NEWTON'S INN COACHING CENTRE

BIOLOGY NOTES (SET I) Chap No 01 - 07

CHAP NO 01 (Introduction To Biology)

Q. Define biology. Explain its branches.

BIOLOGY

"It is a branch of natural science, which deals with the study of life, living things and related phenomenon."

How to define life

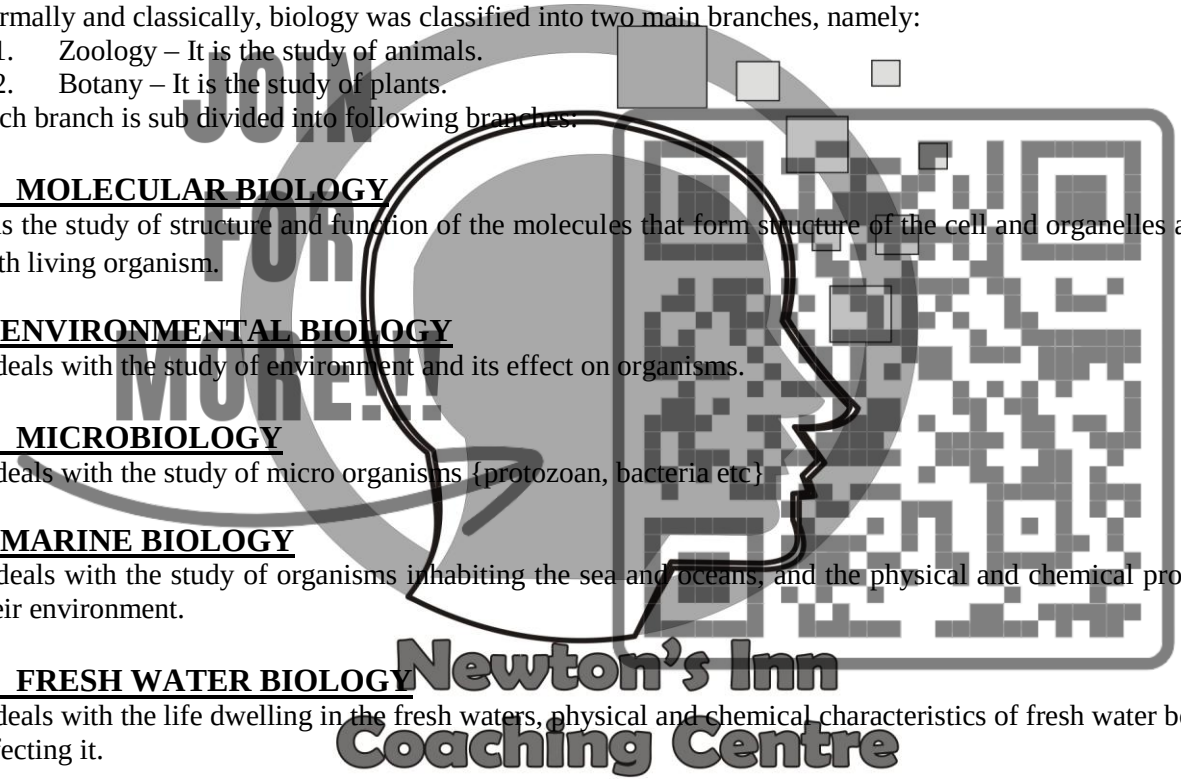
Living things are organized, take materials and energy from the environment, respond to stimuli, reproduce and develop, and adapt to the environment.

BRANCHES OF BIOLOGY

Formally and classically, biology was classified into two main branches, namely:

1. Zoology – It is the study of animals.
2. Botany – It is the study of plants.

Each branch is sub divided into following branches:



1. MOLECULAR BIOLOGY

It is the study of structure and function of the molecules that form structure of the cell and organelles associated with living organism.

2. ENVIRONMENTAL BIOLOGY

It deals with the study of environment and its effect on organisms.

3. MICROBIOLOGY

It deals with the study of micro organisms {protozoan, bacteria etc}

4. MARINE BIOLOGY

It deals with the study of organisms inhabiting the sea and oceans, and the physical and chemical properties of their environment.

5. FRESH WATER BIOLOGY

It deals with the life dwelling in the fresh waters, physical and chemical characteristics of fresh water bodies affecting it.

6. HUMAN BIOLOGY

It deals with the study of all biological aspects of man regarding evolution, anatomy, physiology, health, inheritance etc.

7. GENETICS

It is the study of inheritance of characters through genes and their mode of transmission from parents to off springs.

8. SOCIAL BIOLOGY

It is concerned with the social interactions within a population of a given animal species, especially in human beings focuses on such issues as whether certain behaviour are inherited or culturally induced.

9. BIOTECHNOLOGY

It deals with the data and techniques of engineering and technology for the study and solution of problems concerning living organisms particularly the human beings.

10. PARASITOLOGY
It is the study of different parasites and their effects on their hosts.

11. TAXONOMY
It is the classification, identification naming and grouping of living beings.

Q. What do we mean by modern system of classification?

MODERN SYSTEM OF CLASSIFICATION
Robert Whittaker in 1969 contradicted old concept of "Animals and Plants" and proposed a new system of "Taxonomy". According to this system of classification, Living beings are classified into five Kingdoms, which are explained under:

1. Kingdom Monera
2. Kingdom Protista (Protoctista)
3. Kingdom Mycetes (Fungi)
4. Kingdom Plantae
5. Kingdom Animalia

KINGDOM MONERA
In this kingdom, all living things having "Incipient Nucleus" (Nuclear material is not bounded in a nuclear membrane) are included. They are generally called *Prokaryotes*. Examples are Virus, Bacteria and Blue green Algae.

KINGDOM PROTOCTISTA
These are microscopic a cellular or unicellular *Eukaryotes* (Living beings having complete nucleus). They may be single celled or colonial. Nutrition may be Autotrophic or Holozoic. Examples are Protozoans like Amoeba, Paramecium and single celled Algae like Euglena and Chlamydomonas.

KINGDOM FUNGI
These are unicellular to multicellular Eukaryotic Thalloid, Heterotrophic organisms. Multicellular fungi are filamentous, whole structure of them is called Mycelium made up of Hyphae. Reproduction is generally asexual by means of spores. Examples are Yeast, Moulds and Mushrooms.

KINGDOM PLANTAE
These are Multicellular Eukaryotic Autotrophic (few heterotrophic) living organisms generally having differentiated structures like root, stem and leaves. Examples are all phanerogams and Cryptogams.

KINGDOM ANIMALIA
These are all Eukaryotic, Heterotrophic, multicellular animals (Metazoan) which may be "sessile" or generally "motile". Examples are Man, Monkey, Ant, Star fish.

Q. Describe the levels of biological organization.

The complexity of the living organisms are based upon certain combinations of biochemical elements and the fundamental unit of any element is an element. The Levels of biological organization starts from Atom to the high level organism.

ATOMIC LEVEL
The bodies of all the living organisms are composed of elements and the smallest unit of element is called atom which contains all the properties of atom. These form the basic level of biological organization.

MOLECULAR LEVEL
Atoms combined to form a molecule and these biological molecules forms the organic and inorganic essential compounds of the living organism.
E.g. Proteins and carbohydrates etc.

CELL AND ORGANELLES

Numerous simple and complex molecules arranged in a particular manner to form cells and their organelles. Cell is the fundamental protoplasmic unit of life having DNA which contains all the necessary information which is required for the existence of life.

TISSUE LEVEL

In Multicellular organism cells combine together to form different kinds of tissues which perform various functions of life. E.g. nervous, excretory, connective tissues and in plants xylem and phloem tissues for conduction of water. Etc.

ORGAN AND ORGAN SYSTEM LEVEL:

Various tissues grouped together to form organs and these organs collectively join together to perform a single function called organ system level of body organization. E.g. Heart and different blood vessels collectively form a complete blood vascular system.

ORGANISM LEVEL

When several organ systems work together with complete coordination and cooperation, an individual whole organism is formed.

Q. Describe the broader level of biological organization.

BROADER LEVELS OF ORGANIZATION

Species: A group of very similar potentially interbreeding population.
Population: Members of one species inhabiting the same area.
Community: Two or more populations of different species living and interacting in the same area.
Ecosystem: A Community interaction with its non-living surroundings.
Biosphere: That part of earth inhabited by living organisms.

Q. Describe the emergence of life on earth by the help of geological time period.

TIME PERIODE OF LIFE ORIGINATION: 2.5 Billions years ago approx.

LIFE ORGANIZATION: A cellular as the consequences of gradual modifications in the genetic material new types of living organisms evolved. First living forms are simple a cellular organisms. Researchers from time to time worked curiously and by applying different techniques they come to know from the fossils records about the different group of organisms that arose in different geological times.

Q. Describe the association among living organisms.

The organizations in living organisms are as follows:

Symbiosis: Two organisms live together and at least one or both useful to each other.
Commensalism: Two organisms live together one get benefit other gets no harm no benefit.
Mutualism: Two organisms live together and both are useful to each other if separated both can survive independently.
Parasitism: Two organisms live together one get benefit other gets harm.

Organisms developed from a cellular to multicellular by the process of evolution. This can be studied through fossils which are mostly naturally preserved remains of organisms. By fossils it is confirmed that different groups of fossils have different age and they have developed in different geological periods of time.

Q. Write a note on Hydroponics.

HDROPHONICS:

Definition: "It is the science of growing terrestrial plants in an aerated solution. It is also called soil less or water culture". This technique is used for growing vegetables and other plants. It helps to fulfill the food requirement of people living in particular area. Tomato and other vegetables were experimented in green houses and result obtained satisfactory.

ADVANTAGES:

- It controls the weeds and soil disease problems.
- Area required for cultivation is reduced.
- Crops are successfully grown in the arid parts of the world to meet the food requirement.

Q. Describe phyletic lineage in view of evolution.

Phyletic Lineage:

Phyletic lineage is the common origin of species during the process of evolution. Evolution is the series of gradual changes occurs in living organisms to accommodate themselves in the environment and these changes must be inherited in their off springs. Phyletic lineage is an unbroken series of species, which are arranged in ancestor to descendent arrangement, related with other species, which have evolved from that species immediately, preceded it.

Q. Define cloning. Describe the method and importance of cloning.

CLONING

Definition: It is a method of production of duplicate copies of genetic material; cells or entire multicellular living organism occurs naturally in plants and animals."

Examples: - Some common examples are identical twins, asexual reproduction, regeneration and development of tumors and cancers.

Cloning Method

In this process a fertilized egg nucleus is replaced by the unfertilized egg nucleus and that zygote is then placed in to the womb of the female for complete development. This individual is quite similar to that individual whose nucleus is used. Dolly the sheep was a highly successful clone from a somatic cell, reported back in 1997.

Importance of cloning:

- By this process different kinds of human cells can be replaced such as liver cells, Skin cells, Blood cells etc.
- Defective organs can be replaced by cloned organs.
- This method is used to improve the quality in agriculture and medical sciences.
- Growth hormones, insulin and other substances can be prepared by cloning method.

Q. How can we protect and conserve our environment.

PROTECTION AND CONSERVATION OF THE ENVIRONMENT

Environmental hazards have always been threatened to the mankind. This has been increased due to urbanization and industrialization. Environment is damaged in different ways.

POLLUTION: "This referred to as the unwanted physical or chemical changes occurred in the environment". There are different types of pollution air, land, water, noise pollutions. Green house effect, Acid rain is caused due to pollution. To protect the environment certain effective methods are necessary to apply to reduce the pollution.

DEFORESTATION AND INDUSTRIALIZATION: Cut down the forest and establishing industries also causes disturbance in the biological system of natural environment. Conservation of forests and parks helps to reduce soil erosion and flooding etc.

Q. What do we mean by biological control and disease management?

BIOLOGICAL CONTROL:

Naturally occurring organisms are now used to fight pathogens or pests in most of the countries. This method is called biological control. For example introduction of small fishes in the pond inhibits the production of larvae and pupae of mosquito.

Control of insect pest by free living non pathogenic nematodes and pathogenic nematodes by fungi is another advance approach of biological control and disease management.

In plants crop rotation is very successful in preventing the diseases in which different crops are grown on the same ground and cultivation of same crop is not repeated year after year. Soil fertility can be increased by introducing a crop of leguminous family which has nitrogen bacteria in their root nodules.

Q. Explain biological method in detail.

Like other subjects of science, Biology also has got definite way of investigation for the exploration and discovery of new facts. The scientific way of study and exploration of facts in biology is called Biological Method. Details are as follow:

1. Observation

It is considered as the first step in the finding of facts or hypothesis.

2. Hypothesis

The first logical statement given by scientist about work under study is the hypothesis. It is fairly reliable and simplified version of facts.

a. INDUCTIVE REASONING

After statement scientist uses isolated facts to reach the general idea that explains a phenomenon. Example Robert Hook cell discovery led to further observations and experimentations on plant and animal material.

b. DEDUCTIVE REASONING

Once hypothesis is stated, deductive reasoning involves with if ---then statement. Based on results of accurate experimentation, conclusions are drawn.

3. EXPERIMENT AND OBSERVATION

Hypothesis is then tested experimentally, results are recorded and certain additions or deductions are made accordingly.

4. THEORY

After performing a number of experiments, the results are summarized and if majority of results and observations are in favor, a "theory" is established.

5. LAW

If a theory is tested and always found correct, it is accepted as a rule or law.

Q. Explain application of biology other than cloning and hydroponics.

The biology plays immensely important role for the development and welfare of mankind. It improves the quality of living standard, helps people to promote better health, protection and protection and conservation of environment by Appling the modern techniques in the field of agriculture and medical sciences etc.

Some of the applications of the biology in the medical sciences are as follows.

IMMUNIZATION AND VACCINATION:

Definition: "Immunization is concerned about resistance against diseases which is carried out by vaccination in the world".

Dangerous diseases like Polio, Small pox, hepatitis etc have been controlled and rate of mortality and infection is greatly reduced. Vaccination was first introduced by Edward Jenner in 1795. In this process vaccines are introduced in the body to prevent person from many dangerous diseases. However in many cases protection may not be long life.

ANTIBIOTICS:

Definition: "Antibiotics are chemical substances that prevent the growth or kill the harmful micro-organisms in our body". First antibiotic Penicillin was isolated from a fungus, called penicillium notatum. this great work was done by Fleming, Flory and Chain, they got noble prize. These antibiotics are widely used to control many diseases, such as T.B., Cholera, Leprosy, Anthrax diseases which have been controlled properly in the whole world.

CHEMOTHERAPY:

Definition: "It is a method to control diseases like cancer, AIDS by certain chemicals"

With the advancement of medical sciences, biologists have developed new methods to tackle the problems concerning health. This method has proved to be successful.

RADIOTHERAPY:

Definition: "Use of radioactive rays for the treatment of diseases"

This technique is also useful for the diagnosis of diseases. This process is also destructive to human tissues. When exposed in high doses. However treatments of Cancer and tumors have been successfully introduced by radiotherapy.

INCREASE OF FOOD PRODUCTION:

With the increase of population getting food is the major problem persists in the nature therefore biologists have been constantly engaged to increase the maximum yield of food resources and introduce the latest techniques in agricultural field to produce better quality crops.

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CHAP NO 02 (Biological Molecules)

Q. Define biochemistry. Give its importance.

Biochemistry

Definition: - "It is a branch of biology which deals with the study biochemical compounds and chemical processes in the body of living organisms".

Importance of biochemistry:-

- It helps to get information about structure and formation of biochemical compounds like proteins, carbohydrates etc.
- It explains about abnormal reactions causing disease in our body so these could be treated well by medicines.
- It also explains about the messages transport mechanism in neurons.
- It gives information about the chemical basis of cellular differentiation from fertilized egg to different body organ tissues.
- It explains about the growth of cells
- It explains about the mechanism of memory

Q. Briefly describe the Chemical Composition of Cell.

Introduction:

- The body of all living organisms is composed of cells and a cell contains a living material called Protoplasm.
- It contains enormous biochemical compounds and is responsible for all vital functions of life.
- Protoplasm contain about 70 to 90% water when water evaporates remaining mass is the dry weight of cell.
- The biochemical present in it mainly composed 98% of these six elements C, N_2, P, H_2, O_2 and S.

Q. Name the biological molecules present in living organisms.

Biomolecules can be divided into following groups according to variability in their functions and chemical structures.

- Proteins
- Carbohydrates
- Nucleic acids
- Lipids
- Conjugated molecules

Q. Classify the primary types of organic molecules.

The molecules contain carbon and hydrogen elements necessarily with other elements are called organic molecules. These are formed inside the cell in the following state.

Macromolecules These are huge and highly organized molecules. Ex. DNA, Hemoglobin.

Monomers Macromolecules are composed of large numbers of low molecular weight building blocks or subunits are called monomers. Ex. amino acids.

Polymers These are formed by the combination of more then two monomers. Ex. proteins, lipids etc.

Q. Describe the Biological properties of water.

The biologically important properties of water are as follows:-

Best Solvent: Water is called a universal solvent due to its polar nature and dissolve substances many polar and can also react with non polar substances.

High heat capacity: The specific heat of water is high therefore it is slow to release and absorb heat. This thermal stability plays an important role in biochemical reactions to carried out at fairly constant rate.

High Heat of vaporization: Due to its hydrogen bonding water requires high amount of heat to change in to vapour form. Similarly needs greater amount of energy to freeze. Therefore cellular contents remain stable.

An amphoteric molecule: Water acts as both acid and a base, so it is an amphoteric molecule. Due to this property it acts as the best suitable medium for chemical processes particularly metabolism by maintaining its pH as buffer in the living cell.

Cohesive force in water molecules: There is a force of attraction among the water molecules, it is called cohesive force. It helps in the transportation of substances both outside and inside the cells.

Importance in Metabolism: The water has greater importance for the various metabolic functions because most of them require exclusively the aqueous media.

Water as absorbent for photosynthesis: The water is transparent to light, enabling the specialized photosynthetic organelles, the chloroplast, inside the plant cell to absorb the sunlight for the process of photosynthesis.

Q. Explain the structure and functions of protein in view of amino acids.

Proteins

Proteins are the most important building block of all the living organisms' body. These are large molecules with structural and metabolic functions. Keratin, which makes up hair and nails, and collagen fibers, which support many organs, are examples of structural proteins.

The name protein was suggested by Berzelius in 1838 and the Dutch Chemist G.J. Murlder in 1883 recognized the importance of protein as vital compound. Proteins are complex organic compounds having H, C, O, and N as elements but sometimes they contain P and S also. Due to the presence of N they are called nitrogenous compounds. Egg, meat, fish, pulses are the major source of proteins.

Functions of Proteins:

Some of the important characteristics of proteins are as follows:

Proteins provide many of the structural elements of a cell, and help to bind cells together into tissues.

Some proteins act as contractile elements, to make movement possible; others control the activity of genes, transport needed material across the membrane.

Proteins in the form of antibodies protect animals form disease and, in the form of interferon, attack the viruses which escape form antibodies.

Proteins in the form of some hormones participate in growth and development of living organism.

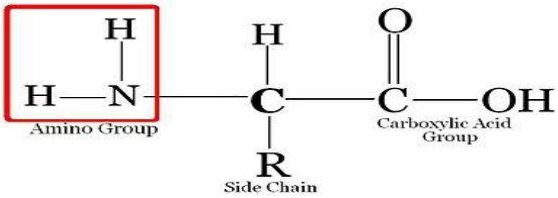
AMINO ACID AS A BUILDING BLOCK OF PROTEIN:

Definition: - "An organic compound containing one or more amino groups ($-NH_2$) and one or more carboxyl groups (-COOH) is known as amino acid".

- The amino acids occur freely in the cytoplasmic matrix.
- The amino acids are derived from the organic acids in which the hydrogen in alpha position is replaced by the amino group. For example the amino acid glycine is formed by the acetic acid and alanine derived from propionic acid.
- Amino acids are linked together by specialized bond or linkage called peptide linkage. Where R is the radical group, it shows the variety of structures.
- The cytoplasm contains about 20 amino acids which are classified in to two groups; hydrophilic amino acids (11) and hydrophobic amino acids (9).

Linkage of Amino Acids:

When two molecules of amino acids are combined then the basic group ($-NH_2$) of one amino acid molecule combines with the carboxylic (-COOH) group of other amino acid and the loss of a water molecule takes place. This condensation of two amino acid molecules by –NH-CO linkage or bond is known as peptide linkage or peptide bond resulting the formation of polypeptide chain formation of protein.



Structure of proteins:

There are four basic level structures of proteins:

1) Primary structure: A polypeptide chain having a linear sequence of amino acid having disulphide (S-S) bond is called primary structure. This structure was discovered by Frederick Sanger and his co-workers at Cambridge University in 1955.

2) Secondary structure: When a polypeptide chain of amino acids become spirally coiled this structure is called Secondary structure of protein. This is a tubular and rigid structure called helix.

3) Tertiary structure: The term Tertiary structure refers to the irregular loops or bends making three dimensional polypeptide structures.

4) Quaternary Structures: it is the association of more than one polypeptide chain into large sized molecules called quaternary structure.

Q. Explain the structure, classification and functions of Carbohydrates.

Carbohydrates

Carbohydrates are the compounds of the carbon, hydrogen and oxygen. They generally represented as $(CH_2O)_n$ and are called hydrate of carbon. Only green parts of plants and certain microbes have the power of synthesizing the carbohydrates form the water and CO_2 in the presence of sunlight and chlorophyll by the process of photosynthesis. Carbohydrates use as a building material and as storage substances in living organisms.

These are classified in to following groups on the basis of monomers.

1. Monosaccharide's (Monomers)
2. Oligosaccharides (Oligomers)
3. Polysaccharides (Polymers)

1. Monosaccharide (Monomers)

These are called simple sugars with the empirical formula $C_n(H_2O)_n$. They are classified and named according to the number of carbon atoms in their molecules as follows.

Class	Formula	Example
Triose	They contain three carbon atoms $C_3 H_6 O_3$	Glyceraldehydes and Dihydroxy acetone
Tetrose	They contain four carbon atoms $C_4 H_8 O_4$	Erythrose, Erythrulose
Pentose	They contain five carbon atoms $C_5H_{10}O_5$	Ribose, Deoxyribose
Hexose	They contain six carbon atoms in their molecules $C_6H_{12}O_6$	Glucose, Fructose etc.
Heptose	They contain seven carbon atoms in their molecules.$C_7H_{14}0_7$	Glucoheptose, Sedoheptulose.

These are found in various fruits and vegetables e.g.

Glucose is a primary source of energy for the cell found in ripe fruits, honey, sugar cane etc. Fructose is also present in fruits and called fruit sugar. Galactose is found in combined state in lactose (milk).

Oligosaccharides

This consists of 2 to 10 monosaccharide in their molecules. These are formed by condensation of monosaccharide. Certain important oligosaccharides are as follows:

- **Disaccharides** contain two monomers e.g. sucrose, lactose, maltose etc.
- **Trisacchrides** contain three monomers e.g. rabinose
- **Tetrasaccharides** contain four monomers e.g. scordose.
- **Pentasacchrides** contain five monomers e.g. verbascose.

Polysaccharides

The polysaccharides are composed of ten to many thousands monosaccharide as the monomers in their molecules. These are of two kinds.

- **Homopolysaccharides** contains similar kinds of monosaccharide in their molecules. E.g. starch, glycogen an cellulose.
- **Heteropolysaccharides** contains different kinds of monosaccharide in their molecules.

Functions of Carbohydrates:

- Carbohydrates are the major source of energy.
- It is also act as storage food in the form of starch in plants and glycogen in animals.
- Cellulose forms the cell wall of the plant cells and provides mechanical support to the cell.

- The hyaluronic acid (Muccopolysacchrides) forms the cementing material of the connective tissues. it occurs in the skin, connective tissues and synovial fluid of the joints.
- The chondroitin sulphate occurs in the cells of the cartilage, skin, cornea, umbilical cord and it serves as a matrix for the bone formation.
- Chitin which is similar to cellulose and serve as a structural polysaccharide for fungi and certain other lower plants and as the exoskeleton of many insects.

Q. Explain the classes of lipid with their characteristics.

Lipids

Bloor in 1943 proposed the term lipid," these are organic compounds which are insoluble in the water but soluble in organic solvent".

- The lipids are non polar and hydrophobic.
- They are the important constituents of the cellular membranes, hormones, and vitamins of the cells.
- They also form the source of energy for the cells.
- The important groups of lipids are as follows.

Acylglycerol (Fats and Oil)

- Generally these are called fats and oils and found in animals and plants.
- These compounds posses double amount of energy then Carbohydrates by having C-H bonds.
- About 16 Kg fats or 144000 k cal energy present in a person of average size.
- Acylglycerol is also called a Triacyglyceride because of three fatty acids linked with one glycerol molecule.

There are two types of Acylglycerol.

Saturated Acylglycerol

- These compounds have no double bond between the carbon atoms.
- These are solid at ordinary temperature.
- These are mostly found in animals

Unsaturated Acylglycerol

- They contain one or more than one double bond between carbon atom.
- They are liquid at ordinary temperature.
- They are found in plants and also called oil. e.g. linolin present in cotton seed.

Waxes

- In waxes, a long chain of fatty acid combines with a long chain of alcohol by ester bonding.
- Being hydrophobic, they are also water proof and resistant to degradation.
- In many plants waxes form a protective cuticle (covering) that retards the loss of water for all exposed parts.
- In animals, waxes are involved in skin and fur maintenance.
- In humans wax is produced by glands in the outer ear canal here its function is to trap dust and dirt particles.

Phospholipids

- These are similar to Tryacylglycerol or an oil except in place of fatty acid is replaced by phosphate group.
- A phosphate group is a polar group that can ionize and therefore is hydrophilic.
- When Phospholipids molecules are placed in water, they form a double layer in which the polar heads face outward and the non polar tails face each other. This property of phospholipids means that they can form an interface or separation between two solutions, such as the interior and exterior of a cell. Therefore helps in cell permeability and transport processes.

Terpenoids

- Terpenoids is a large and important class of lipids.
- They help in oxidation reduction processes as terpens.
- These are found in cell membrane and as plant pigments.

Some important classes of Terpenoids are as follows.

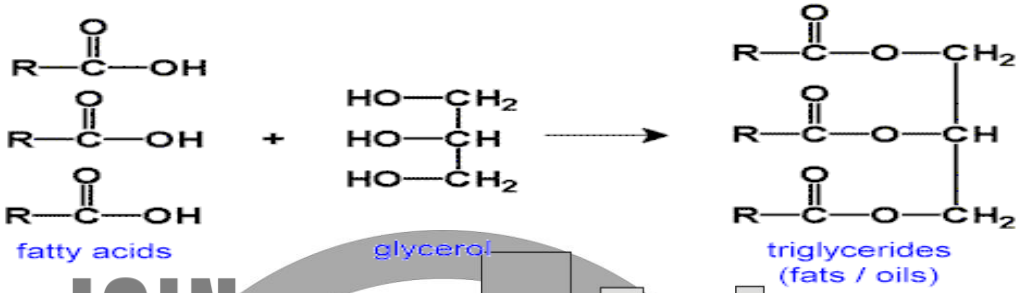
Steroids

- These consist of four fused carbon ring and varies from other steroids primarily by the type of functional groups attached to the rings.
- These fused rings with total of 17 carbon atoms are called steroid nucleus.

- Cholesterol is an important steroid used for the synthesis of other steroids, sex hormones such as testosterone, progesterone and estrogens.

Carotenoids

- The carotenoids are the compound lipids and they form the pigments of the animals and plant cells.
- There are about 70 carotenoids occurring in both types of cells.
- Chemically carotenoids are propyrines which are linked with metals and proteins and forming the important pigments of animals and plant cells such as the chlorophyll and hemoglobin.
- Carotenoids are red, orange, yellow, cream and brown in colours in plants.
- Some important carotenoids are carotene, xanthophylls etc.



Q. Explain the structure and composition of Nucleic acid in view of nucleotide.

Nucleic Acid

- Initially 22 years old a Swedish Friedrich Miescher isolate a nuclear substance and named nuclein, later on it was named nucleic acid.
- These nucleic acids are present in all living organisms in the form of DNA and RNA which often remain combined with nuclear proteins.
- In a typical eukaryotic nucleus thousand times more DNA than a bacterium and a hundred thousand times more than a virus is found.
- Nucleic acids are composed of large numbers of nucleotides like proteins and the arrangements of nucleotides in a chain manner is called polynucleotide or polymer of nucleotide.

Composition of Nucleotide

Definition: "Portion of DNA or RNA molecule composed of one Deoxyribose phosphate unit (in DNA) or one ribose phosphate unit (in RNA) in addition with Purine or a Pyrimidine is called a Nucleotide".

A nucleotide is consists of following three parts.

Pentose sugar
Phosphoric acid
A nitrogen base

Pentose sugar

"Sugar molecules contain five carbon atoms called pentose". These are of two types Ribose ($C_5H_{10}O_5$) or Deoxyribose ($C_5H_{10}O_4$) which serves as a basic skeleton in DNA or RNA.

Phosphoric acid (H_3PO_4)

Phosphoric acid is common in all nucleotides. It is attached with 5^{th} carbon of pentose sugar I each nucleotide.

Nitrogen bases

"The nitrogen containing organic compounds of DNA or RNA are called nitrogenous bases".

There are two basic types of nitrogen bases Purines and Pyrimidine.

Purine includes Adenine and Guanine.

Pyrimidine includes cytosine, thymine and uracil.

Types of nucleotides

Mononucleotide

" Mononucleotide are the molecules used to caries energy and exists singly in the cell". Some of these have extra phosphate group e.g. ATP (adenosine triphosphate).

Dinucleotide

"When two nucleotide are covalently bounded together, these compounds are called dinucleotide". The best example of dinucleotide is Nicotinamide adenine dinucleotide (NAD).

Polynucleotide

Polynucleotides include nucleic acids. These are considered as central dogma of life. These are biological macromolecules serves as repositors of genetic information and precursor to determine the path of growth and development in living organisms and control the synthesis of different biomolecules like proteins etc. Both RNA and DNA are the examples of polynucleotide.

Q. Give a comparison of Starch, Glycogen and Cellulose.

Starch	Glycogen	Cellulose
1. It is the important storage food material of plants. 2. It is found in cereals, legumes, potatoes and other vegetables. 3. It is insoluble in water. 4. It is converted in to simple sugars by hydrolysis and then oxidized to produce energy to be used in metabolism of other Biomolecules.	1. It is also a reserve storage food and commonly known as animal starch. 2. It is found in bacteria, fungi, liver and muscles tissues of animals. 3. It is insoluble in water. 4. It is stored in granular form.	1. Cellulose is a glucose polymer produce in plants. 2. In cellulose glucose molecules are arranged in a linear sequence. 3. It is the main constituent of plant cell wall and most abundant carbohydrate in nature.

Q. Differentiate between RNA and DNA

RNA	DNA
In RNA ribose sugar present.	In DNA Deoxyribose sugar is present.
RNA occur in nucleus, ribosome and in the cytoplasmic matrix.	DNA presents in the nucleus but also occur in the mitochondria plastids and centrioles.
RNA contains Adenine, Guanine, Cytosine and Uracil bases in their nucleotide.	In DNA bases are Adenine, Guanine, Cytosine, and Thymine in their nucleotides.
RNA is of three kinds rRNA, tRNA, and mRNA.	DNA is of just one kind.
RNA work as a Carrier of information in Eukaryotes.	DNA work as hereditary material in Eukaryotes.
RNA is single stranded.	DNA is double stranded helical structure.

Q. Why DNA considered as hereditary material?

The DNA has a key role in all the biosynthetic and hereditary functions of the living organisms. The most important function of the DNA is that it acts as a carrier of genetic information from generation to generation. It is the most stable compound of the biological world which can be considered as immortal.

This can be proved by transformation process in bacteria and infection of bacteria by bacteriophage where it directs the synthesis of more phages. Hershey and Chase thus experimentally confirmed that DNA must be the genetic material.

Q. What are Genes? Explain.

In view of molecular geneticists, a gene is a sequence of DNA nucleotide bases that codes for a product. DNA has specific sequence of nitrogenous bases. These four bases shows enormous combinations in which each of these combinations refer to specific information as we see in protein synthesis where amino acids are represented by different pairs of codons. Thus these combinations representing specific information and are called genes. e.g. a piece

of DNA with 10 nucleotide and exists in over a million different possible sequences of four bases these all are considered as genes which represents specific characters.

Q. Why RNA considered as a Carrier of Information?

RNA is considered as a carrier of information because it receives and transmits the information from the DNA and act accordingly in different biochemical processes.
DNA synthesis RNA which carries information from DNA to the cytoplasm. There are three types of RNA's present in cytoplasm that perform different functions.

Messenger RNA (mRNA): This carries information from DNA to cytoplasmic matrix.

Transfer RNA (tRNA): These are present in the cytoplasm and act according to the instructions coming from DNA through mRNA.

Ribosomal RNA (rRNA): These are present in the ribosome and providing a platform for the attachment of both tRNA and mRNA.

Activities of RNA's can be seen in the process of protein synthesis which is a two step process.

Transcription

In this step DNA synthesis mRNA and transfer the information for the manufacturing of protein in the cytoplasmic matrix.

Translation

In this step information receive in ribosome where rRNA and tRNA work according to the instruction and synthesize the protein.

Q. What are Conjugated Molecules describe their types and functions.

Conjugated Molecules

These are the Biomolecules which are formed by the combination of two different molecules. Following are the types of conjugated molecules.

Glycolipids

"Lipids containing fatty acids carbohydrates and nitrogenous compounds are called Glycolipids". These are important constituent of brain and also called cerebrosides.

Glycoproteins or Mucoids

"When carbohydrates combined with protein molecules these molecules are called Glycoproteins". E.g. egg albumin, gonadotropic hormones etc.

Nucleoproteins

"These are found in the nucleus conjugated with nucleic acid". These are weakly acidic and soluble in water.

Lipoproteins

" Lipids and proteins combined together and form molecules are called Lipoproteins".
These help in the transportation of lipid in the blood plasma.
They also present in cellular organelles.
These occur in the hyaline sheath of nerves, photoreceptive structures, chloroplast and the membranes of bacteria.

Q. Write notes on the following:

ATP (Adenosine Tri Phosphate)

The ATP consists of a Purine base adenine, a pentose sugar ribose and three molecules of the phosphoric acid. in ATP the last phosphate group is linked with ADP by a special bond " because when the last phosphate group of the ATP is released the large amount of energy is released as shown by the following reaction.

NAD (Nicotine Amide Di-nucleotide)

NAD is a Co-enzyme [Coenzymes are the molecules (non-protein) which bind to enzyme (Protein) and serves as a carrier for chemical groups or electrons] that carries electron and work with dehydrogenate enzyme. It removes two hydrogen atom ($2e^- + 2H^+$) from its substrate, both electrons. But only one hydrogen ion is passed to NAD which reduces it to NADH.

NEWTON'S INN COACHING CENTRE

BIOLOGY NOTES (SET II)

CHAP NO 03 (ENZYMES)

Q. Define enzymes and describe their characteristics.

ENZYME

The term enzyme was first used by a scientist named Friedrich Wilhelm Kuhune in 1878 he defined as:
"Enzymes are the organic substances capable of catalyzing specific chemical reactions in the living system".

CHARACTERISTICS OF ENZYME

- These are produced in the cell and act inside or outside the cell as organic biocatalyst.
- Enzymes are large molecules of proteins but may contain non protein molecules.
- They can react with both acidic and alkaline substances.
- They act in a small quantity to bring about change in large amount of substrate.
- Enzymes are specific in their action and react with particular substrate in particular pH.
- Their activities can be accelerated by certain ions like Mg, Ni, and Mn etc. called activators.
- Enzymes are heat sensitive and are called 'Thermo labile'.

Q. What are ribozymes?

RIBOZYMES

During 1980's Thomas Czech and Sidney Altman discovered that certain molecules of ribonucleic acid also function as enzymes. These are called *"ribozymes"* which catalyze reactions involved in processing genetic information to be used by the cell. Generally enzymes are protienecios in nature.

Q. Write a note on energy of Activation.

ENERGY OF ACTIVATION

Definition: "It is the energy required for the formation of chemical complex by the reactants".

Explanation: The enzymes react with the energy rich and energy poor molecules which form an intermediate complex which break into product and enzyme. If activation energy of formation of this complex is low many molecules can react and participate in reaction. In this way activation energy is lowered by the enzyme but in this action equilibrium (ratio of concentration of reactant and product) is remains same.

Q. Describe the theories of enzyme action.

In order to explain the mode of action of enzymes two theories has been given importance which are as follows.

KEY-LOCK THEORY

Fischer (1898) proposed this theory and later improved by Paul filder and D.D. Woods. They said;
"An enzyme act on a particular substrate like particular lock can be unlocked by a particular key".
This theory depends upon physical contact between substrate and enzyme and the groove of specific shape of enzyme is called 'active site'.

INDUCE FIT MODEL

Koshland (1959) proposed this theory and stated that;
"When a substrate combined with an enzyme it induces changes in the enzyme structure and performs its catalytic activity more effectively".

Q. Describe the types of enzymes.

SIMPLE ENZYME: Enzyme contains only protein.

CONJUGATED ENZYME: Enzyme contains another group other then protein. Euler (1932) also named conjugated enzyme as 'Holoenzyme'.

HOLOENZYME: It contains two parts, the protein part called 'apoenzyme' and non protein part called 'prosthetic group'.

TYPES OF HOLOENZYME: On the basis of the nature of prosthetic group, conjugated enzymes or Holoenzyme are of two types;

Co-factors: The Holoenzyme in which prosthetic group is inorganic ion. These inorganic ions are known as Co-factors like Mg, Ca, and K etc.

Co-enzyme: The Holoenzyme in which prosthetic group is an organic ion. These organic prosthetic groups are called Co-enzymes like NAD, NADPH, FMN, ATP etc.

Q. How the concentration of substrate effect enzyme action.

The rate of reaction increases with an increase of amount of substrate until the available enzyme becomes saturated with the substrate. Very high concentration of substrate exerts a retarding effect upon enzyme action and further increase of substrate has no effect on the rate of reaction.

Q. What is the effect of temperature on enzyme activity?

Enzymes are heat sensitive and lost their activity at high temperature and destroyed. The optimum temperature for most of the enzyme is 30 to 37 degree centigrade at 100 degree they destroyed and at 0 degree they become inactive but not destroyed.

Q. What are co-enzymes, activators and inhibitors?

Co-factors have been divided into three categories.

Co-Enzymes: If the co-factor is an organic molecule, it is called co-enzyme without coenzyme certain enzyme are unable to function e.g. NAD, FAD etc.

Activators: Enzyme activity enhance in the presence of inorganic substances which are called activators e.g. Mg, Zn etc.

Inhibitors: Substances which decreases the activity of an enzyme are called inhibitors e.g. DDT and parathion are inhibitors of key enzymes in nervous system.

Q. Write a note on competitive and Non-Competitive inhibitors.

Competitive Inhibitors

These resemble with the substrate molecule and block the active site of enzyme for the entrance of substrate molecule.

Non-Competitive Inhibitors

These bind with the enzyme away from the active site which is called 'allosteric site' this cause the change in enzyme shape and active site hence causing the active site unreceptive to substrate.

Q. What do we mean by Feed-back inhibition?

Feed-back Inhibition

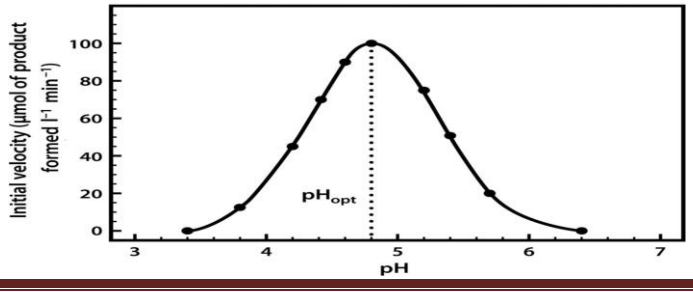
When end product in abundance it attached with the enzyme active site it is called feedback inhibition. This reduces the inhibition and as a result more products is formed but if it is bind with the allosteric site no more product is formed.

Q. Describe the factors affecting enzyme activities.

Following factors affect the enzyme activity:

pH

pH is also a factor in the stability of enzymes. As with activity, for each enzyme there is also a region of pH optimal stability. In addition to temperature and pH there are other factors, such as ionic strength, which can affect the enzymatic reaction.



CONCENTRATION OF SUBSTRATE

The rate of reaction increases with an increase of amount of substrate until the available enzyme becomes saturated with the substrate. Very high concentration of substrate exerts a retarding effect upon enzyme action and further increase of substrate has no effect on the rate of reaction.

WATER

Water is essential for the rate of enzymatic activity. In germinating seeds amount of water increase the activity of enzyme to precede germination.

RADIATION

Enzymes are generally inactivated rapidly by exposure to ultraviolet light and also to Beta, Gamma and X rays.

Co-ENZYMES, ACTIVATORS AND INHIBITORS

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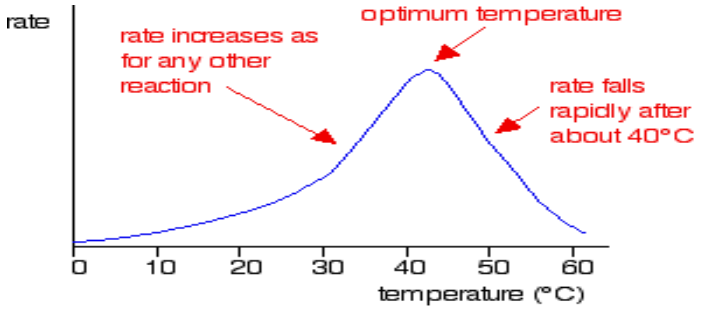
TEMPERATURE

Enzymes are heat sensitive and lost their activity at high temperature and destroyed. The optimum temperature for most of the enzyme is 30 to 37 degree centigrade at 100 degree they destroyed and at 0 degree they become inactive but not destroyed.



CHAP NO 04 (The Cell)

SHORT ANSWERS QUESTIONS

Q. What are the contributions of scientists in the discovery of cell?

CELL

The 'Cell' was first discovered by Robert Hooke (1665) through his research work on the structure of cork. Later Robert Brown (1831) discovered the nucleus in the cell and Schleiden (1838) and Schwann (1839) worked on the cellular organization and proposed a cell theory.

Q. Describe the postulates of cell theory

CELL THEORY

In 1838 Schleiden a German botanist, stated that plants were made of cell. In 1838 another German Zoologist published a report on the cellular basis of animals. Both proposed a cell theory which state that:

- All organisms are composed of one or more cells.
- The cell is the structural unit of life.

Rudolf Virchow (1855) a German pathologist added that:

- Cells can arise only by division of pre-existing cell.

Now cell defined as:

Definition: "Cell is the structural, functional and protoplasmic unit of living organisms or cell is the basic unit of life".

Q. Describe the kinds of microscope.

These are the instruments used to study the cellular organisms. There are different kinds of microscopes which are as follows:

KINDS OF MICROSCOPES

Light Microscope: In which visible light is used as source of illumination.
X-ray Microscope: In which short wave length X-rays are used as source of illumination.
Electron Microscope: In which electron beam is used as source of illumination.
There are two types of electron microscopes:

(a)Transmission Electron Microscope: In this type metal filament or cathode emits the electron beam which pass through the object resulting image is produce on a photographic film.
(b)Scanning Electron Microscope: In this microscope a very fine beam of electrons scans the surface of the specimen, which is coated with thin metal layer. The metal gives off secondary electrons that are collected by a detector to produce an image on a TV screen.

Q. Describe the techniques use to isolate components of cell.

Fractionation: This method is used to determine the chemical composition of cell by breaking the large number of cells in ice cold environment usually in homogenizer.

Centrifugation: It is a method by which molecules and structures of a solution as a result of fractionation are separated according to their shape, size and density, through spinning by a device called centrifuge.

Some other methods are Chromatography, Electrophoresis and Spectrophotometery.

Q. Give a comparison of light and electron microscope.

Light Microscope	Electron Microscope
Advantages: • Cheap to purchase and operate. • Small and portable can be used almost anywhere. • Unaffected by magnetic field. • Preparation of material is relatively quick and simple, requiring only a little expensive. • Material distorted by preparation. • Natural color of the material can be observed. **Disadvantages:** • Magnifies object up to 2000X. • Depth or resolution of field is restricted.	**Disadvantages:** • Expensive to purchase and operate. • Very large and must be operated in special rooms. • Affected by magnetic field. • Preparation of material is lengthy and requires considerable expertise and sometimes. • Preparation of material may distort it. • All images are black and white. **Advantages:** • Magnifies objects over 5, 00,000X. • It is possible to investigate a greater depth of field.

Q. Briefly describe the Magnification, Resolution and contrast.

When handling of microscope three adjustments are important for better view;

Magnification: It means increasing the object view according to the magnifying power of microscope and can be calculated by (Power of eye piece X Power of object).

Resolution: The minimum distance of the object to view clearly is called resolution. The distance plays an important role in the study of object.

Contrast: It is important in identifying one component of cell from another which is usually done by fixing and staining the material.

Q. Difference between prokaryote and eukaryote.

Characteristic	Prokaryotes	Eukaryotes
1. Cell size	Mostly small (1-10µm).	Mostly large (10-100µm).
2. Nucleus	Nucleus not membrane bounded.	Nucleus is membrane bounded.
3. Organelles	Present or not.	Numerous types and differentiated e.g. Mitochondria, Golgi body etc.
4.Tissue formation	Absent.	Present in many groups.
5. Cell division	Fission, budding, no mitosis.	Various means, associated with mitosis.
6. Sexual system	Unidirectional transfer of genes from donor to recipient.	Bidirectional transfer associated with meiosis.
7.Motility organelle	Simple flagella.	Cilia or flagella.
8. Nutrition	Principally absorption.	Absorption, ingestion, photosynthesis.
9. Examples	e.g. blue green algae, Bacteria	e.g. protozoan to metazoans

Q. What are the passive transport methods of plasma membrane?

Passive transport

"Use of a plasma membrane carrier protein to move particles from a region of higher to lower concentration".

Diffusion

It occurs spontaneously few substances freely diffuse across plasma membrane e.g. respiratory gasses.

Osmosis

It maintains a balance between the osmotic pressure of the intracellular fluid and that of interstitial fluid, known as Osmoregulation.

Q. What are the Active transport methods of plasma membrane?

Active transport

"Use of a plasma membrane carrier protein to move particles from a region of lower to higher concentration; it opposes equilibrium and requires energy".

Endocytosis: Plasma membrane participates in the ingestion of food materials by two methods
Phagocytosis: In this process solid particles are ingested by cell.
Pinocytosis: In this process the liquid material is taken in by formation of vesicles inside.
Exocytosis: In this process membrane fusion and the movement of material outside the cell occurred.

Q. Discuss the diseases caused by the abnormal functions of lysosomes.

Over 30 disorders have been reported out of them some are described in the following table.

Tay - Sachs disease represents mental retardation, blindness death by age 3,

Gaucher's disease represents liver and spleen enlargement, erosion of long bones, mental retardation in infantile form only.

Krabbe's disease represents loss of myelin, mental retardation, death by age 2.

Q. Discuss chloroplast as energy converting Organelle.

The chloroplasts are anabolic (biosynthetic) organelles of plant cells and they perform the following functions for the cell.

Role of chloroplast in Photosynthesis: These are energy converting molecules and have an ability to convert solar energy into chemical/ food energy by the process of photosynthesis by the help of chlorophyll and its associated proteins.

Mechanism: During photosynthesis chlorophyll absorb sunlight and transfer its energy in to thylakoid membranes where it is use by ATP and other energy carrier molecules. Later it diffuses by energy carriers at the site called stroma, for synthesis of sugar from carbon dioxide.

Role of chloroplast in Protein synthesis: According to some recent studies DNA of chloroplast codes for chloroplast mRNA, rRNA, tRNA and ribosomal protein for the synthesis of proteins.

DETAILED ANSWERS QUESTIONS

Q. Explain in detail the structure and functions of plasma membrane and Nucleus.

1. PLASMA MEMBRANE

Plasma membrane or Plasma lemma is a living, ultra thin, elastic, and porous, semi permeable membranous covering of the cell. Primarily it provides mechanical support and external form to the protoplasm.

MOLECULAR STRUCTURE OF PLASMA MEMEBRANE

- The plasma membrane composed of two layers of protein molecules and two layers of lipid molecules which is also called phospholipids and interspersed with proteins.
- The phospholipids molecules in the plasma membrane are arranged in the two parallel layers. Their non polar hydrophobic ends face each other whereas their polar hydrophilic ends are associated with carbohydrate and protein etc. It also contains several types of lipids like cholesterol.

FLUID MOSAIC MODEL OF PLASMA MEMBRANE

In 1972 Singer and Nicholson proposed a model of plasma membrane in which the lipid bilayer is retained as the core of the membrane and lipid molecules in a fluid state capable of rotating and moving laterally within the membrane.

The protein associated with lipid bilayer can be divided into two groups.

Integral protein (Intrinsic protein)

These are directly incorporated within the lipid bilayer some of these proteins are believed to provide a channel for water soluble substances.

Peripheral proteins (Extrinsic protein)

These are located entirely outside the lipid bilayer exhibit unloose association with membrane surface.

These proteins are arranged as mosaics within the cell membrane.

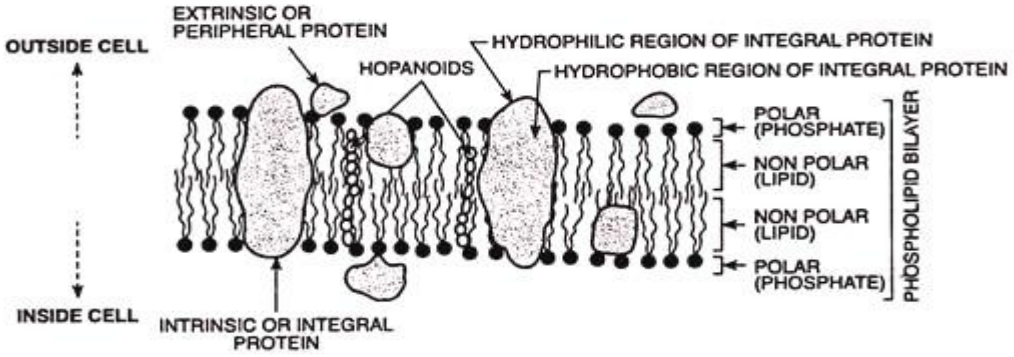


FIG. 5.15. Diagrammatic representation of the fluid mosaic model of plasma membrane.

Functions of Plasma Membrane

Passive transport

"Use of a plasma membrane carrier protein to move particles from a region of higher to lower concentration".

Diffusion

It occurs spontaneously few substances freely diffuse across plasma membrane e.g. respiratory gasses.

Osmosis

It maintains a balance between the osmotic pressure of the intracellular fluid and that of interstitial fluid, known as Osmoregulation.

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2. NUCLEUS

The nucleus is centrally located and spherical cellular component.

Occurrence

The nucleus is found in all the eukaryotic cells of the animal and plant cells. Usually the nucleus remains located in the centre of the cell. Some times its number varies from cell to cell.

Shape & Structure

The nucleus may be spherical, oval, lobed or elongated in shape. Size is variable in various cells between 5 to 25µm. nucleus consists of three structures;

Nuclear membrane

Nucleus is bounded by two membranes of lipoprotein. Nuclear membrane is perforated through which chemical substances passes like proteins, RNA etc.

Nucleoplasm & Chromosomes

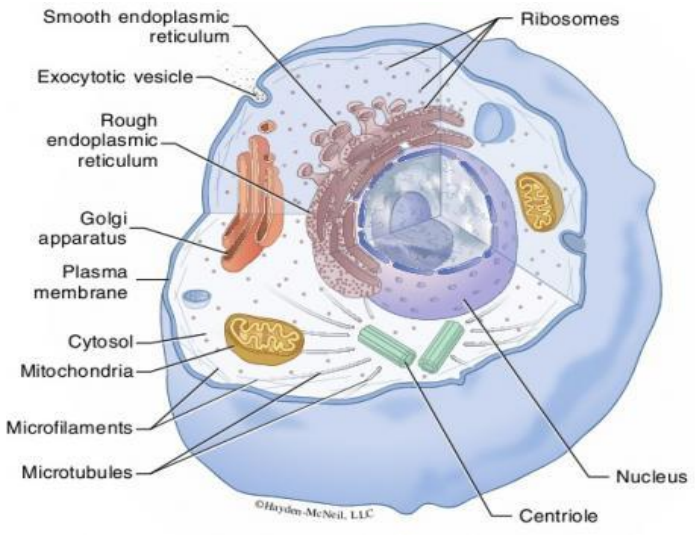
Nucleus is filled by a transparent semisolid granular substance known as Nucleoplasm. It contains many threads like coiled much elongated structures known as chromatin fiber. During cell division these becomes thick and form chromosomes having large molecule of DNA and proteins.

Nucleolus

It is conspicuous spherical body and chemically composed of large amount of ribosomal protein and ribosomal RNA which is essential for protein synthesis and cell division.

Functions of Nucleus

- It regulates growth and reproduction of cell.
- It controls various metabolic activities of cell.
- It contains heredity material DNA where genes are placed and responsible for the characteristics of the whole organism.
- Nucleolus provides the raw materials such as different kinds of rRNA's and ribosomal proteins for biogenesis of ribosome.



3. Cytoplasmic Organelles

Endoplasmic reticulum (ER)

The Cytoplasmic matrix is traversed or crossed by a network of interconnecting tubules and a vesicle which extends from plasma membrane to the nuclear membrane is known as endoplasmic reticulum.

Types of Endoplasmic reticulum (ER)

There are two types of Endoplasmic Reticulum:

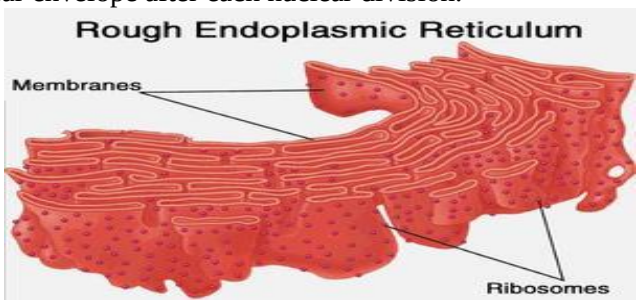
- Granulated or rough Endoplasmic Reticulum
- A granulated or smooth Endoplasmic Reticulum

Occurrence

- Smooth ER is found in steroid producing cells like adipose (fat cells), interstitial glycogen producing cell (liver) and in the muscles cells. Granular ER is heavily coated with ribosome on its outer surface and present mostly in protein synthesizing cells such as mammalian salivary glands and pancreas.
- The membranes of ER is suppose to be originated by in- pushing of plasma membrane in the matrix because chemically it is composed of lipoprotein like plasma membrane the ER is having a single vast interconnectivity which remains bounded by a single membrane.

