoa.

(2011)

5. (a) Why taking an antibiotic is not effective in the common cold?
(b) Name two diseases against which infants below one year are vaccinated.
(c) List two symptoms of any one of this disease.

(2011)

6. (i) Give definition of “health”
(b) State and explain in brief the four major factors, which are causes of disease.

(2011)

7. (i) Match the following columns with correct answer

<i>Organism/Bacteria</i>	<i>Disease</i>
(a) <i>Leishmania</i>	Worm
(b) <i>Staphylococci</i>	Kala-azar
(c) <i>Trypanosoma</i>	Acne
(d) <i>Ascaris lumbricoides</i>	Sleeping sickness

(ii) "High blood pressure can be caused by excessive weight and lack of exercise". Justify the statement.

(2011)

8. (i) State in brief the principle of immunisation.

(ii) Name any two diseases that can be prevented by immunisation.

(2011)

9. (i) Differentiate between acute and chronic diseases.

(ii) Give one example each of acute and of chronic diseases.

(iii) Mention any two causes of baby's disease.

(2011)

10. (i) Match the following columns with correct answers:

Column I	Column II
(a) Fungal disease	(i) Dengue fever
(b) Viral disease	(ii) Cholera
(c) Protozoan disease	(iii) Skin disease
(d) Bacterial disease	(iv) Malaria

(ii) Name any one disease cause when the microbes target:

(a) liver

(b) lungs

(2011)

"Prevention of disease is more desirable than its treatment ". Justify the

11. statement by discussing three major strategies to be adopted for the prevention of infectious diseases.

(2011)

12. (a) Which system of our body is activated in response to infection and how it responds?

(b) Explain how HIV-AIDS virus affects and damages our body?

13. (a) Explain why antibiotics are more effective in curing bacterial disease than viral diseases ?

(2011)

(b) List two means of spreading of infectious disease.

(2011)

What is human immune system? What is a vaccine? How immunisation

14. can be achieved?

(2011)

15. List any two differences between infectious and non-infectious diseases.
Write any **one** example of each disease.

(2011)

16. Ravi suffered from tuberculosis, while Rehman suffered from typhoid.
Which disease caused more damage and why?

(2011)

17. Doctor diagnosed that Radha was suffering from HIV-AIDS. List
(a) any two methods by which she might have contracted the disease.
Name the organ affected by this disease.
(b) List one general mode of prevention of jaundice.
It has been observed that despite the availability of the vaccine for
(c) Hepatitis A in the market, it may not be necessary to be given to
children by the time they are 5 years old. Why ?

(2011)

Multiple Choice Questions

Type 1. Interpretation Type Questions

1. **Fever, delirium, slow pulse, abdominal tenderness and rose coloured rash indicate the disease.**
(a) typhoid
(b) measles
(c) tetanus
(d) chicken pox
2. **AIDS is due to**
(a) reduction to number of helper T-cells
(b) reduction in number of killer T-cells
(c) autoimmunity
(d) non-production
3. **Jaundice is a disease of**
(a) kidney
(b) liver
(c) pancreas

- (d) duodenum
- 4. Which one of the diseases is not infectious ?**
- (a) typhoid
 - (b) leprosy
 - (c) measles
 - (d) leukemia
- 5. Congenital diseases are those which**
- (a) are deficiency diseases
 - (b) are present from time of birth
 - (c) are spread from man to man
 - (d) occur during life time
- 6. Hemophilia is a**
- (a) acute disease
 - (b) deficiency disease
 - (c) chronic disease
 - (d) congenital disease
- 7. BCG vaccine is used to curb**
- (a) pneumonia
 - (b) tuberculosis
 - (c) polio
 - (d) amoebiasis
- 8. Infectious diseases spread through**
- (a) vectors
 - (b) water
 - (c) sexual
 - (d) all of these
- 9. AIDS is mainly caused by**
- (a) sexual intercourse
 - (b) blood transfusion
 - (c) through placental transfusion
 - (d) all of the above
- 10. Common cold is a**
- (a) acute disease
 - (b) chronic disease
 - (c) congenital disease
 - (d) genetic disorder

- 11. Pain in abdomen is**
- (a) symptom
 - (b) sign
 - (c) cause
 - (d) effect
- 12. In chronic disease a patient suffers from**
- (a) poor appetite
 - (b) short breath
 - (c) tiredness
 - (d) all the above
- 13. Which one of the following is incorrect about tuberculosis ?**
- (a) it is caused by *Salmonella*
 - (b) it commonly affects lungs
 - (c) bacteria release tuberculin toxin
 - (d) patient's sputum contains blood.
- 14. *Ascaris lumbricoides* is common roundworm of**
- (a) liver
 - (b) bile duct
 - (c) large intestine
 - (d) small intestine
- 15. Which of the following is a mismatch ?**
- (a) leprosy - bacterial infection
 - (b) AIDS - bacterial infection
 - (c) malaria - protozoan infection
 - (d) elephantiasis - nematode infection

Type 2: Identity - Relationship Type Questions

- 1. Which of the following is non-communicable disease ?**

 - (a) allergy
 - (b) malaria
 - (c) diarrhoea
 - (d) tuberculosis

- 2. A chronic disease is**

 - (a) hypertension
 - (b) typhoid

- (c) diarrhoea
 - (d) kala-azar
- 3. An insect which transmits a disease is known as**
- (a) intermediate host
 - (b) parasite
 - (c) vector
 - (d) prey
- 4. Female *Anopheles* mosquito is a carrier of a pathogen that causes**
- (a) yellow fever
 - (b) filariasis
 - (c) malaria
 - (d) dengue
- 5. Droplet method of transmission of disease is found in**
- (a) common cold
 - (b) AIDS
 - (c) hepatitis
 - (d) syphilis
- 6. A protozoan disease is**
- (a) sleeping sickness
 - (b) kala-azar
 - (c) malaria
 - (d) all the above
- 7. Human disease caused by a bacterium is**
- (a) measles
 - (b) dengue
 - (c) tuberculosis
 - (d) polio
- 8. is the commonest carrier of pathogens**
- (a) mosquito
 - (b) housefly
 - (c) helminth
 - (d) none of these
- 9. AIDS virus has**
- (a) single strand DNA
 - (b) double strand DNA

- (c) single strand RNA
 - (d) double strand RNA
- 10. T.B. is cured by**
- (a) griseofulvin
 - (b) ubiquinone
 - (c) streptomycin
 - (d) encitol
- 11. Goitre is caused due to deficiency of disease ?**
- (a) fluorine
 - (b) vitamin C
 - (c) vitamin A
 - (d) iodine
- 12. Which of the following is a bacterial disease ?**
- (a) hepatitis B
 - (b) poliomyelitis
 - (c) tetanus
 - (d) malaria

Type 3: NCERT Question Bank (Exemplar Problems)

- 1. Vectors can be defined as**
 - (a) microorganisms which cause many diseases
 - (b) animals carry the infecting agents from sick person to another healthy person.
 - (c) infected person
 - (d) diseased plants
- 2. If you live in a overcrowded and poorly ventilated house, it is possible that you may suffer from which of the following diseases.**
 - (a) cholera
 - (b) AIDS
 - (c) air borne diseases
 - (d) cancer
- 3. Viruses, which cause hepatitis, are transmitted through**
 - (a) air
 - (b) water

- (c) food
 - (d) personal contact
- 4. Which one of the following is not important for individual health ?**
- (a) living in clean space
 - (b) good economic condition
 - (c) social equality and harmony
 - (d) living in a large and well furnished house
- 5. We should not allow mosquitoes to breed in our surroundings because they**
- (a) multiply very fast and cause pollution
 - (b) are vectors for many diseases
 - (c) bite and cause skin diseases
 - (d) are not important insects
- 6. Which disease is not transmitted by mosquitoes?**
- (a) malaria
 - (b) dengue
 - (c) encephalitis (brain fever)
 - (d) pneumonia
- 7. AIDS cannot be transmitted by**
- (a) breast feeding
 - (b) blood transfusion
 - (c) hugs
 - (d) sexual contact
- 8. Which one of the following has a long term effect on the health of an individual ?**
- (a) common cold
 - (b) chicken pox
 - (c) stress
 - (d) chewing tobacco
- 9. Which one of the following causes kala-azar ?**
- (a) *Trypanosoma*
 - (b) bacteria
 - (c) *Ascaris*
 - (d) *Leishmania*
- 10. Which one of the following is not a viral disease ?**

- (a) AIDS
 - (b) dengue
 - (c) influenza
 - (d) typhoid
- 11. Which one of the following disease is not transmitted by mosquito ?**
- (a) typhoid
 - (b) dengue
 - (c) malaria
 - (d) brain fever
- 12. Which one of the following is not a bacterial disease ?**
- (a) tuberculosis
 - (b) anthrax
 - (c) cholera
 - (d) influenza
- 13. Which of the following can make you ill if you come in contact with an infected person ?**
- (a) high blood pressure
 - (b) genetic abnormality
 - (c) sneezing
 - (d) blood cancer
- 14. Which one of the following disease is not caused by bacteria ?**
- (a) anthrax
 - (b) typhoid
 - (c) tuberculosis
 - (d) malaria
- 15. Making anti-viral drugs is more difficult than making anti-bacterial medicines because**
- (a) virus make use of host-machinery
 - (b) viruses are on the border line of living and non-living
 - (c) viruses have very few biochemical mechanisms of their own
 - (d) viruses have a protein coat
- 16. Choose the wrong statement**
- (a) high blood pressure is caused by excessive weight and lack of exercise
 - (b) cancers can be caused by genetic abnormalities

- (c) peptic ulcers are caused by eating acidic food
(d) acne is caused by staphylococci
- 17. You are aware of Polio Eradication Programme in your city.**
- Children are vaccinated because**
- (a) vaccination kills the polio causing microorganisms
(b) prevents the entry of polio causing organism
(c) it creates immunity in the body
(d) all the above

ANSWERS

Type 1 MCQs

1. a;
2. a;
3. b;
4. d;
5. b;
6. d;
7. b;
8. d;
9. d;
10. a;
11. a;
12. d;
13. a;
14. d;
15. b.

Type 2 MCQs

1. a;
2. a;
3. c;
4. c;
5. a;
6. d;
7. c;

8. b;
9. c;
10. c;
11. d;
12. c.

Type 3 MCQs

1. b;
2. c;
3. d;
4. d;
5. b;
6. d;
7. c;
8. d;
9. d;
10. d;
11. a;
12. d;
13. c;
14. d;
15. c;
16. c;
17. c.

SOME TYPICAL (ILLUSTRATIVE) QUESTIONS

Open-ended Questions

1. Define the word disease carrier.

Ans. One who harbors germs of a disease but does not suffer from the disease is termed as carrier.

2. What are the common symptoms of infection ?

In nearly all types of infections of the human body, there is a rise in body temperature, an increase rate of heart beat (*i.e.*, pulse rate),

Ans. increased frequency of respiration, dry tongue, poor appetite, concentration of urine and changes in white blood cells circulating the blood.

3. Which parameters to health are difficult to measure ?

Ans. Mental health and social well being.

4. Name the biologist who established that pathogen is a disease agent.

Ans. Robert Koch.

5. Name the enzyme present in tears which prevents eye infections.

Ans. Lysozyme.

6. What kills bacteria in our food in the mouth and stomach ?

Ans. The enzyme lysozyme in saliva kills bacteria in food in our mouth, and in stomach HCl (hydrochloric acid) of gastric juice kills the bacteria.

7. If a pregnant mother is suffering from AIDS, would her child get the disease via genes or placenta.

Ans. Placenta. (AIDS is a viral disease ; it is not a genetic disease).

8. Who discovered small pox vaccine ?

Ans. Edward Jenner.

9. Why it is difficult to develop vaccines for some diseases ?

It is difficult to develop vaccines against the diseases caused by viruses. Viruses are very specific to hosts. They live and multiply only in the living cells. They cannot be cultured on artificial medium. It is because

Ans. of these factors that vaccines are difficult to be prepared in such cases.

However, living cells of human's body which are exposed to action of a virus, secrete a heat stable basic *antiviral* glycoprotein of low molecular weight, called **interferon**.

10. While going abroad, why is it essential to get vaccinated against certain diseases ?

A person may be carrier of some disease. Such a person may take that particular disease to a foreign country. Therefore, all visitors to a

Ans. foreign country are vaccinated against the disease which is not prevalent in that country.

11. Name such a vaccine which saves the life of babies from three diseases.

D.P.T. is a vaccine which is three-in-one. Babies should be immunised

Ans. within the first six weeks of birth. DPT: *D* = Diphtheria, *P* = Pertussis (whooping cough), *T* = Tetanus.

DRAWING / ILLUSTRATION - BASED QUESTIONS

- 1.** Observe the following figure and answer.
 - (i) What is shown by this figure.?
 - (ii) What is depicted by labels A, B, C, D and E.

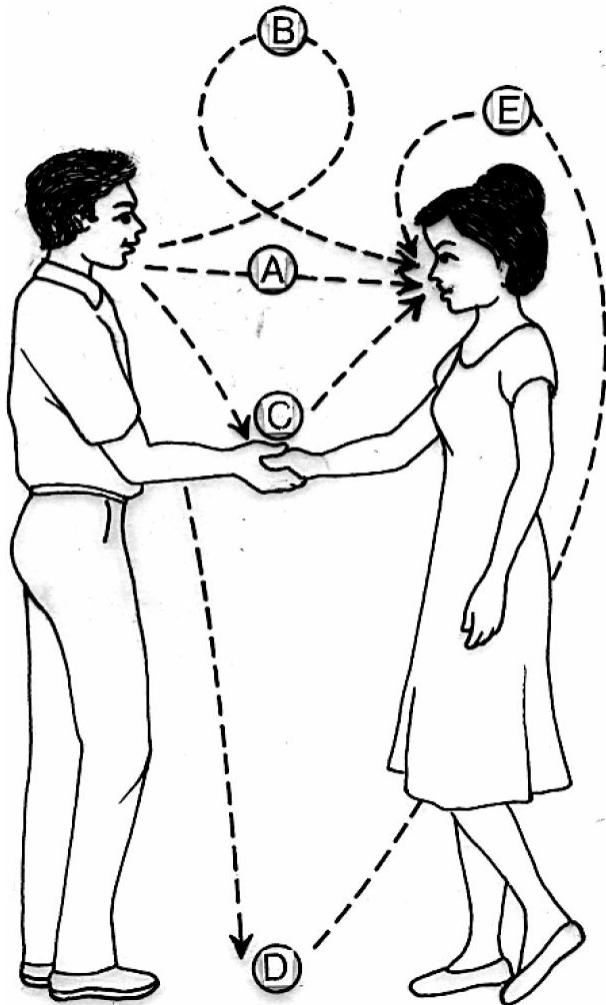


Figure of Q.1.

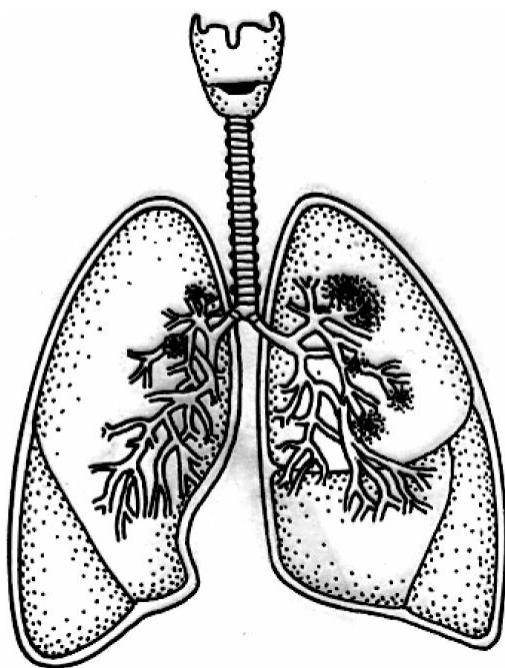


Figure of Q.2.

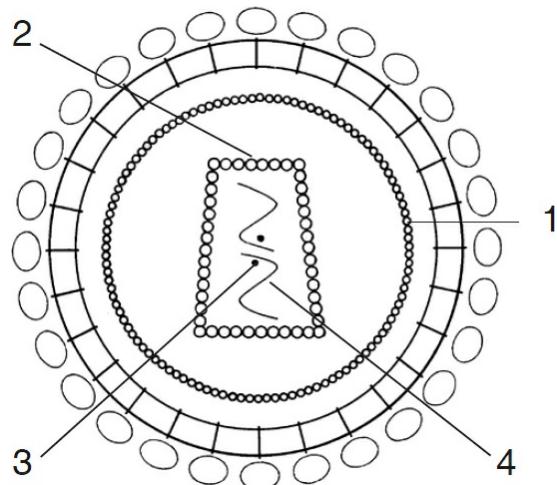


Figure of Q.3.

- Ans.**
- (a) Figure is showing various modes of transmission of pathogens (infectious agents).
 - (b) A—Direct airborne; B — Carried in air with droplets (of cough and sputum of infected person); C—Airborne via hands; D — Some bacilli (bacteria) and viruses withstand drying and E—Carried in air with dust.
2. What does this figure indicate? Name the causative agent for this abnormality.

Ans. The figure show black patches in lungs which indicate that the person is suffering from tuberculosis. Such pictures appear in X-ray plates of the T.B. patients.

The disease is caused by the bacterium *Mycobacterium tuberculosis*.

3. (a) Identify the following figure.
(b) Label the parts marked 1 to 4.

Ans. (a) 1— Protein coat; 2 — Internal viral protein; 3—Reverse transcriptase enzyme; 4 -RNA

COMMUNICATION SKILL-BASED QUESTIONS

1. Why is it difficult to develop vaccines for some diseases?

Ans. The diseases caused due to viral infections generally do not have vaccines to prevent them. This is because viruses are not made of cells. They multiply inside host cell by using the cellular resources of the host body. They do not produce their specific antigens, hence it is difficult to develop vaccines for viral diseases.

2. It is suggested to wear socks and full sleeves to prevent the attack from dengue. Why?

Ans. Dengue is an infectious disease transmitted by the mosquitoes of genus *Aedes*. So, wearing socks and full sleeves will prevent them from biting. Thus, it is a preventive measure against dengue.

3. Explain the statement ‘Prevention is better than cure’ keeping in view the infectious diseases.

Ans. Diseases which are transmitted from one individual to another directly are called infectious diseases. Such diseases are acquired, not inherited. If we prevent the entry of the disease-causing pathogens into our body, then we can prevent the disease from occurring instead of curing the disease after suffering from it.

SOME ACTIVITY BASED QUESTIONS

1. **What processes are used to clean drinking water ?**

Ans. Chlorination or ozonisation, precipitation and filtration.

2. **How is solid waste managed ?**

Garbage or organic waste is composted while the remaining solid waste is

Ans. used in land filling.

3. Why are cases of chronic diseases fewer than cases of acute disease ?

A number of chronic diseases are metabolic disorders which appear after middle age, e.g., diabetes, hypertension. Some require a long exposure to the pathogen, e.g., leprosy. In all cases chronic diseases are slow developing diseases. Therefore, they occur in few cases as compared to acute diseases.

4. It is commonly believed that bad cold takes seven days to subside automatically. After taking medicine, it takes 7 days to cure. Comment.

Bad cold is generally viral in origin. Antibiotic have no role in curing it. Patient's body takes about 7 days to produce interferon (an antiviral substance) to kill the virus of cold.

PAPER-PEN TEST

Time : 30 minutes

Maximum marks : 17

- M.C.Q.**
1. Immuno-deficiency syndrome could develop due to
(a) defective liver
(b) AIDS virus
(c) defective thymus
(d) weak immune system

1

- Blanks** 2. Sleeping sickness is caused by *gambiense*.

1

- T/F** 3. Oral Polio Vaccine (OPV) is a live but attenuated virus which colonises the gastrointestinal tract.

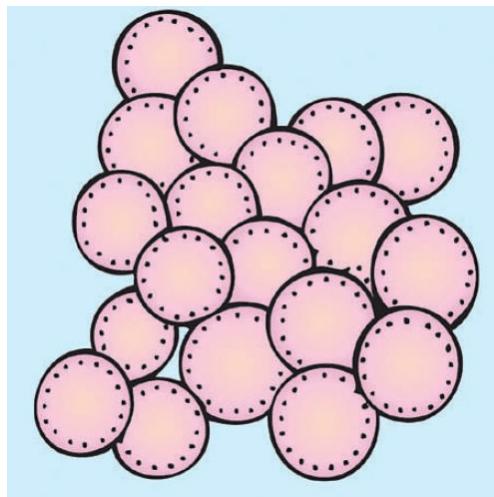
1

- Matching** 4. Match the items of column I and II

<i>Column I</i>	<i>Column II</i>
(a) Hepatitis	(i) <i>Plasmodium</i>
(b) Malaria	(ii) Odomos
(c) Dengue	(iii) <i>Leishmania</i>
(d) Kala-azar	(iv) DNA/RNA virus

5. What does the figure depict ?

HOTS	Name one disease caused by it.	
		2
S.A.I	6. Enumerate the various infectious diseases of humans.	
S.A.II	7. Define immunity, antigen, antibody and antibiotics. Give a note about PPIP.	
		5
L.A.	8. (a) Enumerate bacterial diseases against which vaccines are available. (b) “Prevention is better than cure”. Explain.	



REVISION QUESTIONS

Very Short Answer Questions (Carrying 1 mark each)

1. **What is full form of WHO?**
Ans. World Health Organisation.
2. **How has WHO defined health ?**
Ans. “A state of complete physical, mental and social well being and not merely the absence of disease or infirmity that enables one to lead a social and economically productive life”.
3. **What is disease ?**
Disease (*dis* = without, *ease* = comfort) or disorder of the body or its

- Ans.** part.
- 4. Name the personal issues involved in health.**
- Ans.** Proper balanced food, personal hygiene, timely vaccinations and personal protection from pests and vectors.
- 5. What is acute disease ?**
- Ans.** An acute disease is a short duration disease which often has a relatively severe course.
- 6. What is chronic disease ?**
- Ans.** Chronic disease is a long duration slow developing, disabling disease.
- 7. What do you mean by immediate cause of disease ?**
- Ans.** Immediate, precipitating or first level of cause of a disease is the actual agent or factor that causes the disease, e.g., Virus in common diarrhoea.
- 8. What are contributing causes of disease ?**
- Ans.** Contributing causes are factors which make an individual prone to catch a disease, e.g., undernourishment, defective heredity, poor public health services.
- 9. What are congenital disease ?**
- Ans.** Congenital diseases are the diseases found in an individual right from birth.
- 10. What are acquired disease ?**
- Ans.** Acquired diseases are those diseases which one individual picks up after birth.
- 11. Define infectious disease ?**
- Ans.** Infectious diseases are diseases that are caused by pathogens and are capable of spreading from a diseased person to a healthy person.
- 12. What are non-infectious diseases ?**
- Ans.** Non-infectious diseases are the ones which are produced by the factors other than living organisms and are incapable of spreading from one person to another.
- 13. What do you mean by symptoms of a disease?**
- Ans.** Symptoms are structural and functional manifestations of the presence of a disease.

- 14. What are signs of disease ?**
Ans. Signs are definite clues or indications of a disease.
- 15. Give one example of each of diseases caused by bacteria and virus.**
Ans. Typhoid and polio respectively.
- 16. Name the causal organism of ringworm and elephantitis.**
Ans. Fungus and filarial worm (nematode), respectively.
- 17. Name a sexually transmitted disease caused by bacteria.**
Ans. Syphilis.
- 18. What is full form of HIV ?**
Ans. HIV = Human Immunodeficiency Virus.
- 19. Name the disease transmitted by dog bite.**
Ans. Rabies.
- 20. Name the causal organism of kala-azar.**
Ans. *Leishmania* (protozoa).
- 21. Why female *Anopheles* mosquito feeds on human blood ?**
Ans. It requires proteins of human blood to lay eggs.
- 22. Name two diseases transmitted by the contaminated food and water.**
Ans. Cholera and Hepatitis A.
- 23. Name the causal organism of measles and anthrax respectively.**
Ans. Virus and bacterium respectively.
- 24. Name the target organ of Japanese encephalitis and AIDS virus respectively.**
Ans. Brain and lymph nodes respectively.
- 25. Write any two basic conditions necessary for keeping good health.**
Ans. Eating balanced diet and personal and domestic hygiene.
- 26. Name any two habits, which should be avoided to keep good health.**
Ans. Drinking alcohol and smoking.
- 27. Name the best form of relaxation.**
Ans. Sleep.
- 28. Why we should not eat uncovered food ?**

- Ans.** It may contain microbes and harmful (toxic) substances (e.g., dust).
- 29.** **Name the target cells of *Plasmodium* (malaria pathogen).**
- Ans.** Red blood corpuscles (erythrocytes) and liver cells.
- 30.** **What may be the symptoms of a disease if brain is infected.**
- Ans.** Severe headache and vomiting.
- 31.** **What may be the symptoms of a disease if liver is infected ?**
- Ans.** Jaundice.
- 32.** **On which factor does severity of disease manifestations depend ?**
- Ans.** Number of pathogens (microorganisms).
- 33.** **Name two barriers, which prevent the entry of microbes in the body.**
- Ans.** Intact skin and sweat.
- 34.** **Name the chemical present in the stomach, which kills the microbes.**
- Ans.** HCl.
- 35.** **Name the chemical released by damaged cells which causes inflammation.**
- Ans.** Histamine.
- 36.** **Name the cell which causes phagocytosis.**
- Ans.** Macrophages.
- 37.** **Write down the biochemical process, which is blocked by sulpha drugs in bacteria.**
- Ans.** Folic acid synthesis.
- 38.** **Write down two principles of treatment.**
- Ans.** By reducing the effect of the disease and by killing microbes.
- 39.** **Define antibiotics.**
- Ans.** Antibiotic is a chemical produced by a microorganism, which kills or prevents the growth of other microorganisms.
- 40.** **Name the microbes against which antibiotics are nearly ineffective.**
- Ans.** Viruses.
- 41.** **Name the viral disease against which we have been able to develop drug.**

- Ans.** AIDS.
- 42. Define immunization.**
- Ans.** The process of developing immunity (capability to fight infections) is called immunization.
- 43. Name the most common method to prevent infection ?**
- Ans.** Vaccination.
- 44. Define immunity.**
- Ans.** The capability of the body to fight against infection owing to the presence of specific antibodies is called **immunity**.
- 45. What is full form of DPT ?**
- Ans.** DPT = Diphtheria, pertussis (whooping cough) and tetanus.
- 46. Name two diseases against which vaccines are available.**
- Ans.** Polio and tuberculosis (T.B.).
- 47. Give two examples of viral diseases.**
- Ans.** Influenza, Polio.
- 48. Give two examples of bacterial diseases.**
- Ans.** Tuberculosis (T.B) and Typhoid.
- 49. Give one examples of protozoan diseases.**
- Ans.** Malaria.
- 50. What is infective agent of peptic ulcers ?**
- Ans.** Bacterium- *Helicobacter pylori*.
- 51. Who were awarded Nobel Prize for discovery of treatment for peptic ulcers ?**
- Ans.** Marshall and Warren (Got Nobel prize for Physiology and Medicine, 2005).
- Name the disease in which**
- 52. (a) Patient fears from water;
(b) Yellowing of skin takes place.**
- Ans.** (a) Rabies; (b) Hepatitis.
- 53. Name one sexually transmitted viral disease.**
- Ans.** AIDS.
- 54. What is full form of ORS ?**

- Ans.** ORS = Oral Rehydration Solution.
- 55.** **Name the causal organism and vector of malaria respectively.**
- Ans.** *Plasmodium* and female *Anopheles* mosquito respectively.
- Name the causal organism of**
- 56.** **(a) Tuberculosis;**
(b) Typhoid.
- Ans.** **(a) *Mycobacterium tuberculosis*;**
(b) *Salmonella typhi*.
- 57.** **Name two diseases against which vaccines are available.**
- Ans.** Polio and Measles.
- 58.** **Write full form of AIDS.**
- Ans.** Acquired Immuno-Deficiency Syndrome.
- 59.** **Name two domestic animals which transmit rabies to human beings.**
- Ans.** Rabid dogs and cats.
- 60.** **Name two modes of transmission of AIDS.**
- Ans.** Sexual contact with an infected person and through transfusion of infected blood.
- 61.** **Mention two preventive measures against rabies.**
- Ans.** Rabid animals should be killed and compulsory immunisation of dogs and cats should be done.
- 62.** **Write down the modes of transmission of tuberculosis.**
- Ans.** It is transmitted directly (by sneezing, coughing) and indirectly (air borne disease).
- 63.** **Name the disease in which legs become paralysed.**
- Ans.** Polio.
- 64.** **When was the Pulse Polio Immunization Programme launched in India ?**
- Ans.** 1995-1996.
- 65.** **What is full form of BCG ?**
- Ans.** BCG = Bacillus Calmette Guerin.
- 66.** **Name the causal organism of diarrhoea.**
- Ans.** Bacteria such as *Salmonella* and *Shigella*.

- 67. Name the disease the child will not suffer from if BCG vaccine is given.**

Ans. Tuberculosis.

Short Answer Questions (Carrying 2 marks each)

- 1. Differentiate between healthy and disease free.**
- 2. Name the health problems subsequent to a disaster.**
- 3. What provisions are made by local authorities to provide clean drinking water ?**
- 4. What provisions are made by local authorities for solid waste management ?**
- 5. Distinguish between symptoms and signs of a disease.**
- 6. Write down the causal organisms of the following diseases : Tuberculosis, Kala-azar, Malaria, Measles, Athlete's foot, Cholera.**
- 7. Mention two means of physical contacts by which AIDS does not spread.**
- 8. Differentiate between carrier and vector.**
- 9. Write short note on organ-specific and tissue-specific manifestations of disease.**
- 10. Explain how does the body react after the entry of microbe in the body.**
- 11. Why a person suffering from AIDS cannot fight even very small infections ?**
- 12. "We can treat an infectious disease by killing microbe". Justify the statement with suitable examples.**
- 13. "Prevention is better than cure". Explain.**
- 14. Explain how does vaccine work ?**
- 15. Name any three diseases of human beings caused by bacteria and three diseases caused by virus.**
- 16. How does dehydration set in during diarrhoea?**
- 17. In a cluster of hutments, many people are suffering from malaria. Mention the unhygienic conditions that must be prevailing in that**

- locality. How does a doctor confirm malaria ?
18. Explain the methods of prevention of malaria.
19. It was diagnosed that the body of a patient has lost its power of fighting any infection. Name the disease he is suffering from. What type of microbe is responsible for this disease and how does it spread from one person to the other.
20. Define diarrhoea. Give an account of occurrence, symptoms, prevention and control of this ailment.
21. Why is rabies called hydrophobia ? Explain.
22. Write short note on Pulse Polio Programme.

Long Answer Questions (Carrying 5 marks each)

1. Describe community issues that influence health.
2. Explain various modes of transmission of infectious diseases.
3. Explain the general ways of preventing infection.
4. Write short note on principle of treatment.
5. Write short notes on
 - (a) AIDS ;
 - (b) Malaria.
6. Describe certain bacterial diseases of human beings.
7. Give an account of some important viral diseases of human beings.
8. Write short notes on
 - (a) Tuberculosis ;
 - (b) Polio.

VALUE BASED QUESTIONS

1. **Government has recently taken series of steps to minimise cigarette smoking and tobacco chewing by people as these are injurious to health.**

- (i) List at least three steps taken by government to aware people about harmful effects of cigarette smoking and tobacco chewing.
- (ii) What is passive smoking ?
- (iii) List at least one chronic disease that occurs due to continuous use of tobacco.

Three steps taken by Indian Government to curb menace of smoking are the following:

(a) Each cigarette pack has a label “smoking is injurious to health”.

- Ans.**
- (i) (b) Creation of ‘no smoking zones’ in the cities. (Smoking at public places has been declared a cognizant offence).
 - (c) Putting up hoardings at public places and advertisement clippings in cinema halls about harmful effects of use of tobacco.
 - (ii) Passive smoking means inhalation of tobacco smoke released by smokers by non-smokers.
 - (iii) Cancer (oral cancer / lung cancer).

- The number of dengue cases has increased in Saroj’s village in the last one year. She read in her text book that diseases such as dengue spread through mosquitoes which breed in stagnant water. She**
2. **immediately contacted her friends and some social workers and they decided to kill the mosquitoes in water bodies in the locality. They also took help of nearest municipal office. Answer the following questions:**

- (i) Which preventive measures do you suggest for prevention of such diseases caused by mosquitoes? Mention any two measures.
- (ii) Which values are displayed by Saroj in taking initiative.
- (iii) Suggest one school activity for promoting such values in school students.

(Sample Paper 2012-13)

Saroj can take the following preventive measures against infection of this fatal viral disease (*i.e.*, dengue; Box 5.13).

- Ans.**
- (i) Avoid collection of water in pits, ensure covering of drains, proper and regular disinfection, covering of arms and legs as

dengue mosquito (*Aedes*) is active during day, use of mosquito nets and repellents (e.g., Odomas, All out).

Box 5.13

Mosquitoes are vectors of following common human diseases: Female *Anopheles* spreads malaria, *Culex* spreads filaria and *Aedes* spreads dengue. Dengue is a viral disease.

- (ii) Saroj exhibited following value by his social work: she is conscious of her social responsibility. She is doing a community service. She is aware of healthy living as well as environment protection.
- (iii) **School activity.** (a) Group discussion on the clean environment and preventive measures against mosquito bites. (b) Organizing debates and seminars on mosquito menace and community hygiene. (c) Organizing campaigns for creating awareness amongst masses on hygienic living and hygienic environment.

3. Gangubai has the habit of throwing the household garbage (solid waste) in the drain outside her home. Her neighbour Asha, a literate women, takes the domestic garbage to public garbage bin outside her street.

- (i) **Which act of garbage disposal, Gangubai's or Asha's is correct ?**
- (ii) **What problems would the wrong habit create for the society ?**
- (iii) **How can the wrong habit be corrected ?**

Ans. (i) Gangubai's habit of throwing garbage in the drain is wrong while that of Asha is correct.

Gangubai's habit of passing garbage in the drain not only blocks the drain causing overflow of drain water, spreading of filth resulting in spread of flies, mosquitoes and other creatures but also produces stink all around.

The best method to correct Gangubai's habit is that Asha should talk to her and convince her that throwing garbage (which may contain polythene bags) in the drain is not only

- (iii) harmful to her neighbours but also for her family. Asha could explain Gangubai that dry and hygienic surroundings represent healthy and pleasant environment. If she does not mend her ways, Asha should approach Gangubai's other family members. Other members of the community can also join her in convincing Gangubai.
- Recently, some newspapers carry news about increased incidences of malaria in nearby villages of our city. The Chief Medical Office of the district asked the scientists (zoologists) and their team to conduct thorough survey of the area and suggest necessary steps. The survey revealed that public services were in very poor shape. As a result, lot of garbage and dirty water had accumulated at places which provide ideal sites of breeding of mosquitoes and disease carrying agents (such as house flies, cockroaches, etc.). Recall what you have studied about human diseases in the class and answer following questions:
4. (i) Name causative agent of malaria which insect vector spread it.
(ii) Which step the zoologist immediately took to check the disease ?
(iii) Name the most common antimalarial drug being used. From where it is obtained ?

Ans. (i) Malaria is caused by the toxins produced in human body by malarial parasite, *Plasmodium* (*a protozoan*); Female *Anopheles* mosquito sucks blood of human beings and in the process spreads the malarial parasite in humans.

(ii) Immediate spray and fumigation of insecticides to kill adult mosquitoes as well as their larvae. Petrol or kerosene is sprinkled on dirty/waste waters ditches, pools, puddles, etc., to kill eggs and larvae of mosquitoes.

(iii) Quinine; bark of *Cinchona* tree.

5. Bulbul read an article on "AIDS – A killer syndrome" in a leading newspaper. She also recalled that few days back there was a declamation contest in his school on 'AIDS' where in participants expressed their views about its cause, way of transmission, symptoms and possible preventive measures. As a responsible citizen, Bulbul wanted to explain details of AIDS

disease to her friends who had no knowledge about it ?

- (i) **Expand the abbreviation AIDS. Name its causative organism.**
- (ii) **Why AIDS is considered a syndrome and not merely a disease. Comment.**
- (iii) **List at least three ways in which AIDS can be transmitted from an infected person to other.**
- (iv) **What values are displayed by Bulbul.**

Ans. (i) AIDS – Acquired Immuno Deficiency Syndrome. It is caused by retrovirus - HIV (Human Immunodeficiency Virus).

AIDS is considered as a ‘syndrome’ and not a disease. It is so because AIDS causing virus (HIV) enters the body of healthy person generally through sexual organs or through blood transfusion and subsequently spreads to lymph nodes all over the body. It damages body’s immune system and therefore, body is no longer is able to fight off many minor infections.

- (ii) Even a small cold infection can turn into pneumonia or a minor gut infection may lead to severe diarrhoea with blood loss. The effects of minor diseases become so severe that they kill the patients suffering from AIDS. In other words, there are no specific disease symptoms for AIDS and the patient develops complex diseases and symptoms. AIDS is considered to be a ‘syndrome’ and not merely a disease.

(a) Use of contaminated needles and syringes to inject drugs and vaccines. Use of contaminated razors for shaving.

- (iii) (b) Transfusion of infected blood or blood products.
- (c) Unprotected sexual contact with an AIDS infected person.

(iv) Bulbul, being adolescent, wanted to help her friends by imparting knowledge about dreaded fatal AIDS disease so that they take necessary preventive measures.

Few days back, our school organised health checkup camp. Eminent doctors (General physicians, ophthalmologists, dentists, etc.). Doctor X, leader of the doctor’s team, gave us tips about essential conditions of keeping good health, extrinsic and intrinsic causes of diseases as well as types of diseases. Later, students of the school were examined by the doctors. Next day our class teacher asked us to answer the following questions:

7.

(i) List atleast three conditions essential for good health.

How can we keep our surroundings clean ?

(ii) Mention at least two ways.

(iii) How would you define a disease ?

Three conditions essential for good health are:

Ans. (i) (a) Better sanitation.

(b) Availability of clean drinking water.

(c) Availability of adequate, nutritious food.

We can keep out surrounding clean by:

(ii) (a) providing good sewage and rain water disposal systems.

(b) proper garbage disposal (to manage plastic articles: polythene bags, plastic bottles, etc.

Disease can be defined as physical or functional change from

(iii) the normal state that cause discomfort, or disability, or
impairs health of a living organism.

CHAPTER 6

Natural Resources



Everything that surrounds us is collectively termed as the environment. Environment acts as a life support system for us,

since it is from the environment that we get food to eat, water to drink, air to breathe and all other requirements of our day-to-day life.

6.1. BIOSPHERE AND NATURAL RESOURCES

Biosphere means regions of Earth's crust and atmosphere occupied by the living organism. Biosphere can be divided into three physical divisions—land or lithosphere, water or hydrosphere and air or atmosphere.

Lithosphere is the outer solid crust of Earth ([Fig.6.1](#)) which we call **land**. Its upper weathered part forms the soil.

Hydrosphere is the water component of Earth. 75% of the Earth's surface covered with water in the form of seas, rivers, lakes, ponds, impoundments (= reservoirs), dams, etc. Underground water is another component of the hydrosphere.

Atmosphere is the blanket of air that covers the whole Earth.

