ગુજરાત રાજ્યના શિક્ષણવિભાગના પત્ર-ક્રમાંક
ઉમશ / ૫૫મ / ક-ગ.1 તા. 25-02-11– થી મંજૂર

BIOLOGY

Standard 11

(Semester I)

PLEDGE

India is my country.
All Indians are my brothers and sisters.
I love my country and I am proude of its rich and varied heritage.
I shall always strive to be worthy of it.
I shall respect my parents, teachers and all my elders and treat everyone with courtesy.
I pledge my devotion to my country and its people.
My happiness lies in their well-being and prosperity.

રાજ્ય સરકારની વિનામૂલ્યે યોજના હેઠળનું પુસ્તક

Gujarat State Board of School Textbooks
'Vidyayan', Sector 10-A, Gandhinagar-382010

Authors

Dr. M. I. Patel (Convener)
Dr. Y. M. Dalal
Dr. B. K. Jain
Dr. Yogesh Dabgar
Dr. Chirag Acharya
Dr. N. B. Patel

Reviewers

Dr. B. N. Yagnik
Dr. Sanjay Vediya
Prof. Alkesh I. Shah
Shri Pradip Gaglani
Shri N. D. Dave
Shri Jayshukh B. Harmani
Shri Harshad K. Rajgoar

Language Correction

Shri V. P. Deshpandey

Artist

Shilp Graphics

Co-ordination

Shri Chirag H. Patel
(Subject Co-ordinator : Physics)

Preparation and Planning

Shri Haresh S. Limbachiya
(Dy. Director : Acedamic)

Lay-out and Planning

Shri Haresh S. Limbachiya
(Dy. Director : Production)

PREFACE

The Gujarat State Secondary and Higher Secondary Education Board has prepared new syllabi in accordance with the new national syllabi prepared by the NCERT based on NCF 2005 and core-curriculam. These syllabi are sanctioned by the Government of Gujarat.

It is a pleasure for the Gujarat State Board of School Textbooks to place before the students this textbook of **Biology Standard 11, (Semester I)** prepared according to the new syllabus.

Before publishing the textbook, its manuscript has been fully reviewed by experts and teachers teaching at this level. Following suggestions given by teachers and experts, we have made necessary changes in the manuscript before publishing the textbook.

The board has taken special care to ensure that this textbook is interesting, useful and free from errors. However, we welcome any suggestion, from people interested in education, to improve the quality of the textbook.

Dr. Bharat Pandit
Director
Date : 3/3/2015

Dr. Nitin Pethani
Executive President
Gandhinagar

First Edition : 2011, Reprint : 2011, 2013, 2013, 2014

Published by : Bharat Pandit, Director, on behalf of Gujarat State Board of School Textbooks, 'Vidyayan', Sector 10-A, Gandhinagar

Printed by :

FUNDAMENTAL DUTIES

It shall be the duty of every citizen of India

(A) **to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;**

(B) **to cherish and follow the noble ideals which inspired our national struggle for freedom;**

(C) **to uphold and protect the sovereignty, unity and integrity of India;**

(D) **to defend the country and render national service when called upon to do so;**

(E) **to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;**

(F) **to value and preserve the rich heritage of our composite culture;**

(G) **to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures;**

(H) **to develop the scientific temper, humanism and the spirit of inquiry and reform;**

(I) **to safeguard public property and to abjure violence;**

(J) **to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement;**

(K) **to provide opportunities for education by the parent or the guardian, to his child or a ward between the age of 6-14 years as the case may be.**

* Constitution of India : Section 51-A

INDEX

1

Classification of Living Organisms

Introduction

We live in wonderful nature, which is made up of living as well as non-living Components. The structure and properties of non-living components can be understood through the study of Physics and Chemistry. The properties of non-living components as well as charactersitics of living organisms are fixed. 'Life' is a property of a living organisms. To define life is not easy. Biologists and many other scientists have experimented to under- stand the origin of life. They have also given their opinion and principles regarding the same. Those who possess life are living but what is their identification ? For the identification of living organisms biologists always concentrate on how they function. On the basis of characteristics related with these functions living organisms and non-living components can be understood clearly. On that basis definition can also be given.

What is organism ?

Normally when we define a living organism then we concentrate on it's peculiar charaters. While observing these characters like reproduction, growth, development, their awerness towards environment and adaptation and finally their death, it comes in our mind how unique characters are there in living organisms. As we try to understand the characteristics of living organisms in depth we can add more and more characteristics like metabolism, inheritance, adaptation, control of entropy, death, variation etc. in them.

Reproduction :

Living being can produce new living beings, similar to itself on reaching maturity. Due to this the number of living beings increases and their existance is maintained cotinuously from generation to generation. New living beings take the position in place of dead ones. There are various methods of reproduction like sexual reproduction, asexual reproduction, power of regeneration etc.

Metabolism :

Different types of biochemical processes are constantly carried out in each living cell of organisms. In general these processes are called metabolism. (It is a complex biochemical process.) This process involves catabolism and anabolism, both run sinultaneously. If the ratio of anabolic process is more than catabolic process, growth occurs. Thus growth is an out-put of metabolism. In the same way if the catabolic process is more than anabolic process wear and tear take place in living organism.

Energy transformation also takes place during metabolism in living organisms. This is a complex process but essential in living organism because they have to perform many biological activities. Energy transform is required to do such biological activities. Basically living organisms get energy from their food.

Growth :

To grow in quantity and in number is a character of a living organism. Living organisms increase volume of their body after birth. Multicellur organisms increase through cell divisions. As a result there is growth in the tissues and organ of their body. In plants, growth takes place through out their life where as in animals it occurs during certain age.

Development :

Members of the same species, through the act of copulation, produce zygote as the result of fertilization. Changes take place in cells on the basis of specific functions and this is known as differentiation. It is a character of living organisms. Organogenesis takes place during development. Due to organogenesis, tissues, organs and organ systems are developed in the body of living embryo.

Reaction with environment :

Efficiency of manifestation of feeling towards surrounding or environment is a complex character of each living organism. Manifestation may be in a physical, chemical or biological form. All living organisms from prokaryotes to higher eukaryotes show feeling and reaction towards a silent hint of environment. As for example, plants react against external factors such as light, water, temperature, other living beings, pollutants etc. Animals also possess this character. It is seen that living organisms breed with respect to environmental factors. Every living organism is aware of it's surrounding habitat.

Adaptation :

Living organisms try to show adaptation to environment by changing more or less in their body structure, mode of actions and behaviour. This is now living organisms can sustain in their environment. Those organisms who develop their characters for sustaining influence on efficiency of breeding are considered as more adaptive to their environment. Organisms live in their habitat because they are adapted to their habitat. Fish is adapted to aquatic habitat, birds to arial life and horse to terrestrial life.

Death :

No living organism is immortal. Death is a mystery. We have raised question that why there is death ? Scientists have probed in to it's meaning. We learnt that living organisms use energy through metabolism. Required energy of any system is called free energy. During exchange of energy some amount of energy is consumed in the form of heat, hence the amount of free energy becomes less and as a result measure of disorder increases.

The result of such disorder is called entropy. At regular intervals amount of free energy decreases and amount of entropy increases. As a result the efficiency decreases.

When in all organ systems entropy increases, disorder occurs in organs which stops their functions i.e. death. All living organism die in a time scale. Death is also a meaningful event. If living organisms were immortal, their number would be unlimited. There would be no scope for the birth for new creatures. The number of living individuals of each species remains limited. Components of body further turn to environment due to death, this serial event is continued since long back and it will remain continue. After such knowledge, if we have to define a living organism, we can say that who has life and performs biological processes and also manifests to encironment is a living being.

Efficiency to maintain heredity :

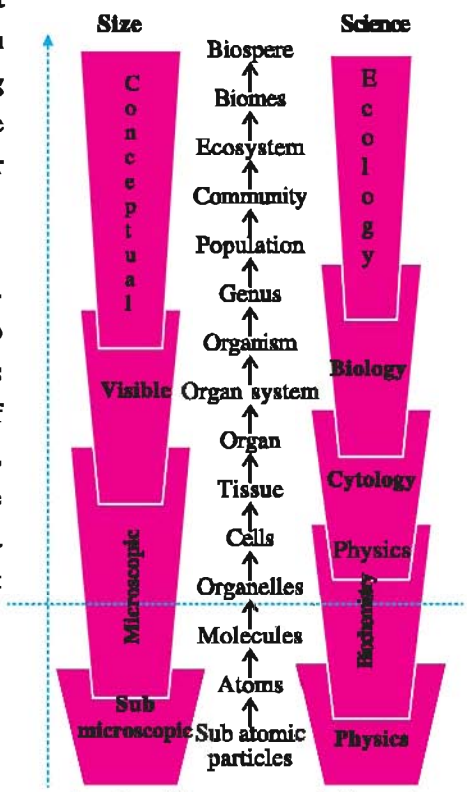
In higher classes of living organisms the phenomenon of life is possible due to internal processes of body. Properties of tissues are not due to constituents present in the cells but it is a result of interactions of the cells. Similarly properties of a cell are not due to constituents of organelle but it is a result of interaction of molecules present in the organelles. Out of such molecules, DNA is inherited by the next progeny produced by parents. It has mysterious genetic codes to produce required chemicals for processes similar to parents. This molecular structure is known as gene. It is a unit of inheritance. This character is not present in non- living things. Legacy is maintained through DNA and is a mysterious character of living organism.

Variation :

As we see around us, we find various living organisms. Why it is so ? Naturally such question can arise. Such diversiform character is called variation. Different characters within same species among individuals is a variation. We have learnt that living organisms adapt to their nature to get maximum utilization from it. For that purpose they show variations. Those living organisms become successful who have efficient variations to use environment. After long period the unit of such variations differ from their original parental characters and a new species arise.

Organisation :

There are various layers of organisation in living organisms. By the association of atoms, molecule is formed. Molecules unite to form macro molecules. By such macro molecules membranes and membranous organelles are constituted. By compilation of organelles cell is formed. A group of cells form a tissue. By tissues, organs and organ systems are organized. As a result body structure is formed. Organism who have such type of body is recognized as a species. These species constitute a population. Populations of different species who live within a same habitat form a biotic community. Ecosystems are structurised through interactions between biotic community and environment. These combined ecosystems form the biosphere. Events of this organisation is remained in hierarchy form, as given in the figure.



Cetegaries of Organisation in Organisam

Biodiversity

There are many microbs, plants and animals habitating in the biosphere. We see them in different zones. They show diversity among many aspects like their volume, shape, life style and many other things. It is called biodiversity. Scientists, for their proper study purpose, establish identification and classify them. If you visit a dense forest you can see many living organisms. These organisms represent in a form of species. Aproximately about 1.7 to 1.8 millions species are identified till today but still we have limited information. Estimated species may be aproximately 50 lac to 5 crore. We can observe greater biodiversity in living organisms if we extend more field study area with continous observations.

Nomenclature :

We know living organisms by their local names during our field study or day to day obser vations in routin e.g. Neem, Mango tree, Crow, Rat, Cockroach etc. These local names vary even from place to place within a country. If we have to describe a certain description which can be easily knowledgable to all, there is a need to standardize the naming which should remain constant all over the world. Method adopted to agreed principals for naming is called nomenclature. The process of idenlifying living organisms attached with such names and described correctly is called identification. In order to facilitate the study of nomenclature and identification many scientists have established different methods, which are acceptable to all.

There is only one scientific name of any organism at world level. Such name is not used for any other living organism. It is not possible to study all organism for their nomenclature. Hence living organisms are meaningfully classified in to groups at primary level. Such method is called classification. Thus classification is a process in which there is a provision of taxon arrangement to classify any living organism to its proper place. Also it should be dependable of easily observable characters, for example we are familiar for certain group by experience e.g. plants, animals, insects, fishes, etc. We integrate with specific characters of that group when we use the word for certain group e.g. there are specific characters for fishes such as aquatic life, gills, fins, scales. If we discuss the mammalian group, we imagine such animal that have ear pinna and hairs on the body. The scientific word taxon is used for proper group for study of living organisms. Thus taxon indicates group at different categories. There is a taxon for plants, maize is also a taxon. Men, insects and fishes are all forms of taxon. Thus based an characteristics, all living organisms can be classified in to different taxa. This process of classification is called taxonomy.

History of classification method

In natural science naturalists and scientists have referred methods of classification from long ago. To classify any set of substances is a part of our common practise, e.g. we classify vessels of kitchen set and arrange them in their proper places. Same is possible for living organisms. In early days man was searching food, clothing and shelter for his own use hence the earliest classification was based on 'use' of living organisms. After that man labour hard to know the interrelationships of such living organisms and due to such effort new branch was created called systemetics. It means a precise method of logical arrangement of organisms. References to classification are found in Sushrut Semihita. Greek philosopher Aristotle had proposed classification of organisms. Scientist Carolas Linnaus studied deeply in this field. He had developed a method for nomenclature of living organisms which was well known as a binomial nomenclature method.

He is known as the father of taxonomy. Bentham and Hooker have done research in depth in the field of plant classification. Their books are helpful to identify plants, to arrange them in herbaria and to prepare regional plant groups. Sir Julion Huxley had developed new systematics by compilation of different branches of biology. Whittaker gave method of classification which is based on five kingdoms. New systematics developed. As the study was done in depth, new systematics are developed through integration of different branches. e.g. chemotaxonomy, cytotaxonomy and numerical taxonomy.

Sources to study systematics :

It is an essential condition for deligence of systematics that he has knowledge of characters of organisms, and salient features of groups and taxa. Such a scholar has to take training for field study. Important characters are required in a scholar such as intense curiosity, concentration, patience, subjective knowledge, cleverness and expertise to use required instruments during this phase. It is also compulsory to obey the rules of field study. Binocular, camera, cutter, foreceps (small and big), required pouches and bags should be kept during study. Some time preservatives should also be kept with us. Detailed study of the field which is to be studied is required. You can select yours surrounding zones, forests, mountains, grounds, grass lands, river, lakes, ocean, for study. These are our open books. It is possible to study systematics through visits to botanical gardens, zoological parks, museums etc. In botanical gardens such plants breed which are medicinal plants, economically important plants as well as rare plants. Green house can be developed for that purpose. There are gene banks. Herbaria are developed where collected plant materials are stored and maintained. Apart from this sketch diagrams, photographs, slides, maps, books of plants are stored there. Different types of animals are kept in animal zoos. Dead stuffed body skeletons, fossils of animals are kept in museums. More information is given in chapter 11.

Principles of Taxonomy :

The nomenclature and classification is based on definite rules. Scientific names of plants are based as per principles of International Code for Botanical Nomenclature (ICBN). Animal taxonomists have to execute the principles of International Code for Zoological Nomenclature. (ICZN)Main rules of taxonomy are as under :

- Normally biological names should be written in Latin. i.e from this language words are chosen. There fore nomenclature of living organism is done in latin language.
- Organisms must be given two names. The first name must be of the genus and the second name must be of the species. The first letter of genus must be in a capital. Species name must be written in small letters. The author's name is written in abbreviated form after species name and at last the popular name of living organism is written.
- When scientific name is written by hand each separate word should underlined. To show its origin in latin it is printed in italic form.
- The generic name used for naming one organism should not be used for any other organism. Example of scientific name : ***Zea mays L.*** **(maize).**

- In some cases name of the sub species is added after the species name. As an exceptional case e.g scientific name of modern man is *Homo sapiens sapiens.*

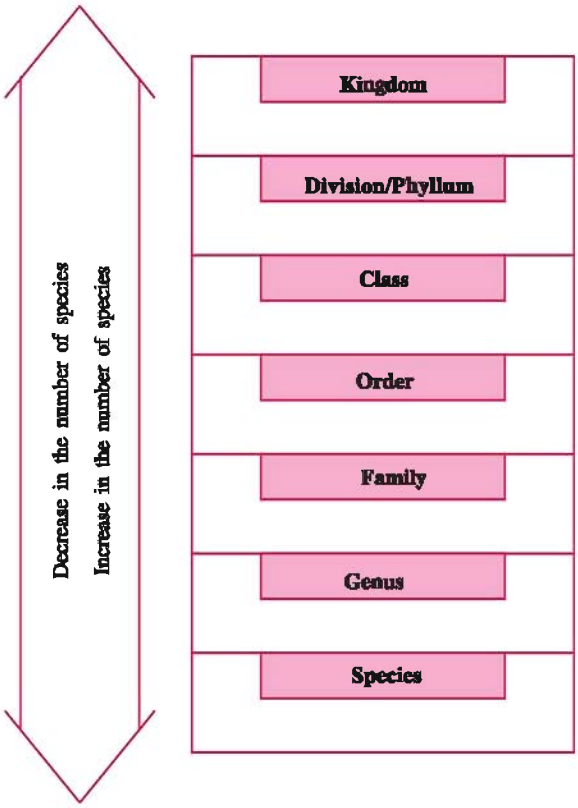
Categories of classification

Classification is not only one step method but it is method of series of sequential steps; in which each taxon shows category. If taxon is a part of classified arrangement with all aspects, it is called a taxonomic category. Such taxa aggregate and form a taxonomic hierarchy. See Fig.

In such classification each taxon is taken as a reference of unit but in a real sense it indicates a specific row in it. Characters either of individual or a group are essential to put living organisms in their related taxa. Similarity and dissimilarity is known through characters and determine their taxa. By such knowledge category is given to living groups at different levels of classification called taxon. The main group in which all other groups (taxa) are included is known as kingdom. After it, taxa are arranged serially : like sub kingdom, phylum, class, sub class, order, family, genus, species. Variations are decreased in sequence from kingdom to species when we see step wise their characters. As the example large number of variations occur in members of animal kingdom which is less seen in the member of their phylum. Same way the dissimilarities present in the members of phylum may not remain in its class, those in class may not ramain in subclass. There are seen more similarities as we go towards species. Let us see explainations of each taxon.

Species :

A group of living individuals which have more similarity in most of their characters and are capable of interbreeding and giving rise to fertile off springs represent species. The latin word written after scientific name indicates such type of species.



Genus :

A group of species having a common ancestor is called a genus. It means one or many species can be included in a single genus. e.g. extinct human race is known as *Homo erractus* where as modern human race is known as *Homo sapiens sapiens.* Thus genus Homo has two species.

Family :

A group of genera which are closely related is called a family. Each family has some specific characteristics e.g. In a study of ornithology columbidae is a family which contains pigeons and doves have different genera and species. But these brids have common characters related to their family where as individual characters differ.

A group of interrelated families constitute an order. Thus a group of orders form a series, a group of series form a subclass and so on up to kingdom taxon is indicated.

Just we have seen that the categories of species, genus and family are depended on their common characters. But after order and than after its serial categories are indentified by their consolidated characters. Let us see some examples.

Taxonomy is as important as other branches in knowledge and economic gain of the society. Deligent in this field becomes a researcher or scientist and is helpful to the society.

Table 1.1 Organisms with their taxonomic categories

Common name	Seientific name	Genus	Family	Series/ Order	z Class	Phylum or Division
Frog	Rana tigrina	Rana	Ranidae	Anura	Amphibia	Vertebrata
Cockroach	Pariplaneta americana	Periplaneta	Blattidae	Orthoptera	Insecta	Arthropoda
Earthworm	Pheretima posthuma	Pheretima	Megasco-lecidae	Opisthopora	Oligochaeta	Anelida
Sunflower	Helianthus annus	Helinathus	Asteraceae	Infirae	Dicotyledones	Angiosperms
Maize	Zea mays	Zea	Poaceae	Glumiflorae	Monocoty ledons	Angiosperms

Summary

Nature is farmed by nonliving and living organisms. One who has life and performs biological processes and manifests to environment is called living organism. Living organism possess certain characters like reproduction, growth, development, reaction with environment, adaptation and death. Besides these it has characteristics like metabolism, entropy, efficiency to maintain heredity. It produces new generation through reproduction. Energy is required during metabolism. Growth is a out put of metabolism. Quantity increases due to growth. Tissues and organs are formed due to differentiation and organogenesis occurs during development. Living organism shows efficiency of manifestations of feeling towards environment. It obtains adaptations to sustain in an environment and creates variations for adaptation. New species is created due to variations, hence biodiversity forms. It has efficiency to maintain heredity before its death.

There is a aggregation of different layers in living organisms. Membranes are formed of large moleculer which are formed from molecules; and molecules are formed from atoms. Cell is formed by membranus organelles. Tissue is constituted by group of cells which are present in organ and organ system. Body is composed by such organ systems. Such living organism is known as species. Population is structured by group of species. Such combained population of a same habitat form a biotic community. By interaction between biotic community and environment constitute an ecosystem. By composition of ecosystem biosphere is constituted.

For the study of living organisms there are nomenclature and identification. Living organisms are classified in to groups. Meaningfully called classification which has species, genus, order, family class, phylum etc. There are certain rules and measures. Many scientist's have contribution in this field. There are various sources for study.

EXERCISE

1. Put a dark colour in a given circle for correct answer :

(1) Scientist who gave classification based on five Kingdom.

(a) Linnaeus ◯ (b) Whittakar ◯

(c) Aristotal ◯ (d) Shusrut ◯

(2) Group of organisms have common ensaster.

(a) Order ◯ (b) Famliy ◯

(c) Species ◯ (d) Genus ◯

(3) Which word is written first of a taxon to write scientific name of living organism ?

(a) Species ◯ (b) Kingdom ◯

(c) Genus ◯ (d) Sub-Kingdom ◯

(4) Scientific name of a modern man

(a) Homo ◯ (b) Homo erractus ◯

(c) Homo sapiens sapiens ◯ (d) Homo sapiens ◯

(5) What structure will be formed when individual species get together ?

(a) Biotic community ◯ (b) Population ◯

(c) Ecosystem ◯ (d) Biosphere ◯

(6) What structure is constituted when populations pass their life in a comman habitat.

(a) Ecosystem ◯ (b) Population ◯

(c) Biotic community ◯ (d) Biosphere ◯

(7) In living organisms measure of free energy in entrophy remains…

(a) Decrease ◯ (b) Balanced ◯

(c) Increase ◯ (d) Increase or Decrease ◯

(8) By whom continuetity is maintained from generation to generation in living organisms ?

(a) DNA ◯ (b) RNA ◯

(c) Organel ◯ (d) Cells ◯

(9) Which sequence is correct for body organization in living organisms of the following ?

(a) Cell → Tissue → Organ → Body ◯

(b) Cell → Tissue → Organ → Organsystem → Body ◯

(c) Body → Organsystem → Tissue → Cell ◯

(d) Tissue → Organ → Organsystem → Body ◯

(10) In which sequence construction is formed after species to biosphere.

(a) Species → Population → Biotic community → Ecosystem → Biosphere ◯

(b) Population → Biotic community → Ecosystem → Biosphere ◯

(c) Biotic community → Many communites → Ecosystem → Biosphere ◯

(d) Population → Ecosystem → Biosphere ◯

(11) A method for naming adopted by rules in living organisms…

(a) Classification ◯ (b) Identification ◯

(c) Taxonomy ◯ (d) Namenclature ◯

(12) Which group is indicated if it bears scales, fins and aquatic life ?

(a) Mammalia ◯ (b) Insecta ◯

(c) Annnelida ◯ (d) Fishes ◯

2. Answer the following questions in short :

(1) Give classification of following organisms as per taxon. Frog, Maize, Cockroach

(2) Elucidate : Variatian, nomenclature, scientific name, biodiversity, entropy

(3) Give definitations : Species, Genus, Family, Class, Kingdom

3. Write in short :

(1) Source to study classification

(2) History of classification

4. Answer the following questions :

(1) What is living organism ? Explain its main characters.

(2) Explain aggregation of living organism at different levels.

(3) Write rules of classification.

(4) Clarify the categories of classification.

(5) Write contribution of scientists in taxonomy.

•

2

Taxonomical Aids

Plants, animals and other organisms inhabit the biosphere. All organisms have direct or indirect interrelations. They show diversities in their structure, functions and behaviour. For the study and identification of these organisms classification is essential which enables us to know interrelationship between them. Classification and identification of organisms require laboratory as well as field studies. Taxonomical studies are useful in agriculture, forestry, industry and in general for knowing our bio-resources and their diversity. The collection of actual specimens of plant and animal species is essential and is the prime source of taxonomical studies. Flora and fauna of various geographical regions can be prepared through taxonomic study. The geographical distribution of organisms can also be explained through it. Measures can also be taken for conservation of endangered and extinction-prone organisms. It is used for classification of an organisms and the information gathered is also stored along with the specimens. In several cases specimens are preserved for future study.

Many procedures and techniques have also been established to store and preserve the information of specimens. Some of the procedures and techniques are as follows.

Herbarium :

Herbarium is a store-house of plant specimens collected from different localities. These specimens are pressed, dried and mounted on appropriate sheets, arranged according to some known systems of classification and kept in pigeon-holes of steel or wooden cup boards.

Herbaria are generally associated with botanical gardens and educational or research organizations. In herbaria, specimens are preserved in a specific manner, which includes, collection, pressing, drying, poisoning, mounting, labeling and arrangement according to some accepted method of classification.

Herbarium specimen

First of all, the plant collected during field study is spread properly between sheets of blotting paper, pressed and dried. Specific preservative chemicals for preservation are sprayed on it. This process is called poisoning. Then, the specimen is mounted on a definite size of thick sheet called herbarium sheet. For maintenance of position of specimen, it is either stiched or an adhesive tape is used. A label occurs on lower right side of the sheet, which shows the scientific name of plant, its family, its popular name, location of its collection, date of collection and other relevant information. Then, sheet is given a reference number. Finally, it is stored in its proper position and sequence in the cupboard. Time to time, treatments like putting naphthalene balls, fumigation etc. are given for protection against humidity, fungus and insects.

Herbaria also maintain collections of diagrammatic sheets, photographs, slides, charts and botanical books.

Functions of herbarium

(1) It provides necessary information for verifying and identifying newly collected plant specimens.

(2) It provides research facilities to the students of taxonomic research.

(3) It provides complete idea of vegetation and the place of origin of plants.

(4) The ecological, economical and ethnobotanical data may be obtained from it.

(5) It provides key for the preparation of modern system of classification.

Information regarding some of the most known herbaria in the world and in India is given below :

Sr. No.	Name of Herbaria	Place
1.	Museum of Natural History	Paris(France)
2.	British Museum of Royal Botanical Garden	Kew (England)
3.	Central National Herbarium	Kolkata
4.	Herbarium of Forest Research Institute	Dehradoon
5.	Herbarium, Department of Botany, M.S. University.	Vadodara

Botanical Gardens

"Botanical Garden means scientifically planned collection of trees, shrubs, herbs and climbers and other living plants from different parts of the globe. They are different from public parks and gardens. Plant species in these gardens are grown for identification purposes. Each plant is labeled indicating its scientific name and family. Various kinds of plants having medicinal and economic importances as well as rare plants are cultivated and maintained in botanical gardens. Plants from other regions are grown in these gardens by creating suitable environment for them. For this purpose, Green houses, Cactus houses, Ferneries, Orchidium, Glass houses, Conservatory and Artificial ponds are developed.

Importance of Botanical gardens :

Botanical gardens play the following important roles :

(1) Aesthetic appeal : Botanical gardens have aesthetic appeal and attract a large number of visitors for observation of plant diversity and some of curious plants. For example, the great Banyan tree in the Indian Botanical Garden at Sibpur (Calcutta).

(2) Material for botanical research : Botanical gardens generally have a wide range of species growing together and offer ready material for botanical research, which can go a long way in understanding taxonomic affinities.

(3) On-site teaching : Collection of plants is often displayed according to families, genera or habitats and can be used for self-instruction or demonstration purpose.

(4) Integrated research projects : Botanical gardens with rich living plants can support broad-based research project which can integrate information from diverse fields such as anatomy, embryology, phytochemistry, cytology, physiology and ecology.

(5) Conservation : Botanical gardens are now gaining increasing importance for their role in conserving genetic diversity, and also in conserving rare and endangered species.

(6) Herbarium and Library : Several major botanical gardens of the world have herbaria and libraries as an integral part of their facilities, and offer taxonomic materials for research at a single place.

(7) Public service : Botanical gardens provide information to the general public on identification of native and exotic species. Staff of botanical gardens gives understanding of landscape gardening, horticulture operations and other allied disciplines.

(8) Production of new species : New varities are developed through grafting, tissue culture, cloning and hybridization in botanical garden.

(9) Germplasm bank : Seed bank can be developed through botanical garden and gene bank can be developed for conservation of rare genes. Many new and improved varities of fruits, vegetables and flowers are the results of researches in botanical gardens.

Over and above all these, such gardens add to the scenic beauty of the region. They also play important role in study of botany, conservation of natural resources and also an important role in the maintenance of the environment.

Thousands of botanical gardens are located worldwide. Of these nearly 800 important gardens are documented in the "International Association of Botanical Garden" (IABG). Some of the major botanical gardens are listed below :

Sr.No.	Name of Garden	Place
1.	Royal Botanical Garden	Kew (England)
2.	New York Botanical Garden	New York (U.S.A.)
3.	Indian Botanical Garden	Shibpur (Kolkota)
4.	National Botanical Research Institute	Lucknow (Uttarpradesh)
5.	Lyoid Botanical Garden	Darjeeling (West Bangal)
6.	Botanical Garden, Vaghai	Vaghai (District. Dang, Gujarat)

Museum

The biological musea are generally set up in educational institutes such as schools, colleges and universities. Musea in the schools and colleges are of primary level, but in universities they are much more rich and informative.

Plant, animal and fossil specimens are collected in the museum for study and reference purposes. Musea often have collections of skeletons of humans and other animals too. The zoological museum has separate galleries for mammals, birds, lower vertebrates, invertebrate, separate room for index collections, skeleton gallery, ethnology gallery, library and laboratory.

Specimens are preserved in the containers or jars in preservative solutions. Plant and animal specimens may also be preserved as dry and are arranged according to some accepted methods of classification. Dead bodies of large animals like birds and mammals are stuffed, by removing various and putting a mixture of cotton, dried powder of plants and preservatives in the body to keep their natural appearances for longer periods. Insects are preserved in insect boxes after collecting, killing and putting on plants. Specimens of rare, endangered or extinct organism are preserved and maintained.

The Natural History Museum at Mumbai, Zoological Survey of India at Jodhpur and Calcutta and the Government Museum at Chennai are very famous. The museum at Vadodara is also very rich. It also provides studies in museology.

The mission of the museum is to understand and preserve biological diversity and cultural heritage.

Zoological Park

Zoological park means "an institution where various kinds of living animals are conserved and exhibited in captivity". The Zoological parks in India are also sometimes referred as the zoological gardens. The main objectives of the zoological park are as under :

(1) *Ex-situ* conservation and propagation of the fauna.

(2) To initiate captive breeding programme for endangered species in initial period following rehabilitation of this species in the wild as per need in accordance with the protocol.

(3) Zoological park runs a centre for providing information to conserve wild-life. It also enhances public awareness of wild-life with the help of public support from different sections of society.

(4) It provides opportunity to study the fauna in scientific manner in which the information are given regarding animal behaviour, adaptation, nutrition, evolution and ecology etc. as well as scientific management and conservation of wild-life.

(5) It provides information regarding health care and rehabilitation of rescued animals.

(6) It inculcates love, affection and creates awareness among the people about wild-life.

(7) It also promotes eco-tourism for employment and sustainable life.

In order to achieve above objectives following facilities are provided in zoological park :

Different types of animals are inhabitated in zoological park. Areas are demarcated as per their classification. For example, Bird house, Wild-Animal house, Reptile house, Snake house, setting up of nocturnal animal house, Crocodile park, Insectariums, Aquarium, Zoological museum and Zoo library to enhance the importance of the park to the visitors. Special care is taken to maintain their life habits and nutritional habits. They are induced to breed and their hybridization is carried out. The severely injured or critically ill animals find a safe protection in the zoological park. The park also conducts various training programmes at school and college levels to educate the people about conservation of biodiversity. The parks have species bank and genebank for a wide variety of flora and fauna. Each zoological park is managed by various sections like administration, animal section, veterinary section, sanitary section, store section, education section, research section, garden section, security section and maintenance section, which are managed by an officer or supervisor.

The zoological parks are working under supervision of the (Central Zoo Authority) and are being run and managed by both private and government organizations.

Safari park (Sasan Gir), Sakkarbaug (Junaghadh), Zoological parks (Ahmedabad and Vadodara) and Indroda park (Gandhinagar) are included in the Zoological parks of Gujarat. National Zoological Park (New Delhi), Rani Jijamata Udyaan Zoo (Mumbai), Nehru Zoological Park (Hydrabad), Himalayan Zoological Park (Gangtok), Trivandrum Zoological Park (Trivandrum) and Arignar Anna Zoological Park (Chennai) are the most prominent Zoological Parks in India.

Summary

A number of taxonomical aids have been developed for identification, naming and classification of organisms. Actual specimens are collected from the field and preserved in the form of herbaria and museum. Live specimen of plants and animals are found in botanical garden and zoological park respectively. In museum there are specific methods to store plant specimens.

EXERCISE

1. Put a dark colour in a given circle for correct answer :

(1) The place where the collected specimen of plant are stored is known as :

(a) Zoological park ◯ (b) Herbarium ◯

(c) Museum ◯ (d) Botanical garden ◯

(2) The specific sequence for collection and preservation of botanical specimen is :

(a) Collection, pressing, poisoning, drying ◯

(b) Collection, drying, pressing, poisoning ◯

(c) Collection, pressing, drying, poisoning ◯

(d) Collection, drying, poisoning, pressing ◯

(3) Where the museum of natural history is located ?

(a) Kolkata ◯ (b) Vadodara ◯

(c) Paris ◯ (d) Mumbai ◯

(4) For the preservation of herbarium specimen which of the following is necessary :

(a) Fumigation process ◯ (b) Stiches with thread ◯

(c) Fixing with adhesive tape ◯ (d) Drying ◯

(5) Where the Great Banyan tree is located ?

(a) New York Botanical garden, New York ◯

(b) Royal Botanical garden, England ◯

(c) Indian Botanical garden, Kolkata ◯

(d) Lyoid Botanical garden, Darjeeling ◯

(6) For the production of new varities which one of the following is not included ?

(a) Tissue culture ◯ (b) Cloning ◯

(c) Hybridization ◯ (d) Horticulture ◯

(7) What is the name of zoological park situated in Junagadh ?

(a) Indroda park ◯ (b) Sakkarbaug ◯

(c) Safari park ◯ (d) Nehru zoological park ◯

2. Short answer questions :

(1) Mention any one importance of the study of classification.

(2) Define-Herbarium

(3) What is poisoning ?

(4) What is botanical garden ?

(5) Where the gene for the endangered species can be conserved ?

(6) Give the full form of IABG ?

(7) Name the botanical garden situated at Darjeeling.

(8) What can be done for the proper preservation of specimen in museum ?

(9) Where the Himalayan zoological park is situated ?

3. Answer the following questions :

(1) Mention different types of methods used for the preservation of plant specimen ?

(2) Mention the functions of herbarium.

(3) Write the contribution of botanical garden.

(4) What are the aims of zoological park ?

(5) Give the names of botanical gardens and zoological parks located in Gujarat.

(6) Write short note on museum.

(7) Describe in brief: The method for making herbarium.

•

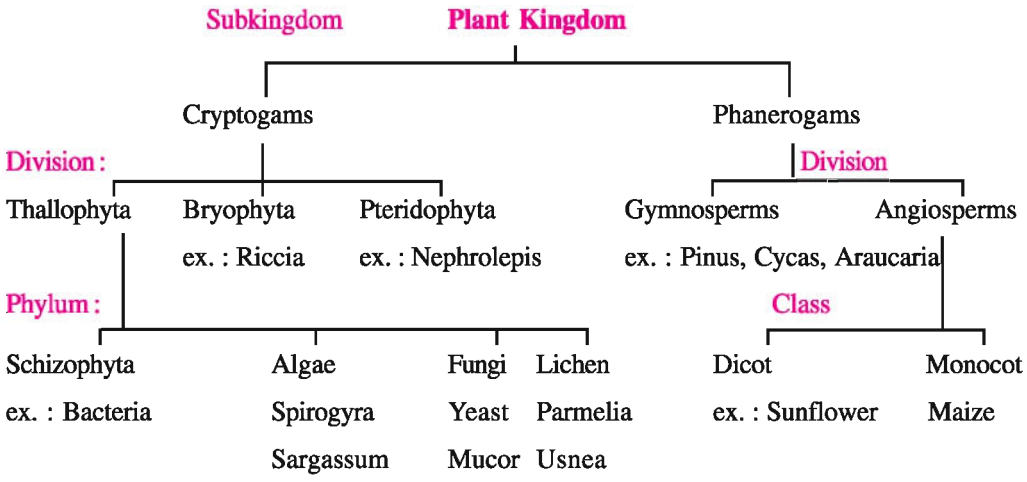
3

Classification of Plant Kingdom

The Science means a Systematic Knowledge of each and Everything

The study of living objects is called Biology. It is divided into two branches-Botany and Zoology. Botany deals with the study of plants from different points of view. This science investigates the internal and external structures of plants through evolutionary and phylogenetical aspects. The functions and characteristics of plants are identified by their cellular structure, habitats, adaptations, nutrition, inter-relationship, reproduction, life cycles, importance and classification. The first formed life is known as protista and they gave rise to two different forms of life- mostly immobile plants and mobile animals.

When the plant life migrated from water to the land, it has undergone a series of successive changes through plant succession. As a result of evolutionary development, the lower and simpler forms are developed in to higher and more complex forms.



(Eichler System of Classification)

Many systems for classifying the plant kingdom have been formulated by various researchers and scientists, from time to time. Scientist Eichler has classified the plant kingdom into two main groups- flowerless or seedless plants called Cryptogams and flowering or seed bearing plants called Phanerogames or Spermatophyta. Cryptogams have been further divided into three groups- Thallophyta, Bryophyta and Pteridophyta. While Phanerogames are classified into two groups- Gymnosperms and Angiosperms. Angiosperms have been classified into two classes- Dicotyledones and Monocotyledones. The Bryophyta, Pteridophyta and Phanerogames are included in Embryophyta.

Five kingdom classification :

Many systems of classification of plants have been proposed by various naturalists and botanists based on different criteria. A Greek naturalist Theophrastus classified plants into four groups on the basis of their habit. Theophrastus is considered as the Father of Botany (370-285 B.C.). A Swedish naturalist Linnaeus classified plants into 24 groups on the basis of sexual characters. Linnaeus is considered as the Father of Taxonomy (1707-1778).

A new five kingdom classification system was given by R. H. Whittaker (1969) on the basis of following four criteria.