Functions of ER

- ER transports the necessary material from exterior to the nucleus or to the Cytoplasmic organelles.
- It provides mechanical support to the Cytoplasmic matrix.
- It serves as supporting platform to the ribosome.
- It forms a frame work of cell with increased surface for various metabolic reactions.
- It also helps in detoxification of harmful drugs storage and release of ions.
- It contains various enzymes which perform various synthetic and metabolic activities.
- ER forms the new nuclear envelope after each nuclear division.



MITOCHONDRIA

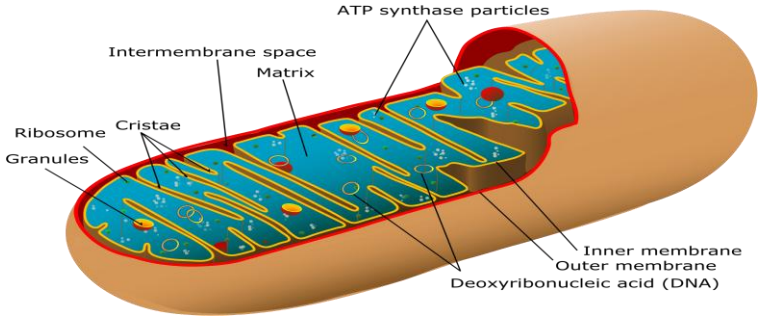
Mitochondria or chondriosomes are membrane bound cytoplasmic organelles universally present in animals and plant cells.

External Morphology

They appear as minute granules, vesicles, rod lets, threads or strings depending upon physiological conditions of the cell. Each mitochondrion is approximately 0.2 to 1.0µm in diameter and about 10µm long.

Internal Morphology

There are two thin membranes which forms the boundaries inside of mitochondrion. Both membranes are made up of lipids and proteins. The inner membrane forms irregular, incomplete partitions called cristae. Interiorly the mitochondrial matrix is having a number of chemical compounds in it while on the cristae enzymes and co-enzymes are located.



FUNCTIONS

- Mitochondria perform most important functions as oxidation, dehydrogenation inside the cell.
- Mitochondria synthesize energy rich compound ATP, they are also known as "power house of the cell".
- Heat production or thermo genesis in mammals which is the 55% of the remaining 45% during oxidation of glucose inside mitochondria.
- Mitochondria also perform biosynthetic or anabolic functions like synthesis of heame for hemoglobin, conversion of cholesterol to steroid hormone in the adrenal cortex.
- Mitochondria have its own DNA by which these are capable to undergo self reproduction by the division.

GOLGI BODIES (Dictyosomes)

This mysterious structure was discovered by an Italian scientist Golgi in 1898. Under Electron microscope, it appears as a cluster of loose sac especially in "Glandular Cells" and size about 0.5µm high and 1-3µm in length. Each organelle consists of central flattened plate like compartments called Cisternae, interconnecting tubules, vesicles and golgian vacuoles.

Cisternae These are sac or cavity filled with fluid contents within a cell and consists of three to seven flat, tubular or filamentous Cisternae in parallel bundles.

Tubules Form the peripheral area of Cisternae arise a complex network of tubules.

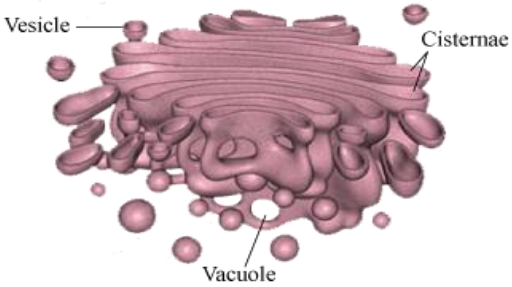
Vesicles These are small droplet like sacs which remain attached to tubules at the periphery of the cisternae. These are of two types.

- **Smooth vesicles:** These contain secretory material and budded off from the ends of cisternal tubules within the net.
- **Coated vesicles**: These are spherical with rough surface.

Golgian Vacuoles: These are large, specious rounded sac like structures occurring at the distal ends of cisternae.

FUNCTIONS

- Processing of secretory and membrane proteins.
- Secretion of polysaccharides.
- Formation of plasma membrane.
- Formation of acrosomes of spermatozoa.



LYSOSOMES

The cytoplasm of animal cells contains many tiny spheroid or irregular-shaped, membrane bounded vesicles known as

lysosomes. These are enzyme filled organelles originated by the Golgi body. These enzymes are kept separated from cytoplasm by means of a membrane called tonoplast. Lysosomes are generally present in animal cells only.

FUNCTIONS

- Their function is the digestion of food material which comes in the cell by Pinocytosis and Phagocytosis.
- The lysosomes of plant cells are membrane bounded storage granules containing hydrolytic digestive enzymes.
- They function as destroyers of foreign particles and worn out cellular components but some times it causes a cell to destroy by itself this process is called autophagy and lysosomes have been referred as suicide sacs

Lysosomal storage diseases

In 1965 W.H. Hers of Belgium explained the importance of lysosomes function in human health he noted that absence of lysosomal enzyme, alpha-glycosidase, could lead to the storage of undigested glycogen accumulate in lysosomes causing swelling of the organelles and irreversible damage to the cell and tissues. Over 30 disorders have been reported out of them some are described in the following table.

Disease	Symptoms
- Tay-sachs disease	- Mental retardation, blindness death by age 3,
- Gaucher's disease	- Liver and spleen enlargement, erosion of long bones, mental retardation in infantile form only.
- Krabbe's disease	- Loss of myelin, mental retardation, death by age 2.

PLASTIDS

- These are cytoplasmic organelles of plant cells and also found in some protozoans like *Euglena*. Plastids are enclosed in double protoplasmic membranes.
- They perform most important biological activities as the synthesis of food and storage of carbohydrates, lipids and proteins.
- They contain DNA and also capable of synthesize protein comparable to that of mitochondria.

Classification of plastids:

- In 1885 A.F.W. Schimper classified the plastids and some of these are as follows.

Chloroplast

- These are most occurring pigments in plants.
- It occurs mostly in green algae and higher plants.
- The chloroplast contains the pigment chlorophyll *a* and *b* and DNA and RNA.
- These are greatly important in manufacturing of food by photosynthesis.

Chloroplast as energy converting Organelles

The chloroplasts are anabolic (biosynthetic) organelles of plant cells and they perform the following functions for the cell.

Role of chloroplast in Photosynthesis: These are energy converting molecules and have an ability to convert solar energy into chemical/ food energy by the process of photosynthesis by the help of chlorophyll and its associated proteins.

Mechanism: During photosynthesis chlorophyll absorb sunlight and transfer its energy in to thylakoid membranes where it is use by ATP and other energy carrier molecules. Later it diffuses by energy carriers at the site called stroma, for synthesis of sugar from carbon dioxide.

Role of chloroplast in Protein synthesis: According to some recent studies DNA of chloroplast codes for chloroplast mRNA, rRNA, tRNA and ribosomal protein for the synthesis of proteins.

Chromoplast

- These are coloured plastids of the plant cells.
- These contain variety of pigments like xanthophylls and carotene.
- These are responsible of various colours in flowers, fruits and other coloured parts except green.

Leucoplast

- The leucoplasts are the colourless plastids which store the food material as carbohydrates lipids and proteins.
- These are develop in the absence of sunlight and are found in the underground part of the plants.

Proplastids

- These are immature colourless plastids occurring in meristemetic tissues of plants.
- They multiply and develop in to chromoplast or chloroplast or leucoplast.

Peroxisomes

- Peroxisomes are another type of oxidative organelles of cells which use molecular oxygen, but produce no ATP molecule.
- These are single membrane bounded micro bodies having enzymes, use to form a toxic molecule hydrogen peroxide (H_2O_2) which is broken down immediately.
- These help in detoxification of alcohol.

Glyoxysomes

- These are single layered micro bodies having a granular stroma.
- Glyoxysomes contain enzymes that metabolize some of the molecules involved in the photosynthetic process and respiration through oxidation of fatty acid.

Cytoskeleton

- " The cytoskeleton is a network of interconnected filaments and tubules that extends from the nucleus to the plasma membrane in eukaryotic cells".
- The cytoskeleton maintains cell shape and causes the cell and its organelles to move.
- The entire cytoskeleton network disappears and reappears at various times in the life of a cell.
- It plays important role in the cell divisions.
- The cytoskeleton contains three types of elements: actin filaments, intermediate filaments and microtubules, which are responsible for cell shape and movement.

Actin filaments/ Microfilaments

- Actin filaments are long, extremely thin fibers (about 7nm in diameter) that occur in bundles or networks.
- The actin filaments contain two chains of globular proteins actin monomers twisted about one another in a helical manner.
- In animals these are present in intestine and help in shorten and extend of microvili.
- In plant cells they form the tracks along which chloroplasts circulates or stream in a particular direction.

Intermediate filaments

These are intermediate in size (8-11nm in diameter) between actin filaments and microtubules.
They are rope like made up of polypeptides
In the skin and hair, these filaments, mechanically support the skin cells by its protein keratin.

Microtubules

These are small hollow cylinders like about 25 nm in diameter and form 0.2-25 μm in length.
Microtubules are made up of globular protein called tubulin.
Microtubules formation is control by centrosomes.
These maintain shape of the cell and acting as tracks along which organelles move.
A single microtubule consists of hundreds of thousands of tubulin subunit arranged in 13 columns are called protofilaments.

Non membrane bound organelles

Ribosomes

- These are small particles composed of rRNA and proteins. These are found in both prokaryotes in Free State and in eukaryotes free or attached with endoplasmic reticulum.
- Ribosomes are composed of two subunits one large and one small these are called Svedberg subunits on the basis of their discoverer Svedberg.
- Ribosomes are regarded as the centre for protein synthesis.

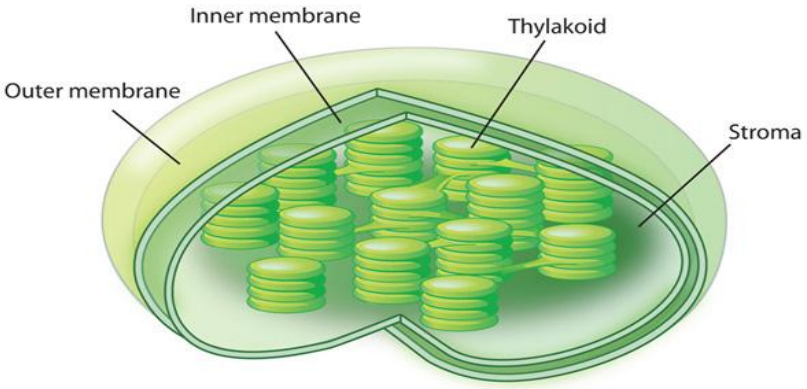
These are manufactured in the nucleolus and transferred to the cytoplasm through nucleopores.

Centrioles

- These are short hollow cylinders with microtubules triplets ring having nine sets of triplets with none in the middle. Each cylinder is of 0.2 micrometer in diameter.
- During cell division the centrioles replicates and moves to opposite side of the cell and thread like fibers begin to radiate from centrioles in all directions called astral rays.

Vacuoles

- A vacuole is a large membranous sac like structure in the cytoplasm surrounded by membrane called **Tonoplast.** Plant cells have large central vacuole then animal cells filled with watery fluid that gives additional support to the cell.
- Vacuoles store substances like sugar and salts in plants.
- They also contain pigments for Colouration in plants and toxic molecules that help protect a plant from predation herbivorous animals.
- In animals vacuoles contain hydrolytic enzymes including proteases, ribonucleases and glycosidases.
- Plant vacuoles contain hydrolytic enzymes which causes lysis of cell after death of the cell.



CHAP NO 05 (Variety of Life)

SHORT ANSWERS QUESTIONS

Q. What do we mean by Biological Classification? What is a character?

Early in human history, it was found useful to know in advance the usefulness and harmfulness of living organisms including plant and animals. These organisms could be sorted out and categorized on the basis of certain specific characters.

Character:

A character can be defined as "Any attribute or descriptive phrase referring to form structure or behavior of a specific organism for a particular purpose."

Ex. Petal length, Corolla Color of flower etc.

Q. Define Homology with examples.

Homology refers to the fundamental similarities of living organism's structure. That might be helpful to correlate them with each other from their common point of origin and controlled by the same genes, For example the flipper of a Whale, the wing of a Bat and arm of man may differ in function but their basic structural pattern is same and these are highly specialized to accommodate themselves in the particular environment.

Q. How Biochemistry help to establish evolutionary relationship among animals?

Other then morphological criteria, other techniques can be used not only in classifying organisms but to establish evolutionary relationship such techniques are Chromatography and Electrophoresis through which we can compare the amino acid sequence in the protein of different organisms or the order of bases in their DNA.

Q. How the fundamental splits take place in the classification of prokaryote and eukaryotes?

Cytology is the bases of classification that help to study the microscopic features of cell. For ex. Bacteria and Cyanobacteria have a unique type of cell structure they are put together in a Kingdom of their own and it is helpful to make a fundamental split in the classification of prokaryote and eukaryotes. Other example is no. of chromosomes in locus and grasshopper etc.

Q. Which taxonomic bases is the final tool for classification?

All the morphological biochemical properties and cytological characters of an individual a species depend upon its genetic constitution. Genetics is the final tool for classifying organisms.

Q. Define Species and the grades of biological classification.

Species: - A species is a group of organisms which have numerous physical features in common and capable of interbreeding and producing viable fertile offspring.

Genera: - Closely related species are grouped together and form genera.

Families: - Different genera grouped together form families.

Order: - Different families grouped together form order.

Classes: - Different order forms class.

Phyla: - Different classes join to from phyla.

Kingdom: - Phylum group together form a Kingdom.

Taxon: - Each grouping of organisms within the taxonomic hierarchy is called taxon.

Q. What do we mean by Nomenclature?

Nomenclature: -

The modern system of naming also derived from the scientist Linnaeus. Some species had a one word name, others had two word names, and still others had names consisting of long descriptive phrases. Linnaeus proposed two word species name first the name of the genus and second a designation for that particular species. This is called Binomial Nomenclature.

Q. Describe the five Kingdoms of classification.

Five kingdom classifications were proposed by Robert Whittaker in 1961.

Kingdom Monera

In this kingdom, all living things having "Incipient Nucleus" (Nuclear material is not bounded in a nuclear membrane) are included. They are generally called *Prokaryotes*. Examples are Virus, Bacteria and Blue green Algae.

Kingdom Protista

These are microscopic acellular or unicellular *Eukaryotes* (Living beings having complete nucleus). They may be single celled or colonial. Nutrition may be Autotrophic or Holozoic. Examples are Protozoans like Amoeba, Paramecium and single celled Algae like Euglena and Chlamydomonas.

Kingdom Mycetes (Fungi)

These are unicellular to multicellular Eukaryotic Thalloid, Heterotrophic organisms. Multicellular fungi are filamentous, whole structure of them is called Mycelium made up of Hyphae. Reproduction is generally asexual by means of spores. Examples are Yeast, Moulds and Mushrooms.

Kingdom Plantae

These are Multicellular Eukaryotic Autotrophic (few heterotrophic) living organisms generally having differentiated structures like root, stem and leaves. Examples are all phanerogams and Cryptogams.

Kingdom Animalia

These are all Eukaryotic, Heterotrophic, multicellular animals (Metazoan) which may be "sessile" or generally "motile". Examples are Man, Monkey, Ant, Star fish.

Q. What are the reasons for making five Kingdom classification?

- Previously organisms were divided into two kingdoms the animal kingdom and plant kingdom but researchers from time to time have been worked on different group of organisms and found that classification cannot fulfill the requirements of the whole living organisms because of following measures concerns.
- The first concerned unicellular flagellates like Euglena and its relatives which were included in Protozoa while these contain chlorophyll and autotrophs or heterotrophs depending upon conditions.
- Another problem with Fungi they lack chlorophyll and feeds heterotrophically by absorption method and their cellular structure differs from plants in several ways.
- Third problem concerns bacteria. Bacteria and Cyanobacteria (formerly blue green algae) have prokaryotic cell structure, so they are similar to each other but different from all eukaryotic organisms. Therefore if living organisms have to be divided into just two kingdoms, probably prokaryote and eukaryotes would be the best.

Q. What are viruses?

Viruses are non cellular smallest organism and probably the most primitive creature on earth. The word virus is a Latin word which means Poison. A Russian scientist "Ivanewsky" discovered it as a living organism and a particle in 1892 A.D. An American biologist "Stanley" isolated "Tobacco Mosaic Virus" from infected leaves in the year 1935 A.D.

Q. Describe some characteristics of viruses.

Virus has dual characters i.e. within host cell it is living, active and replicating but outside the host. It is a dead crystal, completely inactive and may remain so for centuries. Virus never grows and reproduces outside the host cells. Therefore it is an "Obligatory Parasite".

Q. What are the types of viruses?

Virus is a very tiny creature whose structure activities and types can only be studied by means of an "Electron Microscope" with a magnification power more than 0.1 million nanometer. Virus measures about 17-450 millimicrons.

According to the type of host, viruses are of three types namely:

1. Animal virus
2. Plant virus
3. Bacteriophage

Q. Describe the structure of a virus with reference to bacteriophage virus.

- Viruses are of different shapes i.e. spherical, Tetrahedral, Polygonal, Rod shape, polyhedral or Tadpole shaped. Here, structure of a bacteriophage tadpole virus is given as an example.
- Example – Bacteriophage
- Virus is neither animal nor plant therefore it is devoid of cell membrane or cell wall. Externally it is covered with a rigid protein coat called "Capsid". It is broader at one end and narrower at the other. Broader end is called "Head" and narrower end is called "Tail". The inner cavity contains DNA which may consists single or several genomes. The tail is also hollow internally; this cavity is called "Core". Tail is also composed of protein fibrils for movement and Antigenic proteins for attachment with the host.

Q. Differentiate between unenveloped and enveloped Plus-strand RNA Viruses.

Unenveloped Plus-strand RNA Viruses	Enveloped Plus-strand RNA Viruses
• They act directly as mRNA after infecting a host cell, attaching to the host's ribosomes and being translated. • They act directly as mRNA after infecting a host cell, attaching to the host's ribosomes and being translated.	• These all are parasitize animals, are distinguished from the members of the preceding group by their lipid-rich envelops. • These all are parasitize animals, are distinguished from the members of the preceding group by their lipid-rich envelops.

Q. What are Minus-strand RNA Viruses?

They carry RNA strand complementary to the mRNA that carries the genetic information of the appropriate mRNA, which then functions in the cell. Ex. Rhabdo viruses.

Q. Define Viroids.

Viroids are infectious circular molecules of RNA that include from 250 to 400 nucleotides. Viroids lack capsids and have no proteins associated with them.

Q. What is the difference between lytic and lysogenic cycle of phage virus?

Lytic cycle	Lysogenic Cycle
• In lytic phase phage viral DNA takes control of bacterial biochemical activities by attaching itself with bacterial DNA. • Viral DNA along with bacterial DNA produce nucleic acids and proteins required for viral "Replication." • Large numbers of viruses are produced on expense of Bacteria. • Newly formed viruses set free and attack other bacteria for a new cycle.	• Viral DNA combines with the bacterial DNA without harming bacterial DNA. • Viral and bacterial DNA replicates simultaneously. • So a number of generations of bacteria carries viral DNA. • This mutual cycle is called Lysogenic cycle. • Sometimes the "guest" viral DNA reactivates to start Lytic Cycle

Q. How virus causes diseases in plants?

Plant Diseases

Viral infections in plants are the serious threats to the crops. These stunt any plant growth and diminish crop yields.

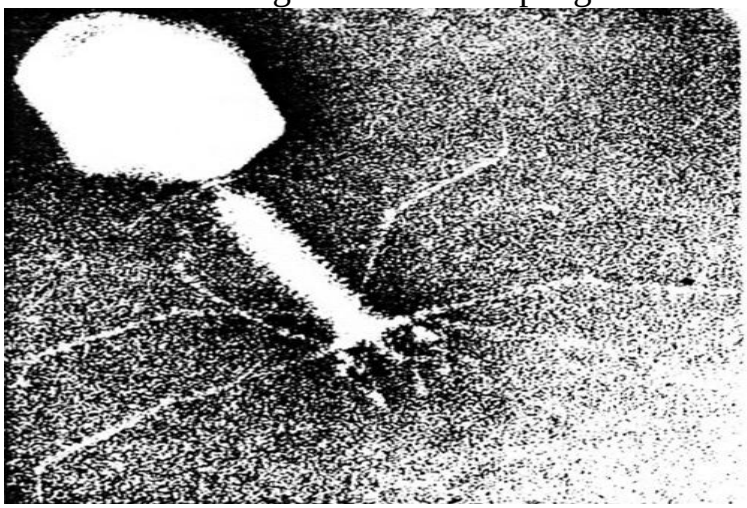
Mode of transmission

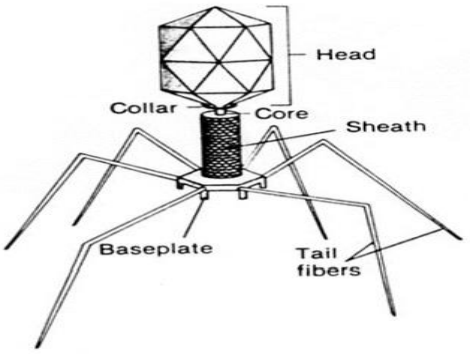
Plants can be infected from any outer source through injured parts or through insects this is called Horizontal transmission. Sometimes plant inherits a viral infection from a parent this is called vertical transmission.

Cure:

Agriculturist have not yet devised cure for most viral infections in plants. They emphasized on breeding genetic varieties of crop plans that are relatively resistant to certain viruses.

Q. Draw a labeled diagram of bacteriophage virus.





Q. Name and their causes of different viral diseases.

Disease name	Caused by
Poliomyelitis	This is caused by Polio Virus and controlled by vaccination.
Colds	This is caused by Rhinoviruses. More then 200 viruses that caused colds have been identified.
Encephalitis, Dengue, yellow fever	These are caused by arboviruses (arthropod born viruses).
AIDS	This is caused by HIV belong to the group Retroviruses. Discovered in 1985.
Rabies	Caused by rhabdovirus
Measles, Mumps	Caused by paramyxovirus.

Q. Write short note on AIDS (Acquired Immune Deficiency Syndrome)?

AIDS (Acquired Immune Deficiency Syndrome)

This is a disorder caused by HIV (Human immuno deficiency virus) in which the body's T4 lymphocyte cells are infected, in that the virus replicates within the T4 cell and let them unaffected to fight invaders inside the body hence body immune system break down and patient exposed to variety of diseases.

Transmission

- HIV can only survive in body fluids and is transmitted by blood or semen. People can contract the disease through:
- It passes from the infected partner to his/her unaffected partner through sexual contact.
- AIDS can be contracted by use of infected injections by means of unsterilized needles and syringes by not only drug users but also to the general public.
- Blood transfusion by already infected with HIV.
- Close contact between infected and non infected people through cuts and open wounds has also been known to pass on the virus.
- By an infected pregnant woman which can pass on the virus to her baby through the placenta at birth or through breast milk during suckling.

Sign and Symptoms

- First sign is a short flu like illness followed by no further effects for months or years.
- Cause of death is commonly a rare type of pneumonia.
- Many patients suffer from skin cancer known as Kaposi's sarcoma.
- Weight loss, fever, dementia, diarrhea, septicemia (blood poisoning and other forms of cancer.
- HIV infects brain cells in more then 50% cases causing dementia and sudden death.
- The brain shrinks, with a loss of memory and mental agility, and behavioral changes occur.

Treatment

- Azidothymidine or Zidovudine was the best known drugs used by 1987 which slows the progression of the disease.
- Ribavarrin found to suppress the AIDS virus under lab condition.
- Sumarin an antiparasitic drug has also shown encouraging results inhibiting viral reproduction in host.
- We should also aware the people about this dangerous disease.
- We should separate the utensils, clothes and etc thing of infected person because it is a transmitted disease.

Q. Define Hepatitis and describe its types.

Hepatitis is an inflammation of the liver. It may be due to viral infections, toxic agents on drugs. It is characterized by jaundice, abdominal pain, liver enlargement fatigue and sometimes fever.

Types of Hepatitis

Hepatitis A: - is transmitted by contact with faces from infected individual it is caused by non enveloped RNA virus.

Hepatitis B: - is caused by unusual DNA virus. It is estimates that people about 200 million around the world are the carriers of hepatitis B this may be transmitted through skin contacts blood transfusion and similar medical procedures.

Hepatitis C: - passes through blood from mother to child during pregnancy and afterwards by sexual contact.

DETAILED ANSWERS QUESTIONS

Q. What are the bases of classification of living organisms?

Living organisms are classified on the bases of homologous, comparative, biochemistry, cytology and genetics.

Homology: It refers to the fundamental similarities of living organism's structure.

For ex. The flipper of a Whale is used for swimming, the wing of a Bat for living and arm of man for grasping. These organs may differ in function but their basic structural pattern is same and these are highly specialized to accommodate themselves in the particular environment Moreover, their same structure might be originated from the common ancestors and controlled by the same genes.

Biochemistry: Other then morphological criteria, other techniques can be used not only in classifying organisms but to establish evolutionary relationship such techniques are Chromatography and Electrophoresis through which we can compare the amino acid sequence in the protein of different organisms or the order of bases in their DNA.

Cytology: Some times we use microscopic features of cell for classification.

For ex. Bacteria and Cyanobacteria have a unique type of cell structure they are put together in a Kingdom of their own and it is helpful to make a fundamental split in the classification of prokaryote and eukaryotes. Other example is no. of chromosomes in locus and grasshopper etc.

Genetics: All the morphological biochemical properties and cytological characters of an individual of a species depend upon its genetic constitution. It is the final tool for classifying organisms.

Q. Describe in detail the classification of viruses.

Generally these are classified on the basis of morphology and nucleic acid they contain which may be DNA or RNA. These groups are as follows.

Unenveloped Plus-strand RNA Viruses (Polio viruses, Rhino viruses):

They act directly as mRNA after infecting a host cell, attaching to the host's ribosomes and being translated. They infect plants and bacteria, causing polio and cold in human beings.

Enveloped Plus-strand RNA Viruses (Hepatitis A and C viruses):

These all are parasitize animals, are distinguished from the members of the preceding group by their lipid-rich envelops. They infect arthropods and vertebrates, causing Leukemia and yellow fever in human beings.

Minus-strand RNA Viruses (Rhabdo viruses and Pox viruses):

They carry RNA strand complementary to the mRNA that carries the genetic information of the appropriate mRNA, which then functions in the cell. Ex. Rhabdo viruses. They infect plants and animal, causing flu, mumps and rabies in human beings

Viroids:

Viroids are infectious circular molecules of RNA that include from 250 to 400 nucleotides. Viroids lack capsids and have no proteins associated with them.

Double strand RNA viruses (Reo viruses) :

The reoviruses, which are double stranded, icosahedral RNA viruses. They cause Colorado tick fever.

Small genome DNA virus (Parvo viruses):

Some of them have single stranded DNA others have double stranded DNA they are icosahedral and about 20 nanometer in diameter. They infect animals causing viral hepatitis and wartz in human beings.

Medium genome and large genome DNA viruses (Herpes viruses):

These are large genome double stranded DNA viruses. They cause herpes shingles, cancers and poxes in human beings.

Bacteriophage:

They are among the most complex viruses. Each of them is made up of at least five separate proteins; a long DNA molecule is coiled within the head.

Retrovirus:

A virus that is replicated in a host cell via the enzymes reverse transcriptase to produce DNA from its RNA genome. They are enveloped virus. Single Strand causes AIDs while Double Strand causes Hepatitis B.

Q. Explain in detail the life cycle of bacteriophage virus.

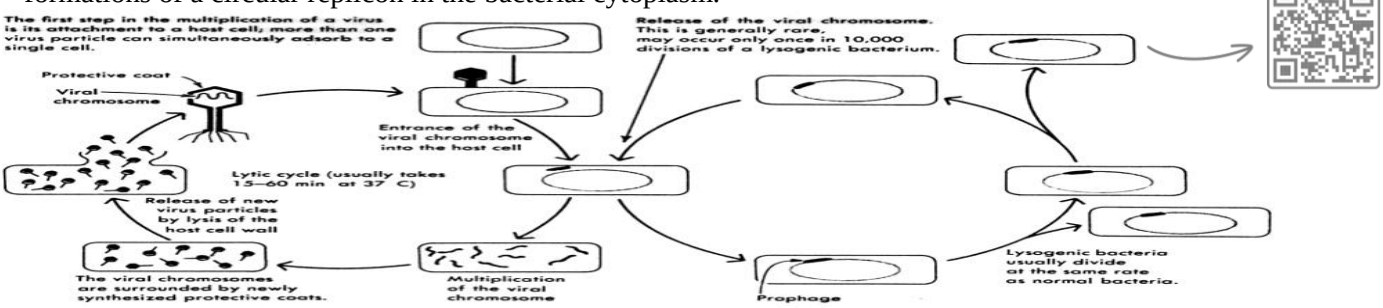
Bacteriophage means "bacteria eater". The name is given due to the fact that these viruses infect bacteria and live as their parasite.

Lytic Cycle

- The lytic cycle is one of the two cycles of viral reproduction, the other being the lysogenic cycle.
- The lytic cycle results in the destruction of the infected cell and its membrane.
- A key difference between the lytic and lysogenic phage cycles is that in the lytic phage, the viral DNA exists as a separate molecule within the bacterial cell, and replicates separately from the host bacterial DNA.
- The location of viral DNA in the lysogenic phage cycle is within the host DNA, therefore in both cases the virus/phage replicates using the host DNA machinery, but in the lytic phage cycle, the phage is a free floating separate molecule to the host DNA.
- Phage virus attaches itself with the bacterial cell wall by means of "tail piece" and secretes enzyme called Lysosomes, it dissolves the bacterial wall through which DNA takes control of Bacterial DNA and its Biochemical activities.
- In this "Master slave" relationship, viral DNA initiates Bacterial enzyme system to produce nucleic acids and proteins required for viral "Replication."
- Therefore a large number of viruses are produced on expense of Bacteria, as a result Bacteria is "Internally eaten" and finally disintegrates, Newly formed viruses set free and attack other bacteria for a new cycle. Such a cycle is called Lytic cycle.

Lysogenic Cycle

- In some instances, viral DNA combines with the bacterial DNA in such a way that instead of "Master slave relationship" a "great host" relationship takes place in which bacterial DNA is not harmed.
- When bacterial DNA replicates, viral DNA also replicates simultaneously.
- So a number of generations can be produced unharmed. This mutual cycle is called Lysogenic cycle.
- Sometimes the "guest" viral DNA reactivates to star Lytic Cycle. Lysogeny, or the lysogenic cycle, is one of two cycles of viral reproduction (the lytic cycle being the other).
- Lysogeny is characterized by integration of the bacteriophage nucleic acid into the host bacterium's genome or formations of a circular replicon in the bacterial cytoplasm.



CHAP NO 06 (Kingdom Prokaryotae)

SHORT ANSWERS QUESTIONS

Q. Briefly describe bacteria.

Introduction

Bacteria or Schizomycophytes were first discovered by Antony Van Leeuwenhoek as the smallest and simplest known living creatures.

Occurrence

Bacteria are omnipresent i.e. they are present everywhere except five. They are able to survive in extremes of environmental conditions i.e. below 0°C and up to 150°C.

Shape and Size

Bacteria are very small, nearly 0.2 to 2 in width and 2 to 10 in length.

Q. Describe the shapes of bacteria.

Bacteria are classified according to their shape as follows;

1. Cocci

These are spherical bacteria and they are non flagellate. If formed solitary (singly) each one is called "Micro coccus". If they are paired then they are called "Strepto cocci" and if they form bunches or clusters they are called "Staphylococci."

2. Bacilli

Oval or Rod shaped Bacteria are called "bacilli". They may be micro, diplo, strepto or staphylo bacilli.

3. Vibro or Coma Shape

These bacteria resemble english comat(,) in their shape. They are always found singly.

4. Spirilla

These bacteria are spring or "Cork screw" shaped and are always solitary.

Q. Describe the composition of bacterial cell wall.

Each bacterium is enveloped in a cell wall as a protoplasmic covering just behind the capsule. It is made up of a complex of sugar with amino acids or sometimes contains "Chitin". Cell wall is thick and rigid. In unfavourable conditions, some of the bacteria enclose themselves in a polysaccharide capsule. Capsule is an additional protective layer around the cell wall and found in some bacteria. It is composed of polysaccharides and proteins.

Q. Describe the role of mesosome in bacteria.

The membrane of bacterial cell is inward to form a special structure, called mesosome. The mesosome takes part in cell division, DNA- replication, and secretions of enzymes, respiration and active transport of enzymes.

Q. What is the composition of bacterial cytoplasm?

It is the fluid ground substance, which fill the inner space of cell. Cytoplasm appears granular containing "Ribosomes". However endoplasmic reticulum, mitochondria and Golgi body are absent. Few small vacuoles are found scattered in the cytoplasm. They contain Glycogen particles as reserved food. Genetic material or DNA is found in the centre of cell as concentrated mass or strands called "Chromatin bodies."

Q. What structures help bacteria in movement and reproduction?

Some of the bacteria are provided with cytoplasmic fibrous structures called "flagella," these are meant for locomotion. Pilli are fine, hollow, filament like structures. These are not used in locomotion, but help in conjugation process of reproduction.

Q. What are the modes of nutrition in bacteria?

According to the mode of nutrition, bacteria are of two types:

1. Autotrophic Bacteria

a) Photosynthetic Bacteria contain chlorophyll and prepare their own food.

b) Chemosynthetic Bacteria use enzymes to catalyze food from different compounds.

2. Heterotrophic Bacteria

a) Saprophytic Bacteria obtain food from dead organic material by decomposing their complex compounds

b) Parasitic Bacteria obtain food by harming other organisms.

c) Symbiotic Bacteria live in association with another living being taking benefit from him and providing the same in return

Q. Describe the types of locomotion in bacteria.

Usually bacteria moves by flagellary and rotatory movement. According to the movement the bacteria are of different types, such as

Phototactic Bacteria: These bacteria move towards or away from light.
Chemotactic Bacteria: These bacteria move towards or away due to the presence of chemical.
Magnetotactic Bacteria: These bacteria are able /to detect magnetic fields of earth.

Q. What are the modes of asexual reproduction in bacteria?

A Sexual Reproduction in bacteria takes place by following methods.

(a) Fission

In fission bacteria first replicates their DNA and then the cytoplasm divides by means of a middle constriction. It is the simplest and less time consuming method.

(b) Endospore Formation

In unfavorable circumstances cytoplasm along with DNA shrinks and accumulates at one side within the cell of bacteria. Later a cyst is formed around cytoplasmic mass called "Endospore." On return of favorable condition cyst breaks and cytoplasm activates and enlarges to form new bacteria.

Q. Describe the sexual reproduction in bacteria.

It is not true sexual reproduction but exchange of DNA or genetic recombination between bacteria. It can take place by means of following methods:

(a) Conjugation

"Transfer of DNA from one to another bacterium through a tube (conjugation tube) is called "onjugation."

(b) Transduction

"Transduction is the process of recombination in which genetic material or DNA of one bacterium is transferred to another bacterium through a bacteriophage virus".

This type of DNA recombination was discovered by Joshua Lederberg and Zinder in 1952.

(c) Transformation

"Bacteria can transform (i.e. undergo genetic change) by receiving genetic information from some other bacteria and acquire his characters."

A British Nobel Prize winner bacteriologist "Fred Griffith" discovered the phenomena of transformation of Genetic charters in bacteria.

Q. How bacteria become useful in Agriculture?

Bacteria living in the nodules over roots of Pea, Beans and other legumes convert atmospheric nitrogen into nitrate and Nitrite fertilizer, similarly other soil bacteria (generally called decomposes) convert dead plants and animal bodies into simpler compounds. Both above-mentioned bacteria increase soil fertility. Bacteria change nitrogen into its compounds like NO_2 and NO_3, this process is called nitrogen fixation these compounds become part of plants food.

Q. What function bacteria perform in alimentary canal?

Certain Symbiotic bacteria live in the alimentary canal of herbivorous where they produce live in the alimentary canal of herbivorous where they produce Cellulase enzyme required for the hydrolysis of cellulose into glucose.

Q. How bacteria are used in the Industries?

Bacteria perform different functions in different industries such as conversion of milk into curd and curd into cheese, ripening of tobacco leaves, tea fermentation, tanning of skins into leather etc.

Q. Which diseases are caused by pathogenic bacteria?

A large number of diseases are caused by bacteria such as Furuncles, Sore throat, Bronchitis, Pneumonia, Tuberculosis, Cholera and Typhoid etc. certain plant diseases are also caused by bacteria such as fine blight of apple and pear, back rot of cabbage, wild fine of tobacco.

Q. How can we control the spread of infectious bacteria?

The different methods to control the infectious micro-organisms are as follows:

- Infected persons should be treated properly by effective medicines.

- Persons in a population should be treated by immunization and vaccination.
- In epidemic condition the infected persons should be kept in quarantine to avoid the spread of infection to healthy persons.
- At different possible stages the life cycle of pathogen should be disrupted, so it can not cause further infection.
- The host bodies of pathogen should be identified and treated well to control the diseases.
- By different ways knowledge and awareness about diseases and infection of pathogen should be provided to the public.
- Many methods should be provided to the public to kill pathogens like;
  High temperature treatment
  By ultraviolet rays
  By the use of antibiotics
  By chemotherapy

Q. What do we mean by Immunization and Vaccination? Explain.

The resistance against the infection by the pathogenic organisms is called immunity. It can be developed by different ways. One method to develop immunization is vaccination and active immunization. Vaccination is used to control many diseases. A vaccine is either used orally e.g. Polio or taken into the body by syringe e.g. Tetanus vaccine. The procedure of vaccination is very effective and beneficial for human being because it helps to control many dangerous diseases such as measles, diphtheria. When large proportion of population is immune, then the disease spreads poorly throughout the population.

Q. Describe the uses and misuses of antibiotics.

Antibiotics are the chemical substances which are used to kill microorganisms that cause infectious diseases. These are produced by certain microorganisms and prevent the activity of other microorganisms.

Use of Antibiotics:

- Antibiotics are used against one or many types of bacteria.
- These attack cell wall, plasma membrane, nuclear material and protein synthesis in bacteria.
- Antibiotics are also used in agriculture to kill different organisms.
- These are also used in animal's feed to provide growth promoting substances.

Misuse of Antibiotics:

- By the extensive use of antibiotics more resistance is developed in pathogenic microorganisms, after that they cause more serious infection in the body.
- Antibiotics have many side-effects. Other organs of the body may be damaged.
- Antibiotics may react with human metabolism and in severe cases death of person may occur.
- Some antibiotics cause allergy in the body, such as Penicillin.

Q. Classify bacteria on the basis of respiration.

According to the respiration there are two types of bacteria.

Aerobes: These bacteria need oxygen for respiration.

Anaerobes: These bacteria do not need O_2 for respiration. These are of different types.

Obligate anaerobes: some bacteria killed in the presence of O_2. These are called obligate anaerobes.

Facultative anaerobes: the bacteria which use O_2 but also can respire without it, they are called facultative anaerobes.

Facultative bacteria: These bacteria respire with oxygen or without it.

Microaerophilic bacteria: These bacteria require little amount of oxygen for their growth.

Q. Describe the stages or phases of growth.

In bacteria there are four phases of growth:

LAG phase: This is inactive phase of bacteria. In this stage bacteria prepare themselves for growth. The cells accumulate essential substances such as water and proteins.

LOG phase: The logarithmic phase is the period in which bacteria grow very rapidly their metabolic activities are maximum.

Stationary phase: After an active growth the bacteria face shortage of food, pH changes and energy is less, so they try to maintain themselves. They also start dying as a result of which their multiplication is equal to their death rate. The number of cells is almost unchanged, so it is called stationary phase.

Death phase: when conditions are totally unfavourable, death occurs rapidly than growing cells when death rate is faster than multiplication rate, it is called death phase.

The factors which affect the bacterial growth are:

(1) Temperature (2) Available nutrients (3) Ionic concentration

Q. Write a note on Nostoc (cyano bacteria/blue green algae).

- Nostoc is a prokaryotic Thallophyte belonging to the kingdom Monera.
- Nostoc is fresh water algae commonly found in ponds, lakes, ditches and pools.
- Sometimes it also grows in damp soil.
- Nostoc is a unicellular plant, a number of cells join to form beaded long filaments.
- Each filament is few inches up to few feet long.
- A large number of filaments entangle in a gelatinous mass to form colony.
- Its cytoplasm is differentiated into two regions; the outer Chromoplast contains pigments like Chlorophyll, Xanthophylls, Phycocyanin etc. and the inner called Centroplasm.
- It is colourless and contains fragments of DNA while true or complete membrane bounded nucleus is absent.
- In each filament there are some larger colourless cells called *heterocyst* are present.
- These cells convert atmospheric nitrogen into proteins and also serve to store food and multiplication.

Q. Describe the asexual methods of reproduction in Nostoc.

Different methods of asexual reproductions are as follows

(a) Hormogonia

The main filament breaks off from the Joints of Heterocyst and form smaller fragments of filament each fragment is called Hormogonium. Hormogonium grows in length by means of mitosis and form new filaments.

(b) Akinete

In unfavourable conditions, some of the Nostoc cells become larger and thick walled and contain reserved food. These cells are called *Akinetes* with outer exospore and inner endospore layer. On return of favourable conditions, exospore bursts and endospore germinates to give rise to new filament.

DETAILED ANSWERS QUESTIONS

Q. Explain the structure of bacteria in detail.

Structurally, bacteria are almost similar. A typical bacillus is given as an example.

Capsule

It is an additional protective layer around the cell wall and found in some bacteria. It is composed of polysaccharides and proteins.

Mesosomes:

The membrane of bacterial cell is inward to form a special structure, called mesosome. The mesosome takes part in cell division, DNA- replication, and secretion of enzymes, respiration and active transport of enzymes.

Cell Wall

Each bacterium posses a cell wall as an outer covering. It is made up of a complex of sugar with amino acids or sometimes contains "Chitin". Cell wall is thick and rigid. In unfavourable conditions, some of the bacteria enclose themselves in a polysaccharide capsule.

Cell Membrane

It is also called "Plasma Membrane," it surrounds the cytoplasm. It is made up of lipo-protein; a complex of lipid and proteins. Cell membrane is "Osmo-regulatory" and porous. It also performs respiration.

Cytoplasm

It is the fluid ground substance, which fill the inner space of cell. Cytoplasm appears granular containing "Ribosomes". However endoplasmic reticulum, mitochondria and Golgi body are absent. Few small vacuoles are found scattered in the cytoplasm. They contain Glycogen particles as reserved food.

Incipient Nucleus

Being Prokaryote, Bacteria are devoid of membrane bounded complete nucleus. They lack nucleolus and Nuclear membrane. Genetic material or DNA is found in the centre of cell as concentrated mass or strands called "Chromatin bodies." Such type of incomplete nucleus is called "Incipient Nucleus."

Flagella

Some of the bacteria are provided with cytoplasmic fibrous structures called "flagella," these are meant for locomotion.

Pilli

These are fine, hollow, filament like structures. These are not used in locomotion, but help in conjugation process of reproduction.

Q . Explain the nutrition in bacteria in detail.

According to the mode of nutrition, bacteria are of two types.

1. Autotrophic Bacteria
2. Heterotrophic Bacteria

1. Autotrophic Bacteria

Bacteria capable to produce their own food material are regarded as Autotrophic Bacteria. They are of two types:

(a) Photosynthetic Bacteria

These bacteria contain Bacterio chlorophyll and chlorobium-chlorophyll and with the help of these pigments produce glucose and Glycogen by means of photosynthesis.

(b) Chemosynthetic Bacteria

These bacteria contain different type of enzymes, which oxidize certain food components or compounds anaerobically to obtain energy. The degraded products are recycled and resynthesized into food.

2. Heterotrophic Bacteria

Heterotrophic bacteria are of following three types:

(a) Saprophytic Bacteria

These bacteria obtain food from dead organic material by decomposing their complex compounds like proteins, fats and carbohydrates into simpler compounds like H_2O, CO_2, NH_3 and Nitrates.

(b) Parasitic Bacteria

These bacteria live on living hosts i.e. animals or plants and obtain their nutrition from them and ultimately harm them by producing serious diseases. Parasitic bacteria may be obligate or facultative parasites.

(c) Symbiotic Bacteria

These are the Bacteria and live in association with another living being taking benefit from him and providing the same in return. Examples are Rhizobium radiciols which live in nodules over roots of leguminous plants taking shelter and food from these plants and produce and provide fertilizer in the form of Nitrates.

Q3. Explain the reproduction in bacteria in detail.

Bacteria reproduce by two methods:

1. A sexual Reproduction
2. Sexual Reproduction

1. A Sexual Reproduction

It is of two main types which are explained below:

(a) Fission

It is the usual method of reproduction. Bacteria first replicate their DNA and then the cytoplasm splits into two halves by means of a middle constriction. It is the simplest and less time consuming method.

(b) Endospore Formation

It is the method of survival in unaffordable circumstances rather than reproduction. In this method, cytoplasm along with DNA shrinks and accumulates at one side within the cell of Rod Shape bacteria. Later on a hard impervious "Cyst" is formed around cytoplasmic mass, the rounded confined encysted mass is called "Endospore." On return of favourable condition cyst breaks and cytoplasm activates and enlarges to form new bacteria. Endospore can survive for months without any harm to bacteria.

2. Sexual Reproduction

It is not true sexual reproduction but exchange of DNA or genetic recombination between bacteria. It can take place by means of following methods:

(a) Conjugation

"Transfer of DNA from one to another bacterium through a tube (conjugation tube) is called Conjugation."

(b) Transduction

"Transduction is the process of recombination in which genetic material or DNA of one bacterium is transferred to another bacterium through a bacteriophage virus.

This type of DNA recombination was discovered by **Joshua Lederberg and Zinder** in 1952.

(c) Transformation

A British Nobel prize winner bacteriologist **"Fred Griffith"** discovered the phenomena of transformation of Genetic charters in bacteria. According to him:

"Bacteria can transform (i.e. undergo genetic change) by receiving genetic information from some other bacteria and acquire his characters."

Q4. Describe the detailed Economic Importance of bacteria.

Different type of bacteria not only causes diseases but some of the bacteria are also economically important for us. Some useful and harmful bacteria are as follows:

(a) Useful Bacteria

(i) Agricultural Bacteria

Bacteria living in the nodules over roots of Pea, Beans and other legumes convert atmospheric nitrogen into nitrate and Nitrite fertilizer, similarly other soil bacteria (generally called decomposes) convert dead plants and animal bodies into simpler compounds. Both above-mentioned bacteria increase soil fertility.

(ii) Medicinal Bacteria

Certain antibiotic drugs are also obtained from Bacteria.

(iii) Amino Acid and Protein Manufacturing Bacteria

Some important proteins and amino acids are also obtained from bacteria.

(iv) Symbiotic Bacteria of Alimentary Canal

Certain Symbiotic bacteria live in the alimentary canal of herbivorous where they produce live in the alimentary canal of herbivorous where they produce Cellulase enzyme required for the hydrolysis of cellulose into glucose.

(v) Industrial Bacteria

Bacteria perform different functions in different industries such as conversion of milk into curd and curd into cheese, ripening of tobacco leaves, tea fermentation, tanning of skins into leather etc.

(vi) Nitrogen fixing Bacteria:

Bacteria change nitrogen into its compounds like NO_2 and NO_3 , this process is called nitrogen fixation.

(b) Harmful Bacteria

(i) Spoilage of Food

Every day a large quantity of food stuff like vegetables, fruits, meat, milk are spoiled by ferments released by bacteria.

(ii) Pathogenic Bacteria

A large number of diseases are caused by bacteria such as Furuncles, Sore throat, Bronchitis, Pneumonia, Tuberculosis, Cholera and Typhoid etc. certain plant diseases are also caused by bacteria such as fine blight of apple and pear, back rot of cabbage, wild fine of tobacco.

Q5. Explain in detail the structure and reproduction of cyano bacteria (Nostoc/blue green algae).

Nostoc

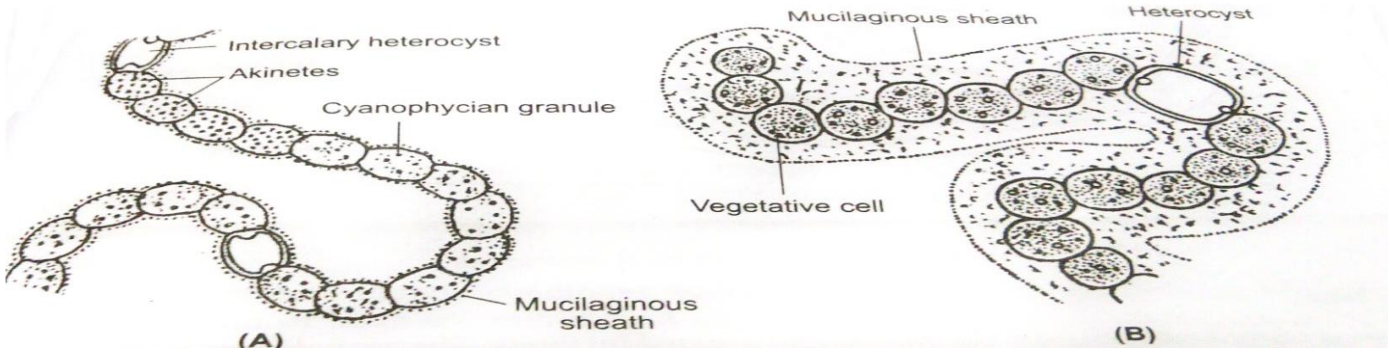
"It is a prokaryotic Thallophyte belonging to the kingdom Monera."

Occurrence

Nostoc is fresh water algae commonly found in ponds, lakes, ditches and pools. Sometimes it also grows in damp soil.

Structure

- Nostoc is a unicellular plant, a number of cells join to form long filaments.
- Each filament is few inches upto few feet long.
- A large number of filaments entangle in a gelatinous mass to form colony.
- Each filament is beaded in appearance and is always unbranched.
- It is surrounded by a layer of Gelatin, which prevent filament from the rotting action of water.



Structure of a Single Cell

- Each cell is rounded in shape with a double cell wall; the outer thicker gelatin coated wall is made up of cellulose and Pectin whereas inner layer is composed of cellulose only.
- Cell membrane is absent.
- Cytoplasm is differentiated into two parts, the outer cytoplasm contains pigments like Chlorophyll, Xanthophyll, Phycocyanin etc mixed in the cytoplasm and not contained in membrane bounded Plastids.
- This outer coloured cytoplasm is called Chromoplasm.
- The inner cytoplasm is called *Centroplasm*. It is colourless and contains fragments of DNA.
- True or complete membrane bounded nucleus is absent; instead of it incipient nucleus is present composed of fragments of DNA.
- There is no membrane bounded organelle in cytoplasm.

Heterocyst

In each filament there are some larger colourless cells called *heterocyst* are present. These cells convert atmospheric nitrogen into proteins and also serve to store food and multiplication.

Nutrition

Nostoc contains chlorophyll therefore it is capable to manufacture its own food material by means of Photosynthesis. Heterocyst also perform nitrogen fixation for filaments.

Reproduction

Like other blue green algae, Nostoc also reproduces asexually. Different methods of asexual reproductions are as follows.

(a) Hormogonia

The junctions of normal cells in filaments with Heterocyst are weak, therefore filaments often break at these points forming smaller fragments of filament, and each fragment is called Hormogonium. Hormogonium grows in length by means of mitosis and form new filaments.

(b) Akinete

In unfavourable conditions, some of the Nostoc cells become larger and thick walled containing reserved food. These cells are called *Akinetes*. Each Akinete is surrounded by a thick layer, the outer wall is called Exospore and the inner wall is called Endospore. On return of favourable conditions, exospore bursts and endospore germinates to give rise to new filament.

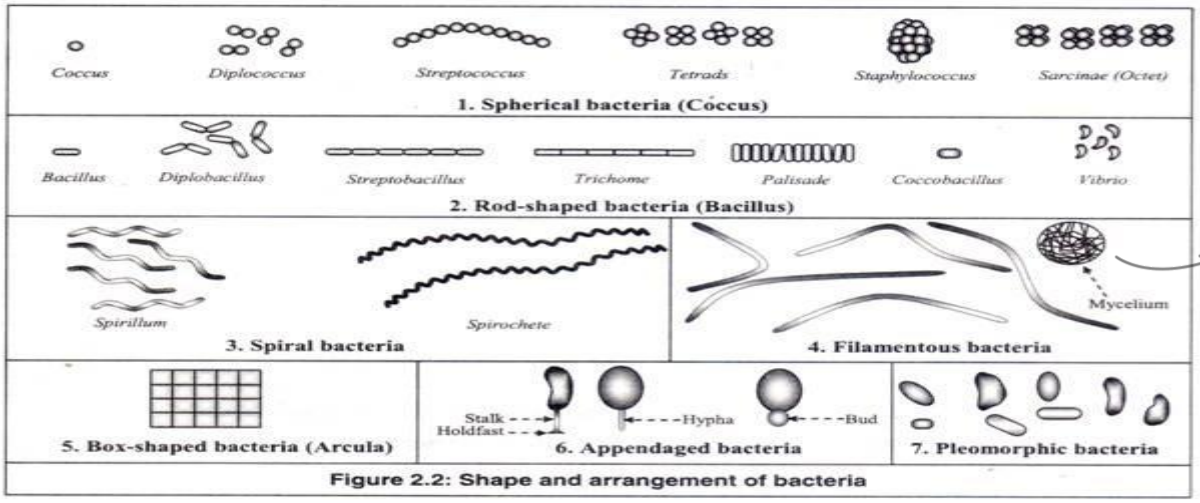


Figure 2.2: Shape and arrangement of bacteria

CHAP NO 07 (Kingdom Protoctista)

SHORT ANSWERS QUESTIONS

Q. Briefly describe the Kingdom Protoctista.

- This kingdom contains eukaryotes that are having true nucleus.
- This includes two groups, the algae and protozoan.
- Algae are found in the ocean, fresh water and on land.
- These are of different types, like brown algae, red algae etc. and important part of the producers in the ecosystem.
- Protozoans are generally heterotrophic unicellular organisms and are a part of zooplanktons in the oceans and fresh water.
- This kingdom also includes oomycota or oomycetes which are now regarded as ancestors of fungi.
- The water molds and slime molds both resemble to the fungi however their life cycle set them apart from fungi.
- Water molds are well known for parasitizing both aquatic and terrestrial forms.