Biosphere has two types of components, biotic and abiotic. Living beings constitute the **biotic component** of the biosphere. Air, water and soil (land) form the non-living or **abiotic component** of the biosphere. Both types of these provide resources to meet the basic needs of life forms. However, the energy required for supporting these life forms is ultimately obtained from sun. Sun's energy is used in synthesis of food for all living beings.

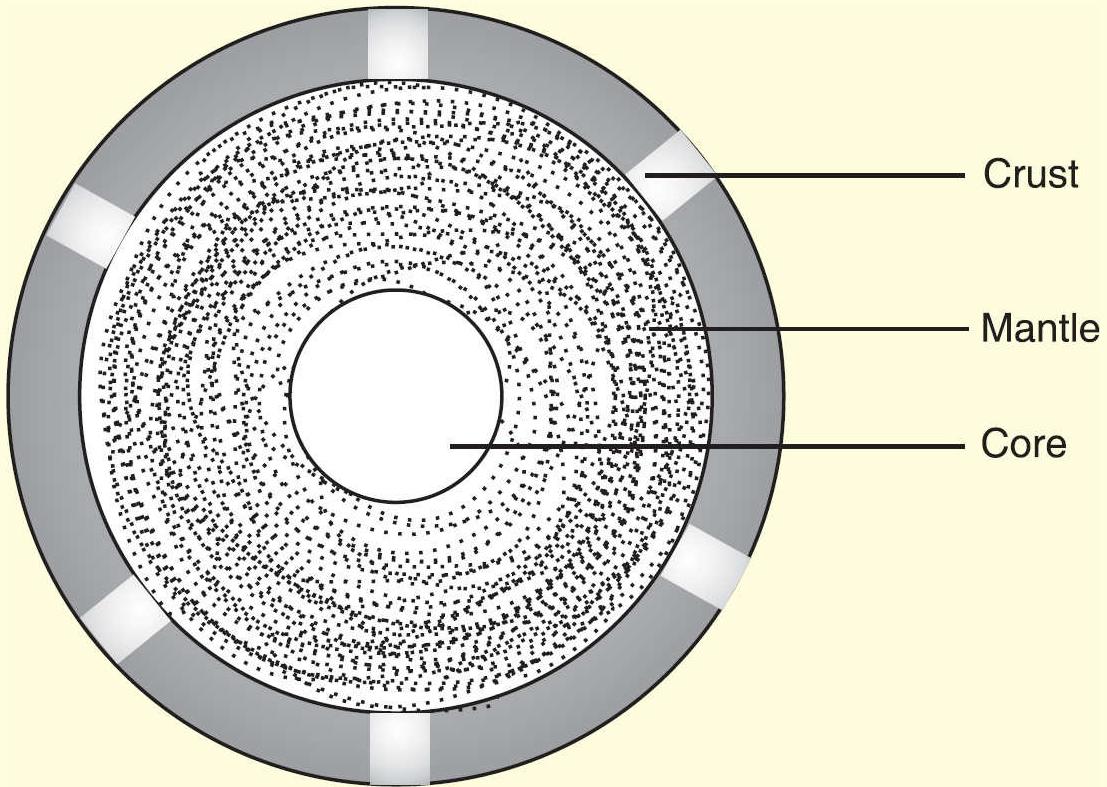
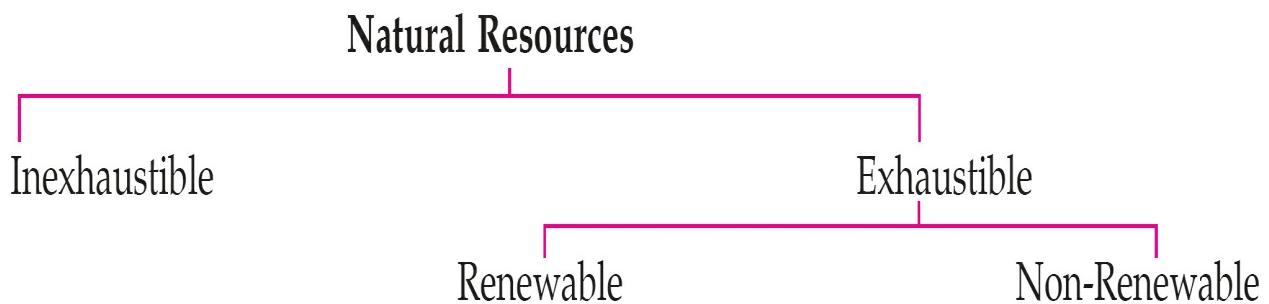


Fig. 6.1. Earth in section.

Types of Natural Resources



Natural resources are living and non-living components of nature which are used by humans to meet their requirements. Since natural resources are available only from the Earth, they are called **Earth resources**. Based on their abundance, natural resources are of two main types, inexhaustible and exhaustible.

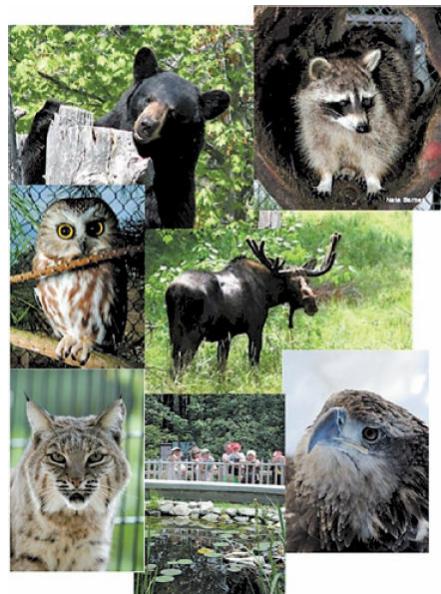
1. Inexhaustible natural resources: They are natural resources which occur in such abundance that they are not likely to get exhausted despite continuous use, e.g., air, water, solar energy.

2. Exhaustible natural resources: They are natural resources which are available in limited quantity. They may get depleted by continuous and indiscriminate human consumption. Exhaustible resources are of two kinds, renewable and non-renewable.

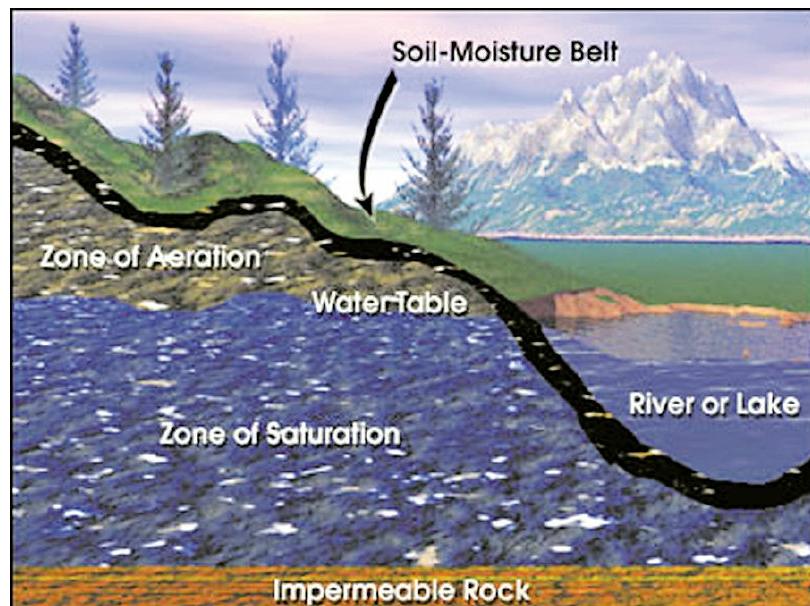
(i) Renewable resources: They are exhaustible resources which get replenished regularly. These include both living and non-living resources which can replenish themselves by quick recycling, e.g., forests, wildlife, soil and underground water. Renewable resources can last for ever if they are used responsibly.



Forest.



Wildlife.



Underground water.



Soil.

Renewable resources

(ii) Non-renewable resources: They are exhaustible resources which once used can not be replenished. Thus, these resources are non-living and cannot replenish themselves by recycling and replacement. If not used carefully they will ultimately get exhausted. Their increased consumption results in quicker exhaustion, e.g., minerals, fossil fuels such as coal and petroleum.



Coal.



Petroleum.



Minerals.

Non-renewable resources

Table 6.1. Differences between renewable and non-renewable resources.

<i>Renewable resources</i>	<i>Non-renewable resources</i>
1. These resources are replenished within reasonable time.	1. Replenishment is not possible.
2. These resources can be used	2. These resources will ultimately

<p>forever provided they are used in limited amounts.</p> <p>3. They are both abiotic and biotic.</p> <p>4. Their availability can be increased only by enhancing replenishment.</p> <p>Examples. Forest, wildlife, underground water* and soil^Δ.</p>	<p>lessen and get exhausted.</p> <p>3. They are abiotic.</p> <p>4. Their increased exploitation will result in quick exhaustion.</p> <p>Examples. Fossil fuels, minerals.</p>
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* The renewable resources such as underground water, forests and wildlife, if not managed properly can become non-renewable.

Δ Since the formation of soil takes thousands of years and is not renewable in the life span of many generations of human beings, so it is thought of as a non-renewable resource.



Box 6.1

All the abiotic components of the environment form weather and climate of a particular area.

Weather. Every moment there are changes in the temperature, biometric pressure, humidity, precipitation (rainfall), sunshine (solar radiation or light), cloudiness, wind direction, speed and other conditions in the troposphere (lowest region of the atmosphere). These short-term changes in the properties of the troposphere form the **weather**. The weather changes take place everyday. A daily weather report is transmitted via radio and television. It tells us about the

temperature, rain, cloud and sunshine of an area.

Climate. It is the average weather of an area. It represents the general pattern of atmospheric or weather conditions, seasonal variations and weather extremes, in a region over an extended period, say 50 years or 100 years (at least 30 years). For example, desert areas have a hot climate whereas snowbound mountains have a cold climate. The most important factors determining the climate of an area are temperature with its seasonal variations and the quality and distribution of precipitation over each year.

6.2. AIR

The multilayered gaseous envelope surrounding the planet Earth is called **atmosphere**. Atmosphere filters sunlight reaching the Earth, affects climate and is a reservoir of several elements which are essential for the life. It is divided into five distinct layers or zones : **troposphere, stratosphere, mesosphere, thermosphere (ionosphere)** and **exosphere** ([Fig. 6.2](#)). Troposphere is the lowest region of atmosphere which contains **air** and is subject of differential heating. It extends from the surface of Earth upto 8 to 20 km. Many important climatic events such as cloud formation, lightening; thundering, thunderstorm formation etc., all take place in troposphere ([Box 6.1](#)).

On Earth, we human beings along with all other biota are surrounded with air. **Air** is a mixture of gases such as nitrogen, oxygen and carbon dioxide ([Table 6.2](#)). Air also contains water vapour and suspended dust particles. Oxygen is required by all living beings for respiration and for burning (combustion) of materials. Air contains about 20 per cent oxygen and its percentage in air is balanced by the process of photosynthesis. Photosynthesis

occurs in chloroplasts of green plants and this metabolic activity requires carbon dioxide, water and sunlight but releases oxygen gas.

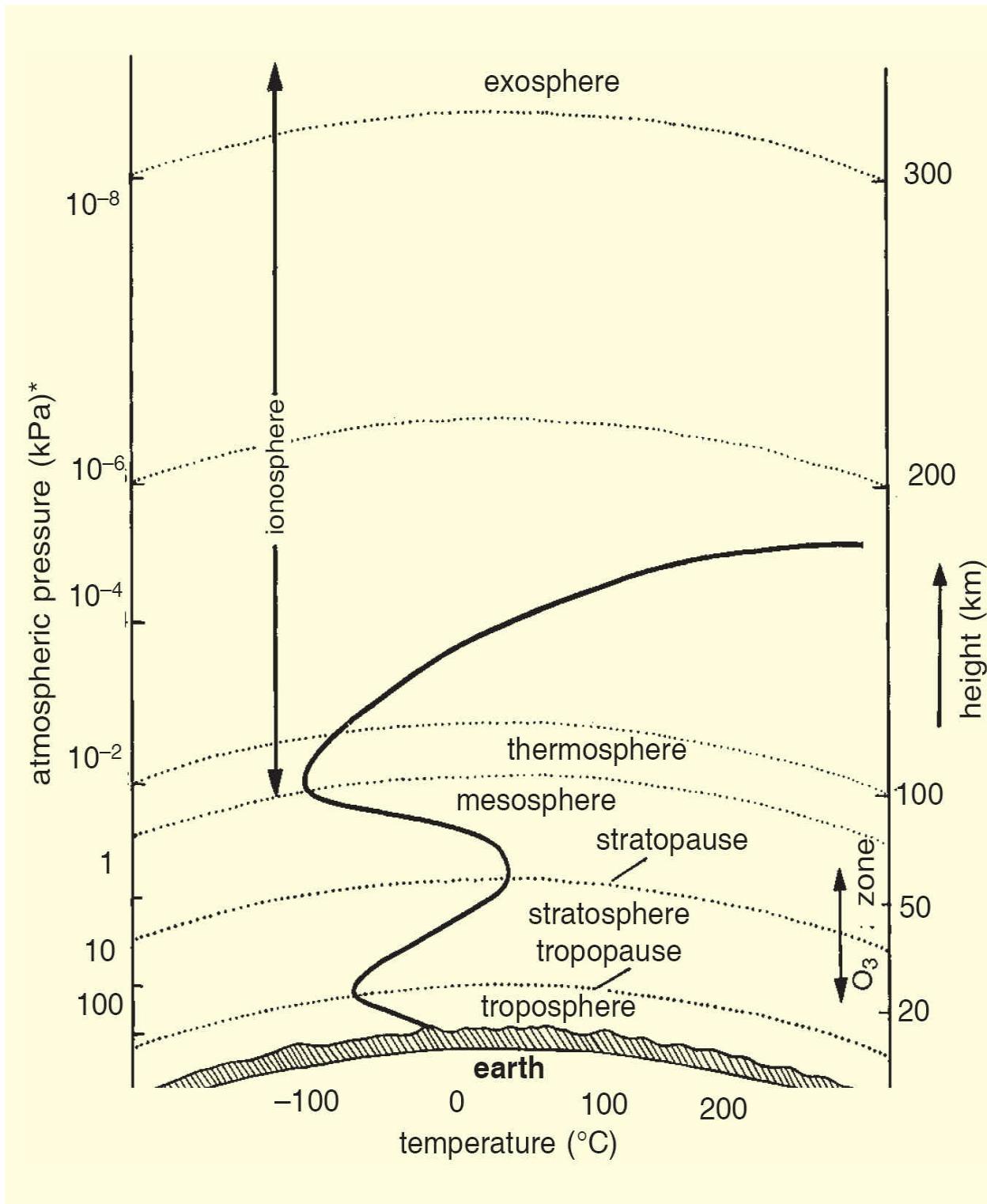


Figure 6.2. The atmosphere.

* Pa = Pascal (Pa = newton/meter²)

Table 6.2. Composition of gases in air.

<i>Component</i>	<i>Percentage of volume</i>
1. Nitrogen (N ₂)	78.09
2. Oxygen (O ₂)	20.93
3. Argon (A)	0.93
4. Carbon dioxide (CO ₂)	0.03
5. Miscellaneous (moisture, dust, etc.)	0.02

IMPORTANCE OF ATMOSPHERE

1. Role of Atmosphere in Climate Control

Air is an inexhaustible natural resource. In a world without air, there would be no plant or animal life, no winds, clouds or rain, no fires and no protection against harmful solar radiations. This is because the atmosphere covers the Earth, like a blanket. Air is a bad conductor of heat. The atmosphere keeps the average temperature of the Earth fairly steady during the day and even during the course of whole year. The atmosphere prevents the sudden increase in temperature during the daylight hours. And at night, atmosphere slows down the escape of heat into outer space. For instance moon, which is about the same distance from the sun that the Earth is, but it lacks an Earth-like atmosphere. As a consequence, on the surface of the moon, the temperature ranges from – 190° C to 110° C. Thus, moon's temperature rises during the sunlit period (day) to about 110°C, and cools to –190°C during dark period (night).

ACTIVITY 6.1

To measure the temperature of water, soil, sand and air in bright sunlight and shade.

Take (i) a beaker full of water, (ii) a beaker full of soil, sand and (iii) a closed bottle containing a thermometer. Keep them in bright sunlight for three hours. Now measure the temperature of all three vessels. Also take the temperature reading in shade at the same time.

You will observe that temperature of soil/sand is more than the temperature of water in bright sunlight. It is so because soil/sand gets heated by solar radiations faster than the water. Therefore, land would become hot faster than the seas. You will also observe that the temperature of air (in shade) is different from the temperature of soil/sand and water (in bright sun light) because of the direct effect of radiations in the latter case.

The temperature should be measured in the shade because in the bright sunlight direct solar radiations will affect the thermometer reading which will not be uniform.

You will observe that the temperature of air in the closed glass bottle is more than the temperature taken in the open air. It is due to green house effect. The solar radiations enter the glass bottle through the glass walls. However, the reradiated rays can not pass through the glass and they heat up the air inside the closed glass container. We come across this phenomenon of green house effect in our daily life. For example, when a car parked in the sun, it gets heated from inside due to green house effect.

2. The Movement of Air : Wind

A cool evening breeze after a hot day or rain after a few days of hot weather bring us considerable relief. Following questions may strike our mind:

1. What cause the movement of air?
2. What decides whether this movement of air will be in the form of a gentle breeze, a strong wind or a terrible storm?
3. What brings the rain?

All the phenomena in above mentioned questions are the result of changes that take place in our atmosphere due to the heating of air and the formation of water vapours.

When the solar radiations fall on the Earth, some are absorbed and majority of these are reflected back or **reradiated** by the land and water bodies. These reflected or reradiated solar radiations heat the atmosphere from below. As a result, **convection currents** are set up in the air ([Activity 6.2](#)). But since the land gets heated faster than the water, the air over land also gets heated faster than the air over water bodies.

Air movement in coastal areas: In coastal areas, during daytime, there is a regular flow of cool air from the sea towards the land. At night, there is a reverse flow of air from land to sea. This happens because during the daytime, land gets heated faster than water. Re-radiation of heat from land heats the air above it. The hot air rises and creates an area of low pressure. Sea water does not get heated so rapidly, so air above the sea is relatively cool. A high pressure area forms above sea water as compared to air over land. Therefore, cooler air over the sea, flows toward the land, where low pressure area exists ([Fig. 6.3](#)). The movement of air from one region to the other creates **winds**.

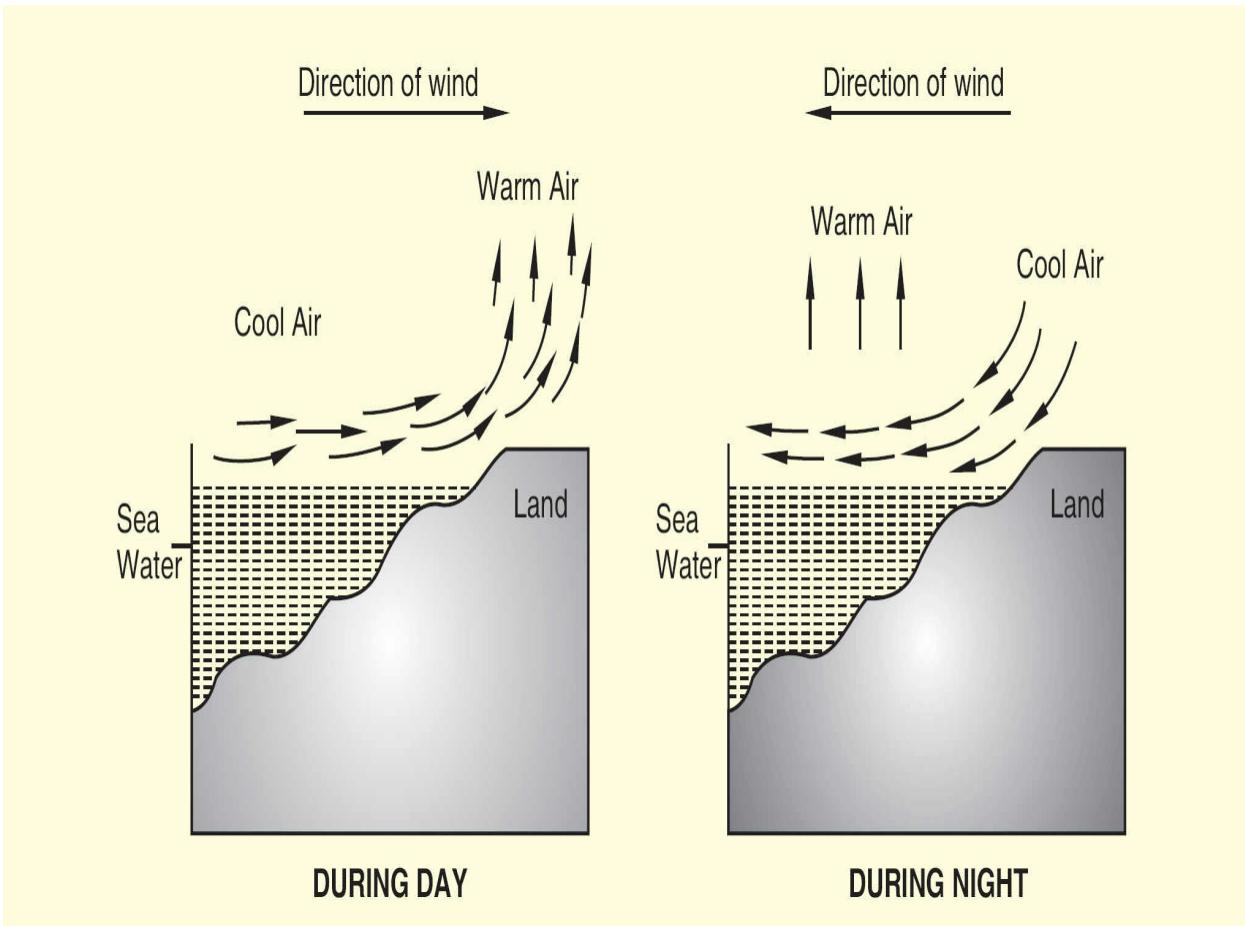


Figure 6.3. Movement of wind from sea to land during day and from land to sea during night.

During the night, reverse flow of air occurs. Land cools down rapidly. Air above the land becomes cooler. Sea water cools down slowly. The air above the sea is hotter and has a lower air pressure as compared to air pressure above the land. Therefore, cooler air present over land flows towards sea.

Wind belts

At a much larger scale, temperature differences across the Earth generate the development of the major **wind belts**. Such wind belts, to some degree, define the climate zones of the world.

ACTIVITY 6.2

To demonstrate that air currents are caused by the uneven heating of air

Place a candle in a beaker or wide-mouthed bottle and light it ([Fig. 6.4](#)). Now, light an incense stick (Agarbatti) and bring it to the edge of the mouth of the beaker or bottle. Observe the direction of flow of smoke. In next step, keep the lighted incense stick a little above the candle and note the direction of flow of smoke. Keep the lighted incense stick in other regions above the beaker or bottle and again note the direction of smoke above the beaker or bottle and again note the direction of smoke.

You will observe that the direction of flow of smoke is different (i) when lighted incense stick is kept at the edge of the mouth of beaker or bottle, (ii) a little above the candle, and (iii) in different regions above the beaker or bottle when the incense stick is kept at the edge of the mouth of the beaker or bottle, the smoke will flow toward the candle and then above. When the incense stick is placed at different regions above the beaker or bottle, the direction of flow of smoke will be towards the candle and then upwards. The patterns revealed by the smoke show us the direction in which the hot and cold air move. The air above the burning candle gets heated and therefore rises, creating a low pressure below. Therefore, air from adjacent cold areas moves towards this low pressure zone.

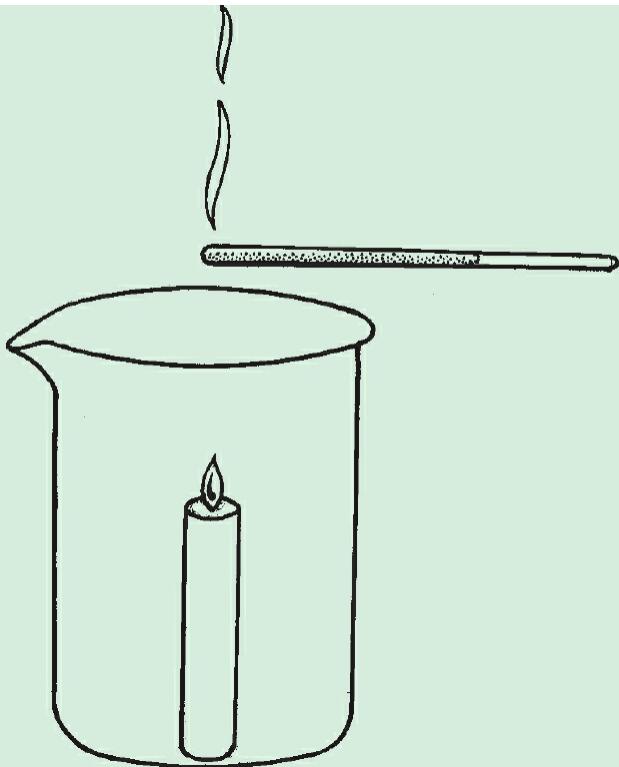


Figure 6.4. Air currents caused by the uneven heating of air.

The movement of air does not follow the quickest straight-line path. In fact, the air moving from high to low pressure follows a spiralling route, outwards from high pressure and inward towards low pressure. This is due to rotation of the Earth beneath the moving air which causes an apparent deflection of the wind to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. The deflection of air is caused by the Coriolis force ([Box 6.2](#)). Consequently, air blows anticlockwise, around a low pressure center (depression) and clockwise, around a high-pressure centre (anticyclone) in the Northern Hemisphere. This situation is reversed in the Southern Hemisphere.

Box 6.2

Coriolis Effect

A force that, like centrifugal force, apparently acts on moving objects when observed in a frame of reference that is itself rotating. Because of the rotation of the observer, a freely moving object does not appear to move steadily in a straight line as usual, but rather as if, besides an outward centrifugal force, “Coriolis force” acts on it, perpendicular to its motion, with a strength proportional to its mass, its velocity, and state of rotation of the frame of reference. The effect, first described in 1835 by **Gaspard de Coriolis** (1792 – 1843) accounts for the familiar circulation of air flow around cyclones, etc.

Fronts. Air temperature is generally higher at ground level due to heating by the sun, and decreases with increasing altitude. This vertical temperature difference creates a significant uplift of air, since warmer air near the surface is lighter than cold air above it. This vertical uplift of air can generate clouds and rain. Sometimes, air from warmer regions of the world collides with air from colder regions. This air mass conversion occurs in the mid-latitudes, where the warm air rises above the colder air, generating **fronts** and **depressions**.

Factors Influencing Movements of Air

Depending upon the energy levels and air pressure, diverse type of atmospheric phenomena occur, such as breeze, wind storm, thunderstorm, monsoon rains, cyclones (tempests/typhoons), etc. Various factors controlling these phenomena are :

1. Uneven heating of land at different parts of Earth.
2. Differences in heating and cooling of land and water bodies.
3. Vaporisation and condensation of water vapours.
4. Rotation of Earth.
5. Presence of high mountain ranges in the path of winds.

6. Difference in topography over which the wind passes.

3. Rain

When water bodies get heated by solar radiations during the day, a large amount of water evaporates and goes into the air. Some amount of water vapour also goes into the atmosphere because of various biological activities such as transpiration by plants. The air carrying water vapour, also gets heated. This hot air rises up, carrying water vapours with it. As the air rises, it expands and cools. This cooling causes the water vapour in the air to condense in the form of tiny droplets. Such process of condensation of water is facilitated when dust and other suspended particles act as the ‘nucleus’ for these droplets to form around. An enormous collection of tiny droplets of water appear in the form of clouds. These droplets of water, once formed, slowly grow bigger due to condensation of more water droplets. When the droplets become big and heavy, they fall down in the form of **rain**. Occasionally, when the temperature of air is very low, precipitation then may occur in the form of snow, sheet or hail.

ACTIVITY 6.3

To demonstrate the role of some factors influencing climatic changes such as formation of clouds and raining

Take an empty plastic bottle in which bottled water is generally sold. Pour 5-10 ml water into it and close the bottle tightly with a cap. Shake the bottle well and then place it in the sun for 10 minutes. Now open the cap of the bottle and allow some smoke from the lighted incense stick to enter the bottle. Quickly close the bottle tightly with the cap. Now, press the bottle hard between your hands as much as possible. After few

seconds release the bottle. Press the bottle again as hard as you can.

This simple experiment replicates, on a very small scale, the happenings when air with a very high content of water vapour goes from a region of high pressure to a region of low pressure. When bottle containing water is kept in the sun, the water evaporates and air inside the bottle gets saturated with water vapour. When the bottle is pressed between your hands, the pressure inside becomes high and air inside the bottle moves in a region of low pressure. It expands and cools. The smoke particles act as ‘nuclei’ on which water vapours condense in the form of tiny droplets. When you release the pressure, the air inside the bottle becomes foggy. When bottle is again pressed, the fog will disappear. It is so because due to high pressure condensed water vapours will fall down and collect as water at the bottom of the bottle. When the experiment is repeated without smoke inside the bottle, one will not observe foggy air inside the bottle as smoke particles are absent and nothing is available in air to act as ‘nucleus’ for water vapours to condense as tiny droplets.

ACTIVITY 6.4

To collect information from newspaper and weather reports rainfall patterns across the country

Read the newspapers daily or alternatively and listen to the weather reports on television. Record the relevant information about rainfall patterns across the country daily in your note book.

You will notice that rainfall patterns in different

regions/cities/towns are not uniform throughout the year. Different regions or cities or towns gets varied amount of rainfall in specific months of the year only. In large parts of India, rains are mostly brought by the south-west or north-east monsoons. You will also observe the month in which your city/ town/ village got the maximum rainfall. Similarly, you will observe the month in which your state or union territory got the maximum rainfall. Rain is not always accompanied by thunders and lightenings. However, it is generally accompanied by thunders and lightening in monsoon months.

Air Pollution



Air Pollution.

Air pollution is the addition of **air pollutants** such as particulate matter, gases and vapours into the atmosphere, has an adverse effect on humans, animals, vegetation and human assets. In fact, air pollution is of two main types : (1) **Natural** (e.g., forest fire, dust storm, pollen); (2) **Human made** (e.g., burning of fossil fuels in industries, vehicles and thermoelectric plants, gaseous emission from industries, mining, processing, stone crushing).

Particulate air pollutants are also called **suspended particulate matter** or **SPM** because they remain suspended in air for a good period of time. SPM consists of smokes, soot (a black powder substance that is produced when coal, wood, etc., is burnt), fly ash and dust (*i.e.*, particles of silica, grit, lead, asbestos, cement, sulphur, etc.). **Gases** that causes air pollution are sulphur dioxide, nitrogen oxides, carbon monoxide, hydrogen sulphide, hydrogen cyanides, hydrogen fluorides, chlorine, methane and ammonia. They are formed from nitrogen, sulphur and carbon compounds of fossil fuels and decaying organic matter. Pollutant **vapours** include unburnt hydrocarbons (benzene).

Effects of air pollution on human beings

1. SPM causes asthma, bronchitis and allergic cold.
2. Pollutant gases cause irritation in eyes, throat and lungs. They injure lungs, liver, kidneys, spleen and nervous system. Heart related diseases tend to increase. Many people develop terminal ailments such as cancer.
3. Hydrocarbon vapours not only damage the internal organs, but also cause cancer.

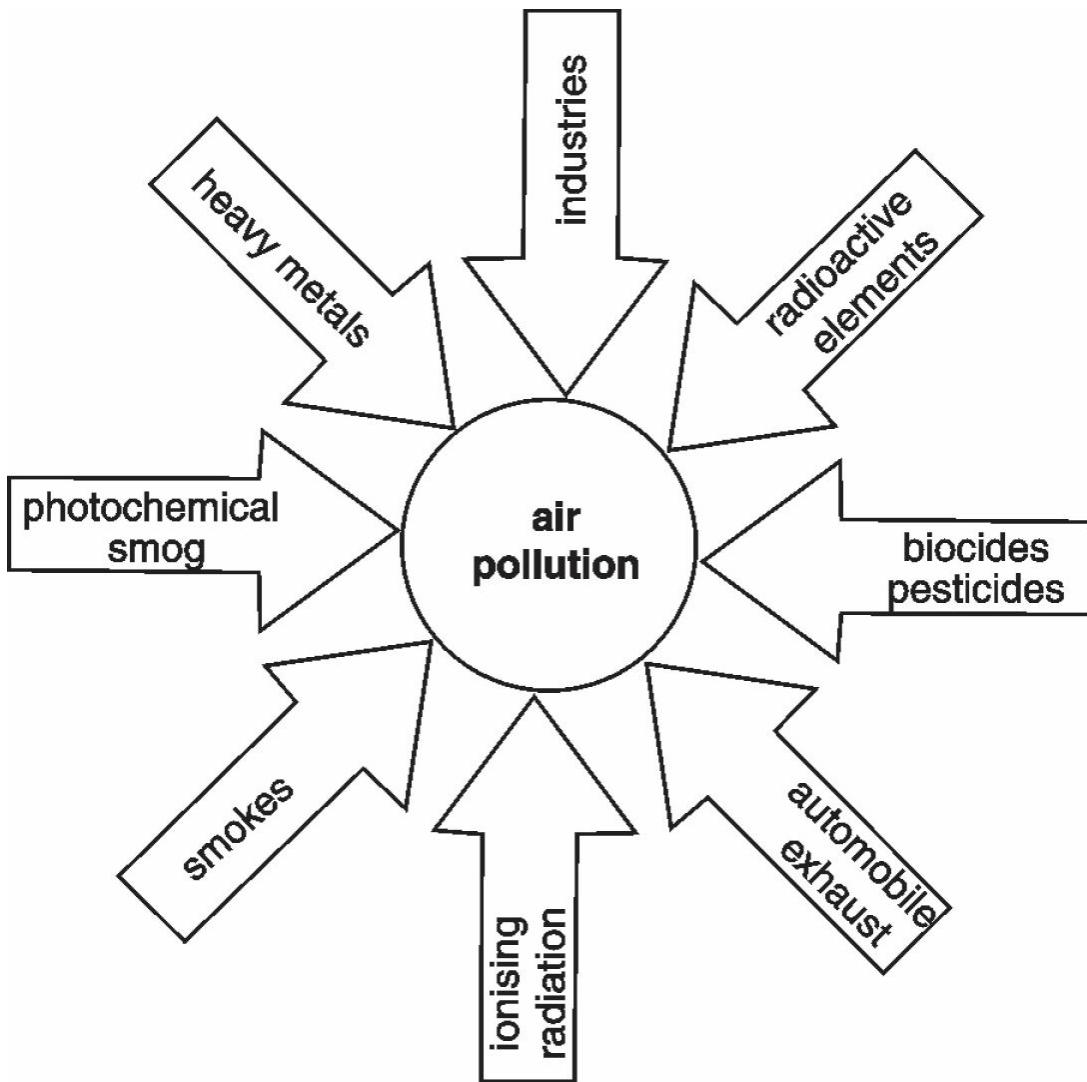


Figure 6.5. Some common sources of air pollution.

Other effects of air pollution

Many injurious effects such as falling of leaves, reduced growth, degeneration of chlorophyll, mottling of leaves, etc., have been noticed in plants. Lichens are very sensitive to the levels of contaminants, such as sulphur dioxide, present in polluted air.



ACTIVITY 6.5

To study lichens growing on the bark of trees in your area

Make a visit to trees growing along busy roads, less busy roads and some distance away from the roads. Record the lichens growing on the barks of trees in above mentioned areas. Compare the lichens growing on trees near busy roads with those on trees some distance away. On the trees near roads, compare the incidence of lichens on the side facing the road with the side away from the road.

Normally, you will observe lichens on the barks of trees as greenish-white crust. On the trees near busy roads, the incidence of lichens would be less as compared to those on the trees on some distance away from the roads. You will also observe more incidence of lichens on the barks of trees on the sides away from the roads as compared to the sides towards the roads. It is so because on busy roads, automobiles regularly, emit air pollutants including sulphur dioxide by burning of the fossil fuels (diesel, petrol). Increased levels of air pollutants such as sulphur dioxide in the air around the busy roads reduce the incidence of lichens on the trees near roads as they are sensitive to increased level of air pollutants such as sulphur dioxide.

Further, SO_2 reacts with water in the atmosphere to form sulphuric acid. This sulphuric acid is washed down into the soil by rain (**acid rainfall**) where it may make the soil highly acidic, thus, affecting the growth of plants and ultimately the forest growth. The acid rainfall severely affects the salmon reproduction and fish yield and also eats into the surface of buildings, eroding the stone (*e.g.*, Taj Mahal) and brick-works.

Air pollution also results in two serious ecological problems of global magnitude—green house effect and peeling of ozone umbrella (hole in ozone layer).

The carbon dioxide of the atmosphere keeps the Earth warm, much like a glass wall that keeps a **greenhouse warm**. This effect is called the **greenhouse effect**. The increase in carbon dioxide in the atmosphere intensifies the greenhouse effect and leads to global warming, *i.e.*, an increase in the average temperature of the Earth.

Ozone Layer and its Depletion

The ozone is an **allotrope** of oxygen. (Allotropy refers to an occurrence of one element in more than one form). It is triatomic (O_3) as compared to diatomic elemental oxygen (O_2). Ozone gas is a blue gas with a pungent odour. It is highly poisonous to living systems. It however, does not exist in an appreciable quantity in the lower atmosphere region called troposphere. Ozone is present in significant amounts in the stratosphere region of atmosphere. Maximum concentration occurs at a height of 23-25 Km above equator or at slightly lower altitude at other places. The density of the ozone layer varies greatly, being thickest at high latitudes in late summer and much thinner over the tropics.