(1) Complexity of cell structure (prokaryotic or eukaryotic)

(2) Complexity of body structure (unicellular or multicellular)

(3) Mode of nutrition-autotrophic (photosynthesis) and-Heterotrophic (absorption and ingestion)

(4) Major ecological role (Producer, Decomposer and Consumer)

The five kingdoms are Monera, Protista, Fungi, Plantae and Animalia.

(1) Kingdom : Monera (The Kingdom of Prokaryotes) :

Microorganisms which are without well organized nucleus (but having nucleoid) and membrane bound organelles are included in this kingdom. Cell wall is rigid and nucleoprotein occurs as the genetic material. Mode of nutrition is autotrophic or heterotrophic. Examples: Bacteria and blue green algae (cyanobacteria) like Anabaena.

Anabaena

(2) Kingdom : Protista (The Kingdom of Unicellular Protozoans and primary aquatic eukaryotes) :

The kingdom includes organisms having well organized nucleii and membrane bound organelles. Nutrition varies from autotrophic to heterotrophic. Examples: *Euglena*, Dinoflagellates, *Amoeba* and *Paramoecium*.

(3) Kingdom : fungi (The Kingdom of Multicellular Decomposers) :

This includes unicellular or multicellular eukaryotic organisms. Cell wall is made up of fungus cellulose (Chitin). The mode of nutrition is either parasitic or saprophytic. Embryo is not formed as a result of sexual reproduction. Examples: Slime mould, Yeast (Unicellular), Mucor (Bread mould) and Mushroom.

(4) Kingdom : Plantae (The Kingdom of Multicellular Producers) :

This kingdom includes all multicellular, aquatic or terrestrial eukaryotic organisms. The mode of nutrition is autotrophic. Plant body is simple and thalloid or differentiated into root, stem and leaves. Cell wall is made up of cellulose. Reproduction results in the formation of embryo except in algae. Examples: Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.

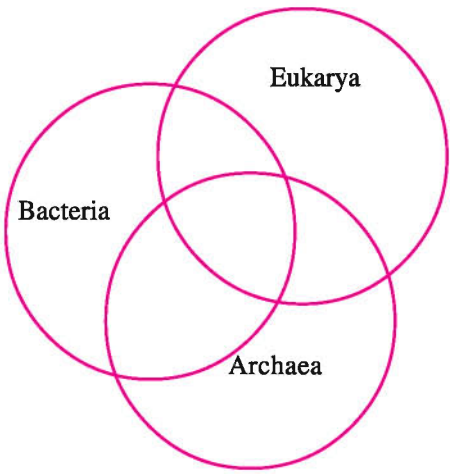
(5) Kingdom Animalia (The Kingdom of Multicellular Consumers) :

The members of this kingdom are multicellular, aquatic or terrestrial, heterotrophic eukaryotes. They show great variations in form, structure and reproduction. Cell wall is absent. Reproduction is mainly by sexual methods. Examples: members of Coelenterata, Platyhelminthes, Nemathelminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Chordata.

Three-domains classification :

The three Domains classification system was given by Woese (1978). It is an evolutionary model of classification. This is based on differences in the sequences of nucleotides in the cell's ribosomal (rRNA), of the cell as well as the lipid structure of cell membrane and its sensitivity to antibiotics. In this system, prokaryotic and eukaryotic organisms are divided into following three domains :

(1) Archaea Domain (2) Bacteria Domain (3) Eukarya Domain



Three-domain classification

1. **Archaea Domain :**
   - They are Prokaryotic cells without nuclear membrane.
   - Cell wall does not contain peptidoglycan.
   - *Archaea* lived in extreme condition.

Examples : Archaebacteria

- Methanogens – responsible for the production of methane
- Halophiles – lived in extreme salty area
- Thermoacidophiles - survive in acidic and high temperatures (in hot spring)

(2) Bacteria Domain :

They are Prokaryotic cells. Cell wall is made up of peptidoglycan. This kingdom includes most known pathogenic prokaryotic organisms.

Examples : Eubacteria

- Cyanobacteria - photosynthesizing bacteria
- Spirochaete - Gram-negative bacteria
- Firmicutes - Gram-positive bacteria

(3) Eukarya Domain :

- They are Eukaryotes, Cell wall is absent, if present it is made up of either cellulose or fungul-cellulose.
- The Eukarya domain is divided into 4 kingdoms: Protists, Fungi, Animalia, and Plantae.

(A) Kingdom Protista : Protista are simple, predominantly unicellular eukaryotic organisms. Examples- slime moulds, euglenoids, algae, and protozoans.

(B) Kingdom Fungi : Fungi are unicellular or multicellular eukaryotic organisms. Cell wall is made up of fungus-cellulose and cells are not organized into tissues. They do not carry out photosynthesis and obtain nutrients through absorption. Examples- sac fungi, club fungi, yeasts, and moulds.

(C) Kingdom Plantae : Plants are multicellular organisms composed of eukaryotic cells. The cell wall is made up of cellulose and the cells are organized into tissues. They obtain nutrients by photosynthesis and absorption. Examples- mosses, ferns, conifers (Gymosperms) and Angiosperms.

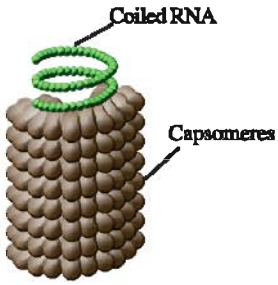
(D) Kingdom Animalia : Animals are multicellular organisms composed of eukaryotic cells. The cell wall is absent and the cells are organized into tissues. They do not carry out photosynthesis and obtain nutrients primarily by ingestion. Examples- sponges, worms, insects, and vertebrates.

Viroids and Viruses

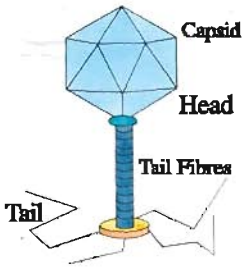
Viroids :

Viroids are discovered by Diener (1971) from infectious agents which are even smaller than viruses. Viroid consists of a very simple structure and short RNA strand. Protective protein coat known as capsid is absent.

Many plant diseases and few animal diseases are caused by viroids for example Potato spindle tuber disease and Alzheimers disease in human being.



TMV



Bacteriophage virus

Viruses :

Virus means poison and the name virus was given by Pasteur to the causative agents of infectious diseases. Invanowsky discovered Tobacco mosaic virus, for the first time and recognized it as a causal organism responsible for tobacco mosaic disease.

Viruses are omnipresent and extremely minute in size. They are so minute that they can pass through bacteria-proof filters. They are ultra-microscopic, crystalline, self reproducing and obligate parasite in living cells. When they are outside of living cell; they remain inactive and behave as non-livings (in free stage), but when they enter inside of living cells, they are active and behave as living organisms (in host cell). Because of this character they are intermediate between living and non-living things and hence, they are called as living chemical. The main structural component is nucleoprotein (nucleic acid and protein). A virus contains only one type of nucleic acid, either DNA or RNA, which is surrounded by a protective protein coat known as capsid. The capsid is made up of many small subunits of capsomeres which are made up of polypeptide chain.

Tobacco mosaic virus and Poliovirus are the examples of plant and animal viruses respectively. Viruses that live on bacteria are known as bacteriophages or bacterial viruses.

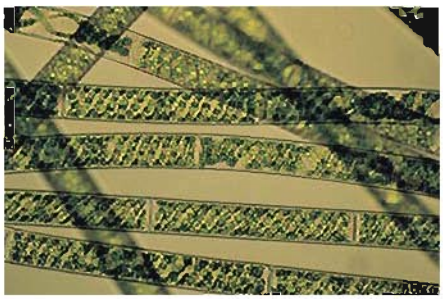
Algae and Fungi :

Algae :

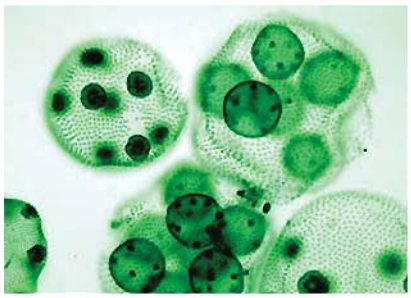
Algae is the first existing group of plants on the earth. As the thallus structure of the plants is very simple, they are known as primitive plants. The study of algae is called Algology or Phycology. Professor Iyengar, is considered as the father of modern algology in India.

Algae are found in fresh water, ocean or moist habitat generally. The plant body does not possess root, stem and leaves hence is called thallus which is unicellular or multicellular, prokaryotic or eukaryotic, filamentous or colonial in form. Cell wall is made up of cellulose. Algae consist chlorophylls and other photosynthetic pigments such as (xenthophyll, phycocynin, phycoerythrin and fucoxenthin), therefore algae are autotrophic in nutrition. Different colours of algae are due to presence of different types of pigments. -Brown algae, Red algae, Cynophycean (blue green algae) algae and Green algae. They contain starch as the reserve food materials. Algae reproduce by vegetative reproduction (by fragmentation), asexual reproduction (by spores) and sexual reproduction (by conjugation). Sex organs are naked. After fertilization, zygote does not develop in to embryo.

Examples : *Nostoc* (cyanophyceae), *Chlamydomonas* (unicellular), *Spirogyra* (filamentous) and *Volvox* (colonial).



Spirogyra



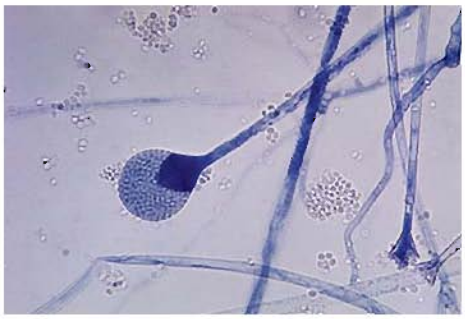
Volvox

Fungi :

Fungi show cosmopolitan distribution. Cells are without chloroplast. The study of fungi is called Mycology.

Fungi grow in water, air, on soil, food, leather, cloth, etc. The plant body (thallus) is called mycelium which is made up of thread-like filaments known as hyphae. Hyphae are septate or aseptate. Cell wall is made up of fungus-cellulose (chitin). Chlorophyll is absent therefore, they can not prepare their own food materials. Hence they are heterotrophs. Some fungi are parasites (obtain nutrition from living organisms) and saprophytes (obtain nutrition from decaying organic materials). Reserve food materials are mainly glycogen and droplets. Fungle reproduction mainly by vegetative reproduction (by fragmentation and budding), asexual reproduction (by zoospores or aplanospores) and sexual reproduction (by conjugation or other types). Sexual reproduction may be isogamous, heterogamous or oogamous type. Sexual reproduction takes place in three phases : (1) Plasmogamy (2) Karyogamy (3) Meiosis.

Examples : *Yeast* (unicellular), *Mucor* (Bread mould), *Agaricus* (Mushroom) and *Penicillium*.



Mucor

Mushroom

Lichens :

Lichens show symbiotic relationship between algae and fungi. Study of lichens is called Lichenology. Lichens were first discovered by Tulsane.

Lichens live in wet and moist habitats and have a composite thalloid structure of algae and fungi. The algal component is known as phycobiont which is autotroph and fungal component is called mycobiont which is heterotroph. Fungi absorb water and mineral nutrients from environment and provides to algae,while algae synthesize food by the process of photosynthesis and provide to fungi. Lichens reproduce asexually by producing oidiospores and pycnidiospores and sexually by producing a distinct structure called fruiting body which produces sex organs (spermogonium and carpogonium). The fruiting body of lichens is called apothecium (cup shaped) or perithecium (flask shaped). On the basis of external form lichens are of three types : (1) Crustose lichens (2) Foliose lichens and (3) Fruticose lichens.

Usnea

Examples : Strigula Parmelia, Usnea.

Bryophytes

These plants occupy a position between algae and pteridophyta. Gametophytic plant body is either thalloid (in liverworts) or erect (in musci). They are simplest and primitive embryophytic plants. Professor Shiv Ram Kashyap, is considered as the father of Inadian bryology. Botanist Rothmelar has divided the bryophytes into three classes : (1) Hepaticopsida (2) Anthocerotopsida and (3) Bryopsida.

Bryophytes are found in moist and shady places such as moist soil or moist walls and on the damp rocks etc. They contain chloroplasts and hence, they are autotrophic. Vascular tissues are absent. Fertilization takes place in the presence of water. After fertilization, zygote undergoes divisions to form embryo. The life cycle of bryophytes has two distinct phases (1) Gametophytic and (2) Sporophytic, alternating with each other. This phenomenon is called alternation of generation.

(1) Gametophytic phase : It is main phase which is haploid, autotrophic, gametes formative(male and female) and responsible for the sexual reproduction.

(2) Sporophytic phase : It is subsidiary phase which is diploid, heterotrophic, spore formative and responsible for the asexual reproduction. Vegetative reproduction takes place through fragmented tubers, adventitious branches and gemmae. Sexual reproduction takes place by sex organs like antheridium (male reproductive organ) and archegonium (female reproductive organ).

Examples : *Riccia*, *Anthoceros* and *Funaria* (Moss).

Riccia

Funaria (Moss)

Pterodophytes :

They were the first land plants on the earth. Pteridophytes are usually terrestrial and grow in moist or shady habitat. They consist root, stem and leaves with well developed vascular tissues (xylem and phloem). Zygote undergoes divisions to form embryo. Spores are produced inside the sporangia. The sporangia are borne on the sporophylls. Sporophylls are arranged in the form of definite cone or strobilus. The sporophylls are of two types.

(1) Homophyllous : produce similar type of spores (homosporous) and

(2) Heterophyllous : (microsporophylls and megasporophylls)- produce different types of spores(heterosporous)-microspores and megaspores. Like bryophytes the life cycle of pteridophytes shows alternation of generation.

There are two distinct phases **(I) Gametophytic phase :** It is a subsidiary phase which is haploid grows as a prothallus, short lived, gametes producing and responsible for the sexual reproduction. **(II) Sporophytic phase :** It is a main diploid phase, long lived, spores producing and responsible for the asexual reproduction. Asexual reproduction takes place by spores which are produced in sporangia and sexual reproduction by sex organs like antheridia and archegonia.

Examples : *Nephrolepis* (common), *Equisetum* (homosporous), *Selaginella* (heterosporous) and *Rhynia* (fossil).

Nephrolepis

Selaginella

Equisetum

Gymnosperms

Plants of this group possess naked seeds. Gymnosperms vary in size from small plants to very large gigantic plants. *Zamia pygmea* is the smallest gymnosperm having an underground tuberous stem. While *Sequoia sempervirens* is the tallest tree of the world, having height of about 150 meters.

Sequoia

Plant body is sporophytic and differentiated into root, stem and leaves. Leaves are two types-(1) Foliage leaves (big and green) and (2) Scaly leaves (minute and brown). They are evergreen, perennial trees or shrubs showing xerophytic characters. Ovules are naked and not enclosed by the ovary therefore recognized as a gymnosperm. Vascular tissues are present. Like bryophytes and pteridophytes, the plant shows alternation of generation. The gametophyte and sporophyte phases alternate with each other to complete the life cycle. (1) Gametophytic phase- It is subsidiary phase which is haploid and short lived and (2) Sporophytic phase- It is a main phase which is diploid, long lived and occurs as a whole plant. Sporophylls are arranged on central axis in the form of cone or strobilus. Cones are unisexual and gymnosperms are heterosporous.

Zamia

In a male cone, microsporophylls bear microsporangia which produce a large number of microspores and in female cone, megasporophyll bears megasporangia which produce four megaspores.

Note : At this point microsporophyll, microsporangium and microspors can be compared with stamen, anther and pollen grains of angiosperms respectively. Similarly megasporophyll and megasporangium can be compared with gynoecium and ovule respectively.

Pollination takes place through wind and formation of endosperm takes place before fertilization (pre-fertilized). Gymnosperms show single fertilization. The ovules are orthotropous. True fruits are lacking because of the absence of ovary.

Examples : Species of the conifer forest like *Cycas*, *Pinus*, *Araucaria* (Christmas tree), *Bennettites* (fossil plant) and *Thuja* (ornamental plant in garden- Morpichh or Vidhya).

Cycas

Thuja

Pinus

Angiosperms :

This spermatophyte group is highly evolved, recent, dominant and biggest plant group all over the world. Angiosperm shows cosmopolitan distribution. The plant species may be hydrophytic, xerophytic, mesophytic or halophytic. Now a days, this plant group represents maximum species, therefore, it occupies first position on the earth. Plant species of angiosperm vary in size, i.e. smallest plant is *Wolffia globosa* which is 2-5mm. in size where as largest plant is *Eucalyptus sp.* With a height of about 90 to 100 meters in Australia.

Rafflesia

Wolffia

Rafflesia arnoldii possesses the largest flower with a weight of about 8 kg. and diameter about 1mt. *Agave* sp. consists largest inflorescence of about 6 mt. height.

Sporophytic plant body is in the form of herbs, shrubs, trees, climbers or lianas. Plant possesses root, stem and leaves like vegetative organs. Vascular tissues are well developed (Xylem and Phloem). Ovules are enclosed in the ovary therefore, recognized as angiosperms. Plant body produces flowers for sexual reproduction, at mature stage. Flowers are unisexual or bisexual. It includes two accessory cycles (Calyx and Corolla) and two necessary cycles (Androecium and Gynoecium). Androecium is the group of stamens. Stamen is differentiated into anther, connective and filament. Gynoecium is the aggregate of carpels and carpel is differentiated into stigma, style and ovary. Pollination takes place through the air, insects and birds.

Formation of endosperm takes place after fertilization (post-fertilized). Double fertilization is seen in angiosperms. After fertilization ovules are transformed into seeds and ovary into fruit. The life cycle shows alternation of generation.

Bentham and Hooker's system of classification is used by most of the well known herbaria of the world. Bentham and Hooker classified the angiosperms into two classes, (1) Dicotyledon and (2) Monocotyledon. An out line of classification along with important characters of various units is given below.

(I) Dicotyledon : Embryo possesses two cotyledons. Flowers are pentamerous and leaves show reticulate venation. **Example-** Sunflower. Class dicotyledon is divided into three sub-classes.

(1) Polypetalae : Petals are free in flower. This sub- class includes three series

(A) Thalamiflorae : Thalamus is dome shaped. This series includes 6 orders and many families.

Example : *Hibiscus rosa-sinensis*- Local name; shoe-flower.

(B) Disciflorae : Thalamus is disc shaped. This series includes 4 orders with several families.

Example : *Citrus limon*- Local name; Lemon.

(C) Calyciflorae : Thalamus is cup shaped. This series includes 5 orders and many families.

Sun-flower

Example : *Rosa indica*- Local name; Rose.

(2) Gamopetalae : petals are fused in the flower. This sub-class includes three series

(A) Inferae : Ovary is inferior. This series includes 3 orders with many families.

Example : *Helianthus annuus*- Local name; Sun-flower.

(B) Heteromerae : Ovary is superior. This series includes 3 orders with several families.

Example : *Madhuca indica*- Local name; Mahudo.

(C) Bicarpellatae : Carpels are usually two in number. This series includes 4 orders with many families.

Example : *Catharanthus roseus*- Local name; Barmasi.

(3) Monochlamydeae : Flowers usually possess one whorl of perianth. It has no order but includes 8 series only and many families.

Example : *Bougainvillia spectabilis*- Local name; Boganvel.

(II) Monocotyledon : Embryo possesses single cotyledon.Leaves show parallel vention. Flowers are trimerous.

Example : *Zea mays - Local name : Maize*

This class does not include any order but it has been divided into 7 series with several families.

Example : *Alium cepa*- Local name; Onion.

Maize

Plant life cycle and alternation of generations :

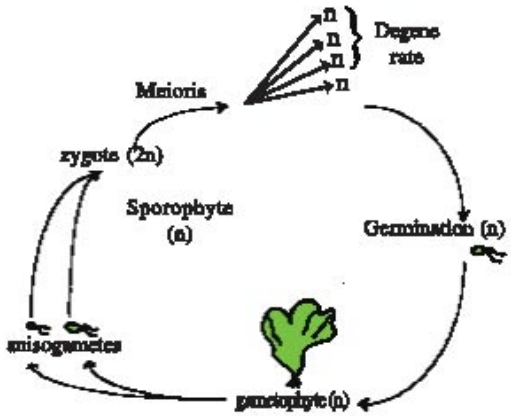
The life cycle of plant shows two distinct phases. (I) Gametophytic and (II) Sporophytic, alternating with each other. This phenomenon is known as alternation of generation.

The haploid plant body produces gametes by mitosis. This plant body represent a gametophyte.

The diploid cells also divide by mitosis to form of diploid plant body which produces haploid spores by meiosis. This is considered as sporophytic phase.

In this way haploid gametophytic (gamete producing) and diploid sporophytic (spore producing) phases alternate in the life cycles of any sexually reproducing plants. There are different plant groups show their alternation of generations in the special following patterns. (1) Haplontic life cycle (2) Diplontic life cycle and (3) Haplo-diplontic life cycle.

(1) Haplontic life cycle :

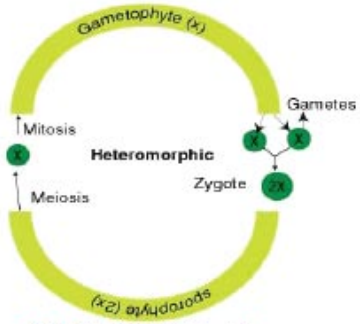


Haplontic life cycle

Some algal cells produce haploid gametes, which is main and active stage called gametophyte phase. These gametes fuse together and produce the diploid zygote which is subsidiary and resting stage and is called sporophyte phase. It is limited to zygote only. Zygote divides meiotically just before germination to form four haploid nuclei. Of these three degenerate and the remaining one enlarges as a new plant body. The plant body is dominant, photosynthetic and haploid. Thus, haploid and diploid stages alternate to each other in some algae. This is called alternation of generation and life cycle is haplontic.

Example : *Volvox* and *Spirogyra*.

(2) Diplontic life cycle :

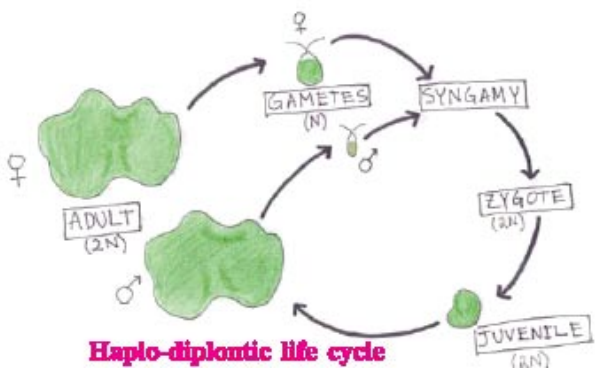


Diplontic life cycle

Gymnosperms and angiosperms are seed bearing plants and show alternation of generation in different manner. During the mature stage, sporophytic plant body produces cones in gymnosperms and flowers in angiosperms for the sexual reproduction. Gametes producing haploid gametophytic phase is short lived, subsidiary and it is limited to gametes formation only. Diploid sporophyte phase is main, long lived, dominant, photosynthetic and independent. Both phases alternate to each other showing alternation of generation. This kind of life cycle is termed as diplontic. Gymnosperms and angiosperms follow this pattern. Exceptionally, e.g. *Fucus* alga is diplontic.

(3) Haplo-diplontic life cycle :

Bryophytes and pteridophytes show intermediate life cycle pattern. Bryophytes show a regular alternation of generation in their life cycles. The haploid gametophyte alternates with a diploid sporophyte. The main plant body is gametophyte, which is haploid, multicellular, short lived, photosynthetic, independent and gametes producing. Fusion of gametes occur to form a diploid zygote. The zygote develops into a diploid sporophyte. which is parasitic on the gametophyte. Zygote divides meiotically to form haploid spores. The spores represent the beginning of the gametophytic generation, which develop a new plant body. Here, the gametophyte alternates with sporophyte called alternation of generation and life cycle is haplo-diplontic.



Haplo-diplontic life cycle

On the other hand, in pteridophyte the main plant body is a sporophyte which is differentiated

into root, stem and leaves. It is diploid, multicellular, long lived, photosynthetic, independent and spore producing. Diploid Sporophyte alternates with short lived haploid gametophyte. There is an alternation of sporophytic and gametophytic generation to complete the life cycle. Such pattern of alternation of generation is called haplo-diplontic. Interestingly, few algae show haplo-diplontic life cycle -i.e. *Ectocarpus* and other seaweeds.

Summary

Five kingdom classification system was given by Whittaker on the basis of following four criteria. (1) Cell structure (2) Body structure (3) Mode of nutrition-autotrophic and heterotrophic (4) Major ecological role. The five kingdoms are Monera, Protista, Fungi, Plantae and Animalia.

The three-domain system is loosely based on five-kingdom system but divides the kingdom Monera into two "domains" *Archae* domain and *Bacteria* domain, while eukaryotic kingdoms in the third *Eukarya* domain. The *Eukarya* are then divided into 4 kingdoms: Protists, Fungi, Plantae and Animalia.

Viroids are discovered by Diever from infectious agents which are even smaller than viruses. They consist of a very simple structure and short RNA strand. Viroids lack protective protein coat known as capsid.

Viruses are self reproducing and obligate parasite in living cells. When they are outside of living cell; they remain inactive and behave as non-living things (in free stage). When they enter inside of living cells, they are active and behave as living organisms (in host cell). Because of this they are intermediate between living and non-living things. They are also called as living chemical.

Algae, Fungi and Lichens are included under thallophyta. The gametophytic plant body is thalloid, without differentiation into true root, stem and leaves. Zygote does not develop into embryo. Algae have chlorophylls and they synthesize their own food so it is autotrophs, while fungi are non chlorophyllus and they do not synthesize their own food so it called heterotrophs. The lichens show symbiotic relationship between algae and fungi components.

Bryophytes are non vascular plants. After fertilization, zygote undergoes divisions to form embryo. The life cycle of bryophytes has two distinct phases (1) Gametophytic phase- Haploid, main, autotrophic, and gametes formative and (2) Sporophytic phase- Diploid, subsidiary, heterotrophic, spores formative.

Pteridophytes have vascular tissues, and develop the embryo. The life cycle of pteridophytes shows alternation of generation. Gametophytic phase is haploid, subsidiary, short lived and Gametes producing while Sporophytic phase is diploid, main, as a plant, long lived and spores producing.

Plant body in gymnosperms is sporophytic. It is differentiated into root, stem and leaves. Ovules are naked and not enclosed by the ovary therefore recognized as a gymnosperm.The sporophytic and gametophytic phases alternate with each other to complete the life cycle. Gametophytic phase is haploid, subsidiary, short lived and underground and Sporophytic phase is diploid, main, long lived and as a whole plant. Endosperm develops before fertilization, ovules are orthotropous and it true fruits are lacking because of the absence of ovary.

In angiosperms, sporophytic plant body is in the form of herbs, shrubs, trees, climbers or lianas. Ovules are enclosed in the ovary therefore, recognized as angiosperms. Endosperm is developed after fertilization. Members of this group show double fertilization. After fertilization ovules are transformed into seeds and ovary into fruit. The plant life cycle shows alternation of generation.

Bentham and Hooker classify the angiosperms into two classes, (I) Dicotyledon and (II) Monocotyledon. The life cycle of plants show two distinct phases. (1) The haploid gametophytic phase and (2) the diploid sporophytic phase. They alternate with each other. There are different plant groups which show their alternation of generations in three special patterns. (1) Haplontic life cycle (2) Diplontic life cycle and (3) Haplo-diplontic life cycle.

EXERCISE

1. Put a dark colour in a given circle for correct answer :

(1) Which classification system had been given by Whittaker ?

(a) Three domain classification ◯ (b) Binomial classification ◯

(c) Five kingdom classification ◯ (d) Artificial classification ◯

(2) The plant cell without chloroplasts is characteristic of…

(a) Fungi ◯ (b) Bryophytes ◯

(c) Algae ◯ (d) Pteridophytes ◯

(3) Which plant group known as the biggest and dominant group recently ?

(a) Bryophytes ◯ (b) Pteridophytes ◯

(c) Gymnosperms ◯ (d) Angiosperms ◯

(4) When the seeds are borne on megasporophylls and not enclosed in a fruits the plant belongs to…

(a) Bryophytes ◯ (b) Pteridophytes ◯

(c) Gymnosperms ◯ (d) Angiosperms ◯

(5) The tallest living tree in the world is…

(a) Wolfia sp. ◯ (b) Zamia sp. ◯

(c) Eucalyptus sp. ◯ (d) Sequoia sp. ◯

(6) Presence of rigid cell wall and formation of embryo are characterized by kingdom..

(a) Protista ◯ (b) Plantae ◯

(c) Monera ◯ (d) Animalia ◯

(7) Embryo formation is not known in…

(a) Gymnosperms ◯ (b) Bryophytes ◯

(c) Algae ◯ (d) Pteridophytes ◯

(8) Who is regarded as the father of taxonomy ?

(a) Theophrastus ◯ (b) Linnaeus ◯

(c) Aristotal ◯ (d) Bentham and Hooker ◯

2. Answer in one word :

(1) What is the main component of fungal cell wall ?

(2) Bacterial cell wall is made up of ————

(3) What is the genetic materials of viruses ?

(4) Nucleoid is the characteristic of ————

3. Define :

(1) Autotrophic nutrition

(2) Heterotrophic nutrition

(3) Alternation of generation

4. Describe in detail :

(1) Out line of the Bantham & Hooker classification system

(2) Five kingdom classification system

(3) Three domain classification system

5. Give Comparative account of the following :

(1) Gametophytic and sporophytic phases

(2) Gymnosperms and angiosperms

6. Mention the general characters of the follwoing :

(1) Algae (2) Fungi (3) Bryophytes

(4) Pteridophytes (5) Gymnosperms (6) Angiosperms

7. Write short note :

(1) Viroids

(2) Virus and

(3) Alternation of generation

8. Write in short :

The basic criteria of five kingdom classification system.

•

4

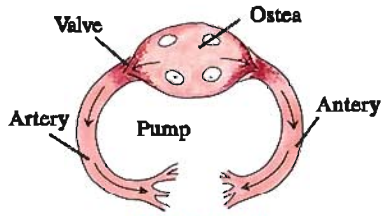
Classification of Animal Kingdom

Number of living organism are seen on the earth. They were also seen in the past. They are varied in their shape, form, size and habit. Some of them are identified, while some are not. The knowledge of classification is useful to identify these unidentified organisms. In chapter-1 we have seen that, classification is a scientific method in which organisms are arranged in different or same taxa according to similarity and dissimilarity.

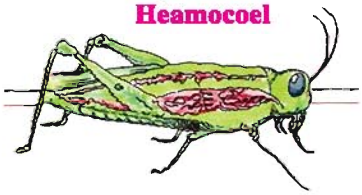
Animal classification is based on their shape, form, size etc., as well as on similarity and dissimilarity in their fundamental features i.e. level of organization, symmetry, coelom, segmentation etc. Animal kingdom is classified, considering above characters. Some important characters are discussed here.

Levels of Organization

Members of animal kingdom exhibit different levels of organization. Protozoans are unicellular animals. Cell is functional and structural unit in them. Sponges are multicelluar but cells are independent functionally, hence they have cellular level of organization. In animals of phylum coelenterata, cells performing same function arranged into tissues, hence they have tissue level of organization. Tissues together form organ and it is called **organ level of organization** e.g. Platyhelminthes. Organs collectively form organ system associated with specific function.Organ systems are seen in Annelids, Arthropods, Molluscus, Echinoderms and Chordates. This level of organization is called organ system level of organization. Organ systems of all phyla of multicellular animals exhibit different structure. Digestive track with only one opening, is called incomplete digestive track eg, Platyhelminthes and when digestive track has two openings i.e anterior mouth and posterior anus, is called complete digestive track eg. Aschelminthes to chordate. Circulatory system is also of two types



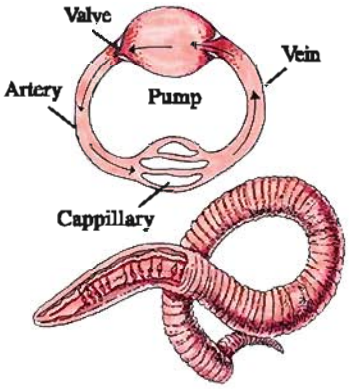
Heamocoel



open system (arasshopper)

(i) Open type : blood flow into the blood sinuses and these sinuses are filled with blood. In this type amount of blood is more. Blood pressure is low and irregular eg. Arthropoda and Mollusca (except cephelopoda).

(ii) closed type : In Annelids, Cephalopods and Vertebrates the blood circulates through arteries, veins and capillaries. Amount of blood is limited. Blood pressure is high and regular. Moreover, diversity in respect to respiratory system, excretory system etc. are seen among the animal phyla.



close system (earth worm)

Symmetry

All types of symmetry are seen in invertebrate animals. Single cell structure of protozoa exhibit bilateral, and radial asymmetry. When, the body of animal can be divided into equal left and right halves by one plane, symmetry is known as **bilateral symmetry** eg. Annelid, Arthropod etc. When the body of animal can be divided in to equal halves by any plane passing through the central axis is called radial symmetry e.g. Coelenterate and Echinoderm and when plane passing through the central axis doesn't divide body of animal in to equal halves called asymmetry eg. Sponges.

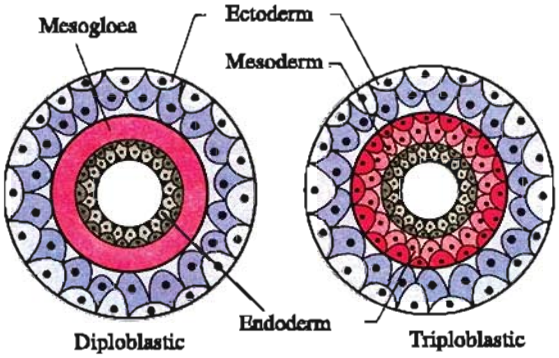
Radial symmetry

Bilateral symmetry

Asymmetry

Diploblastic and Triploblastic Organization :

In the coelenterates cells are arranged in two layers i.e.ectoderm (external) and endoderm(internal). In between these two layers, non-cellular, mesogloea is present. This is called diploblastic organization. If cells are arranged in three layers i.e. ectoderm, endoderm and mesoderm, organization is called triploblastic organization eg. Platyhelminthes to Chordate.

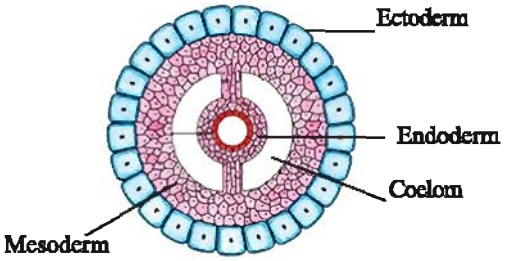


Organisation of germinal layers

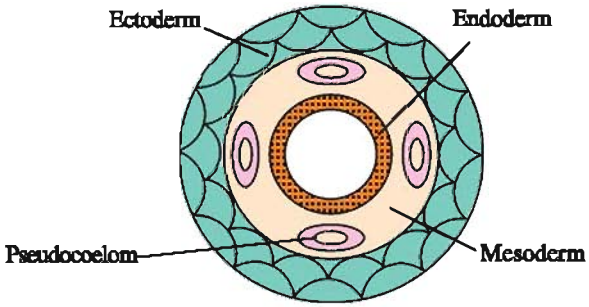
Coelom

Coelom is a cavity, located between digestive track wall and body wall. This cavity is lined by mesoderm. Animals having this type of organization are called **coelomates** eg. Annelid to Chordate. In the animals of phylum aschelminthes mesoderm is present as scattered pouches, it is called **pseudocoelom**

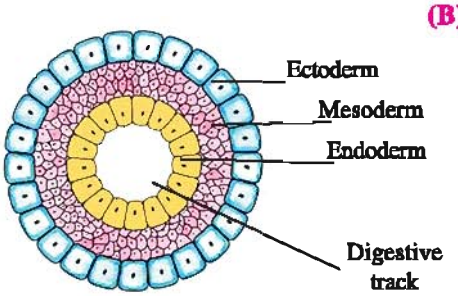
and animals are called **pseudocoelomates**. While in some animals coelom is absent, known as **acoelomates**, eg. Platyhelminthes. Animal kingdom is divided in to **acoelmate, pseudocoelomate** and **coelomate** according to the coelom.



(A) Coelomate



(B) Pseudocoelomate



(C) Acoelomate

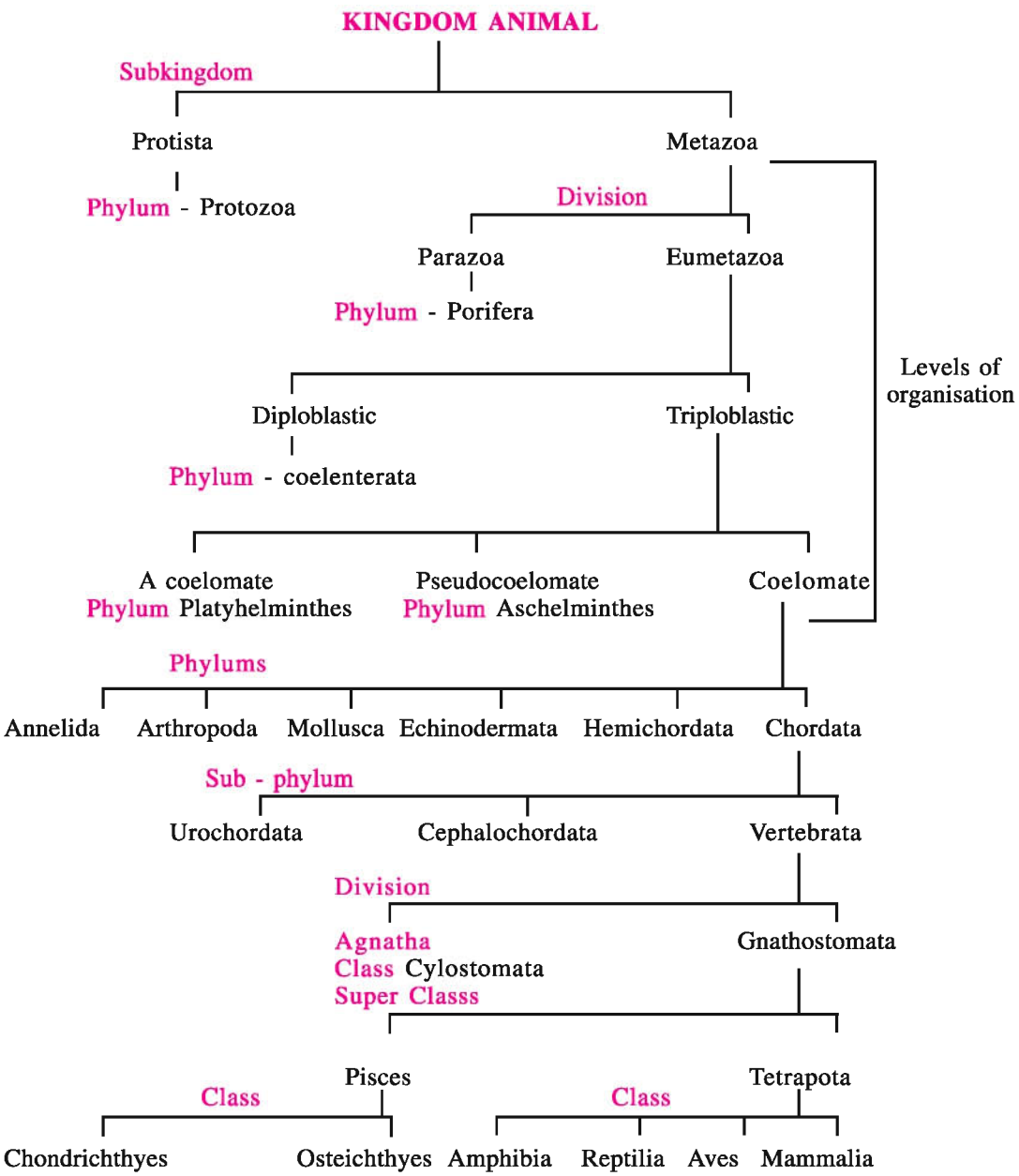
Segmentation

In Earthworm like animals, the body is divided in to equal internal and external segments. It is called metameric segmentation. This type of metameric segmentation is also exhibited in the animals of phyla annelid and arthropod.