Q. Write a note on chlorella.

Introduction

- It is fresh water algae found in reservoirs of stagnant water like ponds, pools, ditches etc.
- It has vast economic importance as an alternate source of food according to the recent investigations and as an experimentation organism.
- It is of great economic importance as recently an antibiotic called chlorellin useful for the control of bacterial diseases has been prepared from the plant.

Structure

- The body is unicellular, spherical and solitary.
- It contains a single nucleus and a cup shaped chloroplast usually without a pyrenoid.

Reproduction

- Reproduction is generally performed by aplanospores.
- This involves the division of protoplast into 8-16 daughter protoplasts.
- Each daughter protoplast secretes a wall to produce a nonmotile aplanospore.
- On release from the parent cell each aplanospore forms a new vegetative cell.
- Zoospores and gametes are unknown.

Q. Describe the structure of ulva.

Ulva is a multicellular, Eukaryotic thalloid algae commonly known as *Sea-Lettuce*. Each thallus is a blade like wrinkled structure almost 20 to 30 cm in length. The lower part of thallus remains attached with rocks by means of "Hold Fast" having elongated cells. Thallus is composed of two layers of cells i.e. outer epidermal layer of cells containing chlorophyll and an inner layer of cells i.e. Medulla serving as storage tissue.

Q. How does the asexual reproduction takes place in Ulva?

It takes place by means of quadriflagellate zoospores produced by asexual diploid (2n) plant called *Sporophyte*. Zoospores are produced in all cells of plant by means of Meiosis. Usually each cell produces 8 – 16 zoospores. Each zoospore on germination gives rise to a new haploid (n) plant.

Q. How does the asexual reproduction takes place in Ulva?

In ulva the haploid plants are developed called Gametophyte. They are morphologically similar to Sporophyte except their number of chromosomes. They produce two isomorphic gametophytes regarded as negative and positive strains. Both gametophytes produce haploid gametes; these gametes are smaller than the zoospores and biflagellate. Similar looking negative and positive gametes or isogametes fuse to form a quadriflagellate zygote i.e. isogamy takes place. The zygote after rest and repeated divisions gives rise to a new diploid sporophytic plant.

Q. How alternation in generation takes place in ulva?

Sporophyte

In Ulva Sporophyte bears diploid number of chromosomes which is 26. This plant develop spores by means of Meiosis, Each spore has haploid (n) or 13 chromosomes. On germination spores give rise to gametophyte plants which are similar to Sporophyte in morphology but differ in the number of chromosomes.

Gametophyte

Gametophyte produces isogametes which fuse to form zygote having Diploid (26) chromosomes. Zygote gives rise to zoospores which germinate to form Diploid Sporophyte and thus whole cycle is repeated. In Ulva, Sporophyte and Gametophytes are of the same morphology therefore, life cycle is called *Isomorphic alternation of Generation*.

DETAILED ANSWERS QUESTIONS

Q. Explain in detail the structure and reproduction in ulva.

Introduction

- It is a multicellular, Eukaryotic thalloid algae commonly known as *Sea-Lettuce*.
- Ulva is a marine algae which grows attached to rocks in intertidal pools.
- It is a thallophytic algae which cannot be differentiated into root, stem or leaf.
- Being an algae, it is autotrophic in nature.

Structure

- Each thallus is a blade like wrinkled structure almost 20 to 30 cm in length.
- The lower part of thallus remains attached with rocks by means of "Hold Fast" having elongated cells.
- Thallus is composed of two layers of cells i.e. outer epidermal layer of cells containing chlorophyll and an inner layer of cells i.e. Medulla serving as storage tissue.

Reproduction (life cycle):

It is of two types namely:

* A sexual Reproduction
* Sexual reproduction

(a) A Sexual Reproduction

It takes place by means of quadriflagellate zoospores produced by asexual diploid (2n) plant called *Sporophyte*. Zoospores are produced in all cells of plant by means of Meiosis. Usually each cell produces 8 – 16 zoospores. Each zoospore on germination gives rise to a new haploid (n) plant.

(b) Sexual Reproduction

The haploid plants of ulva called *Gametophytes*. Two similar looking gametophytes are produces. They are also morphologically similar to Sporophyte except their number of chromosomes. Two Isomorphic gametophytes are regarded as negative and positive strains.Both gametophytes produce haploid gametes; these gametes are smaller than the zoospores and biflagellate. Similar looking negative and positive gametes or isogametes fuse to form a quadriflagellate zygote i.e. isogamy takes place. The zygote after rest and repeated divisions gives rise to a new diploid sporophytic plant.

Alternation in Generation

"The phenomenon in which a plant completes its life cycle in two phases i.e. haploid gametophyte and diploid sporophyte which come in an alternate manner is called alternation of Generation."

Explanation

In Ulva Sporophyte bears 2n i.e. Diploid Chromosomes which are 26. This plant reproduces by means of spores produced by means of Meiosis, Each spore bears haploid (n) or 13 chromosomes. On germination spores give rise to Gametophyte plants which are similar to Sporophyte in morphology but differ in the number of chromosomes. Gametophytes produces isogametes which fuse to form zygote having Diploid (26) chromosomes. Zygote gives rise to zoospores which germinate to form Diploid Sporophyte and thus whole cycle is repeated.

In Ulva, Sporophyte and Gametophytes are of the same morphology therefore, life cycle is called *Isomorphic alternation of Generation*.

Q. Explain Phylum Protozoa with its classes and example of each.

General characteristics of Phylum Protozoa

Habitat

Protozoa are generally found in aquatic environment and live in fresh and marine water. During unfavorable conditions protozoa form cyst that can be dried and transferred from one habitat to another.

Body organization:

Small, usually microscopic organisms simplest and most primitive animals with protoplasmic grade of body organization. Body unicellular containing one or more nuclei which are monomorphic or dimorphic.

Body symmetry

Body symmetry may be bilateral, radially, none or spherical.

Body covering

Body bounded by pellicle or cell membrane some times exoskeleton is also found in the form of shell.

Locomotory organelles

Locomotor organelles if present are finger like pseudopodia or whip like flagella or hair like cilia or absent.

Respiration

Respiration occur through general body surface.

Excretion

Excretion through the general body surface but in forms through a temporary opening in the ectoplasm or through a permanent pore called cytopyge.

Reproduction

Reproduction commonly occurs by sexual or asexual means.

Note: -All the physiological activities are performed by a single cell.

FUNGI LIKE PROTOCTISTS

There are some organisms which are fungi like and included in this kingdom Protoctista. These are non chlorophyllus. There are about 30,000 species of Protozoa are recorded and this phylum is divided in to five classes on the basis of locomotory organelles.

Class Flagellata (Mstigophora)
Class Sarcodina (Rhizopoda)
Class Ciliata (Ciliophora)
Class Suctoria
Class Sporozoa

Class Flagellata (Mstigophora)

These organisms are commonly called flagellates.

Habitat

Organelles of locomotion in adults are flagella which are minimum 1 or maximum 8 in numbers.

Body covering

Body is covered by pellicle.

Reproduction

They reproduce asexually by fission.

Mode of life

They are mostly free living while some are parasites

Autotrophs

Many members of this class have photosynthetic pigment chloroplast.

Phylogeny

These are considered as the ancestors of different groups of plants and animals.

Examples

Trypanosoma, Euglena, Chlamydomonas, Trichomonas (six flagella) etc.

Class Sarcodina (Rhizopoda)

Habitat

They are usually found in fresh water reservoir

Exoskeleton

Marine sarcodinians have shell as exoskeleton and their deposition in the sea make layers called "Radiolarian Ooze or Globigerina Ooze".

Symmetry

These protozoans are asymmetrical.

Body covering

Their have thin elastic cell membrane with projecting finger like irregular locomotory structures called Pseudopodia, Lobopodia, Filopodia, Axopodia or Reticulopodia.

Mode of life

These organisms are free living or parasites.

Nutrition

They obtain food by the process of Phagocytosis in which they engulf food particles.

Example:

Amoeba, Entamoeba, Actinophyrus

Class Ciliata (Ciliophora)

Body covering

All organisms of this class posses ectoplasmic outgrowths cilia on their pellicle (cell membrane) for locomotion.

Cilia

The cilia are thousands in number.

Nucleus

These organisms have micro and mega nucleus.

Reproduction

They reproduce sexually by fission and asexually by conjugation.

Nutrition

Nutrition is heterotrophic they usually have a cytostome or gullet for ingestion of food.

Examples:

Paramecium, Opalina, Balantidium.

Class Suctoria

Body covering

These organisms are closely related to ciliates in young ones having cilia on their cell membrane.

Nucleus

Suctorians also have one micro and one macro nucleus and numerous short cilia.

Attachment

These organisms are stalked and sessile.

Tentacles

With distal end bearing few to many toxic material secreting tentacles which are used to paralyze their prey.

Ciliatur

Adults do not have any ciliature.

Reproduction

Reproduction is asexual by budding.

Example

Acineta, Nyctotherus, Haltaria, Ephelota etc.

Class Sporozoa

Mode of life

Most of these Protozoans are intracellular parasites and incapable of active life outside their hosts.

Locomotion

The adults have no external organelles of locomotion. Cilia or flagella may be present in their gametes.

Fertilization

Fertilization of male and female gametes takes place after which many spores are formed.

Sporozoites

The spores are simple and contain one to many sporozoites which are the infective stage of parasite.

Example

Plasmodium, Monocystis etc.

Q. Explain in detail the Life cycle of plasmodium in Man and Mosquito with labeled diagram.

Geographical Distribution.

Malarial parasites are found in all countries extending from 40^0S to 60^0N. The tropical zone is endemic home for all malarial parasites.

Habitat.

Plasmodium is a digenic endoparasite protozoan passes its life cycle in to two different hosts.

Primary host: A Man in which it passes its immature asexual infective stages.

Secondary host: A Female mosquito in which it passes its mature sexual reproductive stages.

Life cycle in man

The malarial parasite asexual cycle in man is comprises of following stages.

Pre-erythrocytic phase:

- It starts when a female anopheles mosquito bite a healthy man in order to suck the blood then also transmit plasmodium infective spindle shaped sporozoites which are present in the salivary glands of mosquito.
- These sporozoites then enters in to liver parenchyma cells of man passes their developmental stages and turned in to cryptozoites some of them reside in to the liver cells while some enters in to blood RBC and called metacryptozoites.

Erythrocytic phase:

- Each metacryptozoite modified in to trophozoite in RBC.
- As it grows in size a central vacuole developed and the nucleus is pushed to one side this stage is called signet ring stage.
- The trophozoite ingest the haemoglobin protein and turned into amoeboid trophozoite.
- After this stage it becomes a rounded shizont inside that it undergoes further division called schizogony and produces merozoites.

Post-Erythrocytic phase:

- Some merozoites produced in erythrocytic phase reach the liver cells and undergo schizonic development while some remains inside the RBC and turned in sexual forms this is known as post erythrocytic phase.

Gamogony:

- In RBC merozoites becomes gamocytes; the male microgamocytes and female macrogamocytes these forms does not divide and remain in the blood until the mosquito bites and taken up along with blood.

Life cycle in Mosquito

Sexual life cycle of plasmodium is completed in the gut of female Anopheles mosquito which comprises of the following stages.

Gametogony:

- In this stage the gametocytes soon becomes gametes.
- A single male gamocyte forms 6-8 sperms like flagellated motile microgametes and female turned into a single non motile macrogamete.

Syngamy:

- The newly developed gametes of the opposite sexes fused together to form a zygote this process is called syngamy.
- The zygote becomes worm like Ookinete.
- It penetrates the stomach wall to settle down just under the midgut here after absorbing the nutrients it becomes rounded and encyst to form oocyst.

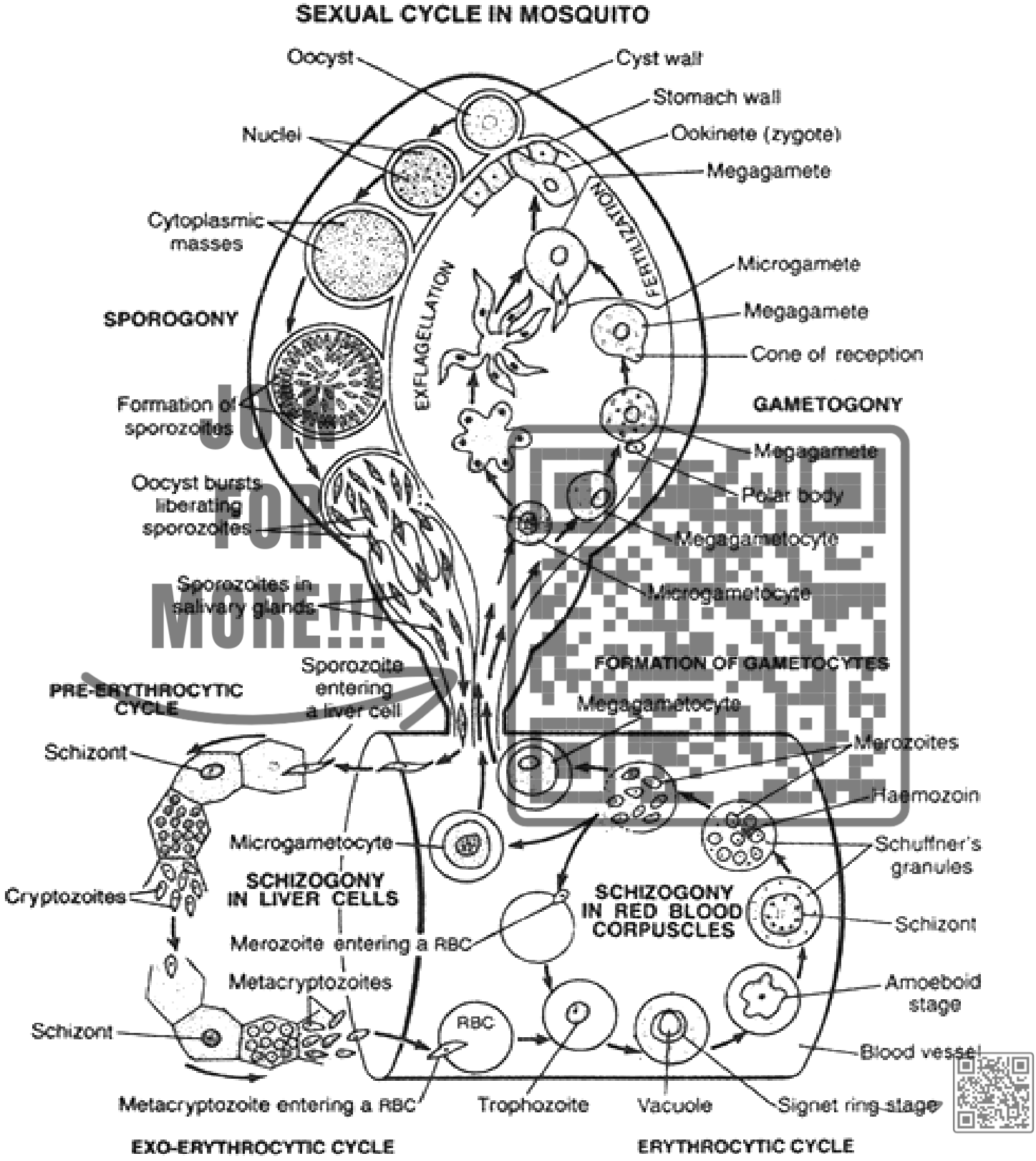
Sporogony:

- In 6-7 days the nucleus of the oocyst divides and forms numerous slender sporozoites by the process of sporogony.
- The cyst burst and the liberated sporozoites migrate towards the salivary glands where they await transfer to a human host.

Symptoms of Malaria:

- The first symptom of malaria appears after few days of infection in man.
- The symptoms are nausea, loss of appetite, constipation and insomnia soon headache, muscular pains, aches in the joints.

- The malarial patient feels fever suffers from shaking chill and sweating the body temperature may rise as high as 106 ^{0}F.



Life cycle of *Plasmodium vivax*

Water molds (Oomycotes):

- Water molds are always found in wet environments, especially in fresh water sources and near the upper layers of moist soil.
- Officially named Oomycota, they are also known as downy mildews and white rusts.
- Water molds were long considered fungi because they produce fungi-like filamentous hyphae and feed on decaying tissue like rotting logs and mulch.

Historical Background:

- The Oomycota species *Phytophthora infestans* caused the Great Potato Famine that killed nearly a million people in Ireland in 1846–1847.
- The water mold virtually wiped out the country's potato crops, which were an essential staple in the Irish diet (sometimes the only food on the table.)
- In addition to widespread starvation and malnutrition, the potato blight led more than 1.5 million Irish to flee the country.
- Because nearly all of the country's potato crops were clones of a few original imports from South America, they had no natural ability to resist the pathogen.

Economic Importance of Phytophthora Infestans:

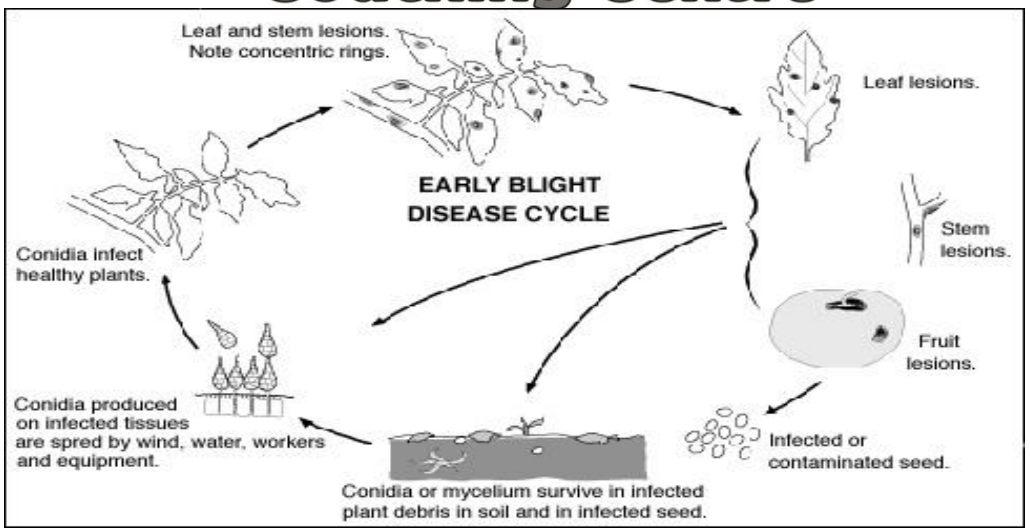
- Another water mold nearly wiped out the entire French wine industry.
- *Plasmopara viticol* (also known as downy mildew of grapes) was brought to Europe in the late 1870s on vines from America meant to be bred with French vines in hopes of yielding hybrids with a greater ability to ward off attacks by aphids.
- The infestation led to the use of the first fungicide, a mixture of copper sulfate and lime, which became known as the Bordeaux mixture for its role in saving the French vines.
- Other water mold species can cause disease in fish.
- The most important species phytophthora infestans causes the late blight of potato.

Reproduction

- The reproduction in water molds takes place by means of asexual and sexual methods.
- Asexual reproduction takes place by means of biflagellate zoospores produced inside the sporangia.
- Sexual reproduction is oogamous. The female sex organ is oogonium and the male organ is antheridium.

Structure of Mycelium

- The mycelium consist of Hyphae having a cell wall made up of cellulose which are endophytic, branched, aseptate, coenocytic, hyaline and nodulated.
- The rounded or branched haustoria are found which absorb food material from the host cells.



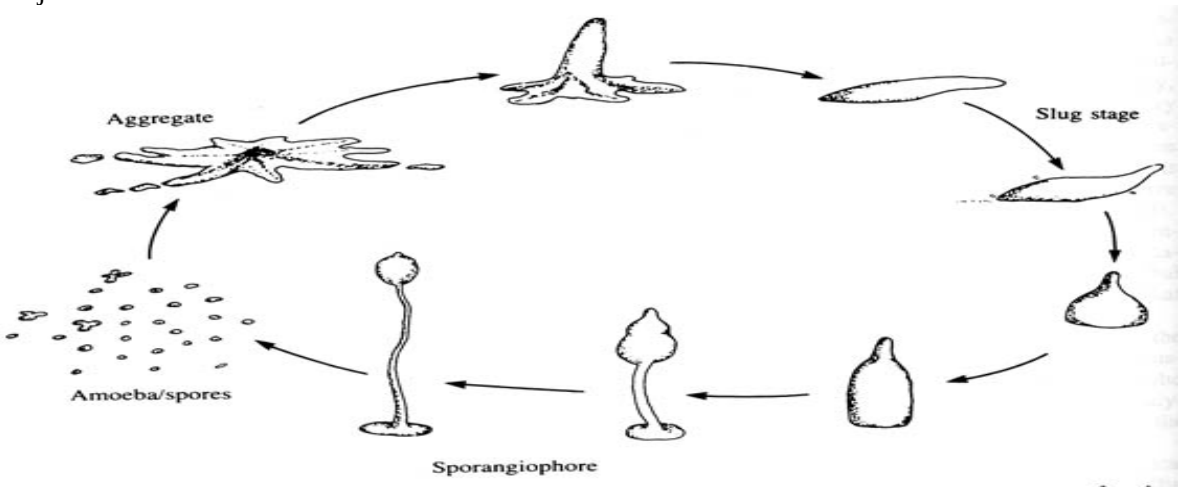
Slime Mold (Gymnomycota)

- **Slime mold** or **slime mould** is an informal name given to several kinds of unrelated eukaryotic organisms that can live freely as single cells, but aggregate together to form multicellular reproductive structures.
- Slime molds were formerly classified as fungi but are no longer considered part of that kingdom.
- Although not related to one another, they are still sometimes grouped for convenience within the paraphyletic group referred to as kingdom Protista.
- More than 500 species of slime mold occur all over the world.
- Their common name refers to part of some of these organisms' life cycles where they can appear as gelatinous "slime".
- Most slime molds are smaller than a few centimeters, but some species may reach sizes of up to several square meters and masses of up to 30 grams.
- Many slime molds, mainly the "cellular" slime molds, do not spend most of their time in this state.
- As long as food is abundant, these slime molds exist as single-celled organisms.
- When food is in short supply, many of these single-celled organisms will congregate and start moving as a single body.
- In this state they are sensitive to airborne chemicals and can detect food sources.
- They can readily change the shape and function of parts and may form stalks that produce fruiting bodies, releasing countless spores, light enough to be carried on the wind or hitch a ride on passing animals.
- They feed on microorganisms that live in any type of dead plant material.
- They contribute to the decomposition of dead vegetation, and feed on bacteria, yeasts, and fungi.
- For this reason, slime molds are usually found in soil, lawns, and on the forest floor, commonly on deciduous logs.
- However, in tropical areas they are also common on inflorescences, fruits and in aerial situations (e.g., in the canopy of trees).
- In urban areas, they are found on mulch or even in the leaf mold in gutters, and also grow in air conditioners, especially when the drain is blocked.

Life Cycle of Slime Mold

- They begin their life from spore germination and multiplication.
- The basic units of slime moulds are haploid amoebae, usually prowling around on the forest floor consuming bacteria.
- Once the supply of food is exhausted, individual amoebae begin to move together. They form streams of cells called pseudoplasmodium moving slowly at about one millimeter/hour. It is now known that the process is initiated with the cAMP signaling molecules released by the starving amoebae.
- Eventually the streams come together and form an aggregation which is at the spot with high concentration of cAMP. The mass can number a hundred thousand cells and might reach a size of a few millimeters.
- Then they stick together by secreting adhesion molecules and creating a slime sheath (cap) which covers all the cells in the mass. The polarity defined by the anterior (front), posterior (back) ends is established by oxygen gradient. The responsible gene for adhesion can be identified by blocking its expression. The resulting mass becomes a loose rubble that is incapable of further development.
- The mass of cells now begins to behave as one, gliding around on the ground as if it were a miniature garden slug leaving a track of slime behind (and hence the name, Figure). The movement of the slug is guided by the higher concentration of cAMP at the anterior region of the cap.
- The migration continues toward higher concentration of ammonia (giving off by decaying organism), which means food for them.
- The slug stops at a favourable spot. The anterio cells become a stalk while the posterior cells climb up and form a spherical head, the sorocarp, which develops into spores. The pattern in this fruiting body is based on a constant ratio of cells in the stalk and in the sorocarp (about 3/4). The cells have now been differentiated into a non-reproductive stalk and spores carrying the next generation. The stalk would soon wither away once its mission (of spore dispersal) has been accomplished. It is found that some strain of slime moulds manage to stay behind in the posterior area of the slug and thus become spores all the time; only their genes get copied into the next generation.
- Finally, on germination of a spore, a pore appears in the cellulose coat through which the amoeba is liberated to begin a new cycle. This life cycle is asexual; there is no fusion of male and female sex cells (gametes).

They exist entirely in haploid state. The slime moulds also run a sexual life cycle which is very different from the one just described.



Chapter 8 THE KINGDOM FUNGI

Question and Answers

Q. Briefly describe the Kingdom fungi.

- The Kingdom Fungi includes fungi which are the most important organisms, both in terms of their ecological and economic roles.
- These are non chlorophyllus eukaryotic may be unicellular (e.g., yeasts) or multicellular (most) organisms obtaining food by breaking down dead organic material.
- They have a characteristic called nuclear mitosis in which nuclear membrane does not break and spindle is formed within the nucleus.
- Fungi are found in a wide variety of habitats, including terrestrial, marine and freshwater.
- About 100,000 species of fungi have been described.

Q. What is the role of fungi in an Ecosystem?

- Most vascular plants could not grow without the symbiotic fungi, or mycorrhizae, that inhabit their roots and supply essential nutrients.
- Other fungi provide numerous drugs (such as penicillin and other antibiotics), foods like mushrooms, truffles and morels, and the bubbles in bread, champagne, and beer.
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Q. Describe the structure of fungi.

- The study of Fungi is called Mycology. Most Fungi are Multicellular Organisms.
- The body of a fungus consists of tiny filaments called Hyphae.
- Multicellular fungi body consist of a mass of interwoven hyphae called a mycelium.
- The stalk of a mushroom is mycelium made of tightly packed hyphae.
- Hyphae are tiny tubes filled with cytoplasm and nuclei, the cell walls of hyphae contain a complex polysaccharide a polymer of amino sugars called chitin.
- The presence of chitin distinguishes cell walls of fungi from those of plants.
- Hyphae are the living, growing part of multicellular fungi.
- Some hyphae are divided by cross section segments or walls septa called septate hyphae.
- The septa have holes through which cytoplasm and organelles can move from segment to segment.
- The hyphae of species that do not have septa are called coenocytic.
- Most fungal cells are not flagellated but one group, the chytridiomycota, has flagella.
- Fungi range in size from a single cell to an individual over 65 square kilometers in size.

Q. Briefly describe yeast.

- Fungi include Unicellular and Multicellular Organisms.
- Yeast are typical Unicellular Fungi.
- Yeast Cells have a Cell Wall containing Chitin, a Cell Membrane, a Nucleus, a Large Vacuole, and membrane-bound organelles.
- Yeast are Eukaryotic organisms that undergo Cell Division usually by budding.

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Fungi are basically chemoheterotrophs. They exhibit four nutritional modes:

Saprobes (Saprotrophs): feed on dead organic matter, as such they are decomposers.

Parasites: some live on the tissues of living organisms (e.g., ringworm and jock itch are caused by parasitic fungi). Some of them are obligate parasites these are host specific or facultative parasites that can grow on their host as well as on artificial growth media.
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- Absorptive nutrition means that fungi excrete hydrolytic enzymes to break-down complex organic molecules into simple ones that can be absorbed.
- These are mainly decomposes cellulose and lignin. In essence, most digestion takes place outside the fungal body.

Q. Describe the association in fungi.

Fungi form two key mutualistic symbiotic associations. These are lichens and mycorrhizae.

1. Lichens

"This is a symbiotic association between certain fungi (mostly Ascomycetes and few Basidiomycetes) and photo autotrophs either green algae or a cyanobacterium or some times both".

The algal components reside inside the fungal hyphae and get protected from strong light and desiccation while fungus obtains food from the algae. These are vary in shape and forms and can be found in harsh places like bare rocks.

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"This is the mutualistic association between certain fungi and roots of vascular plants".

In this association fungi present in the roots and directly absorb P, Zn, Cu and other nutrients from the soil which are useful for better growth of plants while plants provide organic carbon to fungal hyphae.

There are two main types of mycorrhizae.

Endomychorizae In which fungal hyphae penetrate only in to the cell wall.

Ectomychorizae In this association fungal hyphae does not enter the cytoplasm of plant cells and grow between cell walls.

In any case, the presence of fungus gives the plant a greater absorptive surface for the intake of minerals. The fungus also benefits from the association by receiving carbohydrates form the plant.

Q. Describe the asexual reproduction in fungi.

Asexual reproduction

- Asexual Reproduction in Fungi can occur in several ways.
- unicellular fungi can reproduce by Mitosis like Budding in Yeast Cells.
- Most fungi can grow from a small piece of Mycelium called Fragmentation.
- Most fungi can reproduce asexually by haploid identical reproductive cells called Spores.
- Each spore contains a nucleus and dehydrated cytoplasm surrounded by a protected Coat.
- A spore is capable of developing into a new mycelium in a moist nutritive environment.
- The reproductive structures of fungi that produce spores are called fruiting bodies are basically of two types Sporangiophores and Conidiophores.
- Fungal Spores cannot move themselves, but spores are small and light and can be dispersed by wind, animals, insects, or water.
- Fungal spores can be found most everywhere.

Q. Describe the structure of Sporangiophore and Conidiophore.

Sporangiophore

- Sporangiophores are specialized Hyphae that look like upright Stalks.

- On top of the Sporangiophore is an enclosed Sac called a sporangium.
- Inside each sporangium, Spores called sporangiospores are made. Rhizopus, bread mold, is an example of Sporangiospores forming Fungus.

Conidiophore

- Other Fungi form Spores called conidia, which are formed without the Protection of an Enclosed Sac.
- Conidia are formed on top of a stalk-like structure called a conidiophore.
- Penicillium, which produces Penicillin and Cheese, is a Fungus that reproduces asexually by means of conidia.

Q. How sexual reproduction takes place in fungi?

Sexual reproduction

- It involves the fusion of "male" [+ mating type] and "female" [- mating types] hyphae.
- Fungi are unique in that syngamy takes place that means fertilization of morphologically similar gametes.
- Fertilization can be thought to consist of two steps the fusion of the cytoplasm of the two cells and the fusion of the two nuclei.
- Fusion of the cytoplasm is called plasmogamy, and fusion of the nuclei is called karyogamy.
- Plasmogamy without karyogamy leads to a condition in which a hyphae contains two nuclei.
- This is called a dikaryotic condition (dikaryon).
- Fusion of the nuclei is followed by meiosis and the formation of haploid spores that germinate into other hyphae.

Q. Describe the Fungal Classification.

Fungi include four phyla or divisions. The four monophyletic phyla are:

Division	Number of Species	Examples	Distinctive Characteristics	Diseases	Economic Uses
Zygomycota	About 600	Black bread mold	Formation of zygospores	Few	None
Ascomycota	30,000	*Neurospora*, yeasts, morels, truffles	Formation of fine asexual spores; sexual spores in asci; hyphae divided by perforated septa; dikaryons	Powdery mildews of fruits, chestnut blight, Dutch elm disease, ergot	Food (morels, truffles); wine-, beer-, and bread-making (yeasts)
Basidiomycota	25,000	Toadstools, mushrooms, rusts, smuts	Sexual spores in basidia; hyphae divided by perforated septa; dikaryons	Rusts, smuts	Food (mushrooms)
Deuteromycota (Fungi Imperfecti)	25,000	*Penicillin*	Fungi with no known sexual cycles	Ringworm, thrush	Cheeses, antibiotics

Q. Describe the characters and reproduction in division Zygomycota.

- These are called sporangium fungi or common molds
- The zygomycetes, in phylum Zygomycota, are characterized by the formation of sexual spores called zygospores.
- Zygomycota Includes molds & blights such as Rhizopus *stolonifer* (bread mold)
- No septa in hyphae (coenocytic)

Reproduction in Zygomycota

- Asexual reproductive structure called sporangium & produces sporangiospores

- Sexual reproductive spore produced and by conjugation when (+) hyphae & (-) fuse is form zygote called zygosporangium.
- The zygosporangium immediately undergoes meiosis to form haploid cells that develop into zygospores.
- Zygospores can endure harsh environments until conditions improve & new sporangium develops.

Q. Describe the characters of division Basidiomycota.

- These are called club fungi includes mushrooms, toadstools, puffballs, bracket fungi, shelf fungi, stinkhorns, rusts, & smuts.
- The hyphae are subdivided by perforated septa.
- The mycelium forms a diffuse mat, which may grow as large as 35 meters in diameter as in mushrooms.
- Their fruiting bodies are called Basidiocarp.

Q. Describe the structure of mushroom.

- Mushroom body is an example of Basidiocarp made up of stalk called the stipe & a flattened cap
- Stipe may have a skirt like ring below cap called the annulus
- Gills are found on the underside of the cap & are lined with basidia
- Basidium – sexual reproductive structure that make basidiospores
- Basidiospores are released from the gills & germinate to form new hyphae & mycelia
- Vegetative structures found below ground & include rhizoids (anchor & absorb nutrients), hyphae, & mycelia

Q. Describe the sexual Reproduction in Basidiomycota.

- Sexual reproduction is initiated by the fusion of haploid hyphae to form a dikaryotic mycelium.
- The dikaryotic mycelium may persist for years, forming an elaborate structure
- Eventually, some of the nuclei fuse to form diploid nuclei that immediately undergo meiosis.
- Under a mushroom cap, gills are seen radiating out from the center.
- Fusion takes place between these gills, where many spores are produced on tiny bulbs, or basidia.
- Basidiomycetes seldom reproduce asexually.

Q. Describe the characters of division Ascomycota.

- The ascomycetes are the largest division of fungi with some 30,000 species.
- The sac fungi include yeasts, powdery mildews, and many common blue-green molds, as well as morels and truffles.
- Some ascomycetes, or sac-fungi are parasites, cause tree diseases, such as Dutch Elm disease.
- In an ascomycete, the hyphae are divided by cross walls, or septa.
- Asexual spores called conidia form on the tips of specialized hyphae called conidiophores
- Ascocarp – specialized hyphae formed by parent fungi during sexual reproduction
- Asci are the sacs present within the ascocarp and form spores called ascospores.
- Sac Fungi can reproduce both sexually and asexually.

Q. Describe the asexual and sexual reproduction in Ascomycota.

Asexual reproduction:

- Asexual reproduction takes place by spores which are commonly formed either singly or in chains at the tip of a very fine multinucleated specialized hyphae called conidia (the Greek word for "dust").
- An individual hyphae segments into huge numbers of spores that are dispersed by wind, water, or animals and under favourable conditions these develop in to new mycelium.

Sexual reproduction:

- In Sexual reproduction male and female reproductive organs are produced are called antheridia and archegonia respectively at the fungal hyphae.
- At the time of fertilization archigonium provide a passage to the male nuclei for the possible fusion with female nuclei this channel with beak like opening is called trichogyne.

Q. Write a note on Ascus of Ascomycota.

The Ascus

- Ascomycota fungi are distinguished from other fungi by a microscopic sexual reproductive structure or zygote called an Ascus.
- An ascus is formed when two hyphae conjugate. Inside the ascus, nuclei from the hyphae fuse and develop into ascospores.
- The ascospores eventually are released from the ascus and may travel at the radius of 30 centimeters distances on the wind.
-

Q. Describe the reproduction and economic importance of Yeast.

- **Yeast** is a group of unicellular fungi a few species of which are commonly used to leaven bread and ferment alcoholic beverages.
- Most yeast belongs to the division Ascomycota.
- More than one-thousand species of yeasts have been described.

Reproduction in yeast:

- Yeasts can reproduce asexually through budding or sexually through the formation of ascospores.
- During asexual reproduction a new bud grows out of the parent yeast when the condition is right, then after the bud reaches an adult size, it separates from the parent yeast.
- Under low nutrient conditions, yeasts that are capable of sexual reproduction will form ascospores.
- Yeasts that are not capable of going through the full sexual cycle are classified in the genus *Candida*.

Importance of Yeast:

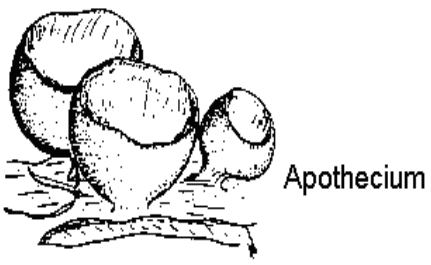
- Yeast physiology can be either obligatory aerobic or facultatively fermentative.
- There is no known obligatory anaerobic yeast.
- In the absence of oxygen, fermentative yeasts produce their energy by converting sugars into carbon dioxide and ethanol (alcohol).
- In brewing, the ethanol is used, while in baking the carbon dioxide raises the bread and the ethanol evaporates.
- Many food, dairy, breweries and wineries have yeast present in large amounts in the influent.
- A few yeasts, such as Candida albicans can cause infection in humans.
- The most commonly used yeast is *Saccharomyces cerevisiae*, which was domesticated for wine.

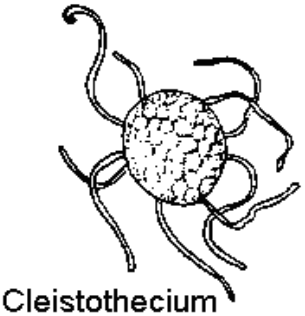
Q. Describe the Ascocarp (Fruiting body) and its types of Ascomycota.

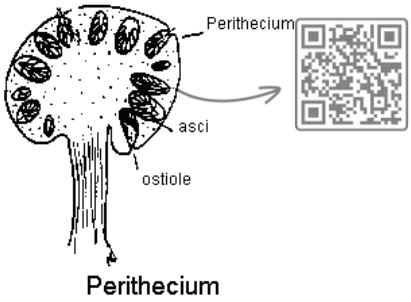
- In division Ascomycota of fungi the asci are differentiated within a structure that is made up of densely interwoven hyphae called ascocarp.
- Ascus formation is usually occurs within a complex structure composed of tightly interwoven hyphae - the "ascocarp".
- Within each ascocarp ascospore or asci are produced that can germinate asexually and form a new hyphae. Many ascocarps are macroscopic, and the only part of the fungi that most people ever see.
- These are of three types.

1. An ascocarp may be open and more or less cup-shaped called an "apothecium"
2. Ascocarp closed and spherical in shape called a "cleistothecium".
3. or flask shaped, with a small pore through which the ascospores escape called a "perithecium".

The layer of asci is called the "hymenium", or hymeneal layer.





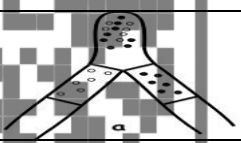
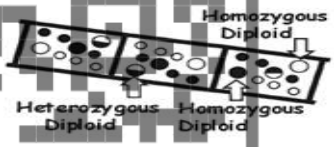
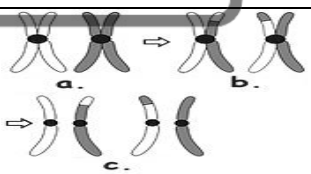
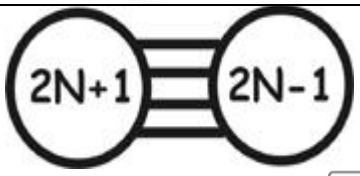


Q. Describe the characters of division Deuteromycota.

- A fourth group of fungi are the Deuteromycota.
- Among the 25, 000 species that have been described some are causes of diseases such as ringworm and athletes foot, and in the production of penicillin, cheeses, and cyclosporin (used in organ transplants).
- The group known as deuteromycetes is also called the "imperfect fungi."
- Asexual reproduction is by means of conidiospores or may be lacking.
- Many of the parasitic fungi are classified into this group.
- This is a polyphyletic group that includes all fungi whose sexual reproductive structure is not known.
- An example of a deuteromycete is *Candida albicans*, a dimorphic fungus responsible for "yeast infections" in humans.

Q. Describe the Parasexual Cycle in Deuteromycota.

- Parasexuality was first discovered by Pontecorvo and Roper (1952) in *Aspergillus nidulans*.
- Parasexuality in fungi can be called genetic recombination without meiosis.
- In the absence of meiosis during the life cycle of imperfect fungi, recombination of hereditary properties and genetic variation still occur by a mechanism called parasexuality.
- It includes the production of diploid nuclei in a heterokaryotic, haploid mycelium that results from plasmogamy and karyogamy; multiplication of the diploid along with haploid nuclei in the heterokaryotic mycelium; sorting out of a diploid homokaryon; segregation and recombination by crossing over at mitosis; and haploidization of the diploid nuclei.
- Sexual and parasexual cycles are not mutually exclusive.
- Some fungi that reproduce sexually also exhibit parasexuality.
- However imperfect fungi reproduce asexually and exhibit parasexuality.
- During the parasexual cycle, the following events take place:

1. Formation of **heterokaryotic mycelium**	
2. Occasional **karyogamy** between two nuclei to form diploid nuclei	
3. Mitosis **of 2N and 1N nuclei.** Mitotic crossing over **during mitosis of some diploid nuclei.**	
4. Haploidization (not meiosis) of some diploid nuclei. Sorting out of new haploid strains.	

Q. Describe in detail the economic importance of fungi.

Fungi and human disease

- Fungi attack the tissues of living plants and animals and cause disease. Fungal diseases are the major concern for humans.
- Mold Spores can cause mild to serious Allergies in some people, sniffling, sneezing, and respiratory distress.
- Fungi may infect the skin, hair, nails, and tissues of the Body. Fungi on the Skin can cause Athlete's foot or Ringworm.

- Fungi can cause Yeast Infections.
- Yeast is commonly found in the mouth, intestines, and, in women, in the vaginal tract.
- Serious fungal diseases that involve the Internal Organs are often caused by Dimorphic Fungi. If their Spores are Inhaled, they can cause severe respiratory illness and spread to many organs.
- Some Mushrooms are Poisonous to Humans, *Amanita* mushroom "death angel" or "destroying angle". They contain Extremely Dangerous Toxins.
- Other fungal poisons include the Aflatoxins, poisons produced by some species of *Aspergillus*. Aflatoxins cause liver cancer.
- Fungi that make aflatoxin may be found as contaminants in peanuts and in grains such as corn and grain sorghum.
- Ergotism is caused by eating bread made from pourle ergot- contaminated rye flour. The poisonous material in the ergot causes nervous spasm, convulsion, psychotic delusion and even gangrene.

FUNGI IN INDUSTRY

- Many Fungi are Valuable Food sources for humans. Yeast, such as *Saccharomyces*, is an important nutritional supplement because it contains vitamins, minerals, and other nutrients.
- Mushrooms are an important Food. *Agaricus* (White Button), shiitake, and portabella mushrooms are often found in grocery stores.
- In other places in the world, people prize the taste of Truffles and Morels, which are Ascocarps found near the Roots of Trees.
- Fungi are used to produce Chemical Compounds that are important to the food-processing industry such as Citric and Gluconic Acid. Citric Acid is used in soft drinks and candies. Gluconic Acid is fed to chickens to enhance the hardness of eggshells.
- *Ashbya gossypii* is a producer of Vitamin B2, an important nutritional supplement.

FUNGI AND THE ENVIRONMENT

- Most Fungi are either saprophytes or decomposers that break down and feed on decaying organic material or dead organisms.
- Fungi obtain nutrients to absorb by secreting digestive enzymes onto the food source. The enzymes break down, or digest, the food.
- Fungi work along with the Monerans and Protoctists to decompose the waste and remains of plants and animals.
- When fungi secrete digestive enzymes into a food source, the Nutrients are released to be used by the fungus and other organisms.
- The Nutrients are recycled and Returned to the Environment.
- Without decomposers, ecosystems would collapse, because many organisms would not obtain enough nutrients to stay alive.
- One scientist estimated that a layer of organic debris about 12 miles thick would now cover the earth if decomposition had never occurred.
- Many Fungi are Plant Pathogens that attack grain and fruit. Wheat Rust is a Basidiomycetes that attacks wheat grains. Other Fungi can attack food crops such as corn, beans, onions, squashes, and tomatoes.

Chapter 8
THE KINGDOM FUNGI
Short Question and Answers

Q. Briefly describe the Kingdom fungi.

The Kingdom Fungi includes fungi which are the most important organisms, both in terms of their ecological and economic roles. These are non chlorophyllus eukaryotic may be unicellular (e.g., yeasts) or multicellular (most) organisms obtaining food by breaking down dead organic material. They have a characteristic called nuclear mitosis in which nuclear membrane does not break and spindle is formed within the nucleus. Fungi are found in a wide variety of habitats, including terrestrial, marine and freshwater. About 100,000 species of fungi have been described.

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Most vascular plants could not grow without the symbiotic fungi, or **mycorrhizae**, that inhabit their roots and supply essential nutrients. Other fungi provide numerous drugs (such as penicillin and other antibiotics), foods like mushrooms, truffles and morels, and the bubbles in bread, champagne, and beer.

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Deuteromycota (Fungi	25,000	*Penicillin*	Fungi with no known sexual cycles	Ringworm, thrush	Cheeses, antibiotics

Imperfecti)					

Q. Describe the characters and reproduction in division Zygomycota.

- These are called sporangium fungi or common molds
- The zygomycetes, in phylum Zygomycota, are characterized by the formation of sexual spores called zygospores.
- Zygomycota Includes molds & blights such as Rhizopus ***stolonifer*** (bread mold)
- No septa in hyphae (**coenocytic**)

Reproduction in Zygomycota

- **Asexual** reproductive structure called **sporangium** & produces **sporangiospores**
- **Sexual** reproductive spore produced and by conjugation when (+) hyphae & (-) fuse is form zygote called zygosporangium**.**
- The zygosporangium immediately undergoes meiosis to form haploid cells that develop into zygospores.
- Zygospores can endure harsh environments until conditions improve & new sporangium develops.

Q. Describe the characters of division Basidiomycota.

- These are called **club fungi** includes mushrooms, toadstools, puffballs, bracket fungi, shelf fungi, stinkhorns, rusts, & smuts.
- The hyphae are subdivided by perforated septa.
- The mycelium forms a diffuse mat, which may grow as large as 35 meters in diameter as in mushrooms.
- Their fruiting bodies are called **Basidiocarp.**

Q. Describe the structure of mushroom.

- Mushroom body is an example of Basidiocarp made up of stalk called the **stipe** & a flattened **cap**
- **Stipe** may have a **skirt like ring** below cap called the **annulus**
- **Gills** are found on the underside of the cap & are lined with **basidia**
- **Basidium** – sexual reproductive structure that make **basidiospores**
- Basidiospores are released from the gills & germinate to form new hyphae & mycelia
- **Vegetative structures** found below ground & include **rhizoids** (anchor & absorb nutrients), **hyphae, & mycelia**

Q. Describe the sexual Reproduction in Basidiomycota.

- Sexual reproduction is initiated by the fusion of haploid hyphae to form a dikaryotic mycelium. The dikaryotic mycelium may persist for years, forming an elaborate structure
- Eventually, some of the nuclei fuse to form diploid nuclei that immediately undergo meiosis.
- Under a mushroom cap, gills are seen radiating out from the center.
- Fusion takes place between these gills, where many spores are produced on tiny bulbs, or basidia.
- Basidiomycetes seldom reproduce asexually.

Q. Describe the characters of division Ascomycota.

- The ascomycetes are the largest division of fungi with some 30,000 species.
- The sac fungi include yeasts, powdery mildews, and many common blue-green molds, as well as morels and truffles.

- Some ascomycetes, or sac-fungi are parasites, cause tree diseases, such as **Dutch Elm** disease.
- In an ascomycete, the hyphae are divided by cross walls, or septa.
- Asexual spores called **conidia** form on the tips of specialized hyphae called **conidiophores**
- **Ascocarp –** specialized hyphae formed by parent fungi during **sexual reproduction**
- **Asci are** the sacs present within the ascocarp and form spores called **ascospores.**
- Sac Fungi can reproduce both sexually and asexually.

Q. Describe the asexual and sexual reproduction in Ascomycota.

Asexual reproduction:

Asexual reproduction takes place by spores which are commonly formed either singly or in chains at the tip of a very fine multinucleated specialized hyphae called conidia (the Greek word for "dust"). An individual hyphae segments into huge numbers of spores that are dispersed by wind, water, or animals and under favourable conditions these develop in to new mycelium.

Sexual reproduction:

In Sexual reproduction male and female reproductive organs are produced are called antheridia and archegonia respectively at the fungal hyphae. At the time of fertilization archigonium provide a passage to the male nuclei for the possible fusion with female nuclei this channel with beak like opening is called trichogyne.

Q. Write a note on Ascus of Ascomycota.

The Ascus

Ascomycota fungi are distinguished from other fungi by a microscopic sexual reproductive structure or zygote called an Ascus. An ascus is formed when two hyphae conjugate. Inside the ascus, nuclei from the hyphae fuse and develop into ascospores. The ascospores eventually are released from the ascus and may travel at the radius of 30 centimeters distances on the wind.

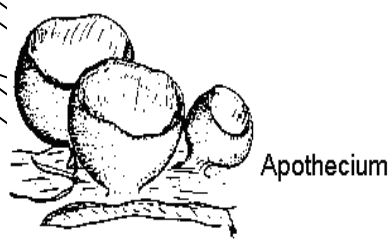
Q. Describe the Ascocarp (Fruiting body) and its types of Ascomycota.

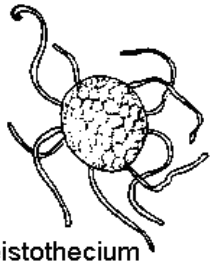
In division Ascomycota of fungi the asci are differentiated within a structure that is made up of densely interwoven hyphae called ascocarp.

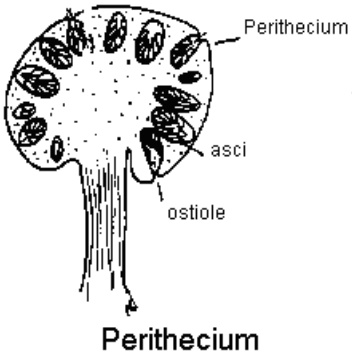
Ascus formation is usually occurs within a complex structure composed of tightly interwoven hyphae - the "**ascocarp**". Within each ascocarp ascospore or asci are produced that can germinate asexually and form a new hyphae. Many ascocarps are macroscopic, and the only part of the fungi that most people ever see. These are of three types.

1. An ascocarp may be open and more or less cup-shaped called an "**apothecium**"
2. Ascocarp closed and spherical in shape called a "**cleistothecium**".
3. or flask shaped, with a small pore through which the **ascospores** escape called a "**perithecium**".

The layer of asci is called the "**hymenium**", or hymeneal layer.







Q. Describe the reproduction and economic importance of Yeast.

Yeast is a group of unicellular fungi a few species of which are commonly used to leaven bread and ferment alcoholic beverages. Most yeast belongs to the division Ascomycota. More than one-thousand species of yeasts have been described.

Reproduction in yeast:

Yeasts can reproduce asexually through budding or sexually through the formation of ascospores. During asexual reproduction a new bud grows out of the parent yeast when the condition is right, then after the bud reaches an adult size, it separates from the parent yeast. Under low nutrient conditions, yeasts that are capable of sexual reproduction will form ascospores. Yeasts that are not capable of going through the full sexual cycle are classified in the genus *Candida*.

Importance of Yeast:

Yeast physiology can be either obligatory aerobic or facultatively fermentative. There is no known obligatory anaerobic yeast. In the absence of oxygen, fermentative yeasts produce their energy by converting sugars into carbon dioxide and ethanol (alcohol). In brewing, the ethanol is used, while in baking the carbon dioxide raises the bread and the ethanol evaporates. Many food, dairy, breweries and wineries have yeast present in large amounts in the influent.

A few yeasts, such as **Candida albicans** can cause infection in humans. The most commonly used yeast is ***Saccharomyces cerevisiae*****,** which was domesticated for wine.

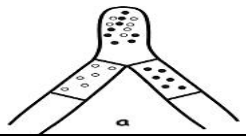
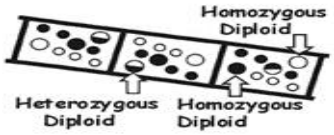
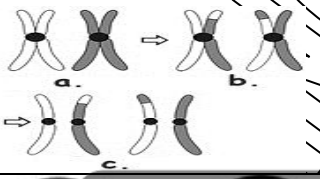
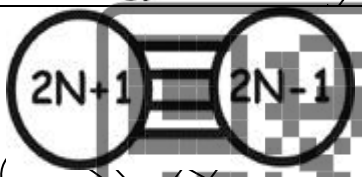
Q. Describe the characters of division Deuteromycota.

A fourth group of fungi are the **Deuteromycota**. Among the 25, 000 species that have been described some are causes of diseases such as ringworm and athletes foot, and in the production of penicillin, cheeses, and cyclosporin (used in organ transplants).

- The group known as deuteromycetes is also called the "imperfect fungi."
- Asexual reproduction is by means of **conidiospores** or may be lacking.
- Many of the parasitic fungi are classified into this group.
- This is a polyphyletic group that includes all fungi whose sexual reproductive structure is not known.
- An example of a deuteromycete is *Candida albicans*, a dimorphic fungus responsible for "yeast infections" in humans.

Q. Describe the Parasexual Cycle in Deuteromycota.

Parasexuality was first discovered by Pontecorvo and Roper (1952) in *Aspergillus nidulans*. Parasexuality in fungi can be called genetic recombination without meiosis. In the absence of meiosis during the life cycle of imperfect fungi, recombination of hereditary properties and genetic variation still occur by a mechanism called parasexuality. It includes the production of diploid nuclei in a heterokaryotic, haploid mycelium that results from plasmogamy and karyogamy; multiplication of the diploid along with haploid nuclei in the heterokaryotic mycelium; sorting out of a diploid homokaryon; segregation and recombination by crossing over at mitosis; and haploidization of the diploid nuclei. Sexual and parasexual cycles are not mutually exclusive. Some fungi that reproduce sexually also exhibit parasexuality. However imperfect fungi reproduce asexually and exhibit parasexuallity. During the parasexual cycle, the following events take place:

1. Formation of **heterokaryotic mycelium**	
2. Occasional **karyogamy** between two nuclei to form diploid nuclei	
3. Mitosis of 2N and 1N nuclei. **Mitotic crossing over** during mitosis of some diploid nuclei.	
4. Haploidization (not meiosis) of some diploid nuclei. Sorting out of new haploid strains.	