The part of atmosphere which is rich in ozone may be called **ozone layer, ozonosphere, ozone umbrella or ozone shield** ([Fig.](#)

[6.6](#)). The ozone layer is highly important as it filters out the harmful, high energy ultraviolet radiations coming from sun. The high energy ultraviolet radiations split ozone into molecular and atomic oxygen:

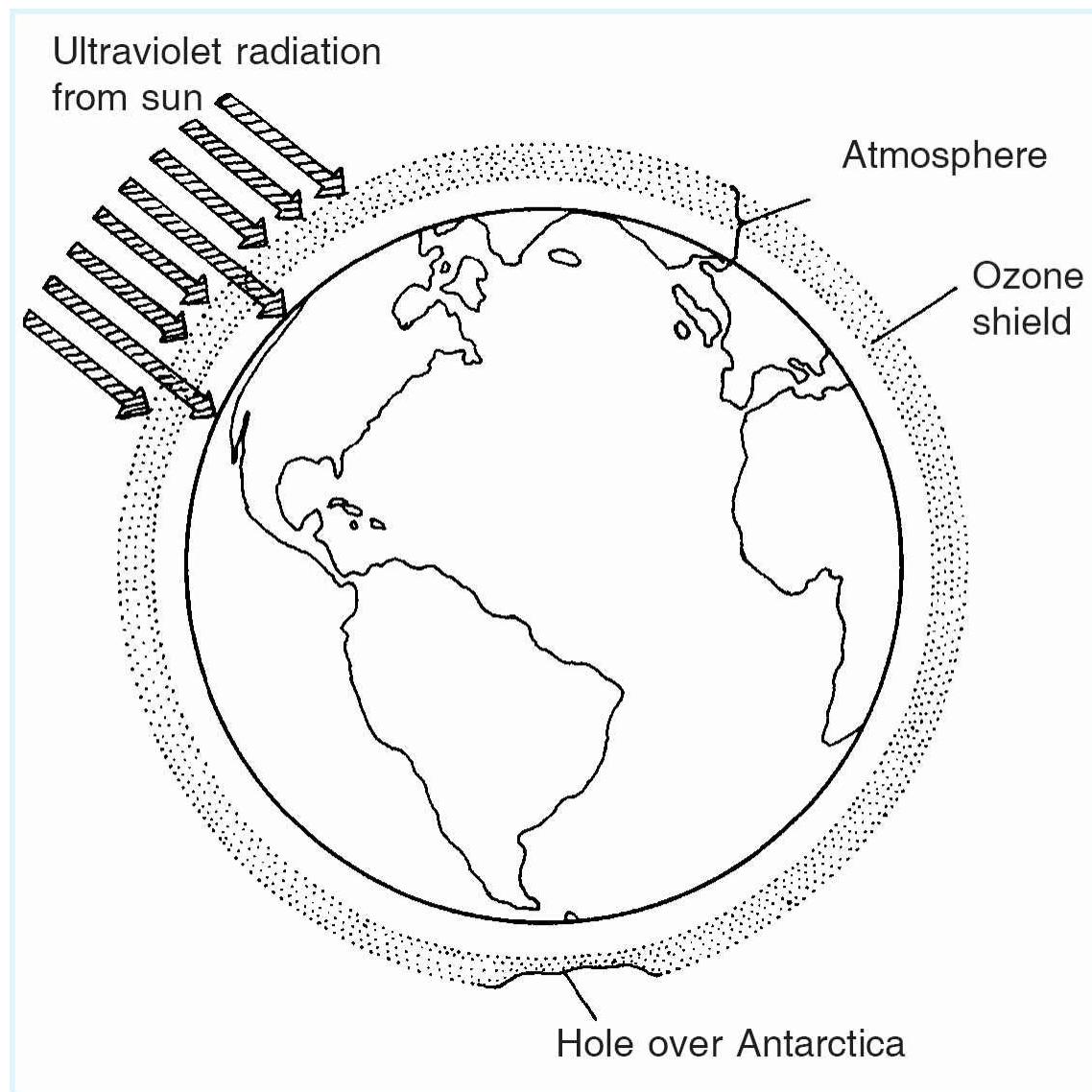
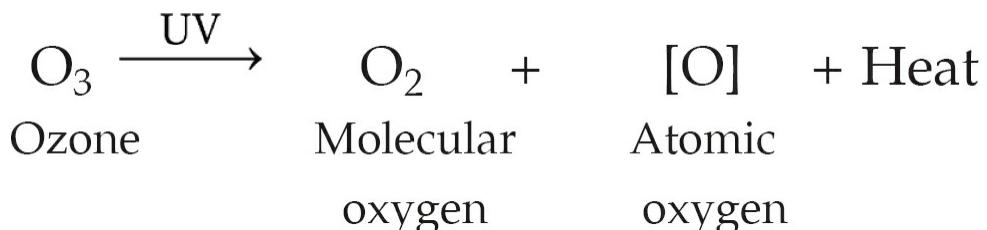


Figure 6.6. Ozone shield. The ozone layer surrounds the Earth and absorbs most of the sun's ultraviolet rays. The thin patch over Antarctica represents the lowered level of atmospheric ozone, due mainly to human use of chlorofluorocarbons.



Heat is liberated which warms the stratosphere. Ozone re-forms as atomic oxygen is highly reactive:



In 1985, **Farman** *et al.*, found that ozone layer had thinned out over Antarctica. It was called an **ozone hole**. A similar but smaller hole was also found over arctic region by **Augestein** (1987). The hole is more prominent in spring season in these regions. Over the years, antarctic ozone hole has widened ([Fig. 6.7](#)). It has grown in size from 13 million km² in 2000. Amount of atmospheric ozone is measured by Dobson spectrometer and is expressed in **Dobson units (DU)**.

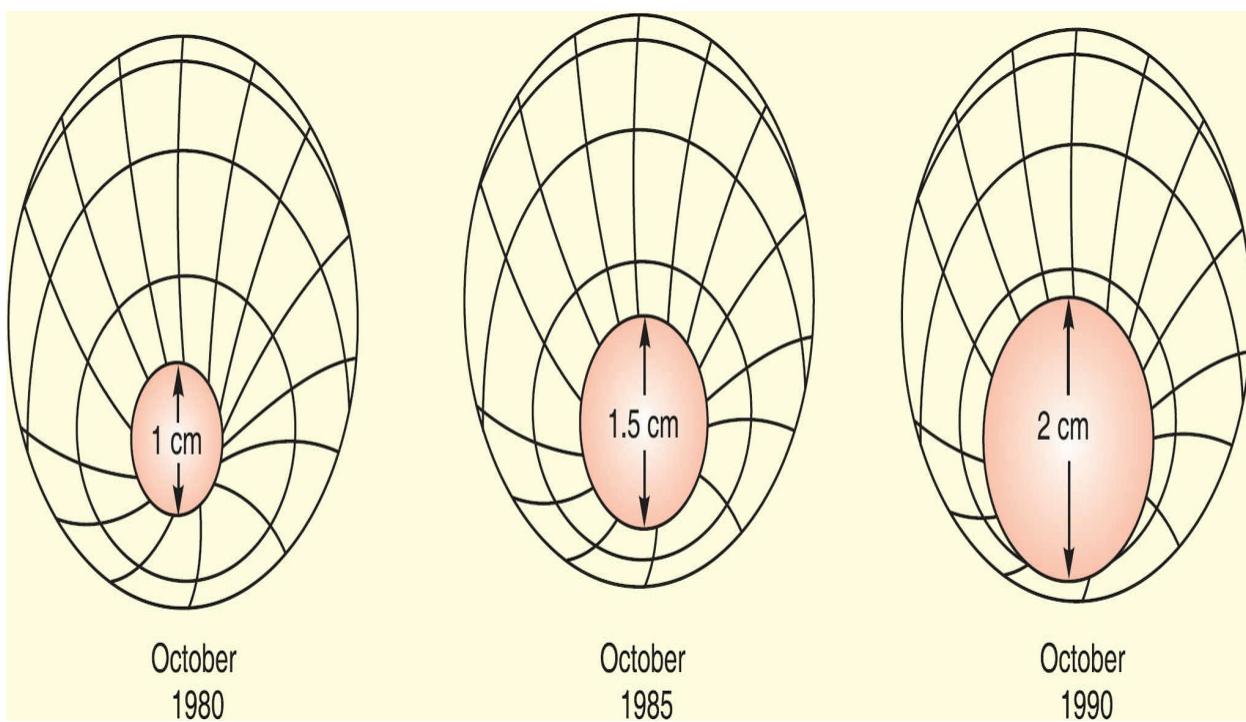


Figure 6.7. Satellite pictures of Earth showing widening of antarctic ozone

hole over the years.

Ozone depleting substances (ODS). Reduction in the concentration of ozone layer is called **ozone depletion**. It is caused by certain chemicals called **ozone depleting substances (ODS)**. The important ODS are chlorofluorocarbons (CFCs), halons, methyl bromide, nitrogen oxides and chlorine, CFCs such as carbon tetrachloride, CCl_3 ; dichlorodifluoromethane, (CCl_2F_2) . They are rich in chlorine, fluorine and carbon. CFCs are commonly used as aerosol propellants, refrigerants, shaving foams, spray agent in scents, etc. Some ODS are released in the stratosphere by jets flying at height.

Effects of ozone depletion: Depleting ozone layer allows more ultraviolet (UV) radiations to pass through it, which reach the Earth's surface. These UV rays cause various harmful effects on human beings, animals, plants and environment such as

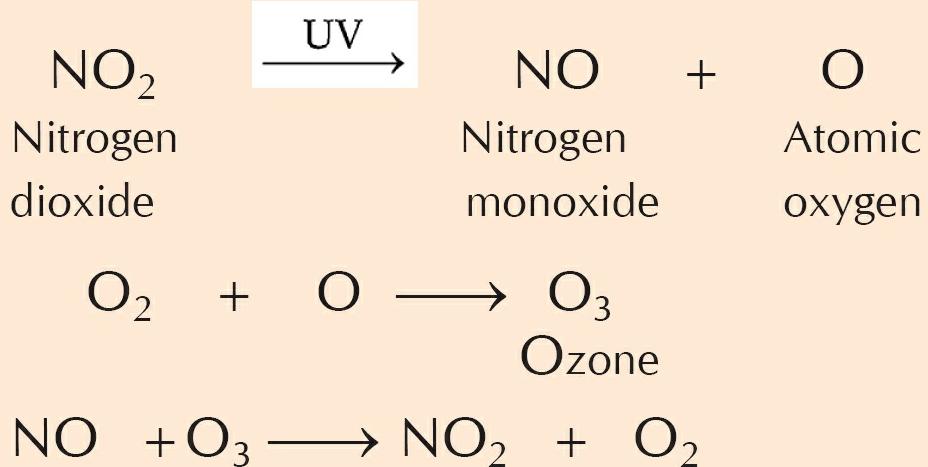
1. Skin cancer.
2. Damage of eyes; also increase in incidence of cataract disease in eyes.
3. Damage of immune system.
4. Increased embryonic mortality in animals and humans.
5. Decreased crop yields.
6. Reduced populations of phytoplankton, zooplankton and certain fish larvae that are important constituents of aquatic food chains.
7. Smog formation ([Box 6.3](#)).

Box 6.3

Smog

Smog is a photochemical haze (dark brown or greyish smoky

mist) caused by the action of solar ultraviolet radiation on atmosphere polluted with **primary pollutants** such as hydrocarbons (methane, ethane, toluene, etc.) and oxide of nitrogen (NO_2) from automobile exhaust:



Atomic oxygen sometimes react with hydrocarbons to form **radicals**. These radicals ultimately combine with oxygen, NO_2 and hydrocarbons to produce **secondary pollutants** such as formaldehyde, aldehydes and **peroxyacetyl nitrate (PAN)**. All these pollutants collectively form **photochemical smog**. Smog not only reduces visibility but is highly suffocating and toxic (harmful to humans, animals and plants).



Smog.

Plans are in pipelines to phase out the use of the ozone depleting substances (ODS) such as CFCs by 2020. The use of the methyl bromide as a pesticide has already been stopped, as it acts as a powerful ozone depleting reagent.

6.3. WATER

Oceans, rivers, streams, lakes, ponds, pools, polar ice caps, water vapour, etc., collectively form the **hydrosphere**. Hydrosphere comprises of **water** which is an inexhaustible natural resource. Water persists as liquid above 0°C and below 100°C. 71% of Earth is covered by oceans which contain 97.5% of the total water. Land contains 2.5% of the total water. A major part (1.9% of the total) of water occurs as ice caps and glaciers. The remaining (0.6% of the total) supports total life. It is called **fresh**

water (water with salt content less than 0.5%). More than 90% of this fresh water is found underground as **ground water**. The remaining 10% fresh water occurs as **surface water** (rivers, dams, lakes, ponds), **soil water** or as water vapours present in the atmosphere.

Terrestrial life cannot consume sea water because their bodies can neither tolerate high salt content of sea water nor eliminate the excess salts from the body. The source of freshwater is rainfall.

Water is one of the most unusual natural compound found on Earth and it is also one of the most important. Water exists in solid (snow), liquid (water) and gaseous (water vapour) forms. Life on Earth began in the seas and water in some form or the other is essential for the maintenance of all life. Water is one of the key agent in soil formation and serves as the living medium for several different ecosystems. Humans use water for drinking, washing of utensils and clothes, sewage disposal, irrigation and for various other purposes.

All reactions that take place within our body and within our cells, occur among water soluble substances. Substances get transported from one part of body to the other in dissolved form. Hence, organisms need to maintain a minimum level of water within their bodies in order to stay alive. Terrestrial - life forms require fresh water for this purpose because their bodies cannot tolerate or get rid of the high amounts of dissolved salts in saline water. Thus, water sources need to be easily accessible to animals and plants to survive on land ([Activity 6.6](#) and [Activity 6.7](#)).

ACTIVITY 6.6

To study the number and variety of plants and animals in an area in dry summer season and after rainy season

Select a small area in some unused land near your school. Count the number and variety of individuals of each species of plant and animal and record the data in your note book. Report this exercise in the same place at least twice a year, once during dry summer season and once after rainy season.

You will observe that the number and variety of plants and animals are not similar both the times. In dry summer months, the number and variety of plants and animals are less as compared to the period after rainy season. It is because of the dry condition in summer season when water availability is less in the soil and environmental temperature becomes relatively high. On the contrary, after rainy season, environmental temperature becomes favourable, having high moisture content and the soil also has sufficiently high content of water.

ACTIVITY 6.7

To study the relationship between the quantity of available water and the number and variety of plants and animals in an area

Select a small area near a water body (*e.g.*, a pond, lake, stream or river). Count the number and variety of plant and animal species present in this area and record the data in your note book. Now, select another small area in a dry, rocky region and again count the number and variety of plants and animals present in this area. Record this data also in your note book. Repeat this activity in two regions in different seasons (*i.e.*, summer, winter and rainy season).

You will observe that the number and variety of plants and animals are more in area near a water body than in an area in

dry, rocky region. It is due to more availability of water and fertile soil near the water body. You will also observe that the number and variety of living organisms (plants and animals) are less in dry summer, and winter seasons and more in rainy season. It is again due to availability of water and other favourable environmental factors in rainy season as compared to summer and winter months which have less favourable parameters.

Thus, availability of water decides not only the number of individuals of each species that are able to survive in a particular area, but it also decides the diversity of life there. Besides the water, there are some other environmental factors which determine the biodiversity of a region. These factors are **temperature** and **nature of soil**.

Ground Water

When rain falls, some water is lost as it **runs off** into trains. This water reaches the rivers and seas and some of it gets lost through evaporation. The remaining water percolates into the ground through the pores between the soil particles, and is termed as **ground water**.

Tiny pore spaces in soil act as capillaries which allow water to move against the pull of gravity resulting in **capillary water**. Some water forms an extremely thin, tightly held film around the soil particles. It is termed as **hygroscopic water**. A small portion of soil water is chemically bound with soil materials and is known as **combined water**. The downward moving water, called **gravitational water**, reaches the underground **water table**, if enough rain falls. Plants can draw only capillary water from the soil. This water is known as **available water**.

Rain Water Harvesting

This technique is used to capture, store and reutilise rain water, by making special water-harvesting structures such as dug-out wells, percolation pits, check dams, and lagoons. Rain water harvesting can be beneficial for all, particularly in the region of scanty rainfall.

ACTIVITY 6.8

Explanation of water harvesting technique

The water which rains down cannot percolate through the hardened soil and flows away quickly to streams, rivers and sea without replenishing the underground water tables. As withdrawal of huge quantities of fresh water continues, underground water table is receding deeper and deeper around the world. The failure of a centralised distribution system and the depletion of underground water table has forced Indian people to adopt *rainwater harvesting and ground water recharge projects*.

1. Rainwater harvesting. Rainwater harvesting involves collection, storage and subsequent use of water deposited by rains. In water stressed, dry regions of the world, rainwater harvesting is an ancient practice. In parts of Rajasthan and Gujarat, people collect whatever they can, the meagre quantity of water that is deposited by rain, in large storage tanks and vessels. This water serves them during most of the year.

In another technique of rainwater harvesting, roof tops properly cleaned are used to collect rain water which is directed through pipes to large underground pucca storage tanks which are sealed off from all sides except for a small opening used for

cleaning and withdrawal purpose. In cities such as Dwarika, Gujarat. people use this collected water for drinking and cooking purpose for most of the year.

2. Groundwater recharging. We can improve the ground water storage capacity of Earth's crust by adopting the following methods.

- (i) Collection of water deposited over roof tops, open fields and slopes by erecting impediments to check the flow.
- (ii) Directing this water to underground water table through wells, bore wells and deep shafts drilled in the soil for the purpose so that collected water goes to under ground deposits quickly.

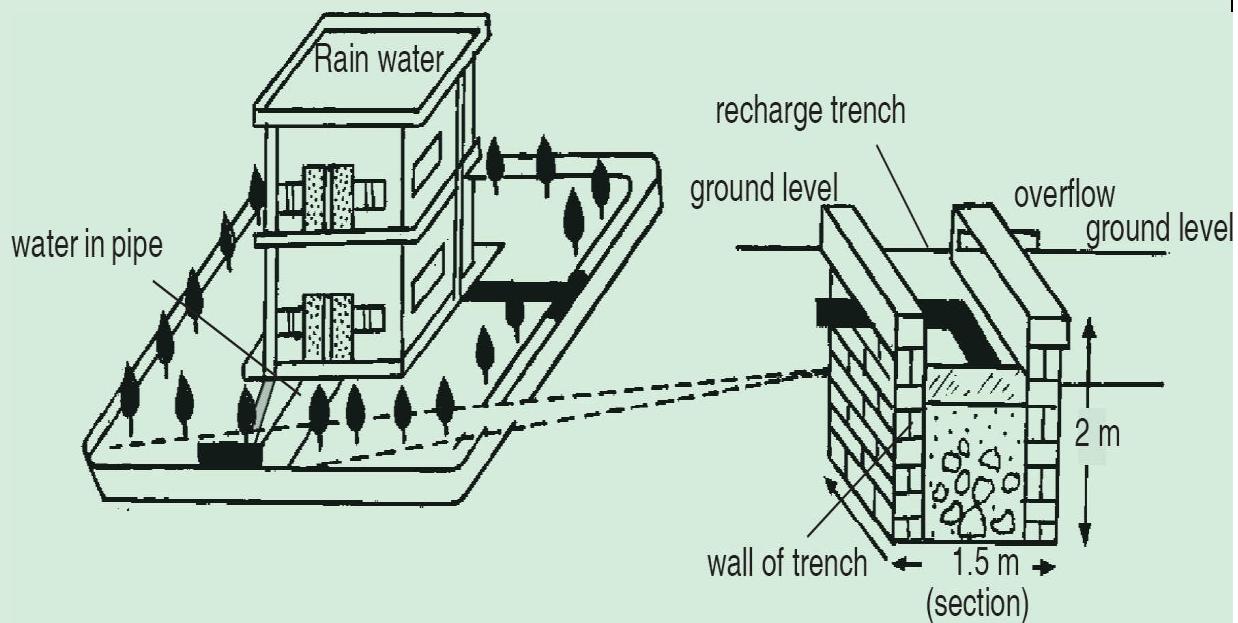


Figure 6.8. Technique of water harvesting and groundwater recharging.

Advantage of Rain-water Harvesting

The technique of rain-water harvesting has the following advantages:

1. It reduces the run-off loss of rain water.

2. It is helpful in controlling floods.
3. It maintains a supply of water during the dry months of the year.
4. It helps to raise the water table.
5. It checks soil erosion.

Traditional Rain-water Harvesting in India

In India, there has been a age-old tradition in villages to have a pond or tank to collect rain water during the rainy season. This pond is used to be a necessary part of village life. Throughout the year, the stored water of the ponds is used for animals and for small irrigation projects. Even the village washerman wash the clothes on these ponds. Likewise, in foothills, the water from the springs is collected by small embankments. The spring water is diverted and transported by hollow bamboo sticks. In Rajasthan, underground tanks (tankas) are well known and khadins were used for harvesting the rainwater. Almost every town in Rajasthan has a number of tanks, baolis and johads and hauzes. All these structures provide supply of water during the water shortage periods.

Box 6.4

Rajendra Singh, fondly known as “*Water man*”, was awarded **Magsaysay Award 2001** for his ingenious technique of harvesting of rain water. He has revived age old Indian technique of collection of rain water in earth check dams (**Johads**) to increase level of water table, recharge the wells and restore greenery in Sirska forest hills in Rajasthan.

Conservation and Management of Water Resources

Some of our natural resources such as air, water and soil,

require proper attention and management. In India, we often face water scarcity. The ground water level goes down in the summer seasons. As a result, during summers the municipal / corporation water supply is restricted, our wells and hand pumps become dry. Such frequent situations of water crisis have forced environmental biologists to seek various means of water conservation. They have suggested the following measures for avoiding misuse and wastage of potable water :

1. Development of integrated water shed plan for drinking, irrigation and industrial uses.
2. Adoption of various flood control methods.
3. Transfer of surplus water to water deficit basins by interlinking of Indian rivers.
4. To identify the over exploited areas of fresh water, extensive hydrogeological surveys are done.
5. The ground water is recharged by artificial means ([Box 6.4](#)).
6. To avoid wastage and misuse of water, there is an urgent need of mass awareness programmes through public and private agencies. Usually water is wasted by leaking taps and excessive irrigation of crop fields.

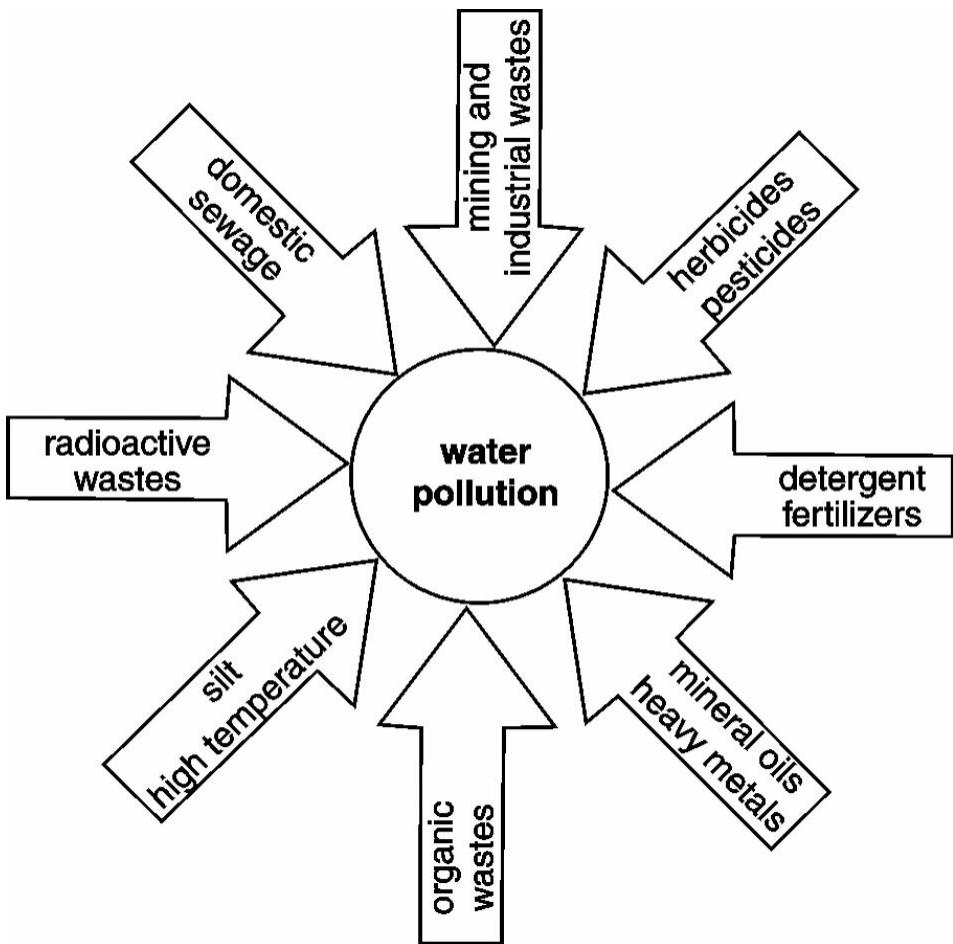


Figure 6.9. Some common sources of water pollution by which our water resources get polluted.

ACTIVITY 6.9

Collect the water samples from different sources such as pond, lake, river, tap, well and even drain. First, observe the presence of biotic components (algae, aquatic plant, zooplankton, etc.) with the help of a magnifying glass. Then perform certain chemical tests (*e.g.*, soap test, EDTA test) for dissolved salts such as **sulphates** and **chlorides** (these salts tend to give hardness to water).

Test pH value (*i.e.*, hydrogen ion concentration or alkalinity and acidity) of water by the help of pH paper strips or pH

universal indicator.

This process of observation can be repeated by collecting water samples from other localities and during different periods of the year.

Water Pollution

An undesirable change in the physical, biological or chemical qualities of water (due to addition of foreign organic, inorganic, biological or radioactive substances) that adversely affects the aquatic life and makes the water unfit for use, is called **water pollution**. Pollution of water is one of the most serious environmental problems of world.

Water pollution may be of following three types:

1. Surface water pollution (or Inland water pollution);
2. Underground water pollution; and
3. Marine water pollution.

Human beings are the main cause of water pollution. However, some pollution also occurs naturally. Soil particles enter water through soil erosion; minerals dissolve in water from rocks and soil; animal wastes and dead fallen leaves (litter) pollute the water sources.



Water pollution.

Types of Water Pollutants

Agents or substances that pollute water are called **water pollutants**. Water pollutants can be classified into following three categories: physical, chemical and biological water pollutants.

1. Physical water pollutants. These include heat and oil-spills. Specific industries and thermal/nuclear power plants use water for cooling in various operations and later return this hot water to water bodies. This result in **thermal pollution**. Another manner in which the temperature of the water in river can be affected is when

water is released from dams. The water inside the deep reservoir would be colder than the water at the surface which gets heated by the sun. High temperature of water reduces its dissolved oxygen content.

2. Chemical water pollutants. These include organic wastes (*e.g.* sewage), detergents, fertilizers, pesticides (*e.g.*, dieldrin, DDT, DDE, BHC, etc.), polychloronated biphenyls [PCBs], inorganic chemicals (*e.g.*, arsenic, cadmium, mercury, lead, nickel, phosphates, nitrates, fluorides, etc.) and radioactive wastes. Common inorganic impurities in water are compounds of calcium and magnesium.

3. Biological water pollutants. These include pathogens such as viruses, bacteria, protozoa, fungi, helminths, nematodes, etc.

Sources or Causes of Water Pollution

The water is polluted by pollutants released by following sources ([Fig. 6.9](#)):

1. Sewage. Organic wastes are contributed as domestic and commercial sewage by food processing plants, dairy farms, piggeries, poultry farms, slaughter houses, breweries, tanneries, etc. Animal excreta discharged into fields or dumped in to pits reaches water bodies through run off and leaching, particularly during the rainy season.

2. Industrial wastes. Effluents of mills and industries such as paper mills, petroleum refineries, etc., contain large quantities of harmful chemicals including acids, alkalies and heavy metals (*e.g.*, mercury salts from paper industries) that are discharged into water bodies (rivers and lakes). These include both inorganic and organic chemicals.

3. Synthetic soaps and detergents. Water containing soaps and

detergents is discharged from houses and certain factories.

4. Fertilizers and pesticides. Fertilizers and pesticides are being used excessively in the fields to increase crop production. These are washed by rainwater into water bodies and pollute them.



5. Petroleum oil. Drilling and shipping operations are common in the oceans. Leakage of petroleum oil during such operations or due to accidents result in water pollution.

6. Solid particles. Rain erodes soil and carries silt to water. Tiny suspended particles of clay and dust also settle in water from air. These soil particles cause turbidity.

7. Thermal pollution : Discharge of hot water from industries and thermal plants into water body changes the normal temperature of the water. The content of oxygen decreases. Reduced oxygen content kills aquatic animals and reduces the rate of decomposition of organic matter which, therefore, accumulates.

Point and Non-point Sources of Water Pollution

1. Point sources. These sources have a specific location for the discharge of water pollutants directly into water bodies. Therefore, these sources are located near the water bodies, *i.e.*, factories, power plants, breweries, underground coal mines and oil wells. It is always easy to treat the pollution coming out of point sources before their discharge into the nearby water bodies.

2. Non-point sources. These pollution sources are scattered and do not have any specific location to discharge pollutants into the water bodies. Examples of non-point sources are run-off from fields, lawns and gardens, road and streets, construction sites, logging areas, etc. Unlike point sources, these sources are difficult to monitor and treat to remove the pollutants.

Harmful Effects of Water Pollution

1. Human diseases. Pathogens are biological pollutants of water. They include viruses, bacteria, fungi, protozoan, helminths, nematodes, etc. They cause following diseases in humans such as typhoid, cholera, dysentery, jaundice, and hepatitis.

2. Disturbance in ecological balance. All types of water pollutants affect the life-forms living in the water. The pollutants can encourage the growth of some life forms and can harm some other life-forms. This affects the balance between various organisms that persists in that system.

3. Removal of desirable substances from water bodies. With increase in the amount of organic wastes in water, bacteria multiply rapidly and use up the available oxygen. Lack of oxygen kills the fish and other animals.

Biological oxygen demand (BOD) indicates the quality of waste water. BOD refers to the amount of dissolved oxygen needed by bacteria in decomposing the organic waste present in water. It is expressed in milligrams of oxygen (O_2) per litre of water. A weak organic waste has BOD less than 1500 mg/litre; a strong one has higher than this.

4. Effect of thermal pollution or change in temperature. Aquatic organisms are used to a certain range of temperature in the water-body where they live; a sudden marked change in this

temperature can be dangerous for them, *e.g.*, it affects breeding of aquatic animals. The eggs and larvae of various animals are particularly susceptible to temperature changes.

5. Destruction of useful microorganisms. When untreated industrial wastes get mixed with water in rivers and lakes, etc., the acids, alkalies and heavy metals present in the industrial wastes kill the useful organisms present in water bodies. As these microorganisms are the natural cleansing agents of water, self-purification process is hindered in these water bodies.

6. Eutrophication. Eutrophication is the process in which dissolved oxygen in water gets reduced due to excessive growth of algae as a result of extra loading of nutrients in the water body. Presence of sewage and fertilizers (nitrates and phosphates) in polluted water provide a lot of nutrients to the algae (phytoplankton) present in water body, resulting excessive growth of algae, termed as **algal bloom**. The algae subsequently die and aerobic decomposers become active. They rapidly consume the dissolved oxygen of the water during decomposition of the dead algae. In the absence of dissolved oxygen, all the aquatic life (including fishes) in the water body dies.

7. Biomagnification (food chain magnification) of chemical. Pesticides such as DDT, DDE, dieldrin, etc., are harmful chemicals that are regularly being used in agriculture to protect crops from the pests (fungi, insects, etc.). Also heavy metals (*e.g.*, mercury, cadmium, tin, lead, arsenic, etc.) are regularly poured from industries into the water bodies. These chemicals are **non-biodegradable**, *i.e.*, unlike the organic sewage wastes they are not broken down by the activity of microorganism. These pesticides/heavy metals enter the soil or are washed away by run off water to surface water bodies such as lakes, streams, rivers.

From soil or water these pesticides/heavy metals then enter the food chain via the producers. At each trophic level, their concentration goes on increasing. This phenomenon of increase in concentration of harmful non-biodegradable chemical substances in the body of living organisms at each trophic level of the food chain is called **biomagnification**. Due to biomagnification fish-eating predatory birds such as kingfishers, osprey and loon become poisoned. For example, biomagnification of mercury in the fishes through a food chain results in **Minamata disease** in fish-eating human populations of the region. Likewise, DDT can accumulate through a series of plankton, small fish, large fish, and birds, and this ultimately results in a magnification of the DDT concentration amounting to several hundred fold in humans.

Cadmium (Cd), another heavy metal, **bioaccumulates** in the liver and kidney and the amount of Cd stored in kidney increase with age. Kidney damage is the most prevalent chronic effect of Cd exposure. The Cd poisoning in Japan has once resulted in **itai itai** disease, which was due to eating of rice produced from soil containing high level of cadmium.

Box 6.5

Bioaccumulation : This term refers to the storage of a pollutant in body tissues of animals and humans (fats, bone, kidney, etc.) at levels higher than found in the environment. Cadmium, dioxins, PAHs (=polycyclic aromatic hydrocarbons), PCBs (polychlorinated biphenyls), etc., are some examples.

Biomagnification : This term is used for the food chain magnification so that the organisms at the top of the food chain contain harmful chemicals such as DDT, methyl mercury, etc.

8. Decomposition of organic matter : Microorganisms bring about decomposition of organic matter brought about by sewage and other organic remains. The process requires oxygen. If organic matter is large or oxygen content is low, **anaerobic breakdown** of organic matter occurs. This produces various pollutants such as hydrogen sulphide, ammonia, methyl sulphides, organic sulphides and methane. Scum and sludge are formed. The water of such a water body becomes, odorous and turbid.

6.4. SOIL

Soil is the portion of the Earth's surface that consists disintegrated rock and decaying organic material. It provides support for many plants and animals. Thickness of soil on the Earth's surface ranges from a few millimeters to 3-4 meters. Terrestrial and aquatic plants depend upon the soil and water bed, respectively for their nutrients, water supply and anchorage.

1. Formation of soil. Soil is formed from the rocks undergoing the following two processes : **1. Weathering ; 2. Paedogenesis.**

A. Weathering. Breakdown of bigger rocks into smaller mineral particles is called **weathering**. Weathering occurs by following *three* means :

(i) Physical weathering. Various climatic factors such as temperature, wind, rain water, ice, snow, glaciers and running water contribute to physical weathering. Water and high temperature cause corrosive humidity and bring about unequal **expansion** and **contraction** of rocks, facilitating their breakdown. Water causes weathering of rocks by three methods: (i) wetting and drying (ii) frost action and (iii) abrasion. The freezing water expands in rock crevices and breaks the rocks. Wind action also causes the weathering of rocks. Strong winds erode the rock

surfaces by rubbing and striking its abrasive particles against the rock surface. River water grinds rock chips and stones into sand and into a finer form – the silt. Soluble components of rocks such as calcium, chloride, sulphates, etc., are removed by water in solution ; they percolate downward. The roots of the plants also have a role in weathering process. They penetrate into the crevices of the rocks and assist in the rock-breaking process.

(ii) Chemical weathering. It involves a variety of chemical processes such as hydrolysis, hydration, oxidation and reduction. The breaking down of complex compounds by the carbonic acid present in water and acidic substances derived from the decomposition of organic matter in soil, are some examples of chemical weathering. The primary end products of the chemical weathering are silica, clay, inorganic salts and hydrated oxides.

(iii) Biological weathering. Biological weathering is done by living organisms such as lichens and bryophytes (mosses). Lichens growing on rock surface extract minerals from the rocks. This creates small crevices at places where a thin layer of soil builds up. Mosses grow over these crevices. They cause deepening of the crevices and result in build up of more soil inside them. Deeper crevices form cracks. These cracks become wider and deeper when the roots of short lived herbs pass into them. With the passage of time, the roots of bigger plants, (e.g., peepal, banyan tree) pass into the cracks. Cracks gradually widen and cause slow fragmentation and eventually pulverisation of rocks.

B. Paedogenesis (soil development). This process concludes the **decomposition** by bacteria and fungi, during which organic materials are broken down, leading to **humification** and **mineralization**. Detritivores, such as nematodes, earthworms, arthropods such as scolopendra, millipede, mites and ants, consume

organic matter and add excretory nitrogen to it. Thus, addition of organic matter (humus) from dead, and decomposed plants and animals, is the final stage in soil formation. A mature soil, thus, has minerals, stored energy in the form of organic matter (such as starch, sugars, cellulose, lipids, proteins), oxides of nitrogen (NO_2 , NO_3), NH^+ ions, water and air.

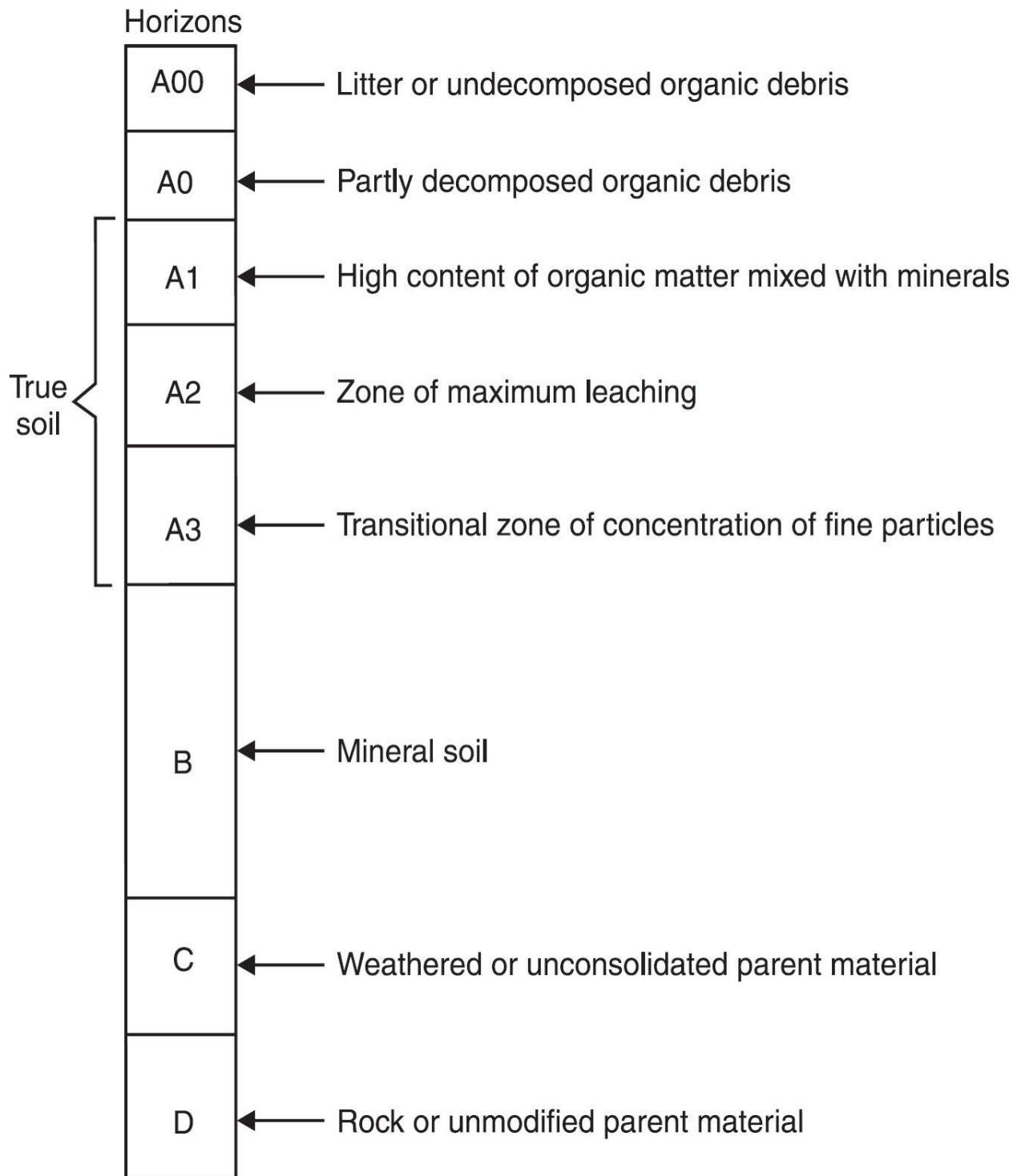


Figure 6.10. The soil profile.

2. Soil profile. The term soil profile represents the vertical section of Earth crust, which is made up of a succession of horizontal layers (horizons), each of which varies in thickness,

colour, texture, structure, consistency, porosity, acidity and composition ([Fig. 6.10](#)).