Notochord

Notochord is mesodermal in origin, dorsally situated and rod like organ. Animal classification is based on the presence and absence of it. If notochord is present animals are called **chordates** eg. Urochordates to Mammal. If notochord is absent, animals are called non chordates, eg. Protozoa to Echinodermata.

Classification of animal kingdom



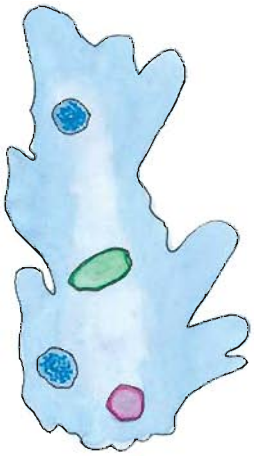
Classification of Animals and its special features

Phylum-Protozoa

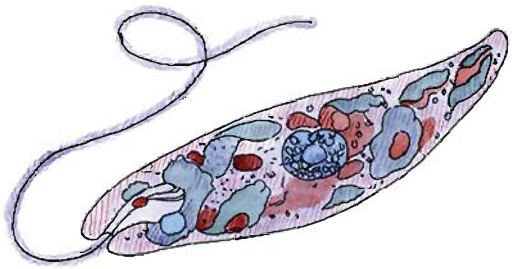
Protozoa is the first phylum of animal kingdom. Protozoa means first animals. Protozoans are microscopic, unicellular and without tissues and organs.

- Protozoan animals are microscopic in size and usually observed with the help of microscope.
- Body is unicellular; with one or more nuclei.
- Cellular body of the animal possesses either asymmetry , bilateral, radial or spherical symmetry.

- Nutrition is generally holozoic, halophytic while some animals are parasitic.
- Locomotion through organelles i.e. pseudopodia, cilia or flagella.
- Animals of the phylum reproduce asexually by binary fission, multiple fission and budding and sexually by conjugation.

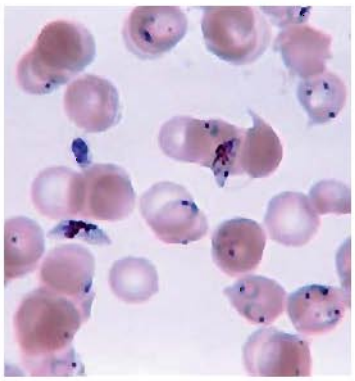


Amoeba



Euglena

Opalina



Plasmodium

Diversity in Protozoa

Examples : *Amoeba, Euglena, Opalina, Plasmodium etc.*

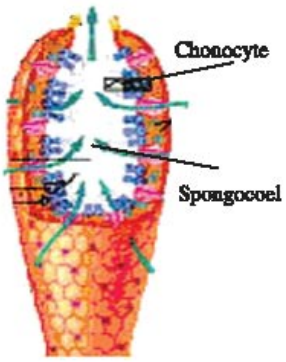
Phylum-Porifera

Multicellular and sessile animals of the phylum porifera possess body pores and lives solitary or colonial life.

- Bodies of animals possess cellular level of organization.
- All animals are aquatic, majority of them are marine and some are seen in fresh water.
- The body of animal is asymmetrical or radially symmetrical.
- The body of animal possesses many pores (ostia) , canals and chambers, from which water current passes through spongocoel and goes out through osculum.

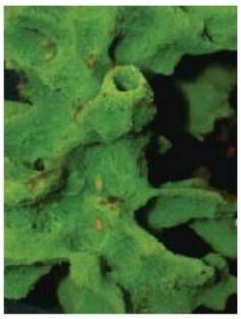
- Collar cells (choanocytes) line the spongocoel, is it's uniqueness.
- Internal skeleton made of different kinds of spicules and sponging fibres
- All sponges are hermaphrodite. Reproduce asexually by budding and gemmules, while sexual reproduction is by ova and spermatozoa. Fertilization is internal. All sponges show power of regeneration.
- Development is indirect, means larval stage seen during development. In sponges **amphiblastula** or **parenchymula** larva are seen.

Example : Lucosolenia, Hyalonema(marine) and Spongila (Fresh Water)



Hyalonema

Lucosolenia



Spongilla

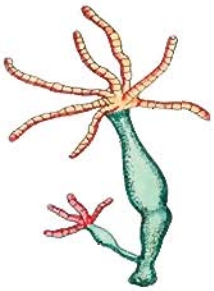
Diversity in Porifera

Phylum-Coelenterata :

Coelenterates are aquatic animals having primary tissue level of organization and tentacles. They also have single coelenteron.

- All animals are aquatic, some of them are marine while some live in fresh water. Animals are sedentary or fee-swimming, solitary or colonial.
- Coelenterates show tissue level of organization and they are dipolobalstic and radically or bilaterally symmetrical.
- Presence of nematocytes is a speciality of coelentrates. They help them to capture food as well as for offence and defence.
- They have central gastro-vascular cavity with a single opening **hypostome.**
- Two types of forms occur in coelenterate : attached polyps and free-swimming medusae. Some species are notable for polymorphism.
- First time nervous system as a nerve net is seen.
- They reproduce asexually by budding and fission while sexually by ovum and sperm. Development is indirect because during life cycle free-swimming **planula** larva is occur.
- Coelenterates exhibit alternation of generation. In this asexual polyps and sexual medusae forms are alternately found.

Example : Hydra, Sea anemone, Jelly fish, coral etc.



Hydra

Sea anemone

Jellyfish

Coral

Diversity in Coelenterata

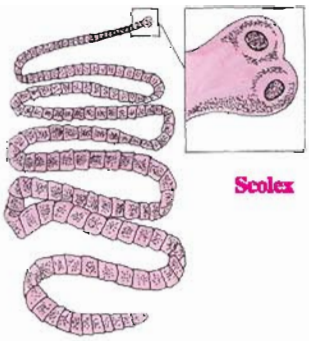
Phylum-Platyhelminthes

- Platyhelminthes are first triploblasitc, bilaterally symmetrical, dorso-ventrally flattened acoelomete animals.
- They have leaf like or tape like dorso-ventrally flattened body.
- Animal having organ level of organization.
- Animals are endoparasites found in animals including human. As a parasitic form external hooks or suckers or both are present to attach host.
- Digestive system is incomplete , branched and without anus.
- Excretory system consists of flame cells and canals.
- Sexes are not separate. Fertilization is internal and development is indirect.

Example : Tapeworm, Liver fluke, Planaria

Planaria

Liverfluke



Tapeworm

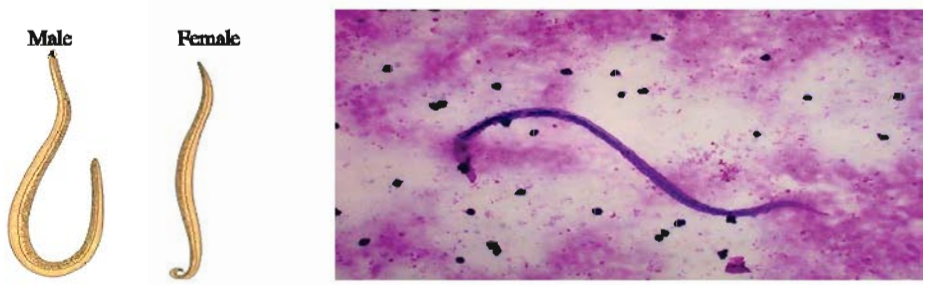
Diversity in Platyhelminthes

Phylum-Aschelminthes

Aschelminthes are mostly pseudocoelomate, triploblastic, bilaterally symmetrical worm like animals.

- Most of animals are aquatic, some are terrestrial and some are parasite.
- They are round or less flattened, triploblastic, bilaterally symmetrical, pseudocoelomate with organ system level of organization.
- Digestive system is complete i.e. mouth and anus are present.
- Excretion through branched excretory ducts.
- Sexes are separate(dioecious). Male is smaller than female.
- Fertilization is internal, development usually direct in which young ones looks like the adults.

Examples : Ascaris, Wuchereria etc.



Ascaris Wuchereria

Diversity in Aschelminches

Phylum-Annelida

Annelids are metamerically segmented, triploblastic, bilaterally symmetrical, coelomate animals.

- Mostly aquatic; some are terrestrial, borrowing or tubicolous, free –living and occasionally parasite.
- Animals are having cylindrical body and organ system level of organization.
- Locomotory organs are setaes (Earthworm), parapodia(Neris) and have longitudinal and circular muscles in body wall.
- Digestive system is complete and digestion is extracellular.
- Circulatory system is closed and respiratory pigment, haemoglobin is present in blood plasma.
- Nephridia are present as an excretory and osmoregulatory organs.

- Nervous system is with paired cerebral ganglia and double ventral nerve cord bearing ganglia and lateral nerves in each segment.
- Animals are dioecious (Nereis) or monoecious (earthworm, leech). Reproduce by sexual method.

Examples : Earthworm, Nereis, Leech etc.

Earthworm

Nereis

Leech

Diversity in Annelida

Phylum-Arthropoda

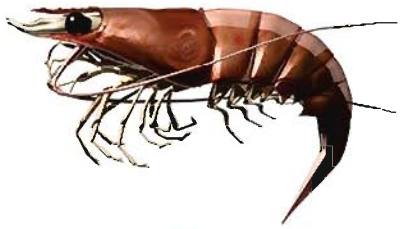
Animals with jointed appendages in which body is divided into head, thorax and abdomen. Over $\frac{2}{3}$ of all known species on earth are arthropods.

- Body of animal is with organ level of organization, bilateral symmetry, triploblasitc, coelmate and metameric segmentation.
- Exoskeleton is chitinous and is sheds at intervals (ecdysis) for growth and development.
- Presence of jointed appendages is speciality of arthropods.
- Body is divided into head , thorax and abdomen. Head and thorax are often fused to form cephalothorax.
- Circulatory system is of open type.
- Respiration occurs mostly through body surface, gills, trachea and book lungs.
- Excretory organs are green gland or malpighian tubules.
- Sensory organs comprises of simple or compound eyes, chemo and tactile receptors, statocysts and auditory organs.
- Sexes usually separate and fertilization usually internal, oviparous or ovoviviparous animal.
- Development may be direct or indirect some of them exhibit parthenogenesis.

Example : Peripatus, Crab, Scorpion, Prawn, Centipede, Cockroach etc.

Peripatus

Crab



Prawn

Centipede

Cockroach

Scorpion

Diversity in Arthropoda

Phylum-Mollusca

Animals are with soft body, bilateral symmetry, triploblast and unsegmented. Soft body is usually protected by shell made up of calcium carbonate.

- Majority animals of the phylum mollusca are aquatic and some are terrestrial.
- Animals are unsegmented body with organ system level of organization.
- Shell, when present is usually seen as an external or in some as an internal skeleton.
- Mantle cavity, is located between body wall and mantle. In mantle feather like gills are present, which act as a respiratory organs.
- Digestive system is complete with a digestive gland. Usually animals have radulla in mouth, which helps in grinding food.
- Circulatory system is of open type and excretion takes place through kidney like special organ.
- They are monoecious or dioecious animals. Fertilizaton is external or internal and development is direct or indirect.

Examples : Chiton, Pila, Dentalium, Pearloyster, Sepia, Octopus etc.

Chiton

Pila

Dentalium

Pearl oyster

Octopus

Sepia

Diversity in Mollusca

Phylum-Echinodermata

- Echinodermates are mostly radially symmetrical and possesses calcium carbonate plates and spines on the body wall and water vascular system.
- Animals are exclusively marine.
- Animals are triploblastic, coelomate and radially symmetrical body with organ system level of organization.
- Body is usually divided into five arms.
- Water vascular system is of coelomic origin including tube feet for locomotory function. Water vascular system is also concerned with respiratory and excretory functions.
- Digestive system is complete and digestive duct is straight or coiled.
- Animals are Dioecious, fertilization is external and development is indirect through freeswimming larva.

  Regeneration of lost-part is characteristic of this phylum.

Examples : Starfish, Seaurchin, Sealily, Sea - cucumber, Brittlestar etc.

Starfish

Seaurchin

Sealily

Sea cucumber

Brittle star

Diversity in Echinodermata

Phylum – Hemichordata

Hemichordates are usually described as primitive chordates 'invertebrate chordates'. Animals of this phylum are wormlike and live a solitary or colonial life.

- Exclusively marines, solitary or colonial and mostly tubicolous animals.
- Animals are wormlike, unsegmented, bilaterally symmetrical, and triploblastic, coelomate and having organ system level of organization.
- Cylindrical body is divided into probosis , collar and trunk.
- Digestive track is complete, straight or 'U' shaped.
- Circulatory system is simple and open type.
- Excretion takes place by single probosis gland which is connected to blood vessels and respiration occurs through gills.
- Animals are usually Dioecious, fertilization is external and development is direct or indirect through free swimming Tornaria larva.

Examples : Balanoglossus etc.

Phylum-Chordata

Animal of phylum chordata possess notochord during embryonic development. Notochord is not seen in invertebrates(non-chordate) animals.

- Animals are triploblastic, coelomate, bilaterally symmetrical, metamerically segmented and possess organ system level of organization.
- Post anal tail is present life long, or during some stages of life.
- Jointed internal skeleton which is made up of cartilage or bone is present in most of members.
- Pharyngeal gill slits are present at some stages.
- Digestive system is complete and circulatory system is of closed type.

Balanoglossus

- Anterior portion of dorsal nerve cord is enlarged into brain.
- Dioecious animals.

Comparison of salient features of chordates and nonchordates are given below.

Table 4.1

Comparison of chordate and nonchordate

No.	Features	Chordate	Nonchordate
1.	Notochord	Present	Absent
2.	Location of digestive track	Ventral side of nerve cord	Dorsal side of nerve cord
3.	Pharyngeal gill slits	Present at some stage of life	Absent
4.	Blood circulatory system	Closed	Open, closed or absent
5.	Heart	Ventral side	Dorsal, lateral or absent
6.	Nervous system	Hollow	Solid
7.	Nerve cord	Single, Dorsal and without ganglia	Double, Ventral and commanly with ganglia
8.	Reproduction	Mostly reproduce sexually	Mostly reproduce a sexually
9.	Body tempreature	Cold and warm blooded	Cold blooded
10.	Post anal tail	Mostly present	Absent

Ascidia

Phylum chordata is divided into three sub-phylum

(1) Urochordata, (2) Cephalochordata and (3) Vertebrata.

(1) Urochordata : Notochord is seen during larval stage only and animals are fully marine.

Examples : Ascidia, Salpa etc

Amphioxus

(2) Cephalochordata : Notochord persists during the whole life span and extended from head to tail.

Examples : Amphioxus

(3) Vertebrata : Notochord is modified into vertebral column at the adult stage. Body is divided into head, neck, trunk and tail. Out of these main characters, animals have some additional characters which are as follow.

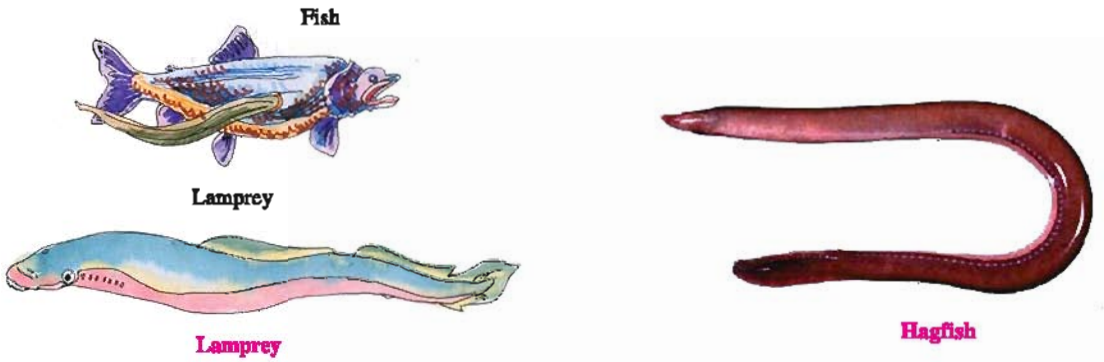
- Skin is covered by protective external skeleton comprising scales plates, feathers, hairs, claws, nails, horns etc.
- Presence of muscles which are attached to the internal skeleton and help in locomotion.
- Blood circulatory system is of closed type, heart is muscular located ventrally and consists of two, three or four chambers.
- Excretion takes place through paired kidney.
- Animals are Dioecious.

Sub-phylum vertebrata is further divided into two divisions: Agnatha (Lamprey and Hagfish) and Gnathostomata on the basis of presence or absence of jaws. Division Gnathostomata is divided into two super-class Pisces (presence of fins) and Tetrapoda (presence two pair of limbs). On the basis of locomotory organs Super-class Pisces is divided into two classes. Chondrichthyes (cartilage skeleton) and Osteichthyes (bony skeleton) according to internal skeleton and super-class. Tetrapoda is divided into Four classes. Amphibia, Reptilia, Aves and Mammalia.

Class – Cyclostomata

- Animals of the class cyclostomata are ectoparasites on fishes during their adult stage.
- Internal skeleton is fibrous and cartilaginous. Skin is without scale contains unicellular mucous glands.
- Jaws are absent.
- Mouth is anterio-ventral, circular and suctorial, hence the class is called cyclostomata.
- Blood circulatory system is of closed type. Heart is two chambered and gill slits are present for respiration.
- One pair kidney as an excretory organ.
- They are marine, but reproduction takes place in fresh water.Larva after metamorphosis return to ocean.

Example : Lamprey, Hagfish etc.



Diversity in Cyclostomata

Class – Chondrichthyes

- Usually they are marine.
- Streamlined body and skin is covered with placoid scales.
- Caudal fin is heterocercal.
- Internal skeleton is made up of cartilage.
- Mouth is anterior-ventrally located and jaws are present.
- Respiration takes place by 5 to 7 pairs of gills, gill slits are uncovered and operculum is absent.
- Heart is two chambered and animals are poikilothermal.
- Dioecious, fertilization internal and oviparous or ovoviviparous animals.

Example : Shark, Ray fish

Shark

Ray fish

Diversity in Chondrichthyes

Class – Osteichthyes

- Animals are aquatic (marine and fresh water).
- Streamlined body and skin is covered by cycloid or ctenoid scales.
- Caudal fin is homocercal.
- Internal skeleton is made up of bones.
- Mouth is usually anterior and jaws are usually with teeth.
- Respiration takes place by 4 pairs of gills, which are covered by operculum.
- Heart is two chambered and animals are poikilothermal.
- Dioecious, fertilization usually external and oviparous animals.
- Air bladders are present, which help them to swim.

Examples : Seahorse, Labeo,Catla etc

Seahorse

Labeo

Catla

Class — Amphibia

- As they have two lives i.e. aquatic & land, hence they are called as Amphibians.
- Amphibians are included in the super-class tetrapoda, becose their main character is presence of two pairs of limbs.
- External skeleton is absent, skin is moist and acts as a respiratory organ.
- Body is divided into head and trunk.
- Internal and middle ears are present, external ear is absent.
- Mouth is large. Upper or both jaws possess small and homodont teeth. Digestive track terminates into cloaca. Excretory and reproductive tracks are also terminate into cloaca.
- Heart is three chambered, with two auricles and one ventricle.
- Coldblooded i.e. poikilothermic animals.
- Dioecious, fertilization is external and development is indirect (through metamorphosis).

Example : Frog, Salamander, Ichthyophis (Limbless) etc.

Frog

Salamander

Ichthyophis

Diversity in Amphibia

Class — Reptilia

- Reptilies represent the first class of vertebrata fully adopted for life on terrestrial habitat.
- The name reptile refers to their habit of locomotion by crawling.
- Usually animals are terrestrial, carnivores, coldblooded and oviparous.
- Body is bilaterally symmetrical and divisible into head, neck, trunk and tail.
- External skeleton is made up of epidermal scales and skin is dry.
- Limbs are uniform, short with claws. Limbs are absent in Snake.
- Digestive track terminates into cloaca.
- Pinna absent. The opening of the ear occurs on the skin surface behind the eye. Tympanic membrane occurs at the base of this opening. The tubular passage in between represents the development of external ear.
- Heart is usually three chambered (two auricles and one incompletely divided ventricle). In crocodile heart is four chambered.
- Respiration takes place through lungs.

- Kidney are present as excretory organ. Uricacid is released as an excretory substance.
- Dioecious, fertilization is internal and development is direct in animals.

Example : Turtle, Chameleon, Calotes, Crocodile, Wall Lizard etc.

Turtle

Chameleon

Calotes

Crocodile

Wall Lizard

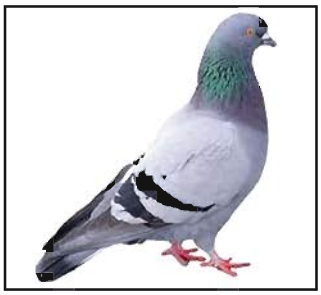
Diversity in Reptilia

Class—Aves

- All birds are inculded in this class.
- Wings (modification of fore limbs) are present for flying in animals of this class,while some birds can not fly.
- Streamlined body and it is divided into head, neck, trunk and tail.
- Jaw is modified into beak and teeth are absent.
- Fethers (covered on body), scales (on limbs), beak, claws etc. acts as an external skeleton. Bones of internal skeleton are porous and hollow, which help them in flying.
- The digestive track has crop for food storage and gizzard for food grinding.
- Heart is four chambered and aortic arch turns toward right side.
- Respiration takes place through lungs and air-sacs associated with lungs, help in flying.
- These are the first vertebrates which are warmblooded.
- Animals are Dioecious, showing internal fertilization and direct embryonic development. They are oviparous animals.

Examples : Pigeon, Crow, Peafowl, Ostrich, Penguin etc.

Crow



Pigeon

Peafowl

Ostrich

Penguin

Diversity in Aves

Class — Mammalia

- **Mammary glands** are present in these animals. Well developed and functional in females only. They secret milk, which provides nutrition to young ones, therefore they are called mammals.
- Found in all types of habitat.
- External skeleton includes hairs on body, horns, hoof and Nail.
- Two pairs of limbs are present, which are used in locomotion.
- External ears develop as pinna.
- Teeth are located in sockets in gums of jaws. They are differentiated into canines, incisors, premolars and molars. Permanent teeth develops after the milk teeth drop in some mammals.
- Digestive track is complete and with digestive gland.
- Heart is four chambered and aortic arch turns toward left.
- Respiration takes place through lungs.
- They are warm-blooded (homoiothermous) animals.
- Dioecious, fertilization is internal and shows direct embryonic development, usually viviparous (to produce young ones) animals.

Examples : Platypus (oviparous), Kangaroo, Rabbit, Rat, Elephant, Dolphin, Whale, Bat (Arial life adaptation) etc.

Platypus

Kangaroo

Rabbit

Rat

Elephant

Dolphin

Whale

Bat

Diversity in Mammals

Summary

Numbers of living organisms are present on the earth. Out of them some are identified, while some are not identified. The knowledge of classification is useful to identify this unidentified organisms. Animal classification is based on their characters like shape, form, size, level of organization symmetry, coelom, segmentation etc.

Members of animal kingdom exhibit different levels of organization. Protozoans are unicellular animals. Sponges have cellular level of orgmiztion. Phylum coelenterata has tissue level of organization. Phylum Platyhelminthes have organ level of organization. Organs are associated into organ system. Annelids, Arthropods, Molluscans Echinoderms and Chordates have organ system level of organization. Organ system of all phyla of multicelluar animals exhibit different structure. Digestive track is of two types: (1) incomplete digestive track eg, Platyhelminthes and (2) complete digestive track eg. Aschelminthes to chordate. Circulatory system is also of two types (i) open type e.g. Arthropods and Molluscans (except Cephelopods) (ii) closed type e.g. Annelids, Cephalopods and Vertebrates. Moreover, diversity among the animal phyla in respect to respiratory system, excretory system etc is exhibited. Invertebrate animals having all types of symmetry. Coelenterates have only two layers i.e. ectoderm and endoderm, hence it is called diploblastic organization. And if cells arranged in three layers i.e ectoderm, endoderm and mesoderm, the organization is called triploblastic eg. Platyhelminthes to chordates. According to the coelom animal kingdom is divided in to **acoelomate, pseudocoelomate** and **coelomate.** Body of animals like earthworm is divided in to equal internal and external segments, so it is known as metameric segmentation. Classification of animals is based on presence and absence of notochord. When notochord is present, animals are called **chordates** eg. Fish to mammals. And when notochord is absent, animals called non-chordates, e.g., Protozoa to Echinoderms.

Table : Salient features of different phyla

Phylum / Salicent features	Protozoa	Porifera	Coelenter-ata	Plathyhel-inthes	Aschelmin-thes	Annelida	Arthropoda	Mollusca	Echinoder-mata	Hemichor-data	Chordata
Level of Organization	-	Cellular	Tissue	Organ	Organ System	Organ System	Organ System	Organ System	Organ System	Organ System	Organ System
Symmetry	Bilateral, Radial, Spherical	Bilateral, Asymmetry	Radial, Bilateral	Bilateral	Bilateral	Bilateral	Bilateral	Bilateral	Radial	Bilateral	Bilateral
Germinallayers	Absent	Absent	Two	Three	Three	Three	Three	Three	Three	Three	Three
Coelom	Absent	Absent	Absent	Absent	Pusedo	Present	Present	Present	Present	Present	Present
Segmentation	Absent	Absent	Absent	Absent	Absent	Present	Present	Absent	Absent	Absent	Present
Notochord	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present
Digestive Systemn	Absent	Absent	Incomp-lete	Incomp-lete	Complete	Complete	Complete	Complete	Complete	Complete	Complete
Circulatory System	Absent	Absent	Absent	Absent	Absent	Present	Present	Present	Present	Present	Present
Resporitary System	Absent	Absent	Absent	Absent	Absent	Present	Present	Present	Present	Present	Present
Reproduction	Asexual sexual	Asexual Sexual	Asexual Sexual	Sexual	Sexual	Sexual	Sexual	Sexual	Sexual	Sexual	Sexual
Fertilization	Occasional	Internal	Internal	Internal	Internal	Internal	Internal	Internal or External	Internal	Internal	Internal or External
Development	-	Indirect	Indirect	Indirect	Direct	Direct	Direct or Indirect	Direct or Indirect	Indirect	Direct or Indirect	Direct
Distunctive Features	Locomotary Organelles. i.e. Pusedo-potium, Cilia, Flagella	Presence of Canal System	Coelentron Present	Flattened Parasites Animals	Female are longer than male	Body divi-ded into equal Segment	Presence of jointed appendages	Usually body cover-ed by Shell	Water Vascular system present	Cylindrical body divi-ded into proboscis, collar and trunk	Hollow nerve cod, gillslits and limbs or wings present

EXERCISE

1. Put a dark Pencil colour in a given circle for correct answer :

(1) Which Phylum has Spongocoel ?

(a) Coelenterata ○ (b) Protozoa ○

(c) Porifera ○ (d) Arthropoda ○

(2) Animal with four chamber heart is?

(a) Whale ○ (b) Earthworm ○

(c) Shark ○ (d) Salamandar ○

(3) Bat is animal of which class?

(a) Reptilia ○ (b) Amphibia ○

(c) Aves ○ (d) Mammalia ○

(4) A class of animal which habitat in both water and land media ?

(a) Reptilia ○ (b) Amphibia ○

(c) Aves ○ (d) Pisces ○

(5) Phylum having radially symmetrical body in animals.

(a) Coelenterata ○ (b) Annelida ○

(c) Arthropoda ○ (d) Mollusca ○

(6) First Phylum of animal kingdom

(a) Porifera ○ (b) Portozoa ○

(c) Chordata ○ (d) Arthropoda ○

(7) Animals having collar Cells.

(a) Sponges ○ (b) Coral ○

(c) Ascaris ○ (d) Amoeba ○

(8) Locomotory organ in earthworm.

(a) Setae ○ (b) Parapodia ○

(c) Suckers ○ (d) Pseudopodia ○

(9) Animal having compound Eye.

(a) Cockroach ○ (b) Chameleon ○

(c) Pila ○ (d) Octopus ○

(10) Function of redula

(a) Food capturing ○ (b) Food grinding ○

(c) Food digestion ○ (d) Excretion ○

(11) Aphylum having all sea animals.

(a) Protozoa ◯ (b) Echinodermata ◯

(c) Platyhelminthes ◯ (d) Mollusca ◯

(12) Phylum having U-Shaped alimentary canals in animals.

(a) Mollusca ◯ (b) Hemichordata ◯

(c) Annelida ◯ (d) Chordata ◯

(13) Animals are of a class cyclostomata.

(a) Hagfish, Jellyfish ◯ (b) Whale, Shark ◯

(c) Lamprey, Hagfish ◯ (d) Lamprey, Catla ◯

(14) Insect are included in which phyllom.

(a) Arthropoda ◯ (b) Mollusca ◯

(c) Hemichordata ◯ (d) Annelida ◯

(15) Animals in which reproduction takes place through budding

(a) Sponges, Tape worm ◯ (b) Hydra, Ascaris ◯

(c) Sponges, Hydra ◯ (d) Hydra, Jellyfish ◯

2. Answer the following questions in short :

(1) Which animal are diploblasitc ?

(2) Animals of phyla has open type of cirulatory system ?

(3) Write functions of nematocytes and flame cells.

(4) From which phylum true coelom starts ?

(5) Write names of any three animals showing metameric segmentation.

(6) Which are two main classes of super-class pisces ?

(7) Which are classes of super-class tetrapoda ?

(8) Name the organs of locomotion protozoa ?

(9) By which methods reproduction takes place in sponges ?

(10) Which phylum has spongocoel ?

(11) Which kinds of forms are seen in the life cycle of coelenterats animals ?

(12) Liver fluke and Tape worm belong to which phylum ?

(13) Which phylla has most parasite animals ?

(14) In which part haemoglobin is present in Earthworm and Rat ?

(15) Write functions with examples of setaes and parapodia.

(16) Write names of respiratory organs of Earthworm.

(17) Write any two names of animals having mantle cavity.

(18) Write function of tube feet.

(19) How chordates differ from non chordates on the basis of their heart?

(20) Which are sub phyla of phylum chordata?

(21) Is lemprey an animal of class pisces? Why ?

3. Answer the following questions :

(1) Why classification of animal kingdom is essential ?

(2) What are the bases of animal kingdom ?

(3) Explain level of organization is animal.

(4) What is open and closed type of circulatory system?

(5) What is symmetry? Explain it with examples.

(6) Which types of organization of embryonic layers is present in porifera to mammalia.

(7) What is coelom? Describe it's types in animals.

(8) Draw a chart of classification of animal kingdom.

(9) Write principal characters of phylum protozoa.

(10) Give phylogenic characters related to following animals. (Only three)
Cockroach, Frog, Ascaris, Rabbit.

(11) Write names of excretory organs with examples of different invertebrate animals.

(12) Write the characters regarding reproduction, fertilization and development in coelomate anilams.

(13) Write short note : Coelom, Symmetry, Segmentation, Excretory Organ.

●

5

Cell Structure

Cell is a structural and functional unit of life. All living organisms are composed of cells. Organisms made up of a single cell are known as unicellular organisms. Amoeba, *Paramoecium*, bacteria, yeast and *Chlamydomonas* are their examples. While others composed of many cells are known as multicellular organisms. Life of these organisms begins as a single cell called zygote. This cell divides repeatedly to produce new cells. The cells thus produced, become differentiated to form tissues, organs and organ systems. As all the cells are produced from a single cell i.e. zygote, by mitotic divisions, the genetic make up of each cell in the body remains the same. Thus any cell of the body is capable of producing a new individual. This character of a cell is known as totipotency.

What is a cell ?

Robert Hook , an English scientist, observed a thin slice of cork under his crude microscope in 1665. He described the cork as composed of small spaces surrounded by firm wall and gave the name cells. Later Robert Brown (1831) discovered the nucleus in the cell. Therefore it is concluded that cell is a structural and functional unit of all living organisms. Each cell is an amazing world by itself: it can take in nutrients, converts these nutrients into energy, carry out specialized functions and reproduce as necessary. Even more amazing is that each cell stores its own set of instructions in the form of genetic material for carrying out each of these activities

The Cell Theory

The cell theory was put forth in 1838 by two scientists. These scientists were Matthias Schleiden, a German Botanist and Theodore Schwann, a British zoologist. Schleiden showed that plants are composed of different kinds of cells which form the tissues of

plants. Schwann studied different types of animal cells and noticed that cells had a thin layer around them which is today known as plasma membrane. He also assumed that the presence of a cell wall is an unique character of the plant cell. Later Schleiden and Schwann jointly proposed the cell theory. According to this :

- All living organisms are made up of cells and their products
- Cell is a structural and functional unit of organisms.

This theory did not explain as how new cells were formed. In 1855 Rudolf Virchow first explained that new cells arise through cell division of preexisting cells. Later the cell theory of Schleiden and Schwann was modified by Virchow to give the cell theory a final shape. Cell theory as presumed today is :

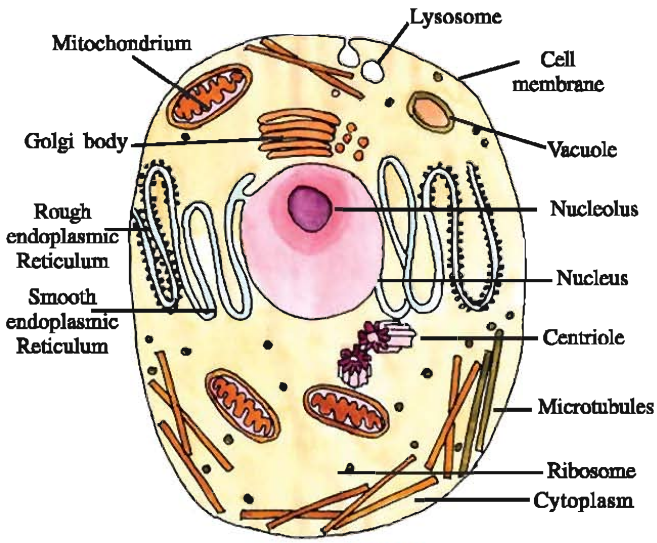
(1) All organisms are made up of cells and cellular products

(2) Cell is a structural and functional unit of organisms.

(3) New cells are formed through divisions of preexisting cells.

An Overview of Cell

A cell is the smallest unit of living matter. All living things including plants and animals are made up of cells. A typical plant cell can be studied in an onion peel while animal cell can be studied by taking cells of human cheek. A plant cell has a distinct cell wall as its outer boundary and inner to that there is a cell membrane or plasma membrane. Animal cell lacks cell wall and plasma membrane forms an outer envelope. The cell membrane surrounds the cell, holds the other parts of the cell in place, and protects the cell. Inside the cell membrane, all cells, except for bacterial cells, contain a nucleus and cytoplasm. The nucleus is a dense membrane bound structure. This nucleus contains the chromosomes which contain the genetic material – DNA. Hence it controls the cell's activities; Cells that have membrane bound nuclei are called eukaryotic whereas cells that lack a membrane bound nucleus are called prokaryotic. The cytoplasm is a jelly-like substance inside the cell where most of the cell's activities take place. Cytoplasm is made up of water and other chemicals.

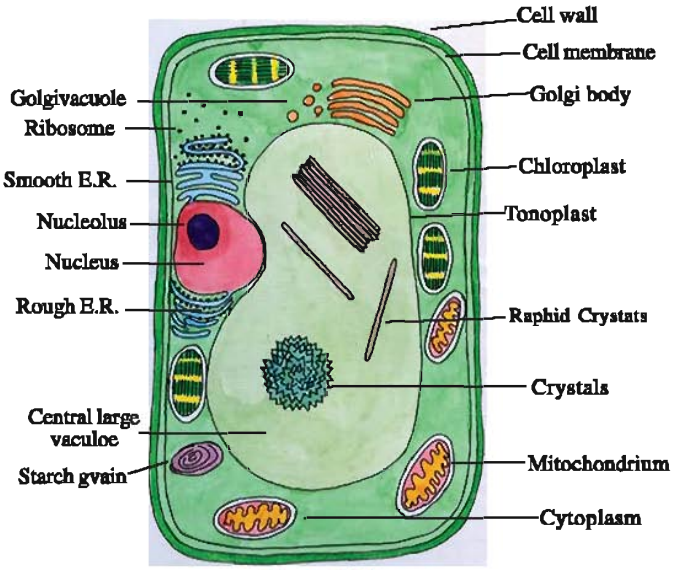


Animal Cell

Besides the nucleus the eukaryotic cells possess membrane bound structures like endoplasmic reticulum (ER), golgi complex, mitochondria, lysosomes, microtubules and vacuoles.These membrane bound structures are called organelles. These membrane bound organelles are absent in prokaryotic cells.Non membrane bound organelles-ribosomes are found in both prokaryotes and eukaryotes. Ribosomes float freely in the cytoplasm or sometimes bind to

another organelle like surface of endoplasmic reticulum. They are also reported in mitochondria and chloroplast. Another non membrane bound organelle called centriole is found only in animal cells. This structure helps in cell division.