Descriptive questions and answers

Q. Describe in detail the economic importance of fungi.

Fungi and human disease

Fungi attack the tissues of living plants and animals and cause disease. Fungal diseases are the major concern for humans.

- Mold Spores can cause mild to serious Allergies in some people, sniffling, sneezing, and respiratory distress.
- Fungi may infect the skin, hair, nails, and tissues of the Body. Fungi on the Skin can cause Athlete's foot or Ringworm.
- Fungi can cause Yeast Infections. Yeast is commonly found in the mouth, intestines, and, in women, in the vaginal tract.
- Serious fungal diseases that involve the Internal Organs are often caused by Dimorphic Fungi. If their Spores are Inhaled, they can cause severe respiratory illness and spread to many organs.
- Some Mushrooms are Poisonous to Humans, ***Amanita*** mushroom "death angel" or "destroying angle". They contain Extremely Dangerous Toxins.
- Other fungal poisons include the **Aflatoxins**, poisons produced by some species of ***Aspergillus***. Aflatoxins cause liver cancer. Fungi that make aflatoxin may be found as contaminants in peanuts and in grains such as corn and grain sorghum. **Ergotism** is caused by eating bread made from pourle ergot- contaminated rye flour. The poisonous material in the ergot causes nervous spasm, convulsion, psychotic delusion and even gangrene.

FUNGI IN INDUSTRY

Many Fungi are Valuable Food sources for humans. Yeast, such as ***Saccharomyces***, is an important nutritional supplement because it contains vitamins, minerals, and other nutrients.

- Mushrooms are an important Food. ***Agaricus*** (White Button), shiitake, and portabella mushrooms are often found in grocery stores.
- In other places in the world, people prize the taste of Truffles and Morels, which are Ascocarps found near the Roots of Trees.
- Fungi are used to produce Chemical Compounds that are important to the food-processing industry such as Citric and Gluconic Acid. Citric Acid is used in soft drinks and candies. Gluconic Acid is fed to chickens to enhance the hardness of eggshells.
- ***Ashbya gossypii*** is a producer of Vitamin B2, an important nutritional supplement.

FUNGI AND THE ENVIRONMENT

Most Fungi are either **saprophytes or decomposers** that break down and feed on decaying organic material or dead organisms.

- Fungi obtain nutrients to absorb by secreting digestive enzymes onto the food source. The enzymes break down, or digest, the food.
- Fungi work along with the Monerans and Protoctists to decompose the waste and remains of plants and animals.
- When fungi secrete digestive enzymes into a food source, the Nutrients are released to be used by the fungus and other organisms.
- The Nutrients are recycled and Returned to the Environment.
- Without decomposers, ecosystems would collapse, because many organisms would not obtain enough nutrients to stay alive.
- One scientist estimated that a layer of organic debris about 12 miles thick would now cover the earth if decomposition had never occurred.
- Many Fungi are Plant Pathogens that attack grain and fruit. Wheat Rust is a Basidiomycetes that attacks wheat grains. Other Fungi can attack food crops such as corn, beans, onions, squashes, and tomatoes.

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Chapter 9
KINGDOM PLANTAE
Short questions and Answers

Q. Describe the characteristics of Plants.

"Plants are eukaryotic photosynthetic multicellular organisms adapted to living on land in terrestrial or aquatic habitat and develop zygote into an embryo".

Characteristics of Plants

- The plant kingdom includes over 250,000 species.
- Plant cell have cell wall made up of cellulose and contain chlorophyll as photosynthetic pigments for making their food by photosynthesis.
- They have a waxy cuticle on their outer surface for protection against water loss.
- Some of them posses a substance lignin to harden the cell wall while sporopollenin is another product to protect them from environmental damages.
- Gametes produced within gametengia and zygote develops in to embryo and retained and nourished with in the protective cells.

Q. Differentiate between Plants and Algae.

Plants	Algae
1. Plants have true roots and leaf bearing shoots with flowers and fruits	Algae do not have such structures.
2. All plants have modifications that protect the gametes and zygote from drying out.	Algae do not have modifications that protect the gametes and zygote from drying out.
3. Plants are adapted to land habitat including terrestrial and aquatic habitat.	Algae are adapted to water environment.

Q. Describe the classification of plants:

Plants are divided in to two groups.

1) Bryophyta **2) Tracheophyta**

Bryophytes are sub divided in to three classes.	**Tracheophyta** have five sub divisions
Class **Hepaticae** (Liverworts) Class **Musci** (Mosses) Class **Anthocerotae** (Hornworts)	Subdivision Psilopsida (Psilopsids) Subdivision Lycopsida (Lycopsids) Subdivision Sphenopsida (Sphenopsids) Subdivision Pterosida (Ferns) Subdivision Spermopsida (Seed plants)

Q. Describe the characteristics of Bryophytes.

Bryophytes (mosses, liverworts, and hornworts) are small green plants that reproduce by means of spores (or vegetatively) instead of seeds.

- There are about 20,000 species of Bryophytes are found throughout the world.
- Most are only a few centimeters high, although some mosses attain a half meter (20 in) or more.

- Although often small and inconspicuous, A remarkable adaptation of bryophytes is their ability to remain alive for long periods without water, even under high temperatures, then resume photosynthesis within seconds after being moistened by rain or dew.
- Bryophytes have no roots but are anchored by slender threads called rhizoids, which also play a role in the absorption of water and mineral nutrients.
- They are sensitive indicators of air and water pollution, and play important roles in the cycling of water and nutrients and in relationships with many other plants and animals.
- They have multicellular sex organs, i.e. the gametes are enclosed by a sterile jacket of cells .
- These are parenchymatous, not filamentous.
- They retain the zygote within the female sex organ and allow it to develop into an embryo.
- They have cutin (a cuticle) on the plant and spores.

Q. Describe the alternation of generation in bryophytes.

All bryophytes show heteromorphic alternation of generation.

- A haploid gametophyte is a dominant generation containing rhizoids, pseudostem and leaves.
- Male sex organs are called antheridia and female called archegonia develop at the tips of stem which are always dioeceous.
- Antheridia mature before archegonia this phenomenon is called **Protoandry**.
- Sperms of antheridia attract by archigonial secretion and swim towards archegonia and fuses with the ovum in the venter to form diploid oospore.
- After repeated mitotic divisions embryo form a diploid sporogonium (a sporophyte). It consists of foot, Seta and capsule.
- With in capsule a spore mother cell is present which divides meiotically and produce haploid spores.
- Each spore develops in to filamentous body called protonema which forms a gametophyte (haploid) to complete life cycle.

Q. What environment faced by the plant when they came on land?

Fossils records of the Silurian/ Devonian periods shows that plants made changes in their structure for the survival on land habitat due to change in environment in these eras for the following reasons.

1. Scarcity of water on land habitat as compare to marine habitat.
2. Carbon containing compounds are not available frequently on land.
3. Fluctuation of temperature on land habitat is much as the temperature in sea.

Q. What were the adaptations adapted by plant to survive on land?

To overcome the environmental problems on land, land plants first adopted themselves to amphibian habitat and later developed a complete terrestrial form of life. Plants adapted the following characters for their survival on land.

1. Rhizoids for water absorption
2. Conservation of water
3. Absorption of CO_2
4. Heterogamy
5. Protection of reproductive cells
6. formation of embryos

Q. Describe the characters of Musci (Mosses)

Characteristics of Mosses

- About 10,000 species of mosses have been discovered
- These are usually radically symmetry.

- The gametophyte has a stem like **axis** with spirally arranged "leaves", which are called **phyllodes**.
- Mosses attach to their substrate with multicellular **rhizoids**.
- Their body may be erect or prostrate.
- Moss "leaves" have a costa (midrib).
- Mosses are found in a range of habitats, although moist and shady habitats are more common. Some mosses are found on rocks and in arid location.
- Mosses are often epiphytes most water absorption is from the surface cells of the moss plant. Like most Bryophytes, mosses can desiccate, or dehydrate for long periods without permanent damage.

Q. Describe the characteristics of Hepaticae (Liverworts).

Liverworts are generally of two types;

1. Leafy liverworts (4,000-6,000 species) - predominately tropical also called scale mosses.
2. Thallose liverworts (3,500 species) - these are further sub-divided into simple and complex thalloids.

Characteristics

- May have a cuticle (especially the thallose liverworts)
- Flattened growth form often prostrate.
- Unicellular rhizoids on lower surface present.
- Upper surface smooth with pores for gas exchange.
- The sporophyte "sporangium" or capsule is simple.
- Spores released by hygroscopic **elaters** (hairs).

A common genus is *Marchantia*

Q. Describe the characteristics of Anthocerotae (Hornworts).

Characteristics

- Hornworts are less common than liverworts or mosses, with only about 100 species identified.
- Hornworts have round, small, thallose-like gametophytes which are found in moist shaded soils. The gametophytes may be unisexual or bisexual, depending on the species.
- The sporophyte is "horn-shaped", and grows from a basal sheath beneath the surface of the gametophyte thallus. The sporophyte continues to grow from a basal meristem, producing spores clustered around a central stalk. The sporophyte tip splits releasing spores. Spores continue to mature for some time, and the Sporophyte continues to split.
- Vegetative reproduction occurs in the hornworts by fragmentation
- Hornworts have just one chloroplast per cell, which is unique among the true plants. One chloroplast per cell is common in many algae.

Q. Briefly describe the Tracheophytes.

This division of plants comprises of green plants having well developed vascular system made up of tracheids, vessels and fibers. This group has five divisions. Subdivision Psilopsida (Psilopsids), Subdivision Lycopsida (Lycopsids), Subdivision Sphenopsida (Sphenopsids), Subdivision Pterosida (Ferns), Subdivision Spermopsida (Seed plants). The woody tissue of trees and capillary tubes for transporting water and sugars makes it possible for trees to reach a great size.

Q. Describe the characteristics of Psilopsida.

Characteristics

- The subphylum Psilotophyta (Psilophyta or Psilopsida) represents the most primitive vascular plants arose in the Silurian and Devonian about 395 mya and are characterized by the presence of tracheids, but they lack true roots or leaves.
- The dominant plant in the alternation of generations is the sporophyte.

- These are simple dichotomously branching plants without leaves. Stems contain chlorophyll and carry out photosynthesis. There is a horizontal stem with a primitive tissue arrangement having a central stele with xylem surrounded by phloem.
- The epidermis has a cuticle and stomata. The upright stem connects to a horizontal stem-like **rhizome** system that is anchored to the substrate through rhizoids.
- There are no clearly-defined roots. There are also no true leaves; however the stem is not smooth, it bears flaps of epidermis that are externally leaf-like, but which contain no vascular tissue.

Q. Write a note on Rhynia.

Rhynia is a primitive plant appeared in Devonian period about 400 million years ago now extinct. The plant body consists of dichotomously branched underground rhizome with rhizoids for absorption of water and salts and erect aerial stem. The branches were green having terminal sporangia.

Internally vascular tissues xylem with surrounding phloem is present. These are surrounded by cortex. The outer layer is epidermis having stomata.

Psilotum and ***Tmesipteris*** are having a sporophyte.

Q. Describe the evolution of leaf.

- It is assumed that a thorn like out growth (Enation) emerged on the surface of the naked stem and with the growth vascular tissues are also formed for the supply of water and support to the leave.
- Another assumption is that leaves were originated from the leafless branching system of the primitive vascular plant.
- After that many veined leaf (megaphyllous) were originated providing the forked branching system in the primitive plants.
- Later on the branching system became flat and spaces were filled in by vascular tissues and looked like a web foot of duck.

Q. Describe the characteristics of Lycopsida

The **Class Lycopsida** includes the **clubmosses**. These plants are often loosely grouped as the fern allies.

- The clubmosses are thought to be structurally similar to the earliest vascular plants almost 10 milloion years ago after the first Psilopsida,
- They have small, scale-like leaves, homosporous spore borne in sporangia at the bases of the leaves, branching stems (usually dichotomous), and generally simple form. Dried spores of the common club moss, known somewhat inaccurately as *lycopodium*, were used to produce flame-effects.
- Leaf-like structures are also seen in the dominant sporophyte generation of some members of the **Lycophyta**. Initially these "leaves" are little more than flaps of tissue growing out of the upright stems (like the enations of *Psilotum*).
- The leaves acquire a **vascular trace** that constitutes a **mid-rib** and called **microphylls**.
- These leaves are much simpler than the extensively-vascularized **megaphylls** of ferns and higher plants, but the presence of vascular tissue identifies them as **true leaves**.

Q. Write a note on *Selaginella.*

Selaginella is a primitive vascular plant belongs to the group Lycopsida. It grows in damp places in the hills. It is slender, much branch plant. The stem bears four rows of leaves. A scaly structure called **ligule** develops on the upper surface of each leaf above its base. The root bearer

region called rhizophora. In ***Selaginella*** an important development is seen called Heterospory i.e. two types of haploid spores are produced by meiosis in two different types of sporangia. The spores germinate to form two types of gametophytes, both of which are reduced in size.

Q. Describe the evolution of seed.

There are three steps involved in evolution of seed.

1. Origin of heterospory.
2. Development of integument for the protection of megasporangia.
3. Retention of the mature megaspores in the sporangia to develop female gametophyte.

The seed formation started when plants produced two different types of micro and megaspores which develop in to male and female gametophytes respectively. This is called **heterospory** as it occurs in *Selaginella.* These spores develop and protected in to two different sporangia which are also found in club mosses, horse tails and ferns.

Later on in fern like plants some branch like structures are modified and formed integument around the sporangia in carboniferous era during evolution. Like wise in seed plants mega spores are protected in the sporangia and develop in to active female gametophyte. The integument not only protects the seed but also provides food to the female gametophyte.

Q. Describe the characteristics of Sphenopsida

Characteristics

- Three hundred million years ago in Devonian the Sphenopsids appeared and during Carboniferous period these become flourished and then decline.
- Most of them were small while some Paleozoic sphenophyts grew up to thirty meters tall (nearly 100 feet).
- The earliest Sphenopsids that has been discovered is *Pseudobornia ursina*, which grew up to 20 m tall with stems up to 60 cm thick.
- Today, the sphenophyts consist of only one genus, *Equisetum* commonly called horse tails, with about thirty living species known worldwide.
- Sphenopsids possess true roots, stem and leaves.
- The stem hollow and jointed surrounded by scaly leaves.
- Spores are produced in cone like **Strobilus** situated terminally on branches.

Q. Describe the characteristics of Pteropsida with reference to Ferns.

The **Ferns** (Division Pteropsida) were prominent plants from 360 until 200 mya, although even today they are common. Members of this group of seedless vascular plants show the greatest species diversity.

- Ferns leaf is the megaphyll. The megaphyll is characterized by extensively branched vasculature.
- The stem branching patterns is dichotomous - each branch being equal to and symmetrical with the other.
- The end portions of a dichotomously branching system are called **telomes**. It is thought that the complex **megaphyll leaf structure** arose when these telomes became **webbed.**

If a sporangium is associated with the telome that ultimately becomes a megaphyll, then that megaphyll would be a **sporophyll** (a sporangium-bearing leaf). If there are two different sporangia involved (the heterosporous situation with micro- and megasporangia) then there would be two types of sporophylls; **microsporophylls** and **megasporophylls**.

Q. Describe the characteristics of Spermopsida

- These are generally called The Seed Plants.

- **"Seed** is a structure in which the embryo (the young sporophyte) is shed from the parent plant, enclosed within a resistant coat, together with a supply of food that aids its establishment".
- **Seed plants** are those which reproduce via seeds while seed less plants reproduce through spores.
- These plants appeared in the late Devonian but in carboniferous period they replaced by Lycopsids and Sphenopsids.
- These plants are divided in to two groups.
    - **i) The Gymnosperms (naked seed)**
    - **ii) The Angiosperms (open seed)**

Q. Briefly describe the Gymnosperms.

The gymnosperms were the first seed plants appeared in late Devonian periode and bear their ovules and seeds exposed on the plant surface. This is in marked contrast to the more recent group of seed plants, the flowering plants, which have their ovules sealed within the flower and their seeds contained within a fruit. The name gymnosperm describes this feature. It literally means naked seed.

Q. Write a note on Ginkgo

Ginkgo

This is a monotypic division, a single species of a single genus, *Ginkgo biloba* the maidenhair tree. Several relatives are known as fossils dating back to Pennsylvanian times. *Ginkgo biloba* was preserved in the gardens of Buddhist monasteries in China and Japan where it was encountered by Westerners in the eighteenth century. It has turned out to be a valuable street tree because of its unusual foliage and tolerance of pollution

Q. Write a note on Cycads.

Cycads

Cycads or similar plants were the food of herbivorous dinosaurs as they appeared in Permian and become abundant in Mesozoic era. They survive as a few species of tropical palm-like trees. *Cycads* species are larger and are often used as ornamentals in tropical areas. The cycads can be viewed as beneficial as they form symbiotic associations with nitrogen fixing bacteria. Cycads decline in Cretaceous period their nine genera containing over a hundred species exist today. Their life cycle is rather similar to the conifers but they have free-swimming sperm.

Q. Describe the male cone of Pinus.

- The male cones are the reproductive organs of Pinus plant.
- Male cones of Pinus typically are found in clusters at the tips of lower side branches and usually take several years to develop.
- In male cones, the modified leaves are called **microsporophylls**.
- Each microsporophyll bears a **microsporangium** in which the **microspores** are produced.
- Inside the microsporangium, each microspore divides and "grows" to form a four-celled **male gametophyte**, also known as **pollen** which contains two sperm nuclei.

Q. Describe the female cone of Pinus.

- The female cones are the reproductive organs of Pinus plant.
- Female cones typically form higher up in the tree, and also usually take several years to develop.
- Modified leaves/scales of female cones are called **megasporophylls** and produce **megaspores**.

- Each scale or megasporophyll has two megasporangia or **ovules** where megaspores can develop.
- Each ovule has a **micropyle** (**pyle** = gate, orifice), a small hole in the near end of the ovule wall so the sperm can enter.

Q. Describe the development of female gametophyte of Pinus plant.

- Development of female gametophyte starts with the Meiotic division in megaspore mother cell that gives a row of 4 haploid nuclei.
- Usually 3 degenerate the remaining one develops into the female gametophyte or ovule.
- This germination and development of the female gametophyte takes up to 13 months, and occurs within the ovule.
- 11 mitotic divisions further occur before any cell walls separate the nuclei.
- At this time, 2 or more archegonia begin to differentiate at the micropylar end.
- At this point the ovule consists of integuments, **nucellus** and gametophyte.
- Gametophyte contains several archegonia, each with an egg cell.
- Archigonium consists of two part lower venter and upper neck.
- In the venter a large egg cell or female gamete is present that takes part in fertilization.

Q. Describe the male gametophyte of Pinus.

- The pollen grain is separated from the archegonia by a layer of nucellus.
- It is through this nuclear material that the pollen tube grows, digesting it as it grows.
- As it grows, the generative cell divides, forming stalk cell & body cell, which then divides to form 2 sperm nuclei.
- A mature male gametophyte then contains a pollen tube, 2 sperm nuclei, and several vegetative nuclei.

Q. Describe the characteristics of angiosperm

- The Angiosperms are the flowering plants, in which the seeds are enclosed in a dry or fleshy fruit that develops from the ovary of the flower.
- Angiosperms are the most diverse and successful of plant groups with well-developed vessels in the xylem and other adaptations to a variety of land habitats.
- Angiosperms are divided into two subclasses: Dicotyledon and Monocotyledon.

Dicotyledons	Monocotyledons
• **Dicotyledons** have two seed leaves (cotyledons) in the embryo. • netted, or branched, leaf veins • Flower parts in multiples of four or five • Root systems generally made up of a large primary root (taproot) with branch roots growing from it; • Stems with vascular cambium and with vascular bundles arranged in a ring	• The **Monocotyledons** have one seed leaf, • Parallel leaf veins, • Flower parts in threes • Fibrous root system • Stems without a vascular cambium and with scattered vascular bundles.

Q. Briefly describe the structure of a flower.

- The leaf-like organs found along the outside of the flower are the **sepals**, collectively called the **calyx**. The next **whorl** of floral parts inward is the **petals**, collectively called the **corolla**.
- The sepals and petals together are sometimes called **accessory** floral parts because they participate in reproduction only indirectly in that their function is related to facilitating pollination.
- The next floral whorl inward is the **stamens** which are collectively referred to as the **androecium**. Finally, the innermost floral part is the **gynoecium** which is composed of **carpals or pistil**. Each pistil

consists of an ovary at its base a slender stalk called style arises from the ovary and ends upwardly called stigma. Inside of the carpel an **ovule** present this contains the egg.

- These last two whorls participate directly in sexual reproduction and are called the **essential** floral parts.

Q. Describe the development of fruit in angiosperms.

The formation of fruit starts from the development of mature seeds and fruits generally involve mitotic divisions of the nuclei and cells. Ovules mature into seeds and the gynoecium matures into a fruit. Macroscopically, the petals and stamens will usually wither and fall off leaving the ovary surrounded by the sepals. By mitotic cell division and uptake of water resulting in cell expansion, the young fruit increases greatly in size. The placenta will become very watery filling the locule or spaces within the carpels.

The angiosperm fruit serves two important functions:

1. To **protect** the seeds during their maturation and

2. To effectively **disperse** the mature seeds. The chief agents in seed and fruit dispersal are wind, water and animals.

Q. How vascular plants considered as successful group of land plants.

Vascular plants are the successful group on land because of well adapted to the life on land by the following ways.

1. Gametophyte is reduced and well protected in the independent sporophyte tissues.
2. Fertilization is not dependent on water. Male gametes are carried within pollen grains and dispersed by wind or insects.
3. Flowering plants produce seeds and these remain in sporophyte plant.
4. These vascular plants are supported by xylem and sclerenchyma tissues. Secondary growth takes place and these become trees or shrubs.
5. True roots are present in vascular plants to absorb soil water.
6. Plants are having water proof cuticle or cork to protect them from desiccation.
7. The epidermis of aerial parts particularly leaves posses stomata for efficient gaseous exchange.

Q. Describe the economic importance of family Rosaceae.

This family has about 100 genera and 2000 species, found growing allover the earth 213 species of about 29 genera are reported from Pakistan.

Economic Importance

1. The members of this family are important in temperate region for fruits and ornamentals in homes, parks and gardens.
2. They rank third in commercial importance in the temperate zone among the families of the flowering plants.
3. The branches of Crataegus and cotoneaster provide excellent walking sticks and wood. The wood of Pyruspastia is used for making tobacco pipes.
4. In Asia their flower's petals of common rose usually called gulabs are used in making gulkand, and are also used in extraction of an essential oil, rose oil, used as perfume when distilled with water the petals give Rose-water or Ark-Gulab, which is used in eye disease, and for many other purpose.

Q. Describe the economic importance of family Soalnacea.

It has about 2000 species belonging to about 90 genera found in tropical and temperate regions. 52 species belonging to about 52 genera have been reported from Pakistan.

Economic importance

1. These plants provide drugs and food while some are ornamental.
2. Potatoes were introduced in 1500's and Ireland people were completely dependent on it.
3. In 1700,s tomatoes were introduced to different parts of the world mainly by Italian.
4. Capsicum spp. are rich in vitamin A and C and used as condiment.
5. Nicotiania tabacum the leaves of which are dried and made into tobacco, which is used in making cigarettes.

Q. Describe the economic importance of Legume Families (Fabaceae: Papilionaceae/ Pea family)

This family has about 9000 species belonging to 400 genera found distributed to all parts of the world. 587 species of 82 genera have been reported form Pakistan.

Economic Importance

1. The members of this family are the source of high-protein food, oil and forage as well as ornamentals.
2. Pulses are belonging to this family which are the food of great economic importance. Cicer aritinum (gram or thick pea Vern. Channa), Pisum Sativum (Pea Vern. Muttor), Lens esculanta (ver. Masure), Phaseolus aureus (mung beans Vern Mung) Phaseolus mung (Vern. Mash or urd), Phaseolus vulgaris (Kidney bean) all these pulses are rich in protein content.
3. Many trees like Butea, Dildurgia of this provide excellent timber for building, furniture and fuel.
4. The seed of Arachis hypogea Peanut or moong phalli are edible and also used for extraction of peanut oil which after hydrogenation is used as vegetable oil.
5. Indigo dyes are obtain form indigofera tinctoria (Vern. Neel) and Butea monosperma, yielding yellow dye from flowers.
6. Glycyrrhiza glabra is used as medicine for cough and cold, clitoria termatea used against snake bite.
7. The red and white seeds of Abrus precatorious are used by jewelers as weight called ratti.
8. Some of them are ornamental plants like Lathyrus, Lupinus, Clitoria, Butea etc.

Q. Describe the economic importance of family Mimosaceae (Acacia family).

This family has about 3000 species belonging to 56 genera are found growing in the world. 49 species of 11genera have been reported form Pakistan.

Economic Importance

1. These trees wood is used for construction purpose or for furniture or as a fuel example Albizzia and Xylia.
2. Arabic gum is obtained from Acacia nilotica and A. Senegal Katha a dye is obtained from Acacia catechu.
3. The tender leaves of Acacia nilotica are used as blood purifier.
4. Some common garden plants grown for their beautiful flowers Mimosa pudica, Acacia melanoxylon.
5. Few species of Prosopis are planted in the arid zones for breaking the wind pressure.

Descriptive Question and answers

Q. Describe the plants adaptation to land habitat.

Fossils records of the Silurian/ Devonian periods shows that plants made changes in their structure for the survival on land habitat due to change in environment in these eras for the following reasons.

1. Scarcity of water on land habitat as compare to marine habitat.
2. Carbon containing compounds are not available frequently on land.
3. Fluctuation of temperature on land habitat is much as the temperature in sea.

To overcome these problems, land plants first adopted themselves to amphibian habitat and later developed a complete terrestrial form of life. Plants adapted the following characters for their survival on land.

1. Rhizoids for water absorption
2. Conservation of water
3. Absorption of CO_2
4. Heterogamy
5. Protection of reproductive cells
6. formation of embryos

1. Rhizoids for water absorption

Plants produced **Rhizoids** which are thin, long hair like structures attached on the lower surface of the plant body for absorption of water from the soil.

2. Conservation of water

Plant body of bryophytes called thallus which is many cells thick to conserve water. Moreover the outer and uppermost layer of cells is covered with cuticle to slower down the rate of transpiration..

3. Absorption of CO_2

Land plants need effective exchange of gases from the environment. In bryophytes, on the upper surface of *Marcantia* thallus lies small pores which open inside into air chambers containing photosynthetic cells present in a large area. The CO_2 from air diffuses into the cytoplasm of these cells and used in photosynthesis.

4. Heterogamy

Bryophytes produce two morphologically different gametes termed as heterogametes, male gametes motile, flagellated or ciliated and female gametes non motile contain reserve food material which is used after fertilization for nourishing the embryo.

5. Protection of reproductive cells

The male and female gametes of land plants are well protected by sex organs called antheridia and archegonia respectively. These are present on the apex of plant shoots along with hair like structures called **paraphyses** which prevent from dryness.

6. Formation of embryos

Land plants develop embryo protected in archegonia by coverings from desiccation and mechanical injury.

Q. Describe the Life cycle of Selaginella.

In ***Selaginella*** an important development is seen called **heterospory** i.e. two **types of haploid spores** are produced by meiosis in **two different types of sporangia**. The spores germinate to form **two types of gametophytes**, both of which are reduced in size.

1. **Microsporangia** - Sporogenous cells go through meiosis to establish haploid **microspores**. These cells later on produced by the mitotic divisions of a given haploid nucleuses of a microspore establish an antheridium which produces many swimming sperm cells. These are released only when the microspore wall ruptures. The sperm need water to swim.

2. **Megasporangia** - Sporogenous cells go through meiosis to establish haploid **megaspores**. These go through mitotic divisions within the spore coat to establish a **mass of food storing cells** (representing the relictual vegetative thallus), and a few archegonia, each of which contains an egg cell.

3. The megaspores are shed and their coats break open to expose the archegonia. The sperm from the microspores that have been shed can then swim to the archigonium and fertilize its egg. The diploid zygote then divides mitotically to form an embryo and, eventually, the new sporophyte.

Q. Describe the life cycle of fern

Ferns have an alternation of generations involving haploid gametophytic and diploid sporophytic phases.

The gametophyte generation of the fern begins with the production of haploid spores in the sporangium. In the young sporangium, the diploid (2N) spore mother cell undergoes meiosis and produces four haploid cells that divide mitotically to form the mature spores.

The mature sporangium has special thickened cells along one side called the annulus that react to changes in humidity. The spores are dispersed by the rapid movement of the dehiscing sporangium which splits between two lip cells. This young gametophyte has chloroplasts and continues to grow via mitotic divisions an apical cell. Eventually, a large, heart-shaped prothallus is formed.

Sperm cells are formed in an antheridium and when released are individually enclosed in "vesicles". On the underside (ventral) of the prothallus, archegonia are frequently clustered around the apical notch as evidenced by the protruding archegonial necks. Each archegonium contains a single egg that is embedded in the prothallus. Water is required to allow the motile sperm to swim to the opening of the archegonium (drawn there by a chemical attractant). At the moment of fertilization, the nuclei of sperm and egg fuse and a diploid zygote is formed. This begins the sporophytic generation again. The zygote divides mitotically to form and embryo and eventually a tiny sporophytic plant.

Q. Describe in detail the life history of Pinus.

This genus requires three years for completion of life cycle. Pollination, fertilization and maturation of seeds take place at different times. Pines are heterosporous by having with megaspores and microspores borne in ovulate and staminate cones respectively. The sporophyte bears two types of reproduction structures referred to as male and female cones.

<u>The Male cone</u>

The "male" cones typically are found in clusters at the tips of lower, side branches, and usually take several years to develop. In these cones, the modified leaves are called **microsporophylls**. Each microsporophyll bears a **microsporangium** in which the **microspores** are produced. Still inside the microsporangium, each microspore divides and "grows" to form a four-celled (four nuclei) **male gametophyte**, also known as **pollen** which contains two sperm nuclei.

The Female cone

The female cones typically form higher up in the tree, and also usually take several years to develop. Their modified leaves/scales are called **megasporophylls** and produce **megaspores**. Each scale (megasporophyll) has two areas (megasporangia or **ovules**) where megaspores can develop. Each ovule has a **micropyle** (**pyle** = gate, orifice), a small hole in the near end of the ovule wall so the sperm can enter.

Female gametophyte

Meiosis of megaspore mother cell gives a row of four haploid nuclei. Usually three degenerate. The remaining one develops into the female gametophyte. This germination and development of the female gametophyte takes up to thirteen months, and occurs within the ovule. Eleven mitotic divisions occur before any cell walls separate the nuclei. This is the free nuclear stage. Cell walls will then begin to form. At this time, two or more archegonia begin to differentiate at the micropylar end. At this point the ovule consists of integuments, nucellus and gametophyte. Gametophyte contains several archegonia, each with an egg cell. A micropylar chamber is beneath the micropyle.

Pollination

Consists of transfer of pollen grain from the staminate cone to the ovulate cone, by means of wind. Cross pollination aided by the fact that the staminate cones are below the ovulate cones, thus the pollen has to travel some distance before rising to the height of the ovulate cones. This occurs in early spring, shortly after emergence of the ovulate cone. As pollen grains fall toward the axis of the ovulate cone they come in contact with a sticky secretion from the ovule, which aids in drawing the pollen into the micropylar chamber, near to the developing gametophyte. Now the male gametophyte begins to germinate from the pollen grain, i.e. pollen tube. Thus both male & female gametophytes develop within the ovule, and are nourished by nucellus.

Male gametophyte

The pollen grain is separated from the archegonia by a layer of nucellus. It is through this nuclear material that the pollen tube grows, digesting it as it grows. As it grows, the generative cell divides, forming stalk cell & body cell, which then divides to form 2 sperm nuclei.
A mature male gametophyte then contains a pollen tube, 2 sperm nuclei, and several vegetative nuclei.

Fertilization

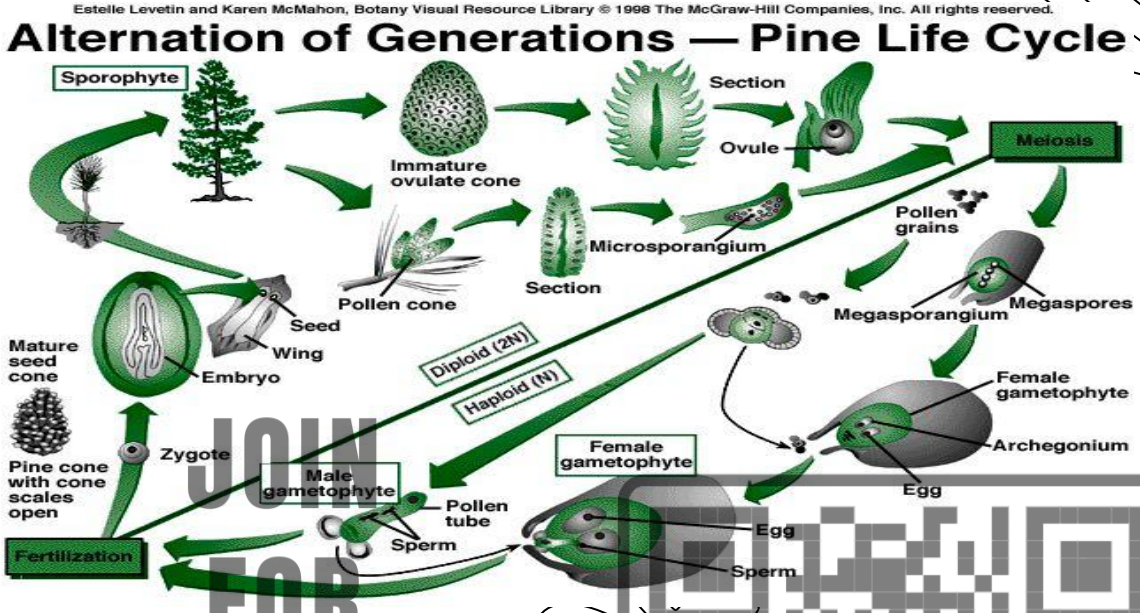
After about one year, the male & female gametophytes are mature, and the pollen tube with sperm nuclei has reached the archegonia. At this time, the contents of the male gametophyte are emptied directly into the egg cell. One of the sperm nuclei fuses with the egg nucleus, the remaining sperm nucleus and vegetative portions quickly disintegrate.

Embryo

The first step is the formation of a proembryo. The zygote nucleus divides twice to give 4 free nuclei, which move to chalazal end of the egg cell. 2 more mitoses result in four tiers of 4 cells. The 4 cells farthest from the micropyle will form the embryo, while the remaining cells may form suspensor cells which push the embryo deep into the gametophyte tissue toward chalazal end

gametophyte. continues to grow and store food for the developing embryo, and for food reserves in the seed. Several embryos may form in a single seed, but usually only one develops.

The mature embryo consists of several cotyledons, a shoot tip, a hypocotyl and a radicle. The embryo & gametophyte are surrounded by two layers - 1. dried nucellus or perisperm, 2. seed coat from ovule integument. The entire structure is the seed. Seed maturity occurs about 12 months after fertilization. Seeds may be dormant for many years. Some remain in cones until burned by fire, others shed seeds readily.



Q. Describe the life cycle of an angiosperm

The angiosperm life cycle possesses the following advances over conifers:

- Reproductive structures are flowers rather than cones.
- Ovules embedded in female sporophylls rather than lying bare on the surface
- Gametophyte still further reduced
- Double fertilization to produce a diploid triploid endosperm nutritive material
- Seeds enclosed in fruits that develop from the ovary or related structures

The angiosperm life cycle begin with the development of the diploid flower on the mature sporophyte plant.

- Within the anther microsporocytes develop and undergo meiosis to produce haploid microspores.
- Each of these undergoes one mitotic division to yield a generative cell and a tube cell.
- These together comprise the immature microgametophyte, or pollen grain.
- The generative cell completes a second mitotic division to produce two sperm nuclei. Inside the ovule a single megasporocyte develops, undergoes meiosis, and produces four haploid megaspores.
- Three of these degenerate, while the fourth undergoes three mitotic divisions to produce an eight-nucleate embryo sac, or mature megagametophyte.
- Upon pollination, the pollen grain germinates on the stigma; a pollen tube grows down the style and into the ovary via the micropyle.
- One sperm nucleus fuses with the egg to create a diploid zygote, while the other sperm nucleus fuses with the two polar nuclei to produce the nutritive, triploid endosperm.
- This process of double fertilization is unique to flowering plants. The embryo develops inside the embryo sac, integuments of the ovule form a protective seed coat around it, and the mature ovary forms a protective fruit around the seed.
- Eventually the seed is shed from the fruit and the embryo temporarily suspends development in order to overwinter.
- Upon receipt of the proper hormonal and environmental cues, seed germination occurs and the embryo grows into a mature diploid sporophyte which produces flowers to complete one cycle of the alternation of generations.

Q. Describe the following families in detail.

Family Rosaceae

- It has about 100 genera and 2000 species, found growing allover the earth 213 species of about 29 genera are reported from Pakistan.
- **Inflorescence:** Variable solitary flowered to racemose and cymose cluster.
- **Flowers:** Bisexual and actinomorphic, hypogynus to epigenous.
- **Calyx:** Sometimes epicalyx is present sepals 5 free or fused.
- **Corolla:** Petals 5, or numerous in multiple of 5, free imbricate rosaceous, large and showy and usually conspicuous.
- **Androecium:** Numerous stamens, sometimes only 5 or 10 free usually bent inward in the bud state; anther small bilocular.
- **Gynoecium:** A simple pistil of 1 to numerous separate carpels, united into a compound pistil, often adinate to the calyx tube; ovary superior to inferior; ovules usually 2 or more per carpel; placentation basal when the carpel is one or apocarpous, but axial when the carpels are many and syncarpous; style simple, as many as the carpels, free or united, stigma linear, spathulate or capitate.
- **Floral Formula:**
- **Diagnostic characters:** Rosaceous corolla, stamens numerous, polyandrous, monocarpellary or polycarpellary syncarpous may be apocarpous.
- **Economic Importance:**

1. The members of this family are important in temperate region for fruits and ornamentals in homes, parks and gardens.
2. They rank third in commercial importance in the temperate zone among the families of the flowering plants.
3. The branches of Crataegus and cotoneaster provide excellent walking sticks and wood. The wood of Pyruspastia is used for making tobacco pipes.
4. In Asia their flower's petals of common rose usually called gulabs are used in making gulkand, and are also used in extraction of an essential oil, rose oil, used as perfume when distilled with water the petals give Rose-water or Ark-Gulab, which is used in eye disease, and for many other purpose.

Familiar Plants:

	Botanical names	**Common names**	
1.	*Pyrus malus*	Apple	seb
2.	*Pyrus communis*	Pear	Nashpati
3.	*Prunus Persia*	Peach	Aru
4.	*Prunus amygdalus*	Almond	Badam
5.	*Rosa indica*	Rose	Gulab

Family Soalnacea

- It has about 2000 species belonging to about 90 genera found in tropical and temperate regions. 52 species belonging to about 52 genera have been reported from Pakistan.
- **Inflorescence:** Typically an axillary cyme or combination of cymes some times helicoids, or axillary umbellate cymes.
- **Flowers:** Bisexual usually actinomorphic or weakly zygomorphic bracteate or ebracteate, hypogynus, usually pentamarous.
- **Calyx:** 5 united sepals, usually persistent.

- **Corolla:** 5 united petals, corolla rotate tubular or infundibuliform.
- **Androecium:** 5 Stamens, polyandrous, epipetalous inserted on the corolla tube and alternate with its lobes, filament usually of unequal length.
- **Gynoecium:** Bicarpellary syncarpous, ovary obliquely placed, superior bilocular or imperfectly tetra-locular by false septum, style terminal, simple or lobed, placentation axial, ovule numerous.
- **Floral Formula:**
- **Diagnostic characters:** Stem with bicollateral vascular bundles, leaves alternate becoming opposite near inflorescence; stipules absent flower actinomorphic pentamerous, stamen 5, epipetalous ovary bi-locular, obliquely placed, placentation axial, fruit berry or capsule.
- **Economic importance:**
  1. These plants provide drugs and food while some are ornamental.
  2. Potatoes were introduced in 1500's and Ireland people were completely dependent on it.
  3. In 1700,s tomatoes were introduced to different parts of the world mainly by Italian.
  4. Capsicum spp. are rich in vitamin A and C and used as condiment.
  5. Nicotiania tabacum the leaves of which are dried and made into tobacco, which is used in making cigarettes.

Familiar Plants

Botanical names	**Common names**
1. *Solanum tuberosum*	Potato
2. *Solanum melongena*	Brinjal
3. *Lycopersicum esculentum*	Tomato
4. *Capsicum anum*	Red-pepper
5. *Datura alba*	Thorn apple

Legume Families
Fabaceae: Papilionaceae/ Pea family

- This family has about 9000 species belonging to 400 genera found distributed to all parts of the world. 587 species of 82 genera have been reported form Pakistan.
- **Inflorescence:** Racemose or solitary axillary.
- **Flowers:** Bisexual, zygomorphic, bracteate, pedicellate, hypo-to perigynous.
- **Calyx:** Sepals, more or less united in a tube, mostly hairy.
- **Corolla:** Papilionaceous, Petals 5, the odd outer petal is large and conspicuous and is called standard or vexillum, two lateral ones free called wings and 2 anterior inner most that fuse to form a boat-shaped structure called the keel or carina, descending imbricate.
- **Androecium:** 10 stamens, mostly diadelphous 9 fused to form sheath round the pistil, while 10th posterior one is free.
- **Gynoecium:** A simple; style long, bent at its base flattened and hairy, stigma simple.
- **Floral formula:**
- **Diagnostic character:** Papilionaceous corolla, 10 stamens, diadelphous, monocarpellary.
- **Economic Importance:**
  1. The members of this family are the source of high-protein food, oil and forage as well as ornamentals.
  2. Pulses are belonging to this family which are the food of great economic importance. Cicer aritinum (gram or thick pea vern. Channa), Pisum sativum (Pea vern. Muttor), Lens esculanta (ver. Masure), Phaseolus aureus (mung beans vern Mung) Phaseolus mung (vern. Mash or urd), Phaseolus vulgaris (Kidney bean) all these pulses are rich in protein content.

3. Many trees like Butea, Dildurgia of this provide excellent timber for building, furniture and fuel.
4. The seed of Arachis hypogea Peanut or moong phalli are edible and also used for extraction of peanut oil which after hydrogenation is used as vegetable oil.
5. Indigo dyes are obtain form indigofera tinctoria (vern. Neel) and Butea monosperma, yielding yellow dye from flowers.
6. Glycyrrhiza glabra is used as medicine for cough and cold, clitoria termatea used against snake bite.
7. The red and white seeds of Abrus precatorious are used by jewelers as weight called ratti.
8. Some of them are ornamental plants like Lathyrus, Lupinus, Clitoria, Butea etc.

Familiar Plants:

Botanical names	Common name
1. *Lathyrus odoratus*	Sweet pea
2. *Arachis hypogea*	Pea-nut
3. *Cicer arietinum*	Gram
4. *Dalbergia sisso*	Red wood
5. *Pisum sativum*	Edible-pea
6. *Sesbania aegyptica*	Sesbania

Mimosaceae: Acacia family

This family has about 3000 species belonging to 56 genera are found growing in the world. 49 species of 11genera have been reported form Pakistan.

- **Inflorescence:** Spike like a head or umbel rarely racemose or globose umbels
- **Flowers:** Bisexual, Actinomorphic, bracteate, pedicellate, hypogynous.
- **Calyx:** Usually 5 Sepals, valvate, free or fused, corolla lobed
- **Corolla:** 5 petals, valuate, free or fused, corolla lobed.
- **Androecium:** 5 to numerous stamens, free monoadelphous, adinate to the base of corolla; anther versatile often crowned by a deciduous gland.
- **Gynoecium:** A simple pistil of I carpel, ovary unilocular superior ovules many placentation marginal, style long filiform, stigma terminal minute.
- **Floral formula:**
- **Diagnostic character:** Five fused sepals, 5 free or fused petals, androecium or 10 monoadelphous monocarpellary.
- **Economic Importance:**
  1. These trees wood is used for construction purpose or for furniture or as a fuel example Albizzia and Xylia.
  2. Arabic gum is obtained from Acacia nilotica and A. Senegal Katha a dye is obtained from Acacia catechu.
  3. The tender leaves of Acacia nilotica are used as blood purifier.
  4. Some common garden plants grown for their beautiful flowers Mimosa pudica, Acacia melanoxylon.
  5. Few species of Prosopis are planted in the arid zones for breaking the wind pressure.

Chapter 10

KINGDOM ANIMALIA

(animals)

Short question and answers

Q. Briefly describe kingdom Animalia.

All animals are members of the Kingdom Animalia, also called Metazoa. Somewhere around 9 or 10 million species of animals inhabit the earth; the exact number is not known and even our estimates are very rough. By far most species of animals are insects, with groups such as mollusks and nematodes also being especially diverse. This Kingdom does not contain the prokaryotes all members of the Animalia are multicellular, and all are heterotrophs (that is, they rely directly or indirectly on other organisms for their nourishment). Most ingest food and digest it in their gastro-vascular cavity.

Q. What do we man by diversity and complexity?

Most animals shows variation in their characteristics all these variations are leading towards diversity in living forms like, most animals are capable of complex and relatively rapid movement compared to plants and other organisms. Most reproduce sexually, by means of differentiated eggs and sperm. Most animals are diploid, meaning that the cells of adults contain two copies of the genetic material.

Organism's complexity in body structure increases when they reach the status of tissue level to organ level grade of body organization. Animals range in size from no more than a few cells like microscopic parazoan Trichoplax to organisms weighing many tons, such as blue whales (to 40 meters long and weighs more than 160,000 Kg. Balaenoptera) and giant squid. Among these extremes a huge range of animals differs not only in size but also in having no organ to a highly specialized organ system.

Q. What are the developmental patterns in animals?

The development of most animals is characterized by distinctive stages, including a zygote, formed by the product of the first few division of cells or cleavage following fertilization called initially **morula**; a **blastula**, which is a hollow ball of cells formed by the developing zygote; and a **gastrula**, which is formed when the blastula folds in on itself to form a double-walled structure with an opening to the outside, the blastopore.

Q. What is the cellular organization in animals?

Animal cells lack the rigid cell walls that characterize plant cells. The bodies of most animals (all except sponges) are made up of cells organized into tissues; each tissue specialized to some degree to perform specific functions. In most, tissues are organized into even more specialized organs these are called Eumatazoa (true Metazoans). Only Phylum Porifera is grouped in a separate sub kingdom Parazoa because of lack of a proper tissue organization.

Q. What are diploblastic and triploblastic organisms?

Diploblastic Organisms:

Animals which develop two germinal layers ectoderm and endoderm are called diploblastic organisms like Cnidarians.

Tripoblastic Organisms:

Animals in which three germinal layers ectoderm, endoderm and mesoderm are formed called triploblastic organisms. Like annelids chordates etc.

Q. Write a note on symmetry.

Symmetry

Symmetry is the overall shape of the body or regularity of figure e.g. frog Planaria. Animals that have no plane of symmetry are said to be asymmetrical e.g. sponges. There are two types of symmetry generally present on living organisms.

a) Bilateral symmetry

When an animal have two identical halves of the body along any one specific axis are called bilateral symmetrical e.g. Frog.

b) Radial Symmetry

A body which has one main axis around which body parts are arranged and the organism can be divided in to identical halves in any plane that passes through the main axis is called radially symmetrical e.g. star fish.

Q. Describe coelom and its types

Coelom is a body cavity which is of two types.

True Coelom

A body cavity which is formed by the displacement of mesodermal cells or lined by mesodermal cells is called coelom e.g. form Annelids to Chordates

False Coelom

A body cavity which is not formed by the mesodermal cells is called false coelom or Pseudocoelom e.g. Nematodes.

Acoelomates

These animals lack a body cavity e.g. Platyhelminthes.

Q. Describe the fate of blastopore.

Blastopore is the opening of embryonic stage which later form either mouth or anus of the animal.

Coelomates are categorized in to two bases on the basis of fate of blastopore.

Protosomes

In this group of organism's blastopore eventually becomes the mouth of adult. E.g. annelids, molluscs and arthropods.

Duterostomes

In this group of organism's blastopore develops in to anus and second openening later forms the mouth. E.g. Echinodermata and chordata.

Q. Write a note on phylum Porifera.

Sponges are a diverse group of sometimes common types, with about 5000 species known across the world. Sponges are sessile and primarily marine, but around 150 species live in fresh water. Sponges have cellular-level organization, meaning that that their cells are specialized so that different cells perform different functions, but similar cells are not organized into tissues and bodies are a sort of loose aggregation of different kinds of cells. Body wall diploblastic with outer

pinacoderm (dermal epithelium), inner choanoderm (gastral epithelium) and gelatinous non-cellular mesenchyme in between; mesenchyme consists of skeletal elements and free amoeboid cells, porocyte cells form pores.

They are supported by a skeleton made up of the protein collagen and calcareous or siliceous spicules. Sponges capture food (detritus particles, plankton, bacteria) that is brought close by water currents created by the choanocytes. Food items are taken into individual amoeboid cells by phagocytosis, and digestion occurs within individual cells.

All sponges are hermaphrodite but cross- fertilization is usually present. Reproduction in sponges is by both sexual and asexual means. Asexual reproduction is by means of external buds. Some species also form internal buds, called gemmules, which can survive extremely unfavorable conditions that cause the rest of the sponge to die.

Q. Describe the body forms in Cnidarians.

Cnidarians have two basic body forms, medusa and polyp.

Medusae,

These are umbrella-shaped bodies and tetramerous (four-part) symmetry such as adult jellyfish. These are free-swimming or floating.. The mouth is usually on the concave side, and the tentacles originate on the rim of the umbrella.

Polyps,

These are tubular bodies and usually sessile. At one end body is attached to the substrate, and a mouth (usually surrounded by tentacles) is found at the other end. Polyps may occur alone or in groups of individuals; in the latter case, different individuals sometimes specialize for different functions, such as reproduction, feeding or defense.

Q. Write a note on Zooids in Cnidarians.

Cnidarians have specialized group of cells performing specific function called Zooids, which are generally interdependent. There are three types of Zooids present Dactylozooid: These are use for defensive or offensive purpose.

Gonozooid: These are use for reproduction.

Gastrozooid: These are use in digestion.

Q. Describe the Polymorphism in Cnidarians.

Polymorphism is common in Cnidarians which is "The occurrence of species in two or more structurally and functionally different kind of Zooids is known as polymorphism". Or "When an organism is found in more then one forms during its life cycle this phenomenon is called polymorphism."

Q. Describe the structure of Cnidoblast in cnidarians.

Cnidoblasts are the specialized structures formed by epidermis and used for defense, offence or to capture prey. These are found through out the epidermis but specially on the tentacles. These are somewhat oval-shaped cell contain nematocyst or stinging structure. The nematocyst is enclosed in a rounded capsule consists of thread or a coiled tube containing spines and stylets. The spines are more than 50 in numbers. In the nematocysts is a poisonous toxin made of a mixture of protein and phenols. These are capable even of penetrating human skin, sometimes producing a painful wound or in extreme cases, death.

Q. Describe the structure of nematocyst in cnidarians.

Nematocyst is a chitinous non living structure present in the Cnidoblast. Cnidoblast cells secrete a double walled chitinous capsule which has a lid or operculum. One end of the capsule forms a tube lying coiled in the capsule with a basal swelling with barbs and a long coiled thread which can be open and closed at the tip. Inside the tube are some spines this whole structure is called a nematocyst.

Q. Write note on phylum Platyhelminthes.

This phylum includes about 15000 species and these are generally called flat worms because of their flat and soft body. Tissue-organ grade of body organization the body cells form definite tissues and the tissues make up organs. Triploblastic and organisms do not have any body cavity. These organisms are bilaterally symmetrical. Dorsoventraly flattened body, mouth and gonopores present on the ventral surface. Their size ranges form microscopic to several meters. Adhesive structures like hooks, spines and suckers and adhesive secretions are common in mouth of the parasitic forms. Digestive system consists of branched intestine. Excretion and osmoregulation by flatworms is controlled by "flame cells" or protonephridia. Flatworms lack a respiratory or circulatory system; these functions take place by absorption through the body wall.

Nonparasitic forms have a simple, incomplete gut; even this is lacking in many parasitic species. Mostly monoecious or hermaphrodite with complex reproductive system; Most flatworms can reproduce sexually or asexually. Development may be direct or indirect. These are free swimming, commensals or parasitic forms.

Examples; Taenia solium (tape worm) , Fasciola hepatica (liver fluke) etc.

Q. Describe the parasitic adaptations in Platyhelminthes.

- Their thick body covers protect them against defense mechanisms of host body.
- The spines, suckers and hooks developed for attachment and replace the locomotory organs, which are not needed by parasitic animals.
- Alimentary canal is reduced, even absent as in Taenia, because of the availability of the digested food from the host.
- Neurosensory organs are not developed due to their passive mode of life.
- Reproductive system is very much developed.
- Fertility rate is very high to cope with chances of danger from the defense mechanism of the host body.

Q. Describe the characteristics of phylum Nematoda.

Nematodes are almost unbelievably abundant. One study reported around 90,000 individual nematodes in a single rotting apple. Another reported 236 species living in a few cubic centimeters of mud. The number of described species is around 12,000, but too little attention has been paid to these animals and the true number may be closer to 500,000.

- **Size:**
  Their size ranging from microscopic to 9 meters. They are tubular and pointed at both ends.
- **Mode of living :**
  Many nematodes are free living and play critical ecological roles as decomposers and predators on microorganisms. These are also parasites of animals and plants.
- **Body wall:**
  Body wall with non-living cuticle, acellular epidermis and longitudinal muscle cell in four bands are present. No cilia; no circulatory and respiratory system.
- **Digestive system:**
  Digestive system completes with muscular pharynx and glands.
- **Nervous system :**
  Nervous system with circumcentric ring and anterior and posterior nerves.