The upper or **A-horizon** is the **top soil**. It contains most of the litter and humus. It also has a zone of leaching, through which dissolved materials seep downward. The roots of small plants are embedded in top soil. The second or **B-horizon** is composed of the mineral soil (sub soil). The third or **C-horizon** contains the unconsolidated parent material. The last or **D-horizon** comprises of rock or unmodified parent material.

3. Composition of soil. Top soil mainly consists of following *four* types of rock particles, which differ in their size, look and texture :

(i) Gravels. These are large particles (small stones) which can be picked up by hand. Particle size of gravels is greater than 2 mm in diameter.

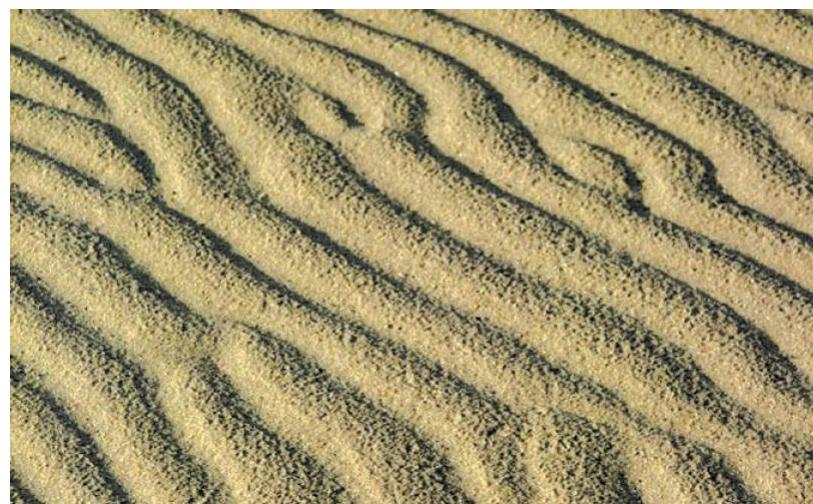
(ii) Sand particles. They are coarse to touch and have particle size ranging from 0.05 mm to 2.00 mm. They can be seen easily by naked eyes.

(iii) Silt particles. These soil particles have particle size between 0.005 to 0.05 mm.

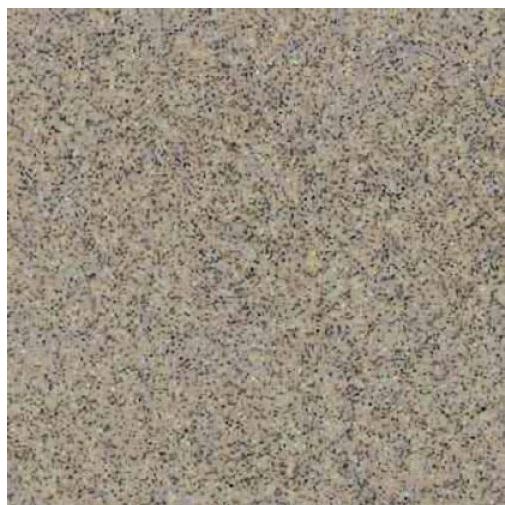
(iv) Clay particles. These are the smallest soil particles, with size less than 0.005 mm.



Gravel.



Sand.



Silt.



Clay.

Composition of soil.

ACTIVITY 6.10

To demonstrate that soil is a mixture

Take some soil in a beaker and put water in it. Make sure that the water is at least five times the amount of soil taken. Now stir the soil and water vigorously with a stirrer and allow the soil to settle down.

A critical examination of this soil water mixture will reveal that soil has settled down at the bottom of the beaker in layers. It is so because soil is a mixture and contains different sized particles of rock in addition to humus (partially dead organic matter). The particles have settled down depending on their size, *i.e.*, one having larger size at the bottom and lighter, smaller sized ones on top of it in layers. You may also find some living organisms or dead partially decayed organic matter floating on the surface of water. Since water is a universal solvent, it must

have certain dissolved soluble materials present in soil (e.g., salt). For that you have to perform certain chemical tests.

4. Types of soils. Based upon the relative amounts of particles and types of particles soils are classified into *three* main types :

(i) Sandy soil. This soil contains a large amount of sand particles and very small portion of silt and clay. It is found in deserts areas. It cannot hold much water.

(ii) Clayey soil. This soil mainly contains clay particles and a small quantity of humus and silt. Clayey soil is compact and can hold water, but cannot trap air.

(iii) Loamy soil. This soil contains clay, silt, sand and humus. Loamy soil has good water holding capacity and is porous, to allow aeration of roots.

From agricultural point of view, soils of India are divided into following types:

A. Residual soil. This soil exists at the place of its formation. Residual soil may be black, red and laterite.

(a) Black soil. It is derived from a **basaltic** rock. It is rich in iron, calcium, aluminium and magnesium. Black soil is porous and contains humus. **Humus** is a dark, finely divided, amorphous organic matter, which consists of decomposed plant and animal material and is rich in C, N, P and S content. Black soil is best suited to grow cotton and sugar cane and is mainly found in Maharashtra, Andhra Pradesh, Gujarat and Madhya Pradesh. It is also found in South Western Uttar Pradesh, Eastern Rajasthan and Haryana.

(b) Red soil. This soil is red due to the presence of iron oxide in it. It contains quartz and clay particles and forms the top soil. Red

soil is poor in lime, magnesium, phosphorus, nitrogen and contains very little quantity of humus. In India, red soil is mainly found in Kerala, Tamil Nadu, southern Karnataka, Andhra Pradesh, Orissa and Madhya Pradesh.

(c) Laterite soil. This soil is also red in colour and is found in regions that receive heavy rainfall. It contains hydrated oxides of aluminium and iron. This soil is rich in nutrients and is good for growing tea, coffee and coconut. In India, laterite soil is found in the Western Ghats, parts of Tamil Nadu, Andhra Pradesh, Orissa and Assam.

B. Transported soil. This type of soil gets displaced and settled at places away from its origin due to gravity, flowing water, wind or glacier. For example, in deserts when sand, is deposited in sand dunes, it is called **aeolian soil**. Transported soil is of following *three* types :

(a) Alluvial soil. It is formed by the deposition of silt brought down from the mountains by the flowing rivers. Alluvial soil is layered and consists of smooth round particles. This soil is rich in humus and contains gravel, sand and clay. This soil is suitable for growing wheat, rice and sugar cane. Alluvial soil is mainly found in the plains of Uttar Pradesh, Haryana, Bihar and Bengal. Alluvial soil is also known as Khadar.

(b) Desert soil. This soil is coarse, sandy and porous. It is greyish brown in colour and rich in minerals. Desert soil produces rich crops when it is supplied with water. Desert soil is found mainly in Rajasthan, Gujarat and Ladakh.

(c) Mountainous soil. This soil varies in its contents from place to place. It consists of sand, stones, clay, shales and limestones. It also contains a good amount of humus. Mountainous soil is mainly found in the Himalayan region. (**Note.** Shales are soft rocks formed

from compressed mud or clay that can be split into thin layers).

Soil consists of a sufficient amount of air, water and many living organisms. **Soil air** occurs within pore spaces of the soil and contains three gases – O₂, CO₂ and N₂. It is rich in moisture. **Soil water**, which is available to plants, is the **capillary water** which exists as a thin film around soil particles. This water, in fact, occurs in smaller soil channels and is held by capillary forces (*e.g.*, surface tension and attraction forces of water molecules). Water, which is retained as a thin and tightly-bound film around individual soil particle is called **hygroscopic water** ([Fig. 6.11](#)). It is not used by plants. Rest of the water in the soil is called **gravitational water** as it is free to drain downwards, through the soil, under the influence of gravity. This water causes **leaching**, *i.e.*, the washing away of minerals (nutrients). The level to which gravitational water drains is called the **water table**.

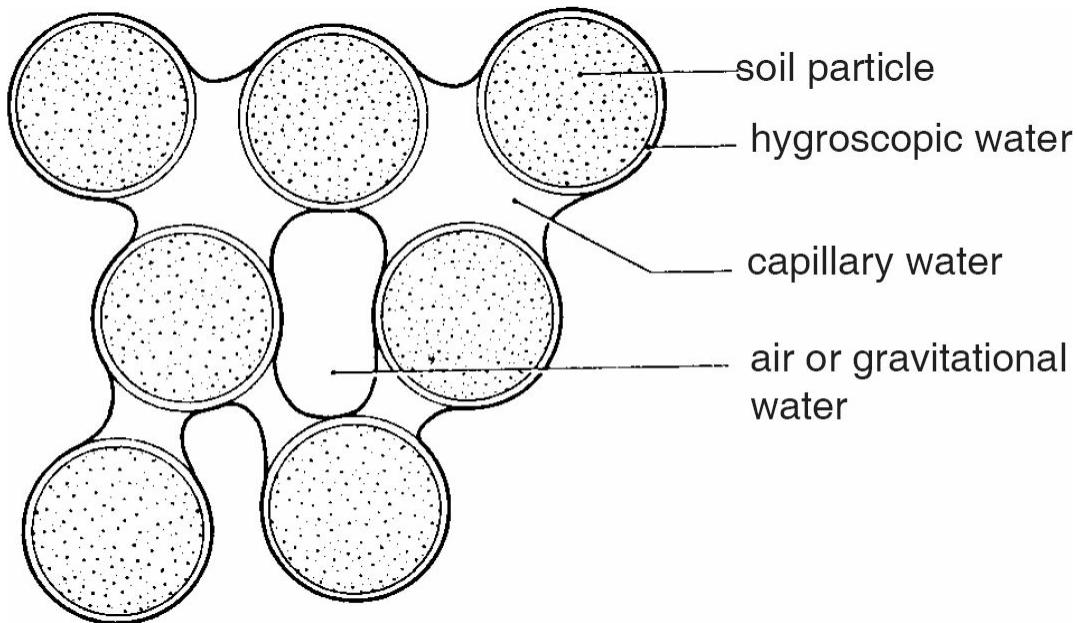


Figure 6.11. Three main types of soil water.

Soil becomes the habitat for many living organisms such as bacteria (including nitrogen-fixing bacteria and blue green algae),

fungi, protozoans, nematodes, land snails, millipedes, centipedes, ants, termites, amphibians, reptiles and mammals (rats, mice and rabbits).

Minerals. Earth has limited non-renewable quantities of minerals distributed unevenly in different parts of the globe. Coal, petroleum copper, aluminium, zinc, lead, iron, silver, gold are the important natural resources to the humankind. Fossil fuels (*e.g.*, coal and petroleum) are being widely used by human beings in industry, transport, house-hold and agriculture. The ever increasing demand of minerals may lead to their depletion within a few decades. Therefore, all the non-renewable minerals (metals and non-metals) should be used judiciously.

Soil Erosion

The removal and transportation of the top layer of soil from its original position to another place, under the effect of strong winds and fast running rainwater, is called **soil erosion**. The top layer of soil is very fertile. It provides anchorage (firm support) to plants and is also a source of nutrients and water to the plants.

Soil erosion normally occurs in bare areas, *i.e.*, areas without plant cover. It is so because the bare topsoil is loose and thus can be easily carried away by strong winds or fast moving water of heavy rains or rivers.



Soil erosion.

I. Causes of Soil Erosion

The soil that we see today in one place has been created over a very long period of time. However, some of the factors that created the soil in the first place and brought the soil to that place may be responsible for the removal of soil too.

1. Strong winds. The soil which is uncovered and loose, is eroded, when it is exposed to strong winds. The winds carry away the fine soil particles to other places.

2. Heavy rains. When rain falls on the unprotected top soil, rain water washes it down into the streams and rivers, etc.

3. Improper farming and suspended cultivation. Farmers loosen the top soil of the agricultural fields either for cultivation or

for removing the weeds. Such soil can get eroded, due to the winds or rains. Sometimes due to certain reasons, ploughed agricultural fields remain fallow (not-cultivated) for a long time and is affected by soil erosion.

4. Human actions. Human activities such as expansion of urban areas has led to removal of vegetation from certain regions. The bare land is thus exposed to agencies (winds, rains) of soil erosion. Thus, large scale deforestation and overgrazing by our domestic animals, not only destroys biodiversity but also leads to soil erosion.

5. Dust storms. Dust storms shift huge amounts of loose soil from one place to another.

6. Frequent floods. Frequent flooding of rivers is another cause of soil erosion. Fast moving water in the rivers removes the top soil of the fields near the river banks and carries it away.

II. Effects of Soil Erosion

Soil erosion results in following human crises:

1. Loss of fertility and desertification. Soil erosion results in the displacement of the top soil from one region to another, thus, reducing its fertility. When the top fertile soil is constantly removed from a region, only infertile sub-soil is left behind. In such a soil, only sparse vegetation can grow. This way, soil erosion gradually turns lush green areas into deserts.

2. Landslides in hilly areas. Barren hills or hills with sparse vegetation are constantly exposed to heavy rain fall that makes the top soils of hills loose. Due to soil erosion, rock pieces of various sizes and loose soil from hills, suddenly slide down the steep slopes of mountains/hills. This phenomenon is called **landslides**. When these rock pieces and soil block the narrow river bed they result in

floods. Sometimes, landslides block the roads and disrupt hill-life. Landslides occasionally kill the people living in downhill areas and destroy their dwellings. Toxic agricultural and industrial chemical that move downhill and downstream with the displaced soil tend to disturb the soil quality.

3. Flash floods. Vegetation in the hilly regions absorb a lot of rain water and keep the top soil intact. Barren hills or hills with sparse vegetation cannot absorb much rain water and thus can not keep the soil intact. So, heavy rains result in rapid movement of water in the areas resulting in flash floods in lower areas causing enormous loss to life and property.

4. Famines (excessive shortage of food). Continuous soil erosion from a region removes the fertile top soil leaving behind only infertile subsoil. Texture change in eroded soil, reduces its water holding capacity. Crops, thus, cannot grow in such infertile, dry soil leading to shortage of food grains in the region. Ultimately such a situation leads to famine in an area.

5. Silting of water reservoirs. Top soil, when washed down by water, clogs drains, water channels, etc., due to deposition. Silt pollutes the water. Problem of silting in water reservoirs lowers the water level in them which ultimately leads to shortage of production by the hydroelectric power stations.

Positive effects of soil erosion. Fertility may be enhanced when soils are washed down from hills into river valleys and deltas or are deposited on prairies by wind.

III. Prevention of soil erosion

1. Intensive cropping. If the fields remain covered with crops throughout the year, their top soil will not be exposed to winds or rains. In such a condition, no soil erosion will occur.

2. Sowing grasses and planting xerophytes. Soil should not be left uncovered. Sowing grasses on barren soil or planting of xerophytes will bind the loose soil. The roots of grasses and xerophytes hold the soil in place. Vegetative cover on the ground also helps in percolating water into deeper layers of soil.

3. Terrace farming (terracing). In terracing the slopes are divided into a number of flat fields to slow down the flow of water. In hilly regions, small crop fields are thus formed in the form of steps or terraces for cultivation of crops. Such terrace farms reduce the flow of rain water down the slopes of hills. Moreover, eroded soil from upper regions of hills gets deposited in lower terraces.

4. Contour bunding. Small bunds (embankments or dikes) are raised on the edges of fields to prevent loss of top soil through wind or water.

5. Conservation tillage. Instead of conventional tillage, reduced or no tillage can be practiced. It prevents soil erosion.

6. Wind breaks. Rows of trees and shrubs are planted at right angles to the prevailing wind flow, to check erosion of soil by the wind.

6. Proper drainage canals around the fields. This method involves the removal of excess rain water through small drainage canals formed around the fields.

7. Making strong embankments along the river banks. Formation of strong embankments of stones, sand bag, etc., on both sides of the rivers particularly in erosion prone areas, this will check soil erosion caused due to the fast moving river water.

Soil degradation due to extensive farming

Modern farming practices involve the use of large amounts of

fertilizers and pesticides. Use of these substances over long periods of times can destroy the soil structure by killing the soil microorganisms that recycle nutrients in the soil. It also kills the earthworms which are helpful in making the rich humus. Fertile soils can quickly become barren if sustainable practices are not followed. Removal of useful components (nutrients) from the soil and addition of other substances (fertilizers, pesticides, etc.) which adversely affect the fertility of soil and kills the diversity of organisms that live in it, is called **soil pollution**.

ACTIVITY 6.11

To demonstrate the role of plants in checking soil erosion

Take two identical trays A and B and fill them with soil. Plant mustard, green gram, barley or paddy seedlings in tray A and keep tray B as such (control). Water both the trays regularly for a few days. When growth of herbage becomes visible, tilt both the trays at an angle as shown in [Fig. 6.12](#). Make sure that the both trays are tilted at the same angle. Now, pour equal quantity of water gently on both the trays in such a way that the water flows out of the trays from other end. Study the amount of soil that has been carried out of the trays with water. Now, pour equal quantities of water on both the trays from a height. The water must be 3-4 times the amount that had been poured earlier. Study the amount of soil that is carried out of the trays with water.

You will observe that in the first set of experiment, more soil will be carried out of tray B than out of tray A. In second set of experiment, when more water is poured on the trays and that too from a height, the flowing with water further loosen the soil. More soil will be loosened in trays B without plants and will be

carried out water than from tray A having plants. It is so because in tray A roots of plant seedlings play important role in checking the soil erosion by binding the soil.

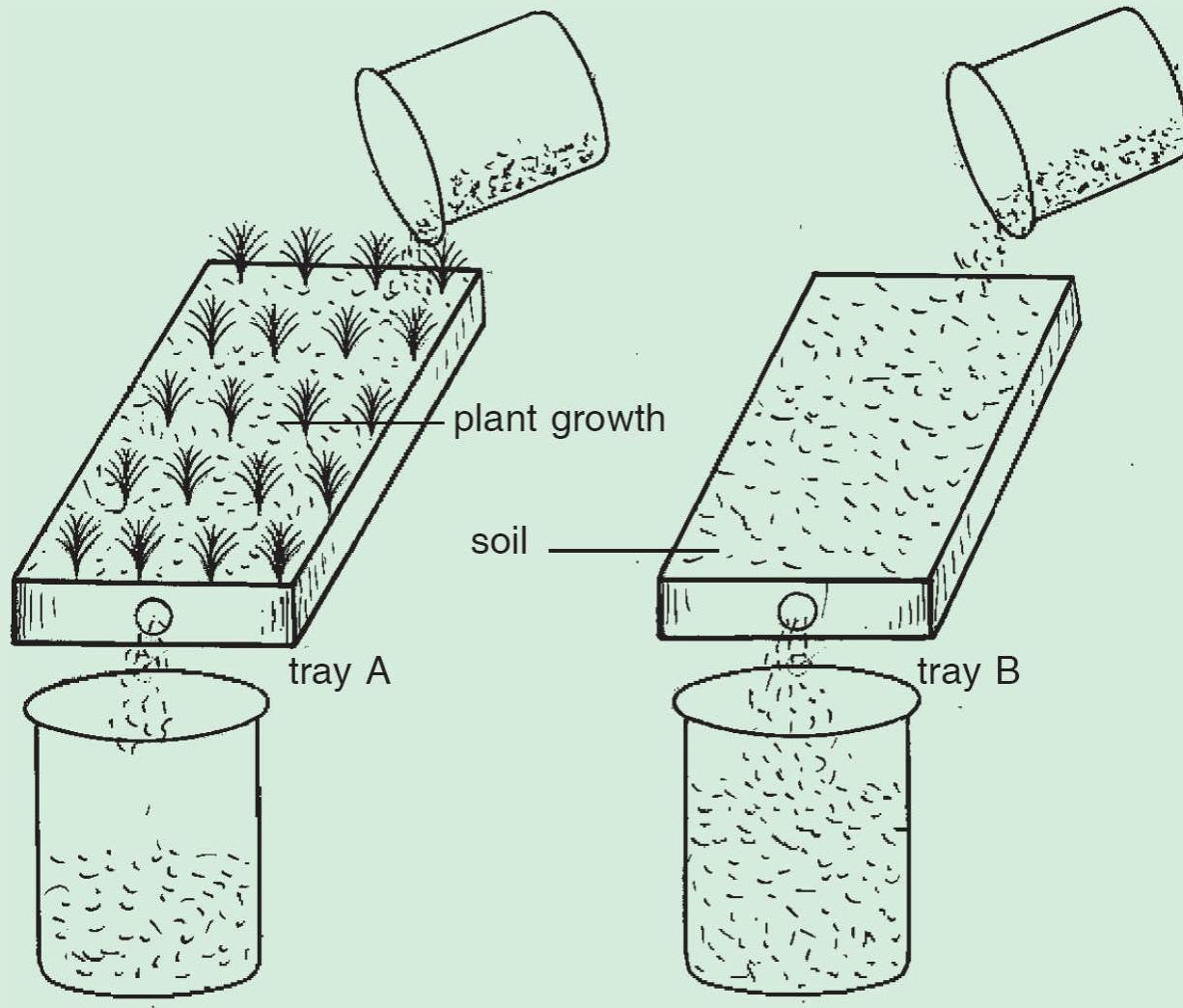


Figure 6.12. Role of plants in checking soil erosion.

Soil compaction, resulting from intensive cultivation with ever larger and heavier farm machinery, definitely reduces yields. About half of the irrigated lands of the world are damaged to some extent by **salinization** (salt accumulation) or **alkalinization** (alkali accumulation).

Soil pollution. Soil pollution is caused by solid wastes and chemicals. The slag heaps from mines spoil the beauty of sites of mines. Pulp and paper mills, sugar mills, oil refineries, power plants, chemicals and fertilizer manufacturing units, iron and steel plants, plastic and rubber producing complexes are some major contributions to soil erosion. Most industrial furnaces and thermal power stations produce **fly ash**, which is a grey, powdery residue of unburnt material, and causes pollution. This fly ash hampers the growth of crop plants and also decreases crops of orchards. Domestic waste also add a large amount of solid. They include food scraps, vegetable remains, packing materials, cans, rags, papers, cinders, ash, broken gadgets, (electronic wastes such as old computers) wood, metals, bones of dead animals, plastics, polythene bags, ceramics, glass, aluminium, rubber (vehicle tyres, tubes), leather (old shoes, belts, purses, suit cases, etc.), construction rubbish, bricks, sand and other junk. This solid waste has two types of pollutants : 1. Degradable and 2. Non-degradable.

(i) **Degradable pollutants** include domestic wastes and sewage that decompose easily.

(ii) **Non-degradable** pollutants which are not degraded and persist in the environment, e.g., plastics, inorganic metallic compounds, oxides, pesticides (DDT), radioactive substances.



Domestic waste.



Sewage.

Degradable pollutants.



Plastics.



Pesticides.

Non-degradable pollutants.

Most of the solid wastes are used in sanitary landfill, some of these are recycled and some is burned by incinerator.

6.5. BIOTIC RESOURCES

The biotic resources of environment include all living organisms including human beings. They may be *producers* of food (*e.g.*, green plants, autotrophic prokaryotes as cyanobacteria) or *consumers* (*e.g.*, animals, fungi, some bacteria, viruses). Microorganisms too have important roles to perform in the environment.



Plants.



Animals.

Biotic resources.

1. Plants

The green plants are the **producers** of food for all living beings. The leaves and other green parts of plants synthesize food (*e.g.*, carbohydrates as sugar and starch; fats and proteins) and release

oxygen. This metabolic activity is called **photosynthesis** and occurs in plant cells, especially in the chloroplasts. The process of photosynthesis needs sunlight and it manufactures food with the help of water absorbed from the soil and carbon dioxide from the atmosphere ([Box 6.6](#)). Beside the food items, green plants also supply us various other things such as timber, medicines, clothes, fuel and even materials for shelter. We already know that all living organisms require oxygen produced by plants during photosynthesis for their survival. Thus plants have great significance — “*they can survive without animals but animals cannot survive without the plants*”.

Box 6.6

Carbon dioxide normally is not regarded as a pollutant but it has two noxious effects : its abundance in air has a suffocating effect in humans and ecologically it results in global warming.

2. Animals

Animals form another important biotic component of the environment. They depend on the plants for their survival. Indeed animals hold a very intimate and unbreakable relationship with the plants.

6.6. BIOGEOCHEMICAL CYCLES

Both non-living (**abiotic**) and living (**biotic**) components of the biosphere constantly interact with each other to form a dynamic, and yet stable system. Such interactions include transfer of matter and energy between the different components of the biosphere.

As far as nutrients are concerned, all living organisms require

eight elements as nutrients in relatively larger amounts. These include carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium and calcium. The living organisms get the nutrient elements from lithosphere (mainly soil), hydrosphere and atmosphere.

The nutrient elements derived from the Earth by the living organisms, for their growth and metabolism are called **biogeochemicals**. These biogeochemicals are continuously recycled. The movement of nutrient elements through the living and non-living components of biosphere, is called **biogeochemical cycle of matter**. The term ‘biogeochemical cycle’ indicates that chemicals circulate through life (bio) and through Earth (geo) again and again (cycles). ‘Geo’ refers to rocks soil, air and water of the Earth.

The biogeochemical cycles are also known as **nutrient cycles**. Each nutrient cycle can also be divided into two compartments or **pools**: (1) **reservoir pool**, the large, slow-moving, generally non-biological component, and (2) **labile or cycling pool**, a smaller but more active portion, that is exchanged (moving back and forth) rapidly between organisms and their immediate environment. Many elements have multiple reservoir pools and some such as nitrogen have multiple labile pools.

From the viewpoint of the ecosphere as a whole, biogeochemical cycles fall into two basic groups:

1. Gaseous biogeochemical cycles, in which the reservoir is in the atmosphere or the hydrosphere (ocean). Gaseous biogeochemical cycles are quick and relatively perfect systems, as their elements remain in more or less uniform circulation. The four most abundant elements in the living systems – nitrogen, carbon, oxygen and hydrogen have chiefly gaseous biogeochemical cycles.

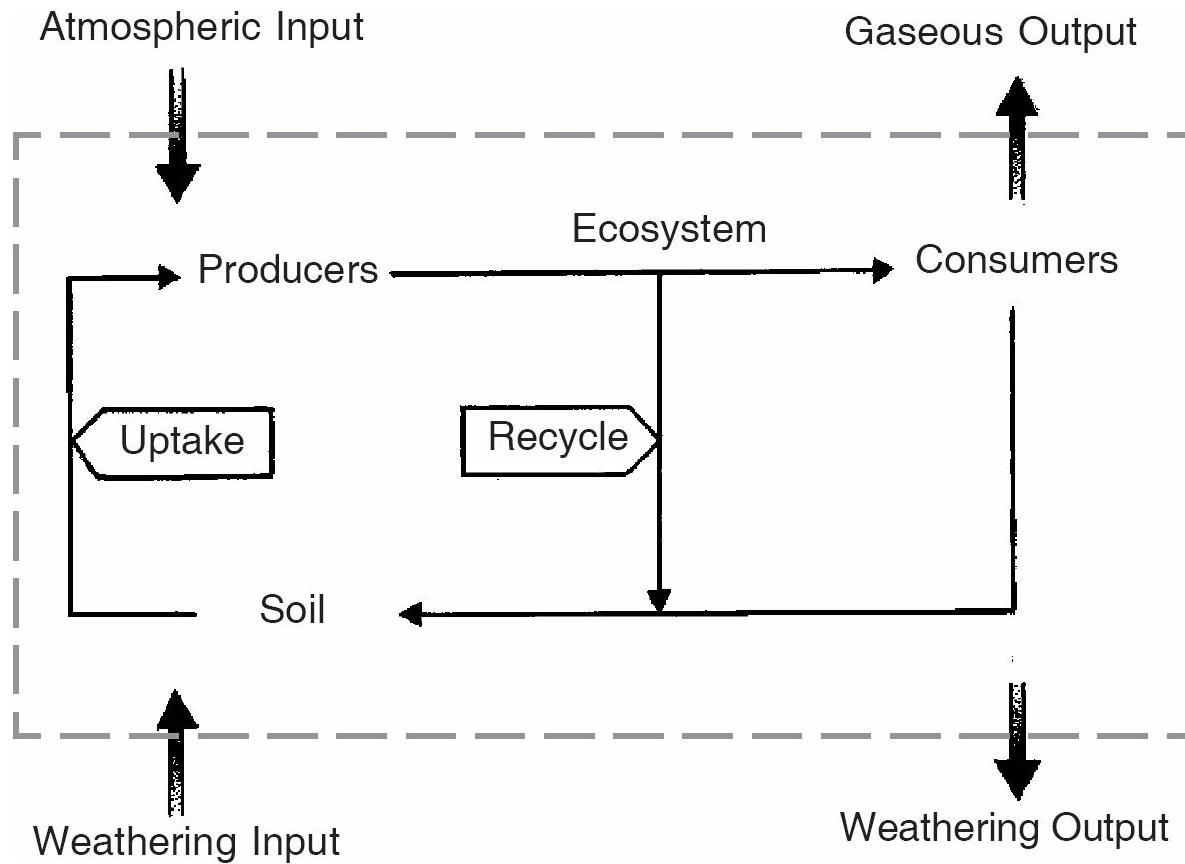


Figure 6.13. Generalised model of nutrient cycling in an ecosystem.

2. Sedimentary biogeochemical cycles are systems in which the reservoir is in the crust of the Earth. Sedimentary biogeochemical cycles are slow and less perfect systems as their elements may get locked in the reservoir pool and may go out of circulation for long periods. Phosphorus, sulphur, potassium and calcium have sedimentary biogeochemical cycles.

The dissipation of energy in some form is always necessary to drive material cycle.

Nutrient Cycling in Ecosystem

Nutrient cycling involves the following three aspects ([Fig. 6.13](#)):

1. Input of nutrients. An ecosystem receives the nutrients from

an external source. It stores them for further use through biological processes.

2. Output of nutrients. Nutrients also move out of an ecosystem and many of them become input to another ecosystem.

Box 6.7

1. Biosphere. That part of Earth environment in which living organisms are found.

2. Detritus. Dead or partially decomposed plant and animal matter (*i.e.*, non-living organic matter).

3. Ecosphere. All the living organisms of Earth interacting with the physical environment as a whole.

4. Actinomycetes. A kind of filamentous bacteria.

3. Internal nutrient cycling. Soil is a reservoir of nutrients. Nutrients are continuously regenerated and stored in soil in forms available to plants. Regeneration of nutrients is done by decomposers (*e.g.*, bacteria, fungi and actinomycetes, see [Box 6.7](#)) by the process of decomposition of detritus. These nutrients are stored in soil for reutilisation. Plants absorb large amounts of nutrients from the soil.

The process of nutrients regeneration and absorption occurs simultaneously due to which a **dynamic state** of nutrients in the soil is maintained.

The process of transfer and absorption of nutrients from the soil, through the plants is called **uptake**. During growth, these absorbed nutrients are metabolically incorporated in plants. Litter fall of vegetation, animal remains, faecal matter of animals

(forming **above ground detritus**) and dead plant roots (forming **below ground detritus**) are acted upon by decomposers to, bring back the nutrients to the soil (**regeneration of nutrients**).

When the uptake of nutrients is more than the amount of nutrients recycled (*e.g.*, in a young growing forest), a part of the uptake is retained in the standing crop. This **retention of nutrients** in the standing crop results in the increase in nutrient contents of the ecosystem. Therefore,

$$\text{Retention} = \text{Uptake} - \text{Recycle}$$

Rates of nutrient uptake, recycle and retention vary greatly in different ecosystems. The amount of different nutrients/weight of biomass or soil can be determined by a number of chemical methods. We can calculate the nutrient budget of ecosystem by determining changes in the nutrient concentrations and the biomass with time.

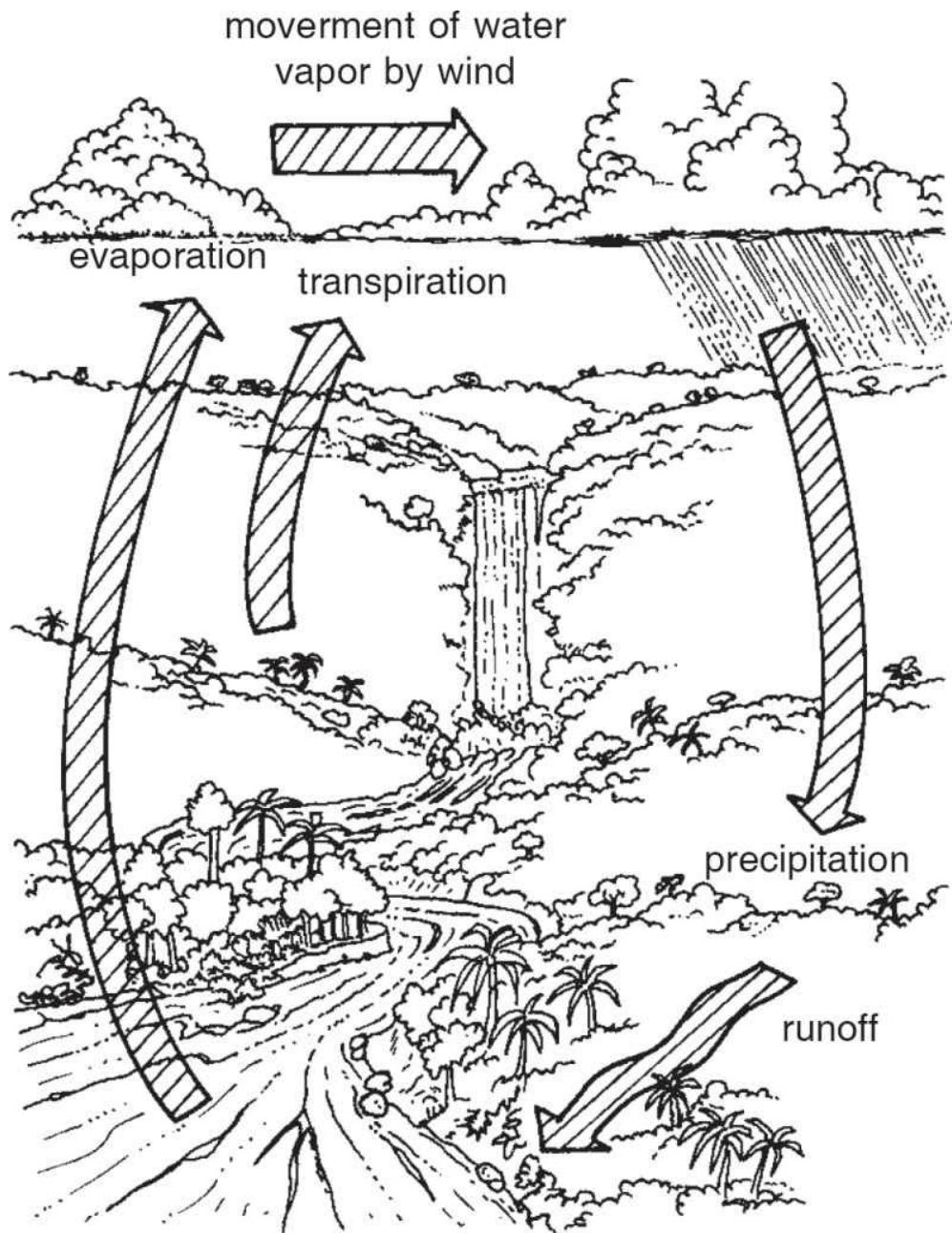
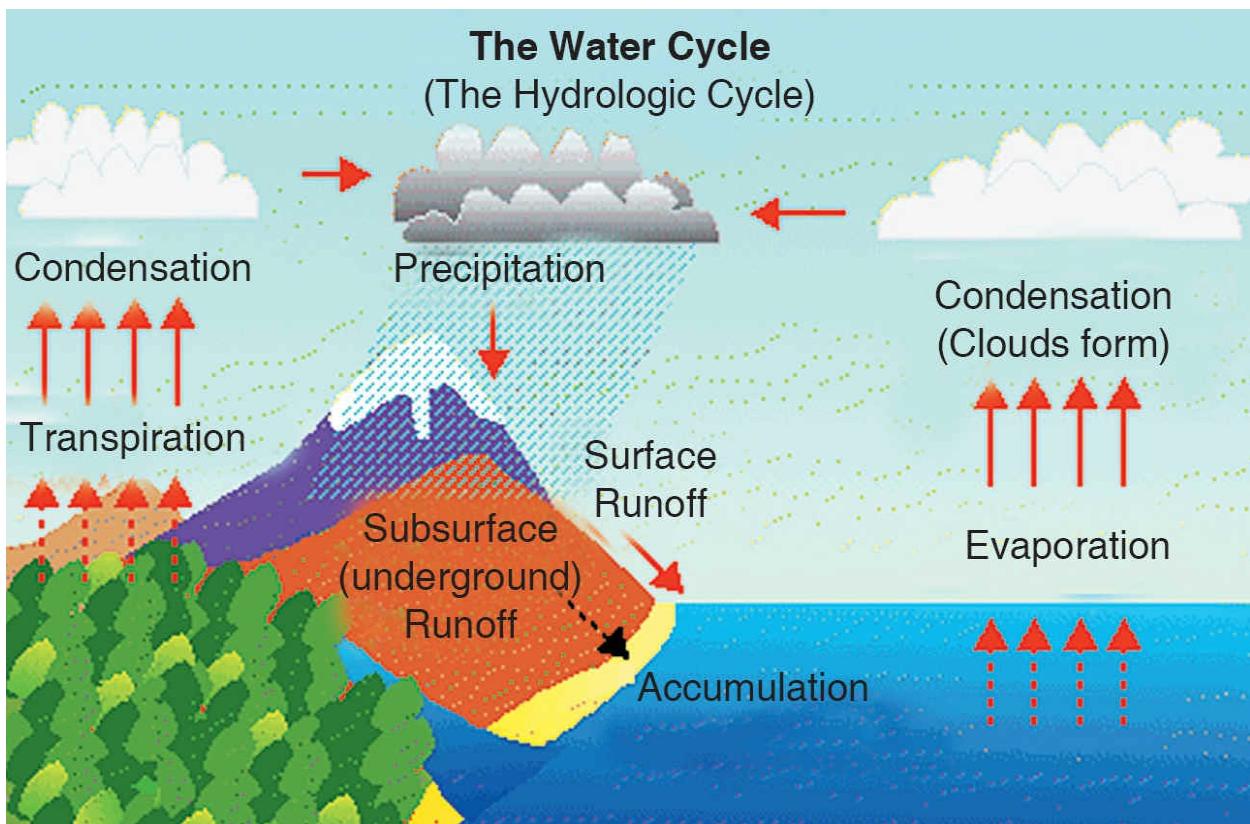


Figure 6.14. Water cycle in nature. A sun-driven global exchange involving evaporation, precipitation, runoff and transpiration to Earth's surface to plants and back again.

1. Water or Hydrological Cycle

Earth differs from other planets in this solar system as it has large amounts of water mostly in liquid form, which supports all life on Earth. There is constant exchange of water between the air,

land and sea and between the living organisms and their environments. Thus, there are two overlapping water cycles in nature: the larger **global water cycle** (Fig. 6.14) which does not involve living organisms, and the smaller **biological water cycle** (Fig. 6.15) that involves living systems.



Hydrological cycle.