Cells have different sizes, shapes, and functions to do. Did you know that the ostrich's egg is the biggest cell while mycoplasmas are the smallest cells ? Even the cells in a single organism may have different shapes, sizes, and functions. Cells also vary greatly in their shape. They may be columnar, cuboid, polygonal, disc like or thread like or sometimes irregular in shapes.



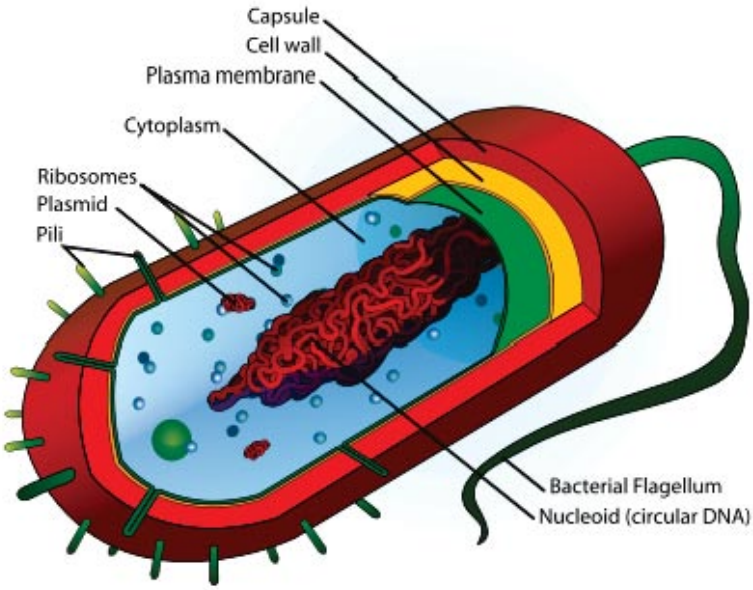
Plant Cell

Before we discuss the various components of a cell, it is important to know what organism the cell comes from. There are two general categories of cells : prokaryotes and eukaryotes.

Prokaryotic Cells :

Prokaryotes are unicellular organisms that lack a nuclear membrane and do not develop or differentiate into multicellular forms. Some organisms grow as filaments or masses of cells, but each cell in the colony is identical and capable of independent existence. The cells may be adjacent to one another because they do not separate after cell divisions or because they remained enclosed in a common sheath or slime secreted by the cells. The prokaryotic cells are represented by bacteria, blue green algae, mycoplasma and PPLO (Pleuro Pneumonia Like Organisms). Prokaryotic cells are smaller than eukaryotic cells. However their cell division is very rapid. They may vary in shape and size. The four basic shapes of bacteria are bacillus (rod), coccus (spherical), vibrio (comma) and spirillum (spiral).

Prokaryotes are distinguished from eukaryotes on the basis of nuclear organization, specifically their lack of a nuclear membrane. Many bacterial cells have small circular DNA out side the genomic DNA. These smaller DNA are called plasmids. The plasmid DNA is responsible for certain unique phenotypic character to bacteria. Prokaryotes also lack the intracellular organelles like mitochondria, chloroplast, endoplasmic reticulum, golgi bodies, centrioles etc. Prokaryotic cells have three architectural regions : **appendages** called flagellum made up of a basal body extended from cytoplasm and pilli-attached to the cell surface, a **cell envelope** consisting of a capsule made up of a cell wall and a plasma membrane and a **cytoplasmic region** that contains the cell genome (DNA),



Prokaryotic cell

ribosomes and various inclusions. A specialized differentiated form of cell membrane called mesosome is the characteristic of prokaryotes.

Cell envelope and its Modifications : Most prokaryotic cells, particularly the bacterial cells are surrounded by a complex cell envelope. Three layers can be demarcated in this envelope. The outermost layer is made up of glycocalyx, the second layer is a cell wall and inner to cell wall is third layer called plasma membrane. The outermost layer could be a loose sheath called slime layer in some bacteria, while in others it may be thick and tough, called the capsule. It mainly serves as a protective layer against attack by phagocytes and by viruses.

The cell wall is the dense layer surrounding the cell membrane. The cell wall can act as a molecular sieve preventing large molecules passing through it.

The plasma membrane is selectively permeable in nature and interacts with the outside world. The prokaryotic cell membrane is a principal structural component of the cell due to following possible functions :

(1) Selectively permeable layer : It allows the entry and exit of some selective molecules but not others.

(2) Energy production : The membrane is a site of electron flow in respiration and photosynthesis leading to photophosphorylation i.e. conversion of ADP to ATP.

(3) Extracellular polymer production : Synthesis of some of the polymers in the cell wall, capsule and extracellular fluid are catalysed by membrane enzymes.

(4) Site of chromosome attachment : The single chromosome is attached to a specific site on membrane at which the replication starts.

(5) Extension of plasma membrane into membranous structures : Structures like mesosomes, vesicles, tubules and lamellae are formed due to extension of plasma membrane. They help in cell wall formation, DNA replication and distribution to daughter cells.

Bacteria can be classified into two groups on the basis of staining procedure developed by Gram viz., those take up the gram stain are Gram positive and the others do not are called Gram negative bacteria.

Some bacteria are motile and they possess flagellum. Flagellum is made up of a basal body and a filament extended from it. The filament is hollow and is made up of flagellin protein. Tubular processes arise from the surface of some bacteria. These are called pilli or fimbrie. They play important role in conjugation.

Ribosomes and Inclusion bodies

Ribosomes are dense particles of 20nm in diameter and are associated with plasma membrane of the cell. They are made up of two subunits – 50S and 30S which combine to 70S prokaryotic ribosomes. Ribosomes are the site of protein synthesis. Several ribosomes may attach to a single mRNA and form a chain called polyribosomes or polysomes.

Inclusion bodies :

There occur a number of inclusion bodies in the cytoplasm also called storage granules by some authors. These bodies are not bounded by any membrane and lie free in cytoplasm, e.g. phosphate granules, cyanophycean granules and glycogen granules. Gas vacuoles are also reported in blue green algae and green photosynthetic bacteria.

Eukaryotic cells :

Eukaryotes include fungi, animals, and plants as well as some unicellular organisms. They possess organized nucleus with nuclear membrane. Eukaryotic cells contain membrane bound organelles in which specific metabolic activities take place. They also possess cytoskeleton. The genetic material is organized into chromosomes.

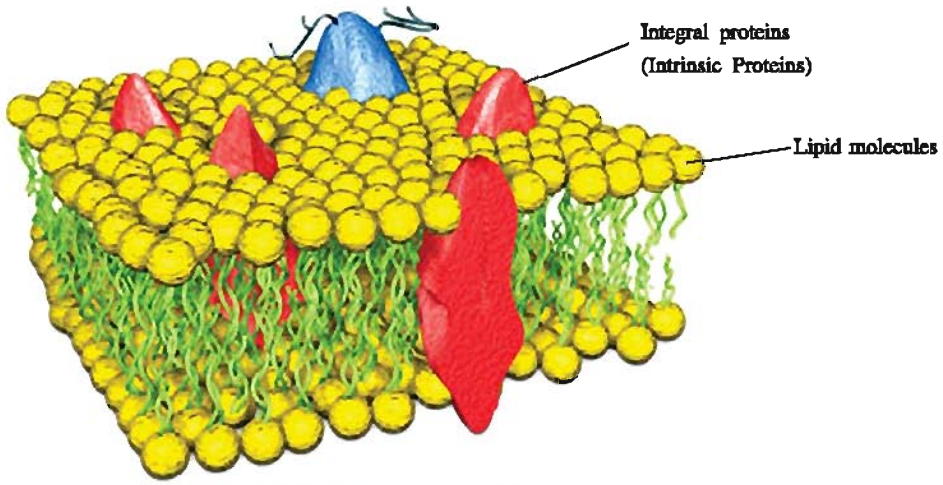
All eukaryotic cells are not identical. Animal and plant cells differ from each other as the former possess centrioles which are absent in plant cells. While plant cells possess cell walls, plastids, and large vacuoles which are absent in animal cells.

Structure and functions of cell organelles :

Let us now look at individual cell organelles to understand their structure and functions.

Cell membrane

Cell membrane or plasma membrane forms the outermost envelope of cytoplasm.. It is composed of lipids and proteins. Lipid molecules are arranged in two layers. Each lipid



Fluid mosaic model of cell membrane

molecule possesses a polar hydrophilic head toward the outer surface and a non polar hydrophobic tail towards the inner surface. This ensures that the non polar tail of saturated hydrocarbons is protected from the aqueous environment. Proteins may be peripheral or integral. Peripheral proteins are associated with the surface. The proteins which are partially or totally buried in the membrane are called integral proteins.

Robertson has proposed a 'unit membrane' concept according to which an uneven protein layer occurs on both the sides of the lipid bilayer. The widely accepted model of the structure of cell membrane is proposed by Singer and Nicolson (1972) . This is called fluid mosaic model.

According to Fluid mosaic model , the plasma membrane is made up of a continuous lipid bilayer and the proteins included in it. This membrane is semi fluid and functionally dynamic. The molecules of lipid and proteins play a role in transport of materials. Peripheral proteins show a loose, superficial arrangement. Hence they can be easily removed. These are extrinsic proteins. The other proteins are integrated . They can not be easily removed. These are intrinsic proteins. Some of them are projecting outside. Through them, passages are created for water soluble materials. Some other proteins are sunk halfway through the lipid layer. They project towards the outer surface. The association of proteins and lipids is a hydrophobic one. The semifluid nature of membrane is because of this.

One of the most important functions of plasma membrane is the transport of the molecules across it. Plasma membrane behaves both as a semipermeable and as a selectively permeable membrane. Transport across the membrane occurs in two main ways – passive transport and active transport.

Passive transport occurs along the concentration gradients i.e. from higher concentration to lower concentration, and hence energy is not required. Water may also move across the membrane from higher to lower concentration. Passive transport is of two types- simple diffusion and facilitated diffusion. Diffusion of water and gases is simple. When the concentration on both the sides of membrane becomes the same, it stops. Movement of water by diffusion is called osmosis. The facilitated diffusion also occurs along the concentration gradients, however involvement of carrier molecules is essential.

Active transport occurs against the concentration gradient. i.e. lower to higher concentration. Such a transport is an energy dependent process in which energy is utilized. e.g., Na^+ and K^+ pump.

Cell wall

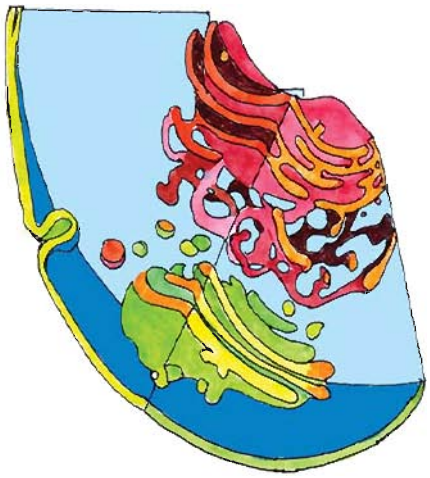
Cell wall is a non living rigid structure which forms an outer covering for the plasma membrane in plants. It not only gives the shape to the cell but also protects the cell from mechanical damage and infection. Algal cell wall is made up of cellulose, galactans, mannos and minerals like calcium carbonate, while in other plants it consists of cellulose, hemicellulose, pectins and proteins. Exceptionally the fungal cell wall also possesses chitin in its structure. The cell wall of young plant cell is called primary cell wall. It is made up of cellulose. A middle lamella made up of calcium pectate occurs between primary walls of two adjacent cells and forms a link between them . A secondary cell wall is formed by deposition of hemicellulose, lignin and suberin on primary cell wall. Cytoplasms of two neighbouring cells are connected through plasmodesmata present in the cell wall and middle lamella.

Endomembrane system

All the membranous organelles in the cells are distinct in terms of their structure and functions. However, many of them are considered together as an endomembrane system because their functions are coordinated. Endoplasmic reticulum, golgi complex, lysosomes and vacuoles are considered as a membrane system. As the functions of mitochondria, chloroplast and peroxisomes are not coordinated with the above components, these are not considered as part of Endomembrane system.

Endoplasmic reticulum

A network of tubular structure spread throughout the cytoplasmic region is called endoplasmic reticulum. The tubules are double walled and bag like structures. These are called cisternae. They maintain association with plasma membrane and nuclear membrane. Those cells which are actively secretary possess many ribosomes on the outer surface of endoplasmic reticulum. Such endoplasmic reticulum is called rough endoplasmic reticulum (RER). Cells involved in large amount of lipid synthesis do not possess ribosomes on endoplasmic reticulum. Such endoplasmic reticulum is called smooth endoplasmic reticulum (SER). In animal cells lipid like steroidal hormones are synthesized in SER.

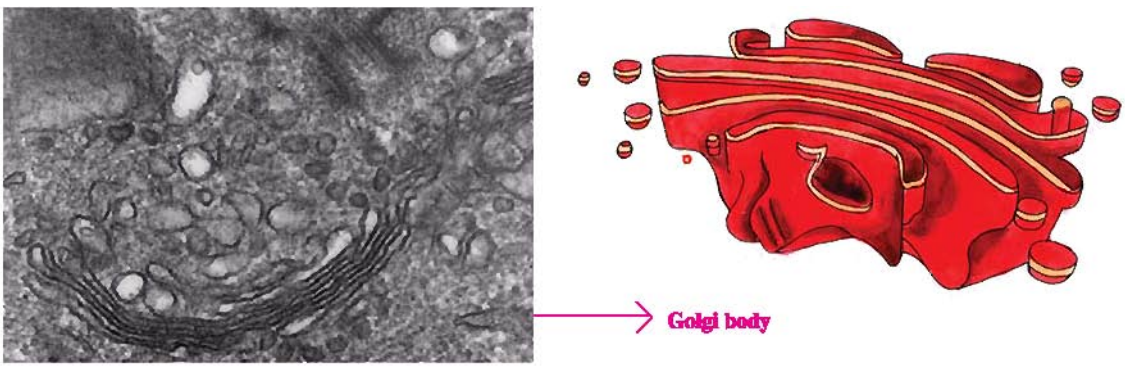


Rough and smooth endoplasmic reticulum

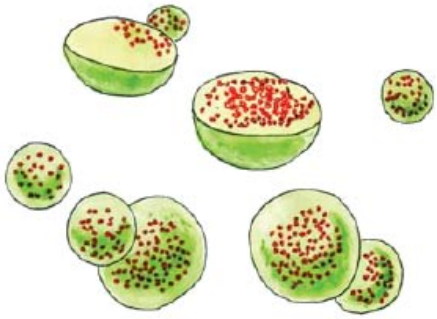
Golgi apparatus

The golgi apparatus was first observed near the nucleus in 1898 by an Italian anatomist Camillo Golgi. Golgi apparatus or Golgi body is formed by a stackpile arrangement of flat, membraneous, baglike units or cisternae of 0.5um to 1.0um diameter. Four to eight units occur in each stackpile. Towards their outer end, round or oblong vesicles appear.

Substances synthesized within endoplasmic reticulum are packed into vesicles through golgi complex and then released into cytoplasm. A number of proteins synthesized by ribosomes on the endoplasmic reticulum are modified in the cisternae of the golgi apparatus before they are released from its outer face. Golgi apparatus is a site for synthesis of glycolipids and glycoproteins.



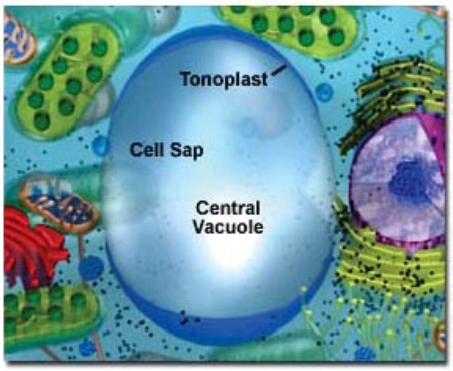
Microscopic view of Golgi body



Lysosomes

Lysosomes

Lysosomes arise as vesicles separated from golgi bodies. They are surrounded by a single layered wall. They are associated with intracellular digestion . They contain enzymes which are capable of digesting almost all macromolecules. These enzymes are hydrolases type (lipases, proteases, carbohydrases). They are important in phagocytosis and pinocytosis like processes. As they are responsible for degradation of worn out cells, they are called 'suicide bags'.

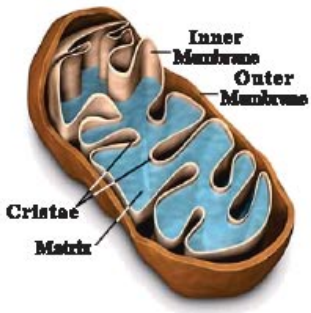


Vacuoles

Vacuoles

The areas in cytoplasm without any cytoplasm are called vacuoles. In plant cells, a large vacuole occurs which is surrounded by a semipermeable membrane called tonoplast. Tonoplast facilitates the transport of a number of ions and other materials against concentration gradients into the vacuole, hence their concentration is significantly higher in the vacuole than in the cytoplasm. Normally vacuoles do not occur in animal cells. In Paramoecium the vacuole is contractile. They create osmotic pressure in cells. Various substances are excreted or stored in them.

Mitochondria



Mitochondria

Mitochondria are self replicating organelles that occur in various number, shapes and sizes in the cytoplasm of all eukaryotic cells. The number of mitochondria per cell depend upon the physiological activity of the cells. Typically they are fibrous, cylindrical or granular having a diameter of 0.2 - 1.0 μm and length 1.0 - 4.1 μm. Each mitochondrion possesses a double walled envelope. The outer layer is continuous while the inner layer has many foldings. These foldings are called cristae which may be tubular or flat. The cristae possess structures known as F_1 particles. The remaining inner region is called matrix. Ribosomes and circular DNA occur in matrix.

Enzymes necessary for Krebs' cycle are located in the matrix of mitochondria. F_1 particles contain components essential for oxidative phosphorylation. Synthesis of ATP takes place here and hence, they are called power house of the cell.

Plastids

Plastids are found in all plant cells. They contain specific pigments. Based on the types of the pigments plastids can be classified into chromoplasts, chloroplasts and leucoplasts.

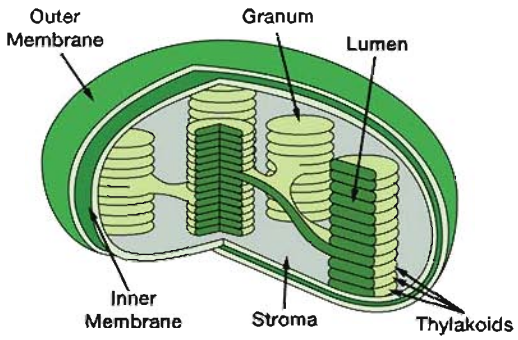
Chromoplasts

These plastids possess pigments other then chlorophylls. They have pigments like carotene, xanthophylls, anthocyanin etc. Various colours in flowers fruits and seeds are due to their presence.

Chloroplasts

These plastids possess chlorophyll pigments. They carryout photosynthesis process.

Majority of chloroplasts are present in the mesophyll of leaves. They are lens shaped, oval, spherical, discoid or even ribbon shaped. They possess variable length i.e., 5 – 10 μm and width 2 – 4 μm. Their number also varies from 1 per cell in *Chlamydomonas* to 20 to 40 per cell in the mesophyll.



Chloroplast

Chloroplast has a double layer wall. The outer layer is continuous. The inner layer forms a highly folded membrane system. The membrane system forms grana. The grana are interconnected by intergranum membranes. The region except the membraneous one is called stroma. Each granum is made up of a stack of flat, lamellar structures. Normally one chloroplast contains 40 to 60 grana. Each granum possesses 2 to 100 thylakoids. Chlorophyll pigments are present in thylakoids. Moreover materials essential for synthesis of ATP through photophosphorylation i.e., light reaction, also present in thylakoids. The stroma contains proteins, ribosomes (70S), circular DNA and enzymes required in dark reaction.

Leucoplasts

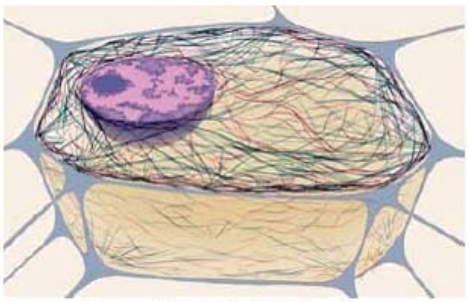
They do not contain any pigments. They act as food storing units. Those which store starch are called amyloplasts. Elaioplasts store fat or oil and aleuroplasts store proteins.

Ribosomes :

Ribosomes are granular structure and are found freely in the cytoplasm as well as associated with endoplasmic reticulum. Ribosomes are 80 S type having two sub units 60 S amd 40 S. Ribosomal RNA and proteins occur in the constitution of ribosomes. Ribosomes located on the endoplasmic reticulum synthesize proteins associated with lysosomes and plasma membrane. The free ribosomes synthesize other proteins. Association of more than one ribosome with a single molecule of m RNA such complex is called polysome or polyribosome.

Cytoskeleton :

Cytoskeleton is formed by three kinds of filaments – microfilaments, microtubules and intermediate filaments. Microfilaments are made up of actin like proteins. They may be scattered or arranged in a network or in a parallel fashion. They are associated with cellular form and cellular movement. Amoeboid movement, cyclosis of protoplasm and transport of particulate matter are due to them.



Cytoskeleton

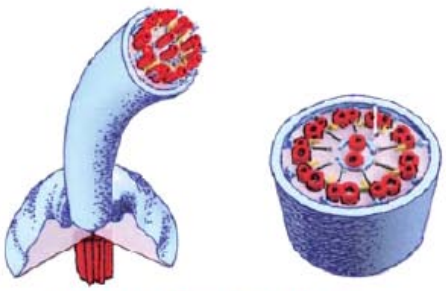
Microtubules consist of hollow tubules are made up of the globular protein- tubulin. They maintain cell shape. They play role in cellular movement and cellular transport of materials. They are also responsible for chromosome movement.

Intermediate filaments are strong and durable protein fibres. They form a basket and provide support to the other filaments and tubules.

The three fibers of the cytoskeleton–microtubules in blue, intermediate filaments in red, and actin in green–play countless roles in the cell.

Cilia and Flagella :

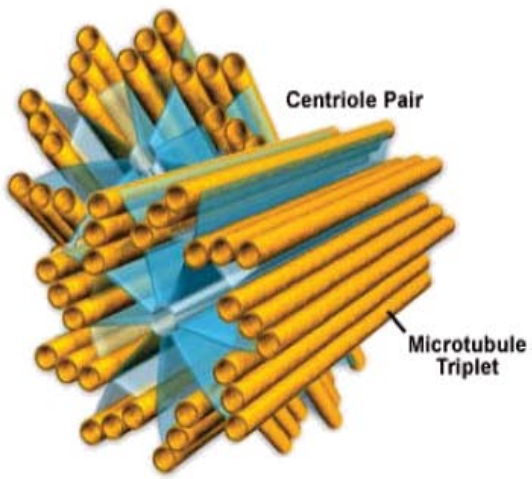
Cilia and flagella are associated with locomotion and movement. They are located on free surface of cells. Cilia are relatively shorter while flagella are longer. Flagella are one or two but cilia are many. Movement generated by both is different.



Ultra structure of Cilium and Flagellum

There is a lot of similarity in their ultrastructure. Both originate in a basal body. Structure of basal body resembles that of centriole. The axis of cilium and flagellum is called axoneme. It is made up of two central and nine pairs of microtubules along the circumference (9 + 2 arrangement) . The adjacent pairs are joined by two filaments. They are also connected with the central microtubules through filaments.

Cilia and flagella are tubular structures enveloped by a membrane . Cilia are observed in *Paramoecium* and flagella can be seen in *Euglena*. Bacteria can also be ciliated or flagellated.



Centrioles

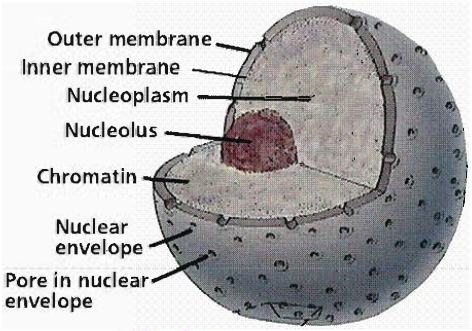
Centrosome and centrioles :

Centrosome is an organelle usually containing two cylindrical structures, arranged at right angle to each other, called centrioles. All animal cells have centriole. It is also found in some algae and fungi. Each centriole is organized like a wheel. Nine triplets forming angles of about 40^0 are arranged in peripheral region. Three microtubules made up of tubulin occur in each triplet. Adjacent triplets are

interconnected by protein fibres. At the centre there occurs a proteinaceous hub. The microtubules of triplets are connected with the hub by filaments. The protoplast surrounding the centrioles is called centrosphere. Centrosome directs formation of the bipolar spindle during cell division. It is also associated in the formation of basal granules, cilia and flagella.

Nucleus

Nucleus is a regulatory centre of various cellular activities. Normally the cells are uninucleate but some cells are binucleate and some are multinucleate. Human RBC and sieve tubes lack nucleus. Nuclear membrane, nucleoplasm, nucleolus and chromatin occur in the structure of nucleus.



Nucleus

Nuclear membrane is a double layered structure. Between these two layers a space called perinuclear space is present. The outer layer is associated with endoplasmic reticulum. It also possesses ribosomes on its outer surface. Nuclear pores occur at various places and they are responsible for transfer of RNA and protein molecules between cytoplasm and nucleoplasm.

The nucleoplasm contains nucleolus and chromatin. Nucleolus is a spherical structure. No membrane surrounds it. They are formed on nucleolar organizer region of some specific chromosomes. Nucleolus is a site for active ribosomal RNA synthesis.

Chromosomes

Chromatin is made up of DNA, RNA and histone and non histone kinds of proteins. In an interphase –cell, the chromosomes are spread as an indistinct network, which is called chromatin. During the process of cell division they appear as thread like structures. Chromosomes appear in the nucleus of eukaryotic cells. During the metaphase of cell division, their shapes become distinct. Every chromosome essentially has a primary constriction or the centromere on the side of which disc shaped structures called kinetochores are present. Depending on the position of centromere chromosomes are classified into four types.

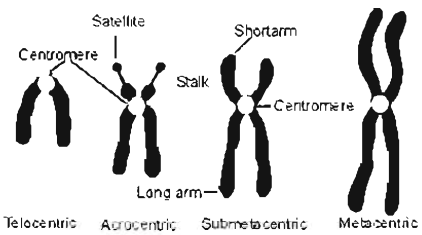
Metacentric : Centromere is located in the centre forming two equal arms of the chromosome.

Sub-metacentric : Centromere is located some distance away from the centre resulting into one shorter and one longer arm of the chromosome.

Acrocentric : Centromere is situated near the end of the chromosome forming one extremely short and one very long arm.

Telocentric : Centromere is located at the end of the chromosome.

Few chromosomes have non staining secondary constrictions at a fixed location. This gives the appearance of a small fragment called the satellite.



Types of chromosomes

Microbodies

Many membrane bound minute vesicles called microbodies that contain various enzymes, are present in the cytoplasm of both, plant and animal cells.

Summary

All living organisms are made up of cells. Cell is a structural and functional unit of organisms. Cells vary in their shape, size and functions. Some organisms are unicellular while others are multicellular. Each cell is having potentiality to produce a new individual and this is called totipotency of cell. On the basis of presence or absence of membrane bound nucleus organisms are classified into prokaryotes (with primitive nucleus) and eukaryotes (with advanced nucleus). Eukaryotes include plants and animals and hence, eukaryotic cells are further classified into plant cells and animal cells. Major differences between plant cells and animal cells are presence of cell wall, plastids and vacuoles in plant cells. A typical eukaryotic cell consists of a cell membrane, cytoplasm and nucleus. Cell membrane, also called as plasma membrane is the outer most layer of animal cell and located inner to cell wall in plant cell. It is selectively permeable membrane which facilitates transport of several molecules. Eukaryotic cells possess membrane bound organelles like endoplasmic reticulum, golgi apparatus, lysosomes, and vacuoles.

Endoplasmic reticulum is made of cisternae. The endoplasmic reticulum with ribosomes on its outer surface is called rough endoplasmic reticulum . It is associated with the synthesis of proteins. Endoplasmic reticulum without ribosomes is known as smooth endoplasmic reticulum. It takes part in the synthesis of lipids. The golgi apparatus is made up of flattened sacs and located near the nucleus. Sometimes it is known as golgi body or golgi complex. Substances synthesized in the endoplasmic reticulum are packed into vesicles of golgi apparatus and then released into cytoplasm. Lysosomes are surrounded by a single layered wall. They contain enzymes which digest all macromolecules. In plant cells large vacuoles are present which possess a membrane called tonoplast. Various substances are excreted or stored in them.

As the mitochondria are associated with the generation of ATP , they are called Power house of cell. Each mitochondrion possesses double layered envelope. Inner layer reveals infoldings called cristae. The inner layer region is called matrix. Krebs' cycle and oxidative phosphorylation like processes are carried out in mitochondria. The inner layer of double wall layered chloroplast forms highly folded membrane system called grana. Each granum is made up of thylakoids which contain photosynthetic pigments. Light reaction of photosynthesis takes place in grana while dark reaction in stroma. 70 S type of ribosomes are present in prokaryotic cells while 80 S type of ribosomes are present in eukaryotic cells. The shape of cytoplasm and thereby the shape of cell is maintained by cytoskeleton which is made up of microfilament, microtubules and intermediate filaments. In eukaryotic cell , nucleus possesses nuclear membrane, nucleolus, nucleoplasm and chromatin materials. Nuclear membrane is double layered structure. Outer layer remains in continuation with endoplasmic reticulum.

EXERCISE

1. Put a dark colour in a given circle for correct answer :

(1) Who discovered nucleus ?

(a) Robert Hook ◯ (b) Robert Brown ◯

(c) Perkinje ◯ (d) Robert Cooke ◯

(2) Which of the followings is non membrane bound organelle ?

(a) Endoplasmic reticulum ◯ (b) Ribosome ◯

(c) Lysosome ◯ (d) Golgi complex ◯

(3) Which one of the followings are having smallest cell ?

(a) Euglena ◯ (b) Yeast ◯

(c) Mycoplasma ◯ (d) Bacteria ◯

(4) Small circular DNA present outside the genomic DNA in many bacterial cells is known as :

(a) Cosmid ◯ (b) Plasmid ◯

(c) Episome ◯ (d) Hybrid ◯

(5) The pilli or fimbrie is associated with the process of :

(a) Locomotion ◯ (b) Movement ◯

(c) Conjugation ◯ (d) Food intake ◯

(6) Which of the following types of ribosomes are present in prokaryotic cells ?

(a) 80 S ◯ (b) 90 S ◯

(c) 70 S ◯ (d) 60 S ◯

(7) According to cell theory :

(a) All cells are living ◯

(b) Cells reproduce by cell division Meiosis ◯

(c) All cells show Mitosis ◯

(d) Cells are structural units of organisms ◯

(8) Who applied cell theory to plants :

(a) Schleiden ◯ (b) Schwann ◯

(c) Virchow ◯ (d) Jensen ◯

(9) Nucleoid is present in :

(a) Plant cell ◯ (b) Animal cell ◯

(c) Bacterial Cell ◯ (d) Virus ◯

(10) Middle lamella in the plant cell is rich in :

(a) Cellulose ◯ (b) Calcium pectate ◯

(c) Lignin ◯ (d) Suberin ◯

(11) Chitin is present in the cell wall of :

(a) Algae ◯ (b) Fungi ◯

(c) Animals ◯ (d) Bacteria ◯

(12) Which organelle is not a part of endomembrane system ?

(a) Chlroplast ○ (b) Endoplasmic reticulum ○

(c) Lysosome ○ (d) Vacuole ○

(13) Which of the following organelles is popularly known as 'Suicide bag' ?

(a) Vacuole ○ (b) Chloroplast ○

(c) Lysosome ○ (d) Gogi complex ○

(14) Prokaryotes are characterized by :

(a) No nucleus ○ (b) No nuclear envelope ○

(c) DNA without histones ○ (d) All the above ○

(15) Which type of chromosome possesses centromere at the end ?

(a) Acrocentric ○ (b) Metacnetric ○

(c) Telocentric ○ (d) Submetacentric ○

2. Answer the following questions in short :

(1) What is cell theory ?

(2) What is the contribution of Rudolf Virchow ?

(3) What are the plastids ?

(4) Write full form of PPLO

(5) What is the function of capsule in bacterial cell ?

(6) Define osmosis

(7) What do you mean by rough endoplasmic reticulum ?

(8) Write the functions of Golgi complex.

(9) Define tonoplast.

(10) What is granum ?

3. Do as directed :

(1) Describe the structure of ribosomes

(2) Differentiate between cilia and flagella.

(3) What are the functions of endoplasmic reticulum ?

(4) Differentiate between animal cell and plant cell

(5) Differentiate between prokaryotic and eukaryotic cell

4. Answer the following questions :

(1) Describe the ultrastructure of cell membrane .

(2) Describe cytoskeleton

(3) Explain ultrastructure and functions of chloroplast.

(4) Explain the types of chromosomes on the basis of location of centromere.

(5) Describe the structure of prokaryotic cell.

●

6

Biomolecules-I
(Carbohydrates and Lipids)

We learnt earlier that cell is the structural and functional unit of all organisms. Various organelles and different kinds of molecules are involved in the structure of cells. All the carbon compounds that we find in living tissues can be called biomolecules. However, living organisms also have inorganic elements and compounds in them. If we perform elemental analysis on a plant tissue, animal tissue or a microbial paste , we obtain a list of elements like carbon, hydrogen, oxygen and several others. Metabolic activities carried out by cells are an out come of various chemical reactions, called biochemical reactions. Many molecules and elements participate in the biochemical reactions. Living organisms obtain a variety of molecules and elements from their environment and use them for the synthesis of vital compounds required in the body.

Chemical substances found in the cells of organisms are classified into two main groups. (1) inorganic and (2) organic.

Inorganic substance include water, mineral elements and mineral salts while organic substance or compounds include carbohydrates, lipids, proteins, nucleic acids, enzymes, hormones etc. The organic compounds chiefly contain the atoms of C, H and O. The formation of bonds between carbon-carbon, carbon-hydrogen or carbon-oxygen leads to the formation of simple or complex compounds which are known as organic compounds

Inorganic substances :

Water and mineral elements are included in inorganic substances.

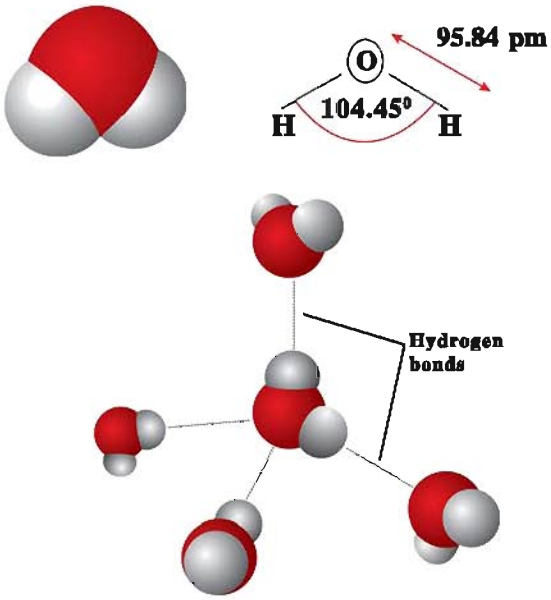
Water :

Water is the mother liquid of all forms of life. The essentiality of water for living system is quite evident as without water, there is no life. In the constitution of any living organism, 65% or more water occurs. In living cell it may be 70 to 90%. Water usually makes up 55% to 78% of the human body. In nature it exists in liquid , solid and gaseous forms. Water is the chemical substance with chemical formula H_2O: one molecule of water has two hydrogen atoms covalently bonded to a single oxygen atom. At room temperature

it is nearly colourless , tasteless and odourless liquid. Let us study important properties of water and their relation to life.

Compared to other fluids, water is the most efficient solvent. Most of the chemicals found in organisms are soluble in water. Thus, homogeneity of cytoplasm is maintained. Moreover, water also provides an excellent transport medium for various chemicals. Thus water transports materials essential for biochemical reactions throughout the body of the organisms. Important respiratory gases like oxygen and carbon dioxide are also transported through water only.

An important feature of water is its polar nature . The hydrogen and oxygen units in its constitution bear partial positive and partial negative charges respectively. Because of this, the molecules remain bound with one another. The bonds present between molecules are known as hydrogen bonds. Because of this property water normally occurs as liquid. Due to polarity only water acts as an efficient solvent and molecules of water get arranged around positive and negative ions and include them within. H - O - H are joined at the angle of 104.45^0. Distance between H and O is 95.84 picometer. (1 Picometer = 10^{-12} meter).



Water has a characteristically high specific and latent heat. Due to these properties any change in the temperature of the surrounding by loss or gain of heat by water does not affect the temperature of water. Since water has a high latent heat, water in lakes and seas does not freeze.

The cohesive force amongst water molecules is very high. This force holds them together. This property plays an important role in the process of ascent of sap in plants.

The density of water is dependent on the dissolved salt content as well as the temperature of the water. The density of water is highest at 4^0 C. Similarly, its viscosity is also high. This property of water enables planktonic organisms to float and move about freely on the surface of water. They do not encounter any mechanical shock in water.

Water has high capacity to conduct heat, hence heat is equally distributed in all the parts of the body of an organism.

Water plays an important role in maintenance of three dimensional form of macromolecules like proteins, nucleicacids etc.

Water also acts as a reactant and provides H^+ and OH^- for many reactions.

Minerals :

Various minerals occur in association with inorganic and organic constituents. Since the beginning of the 19th century, it has been established that plants absorbs inorganic minerals from the soil. Carbon, hydrogen, nitrogen, oxygen , phosphorus, calcium, sulphur, magnesium, iron, manganese, zinc, boron, copper, molybdenum, sodium, potassium and chlorine are important mineral elements for plants. In addition certain other elements such as aluminium, sodium, silicon, chlorine and cobalt are found to be essential for the healthy growth of certain plants. However their importance in all plants is not observed.

Plants obtain **nitrogen** from the soil in the form of nitrogenous salts. Nitrogen is essential for the synthesis of proteins and nucleicacids. It forms a part of vitamins, enzymes and many other substances.

Phosphorus is absorbed by the plants from the soil in the form of phosphate ions. It is an important constituent of nucleicacids, cell membrane, ATP and various enzymes. It plays very important role in energy exchange processes. In the vertebrates, about 80% of the total phosphorus is associated with teeth and bones.

Calcium is essential for strong bones and teeth. It is required in clotting of blood and contraction of muscles. The middle lamella between plant cell is made up of calcium pectate. Calcium also determines the permeability of cell membrane.