- **Reproductive system:**
  Most nematodes are dioecious means both male and female are separate. Development of fertilized eggs is usually direct.
- **Fertilization:**
  Fertilization internal, developments usually direct. Enormous numbers of eggs produced by the females.
  These are grouped into two classes i.e. **Phasmida** and **Aphasmida**.
  Examples ; *Ascaris* (round worm), *Ancylostoma* (Hook worm)

Q. Describe the segmentation in Annelids.

All members of the group are to some extent segmented, in other words, made up of segments that are formed by subdivisions that partially transect the body cavity. Segmentation is also called metamerism. Segments each contain elements of such body systems as circulatory, nervous, and excretory tracts. Metamerism increases the efficiency of body movement by allowing the effect of muscle contraction to be extremely localized, and it makes possible the development of greater complexity in general body organization..

Q. Describe the Advantages of segmentation and coelom.

- Segmentation increases flexibility allowing various parts of the body to bend independently of the other parts.
- Increased flexibility enhances locomotory power.
- The coelom improves swimming or burrowing activities of the annelids by serving as a hydrostatic skeleton.
- In many annelids coelom collects metabolic waste discharged by excretory organs.
- It also provides space for maturation of eggs and sperms.

Q. Describe the economic importance of Annelids.

- Earthworms help farmers by continuously ploughing the soil and adding nitrogenous waste into it thus making the soil more fertile.
- Chinese, Japanese and Indians use them in preparation of various fancy medicines.
- They are also used as a fish bait, as a food of fish.
- These are also used in laboratory for dissections and other research activities.
- Leeches are ectoparasites and suck foul blood from a patient.
- A few annelids are also carrier of some diseases.

Q. Describe the economic importance of Mollusca.

- Members of this phylum are used as food.
- Their shells are used as decorative.
- They secrete a mixture of calcium carbonate and protein is called Nacre or mother of pearl which is deposited around foreign particle and form pearl a precious jewelry item.
- Pearl culture industry is successfully run in Japan and China.

Q. Write a note on phylum Arthropoda.

Arthropoda is the largest phylum of the animal kingdom, and include millions of species. Arthropods include an incredibly diverse group of taxa such as insects, crustaceans, spiders, scorpions, and centipedes. There are far more species of arthropods than species in all other phyla combined, and the number of undescribed species in the largest assemblage of arthropods, the insects, probably numbers in the tens of millions. Members of the phylum have been responsible for the most devastating plagues and famines mankind has known. Yet other species of arthropods are essential for our existence, directly or indirectly providing us with food, clothing, medicines, and protection from harmful organisms.

Q. What are the functions of jointed legs in Arthropoda.

Primitively, each body segment bears a pair of segmented (jointed) appendages; in all living arthropods, many of these appendages are dramatically modified or even lost. Jointed legs whenever present with varied functions. Like swimming, digging, walking, capturing prey, jumping etc. in different species.

Q. What are the components of exoskeleton in arthropods.

The body is covered with an exoskeleton made up primarily of the protein chitin; lipids, other proteins, and calcium carbonate also play a role. Exoskeleton of chitinous cuticle that is shed at intervals this phenomena is called moulting or ecdysis.

Q. Describe the metamorphosis in Arthropoda.

Def; "A process in which series of gradual changes occur which help to transform larval forms in to adult forms are collectively known as Metamorphosis."

These changes are influenced by hormonal and physiological activities.

Metamorphosis is divided in to two types:

Complete Metamorphosis in which larva hatches out of the egg and develops into adult by passing through the stage of pupa and in all these forms do not resemble with the adult. Example Butterfly.

Incomplete Metamorphosis in which nymph hatches out of the egg and develops into adult without passing through the stage of pupa and resemble with the adult. Example Cockroach.

Moulting or Ecdysis: Insects shed their exoskeleton form time to time and form the new one this mechanism of changing exoskeleton is called Moulting or Ecdysis.

Q. Why insect are considered as successful group on land?

Insects are the most successful group of organisms, which are found in allover the world, and in every habitat.

- These can bear the temperature ranging from –65 to 50C.
- These are adapted for any habitat du to various structural and physiological modifications and social adaptations.
- Structural modifications include developed brain and sense organs, developed mouth parts in accordance with the requirements of different kind of food, a protective exoskeleton, development of wings and jointed appendages.
- Physiological modifications include the production of variety of digestive enzymes high reproductive potential and metamorphosis which have collectively increased their chances of survival even in the extreme environments.
- As social insects, they live in a co-ordinated society, which increases the adaptability to the environment and enhances the chances of their survival.

Q. Describe the economic importance of insects.

Insects are incalculably valuable to man. Usually, we think of them in a negative context. Insects eat our food, feed on our blood and skin, contaminate our dwellings, and transmit horrible diseases. But without them, we could not exist. They are a fundamental part of our ecosystem. A brief and incomplete list of their positive roles would include the pollination of many, perhaps most higher plants; the decomposition of organic materials, facilitating the recycling of carbon, nitrogen, and other essential nutrients; the control of populations of harmful invertebrate species (including other insects); the direct production of certain foods (honey, for example); and the manufacture of useful products such as silk and shellac.

Q. Describe the water vascular system of echinoderms.

Echinoderms have a water vascular system consisting of a network of radial canals, which extend through each of the five extensions (arms or rays) of the animal. The water vascular system opening, called a madreporite which opens backward in to stone canal then ring canal and then five radial canals. Each radial canal has lateral connections which lead to a tube foot, which may be composed of three parts. Internally is the ampulla and externally is the podia. At the end of the podia is usually a sucker.

Q. Describe the characters of phylum Chordata.

All chordates have the following features at some point in their life (in the case of humans and many other vertebrates, these features may only be present in the embryo):

- **Pharyngeal slits** - a series of openings that connect the inside of the throat to the outside of the "neck". These are often, but not always, used as gills.
- **Dorsal nerve cord** - a bundle of nerve fibers which runs down the "back". It connects the brain with the lateral muscles and other organs.
- **Notochord** - cartilaginous rod running underneath, and supporting, the nerve cord.
- **Post-anal tail** - an extension of the body past the anal opening
- **Body wall –**triploblastic with three germinal layers: ectoderm endoderm, mesoderm
- **Body size -** small to large, usually bilaterally symmetrical and metamerically segmented
- **Digestive system –** complete with digestive glands.

Q. Describe the division of Chordata.

Phylum Chordata is divided into two groups on the basis of skull.

1) Acraniata or Protochordata and 2) Craniata or Veretebrata

Group: Acraniata or Protochordata

1. All marine, small, primitive or lower chordates.
2. These organisms does not have skull.
3. Notochord does not transform into vertebral column.

Protochordata or Acraniata is divided into two subphyla.

a) Urochordata b) Cephalochordata

Group: Craniata or Vertebrata

1. Notochord (vertebral column), dorsal nerve cord, pharyngeal gill pouches, and postanal tail - all present at some stage of the life cycle or at least in embryonic stages.
2. Integument basically of two layers, an outer epidermis and inner dermis of connective tissues.
3. Notochord is replaced in jawed vertebrates by the vertebrae composed of cartilage, bone or both.

Q. Describe the characteristics of Urochordata.

In this subphylum 1250 species of Tunicates are identified.

- The Urochordata, sometimes known as the Tunicata because these are covered in a protective cover called Tunic and are commonly known as "sea squirts."
- The body of an adult tunicate is quite simple, being essentially a sack with two siphons through which water enters called incurrent or buccal siphon and exits by excurrent siphon. Water is filtered inside the sack-shaped body.
- The pharynx is lined by numerous cilia whose beating creates a current of water that moves into the pharynx and out the numerous gill slits.

- Many tunicates have a larva that is free-swimming and exhibits all chordate characteristics: it has a notochord, a dorsal nerve cord, pharyngeal slits, and a post-anal tail. This "tadpole larva" will swim and it eventually attaches to a hard substrate, it loses its tail and ability to move, and its nervous system largely disintegrates this phenomenon is called retrogressive metamorphosis. Some tunicates are entirely pelagic.
- Notochord and nerve cord only present in Tadpole larva.

Q. Describe the characteristics of subphylum Cephalochordata.

- In this subphylum about 23 species are identified in the genus *Branchiostoma*, formerly called Amphioxus.
- These marine chordates are only a few centimeters long.
- They usually lie partly buried in sandy or muddy substrates with only their anterior mouth and gill apparatus exposed.
- They feed on microscopic particles filtered out of the constant stream of water that enters the mouth and passes through the gill slits into an atrium that opens at the atriopore.
- The notochord extends from the tail to head and therefore these are called Cephalochordata.
- Muscles are segmentally arranged and the dorsal hollow nerve cord is present.
- Cephalochordates lack features found in most or all true vertebrates: the brain is very small and poorly developed, sense organs are also poorly developed, and there are no true **vertebrae**.

Today, amphioxus may be extremely common in shallow sandy environments: at Discovery Bay, Jamaica, up to five thousand individuals per square meter of sand have been reported. In some parts of the world, amphioxus is eaten by humans or by domestic animals; they are important food items in some parts of Asia, where they are commercially harvested.

Q. Describe the distinguishing features of Craniata or Vertebrata.

- The main features of chordates like notochord (vertebral column), dorsal nerve cord, pharyngeal gill pouches, and postanal tail, all present at some stage of the life cycle or at least in embryonic stages.
- Integument basically of two layers, an outer epidermis derived from the ectoderm and inner dermis of connective tissues derived from mesoderm; many modifications of skin among the various classes, such as glands, scales, feathers, claws, horns and hair.
- Notochord is replaced in jawed vertebrates by the vertebrae composed of cartilage, bone or both; distinctive endoskeleton consisting of vertebral column with the cranium, visceral arches, limb girdles and two pairs of jointed appendages is present.
- Muscular perforated pharynx.
- Many muscles attached to the skeleton to provide for movement.
- Complete digestive system is provided with large digestive glands, liver and pancreas is present.
- Circulatory system consisting of the ventral heart (2-4 chambers); a closed blood vessel system of arteries, veins and capillaries; blood fluid containing red blood corpuscles with hemoglobin and white corpuscles.
- Well developed coelom filled with visceral organs.
- Excretory system consisting of paired kidneys provided with ducts to drain waste to cloaca.
- Brain typically divided into five vesicles; 10 or 12 pairs of cranial nerves usually with both motor and sensory functions; an autonomic nervous system in control of involuntary functions of internal organs.
- Endocrine system of ductless glands scattered throughout the body.
- Nearly always separate sexes; each sex containing paired gonads with ducts that discharge their products either into the cloaca or into special openings near the anus.
- Body plan consisting typically of head, trunk and post-anal tail; neck present in some, especially terrestrial forms.

Q. Describe the characteristics of sub phylum Agnatha (Jawless fishes)

Characteristics

- These fishes have Eel shaped body. They are not laterally compressed.
- Endoskeleton is made up of Cartilage.
- Cartilage is light weight, strong and flexible.
- 7 gill openings present posterior to the eyes.
- Ammocoetes is filter feeding, free swimming larval stage for lamprey which lasts about 7 years; then they undergo a metamorphosis and become an adult.
- They have only dorsal and caudal fins with a hypocercal tail.
- Sucker contains horny denticles (look like teeth) with a series of "teeth".
- Very large notochord.
- Brain – large optic lobes, poorly developed cerebellum, ribbon like spinal cord closed circulatory system – 2 chambered heart.
  Examples:
  Lamprey, Hagfish

Q. Describe the characteristics of sub phylum Gnathostomata.

This is the large group of vertebrates in which both upper and lower jaws are present though teeth may be present or absent. Gnathostomata are divided in to two super classes Pisces and Tetrapoda.

- Vertically biting lower and upper jaws present and a number of dermal teeth attached with bones.
- A paired pelvic fins or limbs situated just in front of the anus.
- Gill arches which lie internally to the gills and brachial blood vessels, contrary to the gill arches of all jawless craniates, which are external to the gills and blood vessels.
- A horizontal semicircular canal present in the inner ear

Q. Describe the characteristics of class Pisces.

- All the members of this class are aquatic with integumentary scales.
- They respire with gills counter current respiration give 85% O_2 from water.
- Circulatory system close and single circuit type.
- Sensory System consists of lateral line present on both lateral surfaces of fishes that detects vibrations and movements in the water.
- Oviparous i.e. they lay eggs, except for Chondrichthyes.
- External fertilization except for Chondrichthyes
- Body covered by dermal scales and body provided with paired fins.
- About 25000 species known.

Q. Differentiate between Chondrichthyes and Osteichthyes.

Class Chondrichthyes – Cartilaginous Fish – Sharks and Rays	**Class Osteichthyes – Bony fishes** Ray finned fishes, Trout, Bass

• Endoskeletal system made of cartilage. • Mouth situated on ventral side of the body. • Tail is heterocercal. • Gills are not covered by operculum. • Scales are called **Placoid** which are tooth-like. • Most are **Ovoviviparous** i.e. internal fertilization with eggs retained in the oviducts. • Oxygen the only nourishment given. • Young or born alive. • Few sharks lay leathery-shelled eggs. • Males have claspers which are used to inject sperm.	• Skeletal system made of bone (osteocytes). Heavier and less flexible than cartilage. • Mouth situated interiorly. • Tail is Homocercal means both lobes are equal in length. • Operculum flaps covering gills present. Fish moves these to draw water into its mouth and over the gills. • Scales are dermal called **Cycloid.** • Swim Bladder to compensate for additional weight of bone. • Most are **Oviparous** - external fertilization occurs.

Q. Describe the characters of class Amphibia.

Class Amphibia includes the toads and frogs, salamanders.

- The class name Amphibia appropriately indicates that most of the species live partly in fresh water and partly on land.
- There are several new features that adapted them for terrestrial life, such as legs, lungs, nostrils connecting the mouth cavity, and sense organs that can function in both water and air.
- Amphibians are ectotherms formerly called poikilotherms because they maintain their body temperature by external sources. Like they borrow themselves in the mud in winter season which is called hibernation and in summer they do so again called aestivation.
- Class Amphibians are the lowest and earliest Tetrapoda, or land vertebrates.
- Development of limbs in place of paired fins.
- Replacement of the gills by lungs
- Changes in the circulatory system to provide for respiration by the lungs and skin.
- They have three chambered heart.
- Oviparous and egg without shell.
- Skin with out any external covering or exoskeleton.
- Larva must require aquatic habitat for development.
- Development by progressive and retrogressive metamorphosis.

Q. Describe the origin of Amphibia.

They undoubtedly derived from some fish-like ancestors called Rhipidistian, possibly in Devonian (408-360 mya (million years ago)) times. These are bony lobed fin fishes used to drag their bodies from pond to another by their fins which later on become limbs.

Those amphibians were from a few inches to 15 feet in length, some live in aquatic shallow and swampy stagnant water and some in terrestrial. Some of the large types of Triassic era were permanently aquatic, and several had degenerated to become limbless, like eels or snakes.

Salamanders appeared in the Cretaceous (144-65 mya) and were distinct from earliest frogs, which appeared in the Triassic. Both show degenerative trends in the skull by loss of bones.

A closest member of coelacanth fishes still live in the sea as a living fossil in small numbers.

Q. Why Amphibians are considered as Unsuccessful land Vertebrates.

Amphibians are considered as unsuccessful on land because of the following reasons.

- These are cold blooded animals they cannot bear the variation in temperature on land which restrict their distribution.
- Their thin skin cannot prevent the continuous loss of water that causes desiccation.
- Their eggs are small and without shell which cannot protect embryo on land.
- A larva hatches out in early stages and immediately required water for further development that may not be available all the time on land.

Q. Describe the characteristics of reptilians.

Characteristics of reptiles

- Reptilians include 5000 vertebrate species with dry skin which is covered by epidermal scales. Reptiles have tough skin made of the protein keratin.
- Class Reptilia is made up of the first animals to produce amniotic eggs. In this type of egg, the embryo develops in a fluid filled sac called an amnion. This prevents the egg from drying out, and allowed the reptiles to live only on land.
- Reptiles have scales or shell as exoskeleton.
- Reptiles periodically shed their skin in a process called molting.
- They have well-developed respiratory system with branched bronchial tubes in their lungs.
- Reptiles are homodont and have teeth adapted for holding prey rather than chewing it.
- Reptiles have good hearing and vision and a tongue is used for smell as well as taste. The only disadvantage to reptiles is that they are ectothermic, meaning they warm up by absorbing heat rather than generating their own heat, like birds and mammals.

Q. Describe the past history of reptiles.

The Mesozoic Age (225- 70 mya) is also known as the age of the reptiles because dinosaurs and other reptiles were the predominant animal during that period. Most of those species became extinct about 65 million years ago after a mass extinction possibly caused by a meteor or increased volcanic activity. ***Brontosaurs*** 82 ft. long and 20 ft. high whereas ***Tyrannosaurs*** 60 ft. high and most terrifying creature ever to roam the earth.

However, one lineage of dinosaurs became the birds, and an earlier lineage led to the mammals, which also became more abundant after the age of reptiles. Other reptiles became the current orders, which include Chelonia, the turtles and tortoises, Crocodilia, the alligators and crocodiles, Squamata and Sauria, the snakes, and Rhynchocephalia, assorted other reptiles.

Q. Why reptiles are considered as successful land vertebrates?

Reptiles are considered as successful on land because of the following reasons.

- Reptiles are successful on land because most importantly they have internal mode of fertilization and the amniotic egg permeable to gas but not for water.
- Secondly they have tough exoskeleton of scales and plates which not only protect body but also slow down the loss of water from the body.
- Kidneys are modified to retain water and excrete concentrated urine.
- They are more protected from predators by their appendages and venom.
- They have developed lungs to supply more oxygen for active muscular activity.

Common reptiles are ***Sphenodon*** living fossil found in New Zealand. ***Chelone mydas*** turtle found in Pakistan and crocodiles and venomous snakes etc.

Q. Describe the characteristics of class Aves.

There are about 9000 species of birds found and their study is called Ornithology while study of their nests are called Nidology. They range from a 2gms West Indies Humming bird to a 150 kg Ostrich. Birds are special they are the only vertebrates with the ability to fly. In addition to aerodynamics, birds must have a high surface- area-to-weight ratio and lots of power to fly.

Characteristics

- Body covered with feathers.
- Bones of the skeleton are thin, with air spaces.
- Forelimbs function as wings, not for grasping.
- Toothless beak.
- Body temperature is internally regulated.
- Heart is 4-chambered.
- They posses syrinx instead of larynx for producing sound.
- Fertilization internal and eggs large amniotic.
- Birds that have hooked beaks for tearing flesh are called **raptors**.

Q. Differentiate between Ratitae and Craniatae sub classes of Aves.

Modern birds are divided in to two groups.

1. Sub Class Ratitae

- These are flightless birds having sternum raft like without keel.
- Their wings are either vestigial or rudimentary and flight muscles are poorly developed. Example. Emu, Ostrich, Kiwi, Penguin.

2. Sub Class Craniatae

- These are flying birds having sternum with keel.
- Their wings and pectoral flight muscles are highly developed for flight.

Example: Sparrow, Pigeon etc.

Q. Describe the flight adaptations in birds.

Flight adaptations in birds

- **Muscles**
  The massive **pectoralis** brings the wing down in its power stroke. The **supracoracoideus** lifts the wing. These two muscles make up almost 35% of the total body weight, providing lots of power.
- **Feathers**
  Birds have an enormous number of feathers. Although they are light-weight, they may weight up to twice as much as the bird's skeleton.
- **Shape of the body**
  The stream lined spindle shaped body less resistance to air.
- **Organ reduction (Loss of weight)**
  No birds have teeth. The hand and foot have only 3 fingers and toes, each with only 1 or 2 phalanges. The fibula is degenerate and the caudal vertebrae have decreased in number. There is no urinary bladder, no external sex organs, and usually only one ovary.
- **Wings**
  Primary flight feathers are found on the fingers bones of birds. The **secondary** flight feathers are found on the fore arm. When birds are flying, movement of the hand with its large primaries forms a figure eight or oval in the air, the primary feathers providing the surface area for most of the **propulsion**.

- **Metabolism (Maintenance of body temperature)**
  Birds have a very high rate of metabolism to produce the energy needed for flight. Herbivorous species can digest berries and excrete waste from them in 15 to 30 minutes. Meat eaters can digest small mammals in 3 to 4 hours. This high metabolic rate maintains a high body temperature. Body temperatures in birds range from 38°C to 44°C, compared to mammals which range from 36°C to 39°C.
- **Circulation**
  The circulatory system of birds is very efficient. Their heart is $1^1/_2$ to 2 times larger than that of a equal-sized mammals. Smaller, highly active birds have proportionately larger and more rapidly beating hearts than those of larger birds. The heart rate ranges from 1000 beats per minute in a **hummingbird** to about 400 beats per minute in a domestic chicken.
- **Respiration**
  The respiratory system of birds makes up nearly 20% of the volume of the body, compared to less than 10% in mammals. Birds remove about 31% of the oxygen from inhaled air, while mammals remove only about 24%. The lungs of birds are molded to the ribs. Since there is no diaphragm, aeration of the lungs is accomplished by rib action alone.
- **Bones**
  Many of a bird's skeletal bones are not solid. These bones are hollow and have air spaces to reduce body weight and improve respiration. The breast bone is very broad to anchor the pectoralis muscle. Rigidity of the skeleton is obtained through the fusion of bones, the middle to lower vertebrae in particular.
- **Cervical vertebrae**
  All birds, even small ones, have a large number of cervical vertebrae (13 to 25). These saddle-shaped vertebrae permit great flexibility, allowing the bird to reach all parts of its body.

Q. Describe the characters of class Mammalia.

The Class Mammalia includes around 5000 species placed in around 26 orders. These are the most successful group living on land weighing from 2gms pigmy shrew to a blue whale up to 160,000 kg which is 40m long.

- All mammals share three characteristics not found in other animals: 3 middle ear bones and outer pinna; hairs; and the production of milk by modified sweat glands called mammary glands.
- Mammals have a muscular partition between thoracic and abdominal cavity called diaphragm.
- All the mammals are viviparous i.e. they give birth to their babies.

Q. When mammals originate on earth?

- Mammals seem to be emerged in Mesozoic era from Therapsid reptiles which are extinct and diversified and increased in number by the end of Cretaceous period (Mesozoic era).
- They were small like rats and mice.
- They were nocturnal and live on trees as arboreal or burrowing.
- During Cenozoic era there were placental mammals established, so it is called the Age of Mammals.

Descriptive questions and answers

Q. Describe in detail the characteristics of phylum Cnideria.

The Phylum Cnideria includes such diverse forms as jellyfish, hydra, sea anemones, and corals. This phylum include about 9000 species and commonly known as coelenterates.

- **Body organization :**
  The cell-tissue grade of body organization with most of the cells scattered and specialized for different functions and some forming a tissue, like a nervous tissue or nerve net.
- **Habitat :**
  All aquatic, some fresh water, but mostly marine.
- **Mode of life :**
  Solitary or colonial, sedentary or free swimming.
- **Symmetry :**
  Radial or bilateral symmetrical.
- **Body Forms:**
  Cnidarians have two basic body forms, medusa and polyp.
  Medusae, such as adult jellyfish, are free-swimming or floating. They usually have umbrella-shaped bodies and tetramerous (four-part) symmetry. The mouth is usually on the concave side, and the tentacles originate on the rim of the umbrella.
  Polyps, in contrast, are usually sessile. They have tubular bodies; one end is attached to the substrate, and a mouth (usually surrounded by tentacles) is found at the other end. Polyps may occur alone or in groups of individuals; in the latter case, different individuals sometimes specialize for different functions, such as reproduction, feeding or defense.
- **Zooids :**
  Cnidarians have specialized group of cells performing specific function called Zooids, which are generally interdependent. There are three types of Zooids present Dactylozooid: These are use for defensive or offensive purpose.
  Gonozooid: These are use for reproduction.
  Gastrozooid: These are use in digestion.
- **Polymorphism :**
  Polymorphism is common in Cnidarians which is "The occurrence of species in two or more structurally and functionally different kind of Zooids is known as polymorphism". Or "When an organism is found in more then one forms during its life cycle this phenomenon is called polymorphism."
- **Body wall**
  Body wall diploblastic with two or cellular layers outer epidermis and inner gastrodermis with a gelatinous mesoglea with cells and connective tissue.
- **Gastrovascular cavity :**
  The inner gastrovascular cavity often branched and divided by mesenteries (septa) and with only one opening, the mouth: short and slender tentacles encircle mouth.
- **Nematocysts :**
  One or both body layers with peculiar stinging cell organelles, called nematocysts present on tentacles. Hundreds or thousands of nematocysts may line the tentacles or surface of the cnidarians. They are capable even of penetrating human skin, sometimes producing a painful wound or in extreme cases, death.
- **Nervous system :**
  Nerve net of synaptic or non-synaptic pattern with diffuse conduction.
- **Muscular system :**
  Muscular system consists of epithelial and endothelial muscle cells. In some animals independent nerve fibers are present in the mesoglea.
- **Digestion :**
  Digestion is intracellular as well as extracellular.
- **Other systems :**

Respiratory, circulatory and excretory systems are absent.

- **Reproduction :**
  Reproduction in polyps is by asexual budding (polyps) or sexual formation of gametes (medusa, some polyps). Cnidarian individuals may be monoecious or dioecious. The result of sexual reproduction is a planula larva, which is ciliated and free-swimming.
- **Alternation of generations :**
  Life history commonly based upon alternation of generations or metagenesis, in which "sexual, free medusoid generation alternates with an asexual, sessile, usually colonial polypoid generation during life cycle".
- **Corals or Coral reefs :**
  Many polypoid Cnidarians secrete certain chemicals, which form a hard but dead protective covering around them. These are called Corals or Coral reefs.
- **Phylogeny :**
  Pylogeneticaly it is believed that the Cnidarians have evolved along one of the three evolutionary lines from protoctists. No other phylum of animals is thought to have evolved from Cnideria.
- Phylum Cnideria is divided into three classes, Hydrozoa, Scyphozoa, and Anthozoa.
  Examples: Physalia, Aurelia, Sea anemone.

Classes

Class 1. Hydrozoa

- These are solitary and fresh water or mostly colonial and marine and free swimming.
- Mesoglea noncellular.

Q. Describe the characters of phylum Annelida and its classes with their examples.

Phylum Annelida

These are commonly called segmented worms. There are about 15000 species of annelids known.

- **Body organization :**
  Organ system level of body organization, organs group in to form systems.
- **Habitat :**
  Mostly aquatic marine as well as fresh water; some terrestrial. Members of the Phylum Annelida can be found throughout the world, in marine, freshwater, and terrestrial environments. These are burrowing or tubicolous and ecologically.
- **Mode of living :**
  Sedentary or free living; some commensals and parasite. , they range from passive filter feeders to voracious and active predators
- **Symmetry :**
  Triploblastic, bilaterally symmetrical, Coelomates.
- **Segmentation :**
  All members of the group are to some extent segmented, in other words, made up of segments that are formed by subdivisions that partially transect the body cavity. Segmentation is also called metamerism. Segments each contain elements of such body systems as circulatory, nervous, and excretory tracts. Metamerism increases the efficiency of body movement by allowing the effect of muscle contraction to be extremely localized, and it makes possible the development of greater complexity in general body organization.
- **Body wall :**
  The body wall of annelids is characterized by being made up of both circular and longitudinal muscle fibers surrounded by a moist, acellular cuticle that is secreted by an epidermal epithelium. All annelids except leeches also have chitinous hair-like structures, called setae,

projecting from their cuticle. Sometimes the setae are located on paddle-like appendages called parapodia..

- **Digestive system :**
  Digestive system is a complete tube with mouth and anus.; digestion occurs extracellular.
- **Blood vascular system :**
  Digestive system closed type with blood vessels and many hearts; respiratory pigments either hemoglobin or erythrocruorin dissolved in blood plasma.
- **Respiration :**
  Gases are exchanged through the skin, or sometimes through specialized gills or modified parapodia.
- **Excretory system:**
  Excretory system consisting of metamerically attached metanephridia.
- **Nervous system:**
  Nervous system with a pair of cerebral ganglia (brain) and a double ventral nerve cord bearing ganglia and lateral nerves in each segment.
- **Sensory organs**:
  Annelids have some combination of tactile organs, chemoreceptors, balance receptors, and photoreceptors; some forms have fairly well developed eyes.
- **Sexuality :**
  Mostly Hermaphrodite but in some animals sexes are separate; their larva is called trochophore. Regeneration is common is commonly found in these organisms.
  Annelids are classified into three classes mainly on the basis of number and type of locomotory organs.

Class Polychaeta

- **Habitat :**
  Mostly marine, some are found in fresh water.
- **Segmentation :**
  Segmentation is external and internal.
- **Head :**
  Head distinct with eyes, palps and tentacles.
- **Setae:**
  Setae present on parapodia.
- **Clitellum:**
  Clitellum is absent.
- **Sexes :**
  Sexes are separate, gonads temporary and in many segments.
- **Larvae :**
  A Trochophore larva is present.
  Example Neries, Aphrodite,

Class Oligochaeta

- **Habitat :**
  Mostly terrestrial, some are present in fresh water.
- **Segmentation:**
  Segmentation external and internal.
- **Head :**
  Head is distinct, no tentacles are present on head.
- **Setae**:
  Setae are few, parapodia is absent.
- **Clitellum :**

This is the reproductive segment which has genital openings. Setae are present.

- **Sexes :**
  Hermaphrodites; testes are present anterior to ovaries.
- **Fertilization :**
  Fertilization external, development occurs directly.

Examples Earth worm, tubifex, lumbricus.

Class Hirudinea

- **Segmentation :**
  Body with fixed number of segments (33-35); each segment subdivided into annuli. Segmentation external; parapodia and setae absent.
- **Suckers :**
  Both anterior and posterior ends of the body armed with suckers.
- **Sexes :**
  Hermaphrodites with one male and female gonopores.
- **Fertilization :**
  Fertilization occurs internally.
- **Development:**
  Development usually direct without metamorphosis; eggs develop in cocoons.
- **Mode of life :**
  Generally ectoparasites and blood sucking mostly aquatic, largely fresh water and some marine; some terrestrial and carnivorous.
  Example; Leech, Piscicola (fish leech)

Q. Describe the characters of phylum Mollusca and its classes with their examples.

Phylum Mollusca

Mollusca are soft-bodied animals about 50,000 species of living and 35,000 of fossil mollusca have so far been described. But recently the Phylum Mollusca is made up of over 150,000 diverse species appearing very different but sharing certain basic characteristics making the second largest phylum after Arthropoda.

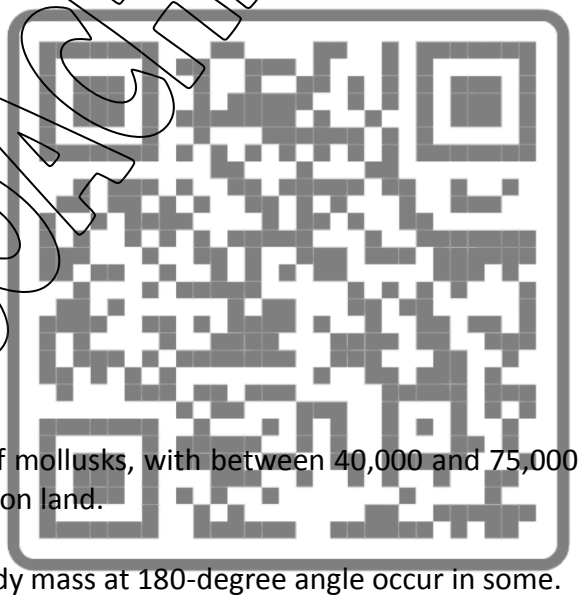
- **Habitat:**
  These are found in Terrestrial or aquatic habitats.
- **Body organization :**
  Tissue-system grade of body organization. Triploblastic, Coelomates, unsegmented and bilaterally symmetrical.
- **Body division :**
  Body divisible into head, mantle, foot and visceral mass.
- **Shell:**
  Many mollusks have an external calcium carbonate shell, hanging over the mantle that is actually produced by the mantle. Shell, when present, usually univalve or bivalve, constituting an exoskeleton, internal in some.
- **Coelom:**
  Coelom reduced and represented mainly by pericardial cavity, gonadial cavity and kidney.
- **Digestive system:**
  Digestive system, complete alimentary canal straight or coiled with a digestive gland or liver; a rasping organ, the redula, usually present. The redula allows the animal to scrape food from surfaces, especially the ocean floor, by sliding back and forth.
- **Circulatory system:**
  Circulatory system open type. But in some it is closed type with heart having one or two sinuses and one ventricle; blood with amoebocytes and haemocyanin.

- **Respiration**:
  Respiration direct through general body surface or by gills or lungs or both.
- **Excretion**:
  Excretion by paired metanephridia (Kidneys).
- **Nervous system:**
  Nervous system is based upon paired ganglia, connectives and nerves.
- **Sense organs:**
  Sense organs include eyes, satatocysts and receptors for touch, smell and taste.
- **Sexuality:**
  Dioecious or monoecious; one or two gonads.
- **Fertilization:**
  Fertilization external or internal; development direct or through free larval forms.
- **Mantle membrane:**
  Mantle a membrane, which is a fold of delicate tissue surrounding the entire body. The mantle is also used in respiration, waste disposal, and sensory reception.
- **Larva :**
  Their larva is called Trochophore.

Phylum Mollusca is divided in to seven classes;

1. **Aplacophora.**
2. **Polyplacophora**
3. **Monoplacophora**
4. **Scaphopoda**
5. **Cephalopoda**
6. **Pelecypoda/Bivalvia**
7. **Gastropoda**

Only three classes will be discussed;



Class Gastropoda

(Gr. gaster, belly + podos, foot)

- **Habitat:**
  Class Gastropoda are the largest group of mollusks, with between 40,000 and 75,000 species. These are also the only mollusks that live on land.
- **Torsion**:
  It is a phenomenon in which coiling of body mass at 180-degree angle occur in some.
- **Head:**
  Well developed eyes, tentacles and redula present.
- **Foot**:
  Foot is large and flat.
- **Shell**:
  Shell present in some if present it is univalve and usually coiled.
  Example Snails, slugs

Class Pelecypoda / Bivalvia

- **Habitat:**
  Mostly marine, few are found in fresh water.
- **Body:**
  Body enclosed in a bivalve shell and laterally compressed. These are marine animals with a hinged shell divided into two halves
- **Head :**
  Bivalves lack head, eyes jaws and redula.
- **Foot**:
  Body often hatchet shaped and extending between mantle lobes.

- **Feeding:**
  These bivalves use the hinges to take in food, and are also able to jet some distance away by closing the hinged shell and squirting the water taken in out of the mantle cavity. Mostly filter feeding.
- **Sexuality:**
  Usually Dioecious, their larvae is called veliger or glochidium larva.

Example Unio, Mytilus.

Class Cephalopoda

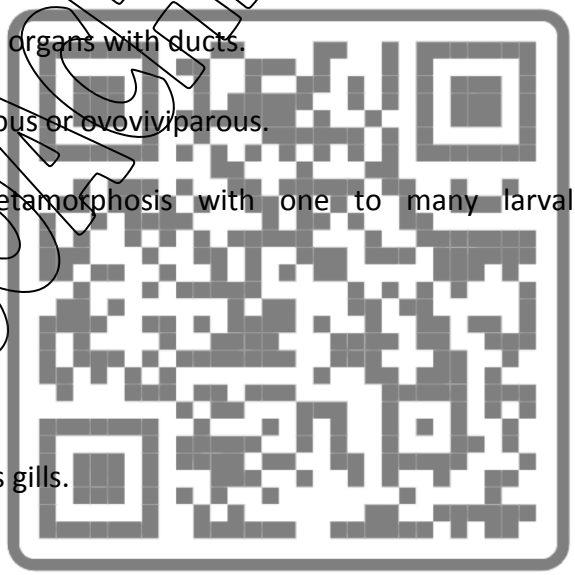
- **Habitat:**
  Class Cephalopoda includes marine and free swimming animals that differ from other mollusks because they are built for speed and agility.
- **Body**:
  Body elongated dorsoventraly and most either have an internal shell,
- **Shell**:
  Shell external, internal or absent.
- **Head:**
  Head is distinct and large with well-developed eyes and siphon. They have large brains enclosed in cartilaginous brain cases and sense organs, redula present.
- **Foot:**
  Foot transformed as tentacles bearing suckers.
- **Sexuality:**
  Dioecious; development usually occurs directly.
  Example: Nautilus (shell external), Sepia (shell internal), Octopus (shell absent).

Q. Describe the characters of Phylum Arthropoda and its classes with their examples.

Phylum Arthropoda

- **Habitat:**
  These animals can be found everywhere on earth wherever the life is possible, even in the deep oil wells.
- **Body organization:**
  Organ system level of body organization. Triploblastic and metamerically segmented.
- **Symmetry :**
  These organisms are usually bilaterally symmetrical.
- **Legs :**
  Primitively, each body segment bears a pair of segmented (jointed) appendages; in all living arthropods, many of these appendages are dramatically modified or even lost. Jointed legs whenever present with varied functions. Like swimming, digging, walking, capturing prey, jumping etc. in different species.
- **Exoskeleton:**
  The body is covered with an exoskeleton made up primarily of the protein chitin; lipids, other proteins, and calcium carbonate also play a role. Exoskeleton of chitinous cuticle that is shed at intervals this phenomena is called moulting or ecdysis.
- **Body division:**
  Body divisible in to head, thorax and abdomen; and often fused to form cephalothorax.
- **Coelom**:
  Coelom largely a blood filled haemocoel.
- **Muscles**:
  Muscles mostly striated, usually capable of rapid contraction and helps in movement.

- **Digestive system:**
  Digestive system complete; mouth parts adapted for various mode of feeding.
- **Circulatory system:**
  Most of the body cavity is an open "haemocoel," or space filled loosely with tissue, sinuses, and blood. The circulatory system is open and consists of a heart, arteries, and the open spaces of the haemocoel.
- **Respiration**:
  Respiration by gills, general body surface trachea or book lungs.
- **Nervous system**:
  Nervous system with a dorsal nerve ring and a double ventral nerve cord.
- **Sensory organs**:
  Sensory organs comprises of simple eyes (ocelli), compound eyes, chemoreceptors.
- **Reproductive system:**
  Most arthropods are dioecious and have paired reproductive organs (ovaries, testes). Fertilization is internal in most but not all groups. Most lay eggs, and development often proceeds with some form of metamorphosis.
- **Excretory organs**:
  Excretory organs are green glands or malphigian tubules.
- **Sexes**:
  Sexes usually separate; paired reproductive organs with ducts.
- **Fertilization**:
  Fertilization usually inside the body; oviparous or ovoviviparous.
- **Development:**
  Development direct or indirect by metamorphosis with one to many larval stages; parthenogenesis is found in some animals.



Class Merostomata:

- **Habitat:**
  Aquatic or marine.
- **Abdominal appendages:**
  Five or six pairs of abdominal appendages as gills.
- **Abdomen:**
  Abdomen ending in a sharp telson.
- **Eyes:**
  Lateral compound eyes are present.
- **Cephalothorax**:
  Cephalothorax with convex, horseshoe shaped carapace.
- **Mouth**:
  Mouth is surrounded by many small palates.
- **Respiration**:
  Respiration by book lungs.

Example: Limulus(king crab)

Class Arachnida :

- **Habitat:**
  Terrestrial or aquatic.
- **Respiration**:
  Respiration by gills, trachea or book lungs.
- **Excretion**:
  Excretion by coxal glands and malphigian tubules.

- **Sexuality:**
  Dioecious; mostly oviparous; they do courtship before mating.
- **Sting:**
  Some of them are large and posses a sting at the end of their abdomen.

- **Feeding:**
  They are predators.
- **Silk gland:**
  They posses a silk gland that secrete a protein that on exposure to air and form silk. threads used in building nests and webs for trapping the preys.
  Examples: Scorpion, Spider .

Class Crustacea:

- **Body**:
  Body is divided in to cephalothoracic and abdominal portions.
- **Body division:**
  Head and thorax fused to form a cephalothorax, which is covered by a single plate of exoskeleton, called carapace.
- **Appendages**:
  Appendages often biramous which are used for walking, swimming and feeding.
- **Respiration**:
  Respiration by gills.
- **Head**:
  Head with 5 segments with 2 pairs of antennae, a pair of mandibles and 2 pairs of maxillae.
- **Sexes**:
  Sexes usually separate.
- **Feeding:**
  Some of them are parasite e.g. Sacculina.
  Examples: Prawn, crabs.

Class Myriapoda:

- **Body segmentation:**
  Body segmented elongated and cylindrical and divisible in to head and trunk.
- **Legs:**
  In each body segment one or two pairs of legs are present.
- **Genital openings**:
  Genital openings are midventral.
- **Habitat:**
  Usually found in dark and damp places.
- **Feeding:**
  Carnivour and bear a poisonous appendage to paralyze prey.
  Example Millipede, Centipede.

Class Insecta:

- **Habitat:**
  They are found in almost every habitat in the biosphere.
- **Body division:**
  Body divisible in to Head, Thorax and Abdomen.
- **Head:**
  Head composed of 6 fused segments, thorax of 3 segments, and abdomen not more then 11 segments.

- **Head appendages:**
  Head bears antenna, compound eyes and mouthparts adapted for different mode of feeding.
- **Thorax**:
  Thorax with three pairs of legs and two pairs of wings.
- **Reproductive genitalia:**
  Reproductive genitalia are present on the last abdominal segments.
- **Respiration**:
  Respiration by trachea opening to outside through spiracles.
- **Sexes:**
  Sexes are separate.
- **Fertilization:**
  Fertilization internal.
- **Metamorphoses**:
  Metamorphoses is present in most of the species. But direct development is also found.
- **Excretion**:
  Excretion through malphigian tubules.
- **Social behavior**:
  Social behavior is very well developed.
- **Mode of living:**
  These are parasite; pest and some of them are beneficial to human being.
  Examples: Cockroach. Butterfly.

Q. Describe the characters of phylum Mollusca and its classes with their examples.

Phylum Echinodermata

Echinoderm is a group of about 6000 species of marine animals. But recently Echinodermata has approximately 7000 described living species and about 13,000 extinct species known from the fossil record. This phylum is the largest without any freshwater or terrestrial forms.

- **Habitat:**

Except for a few species which inhabit brackish waters, all echinoderms are benthic organisms found in marine environments. Echinoderms inhabit depths ranging from shallow waters at tide lines to the deep sea.

- **Body organization:**

Organ system grade of body organization. Triploblastic, Coelomates and radially symmetrical; often pentamarous.

- **Body shape:**

Body unsegmented with globular, star like, spherical, discoidal or elongated shape.

- **Body surface:**

Head absent, five symmetrical radiating areas and five interradii mark body surface. **Pedicellaria** are the spinous structures produced by the skeleton,. Found mainly in echinoids and asteroids. They may be used to capture prey, clean, or hold items to disguise from predators.

- **Endoskeleton:**

An internal skeleton is present throughout members of the phylum. Ossicles, which make up the skeleton, are below an outer dermal layer. The skeletal and muscular arrangement varies among groups.

- **Water vascular system:**

Echinoderms have a water vascular system consisting of a network of canals.

- **Reproduction:**

Echinoderms are mainly having separate sexes (dioecious), with exceptions among the asteroids, holothurians and ophuroids.

- **Primary Diet:**
  carnivore, (scavenger, molluscivore, eats non-insect arthropods); omnivore; planktivore; detritivore, filter-feeding.
- **Alimentary canal:**
  Alimentary canal straight or coiled.
- **Nervous system:**
  Nervous system with out brain but with nerves.
- **Excretory organs:**
  Excretory organs are present.
- **Development:**
  Usually dioecious, fertilization external; development indirect through free swimming larvae bipinnaria.
- **Regeneration:**
  Regeneration is commonly found in these organisms.
  This Phylum is divided in to five classes
  Asteroidea, Holothuroidea, Ophuroidea, Crinoidea and Echinoidea

Q. Describe the characters of craniata or vertebrata with its classes and example of each.

Sub phylum Vertebrata

- The main features of chordates like notochord (vertebral column), dorsal nerve cord, pharyngeal gill pouches, and postanal tail - all present at some stage of the life cycle or at least in embryonic stages.
- Integument basically of two layers, an outer epidermis and inner dermis.
- Notochord is replaced in jawed vertebrates by the vertebrae.
- Muscular perforated pharynx.
- Many muscles attached to the skeleton to provide for movement.
- Complete digestive system is provided with large digestive glands, liver and pancreas is present.
- Circulatory system consisting of the ventral heart (2-4 chambers); a closed blood vessel system of arteries, veins and capillaries; blood fluid containing red blood corpuscles with hemoglobin and white corpuscles.
- Well developed coelom filled with visceral organs.
- Excretory system consisting of paired kidneys provided with ducts to drain waste to cloaca.
- Brain typically divided into five vesicles; 10 or 12 pairs of cranial nerves usually with both motor and sensory functions; an autonomic nervous system in control of involuntary functions of internal organs.
- Endocrine system of ductless glands scattered throughout the body.
- Nearly always separate sexes; each sex containing paired gonads with ducts that discharge their products either into the cloaca or into special openings near the anus.
- Body plan consisting typically of head, trunk and post-anal tail; neck present in some, especially terrestrial forms.

This group is divided into two sub-phyla

1) Agnatha 2) Gnathostomata

Sub phylum: Agnatha – Jawless fish

These fishes have Eel shaped body. They are not laterally compressed. Endoskeleton is made up of Cartilage. 7 gill openings present posterior to the eyes. The only vertebrate parasites
Examples Lamprey, Hagfish

Sub phylum: Gnathostomata

This is the large group of vertebrates in which both upper and lower jaws are present though teeth may be present or absent. Gnathostomata are divided in to two super classes Pisces and Tetrapoda.

Super Class Pisces

- Respire with gills.
- Single circuit circulatory system.
- Sensory system consists of lateral line that detects vibrations and movements in the water.
- Excrete by kidneys to regulate ion and water balance.
- Oviparous - lays eggs, except for Chondrichthyes.
- External fertilization except for Chondrichthyes
- Body covered by dermal scales and body provided with paired fins.
- About 25000 species known.
- This class include Chondrichthyes (cartilaginous fishes) and Osteichthyes (bony fishes) Examples Ray finned fishes, Trout, Bass, Dog fish.

Class Amphibia

- It includes the toads and frogs, salamanders.
- The class name amphibia indicates that most of the species live partly in fresh water and partly on land.
- Amphibians are ectotherms.
- Class Amphibians are the lowest and earliest Tetrapoda, or land vertebrates.
- Replacement of the gills by lungs.
- Incomplete double circuit circulatory system present due to three chambered heart.
- Respiration takes place by the lungs, buccal cavity and skin.

Class Reptilia

- Reptilians include 5000 vertebrate species with dry skin which is covered by epidermal scales.
- Reptiles have tough skin made of the protein keratin.
- These are the first animals to produce amniotic eggs. The embryo develops in a fluid filled sac called an amnion. This prevents the egg from drying out, and allowed the reptiles to live only on land.
- Reptiles periodically shed their skin in a process called molting.
- Reptiles have teeth adapted for holding prey rather than chewing it because most species in this class swallow their prey whole.
- Reptiles have good hearing and vision and a tongue is used for smell as well as taste. Reptiles are ectotherms

Class Aves

There are about 9000 species of birds found and their study is called Ornithology while study of their nests are called Nidology

- Body covered with feathers
- Bones of the skeleton are thin, with air spaces
- Forelimbs function as wings, not for grasping

- Toothless beak
- Body temperature is internally regulated
- Heart is 4-chambered
- They posses syrinx instead of larynx for producing sound.
- Fertilization internal and eggs large amniotic.
- Birds that have hooked beaks for tearing flesh are called **raptors**.

Modern birds are divided in to two groups.

Sub Class Ratitae

- These are flightless birds having sternum raft like without keel.
- Their wings are either vestigial or rudimentary and flight muscles are poorly developed.

Example. Emu, Ostrich, Kiwi, Penguin.

Sub Class Craniatae

- These are flying birds having sternum with keel.
- Their wings and pectoral flight muscles are highly developed for flight.

Example: Sparrow, Pigeon etc.

Class Mammalia

The Class Mammalia includes around 5000 species placed in around 26 orders. These are the most successful group living on land weighing from 2gms pigmy shrew to a blue whale up to 160,000 kg which is 40m long.

- All mammals share three characteristics not found in other animals: 3 middle ear bones and outer pinna; hairs; and the production of milk by modified sweat glands called mammary glands.
- Mammals have a muscular partition between thoracic and abdominal cavity called diaphragm.
- All the mammals are viviparous i.e. they give birth to their babies.
- Mammals have hair. Adults of some species lose most of their hair, but hair is present at least during some phase of the development of all species. Mammalian hair, made of a protein called keratin.
- Mammals are called heterodont and thecodont because of differentiated teeth i.e. incisors, canines, premolars and molars which are fixed in the gums; teeth are replaced just once during an individual's life (this condition is called diphyodonty, and the first set is called "milk teeth).

Now class Mammalia is divided in to three sub classes.

Prototheria, Metatheria and Eutheria

Sub-Class Prototheria (Egg laying mammals):

- These are oviparous or egg laying mammals also called monotrems and mainly found in Australian region.
- Body covered by hairs and spines. Muzzle or snout produced in to beak. External ear absent.
- Mammary glands without nipples situated in a temporary mammary pouch of female which develops during breeding season on the abdomen for feeding of newly hatched immature young.
- They are considered to be a connecting link between reptiles and mammals.

Example: Echidna, Duck billed platypus.

Sub class Metatheria (Pouched mammals)

- This sub class include 250 species almost found in Australia and are called marsupials.
- These are viviparous as they give birth to live young ones. Their eggs retained and fertilized inside the body of female.
- Body furry, i.e. covered with soft hairs. External ear lobes or pinna are well developed.

- Mammary glands with nipples and situated in a permanent ventral abdominal mammary pouch of female which is called marsupium.
  Examples: Kangaroo, Koala bear, Opossums.

Sub class Eutatheria (Placental mammals)

- This sub class includes about 95% of the mammals widespread in almost every habitat on the earth.
- These are viviparous and their embryo retain inside mother in the uterus of mother by a special organ called **placenta** for nutrition and respiration while wastes discharges into mothers circulation.
- Embryonic membranes amnion, chorion and allantoise are present.
- These are herbivore, omnivore and carnivore.
  Examples: Horses, Donkeys, Monkeys, Humans etc.

Chapter #11
BIOENERGETICS
Short Question and answers

Q. What do we mean by bioenergetics?

Living organisms utilize energy as their fuel which is obtain through sunlight in plants and other organisms get this energy by eating plants. This capturing and transfer of energy from one energy level to another energy level in a living system and utilization in biochemical activities is called **bioenergetics.**

Q. Describe ATP as an energy molecule.

Food of living organism contains organic molecules, on degradation these molecules release energy in the form of ATP which is the common energy currency of the cell and used in different types of reactions. ATP is a nucleotide composed of the base adenine and sugar ribose and three phosphate group. It is called a highly energy rich compound because a phosphate group is easily removed and during this process released energy is about 7.3 Kcal / mole in the cell.

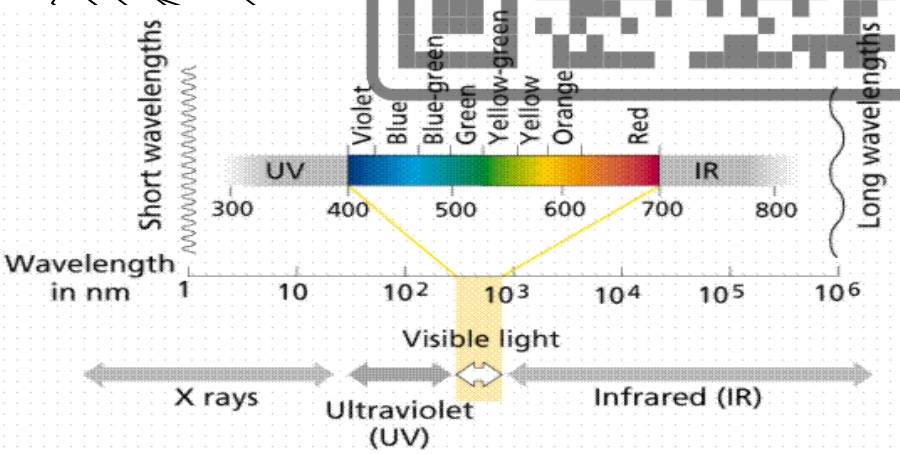
ATP plays several **endrogenic** reaction such as synthesis of protein, lipids, carbohydrates, active transport etc. in **exergonic** reactions like anaerobic glycolysis and oxidative phosphorylation, it also play its role and act as co-enzyme.

Q. What is Photosynthesis?

Photosynthesis is the process by which plants, some bacteria, and some protistans use the energy from sunlight and CO_2, H_2O and chlorophyll to produce sugar, which cellular respiration converts into ATP, the "fuel" used by all living things and oxygen is released.

We can write the overall reaction of this process as:

$$6H_2O + 6CO_2 \text{ ---------> } C_6H_{12}O_6 + 6O_2$$



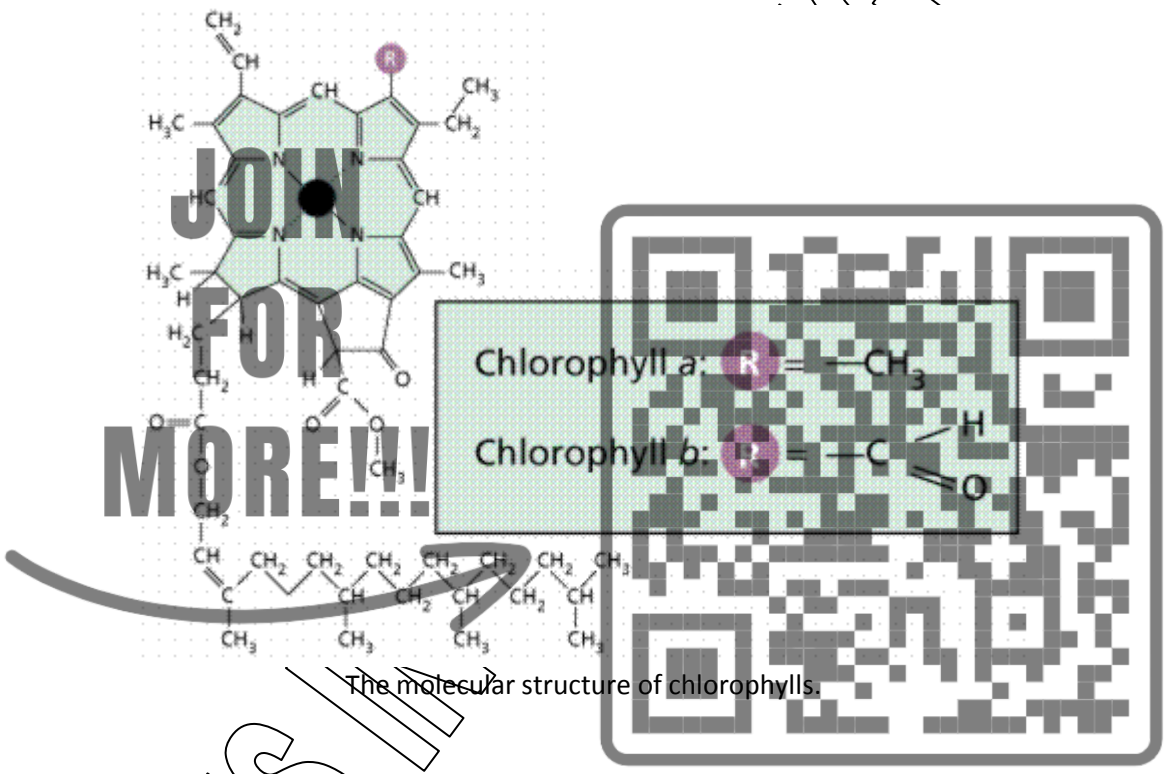
The electromagnetic spectrum.