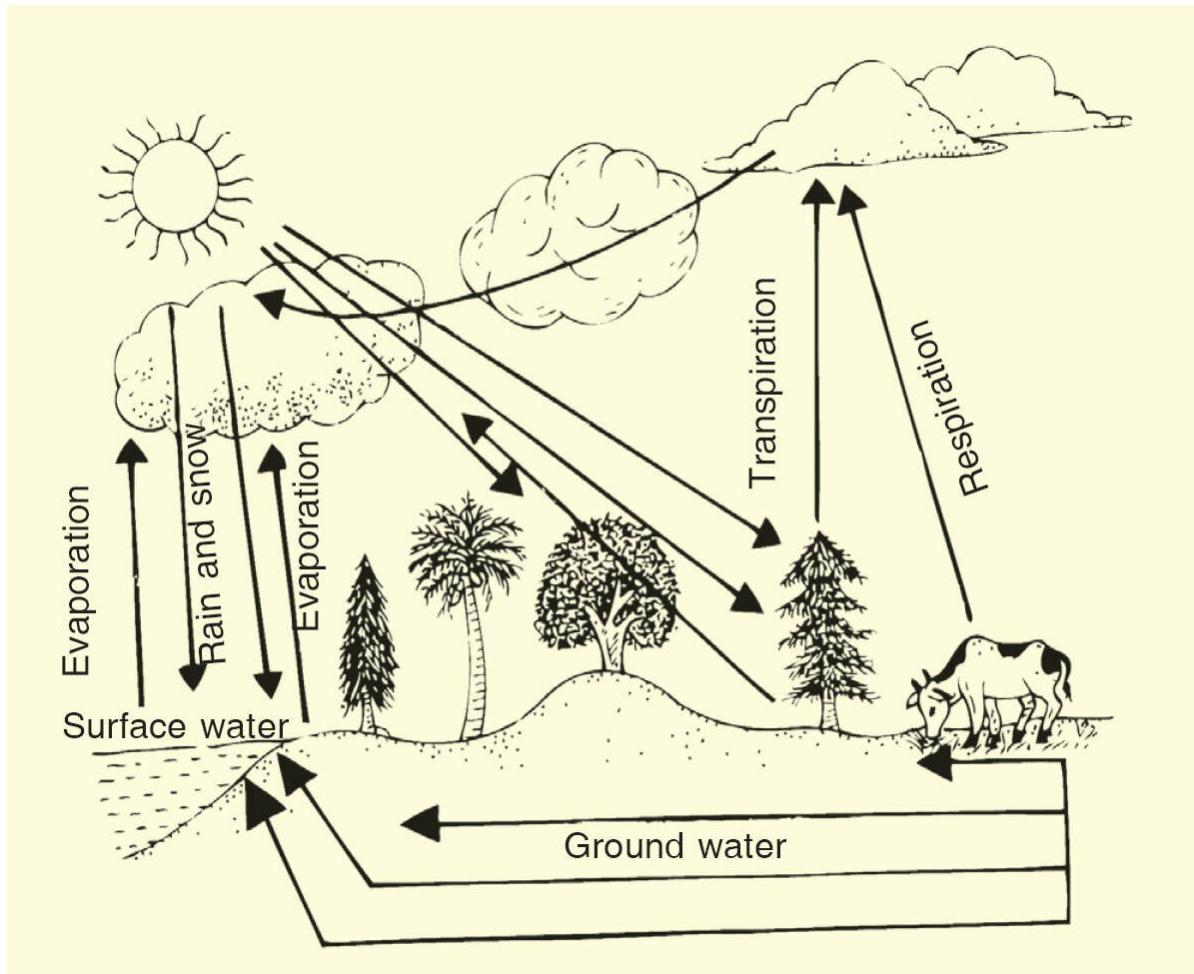


Figure 6.15. Water cycle.

(i) Global water cycle. Water evaporates from the hydrosphere (oceans, seas, rivers, streams, lakes, ponds, moist soil) under sun's heat and forms clouds. The wind blows the clouds over to the land, where after getting cooled enough, the water in clouds falls on Earth as rain, hail and sleet (called **precipitation**). Rain may fall directly into the oceans also. Some water from rain and melting snow, soaks into the ground, but most of it flows in rivers and returns directly to the seas. The ground water comes to surface again with the help of springs and pumps. It is used in agriculture, industry and homes. This water finally evaporates into the atmosphere. Water also evaporates from the snow, reservoirs and ground. Water vapours, added by evaporation to the atmosphere,

again form clouds. This completes the **global water cycle**. The energy to run this cycle, comes from the sunlight.

The ocean forms the **largest global reservoir** of water and atmosphere forms the **smallest global reservoir** of water ([Table 6.3](#)).

Table 6.3. Sizes of reservoirs of global water.

<i>Reservoir</i>	<i>Quantity (in teratons, i.e., 10^{18} g)</i>
1. Oceans	1,380, 000
2. Polar ice, glacier	29,000
3. Ground water (actively exchanged)	4,000
4. Freshwater lakes	125
5. Saline lakes	104
6. Soil moisture	67
7. Rivers	1.32
8. Atmosphere water vapour	14

Therefore, a rapid evaporation from land and sea is essential to replenish the atmosphere's water vapour. It should be noted here that the *second largest global reservoir* of water is polar ice (glacier) and *third largest global reservoir* of water is groundwater. Thus, a large amount of water is locked underground and as perennial snow in the polar regions and on mountain peaks. This is called **locked water**.

(ii) Biological water cycle. The organisms get water from and return it to the global water cycle. Plants absorb water from the soil or water reservoir and add it to the air in vapour form by a process called **transpiration**. Water transpired by trees cools the surrounding air, and plays an important role in determining the microclimate around them. Animals take water from the water reservoir or with food (plants or other animals or their products).

They return it to the air as vapours by **respiration** or to the soil as fluid by **excretion**. Mammals, also excrete water as sweat, which evaporates from their bodies. Water is also added to the environment by death and decay of organisms. Water vapour formed by transpiration and respiration form clouds and enter global water cycle. Rain adds water to soil and reservoir for reuse by plants and animals. This completes the water cycle.

Surface water of Earth represents the most extensive habitat for the organisms. A variety of animals and plants live in water. They possess special adaptations for the aquatic life.

Water is a universal solvent, so, is capable of dissolving large number of substances. As the water flows through or over the rocks containing soluble minerals, various soluble minerals get dissolved in it and get transported to distant places. Thus, many nutrients are carried by water from parent rock to river and then to the seas. Here, these minerals are used by the marine organisms.

Two aspects of water cycle need special emphases:

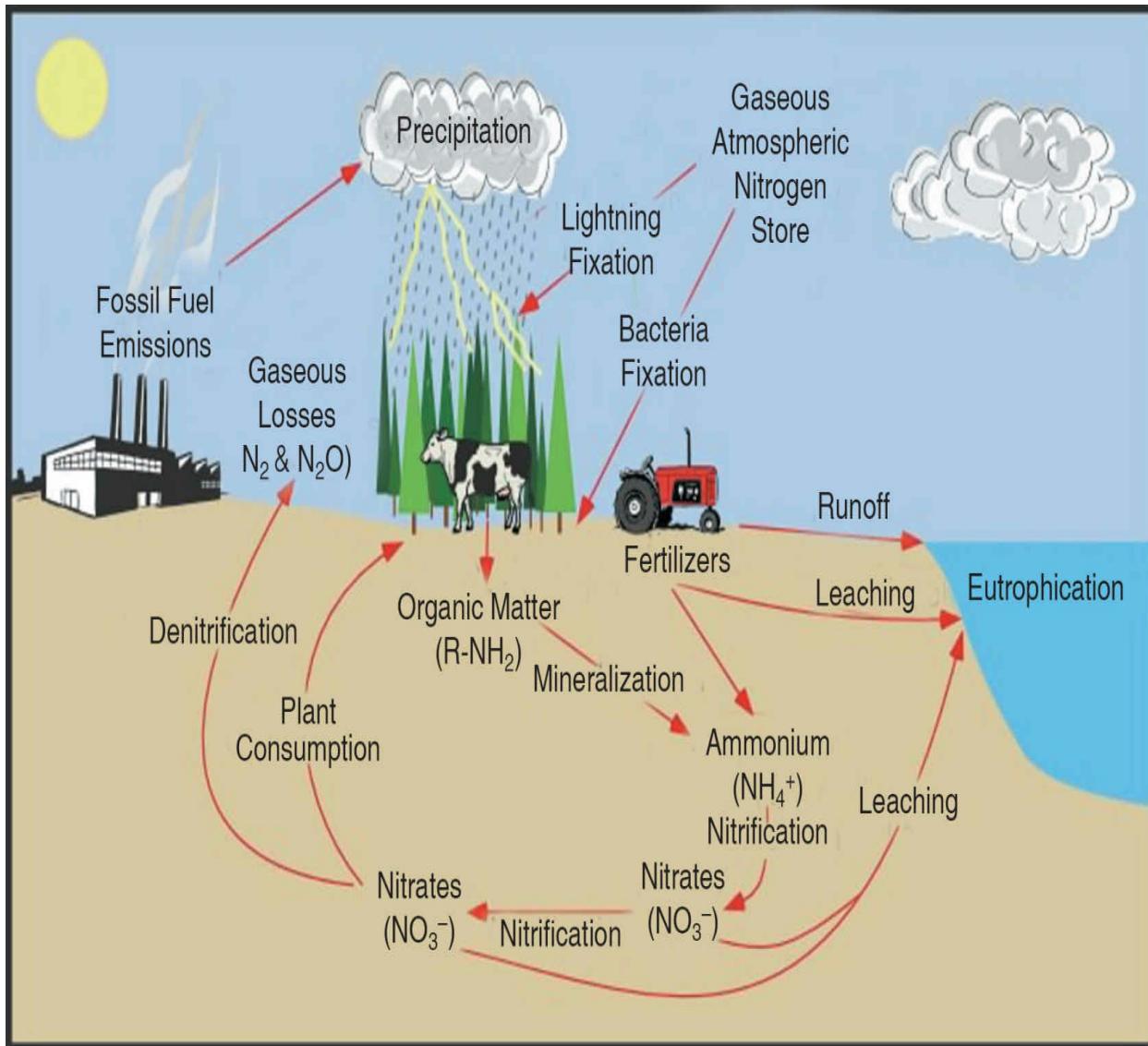
1. More water evaporates from the sea than returns to it by rainfall, and vice versa for the land. In other words, a considerable part of the rainfall that supports land ecosystems and food production comes from water evaporated over the sea.
2. Human activities tend to increase the rate of runoff. Practices such as paving over Earth, ditching and diking rivers, compacting agricultural soils and deforestation ([Box. 6.9](#)), all prevent the recharge of the very important groundwater compartment. Groundwater holds about 13 times more water than all the freshwater lakes, rivers and soils).

Box 6.8

The role of vegetation in promoting transpiration, evaporation and hence rain is especially evident in the tropical rain forests. When people cut down a rain forest in one area, rainwater drains off and eventually reaches the sea instead of evaporating. The ongoing massive destruction of the Earth's tropical rain forests is gradually changing the environmental conditions.

2. Nitrogen Cycle

Nitrogen is another important chemical on Earth and is present in all the living organisms, in the form of protein, amino acids and nucleic acids. It exists in the molecular form (N_2) and in the form of some oxides in the atmosphere. But aerial nitrogen, the most abundant component of air (i.e., 78 per cent) is chemically inert and cannot be used in its pure form by the majority of organisms. First it needs to be converted into **nitrates** (NO_3^-) for the use of plants. The conversion can be done either by **industrial nitrogen fixation** (i.e., manufacturing of ammonium salts and urea or chemical fertilizers) or by some nitrogen fixing bacteria such as *Azotobacter* (occurs freely in soil) and *Rhizobium* (occurs in root nodules of leguminous plants as pea, gram, bean, etc.) which convert the atmospheric nitrogen into water soluble **nitrates**. The process of biofixation of nitrogen is called **nitrogen fixation**. During lightning, nitrogen of atmosphere reacts with oxygen to form dilute nitric acid. This acid comes down to Earth with rainwater. Nitrates are absorbed by plants into their system and utilized for making organic matter (proteins), etc.



Nitrogen cycle.

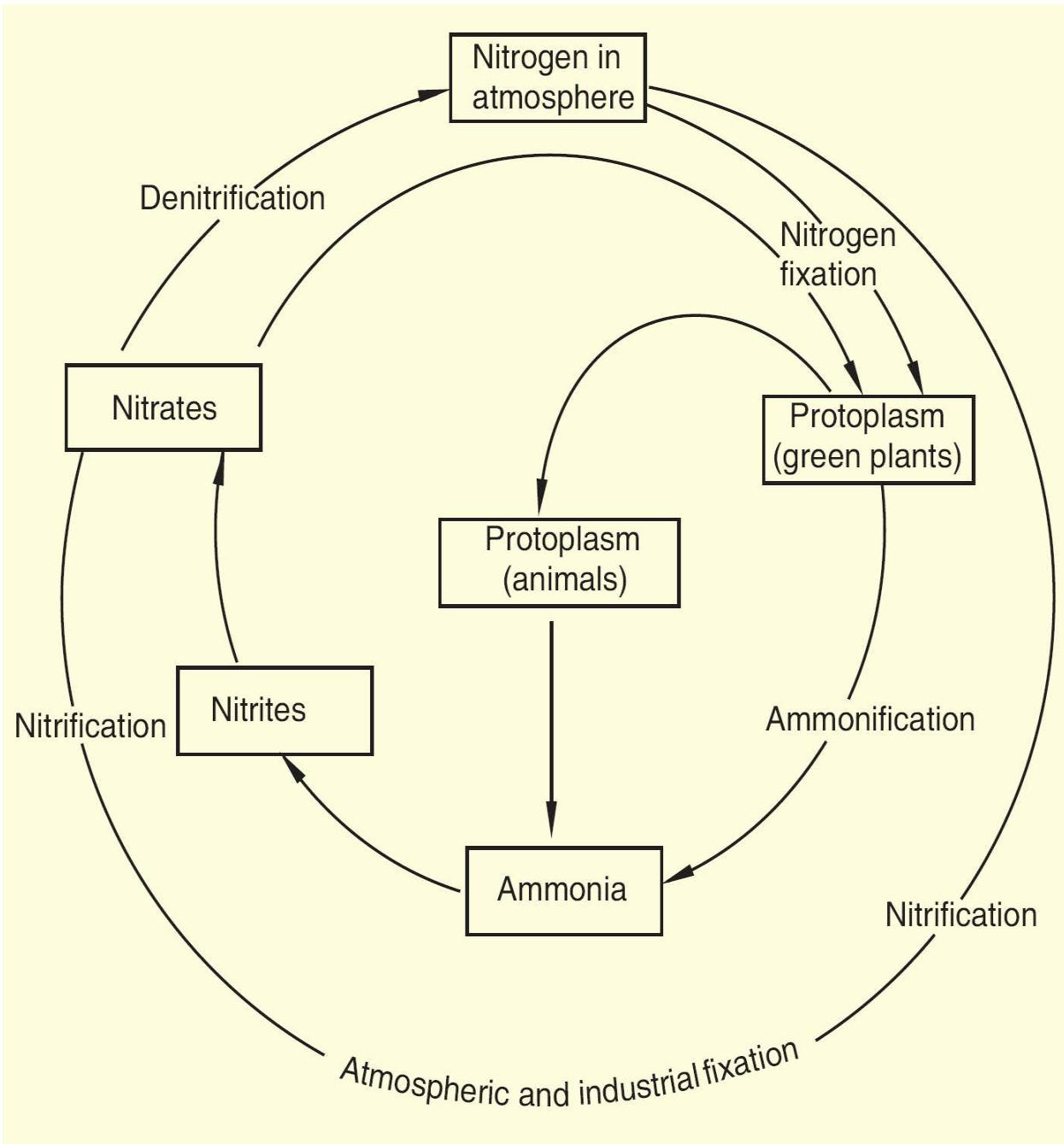


Figure 6.16. Nitrogen cycle



When animals consume plant matter, they break down the plant's nitrogenous compounds and use them to form new animal proteins and other cell components. After an animal excretes urea or uric acid or after an animal or plant dies, certain bacteria carry out ammonification : they produce ammonium ions (NH_4^+) from nitrogen-containing molecules. Plants can then assimilate this ammonium ion themselves or other bacteria can change it to nitrate (NO_3^-) by **nitrification**. Plants take in some of the nitrates produced in this way ([Fig. 6.17](#)).

The process of ammonia formation is called **ammonification** ([Table 6.4](#)). Some microorganisms (*Nitrosomonas*, *Nitrobacter*) convert ammonia into nitrates. The process is called **nitrification**. There are some other bacteria (decomposers, e.g., *Pseudomonas*) which reduce nitrates back to nitrogen or to ammonia or to some other oxides. This process is called **denitrification**. Free nitrogen returns to the atmospheric pool and oxides are taken up by plants.

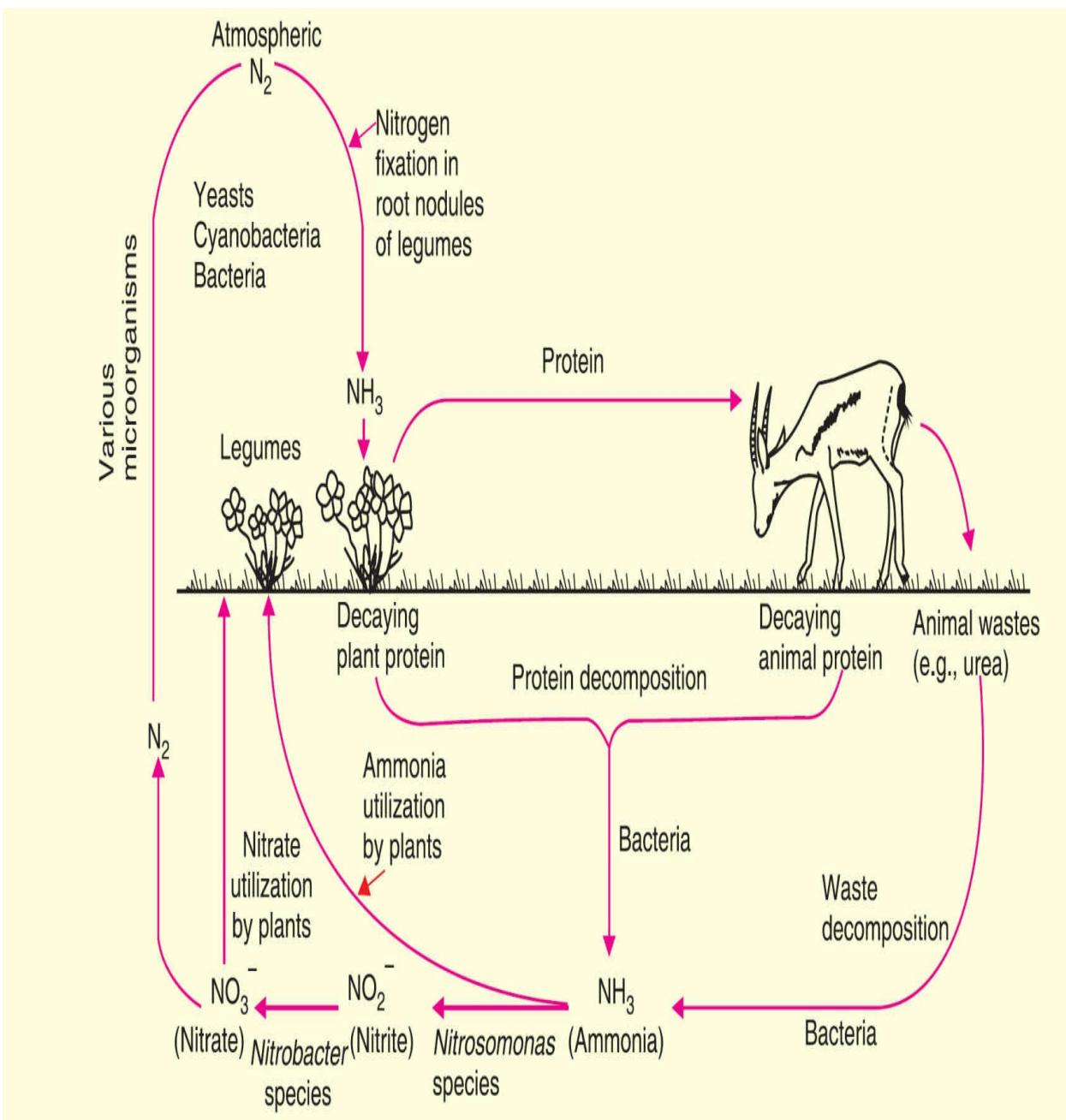


Figure 6.17. The nitrogen cycle. The amount of nitrogen in the atmosphere is maintained by a balance between the processes that withdraw nitrogen from it (nitrogen fixation) and those which add nitrogen to it (denitrification).

Table 6.4. Organisms involved in nitrogen fixation.

Name of microorganism	Role played in nitrogen cycle
1. (a) <i>Rhizobium</i> bacteria (in root-nodules) :	→ Nitrogen fixation
(b) <i>Azotobacter</i> bacteria in soil :	→ Nitrogen fixation (Conversion of atmospheric nitrogen gas into nitrogen compounds)
(c) Blue-green algae:	→ Nitrogen fixation
2. (a) Putrefying bacteria:	→ Ammonification
(b) Fungi:	→ Ammonification (Conversion of nitrogen containing proteins of dead plants and animals into ammonia)
3. Nitrifying bacteria:	→ Nitrification (Conversion of ammonia into nitrites and then into nitrates)
(a) <i>Nitrosomonas</i> bacteria:	→ Convert ammonia into nitrites (NO_2^-)
(b) <i>Nitrobacter</i> bacteria:	→ Convert nitrites into nitrates (NO_3^-)
4. Denitrifying bacteria: (called <i>Pseudomonas</i>)	→ Denitrification (Conversion of nitrate salts into free nitrogen gas)

Nitrogen cycle is called a **perfect cycle** in the biosphere because it maintains the over all amount of nitrogen constant in atmosphere, soil and water ([Box 6.9](#)).

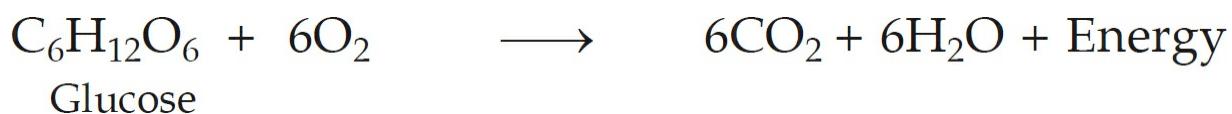
Box 6.9.

1. Nitrogen cycle depends upon at least four different kinds of bacteria known as the decay causes, the nitrifiers, the denitrifiers and the nitrogen fixers and there is a regular circulation of nitrogen through the air, soil, plants and animals.

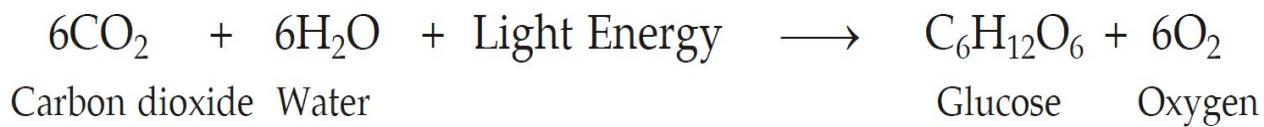
2. The reduction of atmospheric nitrogen (N_2) to the ammonium ions (NH_4^+) is called **nitrogen fixation**. The key to biofixation is the enzyme **nitrogenase** which catalyzes the splitting of N_2 .
3. Nitrogen fixing bacterium of root nodules, *Rhizobium leguminosarum*, is an aerobic bacterium which needs some oxygen for its survival. To help it in this way, root nodules of leguminous plants have a haemoglobin-like protein called **leg haemoglobin**.
4. 16 molecules of ATP are needed by the bacterium for each molecule of nitrogen that is fixed.
5. In the soil microorganism *Klebsiella pneumoniae* a total of 17 genes, called **nif genes** are known to be responsible in nitrogen fixation.
6. Researches in biotechnology are now attempting transfer of '*nif*' genes from prokaryotes to crop plants so that yield of crops such as rice and wheat may be increased.

3. Oxygen Cycle

Oxygen is one of the constituents of water and form about 21 per cent of the air in the atmosphere. It is required for respiration by all the living organisms. Oxygen enters the living world through respiration; it oxidises the food materials and produces energy and carbon dioxide :



The carbon dioxide (CO_2) is utilised by the plants to produce food materials during the process of photosynthesis.



The consequent free oxygen may now be used again in respiration or it may return to environment as molecular oxygen of atmosphere thus, completing the biogeochemical cycle ([Fig. 6.18](#) and [Fig. 6.19](#)).

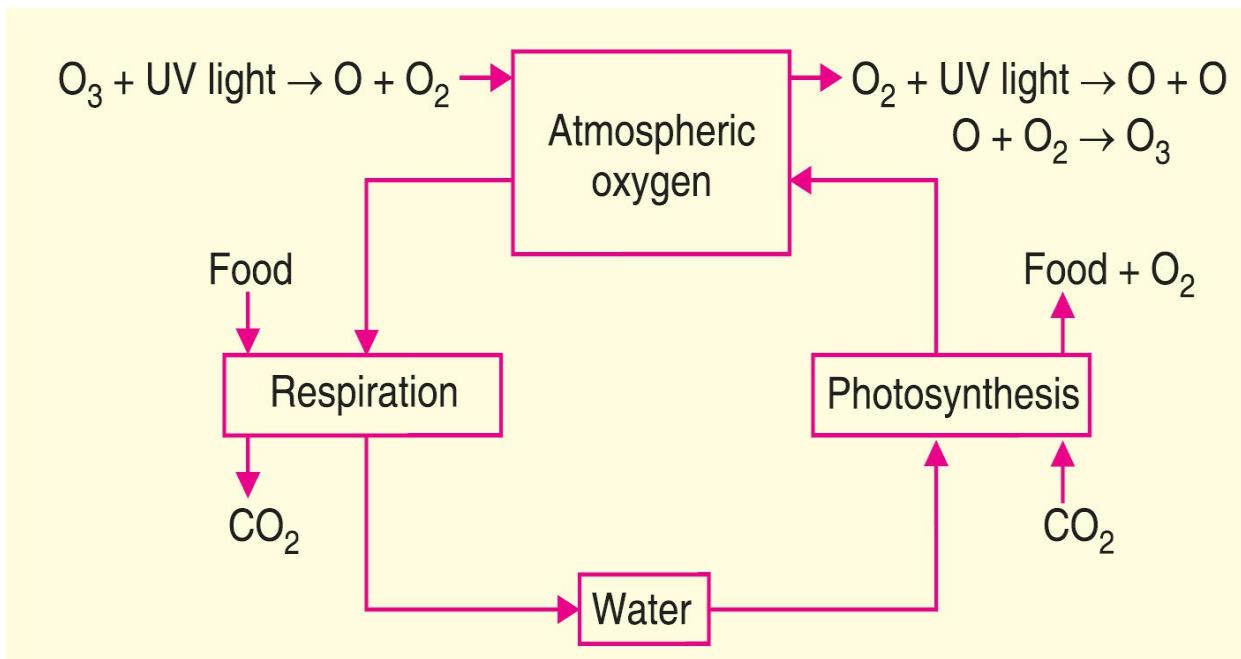


Figure 6.18. The oxygen cycle. As the oxygen concentration in the atmosphere remains constant at 21 percent it is likely that natural degradation of ozone must occur to maintain the ozone : oxygen equilibrium.

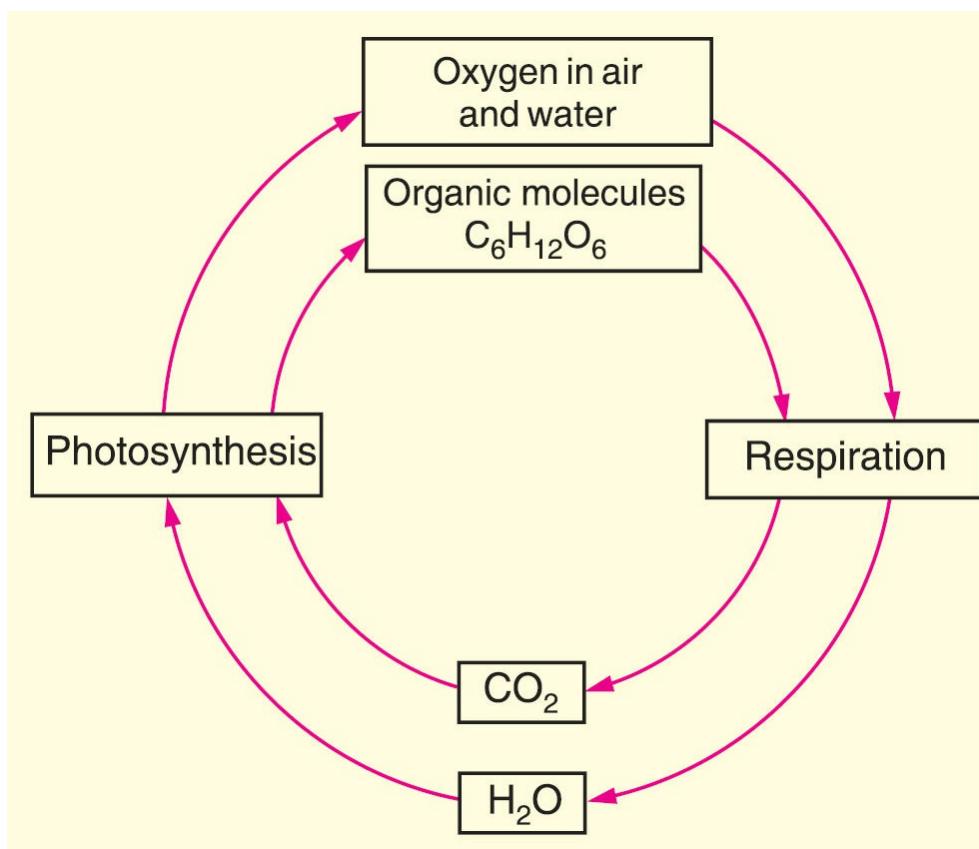


Figure 6.19. Oxygen cycle.

The concentration of oxygen in the air and water is maintained by equal rates of its use in respiration and release in photosynthesis. Oxygen is also released as a part of CO₂ by decomposition of dead organic matter. Some oxygen is added to the air as CO₂, H₂O, sulphur dioxide (SO₂) and nitrogen oxides during burning of fuels (wood, coal, petroleum and natural gas). Some oxides (e.g., nitrate and nitrites) are formed by microbial oxidation process. These oxides release O₂ when reduced by chemical and biological process. Oxygen is temporarily withdrawn from the circulation, when it combines with soil minerals to form their oxides (e.g., when oxygen combines with iron it forms ferric oxide). Some part of the atmospheric oxygen that reacts at the higher levels of the atmosphere is reduced to ozone (O₃) by high

energy ultraviolet (UV) radiation. The ozone layer forms the protective **ozone shield** of the atmosphere.

The ozone layer protects organisms by preventing most of the ultraviolet and X-ray from reaching the Earth's surface. The most recent factor affecting the oxygen cycle of the biosphere and the oxygen budget of the earth is the human being himself, *i.e.*, burning fossil fuels.

4. Carbon Cycle

The carbon is an important constituent of organic compounds found in all living beings in the form of carbohydrates, fats, proteins and nucleic acids. Like the water cycle, the carbon cycle is linked to energy flow because producers — including photosynthetic plants of the forests and oceans and chemosynthetic bacteria of deep-sea vents — require environmental energy (either sunlight or inorganic hydrogen compounds) to trap carbon into sugars (proteins and fats). The trapped carbon comes from carbon dioxide in the surrounding air or water ([Fig. 6.20](#)).

As the cycle proceeds, consumers devour the organic carbon compounds that producers manufacture. Then, via respiration, both consumers and producers return carbon to the nonliving environment in the form of carbon dioxide. Some carbon accumulates for many years in wood and is eventually returned to the atmosphere by fires or through consumption and respiration by fungi, bacteria and other detritivores. Volcanic eruption also releases carbon dioxide to the atmosphere. Thus, there is complete cycling of carbon in the environment by various living and non-living beings.

The carbon sinks. Some of the cycling materials in the physical environment may pass into a **reservoir** or **sink**, and

become unavailable to organisms for eons. For example, there are at least *three* reservoirs for the carbon : (1) some carbon passes from organisms into deposits of peat, coal and oil. There it waits, perhaps millions of years before combustion, either natural or human induced, releases it back into the atmosphere. 2. Some carbon gets incorporated into carbonate rocks, where it is unavailable to organisms for million of years until erosion releases it. 3. The oceans also acts as carbon sinks. Carbon present in ocean water sinks and stays deep in the ocean until chance currents bring it back near the surface where it can reenter the carbon cycle.

In addition to CO_2 , two other forms of carbon are present in the atmosphere in small amounts: carbon monoxide (CO) and methane (CH_4). Both arise from the incomplete or anaerobic decomposition of organic matter; are oxidized to CO_2 in the industry.

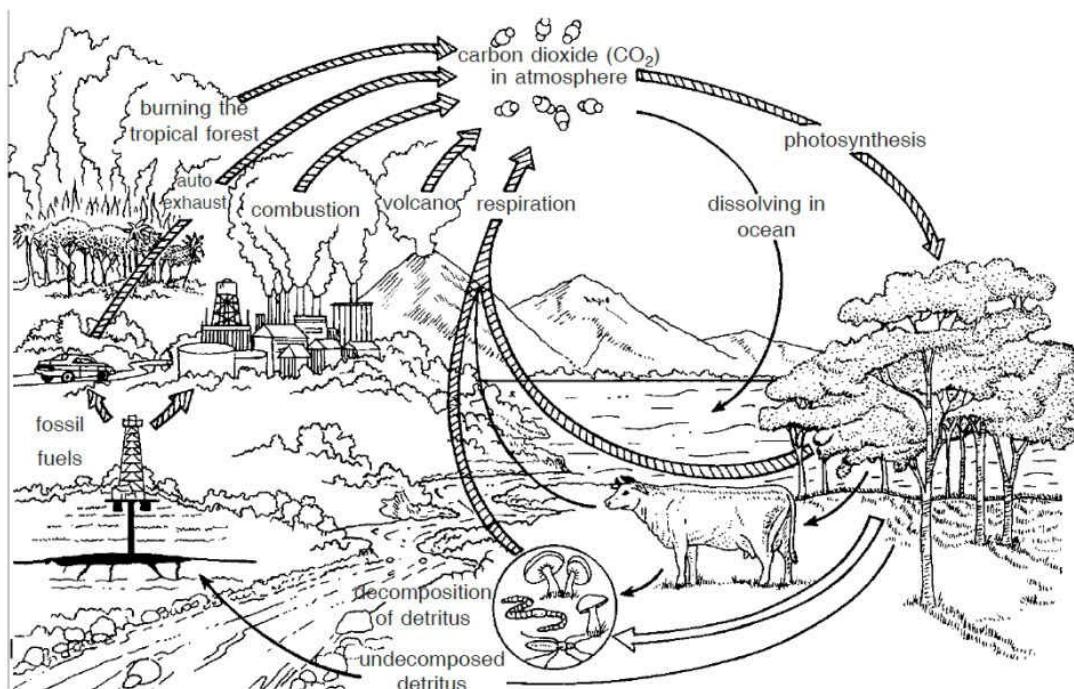


Figure 6.20. The carbon cycle. Carbon tends to cycle from atmosphere to Plants, Animals, Detritivores, Decomposers, Human activities (car, chimney of factory, etc.) and Back. Carbon cycles from atmospheric carbon dioxide to

biological molecules to organic molecules in the soil to geologic deposits of fossil fuels and back to carbon dioxide. Disruption to this cycle can lead to increased atmospheric carbon dioxide and to global warming.

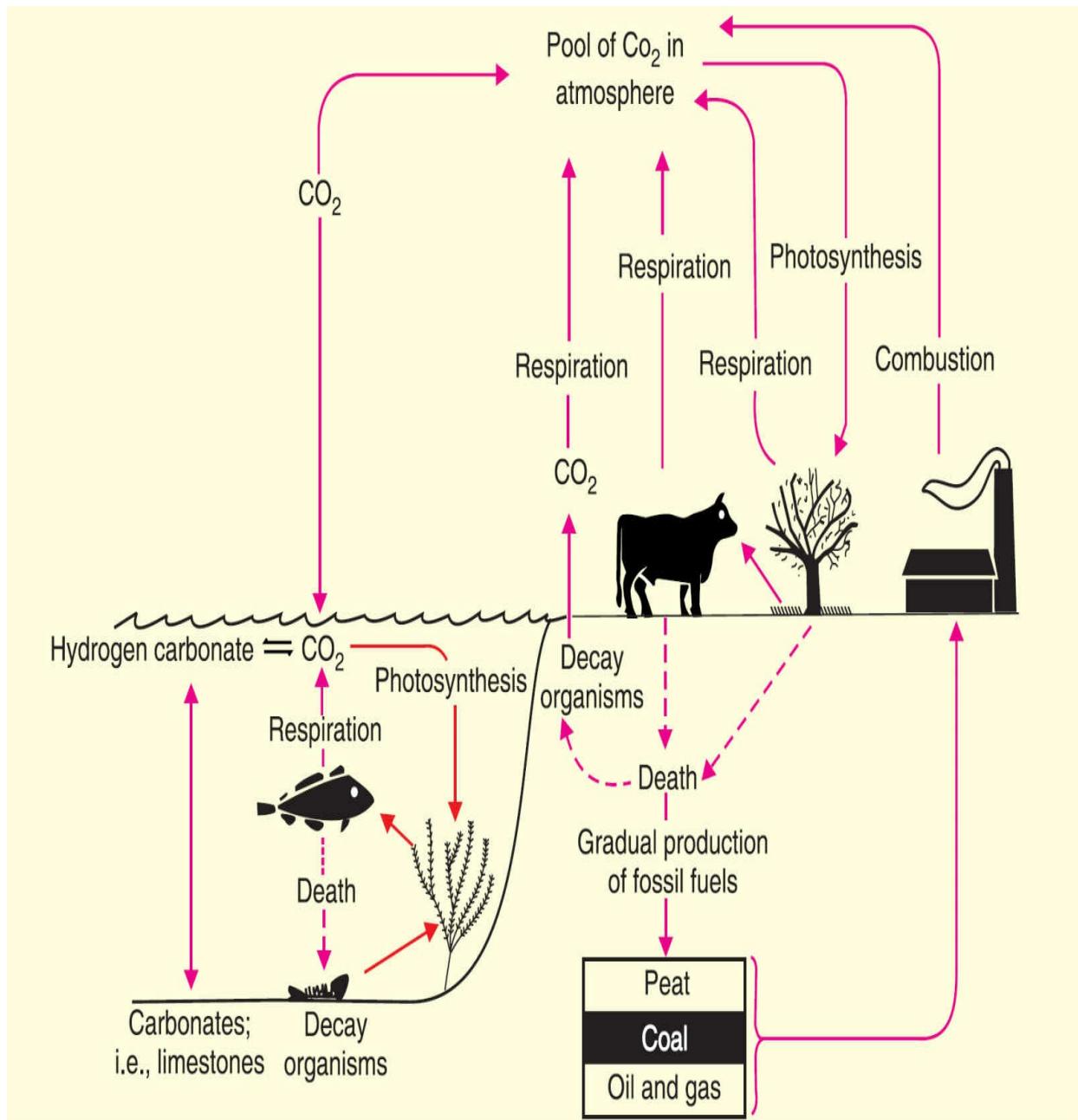


Figure 6.21. Carbon cycle.