Plants obtain **sulphur** from the soil in the form of sulphate ions. Sulphur is found as a structural component of some aminoacids. Cysteine and methionine are sulphur containing amino acids. It is also a structural component of vitamins such as biotin and thiamine. Sulphur is present in hyaline cartilage, ligaments and bone marrow of living organisms, chiefly in the form of sulphates.

Magnesium is an indispensable constituent of chlorophyll in plants. It also plays an important role in the synthesis of ATP and carbohydrates. Enzymes involved in carbohydrates, lipids and protein metabolism contain magnesium.

Iron, myoglobin and cytochrome compounds contain iron. Many enzymes concerned with respiration contain iron in their structure.

In plants **manganese** plays an important role in respiration and nitrogen metabolism, while in animals it is useful for the growth of bones and in reproduction.. It is a co-factor for the activation of enzymes like phosphatase.

Zinc is essential in our body for general growth and reproduction. It takes part in repair of worn out cells. In animal tissues many enzymes are activated in presence of zinc.

Boron is associated with the transport of sugars in plants. It also plays an important role in the production of flowers and fruits, cell divisions and certain other processes.

Copper takes part in the synthesis of haemoglobin in animals and chlorophyll in plants.

Copper is present in haemocyanin, a respiratory pigment in certain arthropods. Enzyme tyrosinase has copper as structural component.

Molybdenum helps in the fixation of nitrogen in plants. In animals it is a component of intestinal enzymes.

Sodium and potassium play an important role in the maintenance of pH and osmotic pressure of intercellular fluids. They also play important role in conduction of nerve impulses.

Chlorine is amongst the main ions in blood. It plays an important role in CO_2 transport. It also takes part in the processes of digestion of food, osmoregulation in blood and maintenance of pH.

Organic substances :

Organic molecules consist primarily of carbon, hydrogen, nitrogen, and oxygen, and, to a smaller extent, phosphorus and sulphur. Other elements sometimes are incorporated but are much less common. Carbon occurs as a main constituent in most substances of protoplast. As carbon is having valency of four, it can combine with other molecules of its own kind as well as with other functional groups to form various kinds of substances. Such chemicals in which the main chemical bonds are formed between C and C, C are H called organic substances.

A biomolecule is any organic molecule that is produced by a living organism, including large polymeric molecules such as proteins, polysaccharides, nucleicacidsand lipids.

These compounds with the exception of lipids, have molecular weights in the range of ten thousand Daltons and above. Biomolecules also include small molecules such as primary metabolites, secondary metabolites, and natural products. For this very reason biomolecules are of two types. (I) those which have molecular weights less than one thousand Dalton are usually referred to as micromolecules or simply biomolecules while (II) those which have molecular weights more than thousand Daltons are called macromolecules or biomacromolecules.

Carbohydrates : Carbohydrate molecules are structurally composed of C, H and O atoms. The ratio of H to O is generally 2:1 but it is not always so. The general formula of carbohydrates is $C_n(H_2O)m$ where the value of n may or may not be the same as that of m. Three main kinds of carbohydrates occur viz. monosaccharides , disaccharides and polysaccharides.

Monosaccharides : Monosaccharides are the simplest form of carbohydrates with only one simple sugar molecule. In their structure , the values of n and m are the same. They essentially contain an aldehyde (–CHO) or ketone ($>C=0$) group in their structure and accordingly they are called aldose sugar or ketose sugar. Monosaccharides are sweet in taste, soluble in water and can pass through the cell membrane. These carbohydrate molecules can not be further hydrolysed to simpler form. Monosaccharides are classified on the basis of the number of carbon atoms in their molecules. Biologically important monosaccharides are triose , pentose and hexose.

Triose sugar ($C_3H_6O_3$) :

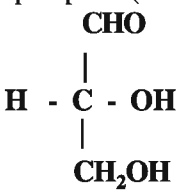
Glyceraldehyde and dihydroxyacetone are the examples of triose sugar.

Phosphoglyceraldehyde (PGAL), synthesized during the dark reaction of photosynthesis is an example of the phosphate of aldotriose sugar. Dihydroxyacetone phosphate formed during respiration, is an example of the phosphate of ketotriose sugar.

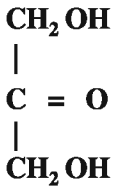
Pentose sugar ($C_5H_{10}O_5$) :

The deoxyribose sugar which occurs as part of the structure of DNA, and the ribose sugar found in the structure of RNA and ATP are example of aldopentose sugar.

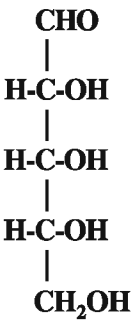
During the dark reaction of photosynthesis, the sugar involved in the constitution of Ribulose diphosphate (RuDP) is an example of ketopentose sugar.



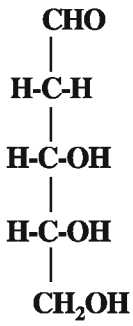
Glyceraldehyde
(Aldo triose Sugar)



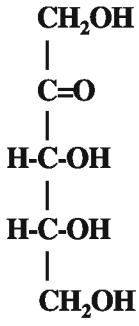
Dihydroxy acetose
(Keto triose Sugar)



Ribose

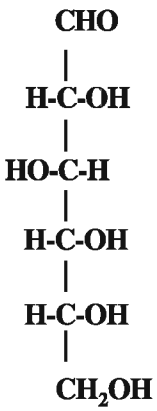


Deoxyribose

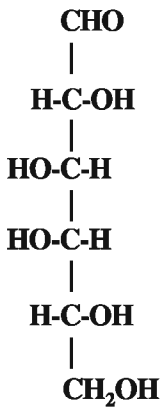


Ribulose

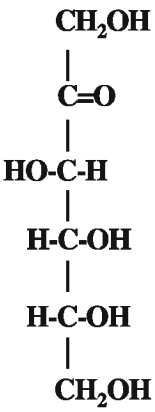
Hexoses ($C_6H_{12}O_6$) : The hexose sugars most commonly include glucose, fructose and galactose. Fructose is a ketohexose found in the juice of fruits. Glucose and Galactose are aldohexoses. Glucose is formed by digestion of starch. Digestion of milk yields Galactose and Glucose. These sugars provide energy of the body.



Glucose



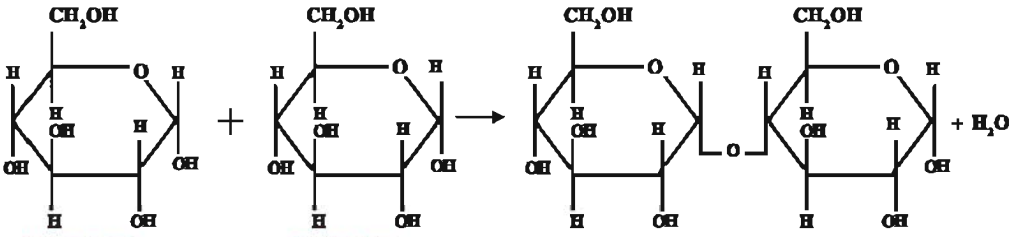
Galactose



Fructose

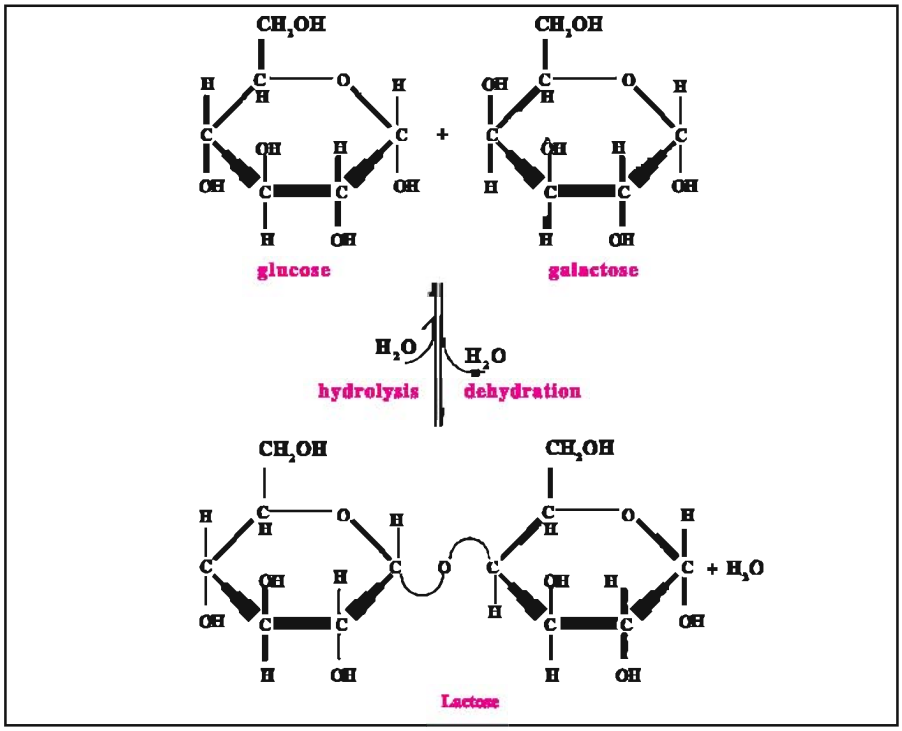
Disaccharides : Disaccharide molecule is formed when two molecules of monosaccharides, particularly two hexoses, are linked together releasing one molecule of water. This linkage is called glycosidic bond. The general formula of disaccharide is $Cn(H_2O)n - 1$ and accordingly the empirical formula is $C_{12}H_{22}O_{11}$. They are sweet in taste and soluble in water.

Generally they are not diffusible through the cell membrane. They can be hydrolyzed to yield their saccharin building blocks by boiling with dilute acid or reacting them with appropriate enzymes. Maltose, sucrose and lactose are the examples of disaccharides. Hydrolysis of a molecule of maltose yields glucose + glucose, that of sucrose yields glucose + fructose and lactose yields glucose + galactose.



GLUCOSE GLUCOSE MALTOSE

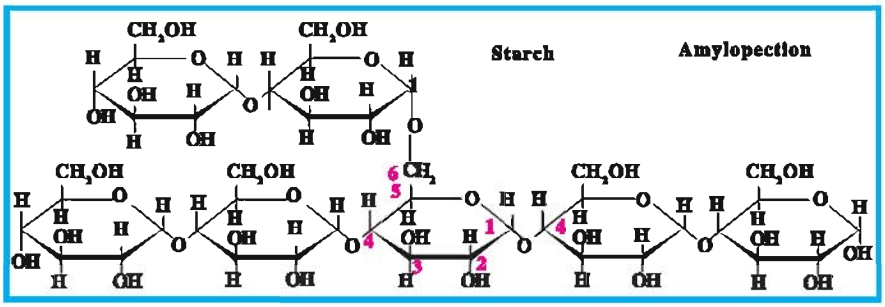
(monosaccharides) (a disaccharide)

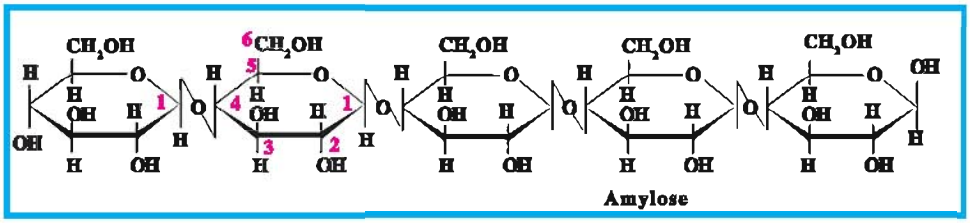


Polysaccharides : When a large number of monosaccharide units become joined through glycosidic bonds and form as long chain, the chain is called polysaccharide. Its structural formula is $(C_6H_{10}O_5)n$. Polysaccharides are not sweet and not soluble in water. The various known forms of the polysaccharides are starch, glycogen, cellulose, chitin and lignin. Starch is made up of unbranched polysaccharide chains made up of glucose units. It is called amylase. Branched polysaccharide chains of glucose also occur in a little amount. These are called amylopectin. In plants food is stored as starch. Branched polysaccharide chains of glucose occur in the constitution of glycogen. These chains are branched. They are called amylopectin chains. In animals the food is stored as glycogen.

Cellulose is also made up of polysaccharide chains of glucose and is the structural component of plant cell wall.

Amylose Amylopectin





Biological importance of carbohydrates

Carbohydrates play an important role in metabolism of cell and constitution of tissues.

Ribose and deoxyribose pentose sugars are the structural components of RNA and DNA respectively.

Carbohydrates are the main source of energy in living organisms. Glucose is most widely used in respiration. The energy released through its oxidation, meets the energy requirement of organisms.

Carbohydrates such as cellulose form the plant cell wall. Starch serves as a stored food in plants while glycogen served as a reserve food in animals.

Lipids : Lipids are the important constituents of the diet because of their high energy value. The lipids are a heterogeneous group of compounds related to fatty acids and include fats, oils, waxes and other related substances. Lipids are oily organic substances, relatively insoluble

in water and considerably soluble in organic solvents like ether , chloroform and benzene. They are formed of C, H and O atoms . The number of H atoms is much more than that of O.

Structure of Lipids

Each molecule of lipid is formed by the combination of one molecule of alcohol with one to three molecules of fatty acids.

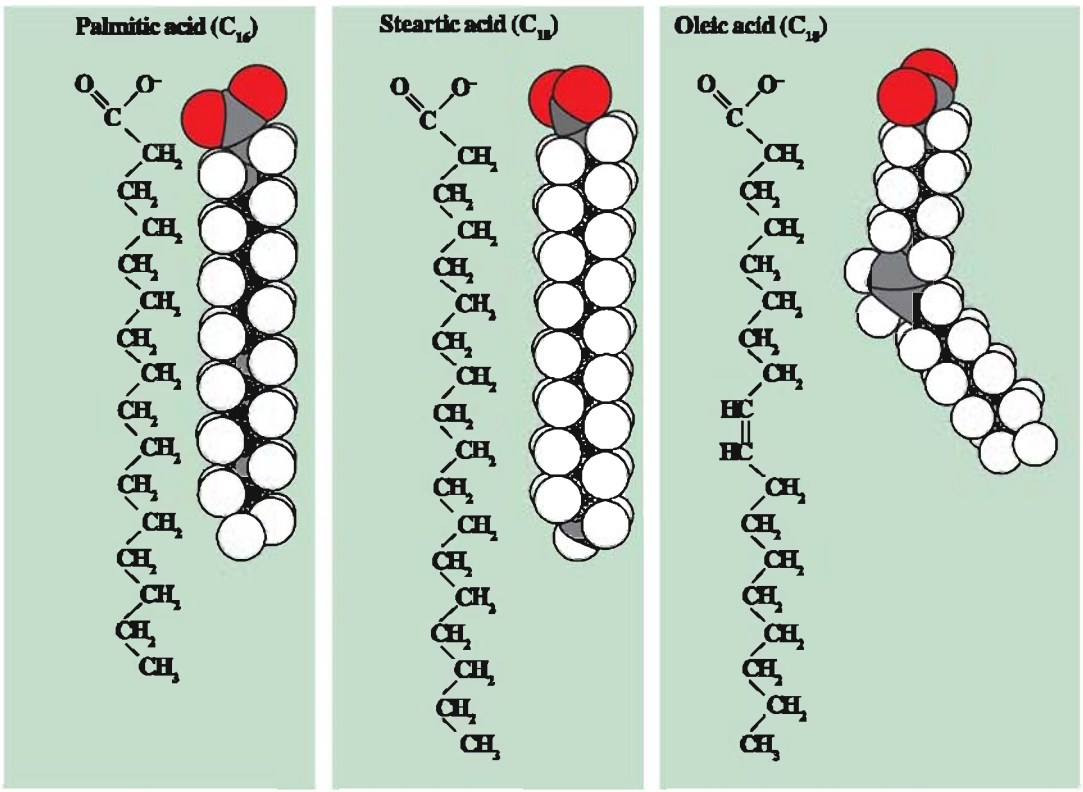
Alcohol is either as trihydroxy alcohol(glycerol) or as monohydroxy alcohol. Trihydroxy alcohol has three carbon and three –OH groups.

Fattyacids are of two types :

(1) Saturated fattyacids and (2) Unsaturated fattyacids.

(1) Saturated fatty acids : They are not able to accept hydrogen or halogen atoms. Two successive carbon atoms therein, are linked by a single bond. . On the basis of number of carbon atoms the saturated fattyacids are of two types : a) Short chain fattyacids e.g., Butyric acid and b) Long chain fatty acids e.g., Palmitic acid, Steartic acid.

(2) Unsaturated fattyacids : They are capable of accepting hydrogen or halogen atoms. Two successive carbon atoms at certain places therein are linked by double bond. On the basis of number of carbon atoms the unsaturated fattyacids are of two types : (a) Short chain fattyacids e.g., Crotonic acid and (b) long chain fattyacids e.g., Oleic acid



In the formation of triglyceride (lipid), each fattyacid molecule binds to -OH of trihydroxy alcohol through its –COOH group by forming easter bond. A molecule of water is released during this.

Types of Lipids

Lipids are of three types : (1) Simple lipids (2) Complex lipids and (3) Steroids.

(1) Simple lipids : Structurally they are formed of one molecule of alcohol and one to three molecules of fatty acids. Simple lipids are of two types : (a) Triglycerides and (b) Waxes.

(a) Triglycerides : In the formation of triglyceride one molecule of glycerol get linked with three molecules of any fattyacids by easter bonds (C-O-O-C) through the process of dehydration releasing three molecules of water.

Equation :

$$\begin{array}{l} H_2C\text{-}OH + HOOC - (R_1) \\ \quad | \\ H\ C\text{-}OH + HOOC - (R_2) \\ \quad | \\ H_2C\text{-}OH + HOOC - (R_3) \end{array} \xrightarrow{\text{dehydration}} \begin{array}{l} H_2C - O - OC - (R_1) \\ \quad | \\ H\ C - O - OC - (R_2) + 3H_2O \\ \quad | \\ H_2C - O - OC - (R_3) \end{array}$$

Glycerol + 3 Fatty acids Triglyceride

Triglycerides are of two types : (1) Fats and (2) oils.

(1) Fats : The fats are solid at room temperature. All the fatty acids in its composition are saturated and mostly having long chain e.g., butter, ghee, animal fat, vegetable ghee etc.

Oils : The oils are liquid at room temperature. One , two or all the fattyacids in its composition are short or long chain fattyacids of unsaturated nature. E.g., ground nut oil, til oil, coconut oil, fish liver oil etc.

(b) Waxes : In the structure of wax an alcohol molecule is not glycerol but some monohydroxy alcohol. A molecule of monohydroxy alcohol is linked with a molecule of long chain saturated fatty acid.

(2) Complex lipids : Those lipids which contain a non lipid constituent in addition to alcohol and fatty acids are called complex lipid. They are named after the non lipid component. Glycolipid (carbohydrate), phospholipid (phosphate) and lipoprotein (protein) are such examples.

(3) Steroids : Steroids are important types of lipids. They do not contain fatty acids. Steroid molecules which contain hydroxyl (-OH) group but do not contain carboxyl (-COOH) group or keto ($>C=O$) group are called sterols, such as cholesterol, ergosterol etc. Cortisone, progesterone etc. are steroid hormones found in animals which contain only carboxyl or keto group.

Biological importance of Lipids

Lipids liberate a very large amount of energy. The energy released is more than double the amount released during respiration of carbohydrates.

Being insoluble in water it is stored in the body as reserve food (in the forms of oil and fat) which can be utilized through the metabolic process as and when required.

They form an insulating layer. The myelin sheath around the nerve fibre contains lipid that prevents the passage of nerve impulses in the adjacent nerve fibres. The subcutaneous fat layer under the skin, maintains body temperature, and body structure.

Lipids such as wax form a protective layer on the outer surface of the aerial plant organs.

Lipids act as a solvent for fat soluble vitamins. Vitamins A, D and E are fat soluble.

It is also structural component of cell organelles. Plasma membrane and membrane of organelles are made up of phospholipid.

The presence of lipid is inevitable for the activity of certain enzymes. E.g., glucose phosphatase.

Steroid hormones, vitamins D and E are synthesized from the derivatives of lipids..

Summary

Although living organisms show a great diversity among them, their chemical composition and metabolic reactions appear to be remarkably similar. Substances present in the body of living organisms can be classified into : 1) inorganic substances and 2) organic substances. Inorganic substances include water and mineral elements. Water is the mother liquid of all forms of life. As most of the chemicals found in the organisms are soluble in water, it is also known as universal solvent. The essentiality of water for living system is quite evident as without water, there is no life Various minerals occur in association with inorganic and organic constituents. The main minerals found in the bodies of organisms are nitrogen, calcium, phosphorus, sodium , magnesium, chlorine and sulphur. Copper, iron, manganese, zinc and boron also occur in extremely small quantities. The substances which are formed due to bond formation between C and H are called organic substances. A Carbohydrate molecule contains Carbon, Hydrogen and Oxygen. There are twice as many Hydrogens as there are Oxygens, the same proportion as water. Carbohydrates have the general formula of $Cn(H_2O)m$. Carbohydrates can be divided into three main types. These are monosaccharides (single sugar units), disaccharides (two sugar units) and polysaccharides (many sugar units). Different monosaccharides contain different numbers of carbon atoms. Trioses contain three, pentoses contain five and hexoses six. Carbohydrates have many different functions and come in many different forms. Ribose and Deoxyribose are both pentose monosaccharides and are found in RNA and DNA. Glucose and Fructose are both hexose monosaccharides. Glucose is an important source of energy in respiration and Fructose is found in fruits. Sucrose is a disaccharide formed from Glucose and fructose.

Alcohol and fatty acids are the structural components of lipids. Complex lipid contains some non lipid component in addition to fattyacids. Lipids are the foodstuffs of highest calorific value and they are stored in the body as a reserve food.

EXERCISE

1. Put a dark colour in a given circle for correct answer :

(1) All monosaccharides are :

(a) Crystalline ◯ (b) Soluble in water ◯

(c) not hydrolysed ◯ (d) All of the above ◯

(2) Lipids differ from carbohydrates in having :

(a) More oxygen than carbon ◯

(b) More carbon but less oxygen ◯

(c) More hydrogen than oxygen ◯

(d) More oxygen than hydrogen ◯

(3) Lactose is composed of :

(a) Glucose + Galactose ◯ (b) Glucose + Glucose ◯

(c) Glucose + Fructose ◯ (d) Fructose + Galactose ◯

(4) Each fat molecule is made of :

(a) One glycerol mol and one fattyacid mol. ◯

(b) One glycerol mol and three fattyacid mol. ◯

(c) Three glycerol mol and one fattyacid mol. ◯

(d) Three glycerol mol and three fattyacid mol ◯

(5) Which of the following macromolecules is a protein ?

(a) Glycogen ○ (b) Inulin ○

(c) Keratin ○ (d) Cholesterol ○

(6) Which type of bonds are present between the water molecule ?

(a) Hydrogen bonds ○ (b) Peptide bonds ○

(c) Glycosidic bonds ○ (d) Ionic bonds ○

(7) Which of the following mineral elements is responsible for permeability of cell membrane ?

(a) Nitrogen ○ (b) Phosphorus ○

(c) Calcium ○ (d) Magnesium ○

(8) Which mineral element is structural component of cysteine and methionine

(a) Calcium ○ (b) Magnesium ○

(c) Sulphur ○ (d) Boron ○

(9) Which mineral element takes part in nitrogen metabolism ?

(a) Boron ○ (b) Zinc ○

(c) Manganese ○ (d) Chlorine ○

(10) Which mineral element is associated with transport of sugar in plants ?

(a) Boron ○ (b) Sodium ○

(c) Zinc ○ (d) Chlorine ○

(11) Which type of sugar is Glyceraldehyde :

(a) Pentose ○ (b) Hexose ○

(c) Triose ○ (d) Octose ○

(12) On hydrolysis maltose gives :

(a) Glucose + Galactose ○ (b) Glucose + Fructose ○

(c) Glucose + Glucose ○ (d) Galactose + Fructose ○

(13) Which type of bond is present between two units forming disaccharide ?

(a) Hydrogen bond ○ (b) Peptide bond ○

(c) Glycosidic bond ○ (d) Easter bond ○

(14) Chitin is an example of :

(a) Monosaccharide ○ (b) Disaccharide ○

(c) Polysaccharide ○ (d) Oligosaccharide ○

(15) Which of the followings is the example of unsaturated fatty acid ?

(a) Crotonic acid ○ (b) Palmitic acid ○

(c) Steric acid ○ (d) Butyric acid ○

2. Answer the following questions in short :

(1) Define organic compounds .

(2) Water molecule shows polarity – Explain

(3) Water is an universal solvent – Explain

(4) Name the Force present between water molecules and responsible for ascent of sap in plants.

(5) Name mineral element essential for growth and reproduction in organism.

(6) Which molecules are covered under organic compounds ?

(7) How much amount of water is present in the body of a human being.?

(8) How much amount of water is present in the living cell ?

(9) In which form plants obtained nitrogen from soil ?

(10) Which mineral element is found in the composition of chlorophyll ?

(11) Which mineral element is found in the structure of Hyaline cartilage ?

(12) Which mineral element takes part in the synthesis of haemoglobin ?

(13) Which mineral element plays important role in the maintenance of pH of intracellular water and osmotic pressure ?

(14) What is the ratio of H and O in the composition of carbohydrate molecule?

(15) Which types of sugar is fructose as example ?

(16) What is structural unit of branched chain of glycogen ?

(17) Mention the types of unsaturated fattyacids on the basis of carbon atoms.

(18) Give an example of lipid possessing –COOH group.

3. Differentiate :

(1) Saturated and Unsaturated fattyacids

(2) Monosaccharides and Polysaccharides

(3) Amylase and Amylopectin

(4) Simple lipids and Complex lipids

4. Do as Directed :

(1) Explain different types of lipids

(2) Write biological importance of lipids

(3) Give structural formula of fattyacids studied by you

(4) What is disaccharides ? Describe in short

(5) Describe different types of carbohydrates with examples.

(6) Mention importance of any five mineral elements studied by you.

(7) Describe mineral elements present in the constitution of proteins and nucleicacids.

(8) Describe molecular structure of water.

(9) Give importance of water.

(10) Describe any one inorganic compound studied by you.

7

Biomolecules –II
(Proteins, Nucleic acids and Enzymes)

The variation in the different species of living organisms is due to the variation in their biomolecules. This variation is due to the differences in the number, types, linear sequence and structural orientation of the amino acids that form their protein structure.

We known that living organisms are complex systems. Thousands of proteins present in the body help to carry out our daily functions These proteins are produced in the cell. An enormous amount of information is required to synthesize proteins. This information is stored in nucleic acids located in nucleus. In this chapter, the molecules involved in the structure of proteins including enzymes and nucleic acids will be discussed.

Proteins

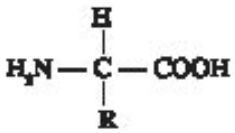
Proteins are very important compounds of cytoplasm. They possess C, H, O, N and S in their constitution. The building blocks of proteins are amino acids. It means each protein molecule is a polymer of amino acids. As there are 20 diffrant types of amino acids, which take part in the synthesis of proteins, a protein is a heteropolymer and not homopolymer. Proteins carry out many functions in living organisms. Some transport nutrients across cell membrane, some fight infectious organisms, some are hormones, some are enzymes etc. Collagen is the most abundant protein in animal world and Ribulose Biphosphate Carboxylase - Oxygenase (RUBISCO) is the most abundant protein in the whole of the biosphere.

Some proteins are soluble in water, some in dilute solutions of acid or base and some others in dilute alcohol. However, keratin (a scleroprotein) found in hair, feathers, scales, horns, nails, claws etc., is not soluble in any solvent. Proteins are destroyed or denatured at high temperature as well as in strong (concentrated) acid, base and alcohol. They are also destroyed when exposed to radiations like X-rays, UV rays etc.

Amino acid

All amino acids possess an amino group ($-NH_2$), a carboxyl group (-COOH), an H and the remainder part called 'R' group. In an amino acid molecule, the carboxyl group is acidic while the amino group is basic. Hence, in solution it acts as an electrolyte and exhibits the properties of both, an acid and a base. Thus it is an amphoteric compound.

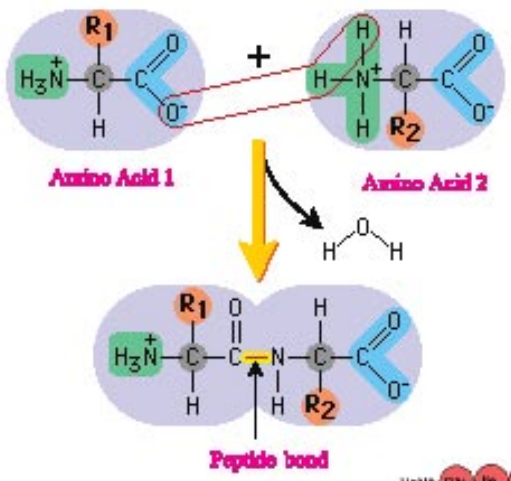
Looking to the general chemical structure of an amino acid, the structure of almost all the amino acids is similar except for their 'R' group. But the chemical structure of 'R' group (functional group) being different, the properties and types of amino acids are different. The biological importance of the amino acid lies in its functional group.



Amino acids are classified on the basis of the 'R' group in their structure. Various methods of classification are in use. The most widely used one is that by Lehninger. Classification is based on the polarity of 'R' group. If a positive or a negative charge occurs in the 'R' group, the amino acids display specific polar characteristics. Such a classification is shown under :

Sr. No.	Kind of amino acids	Examples
1.	Amino acids with nonpolar 'R' group	Alanine, Leucine, Valine, Isoleucine, Methionine, Phenylalanine, Tryptophane, Proline
2.	Amino acids with polar and neutral 'R' group	Aspergine, Cysteine, Serine, Glutamine, Glycine, Threonine, Tyrosine,
3.	Amino acids with polar and negatively charged 'R' group	Aspartic acid, Glutamic acid
4.	Amino acids with polar and positively charged 'R' group	Arginine, Histidine, Lysine

Dipeptide : A dipeptide is formed through the union of two similar or dissimilar amino acid molecules. The bond is formed between the -COOH group of one amino acid and $-NH_2$ group of another amino acid molecule. A molecule of H_2O is released in this process. Such a bond is called peptide bond.



Polypeptide : When many molecules of amino acids become bound as described above, a polypeptide chain is formed. A protein may be made up of one or more polypeptide chain.

One end of every polypeptide chain is called the

amino terminal or N-terminal which has a free amino group. The other end, with its free carboxyl group, is called the carboxyl terminal or C-terminal.

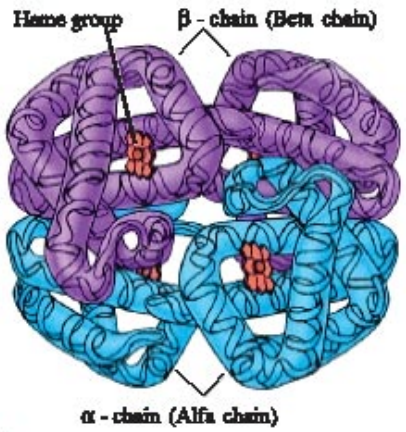
Structure of proteins

The primary structure of protein is determined by the number of amino acid molecules, their kinds and sequence in which they are arranged in polypeptide chain. This aspect is controlled by genes.

In the secondary structure the polypeptide chain becomes helically coiled or may become flat and sheet like. The folding of the chain is mainly due to the presence of hydrogen bonds. Thus folding and hydrogen bonding between the neighbouring amino acids result in the formation of a rigid and tubular structure called a helix.

The tertiary structure of a polypeptide or protein is the three-dimensional arrangement of the atoms within a single polypeptide chain.

The quaternary structure represents a three dimensional form of a protein. It may be of globular or fibrous shape. Quaternary structure, consists of the interactions between different polypeptide chains in proteins. Disulphide, hydrogen, hydrophobic and ionic bonds are involved in the formation of quaternary proteins. Haemoglobin, for example, is composed of four polypeptide chains, 2 alpha chains and 2 beta chains. The molecule contains four haeme groups.



(Quarternaly structure of Haemoglobin)

Importance of proteins

Proteins are the major structural components of the membranes of various cell organelles. They are also chief constituents of protoplasm.

All enzymes are madeup of proteins. Enzymes are responsible for maintenance of proper rates of biochemical reactions in cell. Most of the hormones of pancreas, pituitary and parathyroid glands are peptides in nature.

Actin and myosine in muscle and globular proteins in cilia and flagella are contractile proteins and are responsible for movements.

Immunoglobulin, present in blood plasma, has property of immunity.

Melanin is a protein which imparts colour to the body.

When proteins become associated with some materials other than amino acids, they are known as conjugated proteins. Some of these proteins are very important. For example : Haemoglobin is absolutely essential for transport of oxygen while Chlorophyll is must for photosynthesis.

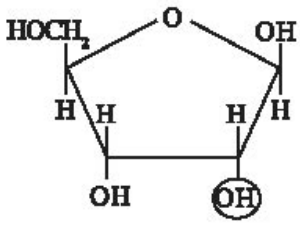
Nucleic acids

The first isolation of what we now refer to as DNA was accomplished by Johannsen Friedrich Miescher. He reported finding a weakly acidic substance of unknown function in the nuclei of human white blood cells, and named this material "nuclein". A few years later, Miescher separated nuclein into protein and nucleic acid components. In the 1920's nucleic

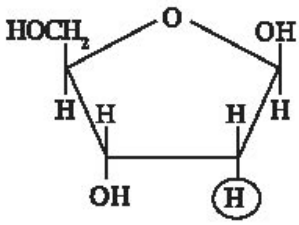
acids were found to be major components of chromosomes, small gene-carrying bodies in the nuclei of complex cells. They are responsible for inheritance in all organisms. Later the nucleic acids were reported in bacteria and viruses. Elemental analysis of nucleic acids showed the presence of phosphorus, in addition to the usual C, H, N & O. Two kinds of nucleic acids occur-DNA and RNA. With little variations there is a similarity in the structure of both but their functions are different. Both kinds of nucleic acids are polynucleotides of structural units known as nucleotides.

Each nucleotide is made up of three subunits – a pentose sugar, a purine or a pyrimidine nitrogen base and phosphoric acid.

Ribose is the pentose sugar in RNA while deoxyribose sugar occurs in DNA.



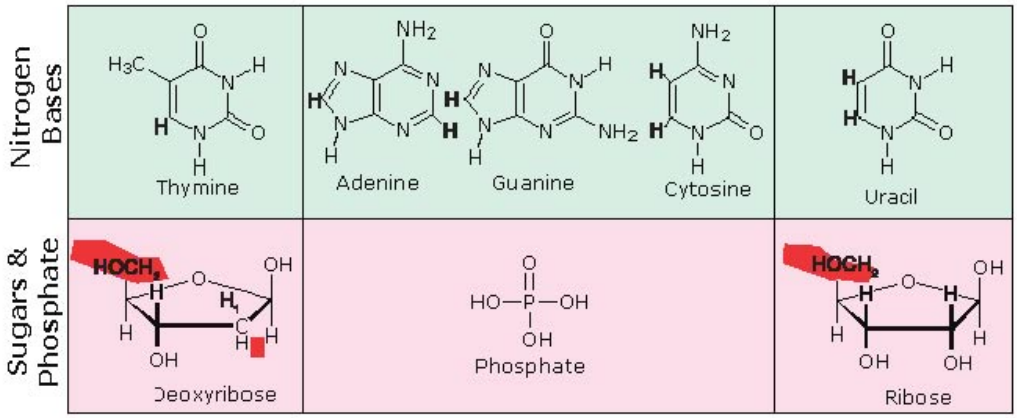
Ribose Sugar



Deoxyribose Sugar

Pentose Sugar

A nitrogen base is a cyclic compound and occurs in one of the two forms – pyrimidine or purine. Purine has two rings in its structure. Adenine and guanine are purine bases. Pyrimidines are made up of one ring. Cytosine, thymine and uracil are the examples of pyrimidine bases. Uracil does not occur in DNA and thymine does not occur in RNA. All other bases are common in both, Phosphoric acid is associated as phosphate.



Components of nucleic acids

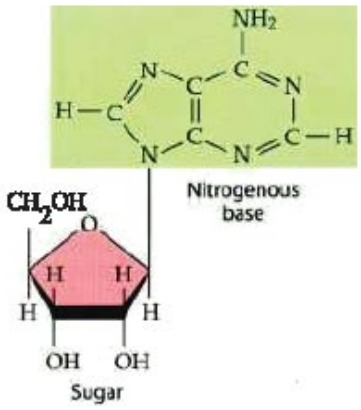
Nucleoside and Nucleotide

Nucleoside : The compound which is formed by the linkage of purine and pyrimidine type of nitrogen base with a pentose sugar is called nucleoside. When a ribose sugar is linked with a nitrogen base, a ribonucleoside is formed, while a deoxyribose sugar linked to a nitrogen base forms a deoxyribonucleoside.

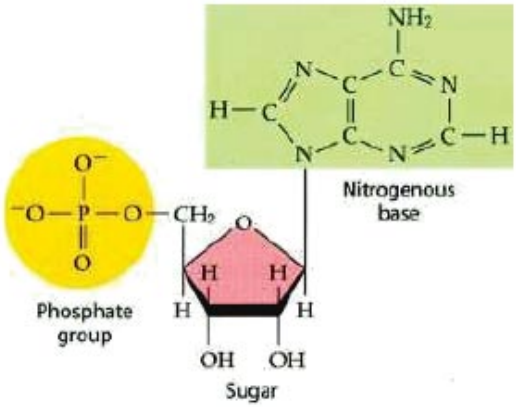
Nucleotide : When a nucleoside is linked to a phosphate it becomes phosphorylated and is

called a nucleotide. When a ribonucleoside binds with a phosphate, it forms a ribonucleotide. Similarly when a deoxyribonucleoside binds with a phosphate, it forms a deoxyribonucleotide.

The nucleotides are involved in formation of RNA and DNA. ATP used as a currency of energy in cells is also one kind of a nucleotide.