Q. Describe the chlorophyll and accessory pigments for light absorption in plants.

A pigment is any substance that absorbs light. The color of the pigment comes from the wavelengths of light reflected. Chlorophyll, the green pigment common to all photosynthetic cells, absorbs all wavelengths of visible light except green, which it reflects to be detected by our eyes. The empirical formula of chlorophyll a is $C_{55}H_{72}O_5N_4Mg$ and chlorophyll b $C_{55}H_{70}O_6N_4Mg$.

All photosynthetic organisms (plants, certain protistans, prochlorobacteria, and Cyanobacteria) have **chlorophyll a.** Accessory pigments absorb energy that chlorophyll a does not absorb. Accessory pigments include **chlorophyll b** (also c, d, and e in algae and protistans), xanthophylls, and carotenoids (such as beta-carotene). Chlorophyll a absorbs its energy from the Violet-Blue and Reddish orange-Red wavelengths, and little from the intermediate (Green-Yellow-Orange) wavelengths. Carotenoids and chlorophyll b absorb some of the energy in the green wavelength.

Numerous chlorophyll a, b and carotenoid molecules are organized along with other pigments called photosystem which has light gathering "antenna complex". When light photon strikes this complex the amount of energy quanta travel through the pigments and reaches a specific chlorophyll a in the region of photosystem called reaction centre where the light reaction begins. Excessive light can damage chlorophyll. Some carotenoids can accept light energy from chlorophyll this function is known as photoreception.



The molecular structure of chlorophylls.

Q. Describe the role of light in photosynthesis.

- The light energy (quanta) is inversely proportional to the wavelength. I.e. longer wavelengths have less energy than do shorter ones.
- The absorption spectrum of light energy is different in plant pigments.
- Light energy is captured by the light harvesting complexes and transferred to the chlorophyll molecules of reaction centers.
- Light energy first absorbed by chlorophyll a molecule in a reaction center that causes the change in its electron energy potential from ground state to excited state .
- Blue light has more energy then red light in light spectrum.
- Red light energy causes to raise an electron to excited state-I and blue light to excited state-II though red light is enough to initiate chemical reactions.
- Movement of energy with in the thylakoid is very rapid and with in nanoseconds it is disbursed.

Q. Describe the role of water in photosynthesis.

- Photosynthesis is a reduction and oxidation process.
- The H^+ ion of water releases by splitting of water molecule and combines with CO_2 to reduce it to sugar.
- Oxygen atom forms O_2 molecules.
- Therefore water provides H^+ ion and e^- necessary for the reduction step leading to assimilation of CO_2.

Q. Describe the role of CO_2 in photosynthesis.

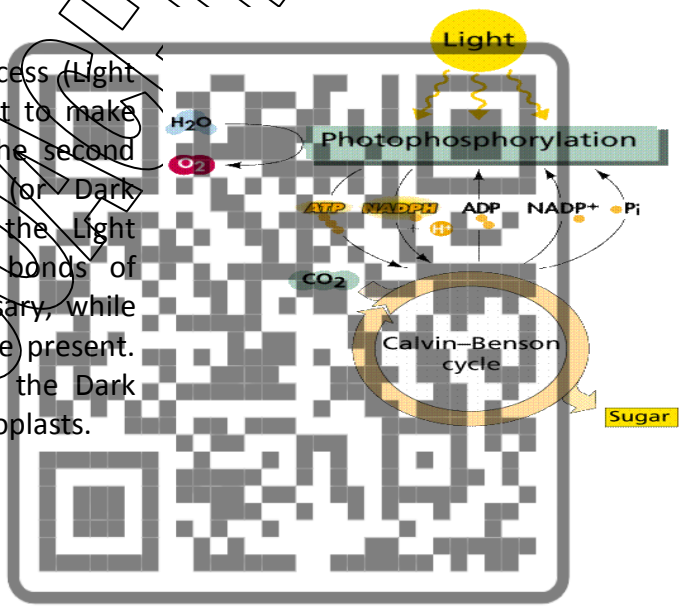
- CO_2 is inevitable for the photosynthetic products i.e. carbohydrates.
- C_3 plants directly incorporate CO_2 in to phosphorylated sugar.
- Increase in the concentration of CO_2 increases the rate of photosynthesis.

Q. Describe the Stages of Photosynthesis.

Photosynthesis is a two stage process.

1. Light Reaction
2. Dark reaction

The first process is the Light Dependent Process (Light Reactions), requires the direct energy of light to make energy carrier molecules that are used in the second process. The Light Independent Process (or Dark Reactions) occurs when the products of the Light Reaction are used to form C-C covalent bonds of carbohydrates presence of light is not necessary, while the energy carriers from the light process are present. The Light Reactions occur in the grana and the Dark Reactions take place in the stroma of the chloroplasts.



Light Reactions

In the Light Dependent Processes (Light Reactions) light strikes chlorophyll a in such a way as to excite electrons to a higher energy state. In a series of reactions the energy is converted (along an electron transport process) into ATP and NADPH. Water is split in the process, releasing oxygen as a by-product of the reaction. The ATP and NADPH are used to make C-C bonds in the Light Independent Process (Dark Reactions).

In the Light Independent Process, carbon dioxide from the atmosphere is captured and modified by the addition of hydrogen to form carbohydrates.

The incorporation of carbon dioxide into organic compounds is known as carbon fixation. The energy for this comes from the first phase of the photosynthetic process.

Photosystems are arrangements of chlorophyll and other pigments packed into thylakoids. Four major groups are present in the thylakoid Photosystem I(PSI), Photosystem II(PSII), the cytochrome b/f complex and ATPase complex. Mobile electron carriers which transport the excited electrons between the complexes are plastoquinone (PQ), Plastocyanin (PC) and Ferridoxin (FD). Many Prokaryotes have only one photosystem, **Photosystem II** (so numbered because, while it was most likely the first to evolve, it was the second one discovered). Eukaryotes have **Photosystem II**

plus **Photosystem I. Photosystem I** uses **chlorophyll a,** in the form referred to as P_{700}. **Photosystem II** uses a form of chlorophyll a known as P_{680}. Both "active" forms of **chlorophyll a** function in photosynthesis due to their association with proteins in the thylakoid membrane.

Electron transport

- At first light photon hits and transfer its energy to chlorophyll a molecule of Photosystem II (P_{680}) which becomes activated.
- The excited electron of Photosystem II (P_{680}) is transferred to a series of electron acceptors(generally called redox reactions)first Phaelophytin, then plastoquinone (PQ) which is associated with Fe ions then Cytochrome complex then Plastocyanin which is a copper containing protein and finally reaches at the chlorophyll P_{700} of Photosystem I this chlorophyll also absorb light energy.
- From the chlorophyll a, P_{700} the electron is transferred to Fe^{+3} in one of the Fe-S proteins, called Ferridoxin reducing substrate (FRS). It is the primary acceptor of Photosystem I.
- From Ferridoxin reducing substrate (FRS) the electron is transferred to the Ferridoxin (Fd). It is an iron containing protein.
- Form Ferridoxin the electron is transferred to NADP. The NADP is reduced to $NADP+H^+$ at the side of stroma of the membrane.

Photophosphorylation is the process of converting energy from a light-excited electron into the pyrophosphate bond of an ADP molecule. This occurs when the electrons from water are excited by the light in the presence of P_{680}. Light energy causes the removal of an electron from a molecule of P_{680} that is part of Photosystem II. The P_{680} requires an electron, which is taken from a water molecule, breaking the water into H^+ ions and O^{-2} ions. These O^{-2} ions combine to form the diatomic O_2 that is released. The electron is "boosted" to a higher energy state and attached to a primary electron acceptor, which begins a series of redox reactions, passing the electron through a series of electron carriers, eventually attaching it to a molecule in Photosystem I. Light acts on a molecule of P_{700} in Photosystem I, causing an electron to be "boosted" to a still higher potential. The electron is attached to a different primary electron acceptor (that is a different molecule from the one associated with Photosystem II).

The electron is passed again through a series of redox reactions, eventually being attached to $NADP^+$ and H^+ to form NADPH, an energy carrier needed in the Light Independent Reaction. The electron from Photosystem II replaces the excited electron in the P_{700} molecule. There is thus a continuous flow of electrons from water to NADPH. This energy is used in Carbon Fixation.

Cyclic Photophosphorylation

Cyclic Electron Flow occurs in some eukaryotes and primitive photosynthetic bacteria. No NADPH is produced, only ATP. In this process chlorophyll a (P_{700}) of Photosystem I absorb energy form the sun light. This occurs when cells may require additional ATP, or when there is no $NADP^+$ to reduce to NADPH. In Photosystem II, the pumping to H ions into the thylakoid and the conversion of ADP + P into ATP is driven by electron gradients established in the thylakoid membrane.

Dark Reaction

Carbon-Fixing Reactions are also known as the Dark Reactions (or Light Independent Reactions) these do not require light and may take place in day and night. The Calvin Cycle occurs in the stroma of chloroplasts (where would it occur in a prokaryote?). Carbon dioxide is captured by the chemical ribulose biphosphate (RuBP). RuBP is a 5-C chemical. Six molecules of carbon dioxide enter the Calvin

Cycle, eventually producing one molecule of glucose. The reactions in this process were worked out by Melvin Calvin (shown below).

The first steps in the Calvin cycle.

The first stable product of the Calvin Cycle is phosphoglycerate (PGA), a 3-C chemical. The energy from ATP and NADPH energy carriers generated by the photosystems is used to attach phosphates to (phosphorylate) the PGA. Eventually there are 12 molecules of glyceraldehyde phosphate (also known as phosphoglyceraldehyde or PGAL, a 3-C), two of which are removed from the cycle to make a glucose. The remaining PGAL molecules are converted by ATP energy to reform 6 RuBP molecules, and thus start the cycle again. Remember the complexity of life, each reaction in this process, as in Kreb's Cycle, is catalyzed by a different reaction-specific enzyme.

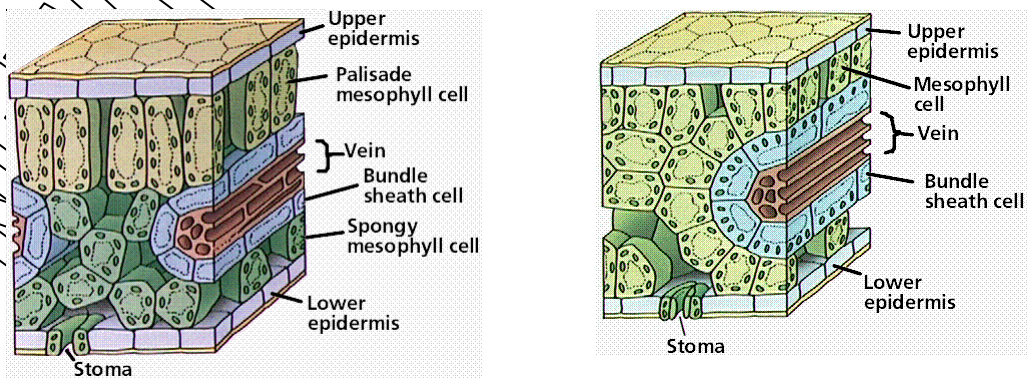
C-4 Pathway

Some plants have developed a preliminary step to the Calvin Cycle (which is also referred to as a C-3 pathway), this preamble step is known as C-4. While most C-fixation begins with RuBP, C-4 begins with a new molecule, phosphoenolpyruvate (PEP), a 3-C chemical that is converted into oxaloacetic acid (OAA, a 4-C chemical) when carbon dioxide is combined with PEP. The OAA is converted to Malic Acid and then transported from the mesophyll cell into the bundle-sheath cell, where OAA is broken down into PEP plus carbon dioxide. The carbon dioxide then enters the Calvin Cycle, with PEP returning to the mesophyll cell. The resulting sugars are now adjacent to the leaf veins and can readily be transported throughout the plant.

The capture of carbon dioxide by PEP is mediated by the enzyme PEP carboxylase, which has a stronger affinity for carbon dioxide than does RuBP carboxylase When carbon dioxide levels decline below the threshold for RuBP carboxylase, RuBP is catalyzed with oxygen instead of carbon dioxide. The product of that reaction forms glycolic acid, a chemical that can be broken down by photorespiration, producing neither NADH nor ATP, in effect dismantling the Calvin Cycle. C-4 plants, which often grow close together, have had to adjust to decreased levels of carbon dioxide by artificially raising the carbon dioxide concentration in certain cells to prevent photorespiration. C-4 plants evolved in the tropics and are adapted to higher temperatures than are the C-3 plants found at higher latitudes. Common C-4 plants include crabgrass, corn, and sugar cane. Note that OAA and Malic Acid also have functions in other processes, thus the chemicals would have been present in all plants, leading scientists to hypothesize that C-4 mechanisms evolved several times independently in response to a similar environmental condition, a type of evolution known as convergent evolution.

Photorespiration.

We can see anatomical differences between C3 and C4 leaves.



Leaf anatomy of a C3 (left) and C4 (right) plant.

CELLULAR RESPIRATION

In Eukaryotic Cells, the reaction of Aerobic Respiration occur Inside MITOCHONDRIA. The Krebs cycle takes place in the Mitochondrial Matrix, and the Electron Transport Chain is located in the Inner Membrane.

Life is driven by energy. The ways that organisms use energy and many are varied, all of life's energy ultimately has the same beginning: the sun. Plants, algae, and some bacteria harvest the energy of sunlight by the process of photosynthesis, thus converting radiant energy to chemical energy. These organisms, along with a few others that use chemical energy in a similar way, are called autotrophs (self-feeders). All organisms live on the energy produced by these autotrophs. Those that do not have the ability to produce their own food are called heterotrophs (fed by others). At least 95 % of the kinds of organisms on earth - - all animals, all fungi, and most protists and bacteria - are heterotrophs; most of them live by feeding on the chemical energy fixed by photosynthesis.

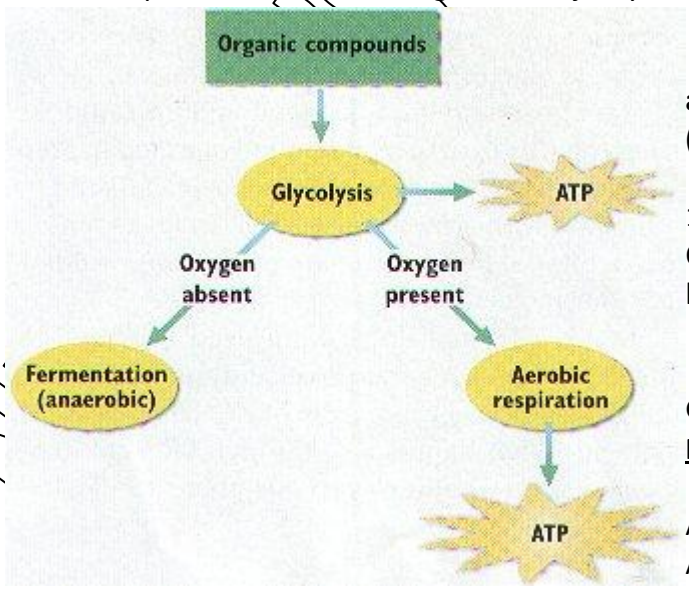
CELLULAR RESPIRATION EQUATION:

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O +$ ENERGY RELEASED (ATP)

7. Cellular Respiration takes place in TWO STAGES.

STAGE 1 - Cellular Respiration begins with a Biochemical Pathway called **GLYCOLYSIS**, that takes place in the **Cells Cytosol**, yields a relatively Small amount of ATP and does not require oxygen.

STAGE 2 - The Second Stage of Cellular Respiration is called **OXIDATIVE RESPIRATION**, and follows Glycolysis. Oxidative Respiration takes place within the Mitochondria. This is far more effective than Glycolysis at recovering energy from food molecules. Oxidative respiration is the method by which plant and animal cells get the majority of their energy.



There are two types of cellular respiration: aerobic (presence of oxygen) and anaerobic (absence of oxygen) respiration or fermentation.

1. Because they operated in the Absence of Oxygen, the FERMENTATION PATHWAYS are said to be **ANAEROBIC PATHWAYS.**

2. If OXYGEN is PRESENT, the products of Glycolysis ENTER the PATHWAYS of **AEROBIC RESPIRATION.**

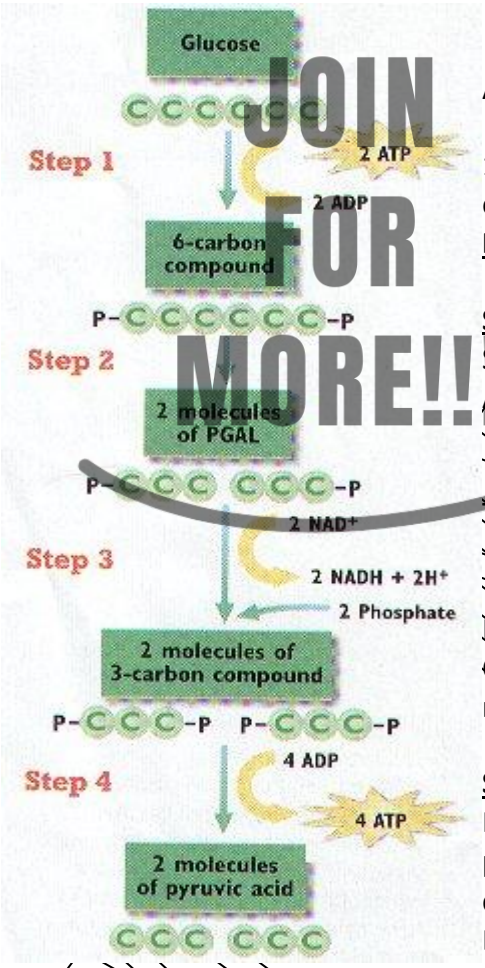
Aerobic Respiration produces a much Larger Amount of ATP, up to 20 times more ATP produced.

GLYCOLYSIS

1. Both types of pathways begin with Glycolysis.

2. Glycolysis is a pathway in which One Six-Carbon Molecule of GLUCOSE is Oxidized to Produce Two Three-Carbon Molecules of **PYRUVIC ACID OR PYRUVATE**.
3. The word **"GLYCOLYSIS" means "The Splitting of Glucose".** In a series of Ten Reactions, a molecule of Glucose is split into Two identical smaller molecules, each called **PYRUVIC ACID or PYRUVATE**.
4. **GLYCOLYSIS** is the process by which glucose is converted to pyruvic acid, and some of its energy is released.
5. **Glycolysis occurs in the CYTOSOL OF THE CELL.**
6. Whether or not Oxygen is present, Glycolysis splits (by oxidation) glucose into three-carbon molecules of pgal. pgal is then converted to three-carbon pyruvic acid.
7. Glucose is a Stable molecule that DOES NOT Break down Easily.

8. For a Molecule of Glucose to undergo Glycolysis, a Cell must First "SPEND" ATP to energize the Glucose Molecule. The ATP provides the **Activation Energy** needed to begin Glycolysis.
9. Although ATP (ENERGY) is used to begin Glycolysis, the reactions that make up the process eventually produce a **net gain of two atp molecules.**



10. Glycolysis is followed BY THE BREAK DOWN OF PYRUVIC ACID.

11. Like other Biochemical Pathways, Glycolysis consists of a series of Chemical Reactions. These reactions can be condensed into **FOUR MAIN STEPS**: (Figure 7-2)

STEP 1 - TWO Phosphates are attached to Glucose, forming a NEW Six-Carbon Compound. The Phosphate Groups come From TWO ATP, which are Converted to ADP.

STEP 2 - The Six-Carbon Compound formed in Step 1 is SPLIT into TWO Three-Carbon Molecules of PGAL.

STEP 3 - The TWO PGAL Molecules are Oxidized, and each Receives a Phosphate Group Forming Two NEW Three-Carbon Compounds. The Phosphate Groups are provided by Two molecules of NAD+ forming NADH.

STEP 4 - The Phosphate Groups added in Step 1 and Step 3 are Removed from the Three-Carbon Compounds. This reaction produces Two molecules of Pyruvic Acid. Each Phosphate Group is combines with a molecule of ADP to make a molecule of ATP. Because a total of Four Phosphate Groups were Added, four molecules of atp are produced.

TWO ATP Molecules were used in Step 1, but FOUR are Produced in Step 4. Therefore, Glycolysis has a NET YIELD of TWO ATP Molecules for every Molecule of Glucose that is converted into Pyruvic Acid. What happens to the Pyruvic Acid depends on the Type of Cell and on whether Oxygen is present.

FERMENTATION

1. In the Absence of Oxygen, Some Cells can Convert Pyruvic Acid into other compounds through Additional Biochemical Pathways that also Occur in the Cytosol.

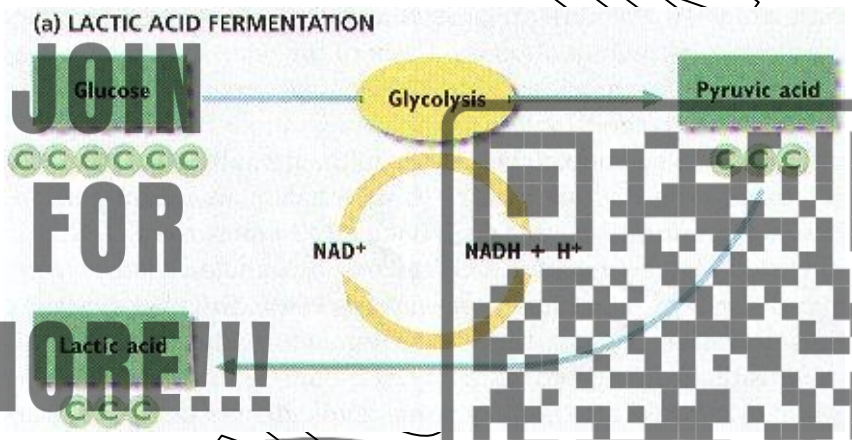
2. The Combination of Glycolysis PLUS these Additional Pathways are known as FERMENTATION.

3. The chemical reactions that release energy from food molecules in he absence of oxygen are also called anaerobic respiration.

4. There are TWO TYPES of Anaerobic Respiration or Fermentation: LACTIC ACID FERMENTATION AND ALCOHOLIC FERMENTATION.

5. During the processes of Fermentation no additional atp is synthesized.

6. lactic acid fermentation is the process that pyruvic acid is converted to lactic acid.



7. Lactic Acid involves the Transfer of TWO Hydrogen atoms from NADH and H+ to Pyruvic Acid. In the process, NADH is Oxidized to form NAD+ which is needed to Keep Glycolysis Operating.

8. Lactic Acid Fermentation by Microorganisms plays an Essential role in the manufacture of Food Products such as YOGURT and CHEESE.

9. certain animal cells, including our muscle cells convert pyruvic acid to lactic acid.

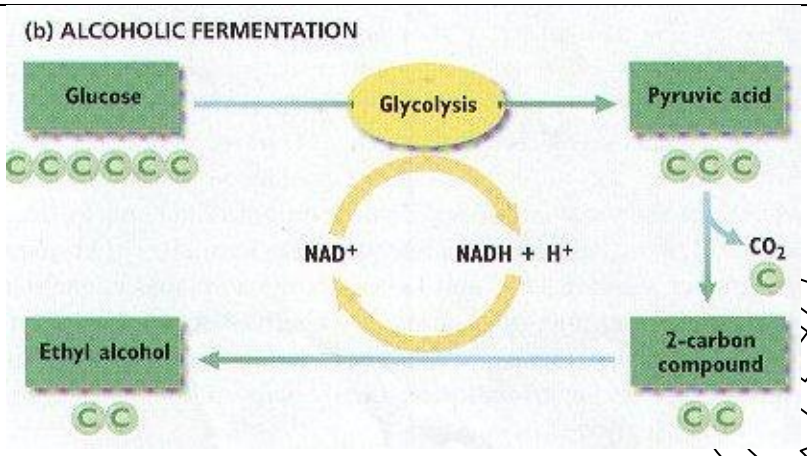
10. during exercise, breathing cannot provide your body with all the oxygen it needs for aerobic respiration. when muscles run out of oxygen, the cells switch to lactic acid fermentation.

11. This process provides your muscles with the energy then need during exercise.

12. The side effects of Lactic Acid Fermentation is Muscle Fatigue, Pain, Cramps, and you feel Soreness.

13. Most Lactic Acid made in the muscles diffuse into the bloodstream, then to the LIVER, where it is converted back to PYRUVIC ACID When Oxygen becomes Available.

14. alcoholic fermentation converts pyruvic acid to carbon dioxide and ethanol (ethyl alcohol).



15. Bakers use Alcoholic Fermentation of YEAST to make Bread.

16. As Yeast Ferments the Carbohydrates in dough, CO2 is produced and trapped in the dough, causing it to rise.

17. When the dough is baked the Yeast Cells Die, and the Alcohol Evaporates, You cannot get drunk from eating bread!

18. Alcoholic Fermentation is used to make wine, beer, and the ethanol added to gasoline to make gasohol.

19. The fact that alcohol is used to power a car indicated the amount of Energy that remains in the Alcohol Molecules.

ENERGY YIELD

1. Energy is Measured in units of **kilocalories (kcal)**. One kilocalorie EQUALS 1,000 calories (cal).

2. Scientist have calculated that the Complete Oxidation of a Standard Amount of Glucose releases 686 kcal.

3. The kcal released from Glucose during **Glycolysis only has the Efficiency of 3.5%.** (Formula page 131)

4. It's clear that the Anaerobic Pathways are NOT Very Efficient in transferring Energy.

5. The Anaerobic Pathways provide enough Energy for many present-day Organisms. Most of these are **UNICELLULAR**, and those that are **Multicellular are Very Small**. All of them have Limited energy Requirements.

6. Larger Organisms have a much Greater Energy Requirements that CANNOT BE Satisfied by the Anaerobic Pathways.

7. Large Organisms, including yourself, meet their Energy Requirements with the More Efficient Pathways of Aerobic Respiration.

AEROBIC RESPIRATION

In most cells, the Pyruvic Acid that is produce in glycolysis does not undergo fermentation. Instead, if Oxygen is available, Pyruvic Acid enters the pathway of Aerobic Respiration, or Cellular

Respiration that requires Oxygen. Aerobic Respiration produces nearly 20 times as much ATP as is produced by glycolysis alone.

OVERVIEW OF AEROBIC RESPIRATION

1. **Aerobic Respiration has TWO Major STAGES: THE KREBS CYCLE and the ELECTRON TRANSPORT CHAIN.**

2. The break down of pyruvic acid in the presence of oxygen is called **aerobic respiration**.

3. Aerobic respiration takes place inside the **cell's mitochondria** ("power house").

4. During aerobic respiration, ATP is produced in two pathways known as the krebs cycle and the electron transport chain.

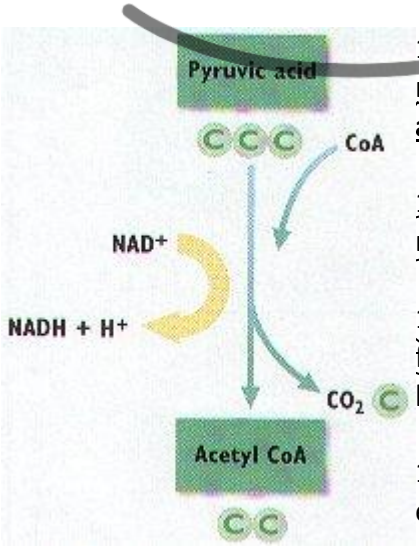
5. The series of oxidation reactions that make up the second phase of aerobic respiration is called the krebs cycle.

6. The krebs cycle is a biochemical pathway that breaks down acetyl CoA, producing ATP, H, and carbon dioxide.

7. **In Prokaryotes the reactions of the Krebs cycle take place in the Cytosol of the Cell.**

8. **In EUKARYOTIC CELLS**, these reactions take place in the **MITOCHONDRIA**.

9. The Pyruvic Acid that is produced in glycolysis Diffuses across the Double Membrane of a Mitochondrion and enters the **MITOCHONDRIAL MATRIX**, the Space Inside the Inner Membrane of a Mitochondrion. (Figure 7-5)



10. When Pyruvic Acid enters the Mitochondrial Matrix, it Reacts with a molecule called **COENZYME A** to form **ACETYL COENZYME A**, abbreviated **acetyl CoA**. CO_2, NADH, and H+ are produced in this reaction. (Figure 7-6)

11. During the process from glycolysis through the krebs cycle, one glucose molecule yields four atp, ten nadh and two fadh2.

12. The energetic electrons in the molecules of nadh and fadh2 that are formed during the krebs cycle are used to make ATP in a series of reactions known as the electron transport chain.

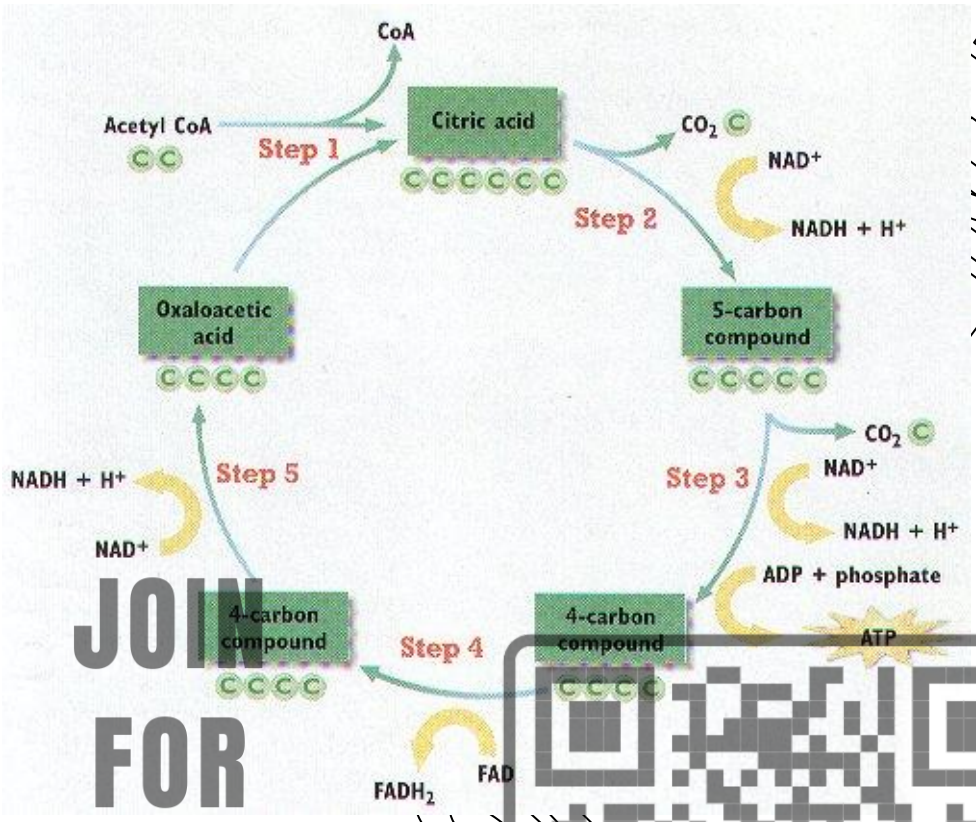
13. Most of the atp produced during aerobic respiration is made by the electron transport chain.

THE KREBS CYCLE

1. The Krebs cycle is a biochemical pathway that breaks down Acetyl CoA, producing CO2, H+, NADH, FADH2, and ATP.

2. The reactions that make up the cycle were identified by Hans Krebs (1900-1980), a German-British biochemist.

3. The Krebs cycle has FIVE Main Steps. ALL Five Steps occur in the Mitochondrial Matrix.



STEP 1 - A Two-Carbon Molecule of Acetyl CoA Combines with a Four-Carbon Compound, **OXALOACETIC ACID** (AHKS-uh-loh-SEET-ik), to Produce a Six-Carbon Compound **CITRIC ACID.**

STEP 2 - Citric Acid Releases a CO2 Molecule and a Hydrogen Atom to Form a Five-Carbon Compound. By LOSING a Hydrogen Atom with its Electron, Citric Acid is OXIDIZED. The Hydrogen atom is transferred to NAD+, REDUCING it to NADH.

STEP 3 - The Five-Carbon Compound Releases a CO2 Molecule and a Hydrogen Atom, forming a Four-Carbon Compound. NAD+ is reduced to NADH. A Molecule of ATP is also Synthesized from ADP.

STEP 4 - The Four-Carbon Compound Releases a Hydrogen Atom to form another Four-Carbon Compound. The Hydrogen is used to Reduce FAD (Flavin Adenine Dinucleotide) to FADH2, a Molecule similar to NAD+ that Accepts Electron during Redox Reactions.

STEP 5 - The Four-Carbon Compound Releases a Hydrogen Atom to REGENERATE OXALOACETIC ACID, which keeps the Krebs cycle operating. The Hydrogen Atom Reduces NAD+ to NADH.

4. In Glycolysis one Glucose Molecule produces TWO Pyruvic Acid Molecules, which can then form TWO Molecules of Acetyl CoA.

5. One Glucose Molecule causes TWO Turns of the Krebs cycle.

6. The Two Turns produce SIX NADH, TWO FADH2, TWO ATP, and FOUR CO2 Molecules.

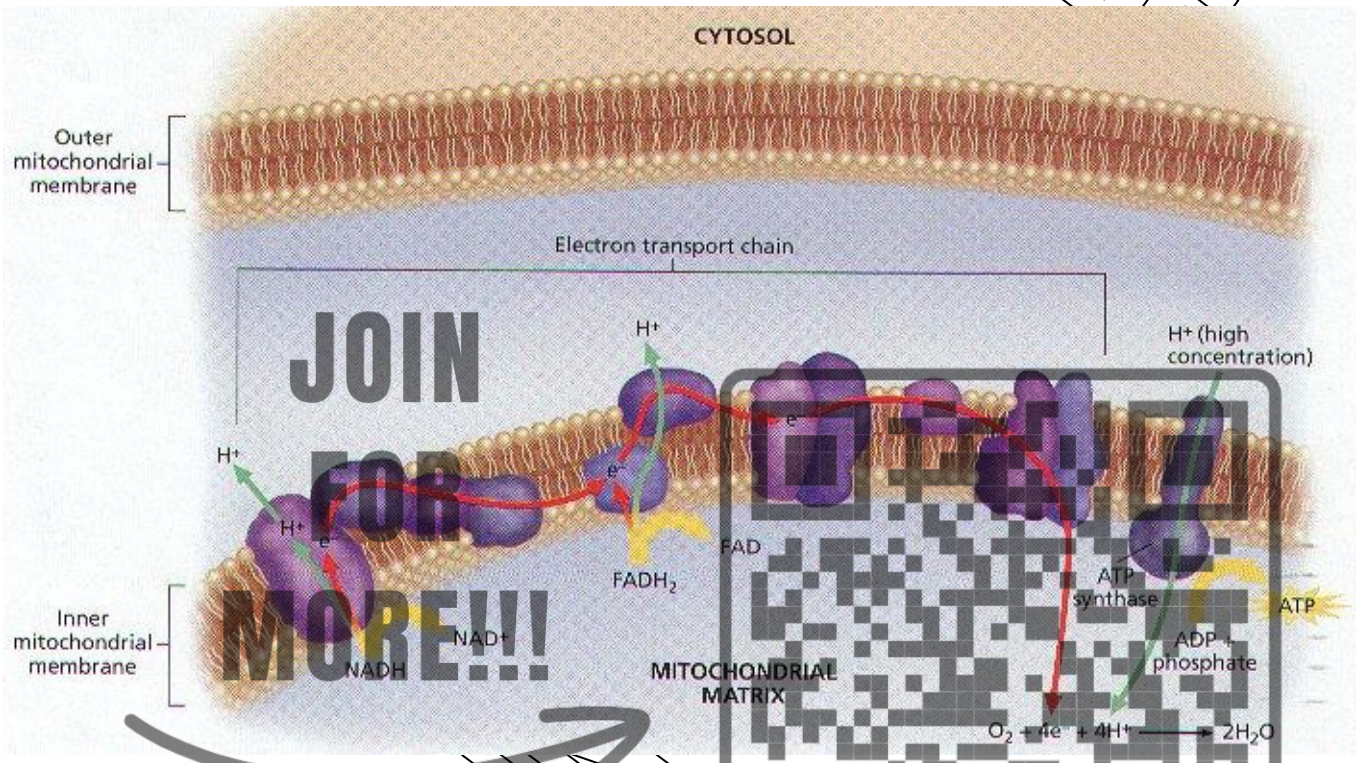
7. The **CO2 is a WASTE PRODUCT** that Diffuses out of the cells and is given off by the organism.

8. The BULK of the Energy released by the Oxidation of Glucose still has NOT been transferred to ATP. Only FOUR Molecules of ATP - TWO from Glycolysis and TWO From the Krebs cycle.

9. 10 Molecules of NADH and the 2 FADH2 Molecules from the Krebs cycle DRIVE the Next Stage of Aerobic Respiration - The Electron Transport Chain.

10. That is Where MOST of the Energy Transfer from Glucose to ATP Actually Occurs.

ELECTRON TRANSPORT CHAIN



1. The **ELECTRON TRANSPORT CHAIN** makes up the Second Stage of Aerobic Respiration.

2. In **EUKARYOTIC CELLS** the Electron Transport chain **LINES the INNER MEMBRANE of the Mitochondrion**, the inner membrane has many long folds called **CRISTAE**.

3. In **Prokaryotes**, **the Electron Transport Chain LINES the CELL MEMBRANE**.

4. ATP is produced by the Electron Transport Chain when NADH and FADH2 RELEASES Hydrogen Atoms, REGENERATING NAD+ and FAD, which return to the Krebs Cycle to be reused. (figure 7-8)

5. The electrons in the hydrogen atoms from NADH and FADH2 are at a High Energy Level.

6. These High Energy Electron are PASSED Along a Series of Molecules. As the move from Molecule to Molecule, the Electrons LOSE some of their Energy.

7. The Energy they LOSE is used to PUMP Protons of the Hydrogen Atoms from the Mitochondrial Matrix to the other side of the Inner Mitochondrial Membrane.

8. The Pumping builds up a High Concentration (A Concentration Gradient) of Protons in the space Between the INNER and OUTER Mitochondrial Membranes.

9. The Concentration Gradient of Protons Drives the Synthesis of ATP by Chemiosmosis.

10. ATP Synthase (enzyme) Molecules are located in the Inner Mitochondrial Membrane. The ATP Synthase MAKES ATP from ADP as Protons move down their Concentration Gradient into the Mitochondrial Matrix.

THE ROLE OF OXYGEN

1. ATP can be synthesized by Chemiosmosis only if Electrons continue to move from molecule to molecule in the Electron Transport Chain.

2. Oxygen SERVES as the FINAL Acceptor of Electrons. By Accepting Electrons from the last molecule in the Electron Transport Chain, Oxygen allows additional electrons to pass along the chain. Allowing ATP to continue to be synthesized.

3. Oxygen also accepts Protons that were once part of the Hydrogen Atoms supplied by NADH and FADH2. By combining with both Electrons and Protons, Oxygen forms WATER:

$$O2 + 4E^- + 4H^+ \longrightarrow 2H2O$$

ENERGY YIELD

1. **Through Aerobic Respiration a Maximum Yield of 38 ATP Molecules can be PRODUCED**. (Figure 7-9)

   A. 2 - Glycolysis
   B. 2 - Krebs cycle
   C. 34 - Electron Transport Chain

2. The actual number of ATP Molecules generated through Aerobic Respiration varies from Cell to Cell.

3. **Most Eukaryotic Cells Produce only about 36 ATP Molecules per Glucose Molecule.**

4. **If a cell produces 38 ATP Molecules the Efficiency would be 66%.**

Energy flow through the Ecosystem.

The existence of living world depends upon the flow of energy and circulation of materials through the ecosystem. The energy is required for the performance of all the life activities. The forms of energy available in an ecosystem are radiant energy, heat energy, chemical energy, and mechanical energy.

Sun as a source of energy.

- Sunlight travels as electromagnetic waves and about 40% is reflected back from clouds and other 15% is absorbed by ozone layer and is converted to heat energy by the atmosphere.
- Remaining 45% reaches to earth, of which a small fragment i.e. is absorbed by green plants while rest is reflected and dispersed.

Unidirectional Flow of energy and its subsequent losses.

- The energy is captured by plants and is stored in the form of potential energy in foodstuffs. These are known as producers and represent the trophic level in the ecosystem.
- The energy stored by plants is passed through the community or ecosystem in a series of steps of eating and being eaten. This is known as food chain.
- If we consider that one square meter of an ecosystem receives 3000 calories of light energy , half of it is utilized by plants and convert 1 to 5% in to food energy and rest passes out as heat in the atmosphere. This is called primary productivity.
- Thus only 15 to 75 calories are transferred to consumers of various levels.
- Further loss takes place due to respiration and only 10% of it i.e. 1.5calories reaches to secondary consumers. Thus at each trophic level there is ten time reduction in availability of energy.

Diagram

Trophic levels

"Each successive level of nourishment as represented by the links of the food chain is known as trophic level".

- The plants are the producers consider as first trophic level.
- The herbivores feed on plants and they are known as primary consumers and included in second trophic level.
- The third trophic level constitute of carnivores which feed upon secondary consumers.
- The secondary consumers are eaten by tertiary consumers which are also carnivores hence they form fourth trophic level.
- And finally these all consumers after death are eaten by decomposers which are as sparotrophs in this way they form 4^{th} and 5^{th} trophic level.

Ecological pyramids

Ecological pyramids represent the trophic structure and also the trophic function of an ecosystem. It is a diagrammatic representation of trophic levels. These may be three general types.

1. **Pyramid of number:** In such pyramid the more abundant species form the base of pyramid and the less abundant species remain near the top.
2. **Pyramid of biomass:** This pyramid indicates the decrease or gradual reduction in biomass at each trophic level from the base to apex.
3. **Pyramid of energy:** It indicates the total energy at each trophic level of the food chain and loss of energy and material takes place as the processes of assimilation and growth are not 100% efficient.

Diagrams

The Efficiency of Energy flow and its significance:

The efficiency of energy flow in an ecosystem depends upon productivity of an ecosystem

- Energy accumulated by plants or the producers in an ecosystem is called **Primary productivity.**
- The total energy produced during photosynthesis is the **Gross primary production (GNP).**
- The energy left after respiration and stored as organic matter in the producers is the **Net primary production (NPP).**

The average efficiency of energy transfer from plants to herbivores is about 10 percent and from animal to animal is about 20 percent.

Advantages of short food chains:

It has been observed that there is a loss of energy at each energy level due to the decrease in biomass. There fore longer food chains like food web consume large amount of energy loss in form of heat is greater as compared to short food chains and short food chains are helpful in providing food for larger populations while food webs or longer food chains sustained lesser population.

Chapter 12
NUTRITION
Short question and answers

Q. Why do organisms need nutrition?

All the living organisms require energy and materials to build up and regulate their body functions. For this purpose they obtain food and utilize it according to their needs this process is known as nutrition. To get these activities done living organisms have to synthesize new protoplasm and oxidize the high energy organic compounds. This requires:

1. Synthesized energy rich compounds or raw material required to synthesize protoplasm.
2. The oxygen used in cellular respiration.

Q. What is autotrophic nutrition?

"When living organisms prepare organic substances from available inorganic raw material taken form their surrounding".
There are two types of autotrophic nutrition.
i) Phototrophic nutrition. ii) Chemotrophic nutrition

Q. Write a note on Phototrophic nutrition.

Phototrophic nutrition

"The organism which has ability to utilize radiant energy to make their own food in the presence of CO_2, H_2O as raw materials and by the help of chlorophyll is called phototrophic organisms and this process is called phototrophic nutrition".
This type of nutrition is found in plants and bacteria. Minerals like N_2, P, S, and Mg etc. are also required to produce different molecules.

a) Phototrophic nutrition in Plants:

The green plants require chlorophyll 'a' and 'b' to absorb the light energy and synthesize energy rich compounds carbohydrates.

$$CO_2 + H_2O \text{----------} > C_6H_{12}O_6 + 6O_2 + H_2O$$

b) Phototrophic nutrition in Bacteria:

Bacteria also synthesize food by photosynthesis. They do posses chlorophyll that differs from plant chlorophyll. The purple sulphur photosynthetic bacteria contain bacteriochlorophyll and carotenoids as photosynthetic pigments while green sulphur bacteria contain chlorobium chlorophyll.

These bacteria usually grow in springs where (H_2S) hydrogen sulphide gas is present and they utilize H_2O instead of O_2. Hydrogen combines with CO_2 to form CH_2O whereas sulphur and water produced as by products.

$$H_2S + CO_2 \text{----------} > (CH_2O)_n + H_2O + S$$

There are non sulphur purple and brown bacteria found in the mud and stagnant water. They contain bacteriochlorophyll pigment. They use organic hydrogen donors whereas sulphur is not the by product in their case.

Q. Describe the Chemotrophic nutrition.

"When organisms use inorganic substances to produce energy for the synthesis of carbohydrates in the absence of light is called Chemotrophic nutrition". These organic compounds are ammonia, nitrates, nitrites, ferrous ions, H_2S and number of metallic and non metallic mateials. Chemosynthetic organisms are mainly bacteria e.g. Ammonia using bacteria.

$NH_4 + 3O_2$----------> $2NO_2 + 2H_2O + 4H$ + energy

Another bacterium oxidizes nitrites (NO_2) to nitrates.

$2NO_2 + O_2$ ----------> $2NO_3$ + energy

Q. Describe the important mineral obtained from the soil in Plants.

Minerals are essential because;

1. Must be required for completion of life cycle

2. Must be involved in some aspect of metabolism as part of a molecule, enzyme cofactor, ion for water balance, etc.

3. No other element can substitute for it

14 of the essential elements are obtained as soil minerals. These are divided into two groups, based on the quantity required by plants, macroelements (macronutrients) and microelements (micronutrients).

Macroelements:

P (phosphorus), K (potassium), N (nitrogen), S (sulfur), Ca (calcium), Mg (magnesium) all except Ca have some fairly direct role in photosynthesis specific roles:

Microelements:

Cu (copper), Zn (zinc), B (boron), Mn (manganese), Mo (molybdenum), Fe (iron), Cl (chlorine), Ni (nickel). In general, micronutrients act as enzyme activators.

Q. What is the importance of nitrogen in plants?

Nitrogen element is found in the form of nitrates or ammonium salts in plants. It becomes a part of proteins nucleotides, nucleic acids and many other organic compounds synthesis. Low supply of nitrogen causes pale yellow leaves due to loss of chlorophyll called chlorosis. Cell division and cell enlargement is inhibited.

Q. What is the importance of Phosphorus in plants?

Phosphorous is taken by plants in the form of soluble phosphates such as H_3PO_4 and HPO_4. It is an essential element involved in the formation of cell membrane as phospholipids, nucleic acids, co-enzymes (NAD and NADP) and organic molecules such as ATP and other Phosphorylated products. It is important in the energy transfer reaction in oxidation-reduction processes. Cambial activity is affected in the absence of Phosphorous.

Q. What is the importance of Potassium in plants?

Potassium is abundantly distributed fixed in soil. Its compounds are readily available for plants. It is important for opening and closing of stomata. It acts as activator for enzymes involved in synthesis of peptide bond and carbohydrate metabolism. Due to deficiency of potassium leaf colour becomes dull or bluish green and irregular chlorosis occurs and necrotic areas appear of the tip and margin of the leaf.

Q. What is the importance of Magnesium in plants?

Magnesium is present in the soil in water-soluble, exchangeable and fixed form and is present in primary mineral. Its carbonates are similar to calcium and held in the soil. It is a constituent of chlorophyll and form green pigment. It carries phosphorus by the time of formation of high oil contents seed which contain lecithin compound. It is transferred from older tissue to younger tissue when its deficiency occurs and reutilized in growth processes. Magnesium is important for the synthesis of fats and metabolisms of carbohydrates and phosphorus. In the absence of Mg severely affected leaves may wither and shed or abscises without the withering stage. Defoliation may severely occur.

Q. Describe the saprophyte plants.

Saprophyte plants

"Plants that break up complex dead organic food material into simple compound and use them for their growth and development are called saprophytes".

- **Total saprophytes** are totally dependent on dead organic matter.
- **Partial saprophytes** fulfill their nutritional requirements partially on dead organic matter.

There are some examples found among flowering plants like *Neothia* (bird's net or orchid) and *Monotrapa* (Indian pipe), the roots of these plants form a mycorrhizal association with the fungal mycelium to help in the absorption process.

Q. Write a note on carnivorous plants.

These plants have leaves modified to trap small animals (insects), digest their prey (the soft tissues), and absorb small organic molecules to fulfill their nitrogen or protein requirment. The carnivorous plants use a variety of features to attract insects: color, scent, nectar reward. These are the same features found in flowers to attract pollinators. These plants have;

- Glands for secretion and absorption
- Leaf modifications: common among plants. Even the parts of flowers (petals, sepals, pistils, stamens) are modified leaves.
- Rapid movements. Some plants, like the sensitive plant, have rapid leaf movements that startle insects.
- So the plant features found in carnivorous plants aren't unique to them. However, the carnivorous plants have put the features together in such a way that they can **catch, digest, and absorb prey**. There are about 400 species are known.
  Examples: Venus flytrap, Bladderwort, Aldrovanda, Pitcher plant, Sundew, Butterwort

Q. Describe the modes of heterotrophic nutrition in animals.

"It is a mode of nutrition in animals in which they are dependent upon other organisms, plants or animals for complex already prepared organic food".

There are different modes of heterotrophic nutrition in animals;

Saprotrophic nutrition involves feeding off the bodies of decaying organisms. Some forms of bacteria and fungi feed in this way.

Parasitism is concerned with feeding off other living organisms.

Detritivore animals feed upon decomposing material like earth worm

Predator animals capture and kill their prey.

Carnivour animals feed only on meet.

Omnivores feed upon meat as well as vegetables.

Filter feeders are those organisms which extract organic compounds form water and use as food.

Fluid feeders suck up body fluid like mosquito.

Q. Describe the holozoic nutrition.

It is the process of heterotrophic nutrition. **"The intake of complex, non-diffusible food is taken in and digested in to smaller diffusible molecules which can be absorbed and assimilated is known as holozoic nutrition"**.

The holozoic nutrition consists of following steps.

- **Ingestion:** Intake of food by different modes.
- **Digestion:** It is a process of breaking down of food in to molecules small enough for body to absorb. Digestion perform by two methods;
    - **Mechanical digestion:** Breakdown of food into smaller sized particles usually performs in mouth and stomach.
    - **Chemical digestion:** Enzymatic digestion of macromolecules into smaller sub-units performs in the GIT.
- **Absorption:** Movement of digested food from digestive system to circulatory system and eventually in the cells.
- **Assimilation:** The utilization of the absorbed food molecules by the body to provide energy and materials for tissue building.
- **Elimination/Egestion:** Release of undigested food from digestive tract

Q. What is the importance of digestion?

It is a process by which large complex insoluble organic food substances are broken down in to smaller simple soluble molecules by the help of enzymes. Digestion is the most important process through which complex molecules are broken down in to simple compounds which can diffuse in to the body and converted in to smaller molecules. These molecules are the source of obtaining energy and getting raw material for the growth and development of the body.

Q. Describe the types of digestive systems.

The digestion is of two types, extracellular and intracellular.

- The **extracellular** digestion takes place out side the cells, but within the digestive tract. The **intracellular** digestion occurs inside the cells.
- The Intracellular digestion in food vacuoles – occurs within the cells and is aided by enzyme from lysosomes, e.g. Paramecium, Amoeba, Porifera (sponges)
- Digestion in **gastrovascular** cavities is also called **sac like digestive system** which consists of mouth as a single opening which opens in to large sac-like body- e.g. Hydra, Porifera - involves both intracellular and extracellular digestion, one opening to the sac.
- Digestion in alimentary canal is considered as the **tube like digestive system** (complete digestive tract): digestion is mostly extracellular, specialized structures along tube, e.g. for storage-stomach, crop, intestine-chemical digestion, gizzard-mechanical digestion, has 2 openings - mouth and anus. examples: earthworms, mollusks, insects, vertebrates.

Q. How does the ingestion takes place in animals?

- It is a process of taking food directly by phagocytosis or the mouth in to the body.
- Phagocytosis occurs in the protozoans, in which food is taken in either through pseudopodia or through ciliary action.
- Metazoans take food through mouth which is the opening for alimentary canal.
- Microphagus feeders like filter feeders swing their limbs with bristles to move water with food particles towards them which they take in.
- Mytilus gets food by the movement of cilia present on the gills causes a current of water towards inhalant siphon and leave via an exhalent siphon.
- Water contains food particles, which get stuck with the mucus. This trapped food is then swept by the cilia towards the mouth.

- In Macrophagus feeder ingestion is performed by tentacles or arms which capture the prey as in *Physalia* or rasping organ radula which scraps the algae in gastropod mollusks. fluid feeders have modified mouth parts for piercing and sucking.

Q. Where the absorption and assimilation of food takes place in animals?

Absorption

In protozoans digested food is directly diffuse in to the cytoplasm and circulated by cyclosis. While in metazoans food absorbed from the intestine and circulated to all the parts of the body through blood and lymph.

Assimilation

Finally the digested food is utilized within the cells either to provide energy or materials to be incorporated into the body.