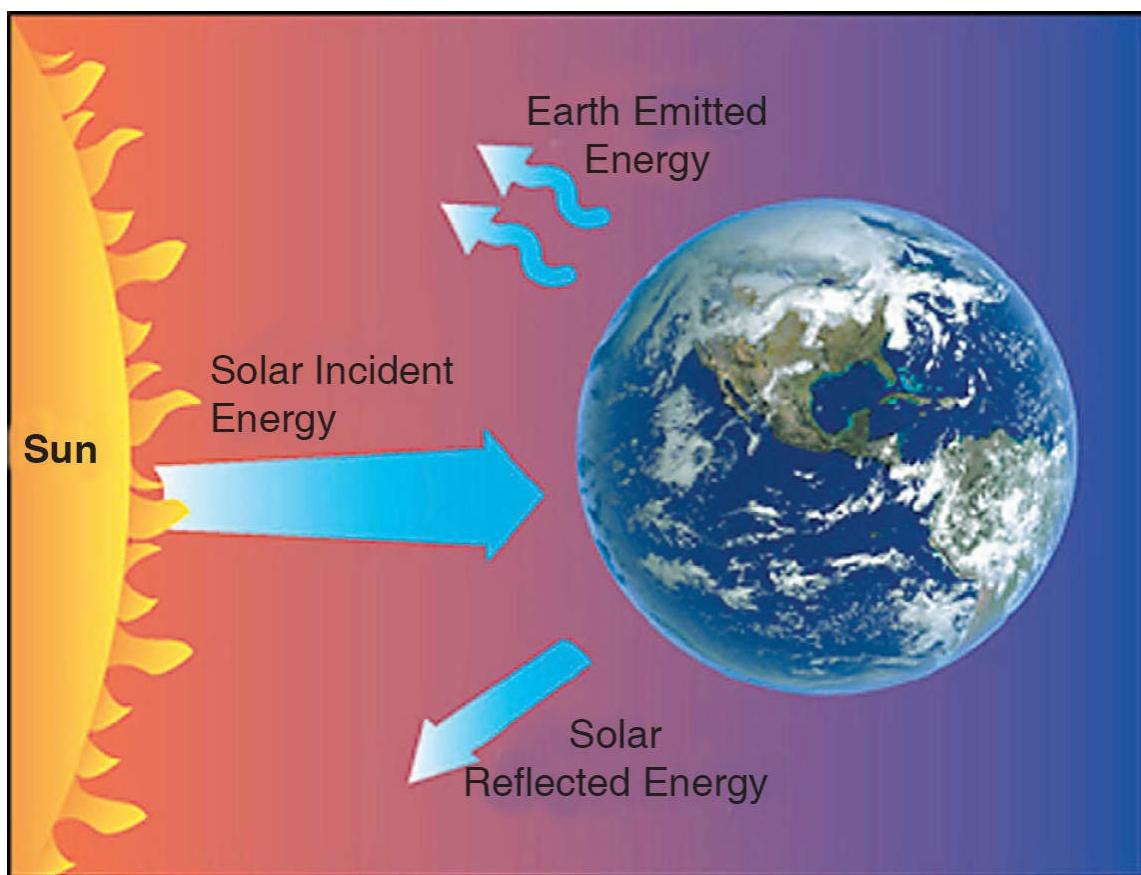


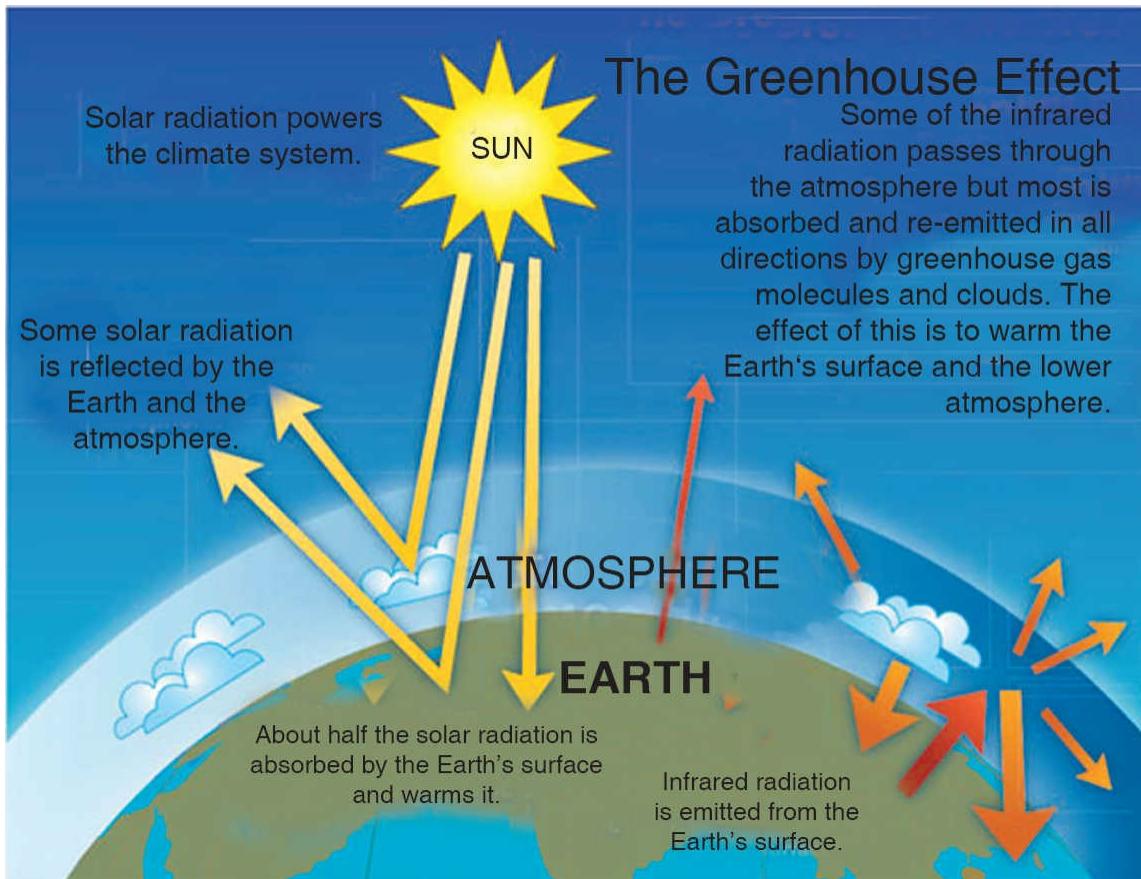
Carbon monoxide. An amount of carbon monoxide (CO) equal to that formed by natural decomposition is injected into the air by the incomplete burning of fossil fuels, especially in automobile exhaust. Carbon monoxide is a deadly poison to humans. It does not pose a global threat, but has become a worrisome pollutant in urban areas.

Methane. Methane (CH_4) is a colourless, flammable gas that is produced naturally by the decomposition of organic matter by anaerobic bacteria, especially in freshwater wetlands, rice paddies and digestive tracts of ruminants (such as cattle) and termites. It is also a major component of natural gas, so the geochemical disturbances associated with mining and drilling for fossil fuels result in the release of methane. Methane has the potential of increasing its contribution to global warming.

Global Warming (Greenhouse effect)

A building mostly made of glass for growing or sheltering the delicate plants is called a **greenhouse**. The glass walls of greenhouse allow sun rays to pass through to the interior. However, reflected back infra red rays are not allowed to escape through the glass walls. Carbon dioxide gas and water vapours present inside the glasshouse further trap the heat and make the green house warmer than the outside air.





The atmosphere cover around the Earth, acts similar to the glass walls of a greenhouse. The air cover allows solar radiations to pass through it to the Earth's surface, but prevents the long wave infrared radiation (which is reflected back from Earth) to escape into the space. Gases such as carbon dioxide (CO_2), methane (CH_4), ozone (O_3), nitrogen oxide (N_2O) and chlorofluorocarbons (CFCs) are called **greenhouse gases (GHGS)**. Among them CO_2 is the most important green house gas. Burning of fossil fuels in homes, industries, automobiles, burning associated with agricultural practices, deforestation, etc., all such practices are increasing levels of CO_2 and CH_4 in atmosphere. These greenhouse gases (mainly carbon dioxide and methane) trap the heat (infrared radiation) reflected by the Earth. This heating up of

the atmosphere leads to an increase in Earth's temperature. This phenomenon is called **global warming** or **greenhouse effect**. These gases are radiatively active, *i.e.*, they allow the solar radiations to pass through them but reflect back the long wave radiations ([Fig. 6.22](#)).

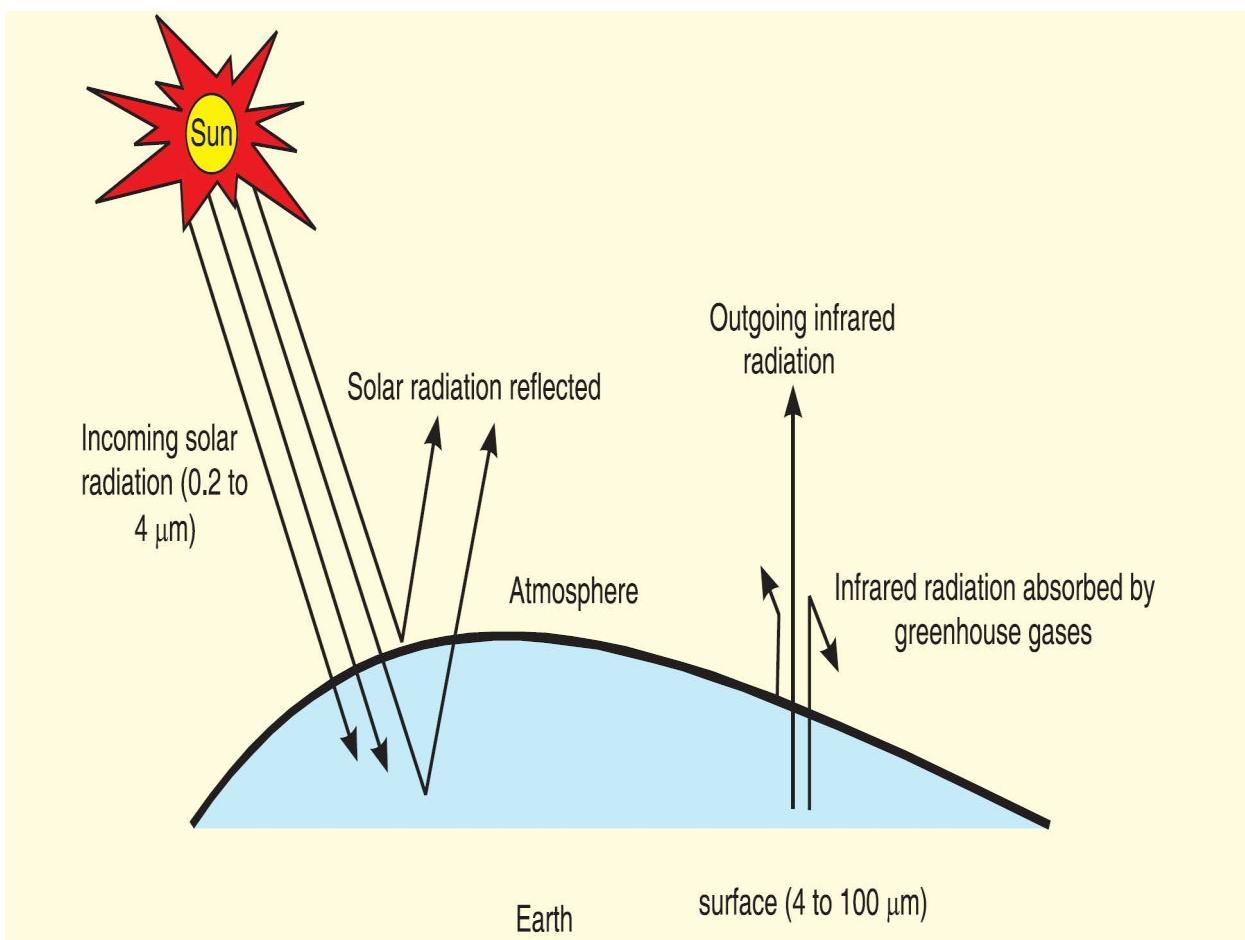


Figure 6.22. Green house effect.

Effect of Global Warming

(i) An increase of as less as 1°C in Earth's temperature can lead to melting of polar ice caps and consequent rise in sea level. A rise in sea level can submerge a number of major cities of the world, which are located along the sea coasts. Besides causing the floods in low-lying coastal cities, global warming poses a threat of recurrence of dust bowl condition of 1930's ([Box 6.10](#)). Dust bowl is an area where vegetation has been lost and soil reduced to dust making it susceptible to erosion.

Box 6.10

Increased global temperature might change fertile crop lands into deserts. In 1930, dust bowl occurred in USA, when *prolonged drought, overplanting and agricultural mismanagement* allowed soil layers to dry out and top soil to blow away driving people from their land.

The dust bowl conditions of the 1930's could befall the great grain-producing regions of the American Midwest, Canada and the Soviet Union. Irrigation would probably not correct the situation, because ground water reserves would quickly become depleted.

(ii) Increase in temperature of the Earth due to green house effect will cause a change in weather and precipitation patterns on the Earth.

(iii) One of the danger of continued global warming is "**methane burp**" which is caused by the melting of the **methane hydrates** in permafrost (of polar ice) and on the sea floor. Methane being a green house gas increases global warming.

Biological Control of the Geochemical Environment

Air is a mixture of many gases such as nitrogen, oxygen, carbon dioxide and water vapour. It is interesting to note that even the composition of air is the result of life on Earth. This is called **Gaia hypothesis** ([Box 6.11](#)). In planets such as Venus and Mars, where no life is known to exist the major component of atmosphere is found to be carbon dioxide ([Fig 6.23](#)).

Box 6.11

Gaia Hypothesis

Gaia hypothesis holds that organisms, especially microorganisms, have evolved with the physical environment to provide an intricate self-regulatory control system that keeps conditions favourable for life on Earth (**Lovelock 1979**).

The atmosphere of Venus traps heat and creates a maximum surface temperature of 48°C, making Venus the hottest planet in our solar system. In contrast, Mars is a cold planet. Highest temperature of Mars is 10°C and lowest –100°C. It has polar caps of frozen CO₂ and ice.

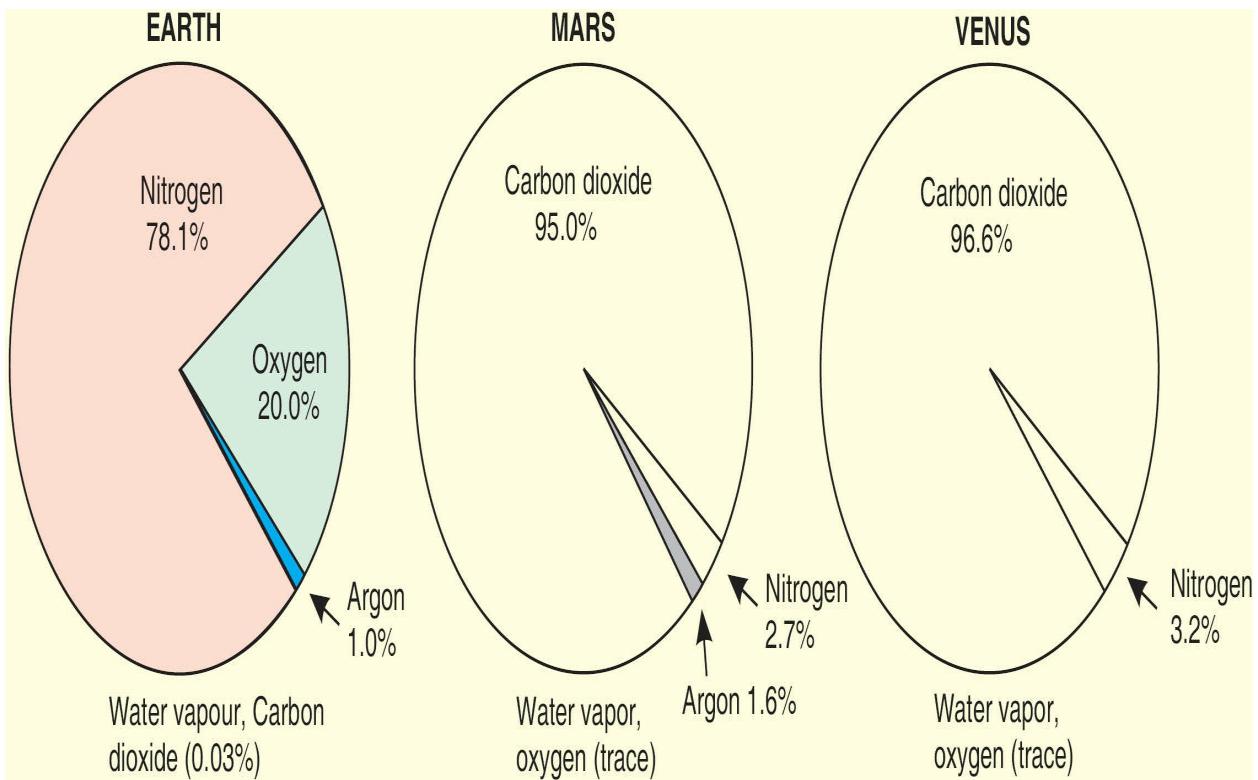


Figure 6.23. Comparison of the major components of the atmosphere on the planet Earth, Mars and Venus. The percentage represent numbers of molecules (moles), not relative weights. Elements without percentage values are present in trace amounts.

SUMMARY

- Life supporting zone of the Earth, where the atmosphere, the hydrosphere and the lithosphere interact and make life possible is called biosphere.
- The environment is the sum total of all the components both from living and non-living ones.
- The living or biotic components include plants, animals, fungi, and microorganisms (bacteria, virus, and unicellular eukaryotes).
- Non-living, physical or abiotic components comprise of air, water, soil, light and temperature.
- Air contains about 78% nitrogen, 21% oxygen and 1% other gases such as carbon dioxide, helium, argon, water vapours, etc.
- Moving air is called wind.

- Carbon dioxide in the atmosphere helps the process of photosynthesis by plants and is responsible for greenhouse effect (= Global warming).
- Ozone layer protects us from the harmful ultraviolet light of the sun.
- Water is an inexhaustible natural resource. It is very important for human, animal and plant life.
- Removal of top layer of soil by wind or rainfall is called soil erosion.
- Chlorofluorocarbons (CFCs) have resulted in a hole in ozone layer due to which sun's UV rays are creating havoc in the humankind and biota.
- All components of the environment are intimately interrelated and interdependent on each other which lead to a balanced environment.
- The chemicals (nutrients) such as water, oxygen, carbon and nitrogen move from one stage to another, *i.e.*, from biotic to abiotic and again to biotic components in a cyclic manner to form the so called biogeochemical cycles.

FORMATIVE ASSESSMENT

CLASS ASSIGNMENT

I. True or False Questions

1. Biosphere forms living mantle of Earth.
2. Ozonosphere is located in troposphere of atmosphere.
3. Clouds are formed in stratosphere of atmosphere.
4. Soil is topmost layer of crust of Earth.
5. 75% of Earth's surface is covered with water.
6. Combustion consumes oxygen and releases carbon dioxide.
7. Winds develop due to uneven heating of Earth.
8. Carbon monoxide and carbon dioxide of air produce acid rain.
9. Chlorine-containing substances are not ODS.
10. The amount of rainfall directly influences the abundance and diversity of life forms.

11. Soil has no role in supplying nutrients to aquatic biota.
12. Gaia hypothesis was proposed by James Lovelock.
13. Fertilizers and pesticides are harmful to soil as they kill the microorganisms involved in recycling of nutrients.
14. Methane is a GHG enhancing global warming.
15. *Rhizobium leguminosarum* is a nitrogen fixing bacteria which occurs in the soil.

ANSWERS

1. True;
2. False;
3. False;
4. True;
5. True;
6. True;
7. True;
8. False;
9. False;
10. True;
11. False;
12. True;
13. True;
14. True
15. False

II. Fill in the Blanks

1. Atmosphere of Mars is rich in
2. Atmosphere of Earth is rich in
3. Surface temperature of moon varies from -190° to
4. CFCs are carbon compounds having both and chlorine
5. makes soil porous and allows water and air to penetrate deep underground.

6. Earthworms are which are involved in paedogenesis.

ANSWERS

II. Fill in the Blanks

1. Carbon dioxide;
2. Nitrogen;
3. 110°C;
4. Fluorine;
5. Humus;
6. Detritivores.

III. Matching Type Questions

(1) **Single Matching.** Match the articles of column I and column II

<i>Column I</i>	<i>Column II</i>
(a) Carbon dioxide	(i) Bacteria
(b) Nitrogen fixation	(ii) ODS (ozone depletion substances)
(c) CFCs (chlorofluorocarbons)	(iii) GHG (green house gas)
(d) Decomposers	(iv) Fossil fuels
(e) Oxides of nitrogen and sulphur	(v) Mineralization

(2) **Double Matching.** Match the contents of columns I, II and III

<i>Column I</i>	<i>Column II</i>	<i>Column II</i>
(a) Mercury	(i) Air and water	I. Living organism
(b) Paedogenesis	(ii) Water pollution	II. Shell (animals)
(c) Abiotic	(iii) Resource	III. Energy
(d) Carbon dioxide	(iv) Photosynthesis	IV. Minamata
(e) Food	(v) Sun, water and wind	V. Soil

(3) Key or Check List Matching: Match the pollutants with the type of pollution—air (A), water (W) and soil (S).

<i>Pollutant</i>	<i>Pollution</i>
(a) Eutrophication chemicals	causing
(b) SPM	
(c) Fly ash	
(d) ODS	

(4) Match Stimulus with Appropriate Response

<i>Conservation practice</i>	<i>Soil A</i>	<i>Water B</i>	<i>Air C</i>
1. Sewage treatment			
2. Terracing			
3. Pollution under control certificate			
4. Vegetation cover			

ANSWERS

- (1) Single Matching (a)-(iii); (b)-(i); (c)-(ii); (d)-(v); (e)-(iv).
- (2) Double Matching (a)-(ii)-(IV); (b)-(v)-(I); (c)-(i)-(V); (d)-(iv)-(II); (e)-(iii)-(III).

- (3) Key or Check List Matching (a) W; (b) A; (c) S; (d) A.
(4) Match Stimulus with Appropriate Response 1 B; 2 A; 3 C; 4 A.

IV. Question–Answer

1. Define the environment.
2. What is biosphere ? Describe its physical divisions ?
3. What are the major basic requirements of life ?
4. What are natural resources ? Give their types.
5. What is atmosphere ? Give its major divisions.
6. What causes winds ?
7. Where and how are clouds formed ?
8. What is air pollution ? How is it caused ? Give its effects.
9. Describe importance of water for the living organisms.
10. Describe various methods of rain (=water) harvesting.
11. Describe various causes of water pollution.
12. Define the soil ? Give its composition and functions.
13. How does soil formation takes place in nature ? Explain.
14. Define soil erosion ? Describe causes of soil erosion.
15. Write down some methods of prevention of soil erosion.
16. Describe water cycle.
17. What is nitrogen fixation ? Describe this phenomenon in context with N₂ cycle.
18. Define biogeochemical cycle. Describe carbon cycle.
19. What is ozone shield ? How is it being corroded ?
20. What would be effect of ozone depletion ?

V. Multiple Choice Questions (MCQs)

- (i) Soil is the component of
- (a) atmosphere
 - (b) hydrosphere
 - (c) lithosphere

- (d) none of the above
- (ii) Air is a mixture of
- (a) nitrogen, oxygen, methane, carbon dioxide
 - (b) nitrogen, oxygen, carbon dioxide, water vapours
 - (c) nitrogen, carbon dioxide, oxygen, carbon monoxide
 - (d) nitrogen, oxygen, carbon monoxide, water vapours
- (iii) Which one is inexhaustible resource ?
- (a) fossil fuels
 - (b) minerals
 - (b) soil
 - (d) solar radiation
- (iv) Cloud formation takes place in which part of atmosphere
- (a) troposphere
 - (b) stratosphere
 - (c) thermosphere
 - (d) ozonosphere
- (v) To which height is ozonosphere present over the equator
- (a) 11 - 16 km
 - (b) 23 - 25 km
 - (c) 16 - 20 km
 - (d) 10 - 12 km
- (vi) Rajasthan and Gujarat fall under
- (a) semiarid zone
 - (b) arid zone
 - (c) intermediate zone
 - (d) wet zone
- (vii) SPM includes
- (a) flyash
 - (b) dust
 - (c) soot and smoke
 - (d) all the above
- (viii) Which of the following is a secondary pollutant
- (a) PAN
 - (b) particulate matter
 - (c) hydrocarbons
 - (d) chlorofluorocarbons

- (ix) Photochemical smog is formed by
- (a) NO₂
 - (b) SO₂
 - (c) CO₂
 - (d) CO
- (x) Causes of water pollution are
- (a) inorganic
 - (b) organic
 - (c) biological
 - (d) all of these
- (xi) Run-off from fertilizer-rich crop-fields causes
- (a) turbidity of water bodies
 - (b) precipitation of toxicants
 - (c) eutrophication of water bodies
 - (d) thermal pollution of water bodies
- (xii) Cadmium pollution of water body produces a disease of humans called
- (a) plumbasim
 - (b) black foot disease
 - (c) methaemoglobinemia
 - (d) itai-itai
- (xiii) Percolation tanks and wells are used for
- (a) irrigation
 - (b) harvesting of flood water
 - (c) supply of drinking water
 - (d) all the above
- (xiv) Which of the following soil is transported by air ?
- (a) alluvial
 - (b) aeolian
 - (c) elluvial
 - (d) glacial
- (xv) Soil that is best suited for plant growth is
- (a) clayey
 - (b) loam
 - (c) sandy
 - (d) gravel

(xvi) Sun causes weathering of rocks through

- (a) mechanical force
- (b) physical phenomena
- (c) chemical changes
- (d) biological changes

(xvii) Biological weathering is caused by

- (a) lichens
- (b) mosses
- (c) roots of plants
- (d) all the above

(xviii) Wind breaks are

- (a) raising edges of fields
- (b) growing grasses alternating with crops
- (c) mud walls
- (d) rows of trees and shrubs

(xix) Signs of eutrophication of water bodies include

- (a) reduced oxygen demand
- (b) rapid decomposition of organic matter
- (c) algal bloom
- (d) fluorosis

(xx) Minamata human disease is caused by pollution of water by

- (a) cadmium
- (b) lead
- (c) mercury
- (d) arsenic

Green plants in an ecosystem are called

(xxi) (a) producers
(b) consumers
(c) decomposers
(d) none of the above

Ecosystem comprises both abiotic and biotic components. Biotic component of an ecosystem consists of

(xxii) (a) producers
(b) consumers
(c) decomposers
(d) all of the above

Name the gas which plays a major role in global warming

- (xxiii) (a) carbon monoxide
(b) nitrous oxide
(c) carbon dioxide
(d) sulphur dioxide

Green house effect is caused by

- (xxiv) (a) green plants
(b) infrared rays
(c) UV-rays
(d) X-rays

Ozone hole over Antarctica appears during

- (xxv) (a) spring
(b) summer
(c) autumn
(d) winter

ANSWERS

- (i) c
(ii) b
(iii) d
(iv) a
(v) b
(vi) b
(vii) d
(viii) a
(ix) a
(x) d
(xi) c
(xii) d
(xiii) d
(xiv) b
(xv) b

(xvi) b

(xvii) d

(xviii) d

(xix) c

(xx) c

(xxi) a

(xxii) d

(xxiii) c

(xxiv) b

(xxv) a.

GROUP DISCUSSION

VI. Organise group discussion on each of the following topics

1. The adverse effects of water pollution on aquatic life.
2. The reason and consequences of ozone layer depletion.
3. The consequences if nitrogen fixation does not take place.
4. Human activities and increase in atmospheric carbon dioxide.

SEMINAR/SYMPOSIUM

VII. Organise a seminar/symposium on each of following topics

1. Water – A wonderful liquid
2. Modern life style-pressure on natural resources.
3. Soil-The lifeline of biotic world.
4. Nitrogen fixation by organisms.
5. Ozone-A natural umbrella of Earth.

GROUP ACTIVITY

VIII. Investigatory Projects

1. Find out the causes of eutrophication in a nearby water body in your city.
2. Find out what are the measures taken by different industries to check air pollution.
3. List some human activities which led to soil erosion in your area.
4. List the results of initiatives taken to save the environment.

IX. Experimental Projects

1. Study different parameters of air and water for controlling pollution.
2. Study different parameters of drinking water.
3. Take some samples of soil from different places such as field, garden, forest, road side, etc., and have comparative study of their physical and chemical features.

X. Survey

1. Visit an environmental laboratory and study the tools and techniques that are used to measure the air and water pollution.
2. Collect data to study the extent the environment friendly fuels are helpful to control air pollution.
3. Find out, where in your city water harvesting projects are operating. Assess their positive results.
4. Collect data on the human activities which have affected the biogeochemical cycles in nature.

SUMMATIVE ASSESSMENT

TYPICAL OR ILLUSTRATIVE QUESTIONS

Open-ended Questions

1. Define soil erosion.

2. Mention any three human activities which are responsible for depletion of the ozone layer.
3. Name any two greenhouse gases.
4. What do you mean by ammonification?
5. Name the region of the atmosphere where most of the atmospheric gases are present.
6. What effects does the increasing organic waste have on the dissolved oxygen content and biochemical oxygen demand of water?
7. What is the phenomenon through which certain pollutants get accumulated in tissues in increasing concentration along the food chain, called?
8. Give three important reasons why soil is essential for living organisms.
9. What is chief source of precipitation?
10. What do you mean by rainwater harvesting?
11. Name two diseases caused by
 - (a) Infectious agents in polluted water,
 - (b) Toxic chemicals in polluted water.

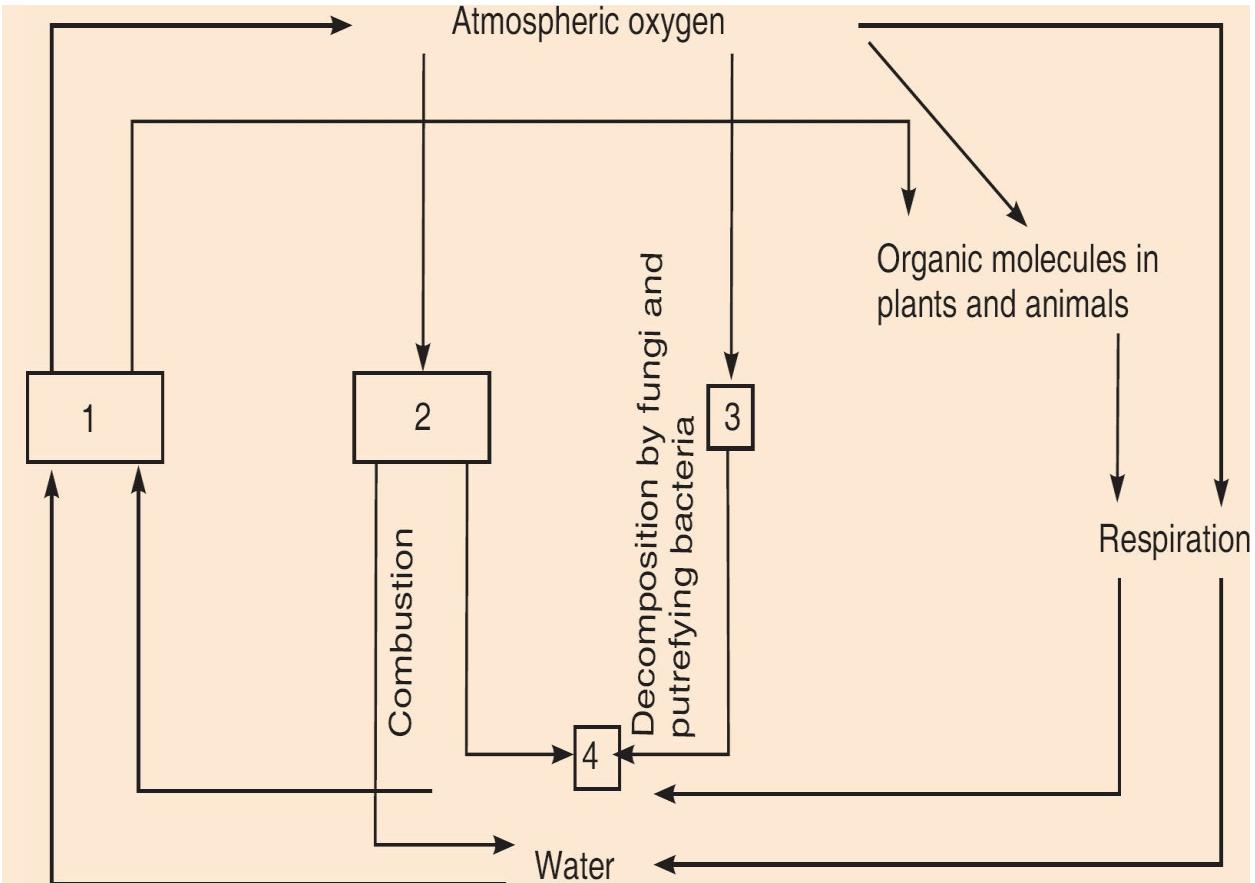
Ans. (a) Diseases caused by infectious agents in polluted water are cholera and typhoid.
(b) Diseases caused by toxic chemicals in polluted water are cancer and arsenicosis.

12. Name three occupational diseases caused due to air pollution.
Also mention their causative factors.

Ans. 1. Asbestosis (by inhalation of asbestos dust);
2. Silicosis (by inhalation of silicon dioxide);
3. Byssinosis (by inhalation of cotton fibres).

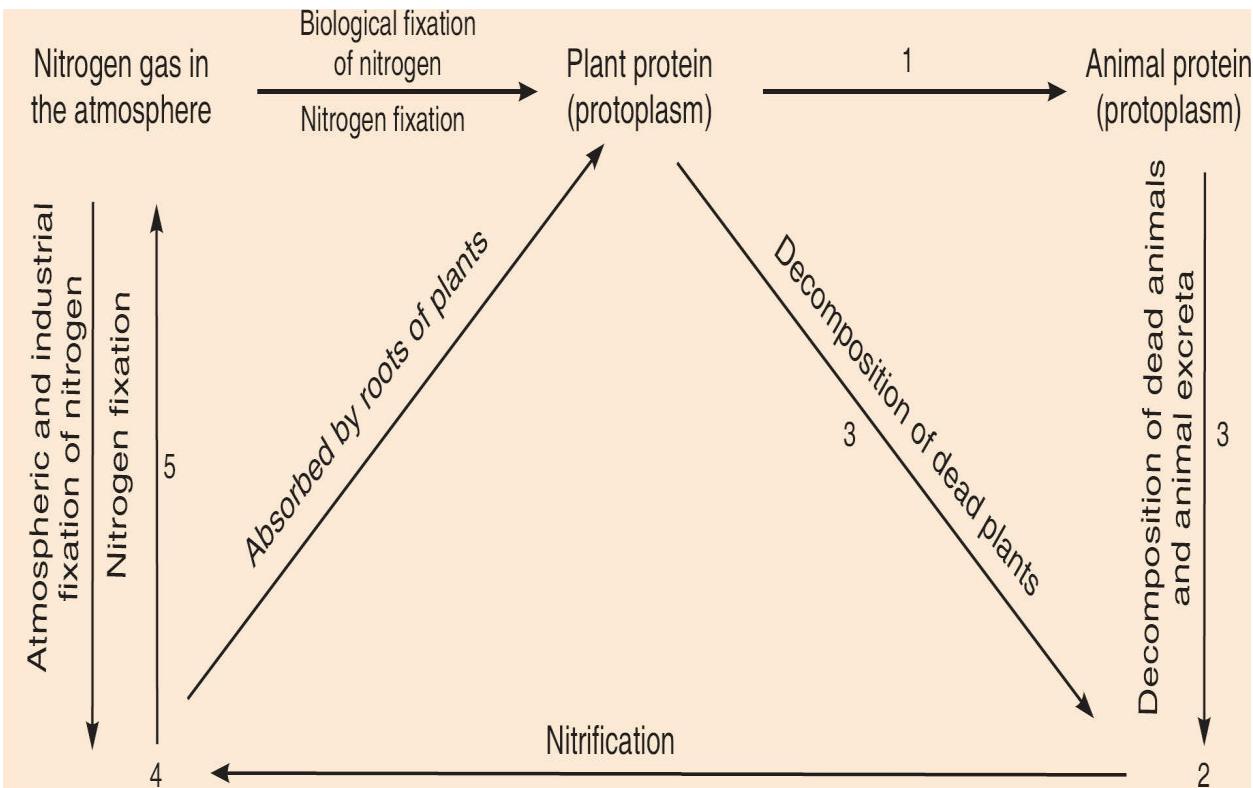
DRAWING/ILLUSTRATION BASED QUESTIONS

1. (a) Identify the biogeochemical cycle given below:
(b) Fill in the blanks marked 1–4.



Ans. (a) The figure indicates the biogeochemical cycle of oxygen.

- (b) 1. Photosynthesis by green plants; 2. Fossil fuels; 3. Dead plants and animals; 4. Carbon dioxide.
- 2. (a) Fill in the blanks marked 1–5 in figure of nitrogen cycle.
- (b) What will happen if the step of ammonification does not take place?
- (c) What will happen if the step of denitrification does not take place?



- Ans.** (a) 1. Animal nutrition; 2. Ammonia in soil 3. Ammonification ; 4. Nitrates in soil; 5. Denitrification.
- (b) If ammonification does not take place, the conversion of complex organic compounds such as proteins and nucleic acids of decaying organisms into ammonia will not take place.
- (c) If denitrification does not take place, conversion of nitrate salts present in soils and water into free molecular nitrogen will not occur.

COMMUNICATION SKILL-BASED QUESTIONS

- What will happen if nitrogen fixation does not take place?

Ans. Majority of organisms are unable to use atmospheric nitrogen directly. Through the process of nitrogen fixation, free nitrogen of air is converted into ammonia and nitrate, which is taken up by plants. In plants, nitrate is converted into amino acids, nucleotides, proteins and other nitrogenous compounds. In the absence of nitrogen fixation process, these substances which are necessary for structural and functional growth of organisms, will

not be formed.

2. Why is life not possible on Venus and Mars?

Ans. The atmosphere on Venus and Mars planets of solar system constitutes about 95-97% carbon dioxide. Life cannot exist in such a CO₂- rich atmosphere.

3. Why are lead compounds added to petrol? How is it harmful?

Ans. Lead compounds are added to petrol to reduce knocking, i.e., rapid combustion. Burning of this petrol leads to formation of lead halides (bromides and chlorides) which are emitted into air with exhaust. Lead inhalation causes anaemia and brain damage, lead poisoning which disturbs the nervous system, liver and kidney.

4. Name the fertilizers whose excessive presence in water bodies results in algal growth. What is the consequence of eutrophication.

Ans. Inorganic fertilizers containing phosphates and nitrates released into water bodies give out a lot of nutrition to phytoplankton. It causes eutrophication. Algal growth occurs tremendously. Decomposition of these algae makes the aerobic decomposers highly active which in turn causes depletion of dissolved oxygen in water bodies. Lack of dissolved oxygen in water leads to death of aquatic animals, especially fishes, due to suffocation.

PAPER - PEN TEST

Time : 30 minutes

Maximum marks : 17

V.S.A.