Molecular structure of nucleoside



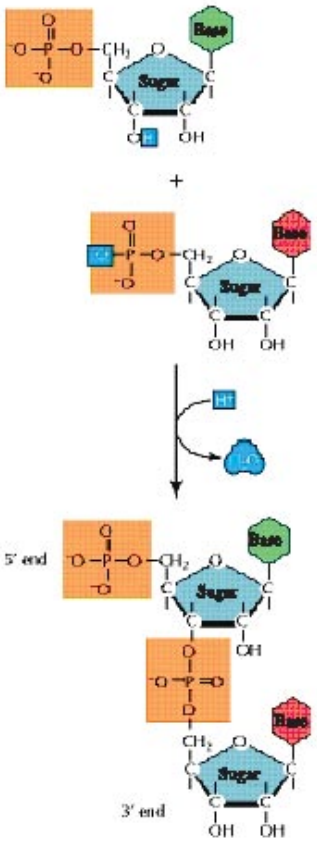
Molecular structure of nucleotide

Formation of dinucleotide

Two sequential nucleotides join through a phosphodiester bond and form a dinucleotide Such union occurs between third carbon of sugar in one nucleotide and fifth carbon of sugar in the other nucleotide.

Formation of polynucleotide

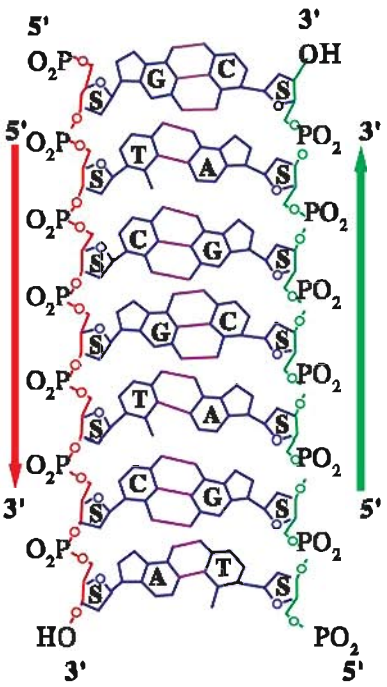
When many nucleotide units unite, a polynucleotide chain is formed. There is one polynucleotide chain in the structure of RNA while two polynucleotide chains in DNA.



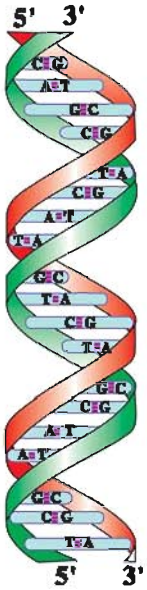
DNA :

DNA was first discovered in the latter half of 19th century . The credit of presenting the complete and precise model of DNA goes to two scientists, Watson and Crick (1953). According to this model of the molecular structure of DNA there are two polynucleotide chains arranged parallel to each other and running in opposite directions. These two chains are connected with each other in a definite manner and are spirally twisted. So it appears like a spiral ladder. The linkages between the two polynucleotide chains are such that a purine base of one chain is linked with a pyrimidine base of the opposite chain. Adenine(A) of one chain is linked with thymine(T) of the opposite chain by two weak hydrogen bonds while cytosine(C) of one chain is linked with guanine(G) of the opposite chain by three weak hydrogen bonds. Thus the purine and pyrimidine bases are in equal proportion in each DNA molecule.

The length of one complete spiral of DNA is 34 Å, while the two chains are 20 Å apart.



Molecular structure of DNA



DNA - helical structure

RNA : (Ribonucleicacid)

The polynucleotide chain containing ribose sugar and uracil nitrogen base but lacking thymine is known as ribonucleic acid. There are three main types of RNA : (1) messenger RNA (2) transfer RNA and (3) ribosomal RNA.

(1) Messenger RNA : Messenger RNA (mRNA) is synthesized from a gene segment of DNA. Out of the two polynucleotide chains of gene, one acts as a template on which m RNA is synthesized. Thus m RNA carries coded genetic information transcribed from DNA for the synthesis of specific type of protein. The m RNA carries the code into the cytoplasm where protein synthesis occurs. The m RNA is degraded after its function is over.

(2) Transfer RNA : Transfer RNA (tRNA) contains about 75 nucleotides, three of which are called anticodons, and one amino acid. There are about sixty one types of t RNA in the cytoplasm. They are synthesized by DNA. During protein synthesis each tRNA picks up definite amino acid and brings it on the ribosome. Amino acids brought by tRNA are sequentially arranged according to the genetic code on m RNA and linked by peptide bonds. This is how primary protein molecules are synthesized.

(3) Ribosomal RNA : This RNA is localized in the ribosome, that is why it is called ribosomal RNA. In the cytoplasm, ribosomal RNA (rRNA) and protein combine to form a nucleoprotein called a ribosome. 80-85 % of the total RNA in the cell is rRNA present in ribosomes. The ribosome serves as the site and carries the enzymes necessary for protein synthesis.

Enzymes

Life is a complex system involving a perfect coordination of a majority of chemical reactions. Some of these reactions result in synthesizing large molecules while others in cleaving large molecules. All these reactions occur very slowly at low temperature and atmospheric pressure-the conditions under which living cells carry on their life processes. Yet in the living cells these reactions proceed at extremely high rates. This is due to presence of biological catalysts in the body.

Specific chemicals which act as biological catalysts are called enzymes. Enzymes are proteinous, water soluble and colloidal form catalysts which are secreted in extremely small quantities by living cells. They participate in biochemical processes occurring at body temperature within or outside the cells and alter the rate of reaction, but are not used up in the process. There are some nucleic acids that behave like enzymes. These are called ribozymes. The substance on which an enzyme acts is termed as a substrate whereas the newly produced substances are called products. For example, if lactose is the substrate , then glucose and galactose are the end products of hydrolysis of lactose in the presence of enzyme lactase.

Structure of enzymes

Chemically all enzymes are proteins. Sometimes, along with the protein a non protein group is linked. In such enzyme the protein part is called an apoenzyme and the non protein part is known as prosthetic group. Among such prosthetic groups metallic ions such as zinc, iron, magnesium, sodium cobalt or any organic substance may be present. This component renders the enzyme active and makes it effective. The prosthetic group may also be known as co-enzyme or co-factor. Nicotinamide Adenine Dinucleotide (NAD), Nicotinamide Adenine Dinucleotide Phosphate (NADP), Flavin Mononucleotide (FMN), flavin Adenine Dinucleotide (FAD) etc., are co-enzymes. In some chemical reactions , the presence of a co-enzyme is essential.

Properties of enzymes

Each enzyme has all the properties related to proteins. Each enzyme is a macromolecule formed of sequential chain of a number of amino acids. All amino acids in this chain are linked by peptide bonds.

Enzymes are specific in their functions. Each enzyme has an effect on a particular reaction only. An enzyme effective for one reaction is not useful in another reaction e.g., lipase can digest lipids only while sucrase can digest sucrose only.

Enzyme are also amphoteric in nature because in their structure, one terminal carries a reactive alkaline amino group ($-NH_2$) and the other terminal carries a reactive acidic carboxyl group (- COOH)

Effect of most enzymes is unidirectional. They can convert substrate into the product but not the product into substrate. However the effect of some enzymes is bidirectional (property of reversibility).

Each enzyme is functional within a specific temperature range. At high temperatures enzymes are denatured while at very low temperature they become inactive but are not destroyed.

Each enzyme is active at a specific pH. Some enzymes are active in acidic medium and some are active in an alkaline medium.

Mechanism of enzyme action

Every enzyme has its own specific three dimensional structure. Based on this , it develops an active site. Active site is that region where the substrate combines with the enzyme molecule. The structure of active site and that of substrate are complementary to each other, such as a "Lock and key". Such a union is called enzyme substrate complex.

Every chemical reaction requires an essential energy level. This level is called activation energy level. Substrate combines with enzyme and forms enzyme substrate complex. This brings down the activation energy level. As a result the reaction rate increases incredibly. Once the reaction is completed , the product is released from the active site of the enzyme. The enzyme remains in its original form. The entire process can be represented by the following equation :

$$E + S \longrightarrow E\text{-}S \text{ complex} \longrightarrow \text{Enzyme} + \text{product}$$

Nomenclature and Classification of Enzymes

Each enzyme is given a name. This can be done in two ways. A suffix –ase can be attached to the name of the substrate on which it acts. For example, the enzyme which acts on sucrose is called sucrase and that which acts on lipids is called lipase. In another way , it is named after the reaction which it carries. For example, enzymes causing hydrolysis are called hydrolases and those causing oxidation are called oxidases.

Enzymes are classified on the basis of the biochemical reactions catalyzed by them. Enzymes are categorized in to six divisions as follows :

(1) Oxidoreductases : This group of enzymes is associated with the oxidation-reduction reactions in the cells. The enzyme which removes hydrogen from the substrate is known as dehydrogenase and the one which adds oxygen to the substrate is known as oxidase. This group of enzymes plays an important role in oxidative phosphorylation associated with Krebs cycle. E.g., succinic dehydrogenase and cytochrome oxidase.

(2) Transferases : The enzymes which bring about the transfer of one group (except hydrogen) from one substrate to another substrate are called transferases. e.g., hexokinase transfers one phosphate group of the ATP to hexose sugar converting glucose into glucose-6-phosphate.

(3) Hydrolases : An enzyme which splits any complex organic substance by adding a molecule of water is known as hydrolase. e.g.,

$$\text{Maltose} + H_2O \xrightarrow{\text{Maltase}} \text{Glucose} + \text{Glucose}$$

(4) Lyases : These enzymes catalyse the cleavage of macromolecules into smaller molecules without adding water molecules. e.g., fructose 1, 6-diphosphate (having 6 carbons) splits into two molecules of triose phosphate in presence of enzyme aldolase during the process of glycolysis.

(5) Isomerases : These enzymes catalyse changes only in the molecular structure of the substrate i.e. conversion of a molecule into an isomer . Transfer of atoms within the molecule results in the formation of a new molecule. e.g.,

$$\text{Glucose-6-phospahte} \xrightarrow{\text{Fructose isomerase}} \text{Fructose-6-phosphate}$$

(6) Synthetases or ligases : These enzymes synthesize a new molecule by joining two molecules with the help of energy obtained from pyrophosphate bond of ATP. For example, Acetyl Co-A synthetase.

$$\text{Acetic acid} + \text{ATP} + \text{Co-A} \xrightarrow[\text{Enzyme}]{\text{Acetyl Co-A synthetase}} \text{Acety Co-A} + \text{AMP} + H_4P_2O_7 \text{ (pyrophosphate)}$$

Each of these classes has more specific subclasses as well. The key to using this classification scheme is to look at the reaction the enzyme catalyzes, decide which type of reaction it is, and apply the appropriate name.

Cofactors

A nonprotein component of enzyme is called cofactor. Cofactors are relatively small molecules compared to the protein part (apoenzyme) of the enzyme. Cofactors possess organic or inorganic constitution. Inorganic cofactors are generally found in the form of metal ion. Example Fe^{++}, Cu^{++}, Na^{+}, Zn^{++} etc.

The presence of zinc is necessary for the activation of carbonic anhydrase. Vanadium is necessary for the activation of nitrogease in the niotrogen fixing bacteria. Sometimes more than one metal ions may be required for the activation of certain enzymes. e.g. enzyme enolase is activated in the presence of magnesium, manganese and zinc. In human beings iron, manganese, cobalt, zinc, selenium and molybdenum are some commonly seen cofactors. Calcium is found in human diet. It is needed for the full activity of many enzymes, such as nitric oxide synthatase, protein phosphatase, or adenylate kinase.

NAD (Nicotinamide Adenine Dinucleotide), NADP (Nicotinamide Adenine Dinucleotide Phosphate), FAD (Flavin Adenine Dinucleotide) and FMN (Flavin mononuc leotide) are organic cofactors. Cofactors can also be classified depending on how tightly they bind to an enzyme, with loosely bound cofactors termed coenzymes and tightly bound cofactors termed prosthetic groups. Many conezymes are derived from vitamins.

Summary

The variations in the characteristics of living organisms of different species are due to the differences in the number, types, linear sequence and structural orientation of amino acids that form proteins. Proteins are important compound of cell. They consist of C, H, N, O and S. Proteins are soluble in water but keratin is insoluble in any solvent. The structural unit of protein is amino acid. In a polypeptide chain amino acids are linked together with the help of peptide bonds, There are twenty types of amino acids found in living organisms. All amino acids possess an amino group , a carboxylic group, an H and a 'R' group. Amino acids differ from each other in the composition of their 'R' group. Due to presence of amino group at one end and carboxyl group at other end, amino acids are amphoteric in nature. Similarly in the structure of protein one end of polypeptide chain possesses amino group and other carboxyl group, it is also amphoteric in nature. Structurally proteins are classified into primary protein, secondary, tertiary and quaternary proteins. All enzymes and many hormones are made up of proteins. When proteins become associated with some materials other than amino acids , they are known as conjugated proteins.

Elemental analysis of nucleic acids showed the presence of phosphorus in addition to the usual C, H, O, and N. Nucleic acids are of two types : RNA and DNA. They are polynucleotides of structural unit known as nucleotides. Each nucleotide is madeup of a pentose sugar, a purine or pyrimidine type of nitrogen base and phosphoric acid. RNA contains ribose pentose sugar while DNA contains deoxyribose pentose sugar. Nitrogen bases are of two types : purine (adenine and guanine) and pyrimidine (cytosine, thymine and uracil). Uracil does not occur in DNA and thymine does not occur in RNA. All other bases are common in both. Many nucleotides unit to form a polynucleotide chain. RNA is made up of single polynucleotide chain while DNA is madeup of double polynucleotide chains. Both the polynucleotide chains in DNA structure are spirally twisted. RNA are of three types : (1) Messenger RNA (2) Transfer RNA and (3) Ribosomal RNA.

Specific chemicals which act as biological catalysts are called enzymes. Chemically all enzymes are proteins. Sometime an enzyme also possesses a non protein part. In such type of enzyme protein part is known as apoenzyme and non protein part is called cofactor. Cofactor may be coenzyme or prosthetic group. This depends on how tightly they bound to an enzyme; with loosely bound cofactors termed coenzyme and tightly bound cofactors termed prosthatic groups. Enzymes are amphoteric in nature and specific in function. They function within a specific temperature and pH range. Enzymes are classified into six categories on the basis of biochemical reactions catalysed by them. These are oxido-reductases, transferases hydrolases, lyases, isomerases and synthetases or ligases.

EXERCISE

1. Put a dark colour in a given circle for correct answer :

(1) How many types of amino acids take part in protein synthesis ?

(a) 18 ◯ (b) 20 ◯

(c) 22 ◯ (d) 24 ◯

(2) Which of the following protein is not soluble in any solvent :

(a) Haemoglobin ◯ (b) Myoglobin ◯

(c) Scleroprotein ◯ (d) Actin ◯

(3) Who classified amino acids ?

(a) Johenson ◯ (b) Lehninger ◯

(c) Virshow ◯ (d) Perkinje ◯

(4) Amino acid with polar and neutral 'R' group is

(a) Alanine ◯ (b) Serine ◯

(c) Valine ◯ (d) Proline ◯

(5) Bond which connects two amino acids

(a) Hydrogen ◯ (b) Ester ◯

(c) Peptide ◯ (d) Glycosidic ◯

(6) A nucleoside consists of

(a) Nitrogen base + Sugar ◯

(b) Nitrogen base + Phosphate ◯

(c) Sugar + Phosphate ◯

(d) Nitrogen base + Sugar +Phosphate ◯

(7) The term nuclein is coined with the name of

(a) Watson ◯ (b) Crick ◯

(c) Friedrich Miescher ◯ (d) Johanson ◯

(8) DNA differs from RNA

(a) In the nature of sugar alone ◯

(b) In the nature of purine alone ◯

(c) In the nature of sugar and pyrimidine ◯

(d) None of the above ◯

(9) Similarity between DNA and RNA is

(a) They are double stranded ◯

(b) They have similar sugar ◯

(c) They are polymers of nucleotides ◯

(d) They have similar pyrimidine ◯

(10) The length of one complete spiral of DNA is :

(a) 10 Å ○ (b) 20 Å ○

(c) 34 Å ○ (d) 32 Å ○

(11) Enzymes are made up of :

(a) Carbohydrates ○ (b) Proteins ○

(c) Hormones ○ (d) Vitamins ○

(12) An apoenzyme is a

(a) Vitamin ○ (b) Lipid ○

(c) Carbohydrate ○ (d) Protein ○

(13) Which type of enzyme is hexokinase ?

(a) Oxido-reductase ○ (b) Transferase ○

(c) Hydrolase ○ (d) Isomerase ○

(14) Which one of the followings is a coenzyme :

(a) Fe^{+2} ○ (b) NAD ○

(c) Lyases ○ (d) ATP ○

(15) Which element is necessary for the activation of nitrogenase

(a) Copper ○ (b) Zinc ○

(c) Vanadium ○ (d) Iron ○

2. Answer in short :

(1) Give full form of RUBISCO

(2) Which elements are present in the structure of protein ?

(3) Mention the components of nucleotide.

(4) Define nucleoside.

(5) Where keratin can be found.

(6) Between which groups of amino acids peptide bond is formed.

(7) Define prosthetic group.

(8) Mention the function of synthetases.

(9) Write the function of tRNA.

(10) Mention the types of pyrimidine nitrogen bases

3. Do as directed :

(1) Describe the formation of dipeptide.

(2) Explain the structure of amino acid.

(3) Give biological importance of proteins.

(4) Describe the structure of haemoglobin molecule.

(5) Explain the formation of dinucleotide.

(6) Write a note on messenger RNA

(7) Mention the properties of enzymes.

(8) Describe the mechanism of enzyme action.

(9) Differentiate between nucleoside and nucleotide.

(10) Write note on co-factors.

4. Describe in detail :

(1) DNA structure

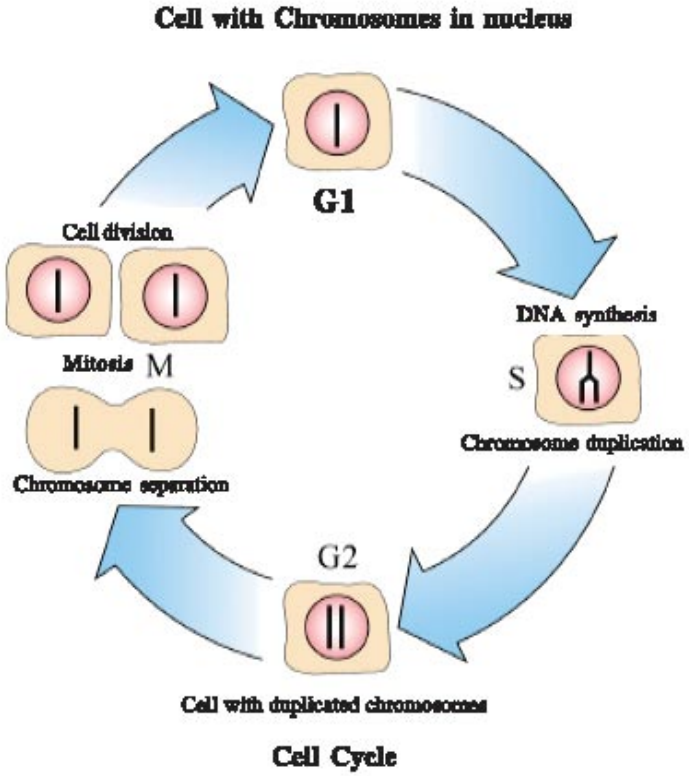
(2) Classification of enzymes

(3) Types of proteins

8

Cell Cycle and Cell Divisions

Growth is a fundamental property of all living organisms. It requires an increase in cell mass, a duplication of genetic materials and a division assuring that each daughter cell receives an equal complement of the genetic material. The body of an adult person contains 10^{14} cells and all cells are derived by successive cycles of cell reproduction starting with a single cell called zygote, formed by the fertilization between male and female gametes. Thus we can say that cell multiplication, by cell division, is an essential criterium for growth of organisms.



Cell Cycle

Cell Cycle :

Every growing cell undergoes a cell cycle. The **cell cycle** is the series of events that takes place inside a cell thus leading to cell division and cell duplication. The period between two successive cell divisions is called cell cycle. Cell cycle is a period between creation of a cell and division of that cell. The human cell divides in culture once in approximately every 24 hours. However this duration of cell cycle can vary from organism to organism and also from cell type to cell type. For example, Yeast cell can complete one cell cycle in every 90 minutes.

Cell cycle comprises of essentially two phases :

(1) Interphase (2) M Phase (Mitosis phase)

(1) Interphase : During interphase, the materials in the cell are nearly duplicated and hence, the size of the cell also increases. This is the phase which involves DNA replication. Chromosomes can not be observed as they are highly dispersed during this phase. They are only recognized as chromatin material. During this phase centrosome forms two centrioles arranged at right angles to each other.

Phases of cell cycle

Interphase can be divided into three subphases :

(1) G_1 phase (Gap_1 phase)

(2) S phase (Synthesis phase)

(3) G_2 phase (Gap_2 phase)

(1) G_1 phase : This is the first stage of interphase. It is the phase between the previous M phase and the fresh round of DNA synthesis hence it is termed as G_1 indicating gap. This stage of the cell cycle is also called the growth phase. There is a lot of biosynthetic activity that occurs at this stage and RNA, proteins and also enzymes required for DNA synthesis in the S phase are synthesized here.

(2) S phase : The DNA synthesis occurs in this stage. At the end of the S phase, all the chromosomes have replicated and they all have two sister chromatids. The amount of DNA becomes double. If the initial amount of DNA is denoted as 2C (chromatid) then it increases to 4C (chromatid).

(3) G_2 phase : This stage lasts till the cell enters mitosis. Here, the main activity is the production of proteins and micro tubules required for Mitosis.

(2) M Phase (Mitosisphase) : Division of cell consists two distinct but integrated activities viz. nuclear division (karyokinesis) followed by cell division (cytokinesis). There are two processes of nuclear division, one that maintains chromosome number – **Mitosis** and another that halves the number – **Meiosis.**

Mitosis : This kind of cell division is described in four main phases. However, it must be kept in mind that the process is a continuous one and phases are meant for easy understanding only. These phases are prophase, metaphase, anaphase and telophase.

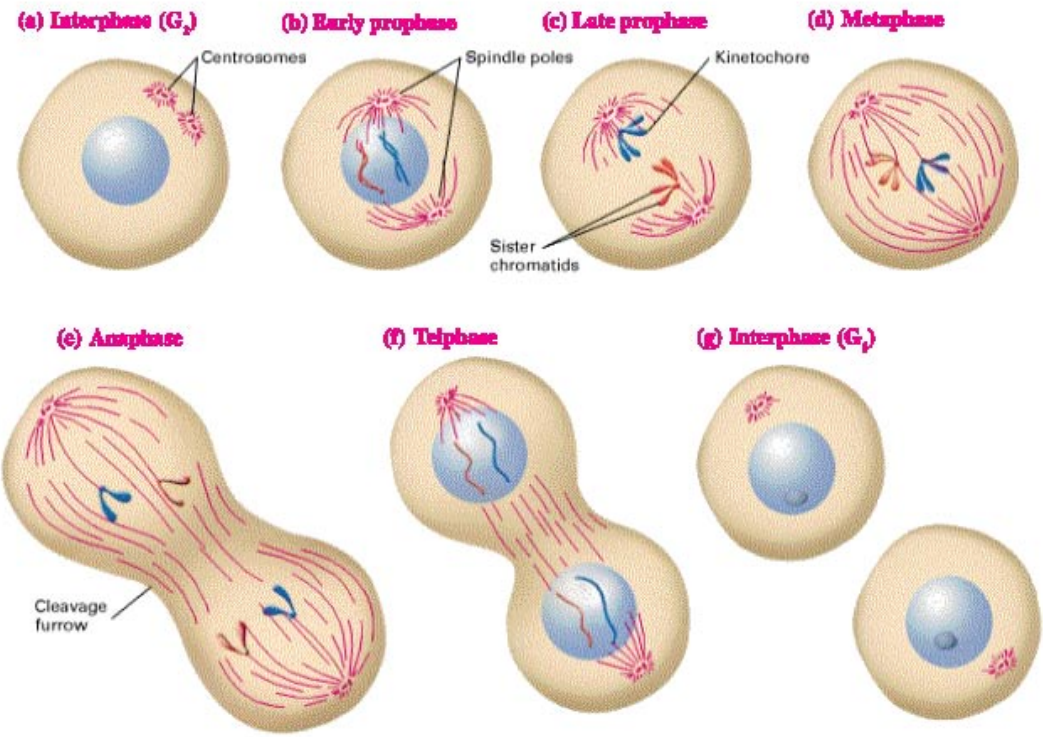
Prophase : This phase begins with the condensation of chromosomes along their lengths. As prophase progresses condensed chromosomes can be observed. At the end of prophase each chromosome appears to be made up of two chromatids and a centromere holding them together. The centrioles which had undergoe duplication during S phase of interphase, now move towards the opposite poles of the cell. Radially arranged asters appear around each unit. Centrioles develop a bipolar spindle which is made up of cytoplasmic fibres of proteins. In plant cells, centrosome is not present yet a bipolar spindle is developed. At the end of prophase nuclear membrane and nucleolus disintegrate and chromosomes spread in the entire cell area.

Metaphase : The complete disintegration of nuclear envelope and nucleolus mark the start of second phase of mitosis. By this stage condensation of chromosomes is completed and they can be seen clearly under the microscope. At this stage each chromosome is made up of two chromatids held together by the centromere. Small disc – shaped structures at the surface of the centromeres are called kinetochores. These structures serve as the sites of attachment of spindle fibers. The spindle fibers attach themselves to the centromere of the chromosomes and align them along the middle of the cell. The line is referred as the equatorial plate or metaphase plate.

Anaphase : In this phase, as the spindle fibers shorten and the centromere splits, the paired chromosomes will separate and start moving to the opposite poles of the cell. At the end of this phase, the number of chromatids collected at each pole, is the same as the number of chromosomes which occurred in the original cell. Now, each chromatid with its independent centromere is known as a chromosome.

Telophase : During this phase, each chromosome expands and individual chromosomes can not be observed. First chromatin network is observed and then chromatin appears. In the meantime, a nucleolus develops on the nucleolar organizer region of a specific chromosome. At the end of this phase, nuclear membrane, golgi complex and endoplasmic reticulum are reformed. Thus two nuclei come into existence at two polar regions. Each nucleus contains the same number of chromosomes as were present in the parent cell.

Cytokinesis : Though not a phase of mitosis, cytokinesis is a separate process that completes the entire process of cell division. In an animal cell constriction of cytoplasm begins from the peripheral region of the cell. It gradually extends towards the centre. Finally two cells become separated. In plant cells, cytokinesis begins from the centre of the cell. A plate called middle lamella, made up of pectin gradually develops from centre towards periphery of the cell. A cell wall is then formed on both the sides of middle lamella. At the time of cytoplasmic division, organelles like mitochondria and plastids get distributed between

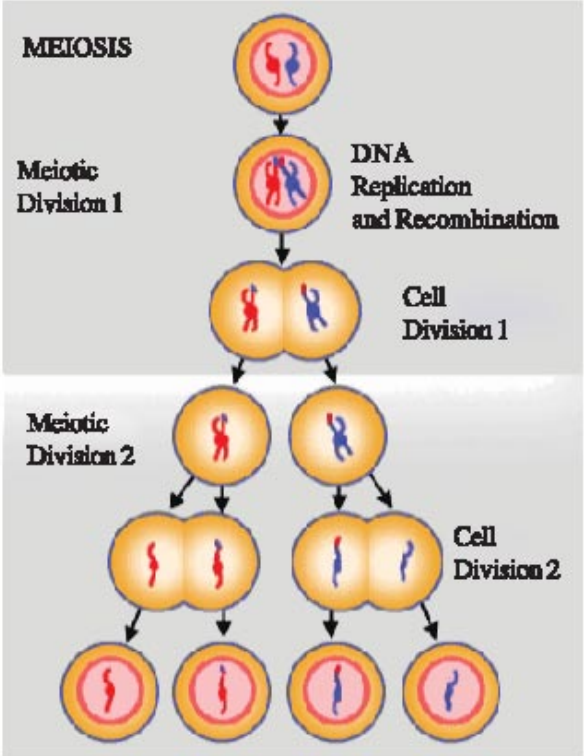


two daughter cells. In some organisms karyokinesis is not followed by cytokinesis, as a result multinucleate condition arises leading to the formation of syncytium.

Significance of Mitosis :

- An organism beginning as a single cell develops its multicellular body through mitosis.
- The number of chromosomes is maintained in all cells.
- Due to division, cells can maintain their efficient size.
- Cells are made available for growth and development. Such cells differentiate to form tissues, organs etc.
- A very significant contribution of mitosis is cell repair. The cells of upper layer of epidermis, cells of the lining of the gut and blood cells are constantly replaced.

-Mitotic divisions in the apical and lateral meristem result in continuous growth in the plants.



Meiosis :

During formation of reproductive cells meiotic cell division occurs. During meiosis the genetic material is replicated once, whereas the cell divides twice. The first division is called meiotic division-I. During this, the chromosomes are distributed in two cells in half their number and hence it is also called reduction division or heterotypic division. The second division is called meiotic division-II. During this, the number of chromosomes is maintained the same in new cells. This is why it is also called equational division or homotypic division. We come across meiosis during gametogenesis in plants and animals. This leads to formation of haploid gametes. Meiosis follows interphase and events of interphase are the same as described earlier in this chapter.

Meiosis–I

The four main stages of meiosis – I are known as prophase – I, metaphase – I, anaphase and telophase – I.

Prophase–I

This phase lasts longer and is divided into five substages.

Leptotene : The leptotene is the first of the meiotic stages. During this stage chromosomes begin to condense and each chromosome appears filamentous. Each chromosome is made up of two chromatids and a centromere joining them. However, the double nature cannot be observed.

Leptotene


Zygotene


Pachytene


Diplotene


Dikinesis

Zygotene : During this stage chromosomes start pairing together along their length. This process is called synapsis. The process progresses in a zipper fashion. The paired chromosomes are called homologous chromosomes. Electron micrographs of this stage indicate that chromosome synapsis is accompanied by the formation of complex structure called synaptonemal complex. Each pair of synapsed homologous chromosomes is referred to as a bivalent. However it is tetravalent in fact.

Pachytene : During this stage bivalent chromosomes now clearly appear as tetrads. Chromatids of chromosomes are twined around one another. This stage is characterized by appearance of recombination nodules (chiasmata), the site at which crossing over occurs between non sister chromatids of the homologous chromosomes. Crossing over, that is exchange of genes, occurs at various places along their length.

Diplotene : The members of each pair of homologous chromosomes start moving away from one another. However, their union is maintained at the points of crossing over. The number of chiasmata depends on the length of chromosomes. They are more in longer chromosomes. Gene exchange occurs at the location of chiasmata.

Dikinesis : During this phase condensation of chromosomes is completed and bipolar spindle is assembled to prepare the homologous chromosomes for separation. Chromatids become separated even at the sites of chiasmata. By the end of diakinesis the nucleolus disappears and nuclear membrane also breaks down.

Metaphase – I: During this phase, pairs of homologous chromosomes become arranged at the equatorial plane of the cell. Of each pair, centromere of one chromosome is towards one pole and that of another is towards the other pole.

Anaphase – I : Chromosomes of a homologous pair move away towards their respective poles. Thus, at the end of this phase, half the number of total chromosomes are collected at each pole.

Telophase – I : During this phase nuclear membrane and nucleolus are reformed. Bipolar spindle is disintegrated. At the end of this phase two nuclei come into existence. Each nucleus contains half as many chromosomes as were present in the parental cell. Each chromosome is made up of two chromatids held together by a centromere.

The stage between two meiotic stages is called interkinesis and is generally short lived.

Meiosis – II : In the period between two meiotic divisions, no replication occurs. In principle, meiosis-II is like the mitotic division described earlier. Meiosis-II can be describe in four phases.

Prophase-II : During this stage, bipolar spindle is formed. Nucleolus gradually disappears and nuclear membrane disintegrates. The chromosomes again become compact.

Metaphase-II : At this stage chromosomes are arragned at the equator. Centromere of each chromosome becomes attached to filament of bipolar spindle. Centromeres of all the chromosomes become arranged in one plane.

Anaphase-II : At this stage centromere of each chromosome divides. Thus each chromatid of a chromosome receives its own separate centromere. Centromeres of two chromatids of a chromosome migrate towards opposite poles. The number of chromatids collected at each pole is the same as the number of chromosomes in parental cell. The chromatids with their independent centromeres are called chromosomes.

Telophase-II : Chromosomes at each pole start uncoiling and once again they get enclosed by nuclear envelop. At this stage individual chromosome can not be observed. Nucleolus is reformed. Cytokinesis separates each nucleus from the other.

Significance of meiosis :

(I) The meiosis maintains a definite and constant number of chromosomes in organisms from generation to generation.

(II) Due to crossing over, meiosis provides an opportunity for the exchange of genes and thus causes the genetic variations among species.

(III) It is important process for evolution.

Differences between Mitosis and Meiosis :

The differences between mitosis and meiosis are as follows :

No.	Mitosis	Meiosis
1.	Mitosis takes place within somatic cell (cells that make up the body)	Meiosis takes place within gamete cells. (sex cells)
2.	One single division of the mother cell results in two daughter cells	Two division of the mother cell result in four meiotic products of haploid gametes
3.	A mitotic mother cell can either be haploid or diploid	A meiotic mother cell is always diploid.
4.	The number of chromosomes per nucleus remains the same after division	The meiotic products contain a haploid (n) number of chromosomes in contrast to the (2n) number of chromosomes in mother cell.
5.	It is preceded by a S-phase in which the amount of DNA is duplicated.	In meiosis, only meiosis I is preceded by a S-phase.
6.	In mitosis, there is no pairing of homologous chromosomes.	During prophase I, complete pairing of all homologous chromosomes takes place.
7.	There is no exchange of DNA (crossing-over) between chromosomes.	There is atleast one crossing-over or DNA exchange per homologous pair or chromosomes.
8.	The centromeres split during anaphase.	The centromeres do separate during anaphase-II, but not during anaphase
9.	The genotype of the daughter cells is identical to that of the mother cells.	Meiotic products differ in their genotype from the mother cell.
10.	After mitosis, each daughter cell has exactly same DNA strands.	After meiosis, each daughter cell has only half of the DNA strands.

Summary

The **cell cycle** is the series of events that takes place inside a cell thus leading to cell division and cell duplication. The cell cycle is divided into two brief stages : **(a) Interphase –** during which the cell grows and accumulates nutrients needed for mitosis and the DNA material duplicates in this stage. It is further divided into G_1, S and G_2 **(b) Mitosis (M) phase –** during which the cell divides itself into two distinct cells, called "daughter cells". Mitosis is also divided into four stages viz. prophase, metaphase, anaphase and telophase. During prophase condensation of chromosomes takes place. Metaphase can be indicated by arrangement of chromosomes at the equatorial plate. During anaphase centromeres divide and chromatids start moving towards the opposite poles. Each chromatid behaves like an individual chromosome during telophase. Nuclear membrane appeared and two nuclei are formed. Nuclear division (karyokinesis) is followed by cytoplasmic division and is called cytokinesis.

There are two stages of meiosis, namely, meiosis I and meiosis-II. Meiosis – I is called reduction division or heterotypic division while meiosis – II is called homotypic division. The parent cell or the dividing cell undergoes a preparatory phase, known as interphase, before entering the two stages of meiosis. Meiosis – I and II consist four common phases viz. prophase, metaphase, anaphase and telophase. The prophase of meiosis – I is a long phase which is further divide into five phases. These are leptotene, zygotene, pachytene, diplotene, and dikenesis. Due to formation of bivalent spindle the chromosomes which are arranged at the equatorial plate during metaphase are pulled towards the opposite poles during anaphase. Each pole receives half the chromosome number of the parental cell during telophase. At the completion of telophase, nuclear membrane and nucleolus reappear. Meiosis – II is similar to mitosis. Both the daughter cells formed by meiosis – I undergo meiosis – II and produce four haploid daughter cells.

EXERCISE

1. Put a dark colour in a given circle for correct answer :

(1) What is the average cell cycle span of a human cell ?

(a) 17 Hrs. ◯ (b) 20 Hrs. ◯

(c) 24 Hrs. ◯ (d) 120 Hrs. ◯

(2) Approximately how many cells are present in the body of an adult person ?

(a) 10^{14} ◯ (b) 10^{16} ◯

(c) 10^{21} ◯ (d) 10^{15} ◯

(3) During cell cycle DNA replication takes place in

(a) G_1 phase ◯ (b) G_2 phase ◯

(c) Interphase ◯ (d) M phase ◯

(4) During which of the following phase of mitosis asters appear around the centrioles.

(a) Prophase ◯ (b) Metaphase ◯

(c) Anaphase ◯ (d) Telophase ◯

(5) At which sub stage of meiosis crossing over takes place ?

(a) Leptotene ◯ (b) Zygotene ◯

(c) Pachytene ◯ (d) Diplotene ◯

(6) During which of the following stage of division nuclear membrane and nucleolus Reappear ?

(a) Prophase ◯ (b) Metaphase ◯

(c) Anaphase ◯ (d) Telophase ◯

(7) What is average cell cycle span of a *Yeast* cell ?

(a) 70 min. ◯ (b) 85 min. ◯

(c) 90 min. ◯ (d) 120 min. ◯

(8) Interphase can be divided into how many sub phases ?

(a) 2 ◯ (b) 4 ◯

(c) 3 ◯ (d) 5 ◯

(9) In how many phases the mitosis can be divided ?

(a) 6 ◯ (b) 4 ◯

(c) 3 ◯ (d) 2 ◯

(10) The result of meiosis is the formation of .....

(a) 4 cells ◯ (b) 2 cells ◯

(c) 8 cells ◯ (d) 6 cells ◯

(11) The locations at which crossing over occurs are known as .....

(a) Centromere ◯ (b) Kinetochore ◯

(c) Chiasmata ◯ (d) Centriole ◯

(12) At which of the following stages of cell cycle Proteins and microtubles required for mitosis are synthesized ?

(a) G_1 phase ◯ (b) G_2 phase ◯

(c) Interphase ◯ (d) M phase ◯

(13) Complete disintegration of nuclear membrane and nucleolus take place during which stage of mitosis ?

(a) Prophase ◯ (b) Metaphase ◯

(c) Anaphase ◯ (d) Telophase ◯

(14) The number of chiasmata depends upon .....

(a) Length of chromosome ◯ (b) Breadth of chromosome ◯

(c) Diameter of chromosome ◯ (d) Pairing of chromosome ◯

2. Answer the following questions in short :

(1) Why mitosis is called equational division ?

(2) Define : Kinetochore

(3) Define : Cell cycle

(4) Why meiosis is known as reduction division ?

(5) Describe : Synapsis

(6) What is Chiasmatum ?

(7) What is the meaning of Syncytium ?

(8) What is bivalent ?

(9) What is interkinesis ?

3. Answer the following questions :

(1) What is significance of meiosis ?

(2) Differentiate : meiosis and mitosis.