Q. Describe the process of nutrition in Amoeba.

Nutrition in amoeba

Protozoa are unicellular, eukaryotic microorganisms. The amoebae move by means of pseudopodia. Many of them obtain their food by holozoic nutrition characterized by direct feeding on microbial cells such as bacteria. "It has been estimated that one species of amoeba requires 40,000 bacteria per cell division. Amoeba are usually found near the surface of the soil in the upper 6 inches. Warm, moist, and organically rich soil encourage a high bacterial population. Amoeba tolerates a range of pH, with a preference for acidity and is capable of encysting when conditions are unfavorable.

Mechanism of feeding in Amoeba

Amoeba engulfs food by its pseudopodia in the form of food cup later on that becomes a food vacuole.

- In the next step lysosomes act upon food vacuole to break it into simpler compounds by their secretion of enzymes Proteases, amylases and lipases.
- The digestive vacuole now decreases in size water withdrawn and first become acidic (pH 5.6) and then becomes alkaline (pH 7.3).
- Soluble food particles are passed into the numerous fine canals radiating from the digestive vacuole and absorbed in to the cytoplasm this process is called micropinocytosis.
- The digested food circulates into the cytoplasm through cyclosis and assimilated in to new cytoplasm.
- The undigested food is egested out by exocytosis at the rear end.

Q. Describe the process of nutrition in Hydra.

Nutrition in Hydra

Hydra is a macrophagus feeder and feed upon small aquatic animals like crustaceans, small annelids, and insect larvae. The digestion is both extracellular and intracellular takes place.

Mechanism of feeding

- Hydra paralyzes its prey by the nematocysts located on the tentacles.
- The tentacle then bend over its mouth and enter the in to the digestive tract for digestion.
- The body cavity having glandular and flagellated musculoepithelial cells secrete proteolytic enzymes for extracellular digestion. While hydra ca digest fats and some carbohydrates as well.
- Extracellular digestion completed in about four hour.
- The semi digested food particles are engulfed by the phagocytic action of the flagellated cells where they are completely digested.
- The undigested food is egested out from the mouth.

Q. Describe the process of nutrition in Planaria.

Nutrition in Planaria

Planaria is a carnivorous worm which feed upon small worms, crustaceans, snails and remains of dead animals.

Mechanism of feeding

- When food comes in contact with planaria by it slimy secretion produced by the mucous glands the pharynx is protruded out through the mouth and seizes the prey.
- Mechanical and chemical digestion starts in the pharynx.
- Pharynx opens into the intestine which consists of three branches, an anterior and two laterals.
- Numerous branching blindly ended diverticula arise from the intestine and penetrate in to the tissues.
- The digested food is then diffused into the mesenchyme cells which help in the distribution
- Undigested food is egested out through the mouth.

Q. Describe the process of nutrition in Cockroach.

Nutrition in Cockroach

Cockroaches are omnivorous and can eat any kind of plant or animal organic matter. It eats dead insets and even its own cast of cuticle.

Digestive organs of Cockroach

The digestive system is tubular and consists of tubular alimentary canal and associated salivary glands. Digestion starts from mouth which have following appendages.

1. Labrum 2. Labium
3. Mandibles (one pair) 4. Maxillae (one pair)
5. Hpopharynx

The alimentary canal consists of the following portions

Pharynx	A small tube behind the mouth and bends backward in to oesophagus.
Oesophagus	This portion passes through the thorax and dilates in to crop.
Crop	It is a large dilated thin walled pear-shaped organ opens in to gizzard.
Gizzard	It is a round, thick walled bag, its lining has six teeth like thickenings. The portion from pre-oral cavity to gizzard is known as **fore gut or stomodeum.**
Mid gut	Behind the gizzard a tubular mid gut or mesentron lies and from the anterior end eight finger like hepatic caeca arises
Hind gut	The mid gut connected with the hind gut or proctodaeum which has a cuticular ectodermal lining, it has a short tubular ileum or small intestine followed by a long colon which ends in to broad rectum and opens by an anus.
Malphigian tubules	At the junction of mid gut and hind gut a large number of fine yellow thread like malphigian tubules arises which are concerned with the excretion.
Salivary Glands	These are present in a pair one on each side of the crop in the thorax.

Mechanism of Digestion:

The maxillae pick up the food and mandibles start chewing. In the preoral cavity food is mixed with saliva. Here salivary amylase acts upon carbohydrates and simple sugar is absorbed by the crop. Remaining food comes in to the gizzard where it is crushed and filtered. Small food particles pass to the mid gut where enzymes produced by hepatic ceacum digest the fats and proteins. Digested food is absorbed in the mesentron and the remaining food stays in the rectum which absorbs and conserves the water form the undigested food before expelling out the feaces.

Q. Describe the salient features of human digestive system.

1. Human digestive tract is complete and complex**.**
2. Each part of the digestive system has a specific function.
3. Digestion of food in humans is an extracellular process.
4. Enzymes are secreted into the digestive tract by nearby glands which never contain food themselves.
5. Digestion requires a cooperative effort by production of hormones and actions of nervous system.

Q. Describe the human dentition.

. Human dentition has many specializations because humans are omnivores. Humans are **diphodont** because they have two sets of teeth, deciduous or milk teeth and **Heterodont** because they have four different types of teeth incisors, canines, premolar and molar.

Thecodont because teeth are embedded in the gums.

Humans have 32 permanent teeth consisting of 8 incisors for cutting and biting, 4 canines for tearing meat, 8 premolars and 12 molars for grinding and crushing the food.

Human dental formula (I 2/2, C 1/1, PM 2/2, M 3/3) x 2 = 32.

Q. Write a note on human salivary glands.

There are three pairs of salivary glands in human mouth that secretes about1.5 dm^3 saliva daily.

The **Parotid glands** lie at the base of the pinnae.

The **Sublingual glands** at the base of the tongue and

The **Submandibular** glands at the base of the lower jaw.

Saliva contains 95% water, some mucous, lysozyme enzyme and salivary amylase. Amylase begins starch digestion which is converted in to maltose is common end product.

Q Describe the composition and secretion of gastric gland.

Gastric glands lie in the stomach fundus region and its secretion called gastric juice. They contain three types of cells;

1. Mucus secreting cells secreting thick layer of mucus that protects the wall of stomach and first part of duodenum from HCl and pepsin

2. Zymogen cells secreting pepsinogen.

3. Oxyntic cells which secrete dilute HCl having a pH 1.5 to 2.5.

This collective secretion is known as gastric juice.

Q. Describe the composition of pancreatic juice.

Pancreatic juice secreted by pancreas and contains the following:

1) **Sodium bicarbonate** [$NaCO_3$] that **neutralizes acidity of chyme**; pH of small intestine is slightly basic;
2) **Pancreatic amylase** that digests starch to maltose
3) **Trypsin** and other enzymes that digest protein to peptides;
4) **Lipase** that digests fat droplets to glycerol and fatty acids.

Q. How the digestive secretions are controlled?

1. **Gastrin** is produced by cells in gastric glands of stomach wall; stimulates gastric glands and increases gastric motility; its secretion is stimulated by a meal rich in protein.

2. **Secretin** is produced by cells in duodenal wall; stimulates pancreas to secrete fluids rich in $NaCO_3$ into duodenum; secretion is stimulated by acid chyme.

3. **Cholecystokinin (CCK)** produced by duodenal wall stimulates pancreas to increase pancreatic juice and liver to increase output of bile; causes gallbladder to release bile; secretion is stimulated by fats.

4. **Gastric inhibitory peptide (GIP)** from duodenal wall inhibits gastric gland secretion and stomach motility.

Q. Describe the functions of Pancreas.

Pancreas lies deep within abdominal cavity, just below stomach, and rests on posterior abdominal wall.It is an elongated and somewhat flattened organ. As an endocrine gland, it secretes glucogon and insulin hormone into bloodstream. As an exocrine gland, it secretes pancreatic juice.

1) Pancreatic juice contains sodium bicarbonate that neutralizes acidic chyme.
2) Digestive enzymes digest carbohydrates, fats and proteins.

Q. Describe the functions of liver.

Liver is a large glandular organ that fills the top of abdominal cavity, just below diaphragm. Liver has numerous functions:

1) It detoxifies blood by removing and metabolizing poisonous substances.
2) It makes plasma proteins including albumin and fibrinogen.
3) Liver destroys old red blood cells; converts hemoglobin to bilirubin and biliverdin in bile.
4) It produces bile stored in gallbladder before entering duodenum to emulsify fats.
5) It stores glucose as glycogen; breaks down glycogen to maintain constant blood glucose concentration.
6) Liver produces urea from amino groups and ammonia.
7) Amino acids can be converted to glucose but deamination (removal of amino groups) must occur.
8) Using complex metabolic pathway, liver converts amino groups to urea.
9) Urea is most common human nitrogenous waste it is transported by blood to kidneys.

Q. Describe the nutritional disorders.

Malnutrition:

"Deficiency or excess of one or more nutrients over a long period of time called malnutrition".

Undernutrition:

"The deficiency of nutrients is known as undernutrition'. It is a prolem of underdeveloped countries.

Preventive measures for undernutrition:

- Breast feeding should be started immediately after birth and continued up to 2 years.
- Complementary feeding must be started at 6 months of life
- Proper hygienic conditions
- Complete vaccination
- Good diet according to weight.

Over nutrition:

"Excess of nutrients is called over nutrition". It is a problem of developed countries.

Preventive measures for over nutrition.

- Calories should be taken according to weight
- Exercise
- Physical activities
- Avoid overeating

- Avoid fatty diet
- Avoid sweats and chocolates, cakes and pastries.

Overweight and obesity:

"It is a condition in which there is an excessive amount of body fat accumulates".

Causes:

- Imbalance between energy intake and expenditure
- Familial
- Endocrine disease
- Increased eating tendency
- Drugs e.g. (Steroid)

Effects:-

a) Cardiovascular diseases
b) Hernia
c) Gall stones
d) Diabetes
e) Anxiety and depression
f) Decreased life expectancy

Preventive measures:-

- Take calories according to age, sex, weight and job.
- Do exercise like walking, jogging, swimming
- Intake of green vegetables and fruits
- Avoid fatty food, cold drinks, Alcohol, Sweets, cakes etc.

Q. Describe the psychological nutritional disorders.

Anorexia Nervosa:

"It is a psychological condition in which there is loss of appetite occurs. It is characterized by refusal to eat". It occurs in girls and young women.

Bulimia Nervosa:

"It is characterized by recurrent bouts of binge eating, lack of self-control overeating during binges". It occurs exclusively in adult women.

Q. Describe the parasitic nutrition in animals.

Parasitic Nutrition:

"Parasitism is an association between two living organisms of different species in which one organism gets benefited while other is at loss." This relation may also be called as metabolic dependence.

The benefited partner is called parasite and the partner is at loss is called host.

- The parasites which live on the surface of host are called **ectoparasites**.
- Parasites live with in the host are called **endoparasite**.
- Parasites live permanently with in the host are called **obligatory parasite.**
- The **Facultative parasite** lives with in the host and after the death of the host continue to feed as saprotrophs on the dead body.

Q. Name some parasitic diseases of man.

Viral diseases:	Influenza, Rabies, yellow fever, poliomyelitis, measles etc.
Bacterial diseases:	Tuberculosis, typhoid, Cholera, Plague, Tetanus, Leprosy etc.
Fungi diseases:	Mostly dermatophytes cause ring worm disease, Athlete's foot and other skin disease.
Protozoan disease:	Malaria, Trypanosomiasis, Leishmaniases, Amoebiasis, etc.
Helminth diseases	Taeniasis by Taenia solium or T.seginata, Ascariases by Ascaris, Enterobiasis by Enterobius vermicularis, filariasis by Filarial worm etc.

Descriptive Question and answers

Q. Describe the role of some important mineral nutrients and their deficiency symptoms.

Nitrogen (N): This element is found in the form of nitrates or ammonium salts

Importance:

- It becomes a part of proteins nucleotides, nucleic acids and many other organic compounds synthesis.

Deficiency symptoms:

1. Low supply of nitrogen causes pale yellow leaves due to loss of chlorophyll called chlorosis.
2. Cell division and cell enlargement is inhibited.
3. Rate of respiration is affected.
4. Some plants leaves turn purple or red due o the **Anthocyanin** pigment e.g. tomato and apples leaves.
5. Plants become short and their leaves remain dormant which adversely affect cereal crops.
6. Prolonged dormancy and early senescence including leaf falls.

Phosphorous (P): Phosphorous is taken by plants in the form of soluble phosphates such as H_3PO_4 and HPO_4.

Importance:

- It is an essential element involved in the formation of cell membrane as phospholipids, nucleic acids, co-enzymes (NAD and NADP) and organic molecules such as ATP and other Phosphorylated products.
- It is important in the energy transfer reaction in oxidation-reduction processes.

Deficiency symptoms:

1. Cambial activity is affected.
2. Tillering of crop plant is reduced.
3. Dormancy is prolonged.
4. Growth is affected and dead necrotic patches appear on leaves, petioles and fruits.
5. Variable colours develop e.g. plate green in *Pisum*, olive green in *Phaseolus*.
6. Causes accumulation of carbohydrates
7. Thickening of tracheal cells are reduced a phloem differentiation becomes incomplete.

Pottasuim (K):

Potassium is abundantly distributed fixed in soil. Its compounds are readily available for plants.

Importance:

- It is important for opening and closing of stomata.
- It acts as activator for enzymes involved in synthesis of peptide bond and carbohydrate metabolism.

Deficiency symptoms:

- Leaf colour becomes dull or bluish green.
- Irregular chlorosis occurs and necrotic areas appear of the tip and margin of the leaf.
- Plant growth stunted with the shortening of internodes and grains production is reduced.
- Lamina of plant leaf curled backward towards the under surface or roll forwarded towards the upper surface.

Magnesium:

Magnesium is present in the soil in water-soluble, exchangeable and fixed form and is present in primary mineral. Its carbonates are similar to calcium and held in the soil.

Importance:

- It is a constituent of chlorophyll and form green pigment.
- It carries phosphorus by the time of formation of high oil contents seed which contain lecithin compound.
- It is transferred from older tissue to younger tissue when its deficiency occurs and reutilized in growth processes.
- Magnesium is important for the synthesis of fats and metabolisms of carbohydrates and phosphorus.

Deficiency symptoms:

- Chlorosis occurs.
- Severely affected leaves may wither and shed or abscis without the withering stage. Defoliation may severely occur.
- Leaves, sometimes, develop necrotic spots.

Q. Describe the heterotrophic mode of nutrition in plant.

Plants which can not prepare their own organic molecules and dependent for the molecular requirement on outside sources are called **heterotrophic plants.**

These are generally categorized in to following types

1. Parasites 2. Saprophytes 3. Carnivorous

1. Parasites

These plants develop hair like out growth called haustoria which penetrate into host tissues for absorbing nutrients requirements.

- **Obligate or total parasites** are those which depend for their nutrition entirely on other living organisms.
- **Facultative or partial parasites** depend partially on other living organisms.

Parasitic Angiosperms

These are classified in to following types:

- Partial stem parasite
- Total stem parasite
- Partial root parasites
- Total root parasite

I. Partial stem parasite

- *Loranthus* has thick green leaves, woody stem and developed haustorial system.
- It can synthesis some of its food with the help of nutrients and water absorbed from the host plant through haustoria.
- The seeds get stuck up to the stem of the host plant and germinate, sending its haustoria in the tissue of the host plant.
- Other examples are *Bauhinia, Viscum, Cassytha filiformish* which suck up nutrients from the vascular tissues of the host plant.

II. Total stem parasite

- Plant like *Cuscuta* (Amer-bail) is a common parasite which attacks stem of many herbs, shrubs and trees.
- They penetrate haustoria inside the tissues of host. The xylem of parasite comes in contact with the xylem and phloem with the phloem of host tissues and sucks the nutrients.
- The host dies off due to exhaustion.

III Partial root parasite

- Sandal wood tree is the example of this parasite.
- Its seedling can grow for a year but not so independently.
- Within a year these roots attack the plant of neighboring trees and absorb nutrients.

IV Total root parasite

- *Orobanche* is the example of this category which attacks the roots of plants belonging to the families Cruciferae and Solanaceae.
- *Cistanche* is another example which attack the roots of *Clatropis, Striga* and also parasite on the roots of sugarcane.
- It is commonly found on Sorghum or Jowar crop.

Saprophytes

"Plants that break up complex dead organic food material into simple compound and use them for their growth and development are called saprophytes".

- **Total saprophytes** are totally dependent on dead organic matter.
- **Partial saprophytes** fulfill their nutritional requirements partially on dead organic matter.

There are some examples found among flowering plants like *Neothia* (bird's net or orchid) and *Monotrapa* (Indian pipe), the roots of these plants form a mycorrhizal association with the fungal mycelium to help in the absorption process.

Carnivorous Plants

These plants have leaves modified to trap small animals (insects), digest their prey (the soft tissues), and absorb small organic molecules to fulfill their nitrogen or protein requirement. These plants have glands for secretion and absorption, leaf modifications. Even the parts of flowers (petals, sepals, pistils, stamens) are modified leaves. Examples of some plants are as follows.

Venus flytrap

When Insect touches trigger on leaf surface. The underside of the leaf rapidly enlarges. This causes the leaf to rapidly fold shut on the insect. Once the insect has been digested, the upper side of the leaf grows. This opens the leaf again and resets the trap.

Pitcher plant

The leave forms a cone. A solution of digestive enzymes is at the base of the cone. Insects fall into the cone, drown, and are digested.

Q. Explain in detail the carnivorous plants.

Carnivorous Plants

These plants have leaves modified to trap small animals (insects), digest their prey (the soft tissues), and absorb small organic molecules to fulfill their nitrogen or protein requirment. The carnivorous plants use a variety of features to attract insects: color, scent, nectar reward. These are the same features found in flowers to attract pollinators. These plants have;

- Glands for secretion and absorption
- Leaf modifications: common among plants. Even the parts of flowers (petals, sepals, pistils, stamens) are modified leaves.
- Rapid movements. Some plants, like the sensitive plant, have rapid leaf movements that startle insects.
- So the plant features found in carnivorous plants aren't unique to them. However, the carnivorous plants have put the features together in such a way that they can **catch, digest, and absorb prey**. There are about 400 species are known. We generally categorized in to two types

- **Active trappers** move to catch prey.
- **Passive trappers** use sticky secretions and pitfalls to catch prey.

Venus flytrap

These are **Active trapper**. When Insect touches trigger on leaf surface. The underside of the leaf rapidly enlarges. This causes the leaf to rapidly fold shut on the insect. Once the insect has been digested, the upper side of the leaf grows. This opens the leaf again and resets the trap.

Bladderwort

Active trapper. Aquatic. A bladder is under tension. Aquatic critter (usually insect larva) brushes against trigger at mouth of the bladder. The bladder opens, a vacuum pulls in the larva, along with a lot of water. Once the larva is digested, the water is removed from the bladder, and the trap is reset.

Aldrovanda

Active trapper. A rootless aquatic plant with floating stem. It has reosettes of modified leaves, which have two lobed mobile lamina having teeth at the margin and sensitive jointed hairs and stalked gland on the surface.

Pitcher plant

Passive trapper. The leave forms a cone. A solution of digestive enzymes is at the base of the cone. Insects fall into the cone, drown, and are digested.

Sundew

Passive trapper. Sticky, stalked glands cover the leaves. Insects get stuck and can't get away. Slowly, the stalks fold over the insects. Eventually, the entire leaf can curl around the insect. By having the leaf in close contact with the insect, you have more efficient digestion and uptake of nutrients.

Butterwort

Passive trapper. Flat sticky glands on leaf surface. Insects get stuck. Slowly, the leaf will curl around the insect for improved digestion and nutrient uptake.

Q. Explain in detail the human digestive system.

Human Digestive system

The process of digestion in humans starts from the mouth.

Human Mouth

1. Human dentition

Human dentition has many specializations because humans are omnivores. Humans are **diphodont** because they have two sets of teeth, **deciduous** or milk teeth and **heterodont** because they have different types of teeth embedded in the gums hence called **Thecodont**. Humans have **32** permanent teeth consisting of **8 incisors** for cutting and biting, **4 canines** for tearing meat, **8 premolars** and **12 molars** for grinding and crushing the food.

Human dental formula (I 2/2, C 1/1, PM 2/2, M 3/3) x 2 = 32

2. Salivary glands

Food is chewed in the mouth and mixed with saliva. Three pairs of salivary glands secrete about 1.5 dm^3 saliva daily by way of ducts into the mouth. The **Parotid glands** lie at the base of the pinnae, **Sublingual glands** at the base of the tongue and the **Submandibular glands** at the base of the lower jaw. Saliva contains; 95% water, some mucous, lysozyme enzyme and salivary amylase is enzyme that begins starch digestion; maltose is common end product.

3. Tongue:

Food is manipulated by a muscular tongue with touch and pressure receptors. Taste buds are located primarily on tongue but also on the surface of the mouth; chemical receptors are stimulated by chemical composition of food. Food is chewed and mixed with saliva to form a bolus in preparation for swallowing.

The Pharynx and the Esophagus

Digestive and respiratory passages come together in **pharynx**, and then separate. During swallowing, path of air to lungs could be blocked if food entered trachea. **Epiglottis** covers opening into **trachea** as muscles move bolus through pharynx into esophagus. **Esophagus** is a muscular tube that moves swallowed food to **stomach** by **peristalsis**.

The Stomach

Stomach has three regions anterior **cardiac region** having mucous glands, middle region the **fundus** which has gastric glands and contain three types of cells **Mucus secreting cells**, **Zymogen cells** secreting pepsinogen and **oxyntic cells** which secrete dilute HCl having a pH 1.5 to 2.5. This collective secretion is known as gastric juice. Stomach stores a liter of partially digested food from continual eating. **Gastric juice** is produced by cells of **gastric glands**. Walls of the stomach contract vigorously and mix food with juices secreted when food enters. Gastric juice contains **hydrochloric acid** and another digestive substance, **pepsin**. This acid kills most bacteria and other microorganisms. Low pH also stops activity of salivary amylase and promotes activity of pepsin. **Pepsin** is a hydrolytic enzyme that acts on proteins to produce peptides.

A thick layer of mucus protects wall of the stomach and first part of duodenum from HCl and pepsin. Stomach contents, a thick, soupy mixture, are called **chyme**. At base of the stomach is a narrow opening controlled by a **sphincter** (a circular muscle valve) When the sphincter relaxes, chyme enters duodenum; a neural reflex causes the sphincter to contract closing off the opening. Duodenum is first part of the small intestine. The sphincter relaxes and allows more chyme to enter the duodenum.

Small Intestine

Human **small intestine** is a coiled muscular tube about three meters long. It has mucous membrane lining with ridges and furrows; surfaces are covered by villi. **Villi** are finger-like projections whose surface cells are covered by microvilli. **Microvilli** are minute projections, a brush border, of surface cells of intestinal villi these increases effective surface area of small intestine.

Duodenum:

As chyme enters duodenum, proteins and carbohydrates are partly digested; no fat digestion occurs. Additional digestion is aided by secretions from **liver** and **pancreas**. **Bile** is a secretion of **liver** temporarily stored in **gallbladder** before sent to duodenum. Bile contain bile salts, bile pigments and water. Bile salts help in emulsification of fat.

The bile pigments are **bilirubin (red) and biliverdin (green)** these are excretory product s and produced by the breakdown of hemoglobin in liver.

This increases fat digestion by increasing surface area of fat globules exposed to enzymes.

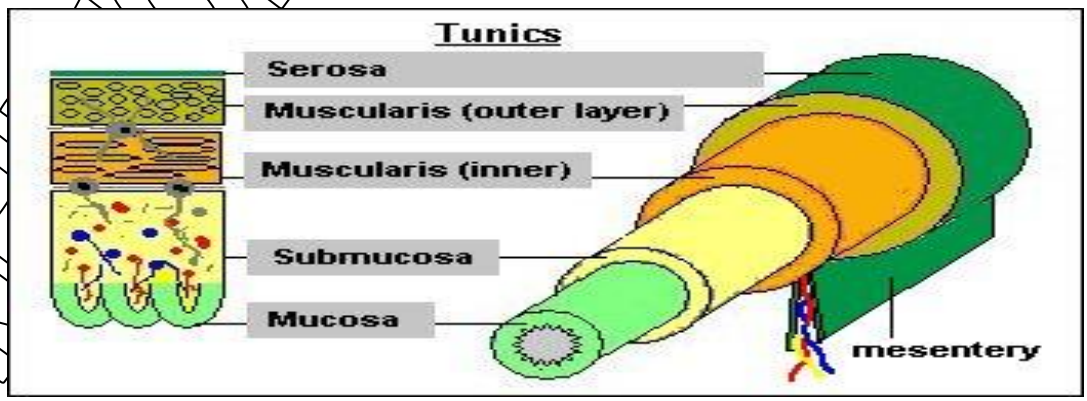
Pancreatic juice secreted by **pancreas** under the stimulation of another hormone called secretin secreted from duodenum and contains the following:

1) **Sodium bicarbonate** [$NaCO_3$] that neutralizes acidity of chyme; pH of small intestine is slightly basic.
2) **Pancreatic amylase** that digests starch to maltose.
3) **Trypsin** enzyme which is activated by enterokinase and digest protein to peptides.
4) **Chymotrypsin** converts casein (milk proteins) in to short chain amino acids.
4) **Lipase** that digests fat droplets to glycerol and fatty acids.

Epithelial cells of villi produce intestinal enzymes attached to plasma membrane of microvilli. Intestinal secretions complete digestion of peptides and sugars; peptides are digested by **peptidases** to amino acids; and maltose from the first step in starch digestion is converted by maltase to glucose. Large molecules of carbohydrates, proteins and fats are broken into small molecules absorbed by villi.

Absorption by Villi

Small intestine is specialized for absorption by the huge number of villi that line the intestinal wall. Each villus contains **blood vessels and a lymphatic lacteal.** Lacteal is lymphatic vessel in an intestinal villus that aids in absorption of fats. Sugars and amino acids enter villi cells and are absorbed into bloodstream. Glycerol and fatty acids enter villi cells; reassembled into fat molecules, they move into lacteals. Absorption involves diffusion and active transport requiring expenditure of cellular energy.



Large Intestine

1. Large intestine is region following the small intestine.
2. It has four parts: **cecum, colon, rectum, and anal canal.**
3. Appendix is a finger-like projection extending from cecum, a blind sac at junction of small and large intestine.
4. The colon is the largest part and has three regions, ascending colon, transverse colon and descending colon.
4. 1.5 liters of water enter digestive tract daily from drinking; another 8.5 liters enter from various secretions. About 95% of this total liquid is reabsorbed by small intestine, remainder by cells of colon.
5. Large intestine functions in ion regulation, absorbing inorganic salts plus vitamin K produced by intestinal bacteria.

Anus and Egestion:

Large intestine that terminates at the **anus**, an external opening and contain undigested food called feces. Feces consist of 75% water and 25% solid matter. One-third of the solid matter is intestinal bacteria. Remainder is undigested wastes, fats, organic material, mucus, and dead cells egested out from intestinal lining. Two spinchter surround the anus an internal one o smooth muscles under the control of autonomic nervous system and an outer one of striated muscles controlled by the voluntary nervous system.

Accessory Organs

Pancreas

Pancreas lies deep within abdominal cavity, just below stomach, and rests on posterior abdominal wall.It is an elongated and somewhat flattened organ. As an endocrine gland, it secretes glucogon and insulin hormone into bloodstream. As an exocrine gland, it secretes pancreatic juice.

1) Pancreatic juice contains sodium bicarbonate that neutralizes acidic chyme.
2) Digestive enzymes digest carbohydrates, fats and proteins.

Liver is a large glandular organ that fills the top of abdominal cavity, just below diaphragm. Liver has numerous functions:

1) It detoxifies blood by removing and metabolizing poisonous substances.
2) It makes plasma proteins including albumin and fibrinogen.
3) Liver destroys old red blood cells; converts hemoglobin to bilirubin and biliverdin in bile.
4) It produces bile stored in **gallbladder** before entering duodenum to emulsify fats.
5) It stores glucose as glycogen; breaks down glycogen to maintain constant blood glucose concentration.
6) Liver produces urea from amino groups and ammonia.
7) Amino acids can be converted to glucose but deamination (removal of amino groups) must occur.
8) Using complex metabolic pathway, liver converts amino groups to urea.
9) Urea is most common human nitrogenous waste it is transported by blood to kidneys.

Q. Explain in detail the disorders of Gastro-Intestinal tract.

Diarrhea

"Rapid movement of fecal matter through large intestine resulting in loose motions".

Causes of Diarrhea

Enteritis: it is caused by virus or bacterial infection of intestinal tract
Cholera: It is caused by bacteria called "Vibrio Cholera.

There is passage of large quantity of water in stools called Rice Water Stools.
Psychogenic Diarrhea it is caused by nervous tension.

Prevention:

- Proper hand washing
- Proper disposal of waste
- Drinking of boiled water
- Proper cocking of food
- Proper washing of food and vegetables
- Proper hygienic conditions
- Good dietary habits

Dysentery:

"Acute inflammation of large intestine characterized by Diarrhoea with blood and mucus in stool.

Causes:

Shigella: Bacterial infection
Entamoeba histolytica: A Protozoan infection.

Constipation:

Def. "infrequent passage of hard stool"

Causes:

- Irregular bowel habit
- Inhibition of defecation reflexes
- Lack of fibre diet
- Lack of fluid intake
- Gastrointestinal disorders

Preventive measures:

- Regular bowel habits
- Diet rich in fibres e.g. fruits and vegetables
- Plenty of water drinking

Piles:

"These are dilated veins occurring in relation to anus". Also known as haemorrhoids.

Types:

a) External: these are covered by skin
b) Internal These are covered by anal mucous membrane

Causes:

Constipation

Prevention:

Avoid constipation

Dyspepsia:

"Epigastric discomfort occur by following meals".

Causes:

- Peptic ulcer
- Gastritis
- Gall stones
- Alcohol
- Pregnancy
- Anxiety, Depression

Symptoms:

- Heart burn
- Flatulence (heavy abdomen)
- Anorexia (loss of appetite)
- Nausea
- Vomiting
- Abdominal pain

Non ulcer or functional Dyspepsia:-

"Persistent dyspepsia for which no cause can be identified".

Cause:

Motor dysfunction of alimentary tract.

Peptic ulcer:

"Mucosal ulceration near acid bearing regions of gastrointestinal tract".

Sites:

1) Duodenum: in first portion
2) Stomach
3) Oesophagus
4) Jejunum

Causes:-

- Impairment of mucosal defense system
- Helico bacter pylori infection (bacterial infection)
- Hereditary
- Excessive secretion of acid and pepsin
- Stress, Anxiety

Preventive measure:

1) Avoid cigarette smoking
2) Avoid Aspirin
3) Avoid Alcohol

Food Poisoning:

It is also called Gastroentritis. It may be caused by

- Infective:- due to Virus , Bacteria or protozoa
- Non infective: due to allergy.

Symptoms:

- Vomiting
- Diarrohea

It occurs with in the 48 hours of consumption of contaminated food or drink.

Causes:

- Salmonella infection (most commonly occurring bacteria)
- E.coli infection
- Vibrio infection
- Bacillus infection

Source of infection:

- Domestic fowl from defrosted or uncooked chicken and uncooked or raw eggs.

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GASEOUS EXCHANGE

GASEOUS EXCHANGE IN ANIMALS

Like other living organisms, animals also exchange gases with their environment during respiration. They take in oxygen and give out carbon dioxide continuously through their moist, RESPIRATORY surfaces.
Respiratory gases move across moist, respiratory surface by diffusion, the concentration gradient of gases play important role in mechanism of gaseous exchange. Oxygen is consumed and carbon dioxide is liberated constantly due to concentration gradient.
The respiratory gases are passed across the respiratory surface by dissolving in water. Moreover, respiratory surface must be large enough in relation to the volume of that animal for efficient gas exchange.

Properties of Respiratory Surfaces (Conditions for Respiration):

Respiratory surface of animals bears following properties.

❶ *Permeable Respiratory Surface:*
Respiratory surface should be permeable in order to diffuse in and diffuse out of gases.

❷ *Larger Respiratory Surface:*
Respiratory surface should be as larger as possible. Larger the respiratory surface, greater exchange of respiratory gases would occur.

❸ *Wet and Moist Respiratory Surface:*
The respiratory surface should be wet and moist, in order to binds mølecules of respiratory gases.

❹ *Thin Respiratory Surface:*
The respiratory surface should be thin and richly supplied with blood.

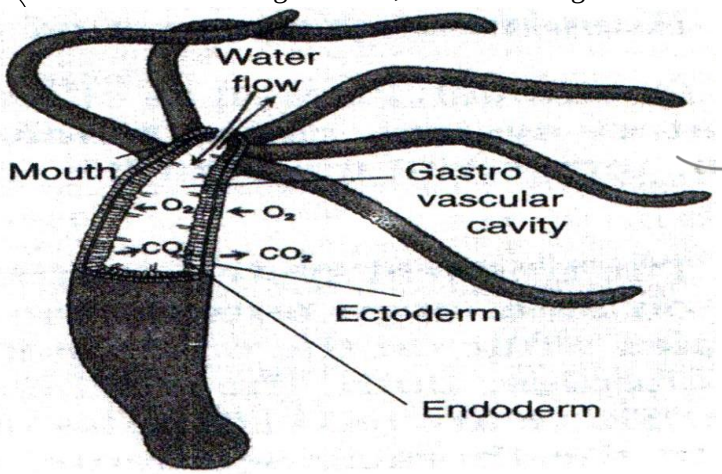
Respiratory surface in animals depends upon:

① The structure
② Habitat and
③ Activity of animal.

In order to maintain greater surface to volume ratio for efficient gas exchange animals have evolved different adaptations in their respiratory surface. In unicellular organisms, gas exchange occurs over the entire surface area (plasma membrane).

Respiratory Organs of Aquatic And Terrestrial Animals:

❶ *Respiratory Organs of Hydra:*
Hydra is multicellular animal with tissue level of organization, but has no organs. Its means there is no specific respiratory organ in Hydra. And exchange of gases take place through general body surface i.e. Ectodermal cells and endodermal cells by the process of DIFFUSION.

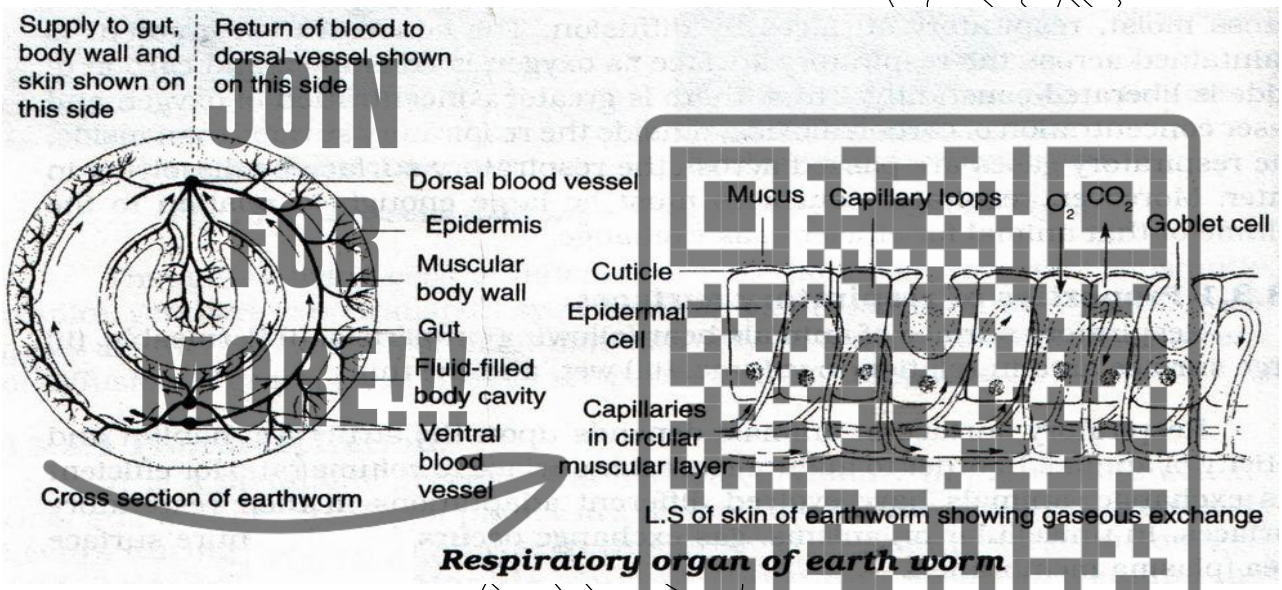


① The Ectodermal cells, exchange gases with external water.
② While endodermal cells exchange respiratory gaseous with water that comes within gastro vascular cavity.

❷ *Respiratory Organs of Earth Worm:*

The scientific name of earth worm is Pheritima posthuma, it is belong to phylum "Annelida" and class "Oligochaeta".

The earthworm has no specialized respiratory organs. It uses its wet skin as respiratory surface. Its moist skin offers enough surface area for efficient gas exchange.



Mechanism of Respiration:

- Its blood consist homeoglobin , hence it is responsible for gaseous transportation
- O_2 + CO_2 dissolve in the blood. O_2 goes to the tissue and CO_2 goes to the skin from where it goes to air.
- In order to keep the skin moist, earthworm has to live in damp soil.
- The moisture is absorbed by mucous secreted from the goblet glands in the skin of earth worm.
- Due to larger size and complexity of the body of earthworm, distribution of respiratory gases from skin to each cell of the body and vice versa posses a problem since diffusion alone cannot distribute gases rapidly to distant cells within the animal.
- So the earthworm has developed a blood vascular system, which can efficiently and rapidly transport respiratory gases within the body.

Respiratory Organs of Cockroach:

Cockroach and all insects has specialized organs for respiration, the respiratory organs known as TRACHEAE.

Tracheal System:

Tracheae with association of spiracles and TRACHEOLES form a respiratory system called TRACHEAL SYSTEM.

1. ***Tracheae*** Tracheal system consists of number of internal tubes called TRACHAE.

2. ***SPIRACLES:*** Tracheae open outside the body through minute slit like pores known as **spiracles**. There are Ten (10) pairs of spiracles on lateral side of the cockroach. Two pairs in thoracic segment and eight pairs in first eight Abdominal segments. Spiracles are opened or closed by valves.

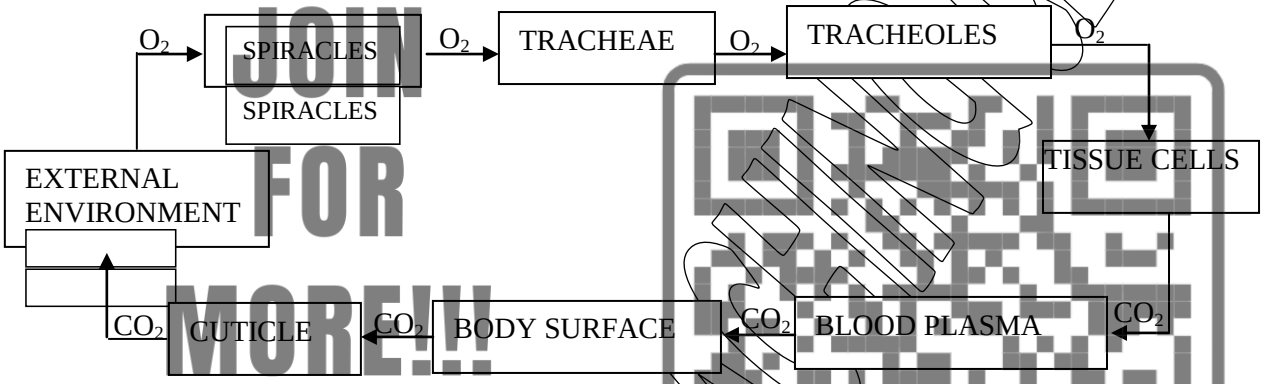
3. ***Tracheoles:*** These are fluid filled fine branches, in which spiracles are open. Tracheoles, finally end as blind, and attached directly with the cells of tissue.

Respiratory Mechanism:

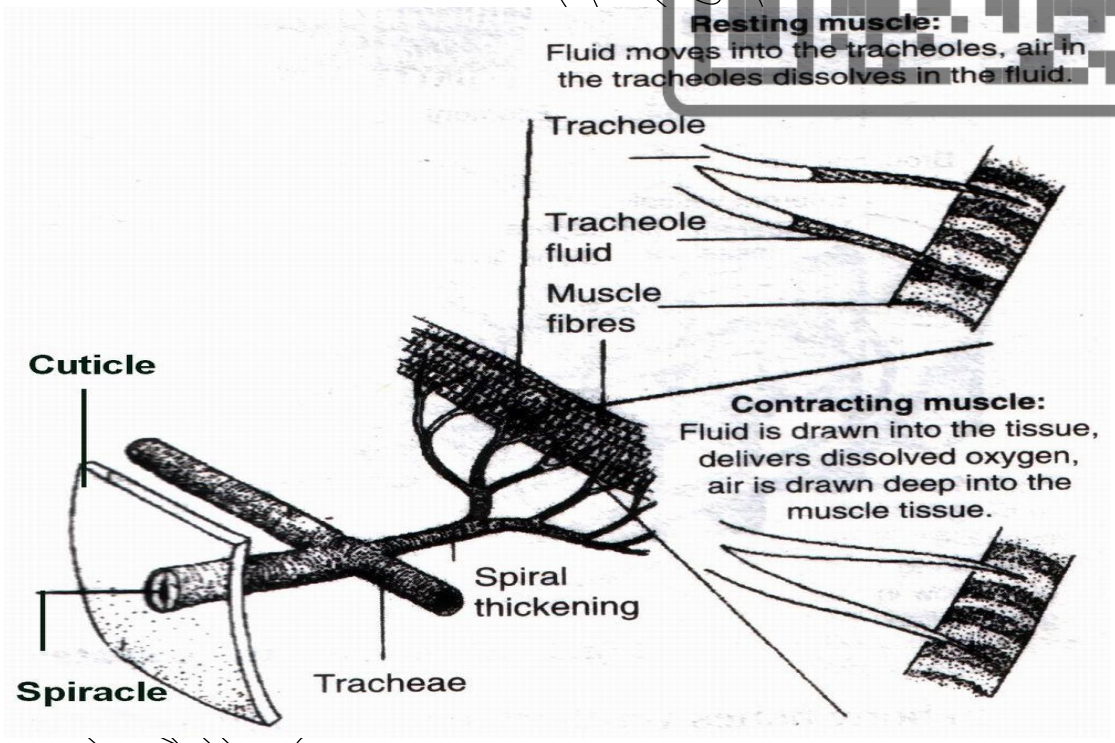
The cockroach takes in air directly from the atmosphere into the tracheae through spiracles. Oxygen diffuse directly into the cells of tissue, through tracheoles.

The removal of CO_2 depend upon blood plasma, through body surface via cuticle:

- Cockroach takes air from abdomen spiraches and at this time all abdominal spiraches are opened and gases goes to the tracheols , were O_2 release and CO_2 take up back to the air in the tracheds.
- At this time all abdominal spirahes closed and abdomen contract.
- All gases goes to thoracic region where thoracie spiraches are open and gases exhales.



Mechanism of Respiration in Cockroach-flow diagram.



Respiratory System of Fish:

Respiratory organs in fish are GILLS. Each gill is a highly vascularized structure. Gills are covered by operculum.

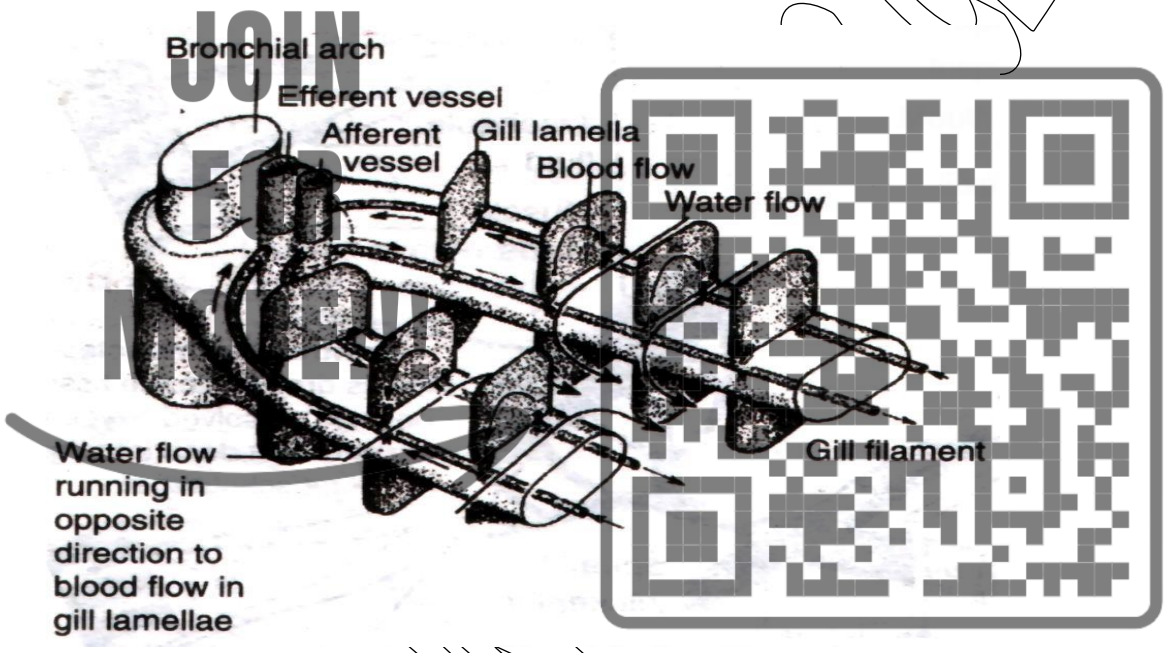
Structure of Gills:

Gills are composed of Gill filaments, Gill bar and Gill lamellae.

i. Gill filaments: Gill filaments are "V" shaped; hundred in numbers, arranged in two rows.

ii. Gill bar: Gill bars are long, curved cartilage or bones, which support to filaments. Gill bars also known as Gill Arch.

iii. Gill lamellae: Each gill filament is folded to form numerous plate like lamellae. Lamellae increase the surface area of the gills each lamella is provided by a dense network of blood capillaries.



Mechanism of Respiration (in fish)

Water with oxygen contents is drawn into mouth for approaching the Gills. The concentration of oxygen in water is low that's why the fish must use considerable energy to ventilate its gills. In the capillaries of each lamella, blood flows in opposite direction to the movement of water across the gills. This is known as **counter current flow** of water and blood, this phenomenon enhance the exchange of gaseous between water and Gills. i.e. counter current flow is very effective as it enables the fish to extract up to 80 % - 90% of the oxygen from water.

Hence the oxygenated blood flow in the efferent artery which goes to body.

RESPIRATORY ORGANS OF FROG:

Respiratory organs of frog are:

i. Skin
ii. Buccal cavity and
iii. Lungs.

That's why there are three method of respiration found in frog, which are known as

i. Cutaneous respiration
ii. Bucco - pharyngeal respiration, and

iii. Pulmonary respiration, respectively.

❶ Cutaneous Respiration:

The gaseous exchange through the skin is known as cutaneous respiration.

❷ Bucco-Pharyngeal Respiration:

The gaseous exchange through, thin and vascularized lining of the buccal cavity is called Bucco-pharyngeal respiration.

❸ Pulmonary Respiration:

Exchange of gases through lungs is known as pulmonary respiration.

a. Structure of Lungs:

Frog has evolved vascularized, paired outgrowths from the lower part of pharynx known as LUNGS. Lungs are simple sacs almost like balloon. The inner surface of lungs, is increased by thin walled air chambers – known as ALVEOLI. The inner surface of alveoli is supported with network of blood capillaries. Thus alveoli act as the site of exchange of gases.

Each lung is connected to outside by the system of tubes, each tube is known as BRONCHUS.

b. Mechanism of Pulmonary Respiration:

Mechanism of pulmonary respiration can be divided into two step. The INHALATION (INSPIRATION) and EXHALATION (EXPIRATION).

Inhalation (Inspiration):

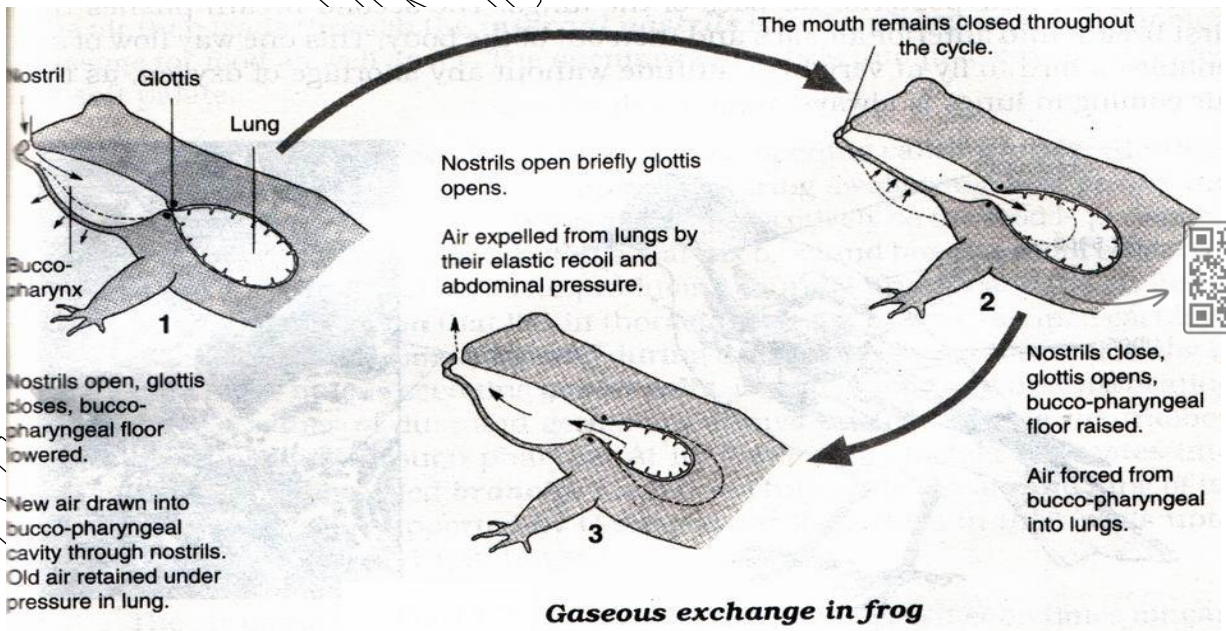
The intake of air known as INHALATION (INSPIRATION). In frog inhalation does in two steps.

① The frog draws air into the buccal cavity by lowering its bucco-pharngeal floor. During this process, it opens the nares and closes the glottis. (Fig # 1)

② Then with the nostrils closed and glottis opened, it raises the buccopharyngeal floor, thus pushing the air into the lungs. (Fig # 2). (This type of ventilation does not allow the lungs to be completely emptied or refilled by air, hence termed as incomplete ventilation.)

Exhalation (Expiration):

The removal of consumed air out of the lungs is called exhalation or expiration during the exhalation the nostrils and glottis become open. Air expelled form the lungs by their elastic recoil and abdominal pressure (Fig # 3).



Gaseous exchange in frog

RESPIRATORY SYSTEM OF BIRDS:

The respiratory organs in bird are lungs.

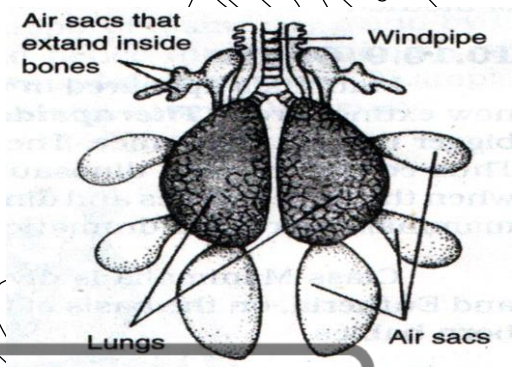
Lungs: are comparatively small and compact and internally sub-divide into parabronchi.

Parabronchi: are numerous, small, highly vascularized thin membranous channel (tubes).

Functions:

i. Parabronchi serve as respiratory surface for gaseous exchange.
ii. Parabronchi are responsible for continuous flow of air in one direction (unidirection).

Air Sacs: Birds have 8 – 9 thin walled, non-muscular, non-vascular, sac like out growth of lungs known as **air sacs**.



Air sacs of a bird

Functions:

i. Air sacs work as bellows that ensure the unidirectional flow of air. Undirection flow of air is known as **complete ventilation**.

MECHANISM OF RESPIRATION:

Birds take two breaths to move air completely through the system of air sacs and lungs.

① The first breath draws fresh air into the posterior air sacs of the lungs.

② The second breath pushes the first breath into anterior air sac then out of the body. Where it passes through lung, each air sec empty into the lungs as O_2 is required.

RESPIRATORY SYSTEM OF MAN:

The respiratory system of man consists of air passage ways and a pair of lungs.

A. Air Passage Ways:

Air passage ways consists of:

(i) External nares (external nostrils)
(ii) Nasal cavity
(iii) Internal nares (internal nostrils)
(iv) Pharynx
(v) Glottis
(vi) Larynx
(vii) Trachea
(viii) Bronchi
(ix) Bronchioles
(x) Lungs

i. External nares (External nostrils):

Atmospheric air enters into a pair of openings called external nares (nostrils), which leads into nasal cavity.

ii. Nasal Cavity:

Nasal cavity is lined internally by:

(a) Ciliated epithelium
(b) Mucous secreting cells
(c) Hairs
(d) Sensory cells of smell.

Thus the air drawn in becomes **warm**, **moist** and **filtered**.

iii. Internal nares (nostrils):
The nasal cavity leads into internal nares (nostrils), while internal nares leads into pharynx.

iv. Pharynx:
Pharynx is a muscular passage lined with mucous membrane. It is a common passage for food as well as air.

v. Glottis:
Pharynx leads air into LARYNX through an opening called GLOTTIS. Glottis is guarded by epiglottis.

vi. Larynx:
Larynx or sound box is a small chamber. It consists of a pair of vocal cords for producing sound. Larynx leads the air into trachea.

vii. Trachea:
Trachea is a wind pipe (air duct) lies in thoracic cavity. It bears C – shaped cartilage rings, which prevent it from collapsing. Its internal lining is ciliated and bears mucus secreting GOBLET CELLS. Due to mucus and upward beating of cilia, dust particles and germs always pushed outside the trachea into the oesophagus through pharynx.

viii. Bronchi:
Trachea at its lower end, bifurcate into two smaller branches called bronchi (singular = bronchus). Each bronchus leads the air into lung of its side. Bronchi are also supported by C – shaped cartilage rings.

ix. Bronchioles:
When the smaller bronchi attain a diameter 1 mm or less then they are called bronchioles. Each bronchus in lungs, divided and re-divided into many bronchioles.