1. Which air pollutants cause hole in ozonosphere ?

1

MCQ

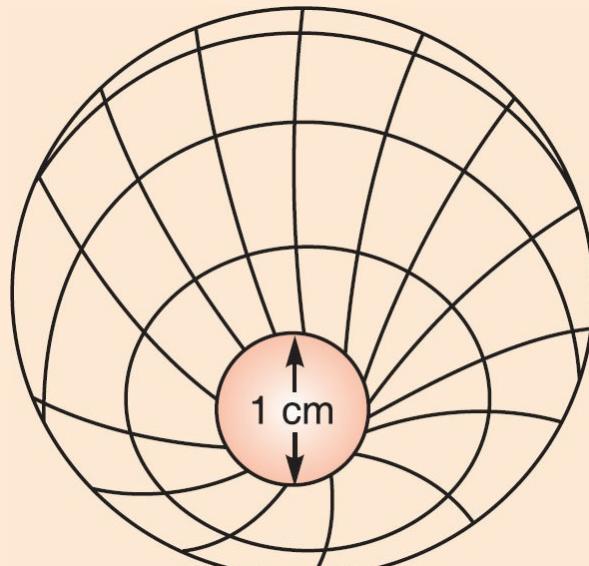
2. Pollution of water is caused by

1

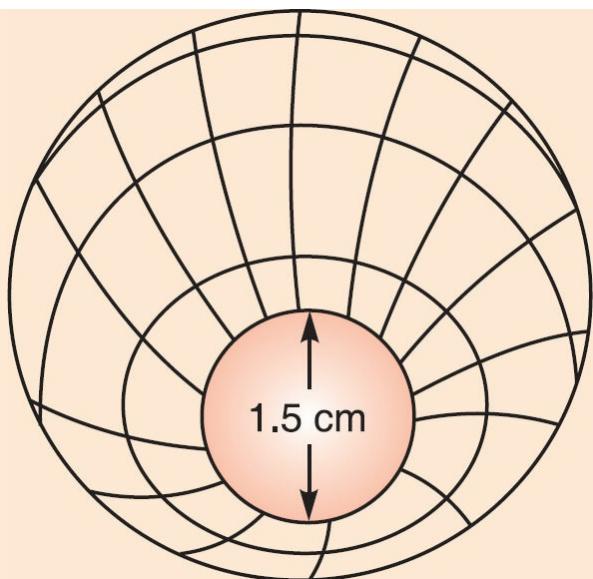
- (a) industrial effluents
- (b) sewage
- (c) farm runoff
- (d) all of these

3. Water pollution due to cadmium results in

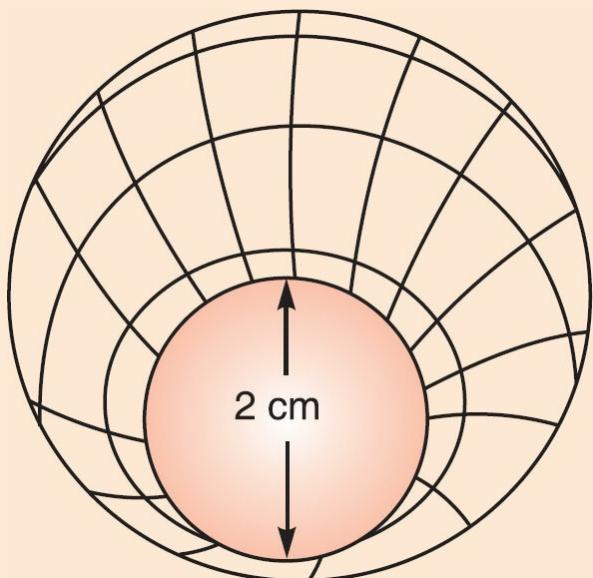
Blanks in humans.	1
True/False	4. Uneven heating of Earth produces winds.	1
Matching	5. <i>Column-I</i>	<i>Column-II</i>
	1. GHG 2. CFCs 3. PAN 4. Lichen	(a) Paedogenesis (b) Methane (c) Global warming (d) Smog
HOTS	6. What does the following figure depict ?	2



October 1980



October 1985



October 1990

- | | | |
|---------------|--|---|
| S.A.I | 7. Describe eutrophication. | 2 |
| S.A.II | 8. Write a short essay on soil erosion. | 3 |
| L.A. | 9. Describe with diagram the nitrogen cycle. | 5 |

Multiple Choice Questions (MCQs)

Type 1. Interpretation Type Questions

- 1. Major component of the atmosphere on Venus and Mars planet is**
 - (a) carbon dioxide
 - (b) oxygen
 - (c) nitrogen
 - (d) water vapours
- 2. All the elements of life support system are**
 - (a) inter-related
 - (b) inter-dependent
 - (c) interconnected
 - (d) all the above
- 3. In a natural ecosystem, decomposers include**
 - (a) bacteria and fungi
 - (b) parasitic algae
 - (c) macroscopic animals
 - (d) all the above
- 4. Pollution is not caused by**
 - (a) thermal power plants
 - (b) automobiles
 - (c) radioactive power plants
 - (d) hydroelectric power plants
- 5. Biosphere occurs**
 - (a) in lithosphere
 - (b) in lithosphere and hydrosphere
 - (c) at place of interaction of lithosphere, hydrosphere and atmosphere
 - (d) in atmosphere and hydrosphere
- 6. Air is**
 - (a) exhaustible resource
 - (b) inexhaustible resource
 - (c) perishable resource
 - (d) both (b) and (c)

7. Daytime temperature of moon is

- (a) 60°C
- (b) 70°C
- (c) 90°C
- (d) 110°C

8. Percentage of total water found as fresh water is

- (a) 46%
- (b) 32%
- (c) 16%
- (d) 2.5%

9. Toxic chemical released by paper industry is

- (a) cadmium
- (b) mercury
- (c) lead
- (d) nickel

10. Fertilizers cause

- (a) eutrophication of water bodies
- (b) killing of most microorganisms
- (c) destruction of crumb structure of soil
- (d) all the above

11. Wind causes weathering of rocks through

- (a) chemical change
- (b) abrasion
- (c) mechanical force
- (d) frost action

12. Forest destruction results in

- (a) loss of wild life
- (b) floods and drought
- (c) soil erosion
- (d) all of these

13. The ultimate source of energy in an ecosystem is

- (a) sunlight
- (b) glucose
- (c) protein
- (d) green plants

14. Which are sensitive to SO₂ pollution ?

- (a) mosses
- (b) lichens
- (c) algae
- (d) ferns

15. Eutrophication results in reduction of :

- (a) dissolved hydrogen
- (b) dissolved oxygen
- (c) mineral salts
- (d) dissolved nitrate

Type 2 : Identity - Relationship Type Questions

1. In nitrogen cycle, which bacteria are responsible for nitrification

- (a) *Clostridium*
- (b) *Rhizobium*
- (c) *Nitrosomonas*
- (d) *Nitrosomonas* and *Nitrobacter*

2. Nif genes occur in

- (a) *Rhizobium*
- (b) *Streptococcus*
- (c) *Penicillium*
- (d) *Aspergillus*

3. Pollution of water is caused by

- (a) industrial effluents
- (b) sewage
- (c) farm runoff
- (d) all of these

4. Greenhouse effect is caused by

- (a) green plants
- (b) infrared rays
- (c) UV-rays
- (d) X-rays

5. Air is

- (a) good conductor of heat
 - (b) bad conductor of heat
 - (c) neither good or bad conductor of heat
 - (d) sometimes good and sometimes bad conductor of heat
- 6. Greenhouse is related to**
- (a) global warming
 - (b) terrace gardening
 - (c) kitchen garden
 - (d) increase growth of algae
- 7. Major source of air pollution is**
- (a) burning of fossil fuels
 - (b) burning of wood
 - (c) burning of biogas
 - (d) burning of dung cakes
- 8. Organisms such as lichens are very sensitive to the levels of ---
----- in the atmosphere**
- (a) carbon dioxide
 - (b) sulphur dioxide
 - (c) carbon monoxide
 - (d) methane
- 9. Major source of formation of soil is**
- (a) rocks
 - (b) snow covered mountains
 - (c) rivers beds
 - (d) volcanoes
- 10. Solar radiation heat-up**
- (a) land faster than the water bodies
 - (b) land slower than the water bodies
 - (c) equally both land and water bodies
 - (d) neither land nor water bodies
- 11. Soil erosion is caused due to**
- (a) strong wind
 - (b) heavy rains
 - (c) keeping the fields fallow for a long
 - (d) all of these
- 12. Soil erosion is can be prevented by**

- (a) terrace farming
 - (b) intensive cropping
 - (c) deforestation
 - (d) both (a) and (b)
- 13. Name the gas which plays major role in global warming**
- (a) carbon monoxide
 - (b) nitrous oxide
 - (c) carbon dioxide
 - (d) sulphur dioxide
- 14. The conversion of NO_3 to N_2 is called**
- (a) nitrification
 - (b) denitrification
 - (c) ammonification
 - (d) nitrogen fixation
- 15. *Nitromonas* bacteria convert**
- (a) nitrite to nitrate
 - (b) ammonia into nitrate
 - (c) ammonia into nitrite
 - (d) nitrite into ammonia
- 16. The ozone layer of the atmosphere blocks**
- (a) infrared radiations
 - (b) sunlight
 - (c) UV radiations
 - (d) both UV and infrared radiation
- 17. Which of the following contribute to green house effect ?**
- (a) methane (CH_4)
 - (b) carbon dioxide (CO_2)
 - (c) chlorofluorocarbons (CFCs)
 - (d) all of these
- 18. Who is popularly known as ‘water man’ ?**
- (a) Gajendra Singh
 - (b) Rajendra Singh
 - (c) Louis Pasteur
 - (d) Tansley
- 19. Chlorofluorocarbons have been in use for**

- (a) aerosol propellants
 - (b) formation of foam
 - (c) refrigerators
 - (d) all the above
- 20. Ozone hole was discovered in**
- (a) 1992
 - (b) 1985
 - (c) 1995
 - (d) 1998

Type 3 : NCERT Question Bank (Exemplar Problems)

- 1. The two forms of oxygen found in the atmosphere are**
 - (a) water and ozone
 - (b) water and oxygen
 - (c) ozone and oxygen
 - (d) water and carbon dioxide
- 2. The atmosphere of the Earth is heated by radiations which are mainly**
 - (a) radiated by sun
 - (b) re-radiated by land
 - (c) re-radiated by water
 - (d) re-radiated by land and water
- 3. What would happen, if all land and water present in the environment is converted to ozone ?**
 - (a) we will be protected more
 - (b) it will become poisonous and kill living forms
 - (c) ozone is not stable, hence it will be toxic
 - (d) it will help harmful sun radiations to reach earth and damage many life forms
- 4. If there were no atmosphere around the earth, the temperature of the earth will**
 - (a) increase
 - (b) go on decreasing
 - (c) increase during day, and decrease during night

- (d) be unaffected
- 5. Which of the following is not a green house gas ?**
- (a) methane
 - (b) carbon dioxide
 - (c) carbon monoxide
 - (d) ammonia
- 6. Which of the following is a recently originated problem of environment ?**
- (a) ozone layer depletion
 - (b) green house effect
 - (c) global warming
 - (d) all of the above
- 7. Ozone layer is getting depleted because of**
- (a) excessive use of automobiles
 - (b) excessive formation of industrial units
 - (c) excessive use of man-made compounds containing both fluorine and chlorine
 - (d) excessive deforestation
- 8. “Ozone-hole” means**
- (a) a large sized hole in the ozone layer
 - (b) thinning of the ozone layer
 - (c) small holes scattered in the ozone layer
 - (d) thickening of ozone in the ozone layer
- 9. When we breathe in air, nitrogen also goes inside along with oxygen. What is fate of this nitrogen ?**
- (a) it moves along with oxygen into the cell
 - (b) it comes out with the CO₂ during exhalation
 - (c) it is absorbed only by the nasal cells
 - (d) nitrogen concentration is already more in the cells so it is not at all absorbed
- 10. One of the following factors does not lead to soil formation in nature**
- (a) sun
 - (b) water
 - (c) wind

- (d) polythene bags
- 11. Major source of mineral in soil is the**
- (a) parent-rock from which soil is formed
 - (b) plants
 - (c) animals
 - (d) bacteria
- 12. The process of nitrogen-fixation by bacteria does not take place in the presence of**
- (a) molecular form of hydrogen
 - (b) elemental form of oxygen
 - (c) water
 - (d) elemental form of nitrogen
- 13. Biotic component of biosphere is not constituted by**
- (a) producers
 - (b) consumers
 - (c) decomposer
 - (d) air
- 14. Total Earth's surface covered by water is**
- (a) 75%
 - (b) 60%
 - (c) 85%
 - (d) 50%
- 15. Choose the correct sequences**
- (a) CO_2 in atmosphere → decomposers → organic carbon in animals → organic carbon in plants
 - (b) CO_2 in atmosphere → organic carbon in plants → organic carbon in animals → inorganic carbon in soil
 - (c) inorganic carbonates in water → organic carbon in plants → organic carbon in animals → scavengers
 - (d) organic carbon in animals → decomposers → CO_2 in atmosphere → organic carbon in plants
- 16. Rainfall patterns depend on**
- (a) the underground water table
 - (b) the number of water bodies in an area
 - (c) the density pattern of human population in an area

- (d) the prevailing season in an area
- 17. One of the following processes is not a step involved in the water-cycle operating in nature**
- (a) evaporation
 - (b) transpiration
 - (c) precipitation
 - (d) photosynthesis
- 18. Among the given options, which one is not correct for the use of large amount of fertilizers and pesticides ?**
- (a) they are eco-friendly
 - (b) they turn the fields barrens after some time
 - (c) they adversely affect the useful component from the soil
 - (d) they destroy the soil fertility
- 19. The nitrogen molecules present in air can be converted into nitrates and nitrites by**
- (a) a biological process of nitrogen fixing bacteria present in the soil
 - (b) a biological process of carbon fixing factor present in soil
 - (c) any of the industries manufacturing nitrogenous compounds
 - (d) the plants used as cereal crops in field
- 20. The term “water pollution” can be defined in several ways. Which of the following statements does not give the correct definition ?**
- (a) the addition of undesirable substances to water bodies
 - (b) the removal of desirable substances from water-bodies
 - (c) a change in pressure of the water bodies
 - (d) a change in temperature of the water bodies
- 21. Which step is not involved in the carbon cycle ?**
- (a) photosynthesis
 - (b) transpiration
 - (c) respiration
 - (d) burning of fossil fuels
- 22. Top-soil contains the following**
- (a) humus and living organisms only
 - (b) humus and soil particles only
 - (c) humus, living organisms and plants

- (d) humus, living organisms and soil particles
- 23. Low-visibility during cold weather is due to**
- (a) formation of fossil fuel
 - (b) unburnt carbon particles or hydrocarbons suspended in air
 - (c) lack of adequate power supply
 - (d) none of these
- 24. Oxygen is returned to the atmosphere mainly by**
- (a) burning of fossil fuel
 - (b) respiration
 - (c) photosynthesis
 - (d) fungi
- 25. An increase in carbon dioxide contents in the atmosphere would not cause**
- (a) more heat to be retained by the environment
 - (b) increase in photosynthesis in plants
 - (c) global warming
 - (d) abundance of desert plants
- 26. Oxygen is harmful for**
- (a) ferns
 - (b) nitrogen-fixing bacteria
 - (c) chara
 - (d) mango tree
- 27. Soil erosion can be prevented by**
- (a) raising forests
 - (b) deforestation
 - (c) excessive use of fertilizer
 - (d) overgrazing by animals
- 28. Growth of lichens on barren rocks is followed by the growth of**
- (a) moss
 - (b) ferns
 - (c) gymnosperms
 - (d) algae
- 29. Marked temperature changes in aquatic environment can affect**
- (a) breeding of animals

- (b) more growth of aquatic plants
- (c) process of digestion in animals
- (d) availability of nutrients

ANSWERS

Type 1 MCQs

- 1. a
- 2. d
- 3. a
- 4. d
- 5. c
- 6. b
- 7. d
- 8. d
- 9. b
- 10. d
- 11. b
- 12. d
- 13. a
- 14. b
- 15. b.

ANSWERS

Type 2 MCQs

- 1. d
- 2. a
- 3. d
- 4. b
- 5. b
- 6. a
- 7. a
- 8. b

9. *a*
10. *a*
11. *d*
12. *d*
13. *c*
14. *b*
15. *c*
16. *c*
17. *d*
18. *b*
19. *d*
20. *b.*

ANSWERS

Type 3 MCQs

1. *c*
2. *d*
3. *b*
4. *c*
5. *d*
6. *d*
7. *c*
8. *b*
9. *a*
10. *d*
11. *a*
12. *b*
13. *d*
14. *a*
15. *b*
16. *b*
17. *d*
18. *a*
19. *a*

20. c
21. b
22. b
23. b
24. c
25. d
26. b
27. a
28. a
29. a.

QUESTIONS OF CBSE SAMPLE PAPERS

1 Mark Questions

1. Name the man made component which is responsible for the depletion of ozone layer.

(2010)

Ans. Chlorofluorocarbon or CFC.

2. Mention one method by which living organisms influence the formation of soil.

(2010)

Ans. Lichens secrete chemicals to dissolve minerals from rock surface, produce crevices where dust collects and mosses grow to form small amount of soil.

3. Name the bacteria responsible for nitrification in nature.

(2011)

4. We are lucky that ozone is not stable near to the Earth's surface. Why? Give appropriate answer.

(2011)

5. How the biosphere is a dynamic and stable system?

(2011)

6. Name any two factors responsible for the formation of the soil.

(2011)

7. Write full form of CFC.

(2011)

- 8.** Name two nitrogen compounds obtained by industrial fixation.
(2011)
- 9.** State one use of ozone.
(2011)
- 10.** State the role of symbiotic bacteria in nitrogen cycle in nature.
(2011)
- 11.** What is the function of ozone which is present in the upper level of the atmosphere?
(2011)
- 12.** Name any one method by which water helps in the formation of soil.
(2011)

2 Marks Questions

- 1.** List two ways in which water is useful to living organisms.
(2010)
Ans. (1) All cellular processes occur in water medium.
(2) Water is general solvent for chemicals found in living world. They react only in dissolved state. Transport also occurs in dissolved state.
- 2.** (a) Mention any two human activities which would be responsible for air pollution.
(b) How is Earth's atmosphere different from that of Venus and Mars?
(2010)
Ans. (a) (i) Burning of fossil fuels in vehicles, thermal plants and industries.
(ii) Particulate and gaseous emissions from industries, mining, processing and stone crushing.
(b) Earth's atmosphere is different from that of Venus and Mars. It contains only 0.03% carbon dioxide in addition to nitrogen, oxygen and water vapour. This is due to consistent presence of life on Earth (Gaia hypothesis). In comparison to Earth's atmosphere, atmosphere of Venus and Mars is rich in CO₂ (having 95 to 97% CO₂) and lifeless.
- 3.** What is soil erosion? List two activities which cause soil erosion.
(2011)

- 4.** What is green house effect? How is it called?
(2011)
- 5.** Give reasons for the following:
- (i) We are lucky that ozone is not stable near Earth's surface.
 - (ii) The combustion of fossil fuels increases the amount of suspended particles in air.
- (2011)
- 6.** What is atmospheric fixation of nitrogen?
(2011)
- 7.** State any two harmful affect each of
- (a) Air pollution and
 - (b) Water pollution.
- (2011)
- 8.** (a) What is soil erosion? State any one way by which it can be prevented.
(b) What is humus? What is the role of earthworms in increasing the quantity of humus.
(2011)
- 9.** (a) List two ways by which carbon dioxide is "fixed" in the environment.
(b) Name two diseases caused due to an increased content of pollutants in the air produced due to the burning of fossil fuels.
- 10.** (a) Why do the terrestrial life forms required fresh water?
(b) Give two examples where fresh water can be found in the frozen form on the Earth.

5 Marks Questions

- 1.** With the help of a labelled diagram show
- (a) Nitrogen cycle in nature
 - (b) Describe briefly any two processes involved in the cycling of N_2 in the environment.

OR

With the help of a labelled diagram show the cycling of carbon in nature. What are the two ways in which carbon dioxide is fixed in the environment.

(2010)

- Ans. (a)** Draw [Fig. 6.15](#) (nitrogen cycle) and label it fully.
- (b) Four major steps of nitrogen cycle are nitrogen fixation, nitrogen assimilation, decomposition and denitrification.
- (i) **Nitrogen fixation.** It is conversion of inert nitrogen gas into biologically acceptable forms. Nitrogen fixation is carried out by a number of free living (*e.g., Azotobacter*) and symbiotic bacteria (*e.g., Rhizobium* in legume roots) and blue-green algae (cyanobacteria). They absorb atmospheric nitrogen and reduce it to ammonia state. Ammonia combines with organic acids to produce amino acids. The latter form proteins. After their death, proteins and other nitrogen compounds are decomposed to form ammonia and nitrates.
- (b) **Nitrogen assimilation.** It is carried out by the plants. They absorb nitrates and ammonium ions from the soil. Nitrate is first changed into ammonium form. Ammonium combines with organic acids to form amino acids and other nitrogenous compounds. Amino acids give rise to proteins. Nucleotides produce nucleic acids (DNA, RNA). Enzymes are formed from proteins. Animals obtain organic nitrogen from plants directly or through food chain.
- OR
- Draw [Fig. 6.20](#) (Carbon cycle) and label it fully.
- Two modes of CO_2 fixation. (i) photosynthesis. All producers pick up CO_2 from their environment and change it into glucose and other organic compounds in the process of photosynthesis.
- (ii) **Formation of shells and skeleton.** Aquatic animals absorb carbonates from water and use the same in building their shells and skeletons.
2. (a) What are forms of oxygen found in the atmosphere?
- (b) “Forests influence the quality of our air, soil and water resources.” Justify the statement.
- (2011)
3. (a) Draw well labelled diagram of oxygen cycle in nature.
- (b) Explain in how many ways O_2 is used up from the atmosphere and how it returns back to atmosphere.
- (2011)
- (a) With the help of well labelled diagram explain water cycle in

4. nature.
- (b) How is green house effect related to Global warming? Explain.

(2011)

5. (a) Draw a well labelled nitrogen cycle in nature.
- (b) Describe one biological and one physical method of conversion of nitrogen to forms like nitrates and nitrites.

OR

- (a) Draw a labelled carbon cycle in nature.
- (b) Describe briefly two process by which carbon dioxide is returned back to the atmosphere.

(2011)

6. Many human activities lead to increasing levels of pollution of air, water bodies and soil “Isolating these activities to specific and limited areas would not help in reducing pollution”. Justify this statement giving at least five reasons.

OR

Explain with the help of a diagram carbon cycle in nature.

(2011)

7. (i) With the help of a neat labelled diagram depict the cycling of carbon in nature.
- (ii) Mention two ways in which carbon dioxide is fixed in the environment.

OR

- (i) Describe green house effect. How the presence of green house gases would lead to global warming.
- (ii) Draw a neat labelled diagram of water cycle in nature.

(2011)

8. (i) Make a neat and labelled sketch of nitrogen cycle in nature.
- (ii) Describe in brief the role of nitrogen fixing bacteria and of lightening in fixing atmospheric nitrogen.

OR

- (i) Draw a neat labelled sketch of carbon cycle in nature.

- (ii) What is green house effect? How does carbon dioxide cause global warming in the atmosphere.
(2011)
9. (a) In coastal areas, wind current moves from sea towards the land during day; but during night it moves from land to sea. Discuss the reason.
- (ii) How are CFCs harmful for the environment and living beings?
(2011)

Questions Based on NCERT Question Bank (Exemplar Problems in Science)

1. How can we prevent loss of top soil ?

Ans. See text under “Control of Soil Erosion”.

2. Rivers from land and minerals to sea water. Discuss how.

Rivers are formed from melting snow, springs, and rain water flowing over land as run off. While passing through and over the rocks, the flowing water picks up minerals, silt and sand. These dissolved and suspended substances are carried by rivers to sea and make them available to marine organisms.

3. How is life of organisms living in water affected when water gets polluted ?

Water gets polluted from domestic wastes (loaded with detergents, faecal matter, etc.), fertilisers and pesticides from crop fields and industrial wastes (heavy metals, waste heat).

Fertilisers and domestic wastes cause eutrophication or increased organic loading and excessive growth of algae (algal bloom). This ultimately reduces oxygen available to aquatic animals (fish, molluscs) and kill them.

(i) Domestic wastes also carry pathogens of a number of human diseases. Some of them can cause diseases of animals as well.

(ii) Pesticides and pollutants of industrial wastes directly harm the aquatic organisms and humans.

4. During summer, if you go near the lake, you feel relief from heat.

Why ?

- Ans.** During day time, air over the land becomes heated up by sun rays, it rises up and creates area of low pressure. Water of lake is not heated up by sun rays so quickly. Evaporation of water from its surface also cools up the lake water. So, air over the surface of lake is cooler. It moves towards the land where low pressure exists. Therefore, during day time a cool breeze flows from lake to the near by ([Fig. 6.3](#)).

In coastal areas, wind current moves from sea towards the land

- 5. during day but during night it moves from land to the sea. Discuss the reason.**

- Ans.** See text “Air Movement in Coastal Areas”.

Following are a few organisms: (a) Lichens; (b) Mosses; (c) Mango

- 6. tree; (d) Cactus, which among the above can grow on stones, help in formation of soil ? Write the mode of their action for making the soil.**

- Ans.** Lichens and Mosses. See text under” Biological weathering”.

- 7. Soil formation is done by both abiotic and biotic factors. List the name of these factors by classifying them as abiotic and biotic.**

- Ans.** (i) **Abiotic factors of soil formation:** Sun, water, wind.

(ii) Biotic factors of soil formation: Lichens, mosses, herbs, shrubs, trees and animals (earthworms).

- 8. All the living organisms are basically made up of C, N, S, P, H and O. How they enter the living forms ?**

- Ans.** Most of these elements first enter plants and become components of organic material during the process of photosynthesis. Thus, they enter from air (CO_2), water (H_2O) and ions (N, S, P) from the soil. From plants the chemicals pass on to other organisms through the food chains.

- 9. Why does the percentage of gases such as oxygen, nitrogen and carbon dioxide remain almost the same in the atmosphere ?**

- Ans.** The composition of gases such as O_2 , N_2 and CO_2 remains same in atmosphere due to the process of biogeochemical cycles.

During these cycles, occur the repeated circulation of biogenetic nutrients between abiotic and biotic components of the environment.

- 10. Why does moon have very cold and very high temperature variations, e.g., from -190°C to 110°C even though it is at the same distance from the sun as the Earth is ?**

Ans. Atmosphere of Earth is a bad conductor so acts as a temperature buffer. However, moon lacks an atmosphere around it. Therefore, moon gets heated up as sun rays fall on its surface. It cools down drastically when there is no sunlight, causing wide fluctuations in its temperature.

11. Why do people love to fly kites near the sea shore ?

Ans. (i) There is a regular unidirectional wind from the sea to land. It helps in flying the kite high.
(ii) The wind is cooler and provide comfort to kite flyers even in bright sun.

12. Why does Mathura refinery pose problems to the Taj Mahal ?

Mathura refinery emits hydrocarbons and sulphur oxides in its exhaust/fumes. Hydrocarbons induce the formation of ozone which is highly oxidizing. Sulphur dioxide produces acid rain which has a corroding effect on marble. As a result, Mathura refinery does pose problems to Taj Mahal.

13. Why do not lichens occur in Delhi where as they commonly grow in Manali or Darjeeling ?

Lichens act as indicators of air pollution. They are sensitive to sulphur dioxide which occurs in sufficient quantity in the atmosphere of Delhi due to large number of vehicles, homes and factories using fossil fuels. Also Delhi exists in semiarid area where atmospheric moisture is low. In Manali and Darjeeling, the atmosphere is humid and has comparatively low contents of sulphur dioxide.

14. Why does water need conservation even though large oceans surround the land masses ?

Salt water of seas and oceans is unfit for consumption by humans, animals, land plants or industries. Therefore, terrestrial biota and human beings have to depend upon fresh-water resources available on land (such as water present in rain, snow, springs, river, lakes, ponds and other freshwater bodies (only about 0.5% of the total water on earth). As a result, freshwater needs its conservation.

15. There is a mass mortality of fish in a pond. What may be the reasons ?

Ans. In a pond, a mass mortality of fish may occur due to following seasons.
(i) Passage of pesticide rich water from crop fields.
(ii) Release of toxic industrial waste.

- (iii) Pouring of hot water from an industry or thermal power plant.
- (iv) Release of waste rich in heavy metals and mercury.
- (v) Blockage of gills of fish by some suspended pollutant such as oil.

16. Lichens are called pioneer colonisers of bare rock. How can they help in formation of soil ?

Lichens release small quantity of acids which corrode the surface of rock creating minute pores and releasing minerals. With the passage of time these minerals deposit on rock to form a thin layer of soil.

17. "Soil is formed by water." If you agree with this statement, then give reasons.

Ans. Yes, water causes weathering of rocks by following three methods.

Wetting and drying. Certain constituents of rocks can pick up

1. moisture and swell up. They contract on drying. Such components (*i.e.*, chemicals) help in breaking of rocks.

Frost action. Water seeps into rock crevices and cracks and may

2. freeze if the temperature goes below 0°C. Frozen water expands and exerts a huge pressure sufficient to break all rocks.

Abrasion. Beating of rocks by rain and hail, wave action on shores and abrasion caused by tumbling rock fragments in running water

3. batter and grind the rocks into smaller and smaller particles. Water carries these particles depositing them downstream. This produces soil (*e.g.*, sand particles) at a far away place from the parent rock.

18. Fertile soil has lots of humus. Why ?

Ans. Fertile soil contains sufficient amount of humus because (i) Humus is required for binding soil particles into crumbs. Crumb formation helps in both hydration and aeration of soil. (ii) Humus makes the soil porous for easy passage of plant roots. (iii) Humus is a source of mineral. (iv) Humus contains chemicals that promote growth of plants.

19. Why step farming is common in hills ?

Ans. Step farming is also called terracing. It is carried out in the hills because terracing slows down the speed of rain water currents, checks soil erosion and increase water absorption by the soil.

20. Why are root nodules useful for the plants ?

Root nodules mostly occur in the legume plants. These nodules contain nitrogen fixing bacteria named *Rhizobium*. The bacteria picks up nitrogen

Ans. from soil atmosphere and convert it into organic compounds. The same pass into the plant so that legumes (e.g., pea, gram) become rich in proteins and other nitrogen compounds.

21. How do fossil fuels cause air pollution ?

Coal and petroleum are the fossil fuels. They are burnt to get energy. Combustion of fossil fuels produces (i) suspended particles, (ii) sulphur oxides; (iii) nitrogen oxides; (iv) carbon dioxide; (v) carbon monoxide;

Ans. (vi) vapours of hydrocarbons. All these are air pollutants. Hydrocarbons act as a source of cancer. Along with nitrogen oxides, they produce ozone and smog. Sulphur and nitrogen oxides give rise to acid rain. They are also irritants and damage eyes and nasal tract.

22. What are the causes of ‘water pollution’ ? Discuss how you can contribute in reducing water pollution.

Ans. See text for causes of ‘water pollution’.

Reduction in Water Pollution

Sewage. The authorities can be persuaded not to pass untreated effluents into water body. Dairy owners of city can be prevailed

(i) upon not to pass dung of cows and buffaloes into municipal waste water lines especially during monsoon days.

(ii) **Garbage.** Domestic waste or garbage should not be thrown on the banks of water bodies.

(iii) **Industrial effluents.** Asking the industrial houses not to release untreated effluents into water body.

(iv) **Washing clothes.** Washing clothes should be discouraged on the banks of water bodies as detergents are a source of eutrophication.

Vegetation cover. Grasses, herbs, shrubs and trees should be planted on the banks of water bodies. This will check soil erosion

(v) and siltation of water bodies. It may also reduce run off from crop fields. Such runoffs are often laden with fertilizers and toxic pesticides which are potent water pollutants.

23. A motor car with its, glass totally closed, is parked directly under the sun. The inside temperature of the car rises very high. Explain.

Glass is transparent to sunlight allowing it to pass into the interior of the car. It heats up the interior. But heat waves do not escape from the car

Ans. due to glass being opaque to the same. As a result, the interior of the car placed in the sun will become very hot. It is similar to glass house effect.

24. Justify “Dust is a pollutant”.

- (i) Dust consists of suspended particles. The latter pass into nasal tract and cause a lot of discomfort including allergic asthma, bronchitis, cough and cold (ii) Dust reduces light intensity (iii) Dust particles are eye irritants. (iv) Dust particles settle over plant foliage and reduce photosynthetic activity (v) Dust particles block stomata reduces gaseous exchange in plants (vi) Dust particles can pick up toxic metals and chemicals being emitted by industries.

25. Explain the role of the sun in the formation of soil.

- Sun plays an important role in weathering of rocks for soil formation. It heats up the rocks during the day. Heating causes the rocks to expand. During night, the rocks cool down and contract. Different parts of a rock expand and contract at different rates resulting in its cracking and breaking up into smaller pieces or fragments (boulders).

26. Carbon dioxide is necessary for plants. Why do we consider it as a pollutant?

- Carbon dioxide gas is essential for photosynthesis by plants. It is also a green-house gas (GHG). Upto 350 ppm (ppm = parts per million) concentration in the atmosphere, CO₂ is both a good raw material as well as essential for keeping the Earth warm. However, when concentration of CO₂ rises (as presently it is 387 ppm), it becomes a pollutant because it results in global warming. The global warming is quite dangerous because it tends to melt polar ice and glaciers existing on mountains, raise in the water level of oceans and submerge severals coastal areas and islands.

NCERT TEXTBOOK QUESTIONS AND EXERCISES WITH ANSWERS

NCERT Textbook Questions

Q.1. How is our atmosphere different from the atmosphere on Venus and Mars?

On the planets Venus and Mars carbon dioxide forms the major component constituting upto 95-97% of the atmosphere. No life is

Ans. known to exist there. On the contrary, on the Earth, air forms the blanket around the Earth having nitrogen (78.08%), oxygen (20.92%), carbon dioxide (0.03%), argon (0.93%) and trace components (0.04%). It has life on it.

Q.2. How does the atmosphere act as a blanket ?

The mass or body of gases that surrounds the Earth or any heavenly body is called **atmosphere**. Earth's atmosphere extends from the surface to a height of more than 1000 km, beyond which it merges gradually with solar atmosphere.

Earth's atmosphere acts as a protective blanket for the organisms to exist. It keeps the average temperature of the Earth fairly steady during the day and even during the course of whole year. In addition, the ozone shield (*i.e.*, high concentration of ozone about 18-26 km above the surface of the Earth) of the atmosphere absorbs most of the harmful UV radiations coming from the sun thereby protecting human beings and animals from their harmful effects.

Q.3. What causes winds?

The movement of air from one region to another creates winds. When the solar radiations fall on the Earth, some are absorbed and majority of these are reflected back or reradiated by the land and water bodies. These reflected or reradiated solar radiations heat up the atmosphere from below. As a result, convection currents are set up in the air. But since land gets heated faster than the water, the air above the land gets heated faster than the air over water bodies. During the day, the air above the land gets heated faster and starts rising, creating a region of low pressure below. As a result, the air over the sea moves into this region of low pressure and forms the wind.

Q.4. How are clouds formed?

When the water bodies are heated with solar radiations during the day, a large amount of water evaporates and goes in the air. The air carrying water vapours also gets heated. This hot air rises up carrying water vapours with it. As the air rises, it expands and cools. This cooling causes the water vapours in the air to condense as tiny droplets. Dust or other suspended particles present in the air act as the "**nucleus**" for these droplets to form around. These droplets of water once formed slowly grow bigger by the condensation of more water droplets. An enormous collection of tiny droplets of water appear as **clouds**. When the droplets have grown big and heavy, they fall down

in the form of rain.

Q.5. **List any three human activities that you think would lead to air pollution.**

- Ans.**
1. Burning of fossil fuel (coal, petroleum products) in automobiles, generators, thermal power plants.
 2. Smoke from industries (*e.g.* brick-kiln, crashers, etc.)
 3. Burning of fuelwood and dung cakes in household cooking.

Q.6. **Why do organisms need water?**

Organisms need water because it plays a vital role in the reactions taking place within organism's cells and body. Water acts as a universal solvent, providing a medium for the chemical reactions to occur. Substances are also transported from one part of body to the other in the dissolved state. Therefore, it is necessary for the organisms to maintain a distinct level of water within their bodies in order to stay alive.

Q.7. **What is the major source of fresh water in the city/town/village where you live?**

Ans. Major sources of fresh water in the city/town/village where we live is underground water.

Q.8. **Do you know of any activity which may be polluting this water source?**

Ans. Percolated dissolved fertilizers and pesticides from the fields, sewage and wastes from factories (which are often stored in underground tanks) are the major sources of underground water pollution.

Q.9. **How is soil formed?**

Ans. Soil is a mixture of small particles of rocks and humus (*i.e.*, organic matter obtained from decaying of living organisms or their wastes). Temperature variations due to radiations of the sun, rain water, winds and living organisms influence the formation of soil from the rocks involving two processes: weathering and paedogenesis.

Breakdown of bigger rocks into small, fine soil particles is called **weathering**. It may occur due to physical, chemical or biological means. Under the influence of solar radiations, rocks heat up and expand. At night, these rocks cool down and contract. Since all the parts of rocks do not expand and contract at the same rate, cracks appear in the rocks and ultimately the large rocks breakdown into

smaller pieces. Flow of water through or over the rocks make the cracks bigger. Flowing/falling water also has an erasing effect on the rocks. On freezing the water expands in rock crevices and break the rocks. Similarly, strong winds continue to rub against hard rocks and erode them. Growth of lichens, mosses and other plants also influence the formation of soil by eroding the rocks over which they are growing.

Paedogenesis involves the **decomposition** of organic materials by bacteria and fungi and **humification** and **mineralization** of decomposed organic matter. Earthworms also play an important role in the soil formation.

Q.10. What is soil erosion?

The topmost layer of the soil that contains humus and living organisms (bacteria, fungi, nematodes, earthworms, etc.) in addition to the mineral particles is called **topsoil**. The removal and transportation of top soil from its original position to another place with the help of certain agents such as strong winds and fast running waters, is called **soil erosion**. Action of walking and grazing by the hooved animals (e.g., sheep, goats, donkeys, horses, mules, cattles, etc.) too result in soil erosion.

Q.11. What are the different methods of preventing or reducing soil erosion?

Soil erosion can be effectively prevented by adopting the following measures: 1. Intensive cropping; 2. Sowing grasses and planting xerophytes; 3. Terrace farming; 4. Proper drainage canals around the fields; 5. Making strong embankments along the river banks; and 6. Checking the overgrazing.

Q.12. What are the different states in which water is found during the water cycle?

Ans. (i) Water vapours in the air which ultimately form clouds, and
(ii) Rain water that falls on Earth and is available to us in water bodies or as underground water.
(iii) Dew, snow, sheet or hail.

Q.13. Name two biologically important compounds that contain both oxygen and nitrogen.

Ans. (i) Nucleic acids (DNA and RNA);
(ii) Proteins.

Q.14. List any three human activities which could lead to an increase in carbon dioxide content of air.

- Ans.**
- (i) Burning of fossil fuels (coal and petroleum products) in homes, industries and automobiles.
 - (ii) Burning associated with agricultural practices.
 - (iii) Deforestation.

Q.15. What is the greenhouse effect ?