(3) How prophase of meiosis differentiates from prophase of mitosis ?

(4) What is significance of mitosis ?

(5) Describe the events taking place during interphase.

(6) What happens during zygotene ?

(7) Describe the events taking place during G_2 phase of cell cycle.

(8) Why meiosis is essential during gametes formation ?

(9) What is the significance of crossing over ?

(10) Explain the importance of bipolar spindles

(11) Mention the significance of centromere.

9

Animal Husbandry and Plant Breeding

Food, shelter and continuity of race are the basic requirments of humanbeing. He remained active form very beginning. Animals and plants are used for food since evolution of man. In the beginning these activities were limited to hunting of animals and gathering of fruits of wild plants. Thousands of years ago, agriculture began and at the same time animal husbandry also started. It is useful for obtaining higher production of food. In this process variations and upgradation have taken place from time to time. Today in the animal husbandry; dairy farming, poultry, apiculture, fisheries and in plant breeding, various methods of breeding and tissue culture are applied for getting more food to fulfill the need of increasing human population. With the help of modern techniques high quality, disease-free varieties of plants and animals can be produced.

Animal husbandry

Animal husbandry is important for food production. Today it is developed as an industry to earn money. Here we discussed some of them.

Dairy farming and its management : The dairy industry, covers the production, processing and distribution of milk and milk products and has a unique importance as it concerns with valuable food stuffs universally consumed by man. Milk is the fresh lacteal secretion of animal intended for the nourishment of the offspring, but exploited as an commodity of food by human being. They also use mammalian milk for a variety of preparations like curd, butter, cheese, sweet etc. For the proper and regular supply of milk, man has domesticated a number of mammals. The only mammals which have received attention worth the purpose are cows, goats and buffalos. During the past 100 years milk and milk products became important articles of commerce.

(1) The processing of milk by factory system was started in the middle of 19^{th} century.

(2) A number of technological advances like pasteurization of milk and sealing it in sterile containers.

(3) With moderuization of dairy it is now possible to distribute milk and its products to every part of the nation.

Industru :

In Gujarat this industry is well developed. Amul dairy, Anand; Dudh Sagar dairy, Mehsana, Banas dairy, Palanpur are main dairy units in Gujarat.

Management of Dairy Industry : Dairy industry is a cooperative result of cattle keepers, farmers, workers, businessmen and officers. Cattle keeper carries good varieties

of cattle. They prepare house hold milk products on their own and sell excess milk to the village dairies. Milk collected through village dairies is sent to main dairies where various milk products are being manufactured. Such dairy products are sold at national as well as international level; our country earns foreign exchange through this industry. This industry has brought white revolution. Dr. Vargese Kurian was a pioneer of this dairy industry in India.

Poultry

Fowls are widely distributed as domesticated animals since times immemorial. In 20th century poultry keeping has become an important small scale industry due to modern need for palatable and nutritive food which it provides in the form of eggs as well as adult animals. The storage and transport facilities helped to a great extent in popularizing it as a trade. India is the native place of the wild Jungle Fowl but little attention has been paid for developing poultry industry in comparison to other countries. In country like India, eggs can be consumed for the proper nutrition of human beings. The researches carried out at the Imperial Veterinary Research Institute (IVRI), Izatnagar have demonstrated the high biological value of eggs and recommended the consumption of eggs. There are several Government poultry farms in India.

Apiculture

Man had started the use of animal products since times immemorial even at the cost of animal's life. Honey has been under use in human civilization since prehistoric period as mentioned in our religious literatures like Vedas, Puranas, Ramayan, Mahabharat and Charak Samhita. Some foreign travellers like Fahiyan and Whenson had discussed the use of honey as a medicine. People were very much dependent upon honey for medicines. Apiculture, is the rearing of honey bee colonies, commonly in hives. Honey is produced by the honeybees. In India people do not take interest in bee keeping from commercial point of view. A location where bees are kept is called an apiary. Huber is known as "the father of modern bee-science".

Queen

Worker

Social organization of honeybee

A highly organized division of labour is found in the colony of honey bees. A good and well developed colony of bees has 40 to 50 thousand individuals consisting of three castes : **(i) Queen :** which is normally the only breeding female in the colony **(ii) Worker :** large number of unfertile female worker bees, typically 30,000 – 50, 000 in number **(iii) Drone :** found in many numbers and work as breeding male drones.

Products of bee keeping : The chief products of bee keeping industry are (i) Honey and (ii) Bee's wax.

Honey : Honey is a viscous, sugary fluid formed from the nectar within the stomach of the honey bee. The bees visit flower, suck the nectar, store it in the stomach and return to the hive. Honey is popularly a used medicine.

Bee's wax : Bee's wax is a very useful by– product of bee keeping industry. It is yellowish to greyish brown in colour and insoluble in water but completely soluble in ether. Bee wax is secreted by the abdominal gland of bees. It is used in the manufacture of cosmetics, paints, polish, carbon paper etc.

Fisheries

Fishery deals with catching, processing or selling of fish and other aquatic living organisms. Population living near the coastal areas is dependent on fish products for food. Common freshwater fishes are Catla, Rohu and Mrigal (commonly known as major carp). Edible marine fisher are Hilsa, Sardines, Mackerel, Pomfrets etc. The fisheries often include a combination of fish and fishers in a region. Directly or indirectly, the livelihood of over 500 million people in developing countries depend on fisheries. Fisheries remain an important business in India. It provides source of income for fishermen and farmers in the coastal states. Gujarat has 1640 km long coastal area where these industries work. To fulfill the demands of fishery

products, different modern techniques are employed to increase the production of aquatic plants and animals, both fresh-water and marine habitat. Fisheries can be saltwater or freshwater. Close to 90 % of the world's fishery catches come from oceans.

Animal breeding :

Santa gertrudis

In animal breeding the improved varieties can be more useful to man.

The goals of animal breeding are as under :

(1) Increase in growth rate.
(2) Higher yield of milk.
(3) Higher quality yield of milk, meat, eggs, wool etc.
(4) Development of disease resistance varieties.
(5) Extension of reproductive phase of life.
(6) Higher rate of reproductive yield etc.

Mule

In animal breeding three, methods like inbreeding, outbreeding and interspecific hybridization are employed.

(1) Inbreeding : All domesticated animal species are a special varity. These all varities are different in their characters and their genetic structure. The reason behind these is reproduction and **heterozygosity**. Thus, through reproduction between same species gene improvement takes place. Collection of desired genes and **homozygosity** is increased. By this method production of inbreed variety is increased. But due to continued inbreeding possibility is increased to collect harmful recessive genes. Therefore, fertility of offsprings gradually decreases.

(2) Outbreeding : In the outbreeding approach, a superior male of any one species is mate with a female of other species. During this breeding differt characters find a chance to come together forming new variety. Such varieties are hybrid varieties and can be more useful. Sometime they are also used in inbreeding. Specific goals can be achieved through this method eg. *Santa gertrudis* (Cow).

(3) Interspecific hybridization : In this method of hybridization, animals of two different species are interbred. The offsprings show characters, quite different from those observed in the species of both parents. Sometimes, the offsprings may possess all the desirable characters. This is economically important eg. Mule (female horse and male ass).

Plant breeding

Through plant breeding methods improved variety can be obtained. The major goals are as per animal breeding. For producing new genetic variety through plant breeding following points have to be considered.

(i) Collection of variability.
(ii) Evaluation and selection of parents.
(iii) Cross hybridization among the selected parents.
(iv) Selection and testing of superior recombinants.
(v) Testing, release and commercialization of new cultivation.

Single Cell Protein (SCP) :

One of the sources of proteins for animals and human nutrition is single cell protein (SCP). The single cell protein is produced by extracting protein of genetically engineered micro-organisms grown in large quantities for use as human or animal protein supplements. Single cell protein is produced by fermentation. Microbes used for single cell protein production include algae, bacteria, yeasts and filamentous fungi. Single cell protein has high protein contents, fats, carbohydrates, vitamins and minerals. It's utilization also reduces environmental pollution.

Among heterotrophs, mushrooms are being cultivated world wide. It has been calculated that a 250 kg. cow produces 200g of protein per day. Where as 250 gms Methylophillus methylotrophs bacteria produces same quantity of protein in a day. The fact that mushrooms are eaten by many people is because of single cell protein.

Biofortification : To improve public health, breeding crops for higher levels of vitamins and minerals or higher protein and healthier fats is the most essential. Breeding for improving varities is carried out in order to increase the amount and quality of protein and oil as well as vitamins and micro nutrients. In maize hybrids have twice the amount of the amino acids, lysine and tryptophan compared to existing maize species. IARI (Indian Agriculture Research Institute), New Delhi works in this field.

Tissue Culture

Plant tissue culture means growing and maintaining the cell, tissue and organ in culture medium. This process is carried out in controlled conditions in laboratory. This is carried out by two methods. (1) Callus culture and suspension culture (2) Embryo culture.

During tissue culture following care should be taken.

(1) To maintain aseptic condition in laboratory.

(2) Selected explant must be put in specific medium.

(3) The equipments must be sterilized through UV Light.

(4) To manage the constant temperature (24ºC) for the explant.

(1) Callus culture : The mass of undifferentiated cells are known as callus. This is made by the separation of organ, tissue and cells and number of cells increases through cell division. They are maintained on agar – agar gel. Growth promoters like auxin and cytokinin are added to the medium. Under this condition cell begins to divide. Callus is obtained within 2 to 3 weeks.

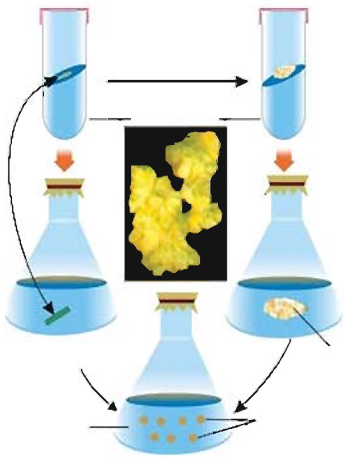
Suspension Culture

In this method isolated cell masses are suspended in a liquid medium. The culture constantly rotates over rotary shaker at 100 to 250 rpm speed in the culture media containing auxin (2, 4 – D). Through this cells easily get aeration. The contents of the medium are thoroughly mixed. The cell masses become differentiated and form small masses. As compared to the callus culture growth is fast.

In plant tissue culture following events are compulsory :

1. An increase in the biomass of cells and tissues.
2. Decrease in nutrient contents in the medium.
3. Decrease in volume of the medium due to evaporation.

Then culture is transfered to a fresh medium. This is called subculturing.



Plant tissue culture

Utility of callus and suspension culture

1. Formation of cell biomass.
2. Regeneration of saplings.
3. Development of genetically modified plants.
4. Protoplast isolation.

(2) Embryo culture : In this a small embryo, from a developing seed is removed and then cultured on media.

Application of the culture method

1. Hybrid plantlet of interspecific can be obtained.
2. In some plants like Orchids, the seeds do not contain stored food. Hence, rapid growth of such plant is obtained through this method.
3. Some seeds stay in dormant condition for longer time. Through this method plantlets can be developed from such seeds.

Mostly plants developing through this method are genetically modified species. They are used for following aims :

(1) Rapid clone distribution. (2) To create genetically modified plants. (3) To create useful plants etc.

Summary

Animals and plants are used for food since human evolution. Thousands of years ago, agriculture began and at the same time animal husbandry has started. It is useful for obtaining higher production of food. In this process variations and upgradation have taken place from time to time. Today in the animal husbandry dairy farming, poultry, apiculture, fisheries etc. and in plant breeding, various methods biofortification and tissue culture are important. With the help of modern techniques high quality, disease free varieties of plants and animals are produced.

EXERCISE

1. Put a dark colour in a given circle for correct answer :

(1) Which is the worker bee in the honey–bee family ?

(a) Sterile male bee ◯ (b) Sterile female bee ◯

(c) Queen ◯ (d) Male bee ◯

(2) Which animal is Hilsa ?

(a) Fish ◯ (b) Variety of female bee ◯

(c) Cow ◯ (d) Wild Jungle Fowl ◯

(3) Which industry is related to white revolution ?

(a) Agriculture ◯ (b) Apiculture ◯

(c) Dairy farming ◯ (d) Fisheries ◯

(4) Main source of Fisheries is :

(a) Rivers ◯ (b) Ponds ◯

(c) Sea ◯ (d) 'Khet talavadi' ◯

(5) Which type of hybridization gave *Santa gertrudis* (Cow) ?

(a) Out breeding ◯ (b) Interspecific hybridization

(c) Inbreeding ◯ (d) Inbreeding and outbreeding

(6) Mass of undifferentiated cells of culture method is known as ?

(a) Tissue ◯ (b) Callus ◯

(c) Suspension ◯ (d) Dead–tissue mass ◯

(7) What is the length (in km) of Gujarat Coastal line ?

(a) 1600 ◯ (b) 1640 ◯

(c) 1500 ◯ (d) 1460 ◯

2. Answer the following questions :

(1) Which is the main source of man's food ?

(2) Explain management of Dairy Farming.

(3) Write the importance of Apiculture.

(4) How honey is produced ?

(5) Give the name of important fishes of fisheries.

(6) Describe social life of honey–bee.

(7) Write the main aims of Animal breeding.

(8) Explain : Inbreeding, Interspecific – hybridization, Callus culture.

(9) What care should taken during tissue culture.

(10) Which methods in the event during plant tissue culture is essential ?

10

Human Health and Diseases (Immunity, Vaccination, Cancer, Aids)

Health is a word frequently used by every human being. How shall we define it ? In simple word 'Health' is neither "the absence of disease" nor "physical fitness." It can be defined as "expression of physical, mental and social well being". If human–being is healthy, then he / she becomes more inclined towards work, and consequently, productivity is boosted leading to economic prosperity. Good health lengthens an individual's life and decreases the deaths of children and pregnant woman.

Balanced diet, personal hygiene and regular exercises are the most essential for preserving good health. Since years, meditation is done to attain physical and mental health. For attaining good health, the awareness of the diseases and their influence on body's different functions, vaccination against infectious diseases, proper disposal of the wastage, the restraint of organisms and forming of healthy and hygienic food and the arrangement of water resources is needed.

When the functions of different parts of the body or systems are affected the symptoms of different diseases are seen in the body. Hence we will feel uneasy.

What is a Disease ?

Any physical or actional change from normal condition which produces unhealthiness or weakness or ruins the health of living being is called a disease. Alternatively, the bad performance of body or body's parts with some particular (Specific) symptoms is called a disease.

(In French *des* = away and *aise* = ease)

According to Oxford English Dictionary a disease is such a condition of body or body's parts that obstructs the functioning of them or creats a chaos.

The diseases are classified into two different types :

(1) Infectious diseases (2) Non–infectious diseases.

(1) Infectious diseases : Infectious disease are easily transmitted from one person to another. These diseases are easily carried away by different types of organisms like virus, bacteria, fungi, protozoa, helminths etc. Some infectious diseases like AIDS are fatal.

(2) Non–infectious diseases : These diseases remain limited to the person in whom it has been developed. They are not transmitted to other persons. Because of the unrestraint growth of specific tissues in the body, non–infectious disease like cancer may occur causing death.

Important Common Diseases

Typhoid :

Typhoid is a common disease caused by rod like bacteria *Salmonella typhi*. These bacteria in diseased condition are found in the intestine of human beings. This disease is very common among children belonging to age-group 1 – 15. Every year approximately 2.5 million people suffer from this disease.

Spreading : This disease is transmitted by the water and food contaminated by patient's feaces. House flies carry these organisms from feaces to food, milk and water. These organisms enter into the body through mouth and reach intestine from where they are carried into other parts of the body through blood circulation. It produces lesion in the wall of intestine. The period of incubation is of one to three weeks, averaging two weeks.

Symptoms : Common symptoms are fever initially for first and second week that subsides in the third and fourth week. Headache, severe weakness, pain in stomach, constipation and loss of appetite are seen. The liver and spleen get enlarged. Typhiod is diagnosed by Widal test.

Control :

Antibiotic Treatment.

Pneumonia :

Pneumonia is caused in human beings by bacteria *Streptococcus pneumoniae* and *Haemophilus influenzae*. Generally *Streptococcus pneumoniae* is called pneumococcus. Pneumonia is a disease of respiratory tract. The fluid gets collected in alveoli because of which the lungs do not get enough oxygen.

Spreading : This disease is spreading by coughing and sputum. Inhaling the pneumococci, it infects the windpipes. Burning is felt in alveolal wall which secrets the protein filled fluid. After that it is used as contagious medium by bacteria and obstructs the windpipes. Incubation period is of one to three days. Pneumonia is generally found in aged people.

Symptoms : The onset of pneumonia is usually sudden chill, followed by fever. Pain in inhalation, cough and headache are seen. In some cases the lips and finger nails turn blue from grey in colour. In pneumonia, some times, because of malnutrition, alcohol and side effects of medicines or infections from some other diseases like influenza, the resistence power of the body is lost. The sputums are bloody and rusty.

Common Cold :

This disease is an important disease among human infectious diseases which is caused by Rhino virus. This virus infects the nose and respiratory passage but not the lungs.

Spreading : The sneezing and coughing of an infectious person or by using pen, books, cup, computer, key-board or mouse used by the infectious being, the healthy person may get infected.

Symptoms : The common symptoms of common cold include nasal congestion and secretion, sore throat, hoarseness, cough, headache, fatigue etc. It lasts for 3 – 7 days at least.

Malaria :

Some diseases in human beings are caused by (vivax falciparum) parasites. For eg. Malaria. Microorganism called *Plasmodium* is responsible for this. *Plasmodium* is responsible for various kinds of Malaria to take place. For severe kind of malaria *Plasmodium falciparum* is responsible and sometimes it proves to be fatal.

The life cycle of plasmodium is completed in two hosts i.e. human being and female *Anopheles* mosquito. Man is a primary host whereas the mosquito is the intermediate or secondary host.

In human beings three stages of it can be seen.

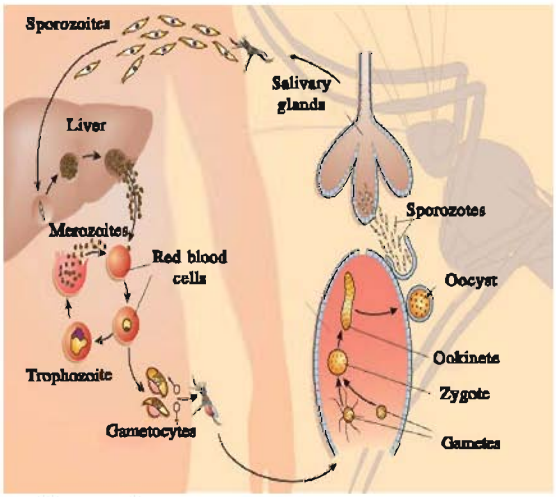
(1) Pre–erythrocytic cycle : The Anopheles mosquito bites, sends small amount of saliva into human body. The sporozoites present in the saliva are introduced to human blood. Sporozoite contains a large nucleus in the center. For about 30 minutes it swims freely in human blood and enters the liver cell. Growing over the food from the liver cells it becomes spherical in shape. This stage is called cryptoschizont. There is a strange kind of asexual reproduction found in cryptoschizont which is called schizogony. It changes into cryptomerozoites, which leaves a liver cell and enter the new healthy liver cells.

(2) Exo–erythrocytic cycle : Cryotomerozoites now enter a new liver cell and grow to achieve spherical shape. This stage in called metacryptoschizont. By asexual reproduction it is converted in to metacryptomerozoite, breaks the liver cells and comes out.

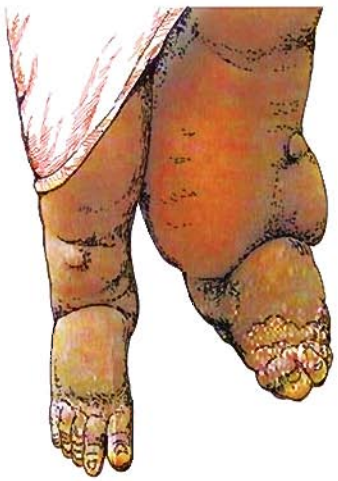
(3) Endoerythrocytic Cycle : This cycle is found in RBC. The metacryptomerozoite enters RBC and becomes spherical in shape which is known as trophozoite. Trophozoite develops many pseudopodia. This stage is known as amoeboid stage. The parasite secrets digestive enzymes and breaks the haemoglobin into haeme and globin. Globin becomes the food of the parasites. While haeme is converted in to toxic matter haemozoine. Now parasites become rounded in shape. This is called schizont. By asexual reproduction this form is converted into merozoites. Merozoites, thereafter, are converted into gametocytes. The gametocytes which are smaller in size and having large nucleus are called male gametocytes, whereas female gametocytes are larger with smaller nucleus.

Life–Cycle in Mosquito :

When female *Anopheles* mosquito sucks gametocyte–containing blood of human being, it enters in the digestive system. The male gametocyte now is recognized as micro gamete and female gametcyte as megagamete. Both gametes are fused and after fertilization converted into Zygote. Zygote becomes elongated and spindle–shaped and it is called ookinete. Ookinete is than coverted into oocyst. It absorbs the nutritive material and its size increases. By undergoing a special kind of sexual reproduction i.e. sporogony, it is converted into sporozoites. This sporozoite enters the salivary glands. Now to continue life–cycle, sporozoite has to enter human blood. When the mosquito bites a human, along with saliva sprozoite are introduced in human blood. The life–cycle continues in human being.



Life cycle in human Life cycle in mosquito



Elephantiasis

(4) Filariasis (Elephantiasis) : Elephantiasis is caused by the filarial worms.

Life Cycle in human

Filarial worms are long string like, white–bodied and pointed at both the sides. Adult male and female are of 40mm and 80mm length respectively. They reside in human beings lymphatic vessels and nodes. Human being is its first host. This worm is viviparous. The female gives birth to the kidworms which are called microfilaria. Then they are transferred to deep blood–vessels. Firstly, they are migrated into skin's epidermal blood–vessels of lungs which are sucked

by Culex *fatigan* mosquito which is a meditor and carrier. Here within 10 days approximately they are developed into larva and are migrated to mosquito's mouth organs. When infected mosquito bites the host human, the larva enter his skin. They enter in new host through the hole in skin made by the mosquito. Through blood they are transferred to lymphatic vessels and lymphatic glands. Here it gets matured in one year as an adult. An adult worm lives for 5 to 8 years.

Effect on the host (Disease agency)

From filarial infection, there is fever in acute condition. In chronic condition, the worm blocks lymphatic vessels. Due to which hands, legs, leg sole, breast and scrotum etc. get swollen. This happens due to thickening of skin and epithelial tissues. The leg gets deformed and swell and thus it is given the name elephantiasis. This disease is not fatal.

Control : Destroy the mosquitoes.

Ringworm

Part of Skin infected by ringworm

In human beings, rings, scaly lesions on various parts of the body are common symptoms. Some fungus like Microsporum, *Trichophyton* and *Epidermophyton* are responsible for scaly lesions.

Symptoms : In common symptoms, there is an appearance of dry, scaly lesions on various parts of the body like skin, nails and head. By constant itching the lesions get expanded. Heat and moisture support fungus to grow in skin folds, thigh corners and between toes.

Spreading : The disease spreads due to use of towel, cloth and combs of the infectious persons. For maintaining personal and public hygiene, prevention of the spreading of several infectious diseases is very important. To maintain personal health, one should keep the body clean and consume clean water, food, vegetables and fruits. For maintaining public health, proper disposal of dirty water, to clean the water of drums and barrels periodically and disinfecting them is necessary. This is a very important solution for preventing the disease spread by water and food.

In addition to the preventions mentioned above for pneumonia and common cold, one should not come into contact with infected people. Malaria and Filariasis spread by mosquitoes and hence the places where mosquitoes lay their eggs should be found and eliminated. The stagnant water of pools and Poodles surrounding your residence should be cleaned. The water of air – cooller should be changed regularly. Mosquito nets should be used. Fishes like *Gambusia* which feed on mosquito larvae can be reared in water reservoirs. Germicides, should be sprayed in drainage canals, ditches. The diseases like 'Dengue' and 'Chikangunya' are spread by *Aedes* mosquitoes Mosquitoes can be prevented from entering the house by fixing of wire – nets on doors and windows. To get protection from polio, diptheria, titanus and pneumonia, vaccination should be used so that they can be properly controlled.

Immunity :

We face a large number of infectious material everyday. However, a few of them lead to diseases. Why ? The reason for it is our body is able to protect itself form such foreign agents. This ability of the host to fight against these infectious diseases is decided by the immune system providing immunity.

Immunities are of two types : (1) Innate Immunity (2) Acquired Immunity

(1) Innate Immunity :

Innate immunity is a natural type of immunity. Innate immunity is so called because it is acquired by heriditary, since birth of animal. In support kind of immunity, various barriers work to inhibit the foreign agents entering our body. Despite this, if microorganisms responsible for

causing disease enter our body then immediately the other resources of this system destroy them. Following four barriers are in Innate immunity.

(i) Physical barrier : The skin of our body is the main physical barrier which prevents the entry of microorganism. Mucus coating of the epithelial lining in the respiratory, gastrointestinal and urogenital tracts also help in trapping microbes entering our body.

(ii) Physiological barrier : Acid in the stomach, saliva in the mouth and tears flow from the eyes to prevent the growth of the microorganisms.

(iii) Cellular Barriers : Certain types of leucocytes like polymorpho Nuclear leucocytes (PMNL), Neutrophils and monocytes leucocytes are natural killer cells found in the blood and macrophage, in tissues can engulf and destroy microbes.

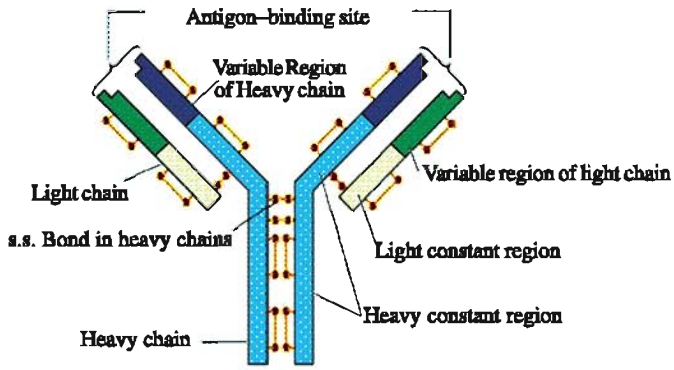
(iv) Cyokine Barriers : Virus infected cells secrete proteins called interferons which protect – uninfected cells from viral infections.

(2) Acquired Immunity (Pathogen Specific) :

Acquired immunity is pathogen specific. It bears memory characteristics. After birth during the lives, animals develop some immunity in their body to fight the diseases which is called Acquired Immunity. When our body comes in contact with a pathogen for the first time and then its response which is called "Primary Response" whose intensity is mild. There after when the same pathogen comes in the contact for the second time, the secondary response is very intense which has the memory of the first encounter by our body.

By two specific kind of lymphocytes i.e. B – lymphocytes and T – lymphocytes residing in our blood, the primary and secondary immune responses are elicited. The B – lymphocytes make an army of proteins to fight with the pathogens into our body. These proteins are called antibodies. T – cells do not produce antibodies but help B – cells to produce antibodies. Each antibody molecule has four peptide chains, two smaller chains are called light chains and two longer chains are called heavy chains. Hence, antibody is represented as $H_2 L_2$.

Different types of antibodies are created in our body which include IgA, IgM, IgE, IgD and IgG. These antibodies are found in blood. Thus this response is called humoral immune response.



Molecular structure of antibody

The other type of immunity is called a Cell–Mediated Immunity (CMI). When some human organs like heart, eye, liver, kidney lose their functioning, for transplantation proper doner is searched out. Why cannot the organs be taken from anybody ? What doctors examine ? The body part from any other animal, any primate or other human being is not acceptable and if it is taken than it may becomes unacceptable later on. It is essential to match blood groups and tissues before and after

transplantation. The body bears the ability to differentiate between 'self' and 'alien' and cell Mediated Immune response is responsible for the rejection of the part.

Active and Passive Immunity

When a host comes into the contact with antigens, the antibodies are produced in his body. Antigen is in the form of dead or alive microoganisms or other proteins. This sort of immunity is called active immunity. Active immunity is slow and takes time to give its full and effective response. This immunitydevelops when the organisms naturally enters or the antigenic beings are introduced in the body in adequate amount so it helps to create antibodies in the body. This is called active immunity.

When readymade antibodies are directly introduced into body to protect it from foreign agents, it is called passive immunity. Do you know why the mother's milk is considered to be very essential for an infant ? The yellowish fluid colostrums is secreted by mother during the initial days of lactation which contains plenty of lgA antibody. It gives protection to the infant. The foetus also obtains some antibodies from the mother through the placenta during pregnancy. These are the examples of passive immunity only.

Vaccination and Immunisation

The principle of immunisation or vaccination is based on the property of 'memory'. In vaccination, the antigen protein of pathogen or the inactivated or weakened pathogens are introduced in the body. Against this antigen antibody is produced in the body. In vaccination, B and T memory cells are also generated which recognize the pathogen quickly and suppresses the subsequent heproduction of invadors. If a person is infected with some dangerous microorganisms, rapid immune response is required. Like in tetanus, the directly produced antibody and antitoxin is entered. In snake biting too the injection which is given to the patients contain performed antibodies against the snake venom. This type of immunisation is called passive immunisation.

By recombinant DNA technology the production of antigenic polypeptides similar to that of pathogenic bacteria or yeast is carried out. By using this method, vaccine can be produced at larger scale, e.g., Hepatitis B vaccine from yeasts.

Allergies

Did this ever happen to you that you go at some new place and suddenly you start sneezing or wheezing without any reason ? Some of us are sensitive to certain particles of environment. The main reason of the above – mentioned reaction is the allergy of pollen, mites etc. which is different at different places. The excess response of the immune system to certain antigens present in the environment is called allergy.

The substances to which such an immune system responses are called allergens. IgE types of antibodies are produced against such substances. In common examples of symptoms include sneezing, watering eyes, running nose and difficulty in breathing. These are common symptoms. Allergies take place due to the release of chemicals like histamine and serotonin from the mast cells. For determining the cause of allergy, the patient is given very small doses of possible allergens and the response observed is studied. The use of drugs like antihistamine, adrenalin and steroids quickly reduce the symptoms of allergy immediately. Due to modern life style the reduction in immunity and more sensitivity are allergens increased. In most of the developed cities of India, more and more children suffer from allergies and asthma.

Auto Immunity

In higher vertebrates memory–based acquired immunity has evolved. This immunity is capable to differentiate between foreign and self antigens. Though we still have not fully understood the basis of this. Two corollaries of this ability have to be understood.

Firstly, higher vertebrates can differentiate foreign molecules and foreign organisms. The science of immunity is largely based upon this principle. Secondly, sometimes due to genetic and other unknown reasons, the body attacks self – cells resulting into damage to the body. This is called auto–immune disease. Rheumatoid arthritis is an auto – immune disease common in our society. Other examples are insuline based diabetes, arthritis, multiple sclerosis etc.

Immune system in our body

The human immune system consists of lymphoid organs, tissues, cells and soluble molecules like antibodies. Immune system is such unique system that recognises foreign agents, responds to them and remembers them. Immune system also plays an important role in allergic reactions, auto immune disease and transplantation of body's organs.

Lymphoid Organs

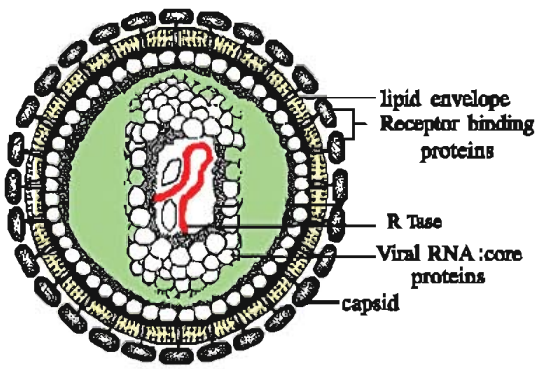
These are such organs in which lymphocytes are generated matured and they also proliferate. The primary lymphoid organs are bone marrow and thymus, in which immature lymphocytes are differentiated into antigen sensitised lymphocytes. After getting matured, the lymphocytes are transferd to secondary lymphoid organs like spleen, lymph nodes, tonsils, and small intestine. The secondary lymphoid organs provides the space for interaction of lymphocytes with the antigen and produces effective cells after the proliferation.

The bone marrow is the main lymphoid organ is which all the blood cells along with lymphocytes are produced. The thymus is an loblike organ and is arranged below the breastbone and near the heart. The thymus gland is large at the time of birth but decreases in size as the age passes and at adulthood it becomes very small. Thymus and bone–marrow both provide micro environments for the development and maturation of T–lymphocytes. The spleen is a large bean shaped organ which mostly process lymphocytes and phagocytes. It acts as a filter of the blood retaining microorganism produced in blood. Spleen also has a large treasure of erythrocytes. The lymph nodes are small solid structure located at different points in lymphatic system. Lymphnodes hold the lymph and microorganisms in the tissue trap. Antigens trapped in the lymph nodes are responsible for functioning of lymphocytes and they cause immune response. There is a lymphoid tissue located inside the surface of important tracts like respiratory, digestive and urogenital tracts which is called Mucosal Associated Lymphoid Tissue (MALT). It constitutes 50 % of the lymphoid tissue in human body.

AIDS

AIDS is a serious, incurable, infectious and fatal disease. The name AIDS stands for Acquired Immuno Deficiency Syndrome. Means it is a disease caused because of damaged of immune system. AIDS was first reported in USA in 1981 and in the last 21 yrs it has spread throughout the world. More that 25 million people have died on account of this disease. In India, the AIDS infection was first seen in Tamilnadu in the year 1886.

AIDS is caused by Human Immuno deficiency Virus (HIV). It is a virus belongs to the group of retrovirus. In HIV genetic the material is RNA. After entering the body of an individual this virus gets into Macrophages. In macrophages where RNA genome of the virus replicates with the help of enzyme reverse transcriptase to form viral DNA. This viral DNA enters the host cell DNA and directs the host cell to produce virus continuously and in this way it acts like HIV manufacturing unit. At that time HIV enters helper T – lymphocytes (TH),



Ritrovirus

replicates and produces progeny viruses. Newly formed virus are released in the blood and attack other helper T–lymphocytes. This is repeated leading to a decrease in the number of helper T–lymphocytes in the body of infected patient. During this period patient suffers from fever for a long time, and loses his weight. Due to the deficiency of immunity patient becomes helpless to protect himself from various infectious diseases.

Transmission of AIDS

- Heterosexual or homosexual physical contact with AIDS patient.
- HIV infected blood transfusion.
- Organ transplant from infective donor.
- By reusing the needle or syringe used by an AIDS patient or containing HIV.
- Through AIDS suffering mother to the foetus during pregnancy as well as through feeding (breast) by a mother to the child. AIDS is not a contagious disease in common way. It does not spread through contact with clothes, utensils etc.

Symptoms of AIDS

HIV infected patients are classified into three stages :

(1) The person appears healthy but does not show symptoms of AIDS. But such person acts as a vector of HIV.

(2) Some people show a little symptoms of AIDS including fatigue, bodyache lasting over four weeks, fever, blood in stool, loss of appetite, loss of body weight etc. This condition is called AIDS–Related Complex (ARC) from this the full blown of AIDS takes place.

(3) AIDS at the final stage :

That is the last phase of this disease. The stage is marked by symptoms :

- Loss of body weight by 10 % without any reasons.
- Continuous fever for one month or more, which is undiagnised.
- Dirrhoea develops.
- Get affected by cough, cold, pneumonia etc.
- Cancer of blood vessels and inflammation of lymph glands.

Diagnosis of AIDS :

Through Enzyme–linked Immunosorbent Assay (ELISA) Test and Western Blot Test (WBT) diagnosis of AIDS can be carried on.

Prevention of AIDS

No valid method to discover AIDS has been invented. No vaccine is available AIDS is totally an incurable disease. In India, the National AIDS Control Organization (NACO) and other Non-government Organizations (NGOs) are doing a lot to educate people for AIDS. WHO (World Health Organization) has started numerous programmes to prevent the spreading of HIV infection.

Preventing Remedies

(1) Don't cross the limit of single marriage life partner for sexual relationship.

(2) At the time of sexual intercourse condom should be used to avoid the danger of AIDS and other sexually–transmitted diseases.

(3) Do not take blood from professional blood donor. If it is needed, blood and blood produets should be used after proper investigation.

(4) Injection should be used after sterlizing the needle and syringe in boiling water and disinfected. The things like tooth–brush, razor, blades which come in direct contact with blood should not be reused, once if it is used by others.

(5) The person suffering from AIDS / HIV should be treated properly and must not be boycotted socially.

Cancer

Cancer is a dreaded disease. In the world the most of the deaths occur due to this disease. In India, more than million people suffer from Cancer and a numerous people die because of it.

In our body, process of cell growth and differentiation is regular and in controlled manner. In Cancer cell, the process of this control breaks down and the process of cell–divisions becomes uncontrollable. In Cancer cell–division is continuous, resulting into masses of cells which form tumors. This tumor is surrounded by connective tissue and confined to one place. Cells are spread to other parts of body through blood or vessels and create the malignant tumors. This state of spreading of Cancer cells in the body is called Metastasis.

Causes of Cancer

Simple cells converted into cancer cells by the process of physical, chemical and biological factors. The factor causing the Cancer is called carcinogens. Ionising radiations like X-rays and gamma rays and non – ionizing radiations like UV cause DNA damage leading to neoplastic transformation. Chemical carcinogens present in tobacco smoke cause lung Cancer. Cancer causing viruses are called oncogenic viruses. The gene prevailed in it is called viral oncogens, Furthermore, in normal cells cellular oncogenes or protooncogens are found. When they are activated under certain conditions, they transform normal cell in to cancerous cell.

Types of Cancer

There are three main types of Cancer

(1) Carcinoma (2) Sarcoma (3) Leukemia

(1) Carcinoma : Abnormal growth in epithelial tissue in body. This cancer is called carcinoma cancer. Breast cancer, lung cancer, cancer of stomach and pancreas are of this type. Skin melanoma is also of this type of cancer.

(2) Sarcoma : The tissue develops from mesoderm in the body that divides uncontrollably and develops cancer which is called sarcoma. Bones, cartilage, muscle and lymph glands cancers are of this type.

(3) Leukemia : Leukemia is the cancer of blood. In blood WBC is found, that originates in bone marrow. The number of leucocytes increases abnormally in this type of cancer. The number of immature WBC is also very high.

Methods of Diagnoising Cancer

(1) Clinical Examination : A Cancer specialist doctor diagnosises cancer through its location and type using various equipments. If needed endoscopy is also performed.