Heat is trapped by glass, and hence the temperature inside a glass enclosure will be much higher than the surroundings. This phenomenon was used to create an enclosure where tropical plants could be kept warm during the winters in colder climates. Such enclosures are called **greenhouses**. Greenhouses have also lent their name to an atmospheric phenomenon. Some gases such as carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs), etc., are

Ans. present in the Earth's atmosphere prevent the escape of heat from the Earth. An increase in the percentage of such gases in the atmosphere would cause the average temperatures to increase worldwide and this is called **greenhouse effect**. Carbon dioxide, methane and chlorofluorocarbons, are such **greenhouse gases**. An increase in the carbon dioxide content in the atmosphere, for example, would cause more heat to be retained by the atmosphere and lead to global warming.

Q.16. What are two forms of oxygen found in the atmosphere?

Ans. Molecular oxygen (O_2) and ozone (O_3).

NCERT Exercises

Q.1. Why is the atmosphere essential for life?

The multilayered gaseous envelope (or blanket) surrounding the planet Earth is called **atmosphere**. Atmosphere filters sunlight reaching the Earth affect climate and is a reservoir of several elements which are essential for life. Oxygen is required by most living beings for respiration and for burning (combustion) of materials. Air contains about 20% oxygen and its percentage in air is balanced by the process of photosynthesis. Photosynthesis occurs in chloroplasts of green plants and this metabolic activity requires CO_2 , water and sunlight but release oxygen gas. Ozone umbrella of

Ans.

atmosphere does not allow penetration of ultraviolet light of solar radiations to reach the Earth. These solar radiations otherwise affect organisms adversely (*e.g.*, UV rays may cause skin cancer in human beings).

Q.2. Why is water essential for life?

Ans. Please refer to NCERT Textbook Questions-[Q.6](#).

Q.3. How are living organisms dependent on the soil? Are organism that live in water totally independent of soil as a resource?

Ans. The top surface layer of Earth capable of supporting plant life is called **soil**. Soil is a complex mixture, comprising of minerals (45%), organic matter (5%), water (25%), air (25%) and living organisms. It is an important resource that determines the diversity of life in an area. Plants are dependent on the soil from where they obtain various types of minerals, water and air. All these three components are essential for the growth of plants. Animals (herbivores) depend on plants for food. Other animals (carnivores) depend on these herbivores. Hence, all living organisms directly or indirectly depend on the soil.

Aquatic organisms are not entirely independent of soil as a resource. Microscopic decomposers (*e.g.*, fungi, archaebacteria and bacteria) present in the bottom sediments of water bodies decompose dead, decaying organic matter into simple, inorganic substances (minerals). The latter get dissolved in water and are available as nutrients for aquatic plants and then indirectly through plants to animals.

Q.4. You have seen weather reports on television and in newspapers. How do you think we are able to predict the weather?

Ans. We daily see weather reports on television and newspapers. These informations about the weather are recorded by meteorological laboratories present in different cities of the country. Information such as direction and speed of wind, average daily minimum and maximum temperature, relative humidity, patterns of cloud formation, depression zones over an area, etc., are recorded with the help of instruments and then displayed on television, published in newspapers or broadcasted on the radio. This meteorological information helps us to predict the weather and to act accordingly. For example a farmer can decide his next step for agriculture according to latest weather report and may be benefitted.

Q.5.

We know that many human activities lead to increase levels of pollution of air, water bodies and soil. Do you think that isolating these activities to specific and limited areas would help in reducing pollution?

Ans.

We have studied that many human activities lead to increase the levels of pollution of the air, water bodies and soil. Isolating such activities to specific and limited areas may help in reducing only soil pollution. However, air and water pollution cannot be checked. For instance air pollution brings about global environmental changes such as (i) **acid rainfalls**; (ii) **global warming** due to increase in the concentration of green house gases (carbon dioxide, methane and chlorofluorocarbons) in the atmosphere; (iii) **depletion of ozone layer**.

In the same way, water keeps moving in streams, rivers and oceans. It distributes wastes to far off places from the point of their discharge. Similarly, underground water pollution due to sewage, industrial wastes and agricultural percolation (of fertilizers and pesticides) will affect large areas.

Q.6.

Write a note on how forests influence the air, soil and water resources.

Ans.

Forest is a large area covered thickly with trees and other plants such as shrubs and grasses. Any forest is a renewable natural resource. Forests influence the air, water and soil resources in following ways:

1. Forests shape natural environment by influencing such factors as temperature, humidity and precipitation.

2. Forests shape the soil environment by affecting its composition, structure, the chemical properties, water contents, etc.

3. Forests play important role in running the biogeochemical cycles of water, carbon, nitrogen, oxygen, and other elements.

4. Forest plants maintain the CO_2 and O_2 balance in the atmosphere.

Roots of forest plants bind the soil and do not allow erosion of soil by fast winds or fast moving water. In this way they help in

5. maintaining the fertility of soil. Many bacteria present in root nodules (*e.g., Rhizobium* bacteria in root nodules of leguminous plants) replenish to the soil.

6. Forests check flooding, landslides and shifting of sand and silting of rivers.

QUESTIONS BASED ON HIGHER ORDER THINKING SKILLS (HOTS)

Q.1. (a) Fill in the blanks: A, B, and C.

(b) Identify the biogeochemical cycle.

Ans. (a) Fill in the blanks. A — Food/organic molecules / Glucose, $C_6H_{12}O_6$; B — Photosynthesis; C — Respiration.

(b) Identification. Oxygen cycle.

Q.2. (a) Identify the biogeochemical cycle.

(b) Fill in the blanks: A, B, C and D.

(c) What will happen if the step E does not occur.

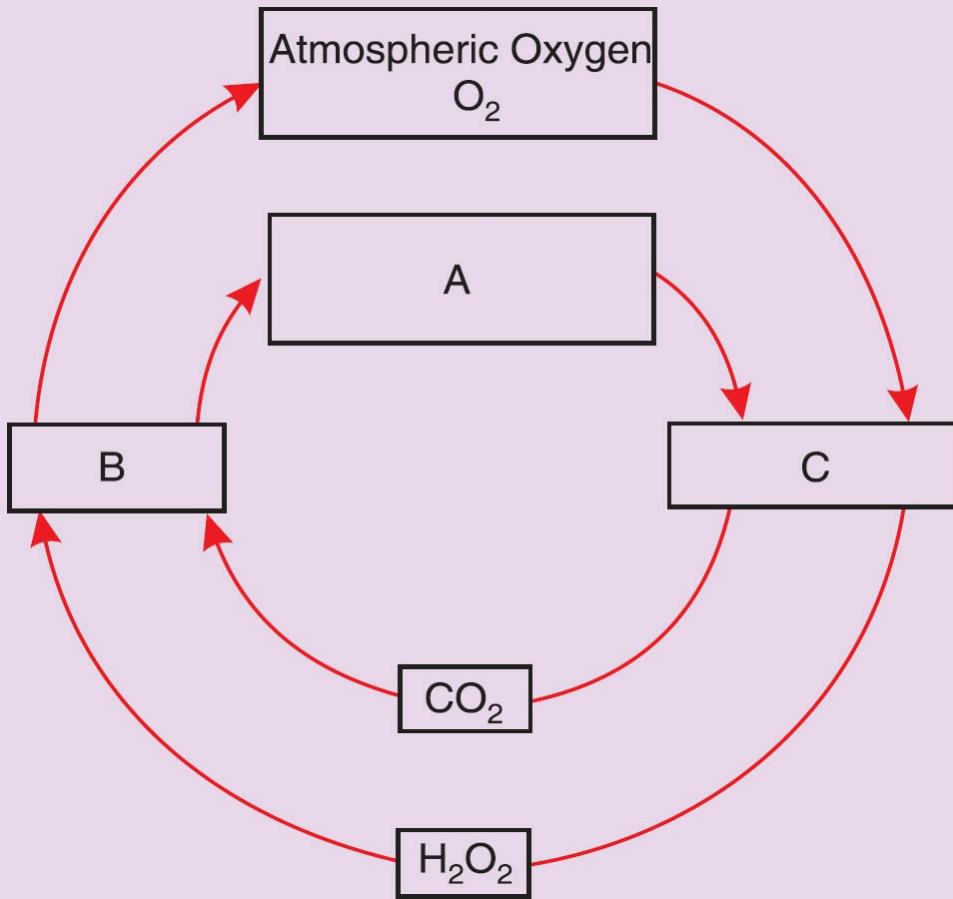


Figure of Q.1

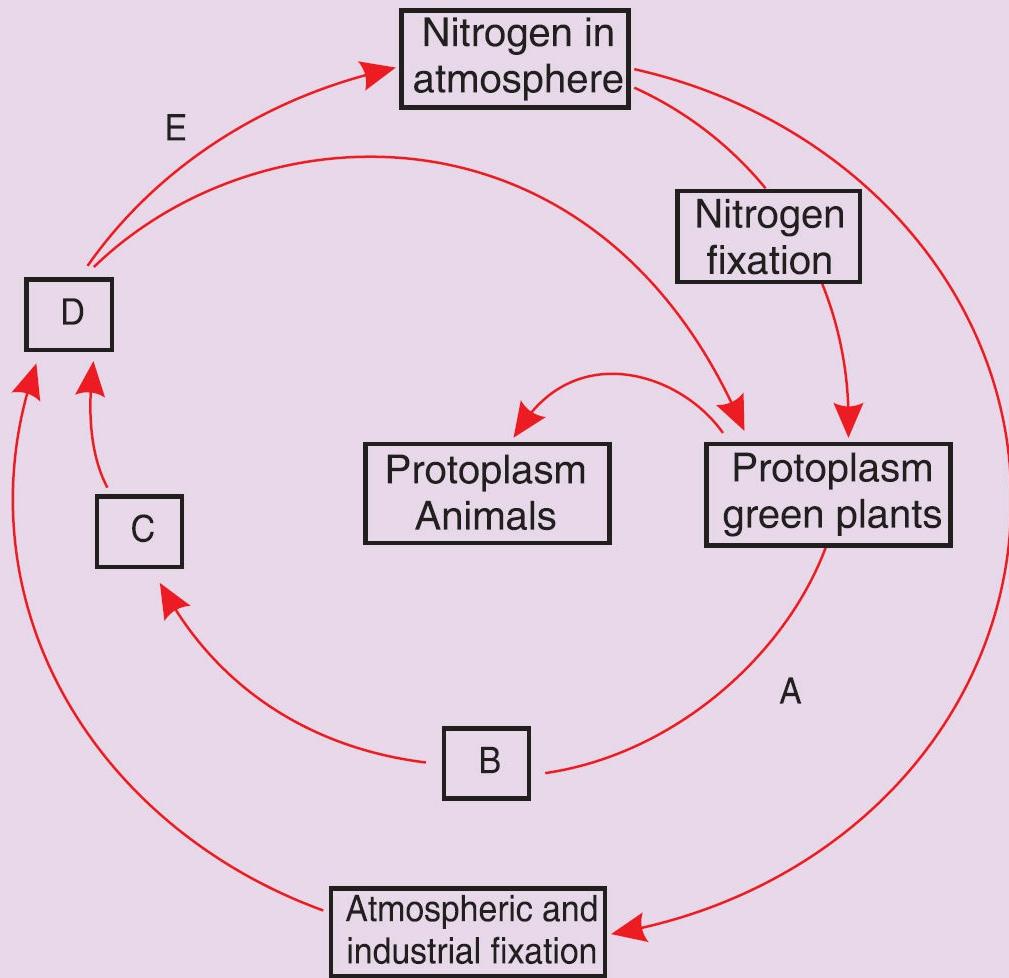


Figure of Q. 2

Ans. (a) **Identification:** Nitrogen cycle.

(b) **Fill in the blanks:** A—Ammonification; B — Ammonia; C — Nitrite; D — Nitrates.

(c) In the absence of step E, there will be no replenishment of atmospheric nitrogen.

Q.3. (a) **List two main sources of emission of carbon dioxide.**

(b) **How carbon monoxide is harmful ?**

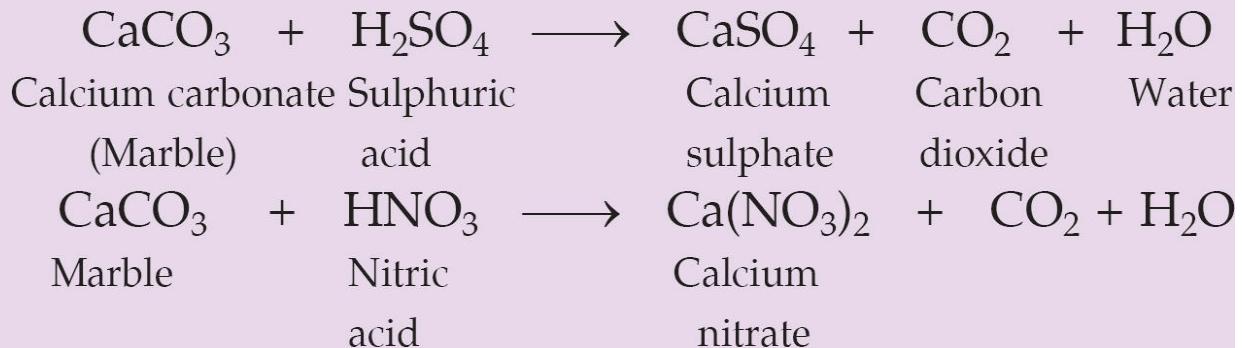
Ans. (a) Two main sources of carbon monoxide are exhaust of motor vehicles and coal-burning or cigarette.

(b) Refer S.A.Q. [23](#).

Q.4. (a) **Name two acids that are usually present in rain water.**

(b) How these acids affect our heritage monuments such as Taj Mahal ?

- Ans.** (a) Sulphuric acid (H_2SO_4) and Nitric acid (HNO_3)
(b) The acids present in acid rain react with marble of Taj Mahal of Agra (U.P.) and corrode it. Chemical reactions involved are :



Q.5. List the chemicals whose biomagnification result in following diseases in humans : (i) Minamata disease; (ii) Itai Itai disease.

- Ans.** Heavy metals: (i) Mercury; (ii) Cadmium.
Q.6. (a) List two bacteria which bring about nitrification.
(b) List one denitrifying bacteria.
(c) List any two bacteria which play a role in biological nitrogen fixation.

- Ans.** (a) *Nitrobacter, Nitrocystis*.
(b) *Pseudomonas*
 Azobacter, blue green algae (*Anabaena*), *Rhizobium leguminosarum* (lives as symbiont in nodules of roots of leguminous plants such as pea).

REVISION QUESTIONS

Very Short Answer Type Questions (Carrying 1 mark each)

1. What is biosphere ?

- Ans.** Biosphere is living mantle of Earth where living beings occur.
- 2. Name the physical divisions of biosphere.**
- Ans:** There are three physical divisions of biosphere. Lithosphere (land or soil), hydrosphere (water), and atmosphere (air).
- 3. What are natural resources ?**
- Ans.** The materials present in natural environment (atmosphere, lithosphere, and hydrosphere) and useful to life form are called natural resources.
- 4. What is the literal meaning of resource ?**
- Ans.** Means of supplying a material generally held in reserve is called a resource.
- 5. Name one (1) Inexhaustible resource, (2) Renewable exhaustible resource (3) Non-renewable exhaustible resource**
- Ans.** (1) Inexhaustible resource: Air
(2) Renewable exhaustible resource: Forests
(3) Non-renewable exhaustible resource: Fossil fuels.
- 6. Name any inexhaustible natural resource.**
- Ans.** Solar energy.
- 7. Define atmosphere.**
- Ans.** Atmosphere is a transparent gaseous envelope that surrounds the Earth.
- 8. Name two planets other than Earth which also have an atmosphere.**
- Ans.** Venus and Mars also possess atmosphere.
- 9. What is the major component of atmosphere of Earth and Mars/Venus ?**
- Ans.** The major component of atmosphere of Earth is nitrogen (78.08%) while that of Mars and Venus is carbon dioxide (95-97%).
- 10. Name the region of atmosphere where (a) ozone layers is present; (b) Most of the atmospheric gases are present.**
- Ans.** (a) Stratosphere; (b) Troposphere.
- 11. What percentage of carbon dioxide is present in the atmosphere ?**
- Ans.** 0.03% or more precisely 0.033%.
- 12. What is air ?**

- Ans.** Air is a gaseous mixture that occurs over the Earth and is breathed by all land plants and animals.
- 13. Why is life on Mars and Venus planets not possible ?**
- Ans.** It is so because on these planets carbon dioxide forms about 95-97% of the atmosphere.
- 14. Name the two important biological processes in which air is essential.**
- Ans.** Respiration and photosynthesis.
- 15. Name the gas which has the highest percentage in air.**
- Ans.** Nitrogen.
- 16. Why air is called “breath of life” ?**
- Ans.** Air contains oxygen. The latter is needed by most organisms and plants for all respiration to go on. It is, therefore, rightly called the breath of life.
- 17. Which forms the nuclei for condensation of water vapours in the atmosphere ?**
- Ans.** Dust and smoke particles.
- 18. What is the direction of air in coastal areas during the night ?**
- Ans.** During the night the direction of air currents or wind is from land to sea.
- 19. What would be the direction of air currents coming from Allahabad after it is intercepted by Himalaya in North ?**
- Ans.** Westwards because of the occurrence of low pressure.



20. What is rain gauge ?

Ans. Rain gauge is an instrument for measuring the amount of rainfall.

21. Define air pollution.

Ans. Air pollution is degradation of the quality of air due to addition of natural or human made particulate matter, gases and vapours that have an adverse effect on humans, animals and vegetation.

22. What is smog ?

Ans. Smog is opaque dark brown or greyish mist occurring in cold weather reducing visibility and affecting living organisms.

23. What is acid rain ?

Ans. Acid rain is rain with a pH of less than 5 due to dissolution of sulphur dioxide, nitrogen oxides and hydrochloric acid in it.

24. Lichens are sensitive to which component of air pollution.

Ans. Sulphur dioxide.

Name the common air pollutant which causes depletion of ozone layer.

Ans. Chlorofluorocarbons (CFCs).

26. Name the major green house gas responsible for causing global

warming.

Ans. Carbon dioxide.

27. How ozone layer is useful to us ?

Ans. Ozone protects human beings by absorbing harmful UV radiations of sunlight.

28. Name any one source of emission of carbon monoxide ?

Ans. Motor vehicles.

29. Which of the following two gases has more affinity for hemoglobin ?

(i) Oxygen

(ii) Carbon monoxide

Ans. (ii) Carbon monoxide

30. Name the component present in marble which reacts with acids present in acid rain.

Ans. Calcium carbonate.

31. Where is the major part of fresh water bound up ?

Ans. In the form of ice caps and glaciers (1.9% out of 2.5% of fresh water).

32. Which one determines the density and richness of biota ?

Ans. Availability of water in the form of rainfall.

33. Name parts of India with maximum diversity.

Ans. Western Ghats and north-east India.

34. Name an area in India with very poor vegetation.

Ans. Parts of Rajasthan (Hot desert) such as Jaisalmer and Dras (cold desert).

35. What is water harvesting ?

Ans. Water harvesting is collection and storage of rain water for use later in the non-rainy season. It also recharge the aquifers of underground water.

36. Define water pollution.

Ans. Water pollution is degradation of the quality of water due to addition of undesirable substances or removal of desirable substances.

37. Name two common pathogens in polluted water.

Bacteria (e.g., *E. coli*) and protozoa.

Ans.

38. Name any three water pollutants.

Ans. Sewage, industrial wastes, and fertilizers or pesticides.

39. What is sewage ?

Ans. Sewage is human waste carried by municipal drains.

40. Name the disease caused by mercury pollution of water.

Ans. Minamata disease.

41. What is thermal pollution ?

Ans. Thermal pollution is raising temperature of water due to addition of hot water or hot effluents into it.

42. Define soil.

Ans. The top surface layer of Earth (*i.e.*, weathered part of Earth crust) capable of supporting plant life is called soil.

43. Name three physical agents which cause weathering of rocks.

Ans. (i) Temperature variations ; (ii) Rain water : (iii) Wind.

44. Name the two processes which contribute to soil formation.

Ans. (i) Weathering of rocks,

(ii) Decomposition of organic matter and subsequent humification and mineralization.

45. What is soil pollution ?

Ans. Contamination of soil with solid wastes, chemicals and excess of fertilizers and pesticides thus reducing its fertility and quality, is called soil pollution.

46. Give two effects of soil erosion.

Ans. (i) Reduction in fertility of soil;

(ii) Desertification.

47. What is paedogenesis ?

Ans. Paedogenesis is the process of formation of soil from upper rocky crust of Earth.

48. What is weathering ?

Ans. Weathering is pulverization of rocks to form fine particles.

49. Name the types of weathering.

- Ans.** There are three types of weathering of rocks : physical, chemical and biological.
- 50. What is humification ?**
- Ans.** Humification is addition of partially decomposed organic matter or humus into weathered rock particles to form soil.
- 51. What is top soil ?**
- Top soil is the upper fertile biologically active layer of soil which is rich in minerals, organic matter, microorganisms (bacteria, fungi, earthworms and other animals). Roots of plants are mostly restricted to top soil.
- 52. What is function of wind breaks ?**
- Wind breaks are a few rows of trees and shrubs planted on border of the crop fields at right angles to the direction of wind. This technique remains effective in checking of soil erosion by the wind.
- 53. What is terracing ?**
- Terracing is building flat crop fields on the slopes of hills so as to slow down the flow of water and checking soil erosion.
- 54. Name the type of water (present in the soil) which can be absorbed by plants.**
- Ans.** Capillary water.
- 55. What is detritus ?**
- Ans.** Dead remains of plants and animals are called detritus.
- 56. What are detritivores ? Name any one of them.**
- Ans.** The organisms which consume detritus are called detritivores, e.g., Earthworm.
- 57. What is methane burp?**
- Ans.** Methane burp is a process of periodical release or belching of methane in huge quantities. This is caused by the melting of the methane hydrates existing in permafrost and sea floor. Methane is a GHG, one of the main culprit of global warming.
- 58. What are biogeochemical cycles ?**
- Ans.** Biogeochemical cycles are repeated circulation of biogeochemicals between abiotic and biotic components of the environment which result in their repeated withdrawal and replacement of their pool.

59. Define the biogeochemicals?

Ans. Biogeochemicals are essential elements or nutrients (H_2O , N, O, C, etc.) required by living organisms which are obtained from Earth (land, air and water).

60. How do marine organisms receive continuous supply of nutrients ?

Ans. Marine organisms receive continuous supply of nutrients by rivers which bring the same from rocks and soils over which water flows.

61. What is water cycle ? Give its other name.

Ans. **Water cycle or Hydrological cycle** is repeated circulation of water among various components of the biosphere involving evaporation of water more from the sea and falling (precipitating) more on land and flowing back into the sea by rivers.

62. What is nitrogen fixation ?

Ans. Conversion of inert elemental nitrogen gas into biologically usable form is called **nitrogen fixation**.

63. Name the bacterium capable of nitrogen fixation which resides in the root nodules of legumes.

Ans. *Rhizobium leguminosarum*.

64. What is ammonification ?

Ans. **Ammonification** is release of ammonia from amino acids during the decomposition of proteins.

65. Name a bacterium that causes ammonification.

Ans. *Bacillus ramosus*.

66. Define nitrification.

Ans. Nitrification is oxidation of ammonia (released during ammonification) into nitrate state.

67. Name the types of bacteria involved in nitrification.

Ans. Nitrification is performed by two types of bacteria (i) Nitrite bacteria, e.g., *Nitromonas*; (ii) Nitrate bacteria, e.g., *Nitrobacter*.

68. What is denitrification ?

Ans. **Denitrification** is reduction of nitrates into gaseous nitrogen which escapes from soil into atmosphere.

Name the process which causes a long term withdrawal of carbon

69. from carbon cycle ?

Ans. Formation of carbonate or limestone rocks.

70. What is the reason of increasing concentration of carbon dioxide in the atmosphere ?

Ans. Deforestation and increased combustion of fossil fuels.

71. What is green house ?

Ans. **Green house** is a glass enclosure that is used for growing tropical plants in colder areas even during the winter.

72. What is greenhouse effect ?

Ans. Green house effect (= global warming) is keeping an area warm by allowing the solar radiations to pass in but preventing long wavelength heat waves to escape due to presence of radiatively active gases and glasspanes.

73. What are green house gases ?

Ans. Green house gases (GHGs) are radiatively active gases which allow the solar radiations to pass through but reflect back long wave heat radiations.

74. What do you mean by global warming ?

Ans. Global warming is raising the temperature of surface of Earth and nearby atmosphere (due to green house effect).

75. How is oxygen replenished in nature ?

Ans. Oxygen is replenished through photosynthesis.

76. What is ozone layer (= umbrella) ?

Ans. It is a layer in stratosphere which is rich in ozone.

77. What is ODS ?

Ans. ODS is ozone depleting substance (e.g., CFCs) which causes breakdown of ozone present in ozone layer into oxygen.



78. What is Ozone hole ?

Ans. Ozone hole is drastic depletion of ozone in the ozone layer as present over Antarctica during polar spring.

Short Answer Questions (Carrying 2 marks each)

1. What are inexhaustible resources ?

Ans. These are present in unlimited quantity in nature and are not likely to be exhausted by human use, e.g. air, solar energy.

2. Define renewable resources ?

Ans. Renewable natural resources are those which can maintain themselves or can be replaced if managed wisely, e.g. water, soil, living things such as crops, forests, domestic animals, wildlife.

3. Give two examples of non-renewable resources.

Ans. (i) Metallic minerals
(ii) Fossil fuels.

4. Give two ways in which carbon dioxide is fixed.

Ans. (i) Green plants, through photosynthesis, convert carbon dioxide (CO_2) to glucose in the presence of sunlight.
(ii) Many marine animals use carbonates dissolved in sea water to form their shells.

5. Name the articles which act as nucleus for water droplets to form around in the atmosphere.

Ans. Dust, smoke and other suspended particles of air.

6. Explain the phenomena of : (a) Acid rain ; (b) Global warming

Ans. See [section 6.2](#).

7. Name respiratory diseases that may occur due to air pollution.

Ans. Bronchitis, asthma, lung cancer, tuberculosis.

8. Name the two acids that are present in acid rain.

Ans. Sulphuric acid (H_2SO_4) and Nitric acid (HNO_3).

9. What is rain water harvesting ?

Ans. This technique is used to capture and store rain water by making special water harvesting structures ([Fig 6.9](#)), so that there is an increase in the recharge of underground water resources.

10. Name two examples of green house gases which contribute maximum toward global warming.

Ans. Carbon dioxide and methane.

11. Why is lead compound added to petrol ? What is its harm ?

Generally, tetraethyl lead is added to petrol to make it burn smoothly in motor vehicles. However, burning of petrol in automobiles releases

Ans. toxic lead compounds through the exhaust pipes of automobiles. Continuous inhalation of these compounds causes anaemia, brain damage, convulsions and even death.

12. Name two fresh water sources which provide fresh water for human use.

Ans. 1. Ground water ; 2. Surface water (ponds, lakes, streams, rivers, etc.).

13. List main sources of water pollution.

Ans. (i) Sewage ; (ii) Industrial wastes ; (iii) Synthetic soaps and detergents ; (iv) Fertilizers and pesticides ; (v) Petroleum ; (vi) Heat.

14. What are non-biodegradable substances ?

Ans. These are substances which cannot be broken down by the activity of microorganisms. These substances go on concentrating at each trophic level of food chain, e.g., DDT and heavy metal (mercury, cadmium, etc.).

15. Define eutrophication. What is ill effect of eutrophication ?

Ans. Eutrophication is nutrient enrichment (*i.e.*, addition of nitrates and phosphates) of water body that results in the growth of aquatic plants, especially algae causing colouration of water known as **algal bloom**. It leads to depletion of dissolved oxygen in water resulting in killing of aquatic organisms (*e.g.*, fish).

16. What is biomagnification ? Name two heavy metals which, when magnified resulted in diseases in humans.

Ans. The phenomenon of increase in the concentration of harmful non-biodegradable substances in the body of living organisms at each trophic level of the food chain is called biomagnification. Two heavy metals which are biomagnified are mercury and cadmium.

17. What do you mean by biological weathering ? Give two examples.

Ans. The whole process of weathering of rocks involving living organisms is called biological weathering, *e.g.*, Lichens, mosses, herbs, shrubs

and trees.

18. What is humus ? What are its functions ?

Ans. Humus is partially decayed organic matter. It makes soil porous, thereby increasing its air and water holding capacity. It is rich in nutrients (*e.g.*, minerals) that promote plant growth. Being black or dark brown in colour, humus absorbs heat to warm up the soil.

19. Name two measures which prevent the soil erosion.

Ans. (i) Intensive cropping and reforestation ; (ii) Terrace farming.

20. Differentiate between humification and mineralization.

Humification. It is the process by which simplified detritus gets converted into dark coloured amorphous substance, the humus (humic substances) in the soil. It is relatively a rapid process than mineralization. *Mineralization.* It is release of organically bound nutrients into an inorganic form (*i.e.*, minerals) available to plants. This slow process is performed by decomposers existing in soil and feeding on humus (Odum and Barrett, 2005).

21. What do you mean by hygroscopic water and combined water in the soil ? Are these available to plants?

Ans. *Hygroscopic* means tendency of absorbing moisture from the air. Some water in the soil forms an extremely thin tightly held film around the soil particles. It is called hygroscopic water. In the soil, a small portion of soil water is chemically bound with soil materials. It is called combined water. Both of these types of water in the soil are not available to plants for absorption by their roots.

22. Give two main sources of carbon.

Ans. Fossil fuels, air.

23. Explain carbon monoxide poisoning.

Ans. Carbon monoxide (CO) is a toxic air pollutant. It is exhaled from motor vehicles as one of the exhaust gases, and also from cigarette smoke. Our blood has respiratory pigment, haemoglobin (Hb) in the erythrocytes (RBCs) and it has high affinity for oxygen. As a result, oxygen combines with haemoglobin in the lungs and is carried by blood to various body tissues as oxyhaemoglobin (OHb). Carbon monoxide (CO), a poisonous gas, has *200 times more affinity for haemoglobin than oxygen*. When the polluted air containing large amount of CO is inhaled, the CO then combines with haemoglobin to

form a stable poisonous compound called **carboxyhaemoglobin (COHb)**. This drastically reduces the availability of oxygen to the body tissues and leads to suffocation and finally death.

Short Answer Questions (Carrying 3 marks each)

1. Write down the composition of air.
2. How does oxygen and carbon dioxide remain nearly constant in the atmosphere?
3. How dose the average temperature of Earth remain fairly steady?
4. How are winds produced ?
5. Set up an experiment to measure gain and loss of heat by water, sand and air.
6. Demonstrate the formation of convective currents.
7. Enumerate the factors that influence movement of air.
8. How is rain produced ?
9. Set up an experiment to demonstrate the effect of low pressure and particulate nuclei over water vapours.
10. Describe the major components of air pollution.
11. Write a brief note on acid rain.
12. Explain what is smog. Give its effects.
13. What are the effects of air pollution on human beings ?
14. Explain the direction of air movement during the day and night in coastal areas.
15. Give role of atmosphere in climatic control.
16. Briefly explain main layers of the atmosphere.
17. Explain natural and human-made sources of air pollution.
18. How are clouds formed?
19. What is global warming ? Give its effects.
20. Briefly explain depletion of ozone layer and its effects.
21. Explain phenomenon of acid rain.
22. Explain rain water harvesting.
23. What is climate ?
24. Define the weather.

25. How are CFCs harmful?
26. What is weathering ? Elucidate in the various types of weathering.
27. What is soil erosion ? Explain means of preventing it.
28. How do organisms contribute in the formation of soil ?
29. Discuss how water is replenished in sea.
30. Write a note on nitrogen fixation?
31. How is nitrogen replenished in atmosphere.
32. Describe the methods of carbon replenishment of atmosphere.
33. What are the possible dangers of global warming?
34. How is carbon dioxide concentration of atmosphere rising ?
35. Why is ozone layer called ozone umbrella/shield ?
36. What would be the effects on widening of ozone hole ?
37. Explain water cycle in detail.
38. Draw diagram of (i) nitrogen cycle; (ii) carbon cycle.
39. Name four types of bacteria involved in nitrogen cycle.
40. Draw a diagrammatic sketch of oxygen cycle in nature.
41. Make sketch of hydrological cycle in nature.
42. Briefly describe three aspects of nutrient cycles.
43. Describe biological water cycles.

Long Answer Questions (Carrying 5 marks each)

1. Prepare a flow chart of various natural resources.
2. Why is air called breath of life ? Enumerate functions of air or atmosphere.
3. Describe the causes and effects of air pollution.
4. Explain ozone layer, its depletion and effects of ozone depletion.
5. Give an account of various sources and harmful effects of water pollution.
6. Explain the following : (i) Eutrophication ; (ii) Biomagnification.
7. Why water is necessary for living organisms ? Explain.
8. What is soil ? How does it form ?
9. Give various sources and harmful effects of soil pollution.
10. Define soil erosion. Give its causes, effects and preventive

measures.

11. Describe nitrogen cycle.
12. Mention briefly the role of decomposers of cycling of materials.

VALUE BASED QUESTIONS

Q.1.

In the early December 2012, Capital Delhi was in news for smog due to increased air pollution. Smog resulted in reduced visibility and consequent road accidents, traffic jams, and also caused harmful effects to biotic components in the capital.

- (i) What is smog ? Is it a primary or secondary pollutant ?
- (ii) Justify by giving two reasons why is it harmful to human beings.

Ans.

- Smog is a dark fog formed by condensation of water vapour, dust and smoke particles, and various gaseous pollutants such as oxides of nitrogen, sulphur dioxide, etc., in the troposphere. It is a secondary pollutant.
- (i) Smog reduced visibility leading to accidents.
 - (ii) (a) Smog produces respiratory problems, particularly in young ones and old people.

Q.2.

Government efforts have resulted in increase in population of rhinoceros in some pockets in Northeast region of our country. These mammals consume foliage in large quantities and then move to nearby small water bodies where they defaecate. Recently these water bodies are witnessing algal blooms (or growth) and are getting ultimately choked of affecting even activities of rhinos.

- (i) What is possible reason of algal growth in these water bodies ? Name the process involved.
- (ii) What will be consequence of excessive choking of water bodies with algal bloom.
- (iii) List atleast one step that government must take to save such water bodies.

Ans.

- Faecal matter of rhinoceros provides extra nutrients in the water body. As a result, there occurs excessive growth of algae (called

algal bloom). This process is called eutrophication.

- The algae die and aerobic decomposers in the benthic region become active. They rapidly consume dissolved oxygen of the water to decompose these dead algae. In the absence of dissolved oxygen, all aquatic life (including fishes) will die. In this way, eutrophication deprives us of one of our sources of food.
- (iii) Government must take immediate steps to clean these water bodies by removing algae as well as sediment (slit).
3. **It has been made mandatory to install rain water harvesting system and solar water heater in all buildings in urban areas.**

- (i) **What is the rationale when rain water already passes into drains ?**
- (ii) **Why are solar water heaters are being installed when electric geysers are available ?**

Ans.

- Rain water passed into drain does not enter the ground but is taken out of the urban area and poured into a water body at quite a distance with or without treatment. However, ground water is being withdrawn everywhere for drinking, industrial and irrigation purposes. As a result, the level of ground water is going down and arid conditions are being faced in many areas. In rain water harvesting, rain water from a building is passed directly into ground, dug-wells or water pumps. This recharges ground water.
- Installation of solar water heaters is a method of saving electricity which is always in short supply due to rapid urbanisation, industrialization and intensive agriculture. Coal / gas based power plants are polluting units, they add carbon dioxide to the atmosphere causing global warming. Saving electricity is now a valued social responsibility.

Q.4.

Environment biologists have recently reported that (i) Carbon dioxide concentration in the atmosphere has reached more than 390 ppm. (ii) The antarctic and arctic waters are becoming acidic causing thinning of animal shells. (iii) Polar ice is melting. (iv) Some low lying islands have submerged in sea.

- (a) **What are the reasons behind all these changes occurring on earth ?**
- (b) **Suggest a mechanism to control the same and if possible to reverse the trend.**

The reason for these global ecological changes is faulty recycling of carbon dioxide. More of carbon dioxide is being produced than its consumption in photosynthesis due to following curses of urbanisations: (i) Excess combustion of fossil fuels in industries, power houses, automobiles, homes and other places. (ii) Reduced intake of CO₂ by plants due to deforestation (Forests serve as sinks of carbon dioxide utilization). (iii) Higher amounts of CO₂ entering the atmosphere not only increases its atmospheric concentration but also the concentration of dissolved CO₂ in water, especially in colder seas. The acidity tends to do thinning of the shells of many marine animals. (iv) CO₂ is a green house gas which is causing global warming. Rise in global temperature is melting snow over poles. This is raising the level of sea water slowly. It has already submerged some low lying islands.

Ans.

- (a) **Suggestions for checking global warming.** (i) Large scale tree plantation in all vacant area. (ii) Reduced felling of forest trees. (iii) Reducing consumption of fossil fuels by reducing dependence on thermal power plants, increasing efficiency of automobiles and switching over to alternate technologies that do not consume fossil fuels (e.g., Solar power systems, small hydroelectric power plants, windmills, etc.).

Q.5.

On a school trip to an industrial estate, students found that the marble used in the office buildings has lost its shine and become pitted.

- (i) What is the reason of marble pitting ?**
- (ii) Can this factor cause harm to vegetation as well ?**
- (iii) Suggest methods to prevent this.**

Ans.

- (i) Pitting and discolouring of marble is due to corrosive action of dry or wet acid rain, comprising sulphur dioxide and nitrogen oxides, emitted during combustion of fossil fuels in industries. The acid reacts with insoluble calcium carbonate of marble and converts it into soluble calcium sulphate and calcium nitrate.
- (ii) Yes. Acid rain can cause harm to vegetation by (a) direct action of acid over plants causing death of leaves. (b) solubilisation of essential minerals and their leaching leaving only toxic minerals in the soil.
- (iii) Use of wet scrubbers to remove acidic gases from the industrial

emission.

- Q.6.**
- (i) Razia saw excessive growth of blue-green algae in nearby pond of her village.
 - (ii) Fish, which was previously in plenty were nowhere to be seen. The pond is started to give a stink. Water of the pond changes its colour and is found to be not suitable for cattle. Some of the cattle who visited the pond for drinking and bathing have fallen sick.
 - (iii) What explanation will Razia give for these anomalies to the paniced villagers.

Ans.

- (i) Bloom forming algae occur in a pond only when the quality of pond water has crumbled due to pollution. Blue-green algae secrete toxins that are harmful to animals and humans.
- (ii) Fish of the polluted pond must have died due to deficiency of oxygen in pond water. Oxygen deficiency occurs when there is excess of organic matter (called organic loading). The aerobic decomposers consume the dissolved oxygen. This is followed by anaerobic decomposition of organic matter. It produces sulphides and other sludge producing substances. Blue-green algae can grow under such circumstances.

(iii) Stink from the eutrophic pond comes from anaerobic breakdown products of organic matter. The toxins released by blue-green algae further decline the quality of water causing sickness and skin rashes in animals and human beings.

(iv) Razia could explain the villagers that deterioration of pond has been due to excess of chemical fertilizers used by them in their crop fields. Rain wash brought these fertilizers into the pond. This is called eutrophication. There was initial spurt in the growth of aquatic plants due to this. Excess plant matter slowly caused organic loading of water that reduced its oxygen content killing the fish and other aquatic animals. So fertilizers should be used very judiciously in the fields. Pond should also not be used as garbage bin or septic tanks of village community.