(2) Histocytogical Tests : Small mass of tissue biopsy is taken from the suspected organ. It is microscopically examined. For uterine or uterine mouth cancer a small mass of tissue from that part, is examined. It is called PAP smear.

(3) Radiation Technique : Examine through X-rays. To examine the internal organs of the body CT and MRI scan are also used. In computed Tomography by using (gamma–rays) – rays

the three dimentional picture of the internal structure of any one organ is obtained. MRI uses strong magnetic fields and non–ionizing radiations to accurately detect Pathological and Psycholoical changes in the living tissue.

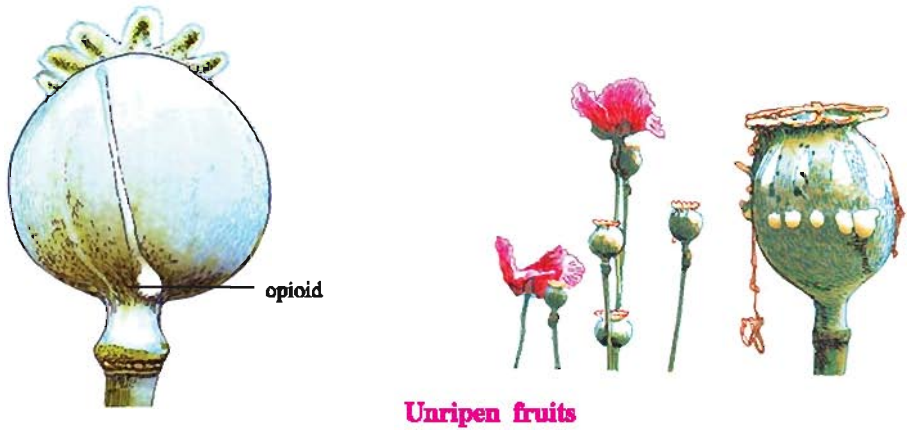
(4) **Laboratory Tests :** For diagnosing cancer the blood and urine are checked in the laboratory. In some specific Cancer tests antibody is used against cancer specific antigen.

Treatment of Cancer

The common approaches for the treatment of cancer are surgery, radiation therapy and immunotherapy. In radiation therapy, the tumors are given radiation treatment. But it care is taken that its surrounding normal tissues don't get exposed to rays. Some anticancer drugs are also used to destroy the cancerous cells. Some of these are specific for particular tumors. In majority of drugs, side–effects are seen, like, hair loss, anemia etc. Mostly in cancer the treatment is done in combination of surgery, radiotherapy and chemotherapy. Immunity too is useful to destroy the tumor cells, eg. Interferon.

Drags and Alcohol Abuse

It is observed on the basis of surveys and statistics that the use of drugs and alcohol is seen in the youth especially due to which many harmful effects originate. The youths should be given proper education and guidance to safeguard them against these dangerous behaviour. Narcotic drugs like Opioids, Cannabinoids, Cocaine, Haroine, Marijuria and LSD are extracted from flowery plants and fungi.



Unripen fruits

Opioids are the drugs which are bound with specific opioid receptors present in our central nervous system and gastro – intestinal tract. Opioids is dry latex which is obtained by making fissure in unriped fruits. This white fluid is dried and allowed to get hardened which is converted into brownish colour next day which is round opioid. From opioid pain–reliving drugs and medicines like morphine and codeine are obtained.

Morphine is a well–known pain reliever drug which generally acts on the nerve cells of small brain, obstructs pain and relive the body from pain which functions as a stimulater. Opium inspires pleasant feelings. It draws out anxiety, fear and stress and it leads to the addiction.

Codeine is another type of alkaloid obtained from opium. That is a pain–reliver medicine. Sometimes it is used in the cough syrup too because it cools down the reactions of cough. It is used to prevent the stress of breathing at the time of asthma attack and to relive the stress felt in stomach and intestine. The immature seed acetylation of opium is used as medicine but as soon as the seed gets matured, it loses its medicinal property and is used as food.

Heroin or diacetylmorphine is white crystalline material which is a pain reliver and is pleasure related drug. It causes an addiction if taken frequently. Smack (brown sugar) is an unclear byproduct of Haroine.

Cannabis indica

Cannabinoids are a group of chemicals, which gets connected internally to cannabinoid receptors present in the brain. Cannbinoids, Bhang, Ganja and Charas are obtained from drived levels and flowers of *Cannabis indica* are obtained from the inflorescenes of the plant and dried leaves. While the other drug marijuana is obtained from *Canabis sativa*. Marijuana is obtained from flower tops, leaves and resin of *Cannabis plants*. The main active element of it is Delda – 9 Tetrahydrocannabinol (THC). When this medicine is taken, the eye – Pupils get dilated. Urine is produced more quantity and the level of sugar in the blood increases. Marijuana is taken with tobacco in cigarrates. There are no indication on effect of use because its effect in every individual is different. The users sometimes become wild and cruel and become harmful for others and for one ownself. Coca alkaloid or cocaine (crack) is obtained from coca plant *Erythroxylum coca*, grown in south America. It is obtained from dry leaves and branches of coca plants. It has a potent stimulating action on central nervous system. It obstructs hunger, produces sleeplessness hallucinations which harm the mental performances later on. The individual is found to indulge in madness. The abuse of coccaine leads to severe headache, fit or heart failures or failure of respiratory system leading to death. Other well known plants with hallucinogenic properties are *Atropa beladona* and *Datura cannabinoid* are also being used by some sports persons Haris is a potent resin which is obtained from female fruits of *Cannabis* plant. LSD is basically hallucinogenic chemical helps in changing the mental condition. That is produced from Lysergic acid found from ergot of mustard seed. There cannot be any specific indication of LSD. Amphetamitcs is a stimulating pill. Mostly people use it to keep awake at night. Its effect resembles that of coccaine. Barbiturates is a medicine which makes a person feel comfort and relief. It is generally used as sleeping pills. Using the above mentioned drugs frequently one cannot live without these drugs and consequently they harm the organs in longer period.

Erythroxylum coca

Excessive use of smoking also leads to hard drugs. The tobacco is used for smoking, chewing and snuffing. Tobacco contains a large number of chemical substances including nicotine. Nicotine stimulates adrenal gland to release adrenaline and non–adrenaline into blood circulation, raising blood pressure and increase heart beats. Smoking leads to increased incidence of cancers of lungs, urinary bladder and throat, trachea, stomach ulcer, respiratory blockage and emphysema, coronary heart disease. Tobacco chewing leads to increased risk of cancer of the oral cavity. Smoking increases carbon monoxide content in blood and the proportion of oxygen is reduced in haemoglobin. This causes oxygen deficiency in the body. The smokers should attend to the warning written on the cigarette packet while buying that smoking is injurious to health, that should be followed strictly. Despite, smoking is much prevalent in society. Smoking and tobacco chewing are dangerous, so the youths and old should retrain from such habits. Every addict requires counselling and medical help to get rid of the habit.

Drugs found from Plants

Name of Plant	Drugs Found from Part of Plant	Name of Drugs and Its Type
(1) Opium poppy Papaver Somniferum	Unripe fruits, latex Milk	Opium and its derirvatives Morphine, Cocain Haroine (Pain reliving drags)
(2) Hemp Plant *Cannabis indica* *Cannabis sativa*	i. Plants Leaf and flower ii. Dry plant, apex unfertilised fruit iii. Leaves and flowers iv. Plants apex dry flower	i. Bhang (Hallucinoginic) ii. Ganja (Hallucinogenic) iii. Charas (Hallucinogenic) iv. Marijuana (Hallucinogenic)
(3) Coca Plant Erythroxlylon coca	Dry Leaves and young twig	Cocaine (Stimulating) Crack (highly stimulating)
(4) Ergot Fungus *Claviceps purpurea*	Fruit bodies	Lysergic acid diethylamine (LSD) (hallucinogenic)

Adolescence and Drug / Alcohol Abuse

The period between 12 – 18 years of a child is known as adolescene. It is a link between childhood and adulthood. With adolscene we see some biological and behavioural changes. In fact, Adolescence is a very sensitive phase of mental and psychological development of a child. In an adolocent, for excitement and adventure, curiosity is needed and as through experiments, common purposes are achieved. In the same way, curiosity leads the adolescent to try drugs and alcohol. Thus adolescents, by getting inspired from curiosity and experiment, consume drug or alcohol for the first time. But later on they become addict to it by escaping from facing problems instead. Adolscents, later on, if fail to perform better in the examination, are drawn to stress and under pressure they start consuming drugs and alcohol. This becomes a chief cause of initiating of taking drugs and alcohol. To remove these habits, awareness through newspapers, films, internet, television can be carried out. In which proper persuasion is given to remove the habits thoroughly. For the intake of drugs and alcohol, many other factors are responsible too such as failure of getting family support, unsupporitve family structure, not getting proper facilities due to poor financial condition of family pressures can be included.

Addiction and Dependence

Because of the perceived benefits, drugs are frequently used. The inherent addictive nature of alcohol and drugs is the most important thing which one fails to realise. Addiction is a psychological attachment to certain effects – such as euphoria and a temporary feeling of well–being associated with drug and alcohol. The frequent use of alcoholic matters raises the tolerance level of the receptors present in our body. Consequently the receptors respond only to higher doses of drugs or alcohol leading to greater intake and addiction. The use of these drugs, however only once, can be a fore–runner to addiction. Thus, the addictive potential of drugs and alcohol, pull the user into a vicious circle leading to their regular abuse from which he / she may not be able to get out and it is resulted into addiction. If the person does not get any proper guidance or counselling, he is addicted and becomes dependent on their use.

Because of dependence the mental attitude of the body in certain direction gets cleared, if regular dose of drugs / alcohol is abruptly discontinued, the most unpleasant withdrawal syndrome takes place. This is characterised by anxiety, shakinees, nausea and sweating. To get relived from it the addict should reuse the drug and alcohol. In certain cases, withdrawal symptoms can be severe and even life threatening and the person may need medical supervision.

Effects of Drug / Alcohol Substances :

With the abuse of alcoholic substance and drugs, the person is influenced instantly and he behaves unthoughtfully, rashly and harms things. Because of excessive intake of alcoholic substances,

the respiratory system fails causing death, unconsciousness and obstructs the heartbeats. Alongwith alcoholic substances, if drug is taken excessively it leads to death. The excessive intake of alcohol and drugs in youths leads to their unnecessary absence in schools and colleges which affects their academic achievement and personal health also gets affected. Moreover stress, aggressiveness and violence take place and relationships with friends and family members get spoilt. One may face loss of interest in hobbies. There are changes in sleeping and eating habits, irregularities in weight and apetite. If the addict would not get the money to purchase alcohol, he / she may resort to stealing and is ruined mentally and financially. He also ruins his family. If an addict takes the drugs intravenously, he may get infected to AIDS and Hepatitis – B through of the needle and syringe. In adolescent, the intake of alcohol has an adverse effect over a longer period. The excessive and chronic use of drugs and alcohol damages nervous system and it leads to severe liver diseases like cirrhosis. If the alcohol is taken during pregnancy, it affects the foetus severely.

To enhance the performance, the drugs and alcohol are excessively misused. The sports persons abuse the alcohol to increase muscular strength. They misuse anabolis steroids and several hormones for this. The use of anabolic steroids in female causes the following effects : the features like males manasculinisation, increased aggressiveness, depression, abnormal menstrual cycles, excessive growth of hair on face and body etc. While in males increasing of acne, increased agressiveness, depression, reduction in the size of testicles, decreased sperm production, liver dysfunction, increasing baldness etc. side effect can be seen. In adolescent male and female development of acne on face and the growth centres get closed which results into stagnant growth.

Prevention and Control

The habits of smoking, taking drugs or alcohol is common in youth. It is there in adolescene as well. So by identifying the situation, it is advisable to keep the adolescent away from using drugs and alcohol. The teachers and parents should tackle the situation responsiby. The below mentioned measures of prevention and control should be specifically used by the addict of alcohol and drugs.

To refrain oneself from undue pressure

Every boy or girl should be grown according to his / her personality and choice. He / She should not be forced to follow something which they are not interested in and should not be bound within any boundary. They should be allowed to perform the activities like studies, sports and others.

Education and Counselling

The boys and girls should be educated and counselled to face problems, changes and stresses. They should be encouraged to face failures and disappointments. "Failures are a part of life" should be taught to them. They should be encouraged to employ their energy in sports, reading, music, yoga and other extracurricular activities.

Support from Parents

Parents should help their children always and provide them proper guidance whenever needed. Help may be even sought from close and trustful friends.

Looking Towards Dangerous Signs :

Alert parents and teachers need to identify dangerous signs and discuss them properly. The friends should also instantly bring the matter to the notice of his parents and teacher, if they found someone taking drugs / alcohol without hesitation. This can be helpful in initiating proper treatment, cure and approach remedial steps.

Professional Consultancy and Medical Help

About the above – issue plenty of advice can be sought from psychologists and psychiatrists. To get free from addiction, rehabilitation, programmes can be arranged through which the individual who is trapped in such quagmire may be helped to get out of it. With such help the affected individuals, with enough efforts and strong will power, may get rid of the problems completely and will be able to lead a healthy and normal life.

Summary

Health is not only the absence of disease but is also a state of complete physical, social, mental and psychological well – being. Diseases like typhoid, cholera, pneumonia, infectious diseases of skin, malaria and many others are a major cause of distress to human beings. Vector – borne diseases like malaria especially one caused by *Plasmodium falciparum*, if not treated, may prove fatal. Besides personal clealiness and hygiene, public health measures like proper disposal of waste, decontamination of drinking water, control of vectors like mosquitoes and immunization are very helpful in preventing these diseases. Our immune system plays the major role in preventing these diseases when we are exposed to disease–causing agents. The innate defences of our body like skin, mucous membrances, antimicrobial substances which are present in our tears, saliva and phagocytic cells helps to obstruct the entry of pathogens in our body. If the pathogens become successful in getting into our body, the cell serve to kill these pathogens. Immune System has memory. Now when the pathogens reenter our body, the immune response is rapid and more intense. Among other diseases, AIDS and Cancer kill a large number of individuals world wide AIDS is spread by HIV and is fatal but by keeping certain precaution it can be prevented. Many cancers are curable if detected early and appropriate measures are taken. Drug and alcohol abuse is done by youth and adolescent mostly. Drug and alcohol are intoxicant in nature and their perceived benefits like relief from stress, a person may try taking this in face of peer pressure, examination – related and competition – related stresses. By doing so, he / she gets addicted. To get protected from this effect education about the harmful effects, counselling and seeking immediate professional and medical help would relieve the individual from these evils completely.

By securing required kind of vaccination to prevent diseases, fearless situations may be produced.

EXERCISE

1. Put a dark colour in a given circle for correct answer :

(1) What is obtained from Cannabis indica ?
- (a) Cannabinoids ◯ (b) LSD ◯
- (c) Coccaine ◯ (d) Barbiturate ◯

(2) Which of the following substances is obtained from fungus Ergot ?
- (a) Charas ◯ (b) Marijuana ◯
- (c) Coccaine ◯ (d) LSD ◯

(3) Which drug is obtained from opioids ?
- (a) Marijuana ◯ (b) Ganja ◯
- (c) Coccaine ◯ (d) Morphine ◯

(4) From which part of the plant opioids is obtained ?
- (a) Leaf ◯ (b) Fruit ◯
- (c) Flower ◯ (d) Root ◯

(5) The one responsible for liver cirrhosis…..
- (a) Hashish ◯ (b) Charas ◯
- (c) Coccaine ◯ (d) Liquor ◯

(6) Which of the following disease doesnot cause due to smoking ?
- (a) Malaria ◯ (b) Lung Cancer ◯
- (c) Inflammation of Neck ◯ (d) Liver ◯

(7) Who secretes interferons ?
- (a) Bacteria ◯ (b) Organism ◯
- (c) Virus ◯ (d)

(8) This is brownsugar……
- (a) Hashish ◯ (b) Barbiturate ◯
- (c) LSD ◯ (d) Heroin ◯

(9) From which plant coccaine is obtained ?
- (a) Cannabis indica ◯ (b) Cannabis setiva ◯
- (c) Erithoxaylam coca ◯ (d) Coffee aerabica ◯

(10) The main Macrophage Cells are....
(a) Lymphocyte ◯ (b) Macrofaesis ◯
(c) Mast cells ◯ (d) Plasma cells ◯

(11) The reason of AIDS to take place.....
(a) The helper T – Lymphoid cells destroy ◯
(b) The killer T – Cells getting destroyed ◯
(c) Auto Immunity ◯
(d) Desreasing of Interferon ◯

(12) The tears falling from eyes and salvia in the mouth is which kind of barrier of innate immunity ?
(a) Physical Barrier ◯ (b) Physiological Barrier ◯
(c) Cellular Barrier ◯ (d) Cycokine Barrier ◯

(13) Which kind of protein is Interferonce ?
(a) Complex Protein ◯ (b) Anti bacterial protein ◯
(c) Antiviral protein ◯ (d) Anticlotting protein ◯

(14) By what does. Elephantiasis occurs ?
(a) The presence of filarial worm virus on the wall ◯
(b) By biting of filarial worm ◯
(c) Micro filarial ◯
(d) Dead matured filarial ◯

2. Answer the following questions in short :

(1) What is a disease ?
(2) Mention the types of disease.
(3) How does Typhoid disease spread ? Discuss how can it get controlled ?
(4) How does pneumonia disease take place. Discuss the controlling measures ?
(5) Give full name of the folliwng : (1) AIDS (2) HIV (3) NACO (4) ARC
(6) Wich fungus couses ringworm ? State its features.

3. Distinguish between :

(1) Infectious disease and non – infectious disease.
(2) Innate Immunity and Acquired Immunity.
(3) Active Immunity and Passive Immunity.

4. Answer the following questions :

(1) Draw a figure indicating names of antibody.
(2) How does AIDS get spread ?
(3) Write the reasons responsible for Cancer.
(4) Describe the Adolescene and Habits.
(5) Describe the effects of drugs / alcohol.

5. Answer the follwoing questions in short :

(1) How does opium obtained ?
(2) What is Smack ?
(3) How does cocaine obtained ?
(4) Is alcohol a food ?
(5) What disease of liver takes place by excessive intake of alcohol ?
(6) What problems are faced if we stop taking alcohol suddenly ?
(7) Which disease occurs because of smoking ?
(8) From which fungus LSD Obrained ?
(9) Which alcohol is used in cough syrup mostly ?

6. Answer in two lines :

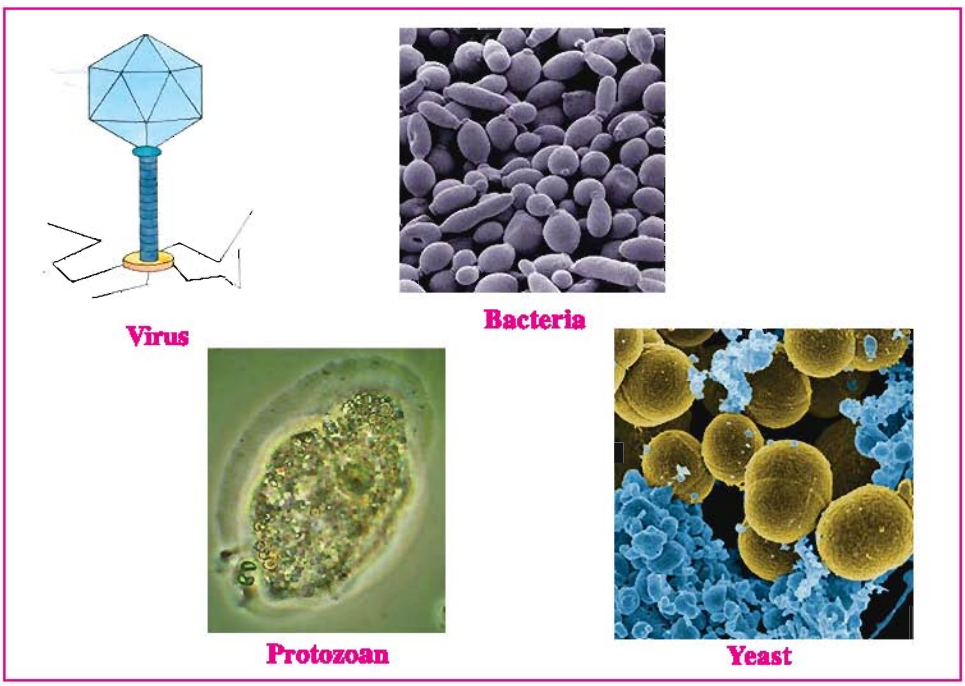
(1) What is morphine ? Mention its uses and abuses ?
(2) In what different forms tobacco is obtained ?
(3) Which four organs are affected by doing smoking ?
(4) How does LSD obtained ? Discuss its effects.
(5) From what cocain is derived ? State its effects.

11

Microbes and Human Welfare

The living organisms show a diversity as well as usefulness in nature. There is also a diversity in microbes which can not seen by naked eyes, e.g. protozoan, bacteria, fungi, virus. Except some microbes many microbes are useful to mankind. They inhabitate water, soil, land, in a body and also every where. They have ability to live even in adverse condition. These microbes are exploited in different ways for human welfare by the broad knowledge of modern biotechnology and genetic engineering. They are being used since long. There are different methods to grow these organisms in nutritive media. Some known microbes are shown in fig. 11.1.

We will discuss microbes in human well fare in this chapter.



Microbes in household products

Some food materials which we take in our daily diet are obtained by microbial process. The common example is to prepare curd from milk, which is very old technique. *Lactobacillus* bacteria along with other bacteria are used in this process. They are collectively known as lactic acid bacteria (LAB). Curd is prepared by adding small amount of curd or butter milk in a required milk and incubated at suitable temperature. The milk is coagulated and milk protein is digested by acids produced through LAB. LAB also improves the amount of vitamin B_{12}. These LAB protect us form the adverse effect of harmful bacteria present in our stomach. There is a role of such microbes to prepare food like dosa, idli etc. In dough prepared for that purpuse, fermentation is done by bacteria. Bakers Yeast *Saccharhomyces cerevisiae* is used to prepare bread. In this way many traditional drinks and foods are obtained by microbes. Such drinks and foods are prepared by fermentation process of microbes. Today a traditional drink is also prepared by fermenting sap from plam tree in south India. Food material is prepared from fish, soybean and bomboo by passing them through fermentation process. Cheese is prepared by such methods. By modernization of technique, its texture, flavour and test has improved. e.g mold is grown for Roquefort cheese. Swiss cheese is prepared with the help of *Propiani bacterium Sharmanii.* Ensilage is a food for cattle. It is prepared from a fermentation of carbohydrates in green plant tissue. Pickles are the result of lactic acid fermentation of fruits like citrus and vegetables.

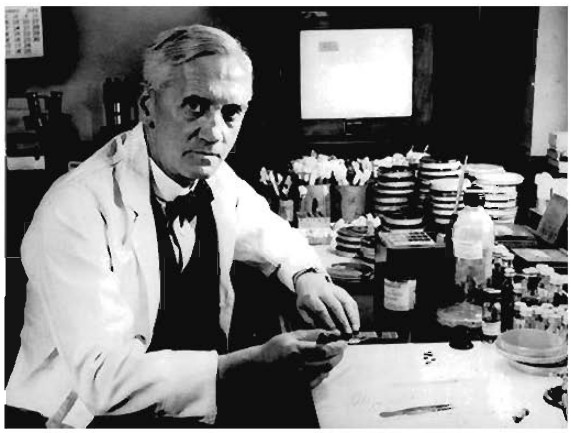
Microbes in Industrial Products

Many products useful to mankind are synthesized at commercial level through microbes e.g. beverages, antibiotics, carbonic acids, alcohol, enzymes, proteins, industrial chemicals, steroids, vaccines, amino acids, energy fuel etc. Useful microbes are grown in large vessel on industrial scale. Wine, beer, whisky, brandy or rum like beverages are produced with the help of yeast. *Saccharomyces cerevisiae* from centuries by this method. Such yeast is known as Brewer's yeast. Ethanol is produced from cereals and fruit juices with the help of this yeast.

Ethanol is used as a fuel for vehicles in Brazil. Methane which is used as a energy resource is produced by using methanogenic bacteria. Other fuel is hydrogen, that could be produced by microbes in future. Photosynthetic microbes produce H_2. They are able to convert solar energy in to fuel energy that can be stored.

Antibiotics available from market are one type of chemicals. It is regarded as one of the most significant discoveries of the twentieth century. These medicines made remarkable contribution for Human welfare. Alexander Fleming was the first to discover antibiotic Penicillin.

Penicillin is obtained from *Penicillium notatum.* However, its full potential as an effective drug was made possible later by Ernest Chain and Howard Florey. These three scientists were awarded the Nobel prize in 1945, for this discovery. Then after, other antibiotics for fatal diseases like plague, whooping cough (Kali Khansi), diphtheria, leprosy, etc were discovered. Today, we can not imagine a world without antibiotics. Carbomycin, bacitracin, fumagillin, tetracycline are other



antibiotics. Beside this important carbonic acids are also obtained through other microbes. Citric acid is produced by fungus *Aspergillus niger,* Acetic acid by *Acetobactor aceti,* Butaric acid by *Clostridium butylicum* and Lactic acid by *Lactobacillus* on large scale. Other acids like glouconic acid, L-malic acid, etachonic acid etc. are also produced by such method. Amino acids like L-lysin also produce by the same way.

Enzymes are produced through micro organisms in industries. Most of them are produced by yeasts. e.g. glucose oxidase, amylase, protease, glucaxylase, renin, lipase, cellulase etc. Lipases are used in removing oily stains in laundry. Fermentation process is used to produce some vitamins e.g. riboflavin is produced by *Arabia gossipae*. Same way steroid like hydroxyprojesteron is produced by *Rhizopus nigricans.* Streptokinase which is produced by *Streptococcus* bacterial strain modified through genetic engineering is used to prevent blood clotting in blood vessels, Cyclosporin A is obtained from Trichodermopoly sporam yeast and is used as an immunosuppressive agent in organ transplantation in patients. Statins is used to reduce blood cholesterol. It is produced from fungus *Monoscus purpureus.*

Microbes in sewage treatment

Municipal waste–water is called sewage. Treatment for cleaning of urban sewage is known as sewage treatment. Sewage is a waste water containing human excreta. In such a sewage large amount of organic matter and microbes are also present, many of which are pathogenic. Such water is treated through heterotrophic bacteria and there after the effluent is released to rivers. Such plants are known as sewage treatment plants. Through these processes water pollution is controlled (prevented). Whole process is done in two phases.

Primary Treatment

Physical particles present in a sewage are removed through filtration and sedimentation in a first stage. The process is done in a series of stages.Initially, floating debris is removed. Then the grit (Soil and small pebbles) are removed by sedimentation. Such solids accumulate at the bottom and form a sludge, upper free water is known as effluent. The effluent present in a first tank is used for secondary treatment. It is a biological process. The primary effluent is passed in to large aeration tank where it is constantly agitated mechanically and air is pumped into it. This allows vigorous growth of aerobic bacteria. These bacteria associated with filaments of molds present in the water and form, flocks, Microbes, including bacteria consume organic matter present in effluent hence most of amount of organic matter present in a water is utilized due to chemical reaction.

As a result of degradation biochemical oxygen demand (BOD) reduces. Thus BOD means amount of oxygen needed for degradation in water or indirectly it is a measure of the organic matter in a water. The greater the BOD of waste water, the more the pollutants.

Once the BOD of sewage is reduced significantly as per requirement, the effluent is passed into a settling tank where the bacterial 'flocks' are allowed to sediment. Such sediment is known as activated sludge. A small part of the sludge is again pumped back in to the aeration tank which serves as the starter inoculum. The remaining major part of the sludge is pumped in to tanks called anaerobic sludge digesters. Here, other kinds of bacteria which grow anerobically, digest the bacteria and fungi present in the sludge. Mixed gases are produced in this process. Methane, hydrogen sulphide and carbon dioxide are formed in it.

Biogas is formed from this gas and can be used as source of fuel energy. Thus plants and bacteria in these serve for human welfare. But these plants are not sufficient for growing human population and so can not solve the problem of pollution. The ministry of forest and

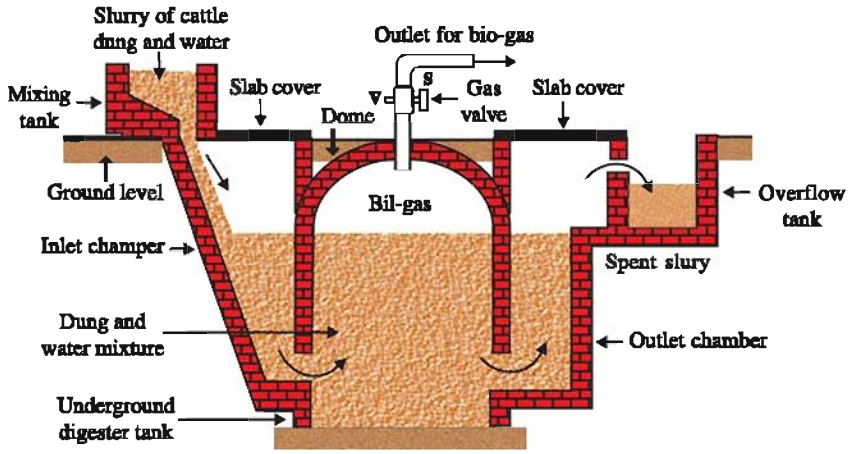
environment has initiated Ganga action plan and Yamuna action plan to save rivers from pollution. It is our moral duty that we should not pollute our Lokmata rivers.

Microbes in Production of Biogas

In village areas biogas plants are important for their economy and cleanness of the area. We know that biogas is a mixture of gases which are used in fuel energy. Bacteria grow in excreta or decaying material. Due to their anaerobic respiration like metabolic activities, such mixture of gases are produced in biogas plants. The types of gases is based on types of bacteria and type of a massed matter. If bacteria react on cellulosic material, large amount of methane gas is produced along with CO_2 and H_2. These bacteria are collectively called methanogens. These bacteria are also present in the lumen (a part of stomach). Herbivores use cellulose as food. It is digested with the help of such bacteria.

Hence, there are large number of such bacteria in a dung of cattle. Thus the excreta (dung) is used to prepare biogas. It is known as gobargas by the people.

A concrete pit is prepared (3 to 5m in depth) in which bio-wastes are collected along with slurry. A floating cover is placed on it, which rises as the gas is produced by bacteria. A pipe is attached to the plant to collect the gas. Its outlet is attached with domestic appliances. Thus gas is used for cooking and lighting. The remaining slurry is removed through pipeline, which is used as a fertilizer. Such plants can be easily operated in rural areas because dung is available in large amount due to animal husbandry.



Fixed-dome type bio-gas plant

The technology of biogas production is developed in India mainly due to the efforts of Indian Agricultural Research Institute (IARI) and Khadi and Village Industries Commission (KVIC). By making visit and talking with management holders, we can get more information and knowledge about biogas.

Microbes as Biocontrol Agents

The factors which harm crops in the field of agriculture are normally considered as pest. Mainly insects, fungi, bacteria are important pests decreasing crop production. For their control many synthetic insecticides (Pesticides), pesticides, fungicides chemicals are available in market. Weedicides are available to remove extra weeds. There is a pollution in soil, water, air due to heavy use of pesticides. Now, as an alternative to such chemicals, biochemicals are produced through biocontrol agents. By using such pesticides, natural

balance (balance of ecosystem) is maintained. *Bacillus thuringiensis* are effectively used to control pest of cotton and fruit trees. Bacterial toxin is produced in the crops through genetic engineering. The toxin produced by such plants reaches into the gut of sucking insects. Due to its fatal effect, insects and their larvae are killed. There is no harm to other insects, Immunity increases in plants. Cotton which is grown by such method is well known as Bt – Cotton. A biological control being developed for treatment of other plant diseases are some fungus varieties e.g. *Trichoderma.* It is a free – living fungus. It is proved as effective biocontrol agent. Baculo viruses are pathogens that infect insects and some arthropods. By knowing this fact, it is used as a biocontrol agent. It is not harmful to other useful animals. It is used in integrated pest control management (IPM). In vegetables, fruits and cereal crops, diseases are caused by nematodes. Bionemedicides, prepared through viruses, fungi and bacteria, are proved useful drug to control it. The pest Quantum 4000 prepared by *Pseudomonas* sp. is proved effective pest for cereals and vegetable crops. Fungicides weed killer are also prepared by fungi.

Microbes as Biofertilisers

Biofertilisers are developed as alternative to the pollutiong causing chemical fertilizers, and proved effective. Farmers are switching over to organic farming in which biofertilisers are used. Bacteria, fungi and cyanobacteria are useful, microorganisms. *Rhizobium* bacteria live in symbiotic association with nodules of root system of leguminous plants. These bacteria fix atmospheric nitrogen in to organic forms in soil. It becomes nutrient for such plants. Other bacteria like *Azospirillum* and *Azotobacter* also fix atmospheric nitrogen in their free living stage in the soil. Mycorrhiza is formed by symbiotic association between many members of fungus *Glomus* sp. and other plants. Mycrorrhiza absorbs phosphorous from the soil and supply to plants. Hence immunity increases in plants against pest present on roots of plants. Plants can sustain against salinity and drought. *Anabaena, Nostoc, Oscillatoria* like autotrophs are also helpful. In paddy fields, cynobacteria are commonly found biofertilisers. Blue green algae also add organic matter to the soil and increase fertility. A number of biofertilisers are available commercially in the market.

Thus in various areas microorganisms are helpful for human welfare. They shovvs enormous biodiversity. Different strains are useful in different fields. Information about this aspect is essential. We should not kill them through pollution.

Summary

Virus, bacteria, fungi, algae, protozoan are microscopic in size hence known as microbes or microorganisms. They are harmful as well as useful to human being. They are found in all types of habitats. They are exploited in different fields by modern technology. Bacteria and fungi are used in making household products such as curd, dosa and idli, bread, beverages etc. Different types of pharmaceutical products are the result of reactions done by microbes. They produces antibiotics, carbonic acids, alcohol, enzymes, protein, steroids etc. Microbes are important in fuel energy production. Sewage treatment plants and biogas plants are possible due to such of microbes only. Biogas is a mixture of methnane, CO_2, and H_2 gases which are used in fuel energy. Bacteria, fungi, algae, virus are used in biocontrol and biofertilisers in agriculture. We should use such chemicals instead of synthetic artificial chemicals in our life style.

EXERCISE

1. Fill up coloured by pencil in a round circle against a true answers give below :

(1) Microbe which convert milk in to curd is…

(a) Yeast ◯ (b) Protozoan ◯

(c) Bacteria ◯ (d) Virus ◯

(2) In which process Backer's yeast is used ?

(a) To prepare bread ◯ (b) Nitrogen fixation ◯

(c) Production of biogas ◯ (d) Sewage treatment ◯

(3) 'Toddy' Beverage used in south India is of which tree's by-product ?

(a) Coconut ◯ (b) Tad ◯

(c) Tick ◯ (d) Palm ◯

(4) First inventor of penicillin antibiotic was

(a) Louie Pasture ◯ (b) Alexander Fleming ◯

(c) Ernest Chain ◯ (d) Howard Florey ◯

(5) Acid obtained from the fungus *Aspergillus niger* was 18…

(a) Citric acid ◯ (b) Acetic acid ◯

(c) Buteric acid ◯ (d) Lactic acid ◯

(6) By which microbe acetic acid is obtained ?

(a) Lactobacillus ◯ (b) Azotobacter acetatae ◯

(c) Aspergillus niger ◯ (d) Clostridium butyricum ◯

(7) What is riboflavin ?

(a) Enzyme ◯ (b) Antibiotic ◯

(c) Vitamin ◯ (d) Insecticide ◯

(8) A chemical which prevent blood clotting in blood vessels….

(a) Streptokinase ◯ (b) Sterins ◯

(c) Cyclosperin ◯ (d) Insulin ◯

(9) During which process flocs is formed ?

(a) Sewage treatment ◯ (b) Production of Bt-Cotton ◯

(c) Process of biogas ◯ (d) Wine industry ◯

(10) Which is principle component in a food of herbivore ?

(a) Nitrogen matter ◯ (b) Lipid ◯

(c) Salt ◯ (d) cellulose ◯

(11) In which country IARI institute is located ?

(a) China ◯ (b) Brazil ◯

(c) India ◯ (d) Germany ◯

(12) Microbe which produces diseases in insects and arthropods

(a) Lactobacillus ◯ (b) Penicillium ◯

(c) Bacullo virus ◯ (d) Bacillus thuringiensis ◯

(13) To whom control bionemeticides ?

(a) Arthropods ○ (b) Nematodes ○

(c) Insects ○ (d) Pathogen fungus ○

(14) Microorganisms live as a symbiotic association in leguminous plants.

(a) *Rhizobium* ○ (b) Backer's fungus ○

(c) Protozoans ○ (d) Virus ○

(15) Bacteria which prepare biofertiliser in paddy field...

(a) Bacterium Saranac ○ (b) Methanogenic bacteria ○

(c) *Streptoccus* ○ (d) Cynobacteria ○

(16) Oscillatoria is considered as which type of microbe ?

(a) Heterotrophy ○ (b) Autotroph ○

(c) Symbiotic ○ (d) Parasite ○

(17) By which living organism penicillin is produced ?

(a) Fungus ○ (b) Bacteria ○

(c) Virus ○ (d) Algae ○

2. Answer the following questions in short :

(1) Make a list of microbes which are useful in human welfare and write importance of each.

(2) In which fields bacteria are useful to human welfare ? Give a list.

(3) Which microbes are useful in house hold products ? and how ?

(4) Which chemicals are obtained by microorganism in industries ? Give list.

(5) What is sewage treatment plant ? Explain its objective.

(6) Write short note : Biogas, Biofertiliser

(7) What is biological control ? explain it with the help of a example Bt-cotton.

(8) Explain : Antibiotics, sewage, sludge, effluent, BOD, Symbiosis.

(9) Write full name : LAB, BOD, STPS, IARI, KVIC, IPM

3. Write yours answer within one or two lines only :

(1) What is microbes ? Write its example.

(2) Write use of *Lactobacillus* bacteria.

(3) What is baker's yeast ?

(4) How 'Toddy' beverage is prepared ?

(5) Which carbonic acids are prepared by microorganisms ?

(6) Which are nitrifying bacteria ?

(7) For what ? which BOD measure ?

(8) Which gases are present in biogas ?

(9) Which types of pests are present on crops ?

(10) Which type of bacteria are used in Bt-cotton ?

(11) Which fungus provides phosphorous to plants ?

(12) Which scientists were honoured by noble prize in medicine field in 1945 ?