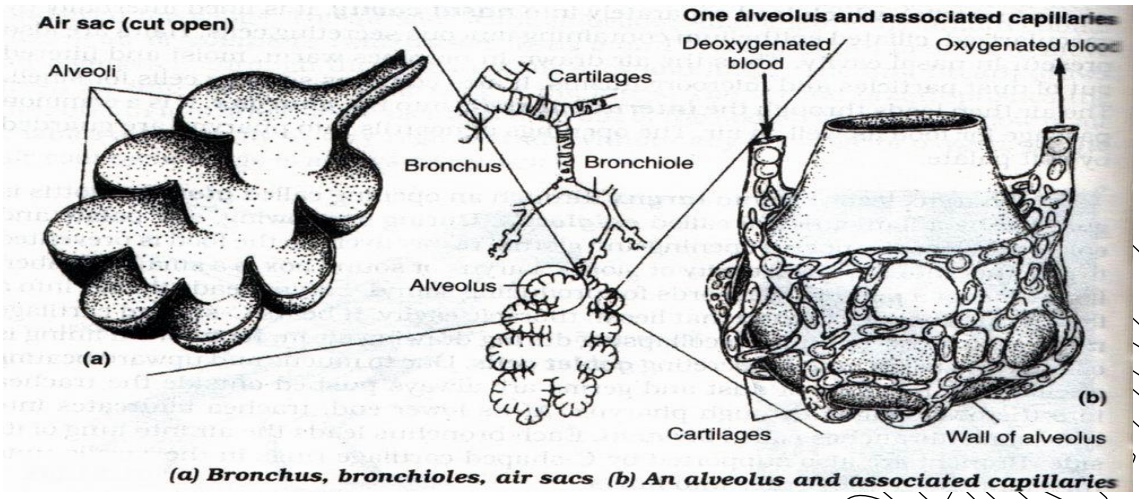
x. Lungs:
Eeach bronchioles finally opens into an air sac in lungs.

B. Lungs:
Lungs are paired, soft spongy and highly vascularized structures. The right lung is partitioned into three lobes while the left lung into two lobes.
Lungs are situated in the thoracic cavity. The walls of thoracic cavity is formed of:

① inter-costal muscles ② 12 pairs of ribs
③ vertebral column and ④ sternum bone

The thoracic cavity is separated from the abdomen by a muscular partition called DIAPHRAGM.

Each lung is enclosed by two, thin membranes known as PLEURAL MEMBRANES, within the pleural membranes, there is a fluid filled, narrow cavity called PLURAL CAVITY. This fluid acts as a lubricant.
Inside each lung, each bronchiole terminates at a tiny, hollow sac-like alveiolar duct contaning a number of air sacs or ALVEOLI. The alveoli are considered as the RESPIRATORY SURFACES of lungs. A single alveolus is composed of single layer of epithelial cells with a slightly larger diameter then the blood capillary. Each alveolus is surrounded by extensive network of blood capillaries. Alveoli is the site of exchange of respiratory gases.



(a) Bronchus, bronchioles, air sacs (b) An alveolus and associated capillaries

It has been estimated that both lungs contain about 700 million alveoli with a surface area equal to that of tennis court or 20 times the body's entire skin surface.

BREATHING IN MAN:

A process of taking in and giving out of air from the atmosphere upto the respiratory surface and vice versa is called breathing.

In man (mammals) breathing is termed as NEGATIVE PRESSURE BRETHING; In this kind of breathing, air is drawn into the lungs due to negative pressure i.e. decrease in pressure in thoracic cavity as compared to atmospheric pressure.

MECHANISM OF BREATHING:

Process of breathing consists of two phases.

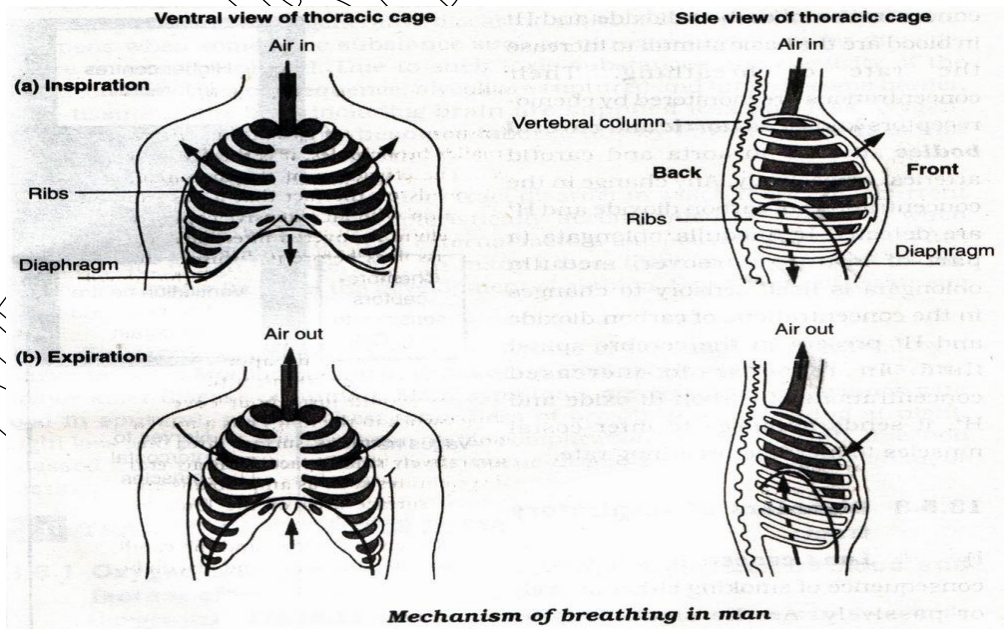
❶ *Inspiration (Inhalation):*

The intake of air is known as inspiration or inhalation. During inspiration the volume of thoracic cavity increase by the following events.

(a) Contraction of external intercostals muscles and relaxation of internal intercostals muscles moves the ribs and sternum outward and upward.

(b) Contraction of diaphragm, makes diaphragm flat, and moves it downward.

When the volume of chest cavity is increased, and a negative pressure is developed inside the thoracic cavity and ultimately in the lungs, so the air form the outside rushes into the lungs.
Inspiration is energy consuming process.



Mechanism of breathing in man

❷ *Expiration (Exhalation):*

Letting out of air is known as expiration / exhalation. During expiration the volume of thoracic cavity decrease by following events.

(a) Relaxation of external intercostal muscles, and contraction of internal intercostals muscles, moves the ribs and sternum inward and downward.

(b) Relaxation of diapharagm, makes diaphragm dome shaped and also moves it upward.

When the volume of chest cavity decreased, lungs are compressed, so the air along with water vapours is exhaled outside through respiratory passage.

Expiration is a passive process.

RATE OF BREATHING / CONTROL OF BREATHING:

The breathing rate of man is 15 – 20 breathe per minutes.

There are two types of breathing control.

❶ *Voluntary Control:*

Some time we can hold our breath for a short time or can breathe faster and deeper at our will. This is termed as VOLUNTARY CONTROL.

❷ *Involuntary Control:*

Mostly, rate of breathing controlled automatically, this is termed as INVOLUNTARY CONTROL.

MECHANISM OF INVOLUNTARY BREATHE CONTROL:

Involuntary breathe control is maintained by co-ordination of respiratory and cardiovascular systems.

↳ Increase concentration of CO_2 and H^+ in blood increase the rate of breathing.

↳ The concentration of CO_2 and H^+ are monitored by CHEMORECEPTORS known as :
(a) – Aortic: situated in Aorta.
(b) – Carotid bodies: situated in carotid arteries.

↳ The concentration of CO_2 and H^+ also detected by medulla oblongata, by two ways.

i. Concentration in blood.
ii. Concentration in cerebro-spinal fluid.

If CO_2 and H^+ concentration become increased in blood or cerebro –spinal fluid, the medulla oblongata sends impulses to inter- costal muscle to breathe fastly and deeply.

DISORDERS OF RESPIRATORY TRACT:

❶ *Lung Cancer:*

Smoking is the main causative agent of lung cancer (carcinoma). Lung cancer can get any person, unless He is active smoker or passive smoker.

How lung cancer develops?

The lung cancer develops by following mechanism.

i. As the smoke passes through the respiratory passage, its toxic contents like nicotine, so_2 etc, cause gradual loss of cilia of epithelial cells of respiratory passage.
ii. So, that dust and germs are settled inside the lungs.

iii. Later, cells with abnormal nuclei appear in the thickened epithelial lining, which start dividing rapidly without following normal cell cycle.
Iv Finally, these cells with abnormal nuclei break the thickened epithelial lining and penetrate into the other tissues causing cancer.

❷ *Emphysema:*

It is lung disease in which Alveoli gradually deteriorate become bad and non-functional) Hence, it is degenerative disease.

How emphysema develops?

i. When some toxic substance such as nitrogen oxides, sulfer-di-oxide are constantly inhaled the emphysema develops.
ii. Such toxic substance decrease the elasticity of lungs.
iii. With the passage of time, the Alveoli become ruptured and lungs become harder.
iv. So, the tissues of body are supplied less and less oxygen. Such as brain tissue.

Sign and symptoms

(a) Victim's breathing becomes labored day by day.
(b) Victim become depressed, irritable and sluggish (inactive).

❸ *Asthma*

It is respiratory tract disorder in which breathlessness attacks occur again and again and it is supplemented by audible chesty whistling sound (wheezing) when breathing out.

Causative agents

1) Asthma caused by external factors, like pollens, dust, animal fur, common cold, cough smoke, etc.
2) Heridity is also a major factor.

Effects of Asthma

In severe case, Asthma may be fatal.

❹ *Tuberculosis (T.B)*

It is infectious disease and caused by **Mycobacterium tuberculosis** it was once major killer disease of human.

Sign and symptoms:

① coughing ② blood in sputum ③ pain in chest
④ shortness of breath, ⑤ fever ⑥ sweating at night
⑦ weight loss and ⑧ poor appetite.

Transmission of T.B:

T. B passed from person to person in air-borne droplets produced by coughing or sneezing.

Effect:

T.B can cause death.

TRANSPORT OF GASES IN MAN:

Transport of gases in man, influences by following factor:

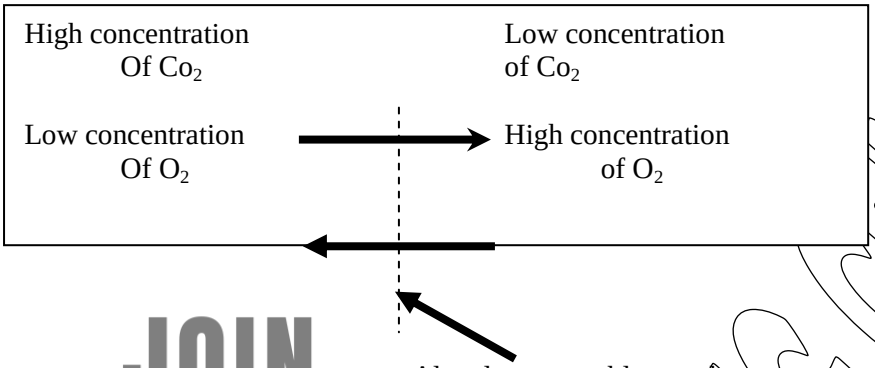
① Oxygen and Carbon dioxide carrying capacities of blood.
② Lung capacities.
③ Role of heamoglobin and Myoglobin.

❶ *Oxygen and Carbon dioxide carrying capacities of blood:*

Blood have concentrated quantity of oxygen is known as **oxygenated blood.** It is **bright red** in color.

Blood have concentrated quantity of carbon dioxide is called **Deoxygenated blood.** It is **dark radish** in color, and appears bluish through the skin.

Oxygen and carbon dioxide are exchange in **Alveoli** of lungs by diffusion. Blood returning form the tissues is deoxygenated blood. Due to its higher concentration of carbon dioxide (respiratory by product.), co_2 diffuses from the tissues into the blood, which is brought in lungs. while in lungs, due to greater concentration of co_2 in blood, it moves out into alveoli where its concentration is lower.
While in the case of oxygen, the oxygen concentrated in alveoli, thus oxygen diffuse from the Alveoli into blood, and blood goes to the level of tissue.



❷ Lung Capacity:

The total lung capacity of an adult human being is about 5 liters (5000 cm^3) of Air.

Tidal volume:

"The volume of air moved in and out of the lungs during a single normal respiratory cycle is known as tidal volume.
During normal breathing (respiratory cycle) a person takes in and gives out air approximately half of a liter (450 – 500 cm^3). This is only about 10 % of total capacity of lungs. And this is also known as tidal volume.

Vital Capacity:

"The maximum volume of Air that can be inspired and expired due to extra-deep breath is known as vital capacity.

The average vital capacity of lungs is 4 liters.

Residual Volume

"After a complete expiration the remaining volume of air in lungs termed as residual volume.

❸ Role of Haemoglobin and Myoglobin:

Haemoglobin:

Hemoglobin is an iron containing protein, is a respiratory pigment, present in the red blood corpuscles of vertebrates.
Each hemoglobin molecule has 4 iron containing groups called **Heme.** Hemoglobin (Hb) binds to oxygen to form a loose compound called **oxy-hemoglobin.** Each hemoglobin molecule binds up to 4- oxygen molecules. Since there are about 280 million Hb molecules in each R.B.C. so each R.B.C. is capable of carrying more than a billion molecules of oxygen.

Myooglbin:

Myoglbin is also a protein, but smaller than hemoglobin, found in muscles. It can bind to oxygen more tightly than hemoglobin. It gives red color to muscles.

Transports Of Oxygen:

In the transport of oxygen Hemoglobin and Myoglobin are involved. Each hemoglobin molecules has 4- iron containing groups called heme. Actually the 1- molecules of oxygen binds with each iron reversibly. Nearly all oxygen carried by blood is bound to Hb.

Thus, due to Hb, blood could carry 70 times more oxygen than plasma. Hb binds to oxygen to form a lose compound called oxy-hemoglobin. It is carried to the tissues where due to low concentration of oxygen in tissue, oxy-hemoglobin dissociates releasing oxygen. Which enters in tissue. The whole process can be represented by the following equation.

$$Hb + 4O_2 \underset{\text{Tissue}}{\overset{\text{Lungs}}{\rightleftharpoons}} Hb(O_2)_4$$

(Oxyhaemoglobin)

Transport of CO_2:

Carbon dioxide transport by three ways:

A. CO_2 Transportation by Hemoglobin:

Partial (35%) transportation of carbon dioxide from tissue to Alveoli is done by Hemoglobin. CO_2 due to its higher concentration in tissues diffuses out into the blood, and it combines with amino group of hemoglobin to form a molecule called **carbaminohaemoglobin.** In Alveoli, it breaks and carbon dioxide diffuses out into Alveoli.

B. CO_2 transportation by water of R.B.C.:

By this way 60 % carbon dioxide transport,

$$CO_2 + H_2O \underset{\text{Carbonic anhydrase}}{\overset{\text{Carbonic anhydrase}}{\rightleftharpoons}} HCO_3^- + H^+$$

$$H_2CO_3 \underset{\text{Carbonic anhydrase}}{\overset{\text{Carbonic anhydrase}}{\rightleftharpoons}} HCO_3^- + H^+$$

$$HCO_3^- + Na^+ \underset{\text{Carbonic anhydrase}}{\overset{\text{Carbonic anhydrase}}{\rightleftharpoons}} NaHCO_3$$

C. CO_2 transportation by water of plasma:

By this way 5% carbon dioxide transport.

$$CO_2 + H_2O \rightleftharpoons H_2CO_3$$

$$H_2CO_3 \rightleftharpoons HCO_3 + H^+$$

$$HCO_3 + K^4 \rightleftharpoons KHCO_3$$

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Chapter 14
TRANSPORT
Short questions

Q. What are the levels of transport occur in plants?

Land plants require a transport system because unlike their aquatic ancestors, photosynthetic plant organs have no direct access to water and minerals.

Three levels of transport occur in plants:

1. Uptake of water and solutes by individual cells.
2. Short-distance cell-to-cell transport at the level of tissues and organs.
3. Long-distance transport of sap in xylem and phloem at the whole-plant level.

Q. How does plants uptake and transport water and minerals form the soil.

There are certain processes involved in the uptake of minerals and water from the soil. These are Diffusion, Facilated diffusion, Osmosis, Imbibition and active transport.

Q. What do we mean by active and passive transport of solutes?

Active and passive transport of solutes

The plasma membrane's selective permeability controls the movement of solutes between a plant cell and the extracellular fluids. Solutes may move by passive or active transport.

Passive transport occurs when a solute molecule diffuses across a membrane down a concentration gradient.

- In this process no direct expenditure of energy incurred by the cell.
- In passive transport the proteins embedded in the cell membrane may increase the speed of solutes to cross.

Active transport occurs when a solute molecule is moved across a membrane against a concentration gradient.

- Active transport is an energy requiring process.
- The proton pump is an active transporter important to plants.

Q. Write a note on Diffusion.

Definition: "The movement of molecules from the region of higher concentration to the region of lower concentration is called diffusion".

Explanation: Diffusion is spontaneous and no energy is required in this process. It increases with the increase in temperature. It occurs due to the change in concentration of ions or molecules between the two mediums i.e. liquids and gases. Diffusion occurs till the equilibrium is established between two environments of different concentration.

In living cell molecules diffuses freely through a cell membrane like CO_2, O_2 and fat soluble molecules etc till the concentration equalizer.

Q. What do we mean by facilitated diffusion?

Definition: "The movement of molecules or ions across the cell membrane through certain specific proteins is called facilitated diffusion".

Explanation:

- The selective permeability of a plant cell's plasma membrane controls the movement of solutes between the cell and the extracellular solution.

- Molecules tend to move down their concentration gradient, and when this occurs across a membrane it is called passive transport and occurs without the direct expenditure of metabolic energy by the cell.
- Transport proteins embedded in the membrane can speed movement across the membrane.
- Some intrinsic proteins bind selectively to a solute on one side of the membrane and transport certain large molecules like glucose and charged particles membrane on the opposite side.

Q. Describe the process of osmosis.

Definition: **"**Osmosis is the passage of water from a region of high water concentration through a semi-permeable membrane to a region of low water concentration".
OR
"Osmosis is the passage of water from a dilute solution through a semi-permeable membrane to a more concentrated solution.

Explanation

Semi-permeable membranes are very thin layers of material. Cell membranes will allow small molecules like Oxygen, water, Carbon Dioxide, Ammonia, Glucose, amino-acids, etc. to pass through. Cell membranes will not allow larger molecules like Sucrose, Starch, protein, etc.

Experiment for Osmosis:

If we have a 'U' shaped tube with one side filled with water and other side with sugar solution these sides are marked as **A** and **B** respectively.

1. These two liquids are held separated by a semi permeable membrane. Water molecules are free to pass across the cell membrane in both directions, but more water will come into the side **B** and the level of sugar solution will rise.
2. The raised level of sugar solution shows the movement of water molecules from the region of higher concentration to lower concentration through semi permeable membrane.

Q. What are the consequences of osmosis in plant cell?

- Plant cells always have a strong cell wall surrounding them. When the take up water by osmosis they start to swell, but the cell wall prevents them from bursting.
- Plant cells become "turgid" when they are put in dilute solutions. Turgid means swollen and hard. The pressure inside the cell rises, eventually the internal pressure of the cell is so high that no more water can enter the cell. This liquid or hydrostatic pressure works against osmosis.
- Turgidity is very important to plants because this is what make the green parts of the plant "stand up" into the sunlight.
- Turgidity of guard cells also helps in maintaining the opening of stomata.
- Osmosis helps to transport the mineral salts through out the plant body.

Osmosis results in the net uptake or loss of water by the cell and depends on which component, the cell or extracellular fluids, has the highest water potential.

Q. Define and briefly explain the active transport.

Definition

"The movement of molecules or ions across the cell membrane against the concentration gradient is called active transport". Active transport requires cell metabolic energy ATP.

Explanation:

Active transport in animals:

- In animals nerve impulses are carried by sodium potassium pump which is an example of active transport mechanism. In nerve cells K^+ concentration is much greater then Na^+ inside while out

side Na^+ is higher then K^+. Even then nerve cell pumps Na^+ out and K^+ in against the concentration gradient.

- In the intestine the cells transport glucose in to the blood from lower to higher concentration.

Active transport in Plants:

- The translocation of nutrients through Phloem is an active transport mechanism. In source leaves the concentration of sucrose in sieve elements and companion cells is much greater then of mesophyll cells which mean sucrose is transported against the concentration gradient.

Q. Define and briefly explain Imbibition.

Definition:

"The swelling up of hydrophilic substances (water loving) by absorption of water is known as imbibition."

Explanation:

- The swelling of dry seeds in water and the wrapping of wooden framework during the rainy season are the common examples of Imbibition.
- In plant cells, the primary and secondary cell walls are made of pectic substances and cellulose imbibe the large quantities of water.

Q. Describe the water status in plants.

Water is the important constituent of the cellular matrix and plays vital role in biochemical reactions in living organisms. The growing tissue in plants (leaves, root tips) retains 80 to 90% water while the woody parts of trees have 45 to 60% water by weight. Water serves as the solvent which transports minerals and dissolved carbohydrates throughout the plant. Water is continually supplied to the plants by different mechanisms of transportation like Diffusion, Osmosis, and Active transport.

- Diffusion moves water from the region of high water concentration to lower water concentration. Bulk flow of water occurs due to pressure differences.
- Osmosis helps water to move across the differentially permeable membrane. It depends upon certain factors like chemical potential of water or water potential, osmotic potential of two separating solution and pressure potential across the membrane and cell wall.

Q. Describe the term Water Potential.

Definition: Water potential is the difference between the free energy of water molecules in pure water and energy of water in any other system".

Or

"The free energy of water that is a consequence of solute concentration and applied pressure; physical property predicting the direction of water flow".

It is basically the amount of free chemical energy present in water that represents a potential for performing work. All living things require a continuous input of free energy. In the case of water movements this free energy is involved in water flow. The unit of chemical potential is energy per mole of a substance (joules per mole)

According to plant physiologist water potential is the difference between the free energy of water molecules in pure water and energy of water in any other system.

Q. What are the factors that effect water potential?

The free energy of water is expressed in pressure unit such as megapascals and symbolised by Greek letter psi '□' (MPa; IMPa=9.87 atmosphere).

Water potential is a relative quantity and depends upon concentration , pressure and gravity. This relation may be written as

□ = □* + $f_{(concentration)}$ + $f_{(pressure)}$ + $f_{(Gravity)}$

Where □* is the water potential at standard state, while the others are the effects of these factors on water potential.

Pure water has been assigned the value of water potential 0 MPa. Addition of solute particles lowers the mole fraction

Q. What are the principal uses of water potential?

The concept of water potential has two principal uses.

- First, the water potential is the quantity that governs the direction of water flow across cell membrane. Specifically the difference in water potential (Δ□) across a membrane is the driving force that leads to transport of water by osmosis.
- The second important use of water potential is as a measure of water status in plant. Water deficits leads to inhibition of plant growth and photosynthesis as ell as some other effects.

Q. What is the impact of water potential in the leaf?

Evaporation from the leaf sets up a water potential gradient between the outside air and the leafs air spaces. The gradient is transmitted into the photosynthetic cells and on to the water-filled xylem in the leaf vein.

Q. What are the components of water potential?

Water potential has two components:

1. **Pressure Potential:** The physical component of water potential created by pressure or tension (suction)
2. **Osmotic potential:** The component of water potential created by solutes; the tendency to move because of osmosis.

Therefore, water potential can be lowered either by decreasing pressure, or by adding solutes. In either case, water will be drawn into area from areas with a higher water potential.

Q. Describe the osmotic potential or solute potential.

The solution of two different concentrations is having a pressure in response to maintain the concentration gradient equilibrium when a semi permeable membrane is placed in to the solution is known as Osmotic pressure.

Definition: "**The propensity of a solution of different concentration to diffuse in another if these are separated by a semi permeable membrane is known as osmotic potential.**

Osmotic potential decreases with the increase of osmotic concentration and vice versa. Water moves from the solution of high osmotic potential to the solution of low osmotic potential under constant temperature and pressure.

Osmotic potential or solute potential is represented by Ψ_s which shows the measure of change in water potential due to the presence of solute molecules. It is usually found negative. In solution, it is a negative quantity and equals to the negative of osmotic pressure π i.e. = Ψ_s — π.

Water potential is also called pressure potential and symobilized by Ψ_p. It is identical to pressure P; which is defined as the hydrostatic pressure in excess of atmosphere pressure.

Q. Describe the cell water relations in plants.

There are fo1lowing components essential for the cell water relation in plants.

- **Cell wall:** This is the outer most covering of the plant cell made up of cellulose and pectin. It is non living
- **Cytoplasm:** It forms protoplasm along with nucleus and consists of numerous membrane bound organelles.
- **Vacuoles:** These are membrane (tonoplast) bound structures filled with cell sap; a solution of salts and organic acid and sugar.

Explanation:

- The solutes particles concentration known as solute potential Ψ_s inside the cell minimizes the water potential 'Ψ' of cell sap.
- When a cell is placed in high water potential solution water moves toward vacuoles by passing through tonoplast and cell membrane.
- Vacuoles filled with water develop internal hydrostatic pressure encountered by cell wall this is known as pressure potential Ψ_p.
- When this pressure becomes high the cell wall fully stretched and cell unable to take any water is said to be turgid.
- Plant biologists have adapted to show the plant water relations by following equation.

$$\Psi = \Psi_s + \Psi_p$$

Osmotic (solute) and turgor (pressure) potential sum to equal the total water potential:

Q. Describe the process of P1asmolysis and Deplasmolysis.

P1asmolysis

When plant cells are placed in concentrated sugar solutions they lose water by osmosis and they become "flaccid"; this is the exact opposite of "turgid" and they are said to be plasmolysed. Plasmolysis is a process in which a cell starts exosmosis when it is kept in a highly concentrated solution (hypertonic solution), as a result of which its protoplasm shrinks and cell is called plasmolysed cell. When plant cells are placed in a solution which has exactly the same osmotic strength the cells they are in a state between turgidity and flaccidity. We call this **incipient plasmolysis.** "Incipient" means "about to be".

Deplasmolysis

When a plasmolysed cell is placed in a solution having less concentration than that of the cell sap (hypotonic solution), endosmosis takes place i.e. the water enters the cell, as result of this process the protoplasm again retains its original position, it is known deplasmolysis.

Q. How water and minerals are taken up in plants?

Water is essential in the body of plant. It brings about a number of plant activities. Mineral salts are also absorbed along with water by the roots of plant from the soil. The maximum absorption takes place in root-hair zone which is situated 1-10 cms behind the root tip. From the roots the water flows through the whole plant body in redial direction is called Lateral transport. Absorption

of water from the surface takes place by following structures.

Q. What are the pathways of water movement in plants?

There are three pathways of water movement, by which water is reached to the xylem vessels.

1. Cell to cell path way
2. Symplast path way
3. Apolast pathway

Q. Describe the Cell to cell pathway of water in plants.

Cell to cell pathway

In this mechanism the water enters the root hairs from the soil due to the difference concentration. From root hairs the epidermal cells, then it moves from cell to cell across the cell wall and cell membrane by osmosis.

Q. Describe the Symplast pathway of water in plants.

Symplast pathway

In the cortical cells of root the cytoplasm of one cell is connected with the cytoplasm of another cell through the pores of cell walls. These cytoplasmic connections through the pores are called plasmodesmata. When water and solutes are moved through these plasmodesmata, it is known as symplastic pathway. In this pathway the water is cross only through the plasma membrane of root hairs.

Q. Describe the Apoplast pathway of water in plants.

Apoplast pathway

The cell walls of epidermal cells and cortical cells form a continuous system of water flow. Their walls are hydrophilic, so soil solution moves freely through extracellular pathway provided by continuous system of cell walls is called apoplast pathway.

The inner layer of cortex is endodermis. It has a waxy belt, called casparian strip, acts as a check point, so water and minerals can not pass through the endodermis and this can not enter the xylem via apoplast i.e. the extracellular pathway, at this stage symplast pathway helps in the movement of solution. From endodermal cells the water flows into pericycle and then into xylem cells by osmosis via symplast and apoplast.

Q. Describe the process of ascent of sap.

Definition: "The upward movement of water from roots to the leaves or transpiring surfaces against the force of gravity is known as ascent of sap".

Plants ascent sap in short herbs to long 90 meters tree through specialized structures known as Vessels and Tracheids.

Q. Describe the characters of Vessels and Tracheids.

Vessels

- These are elongated tube like thick walled structures consist of dead cell on maturity.
- Their diameter is about 20htm to 70Am (0.7 mm).
- Vessels walls are perforated and connected with each other by their end for the upward movement of water.
- These provide the long route of water from roots up to leaves about 10 times faster then Tracheids.
- Vessels are of different types like Annular, Spiral, Scalariform, Reticulate and Pitted.

Tracheids

- These are thick walled and about 30 [cm in diameter and several mm in length.

- These are having angular walls and smaller then vessels.
- They are tapered at both ends and connected by these ends.
- These are dead with thick, lignified, perforated walls. Their small holes are called pits.
- These pits help in transportation of water and minerals freely from one tracheid to another.
- These are the only water conducting ducts in ferns ad conifers.

Q. What do we mean by root pressure?

Root Pressure

When transpiration is low, active transport of ions into the xylem decreases the stele's (the root stele is basically everything surrounded by the endodermis primarily the xylem and the phloem) water potential and causes water to flow into the stele. This osmotic water uptake increases pressure which forces fluid up the xylem this is called **root pressure.**

Q. What is TACT mechanism?

Water Movement in xylem takes place through TACT Mechanism. Four important forces combine to transport water solutions from the roots, through the xylem elements, and into the leaves. These TACT forces are:

- Transpiration
- Adhesion
- Cohesion
- Tension

Q. Define transpiration and describe the structure of guard cell.

Transpiration

Definition: "The loss of water through aerial parts of plant is called transpiration".

Structure of guard cells

A **stoma** is a physical gap between two special epidermal cells called guard cells. When a pair of guard cells is turgid (full of water) they bow in such a way as to increase the gap (stoma) between them. If the plant experiences water deprivation it will wilt. To compensate the guard cells become flaccid and the stoma is closed. The structure of guard Cells explains why they bow apart when turgid.

1. The two guard cells are fused at their ends.
2. The inner cell walls which form the stoma are thicker than the outer walls.
3. Cellulose microfibrils are oriented radially rather than longitudinally.

Stomata are more concentrated on the bottom of leaves. The water loss prevented by waxy cuticle on the leaf surface.

Q. How Stomata open and dose

The opening and closing of stomata depends upon turgidity of guard cells. Water enters the central vacuole by osmosis and increases the turgor pressure. The following factors involve in stomatal changes.

Factors trigger the Change of shape in guard cells

1. **Increase in blue light at dawn** - a blue light sensitive receptor activates proton pumps and turgor pressure increases and causes opening of stomata. When darkness comes the guard cells consume a carbohydrate which decreases the osmotic potential resulting exosmosis and closing of stomata. Light also stimulates the photosynthetic production of **ATP**
2. **Absence of CO2 -** Decrease of CO2 in leaf air spaces due to photosynthesis in the mesophyll

causes opening of stomata. High temperature increases CO, in leaf air spaces due to increased respiration causes closing of stomata.

3. **Circadian rhythms -** All eukaryotic cells have chemical based metabolic clocks entrained to the day-night cycle. A common 24 hour biological clock is responsible circadian rhythms (circa, about - dies, day)
4. **Concentration of K^+ ion-** In clay time K^+ is actively transported by guard cells. Turgor pressure increases because of a negative water potential due to an inflow of potassium ions (K^+) the cell becomes hypertonic to its environment. Then water comes inside the epidermal cells by osmosis. Reversible uptake of K^+ ions takes place because of the membrane potential created when H^+ are actively pumped out of the cell - consuming ATP. The cell's interior becomes negative compared to the surroundings. Water flows out of guard cells causing them to become flaccid which result the closure of stomata.

Q. Describe the factors affecting rate of transpiration.

Factors Affecting Transpiration

- **Light:** Rate of transpiration increases when plant more exposed to light because it warms the leave and stimulates the opening of stomata.
- **Temperature:** Transpiration increases due to the high temperature. Water molecules kinetic energy increases resulting rapid evaporation of water molecules from the cells occur that impacts the opening and closing of stomata.
- **Wind:** During high velocity wind transpiration increases because more water vapours readily removed and the surrounding of plant is replaced by fresh dry air.
- **Humidity:** Whenever humidity increases in the surrounding it lowers the rate of transpiration. This is because of slow diffusion of water from leaf to the surrounding. When surrounding is dry the situation inverse.
- **Soil Water:** Sufficient amount of water fasten the rate of transpiration and vice versa. High concentration of salts in the soil increases the osmotic pressure of soil, it reduces the absorption of water it also decreases the rate of transpiration.

Q. Describe the Advantages and Disadvantages of Transpiration.

Advantages of Transpiration

- It supplies water for photosynthesis
- Transports minerals from the soil to all parts of the plant
- Cools leaf surfaces some 10 to 15 degrees by evaporative cooling
- Maintain the plant's shape and structure by keeping cells turgid
- Assist in mineral transfer from roots to shoots,
- Evaporative cooling reduces risk of leaf temperature becoming too high for enzymes to function.
- If transpiration exceeds delivery of water by xylem, plants wilt.
- Plants can adjust to reduce risks of wilting.
- Regulating the size of stomatal openings also reduces transpiration

Disadvantages of Transpiration

- Excessive transpiration causes death of a plant.
- During unfavourable season in order to reduce the rate of transpiration plants shed their leaves.
- Certain plants modified their leaves in to spines ur scales to minimize the rate of transpiration that ultimately reduces the photosynthetic area which lowers the photosynthetic products.

Q. What do we mean by translocation of organic solutes?

Definition

"The transport of the products of photosynthesis by phloem to the rest of the plant is called Translocation".

Explanation

In angiosperms, sieve-tube specialized cells of phloem that function in translocation. Sieve-tube cells (Phloem) are arranged end-to-end forming long sieve tubes. Porous cross walls called sieve plates are in between the membranes and allow water to move freely along the sieve tubes. Phloem sap contains primarily sucrose, but also minerals, amino acids and hormones.
The phloem transport is also referred as source to sink transport

Q. Define source-to-sink transport.

Phloem sap movement is not unidirectional; it moves through the sieve tubes from source to a sink organs.

- **Source:** An organ of a plant where sugar is produced by photosynthesis or by the breakdown of starch (usually leaves)
- **Sink:** An organ of a plant that consumes or stores sugar (growing parts of plant, fruits, non green stems and trunks, and others).

Q. What do we mean by phloem loading and unloading?

There are steps involve in the movement of photosynthetic products with in the leaf.

- Sucrose produced in the cytosol of mesophyll cells (source) of leaf and translocated into sieve-tubes before it can be translocated to a sink this step is called **Phloem loading**.
- Sucrose in sieve elements moved away from the source tissues to the long distance sink reservoirs this process ids termed as **phloem unloading**.

Q. What is pressure flow or mass flow Hypothesis (Munch Hypothesis)?

The accepted mechanism needed for the translocation of sugars from source to sink is called the pressure flow hypothesis. Phloem translocation or Pressure Flow Hypothesis was proposed by **Ernest Munch** in 1930 according to him "**The flow of solution in the sieve elements is driven by a pressure gradient is produced due to differences in osmotic pressure between sources and sink".**

Q. How the materials are transported in Hydra?

Transportation in Hydra:

"The transportation of materials occurs in hydra by diffusion through general body surface".
Mechanism: - hydra lives in aquatic habitat. Water enter in to its gastro vascular cavity by mouth for distribution and digestion of substances all these materials like digested food, oxygen, CO_2 and metabolic waste are transported by diffusion are waste expelled from the body cavity by mouth.

Q. How the materials are transported in Planaria?

Planaria:

In Planaria the gaseous exchange takes place by diffusion while digested food is transported to the body cells in inside the specialized intestine.

Q. What is Circulatory System? Describe its characteristics.

Circulatory system

"A System serves for mass flow and exchange of materials with in the specific channels in the body called Circulatory system". The higher level living organisms immensely require a circulatory

system due to the development of coelom to transport the metabolic products within the body which included food material and toxic materials.

General characteristics of a Circulatory system:

- The circulatory system must consists of coelomic fluid i.e. blood or lymph
- The body fluid is pumped by a specialized organ like heart.
- The blood travels along the tubes called blood vessels.
- It has one way valves to keep the medium flowing in one direction.

Q. Describe the types of circulatory system:

There are generally two types of circulatory systems

i) Open type Circulatory System:

- When the blood and interstitial fluid circulates within the open body cavities (sinuses) and bathes the surrounding tissues is called open type circulatory system.
- The body cavity called haemocoel filled in with blood is known as haemolymph.
- The blood pressure is never high in open type circulatory system because heart is weakly muscular and blood is in large spaces.

ii) Closed type Circulatory System:

- When the blood consists of cells and plasma is pumped by hart into a system of blood vessels is called closed type circulatory system.
- The blood flow through vessels and remain separate from the interstitial fluid.
- The blood pressure is high in closed type circulatory system because heart is strong muscular pumping organ to push blood in to blood vessels.
-

Q. Differentiate the features of circulatory system of cockroach and earth worm.

Main features	Cockroach	Earth worm
1. Type	Open type	Closed type
2. Circulation	Blood flow through hollow open chambers called sinuses.	Blood flows through closed blood vessels.
3. Contact of blood	The surrounding tissues are bathed with blood.	Surrounding tissues are not in contact with blood.
4. Body cavity	The coelom is not large	The coelom is large.
5. Intersitial fluid	Blood and interstitial fluid are mixed together.	Blood and interstitial fluid are separate.
6. Distribution of blood.	It is poorly controlled	Fairly controlled and is adjustable.
7. vessels	A single dorsal vessel runs midorsally from head to the posterior end.	Dorsal and ventral blood vessels run above and below the alimentary canal from anterior to posterior ends.
8. Flow of blood.	Forward in dorsal vessel.	Forward in dorsal vessel and backward in ventral vessel.
9. Hearts	Modified posterior part of dorsal aorta having thirteen chambers.	Modified circular vessels connecting the dorsal and ventral vessel in 7^{th}, 9^{th}, 12^{th}, 13^{th} segment.
10. Veins and capillaries	Absent	Present
11. Blood	Colorless, having no haemoglobin.	Red, haemoglobin is dissolved in plasma.
12. Transport	It transports, digested food and excretory products but no gases.	It transports digested food, excretory products as well as gases.

Q.

Define the Pulmonary and Systemic circulation.

Pulmonary Circulation

When deoxygenated blood enters in to the right side of the heart to pump in to the lungs for the oxygenation it is called pulmonary circulation.

Systemic Circulation

When oxygenated blood enters in to the left side of the heart to be distributed to all parts of the body is called systemic circulation.

The type of circulation included both systemic and pulmonary circulation is known as **Complete Double Circulation.**

Q. Describe the characteristics of single circuit, incomplete double circuit and complete double circuit circulation in Animals

Single Circuit circulation plan (Fish)

- Blood flows in one direction and the heart never receives oxygenated blood for pumping.
- Heart consists of one atrium and one ventricle.
- From aorta the venous blood passes in to the afferent brachial arteries in to the gills for oxygenation.
- Oxygenated blood runs through efferent brachial arteries and distributed to the all parts of the body.

Incomplete Double circuit circulation plan (Amphibians & Reptiles)

- Bloods comes in to heart form two different ways but oxygenated and deoxygenated blood mix in the ventricle.
- Heart consists of two atrium and one ventricle.
- The deoxygenated blood comes in to the right atrium by vanacava and goes into the lungs for oxygenation by pulmonary vein.
- The oxygenated blood from the lungs comes in left atrium and distributed throughout the body by arteries.

Complete double circuit circulation plan (Birds & Mammals)

- Blood comes in to heart from two different ways and does not mix auricles and ventricles are separated by septum.
- The right side of heart receives deoxygenated blood and left side receives oxygenated blood.
- Deoxygenated blood goes to lungs for oxygenation and returns bask to heart by pulmonary circulation.
- Oxygenated blood distributed form heart to all parts of the body and hence it is called double type of circulation except lungs by systemic circulation.

Q. Give a comparison of evolution of heart in vertebrates.

During the evolution of heart there are many changes takes place in different organisms

Fishes	Amphibians	Reptiles	Birds and Mammals
Heart is simply two chambered and atrium receives the blood through veins and drained the blood in to the conus arteriosus and pumps in to the body.	**Heart** is three chambered and consists of two atria and one ventricle. Right atrium receives deoxygenated from the body and left atrium oxygenated blood from the lungs and these two types of blood get mixed in ventricle to some extent.	**Heart** is tri-chambered but ventricle is divided by a false septum which is complete in crocodilians.	**Heart** is four chambered with two atria and two ventricles oxygenated blood circulates through left side and deoxygenated blood through left side. These organisms have complete double circuit circulation.

Q. Define Blood and describe the composition of blood.

Blood

"Blood is a viscous, red fluid connective tissue, comprising colorless plasma in which the blood corpuscles float".

Blood corpuscles: These are the blood cells which form the remaining 45% of the blood. They are of two types; red blood cells and white blood cells.

Plasma

Blood is a connective tissue in which the matrix is plasma. It constitutes of about 55% of blood and

Platelets

These are irregular cell fragments, non-nucleated, produced within the bone marrow. They help in blood clotting. These cells are produced at the rate of 200 billion a day, and the bloodstream carries more than a trillion.

Q. Describe the composition of blood plasma.

Plasma of blood composed of following constituents.

Water	92%
Inorganic ions	Na, Ca, K, Mg, Cl, HCO_3, HPO_4, SO_4.
Gases	O_2, CO_2
Protein	albumin, globulins, fibrinogens
Organic nutrients	Glucose, fats, phospholipids, amino acids, etc.
Nitrogenous waste products	Urea, ammonia, uric acid
Regulatory substances	Hormones, enzymes.

Q. Describe the characteristics of Red blood corpuscles (Erythrocytes).

Red blood corpuscles (Erythrocytes).

- These are biconcave, non nucleated circular plate-like cells.
- Their average diameter is 7-8 micron.

- There are about 4 to 6 million RBCs per mm3 in the whole blood and each of these contains about 200 million hemoglobin molecules.
- They contain respiratory pigment hemoglobin which is an iron bound protein for the attachment of oxygen.
- These are formed in bone marrow and destroy in 120 days in liver or spleen. The iron retained and rest passed as bile pigment bilirubin and biliverdin.
- Blood contain an enzyme called carbonic anhydrase which plays a role in CO_2 transport.

Q. Describe the characteristics of White blood corpuscles (Leukocytes).

White blood corpuscles (Leukocytes)

- These are nucleated irregular cells, larger but less numerous than the R.B.Cs with only 7,000-8,000 cells per mm3.
- They are formed in bone marrow, spleen, thymus and lymph nodes.
- They have a short life and are destroy with in a few 20-30 hrs.
- These are constituted of Granular leukocytes and agranular leukocytes.

Q. Describe the types and functions of leukocytes.

Granular leukocytes	Size	Function
Neutrophils	9-12µm	Phagocytize primarily bacteria
Eosinophils	9-12µm	Phagocytize and destroy antigen-antibody complexes
Basophils	9-12µm	Congregates in tissues; release histamine when stimulated.
Agranular leukocytes	**Size**	**Function**
Lymphocytes	8-10µm	Produce antibodies in blood and lymph
Monocytes	12-20µm	Become macrophage-phagocytize bacteria and viruses

Q. Describe the functions of blood.

Functions of Blood

1. **Transport of Nutrition:** Blood transports digested food, water and other substances from alimentary canal to the various parts of the body.
2. **Transport of waste substances:** From the tissues to the excretory organs for their discharge.
3. **Transport of metabolic by-products:** form the area of production to other parts of the body.
4. **Transport of hormones:** from the endocrine glands to the target organs.
5. **Distribution of body heat:** to maintain a uniform body temperature.
6. **Transport of oxygen and carbon dioxide:** oxygen is transported from te lungs to all the parts of the body and carbon dioxide form the cells to the lungs for removal.
7. **Defence against Diseases:** By phagocytosis of WBCs germs are engulfed and digested.
8. **Protection against its own loss:** By clotting, making a clot over the injured part.

Q. Write a note on disorders of blood.

The disorders of blood are as follows.

Leukemia

- It is the disorder about increased number of leucocytes in the blood.
- They obstruct normal blood cell formation in the bone marrow.
- This cause death most often causes hemorrhage or infection.

Causes:

- Ionizing radiation, cytotoxic drugs, retroviruses, genetic etc.

Thalassaemia

- In this disorder abnormal type of hemoglobin are produced.
- It mostly occurs when a person is homozygous. These persons either unable to synthesize hemoglobin or produces in small amount.
- It is common in children resulting enlargement of kidneys.

Causes:

- Heredity
- Failure to synthesize beta chains.

Q. Write a note on cardiac cycle.

Cardiac Cycle:

"The sequence of events which take place during the completion of one heart beat is called cardiac cycle". During heart beat heart contract and relaxed. The resting period of heart is known as diastole and the period of contraction is known as systole. The events in cardiac cycles are as follows:

- The right atrium receives deoxygenated blood from the vanacava and left atrium receives oxygenated blood from the lungs.
- When blood comes in the atria these contracts simultaneously and blood drained in to the ventricles this event is known as **atrial systole**.
- Then immediately ventricles contract this event is termed as **ventricular systole**. These movements of the blood are controlled by valves.
- The volume of blood pumped per minute by the left ventricle into the systemic circuit is called **cardiac output**.

Q. Describe the events takes place during heart beat.

Heart Beats

- A human heart beats 72 times per minute at rest and produce audible sounds.
- When ventricle contract (Systole) blood rushes against the closed AV valves. This produces the first sound LUB.
- This causes the high pressure of blood in the aorta and tends to force some blood back towards the ventricles (Diastole) which closes the aortae valves. This impact of the back flow against the valves causes the second heart sound DUP.
- One complete systole and diastole lasts for about 0.8 seconds.
- A defect in one or more of the heart valve causes a condition known as heart murmur, in which hissing sound is produced.

Q. Define the following.

1) S-A Node **3) Blue babies**
2) Pace Maker **4) Artificial Pace Maker.**

S-A Node

The contraction of the heart stimulates by a S-A Node situated in a region of right atrium. It is a vestige of sinusvenosus and consists of cardiac muscles and few motor nerve endings.

Pace Maker:
S-A node initiates the heart beat and it is also known as pace maker because it stimulates the contraction of heart muscles.

A-V Node:
It is located near the S-A node and stimulated by the S-A node by the difference of 0.15 seconds. Its excitation travels all parts of the ventricle, due to which contraction in ventricles occur.

Artificial Pace Maker:
It is an artificial electronic device that supplies electrical impulses to the heart to maintain the heart beat at a regular rate. It is place in the chest beneath the skin in replacement of SAN if not functioning properly.

Blue Babies:
In medical sciences it is also known as cyanoses. In this abnormality hemoglobin is reduced and skin becomes bluish. It is mostly caused by cyanotic heart disease in which atrial septum defect (ASD), ventricular septum defect (VSD) and persistent ductus arteriosus occur.

Q. What are the types of blood vessels?

Blood Vessels
Closed vessels through which blood circulates within the body are known as blood vessels. These are of following types.

1) **Arteries**
2) **Veins**
3) **Capillaries**

Q. Describe the characteristics of arteries.

Arteries

- These blood vessels carry blood from heart to other parts of the body.
- They carry oxygenated blood except pulmonary artery.
- Arteries are **thick** walled to bear the pressure of blood exerted by the heart.
- These vessels consist of three layers. The outer **tunica externa** composed of connective tissues having collagen fibers, the middle layer **tunica media** and the inner **tunica interna**.
- These are elastic with **narrow lumen**, pulsatile and maintain the blood flow by their semilunar valves.
- The smaller arteries are known as arterioles contain sphincters at their capillary ends which regulate the flow of blood.

Q. Describe the characteristics of Veins.

Veins

- These blood vessels bring blood to the heart from other parts of the body.
- They carry deoxygenated blood except pulmonary vein.
- Veins are **thin** walled and semilunar valves present that prevent the backward flow of blood.
- These vessels also consist of three layers. The outer **tunica externa** composed of connective tissues having collagen fibers, the middle layer **tunica media** and the inner **tunica interna**.
- These are less elastic and less muscular with **wide lumen**.
- The flow of blood is less pulsatile and low.
- The smaller veins are known as venule contains sphincters at their capillary ends which regulate the flow of blood.

Q. Describe the characteristics of capillaries.

Capillaries

- The capillaries are the extremely narrow (7-10 micron in diameter), thin walled microscopic vessels.
- Their walls consist of a single layer of endothelium, which presents very little resistance to the diffusion of dissolved substances in or out.
- Material exchange only by diffusion or active transport.
- The nitrogenous waste is filtered through the capillaries in to the excretory tubules for discharge.

Q. Write a note on blood pressure.

Blood Pressure

"Blood pressure is the hydrostatic force exerted by the blood against unit area of the vessel wall".

It is measured in millimeters of mercury (mmHg). The well known apparatus for blood pressure measurement is known as sphygmomanometer. When the arterioles are constricted (vasoconstriction) the blood pressure rises; when they are dilated (Vasodialation), the blood pressure falls. Blood pressure during systole of the ventricle is about 120mm Hg and 80 mm Hg during diastole. This is expressed as a B.P. of 120/80. The difference between systolic and diastolic pressure is called pulse pressure.

Blood Flow

Blood flow through the vessels in uneven speed in large arteries it is fast and in capillaries it flows slowly, permitting the exchange of materials between the blood and interstitial fluid.

Q. Briefly describe the Lymphatic System.

The lymphatic system defends the body from foreign invasion by disease causing agents such as viruses, bacteria, or fungi. The lymphatic system consists macroscopically of: the bone marrow, spleen, thymus gland, lymph nodes, tonsils, appendix, and a few other organs.

The lymph system contains a network of vessels that assists in circulating body fluids. These vessels transport excess fluids away from interstitial spaces in body tissue and return it to the bloodstream. Lymphatic vessels prevent the backflow of the lymph fluid. They have specialized organs called lymph nodes which filter out destroyed microorganisms.

Q. Describe the components of Lymphatic system.

The components of lymphatic system are Lymph, Lymph capillaries, vessel, and Lymph Glands/Nodes.

Lymph.—Lymph, found only in the closed lymphatic vessels, is a transparent, colorless, or slightly yellow, watery fluid of specific gravity about 1.015; it closely resembles the blood plasma, but is more dilute. When it is examined under the microscope, leucocytes of the lymphocyte class are found floating in the transparent fluid.

Lymphatic Capillaries.—The complex capillary plexuses which consist of a single layer of thin flat endothelial cells lie in the connective-tissue spaces in the various regions of the body to which they are distributed and are bathed by the intercellular tissue fluids.

Lymphatic Vessels.—The lymphatic vessels are delicate, and transparent that the fluid they contain is readily seen through them. They have some internally valved constrictions, which give them a knotted or beaded appearance. Lymphatic vessels have been found in nearly every organ of the body which contains blood vessels.

Lymph Glands/Nodes.—The lymph glands are small oval or bean-shaped bodies, situated in the course of lymphatic and lacteal vessels so that the lymph and chyle pass through them on their way to the blood.

Q. Describe the structure of lymph gland

Structure of Lymph Glands/Nodes.

A lymph gland consists of

(1) A fibrous envelope or capsule**.**

(2) Quantity of lymphoid tissue occupying these spaces without completely filling them.

(3) A free supply of blood vessels and

(4) The afferent and efferent vessels communicating through the lymph paths in the substance of the gland.

Q. Write a note on functions of lymphatic system.

Functions of lymphatic system

1. Drainage system:

It provides ways to transport water and plasma proteins that have dropped away from the blood vessels and poured back to circulation. Without which death occur in 24 hrs.

2. Defense of the body:

Any foreign organisms are removed by macrophages residing in the lymph nodes.

3. Absorption and delivery of fats:

Lymph capillaries called lacteals absorb fats in intestinal villies and delivered to the blood circulatory system.

Q. Define Edema and describe its causes.

Edema

"It refers to increased fluid in the interstitial tissues spaces or body cavities".

It may be localized or systemic.

Causes of Edema

- Congestive heart failure
- Malnutrition (most common cause)
- Lymphatic obstruction e.g. filariases.
- Rena insufficiency
- Hypertension
- Angiogenesis (formation of blood vessels)

Q. Write a note on Atherosclerosis.

Atherosclerosis

"It denotes thickening and loss of elasticity of arterial walls". It is a slowly progressive disease of arteries characterized by formation of **atheromatous plaques** (deposition of cholesterol in vessel lumen) which cause narrowing of lumen impairing blood flow.

Histology

It consists of

a) Superficial fibrous cap made of smooth muscles cells, Leucocytes and dense connective tissue extracellular matrix.
b) Beneath the cap, there is a "necrotic core". This contains dead cells, lipids, cholesterol, foam cells, plasma proteins, proliferating blood vessels in the periphery.

Causes:
Increasing age, Male, Family history, Hypertension, Hyperlipidemia (high cholesterol, high triglycerides), Cigarette smoking, Diabetes, Obesity, Physical inactivity, Stress etc.

Effects
It can cause "Angina Pectoris". In which patient presents with severe pain in the chest radiating towards left shoulders, arms or jaws. It occurs due to decreased blood supply to heart because of atherosclerosis in coronary artery.

Q. Describe Hypertension.

Hypertension
"Sustained high blood pressure is known as hypertension." It is also known as silent killer. If the systolic blood pressure is above 140 and the diastolic blood pressure is about 90 at least two readings on separate occasion is considered hypertension.

Q. Write a note on Myocardial infarction (Heart attack).

"Acute ischemic necrosis (death of the part of heart muscles) of an area of myocardium is known as myocardial infarction". This is also known as heart attack.
Explanation: when an area of heart muscle is deprived of oxygen and nutrients due to impairment of blood supply as a result of coronary thrombosis are embolism, that area is died and heart muscles is necrosed or infracted.

Q. What is immune system define immunity.

Immune System
Immune System, group of cells, molecules, and organs that act together to defend the body against foreign invaders that may cause disease, such as bacteria, viruses, and fungi. The health of the body is dependent on the immune system's ability to recognize and then repel or destroy these invaders.
Immunity:
"The ability to resist microorganisms, their toxins if any, foreign cells, and abnormal cells of the body is termed as immunity".

Q. What are the components of immune system?

The components of immune system are as follows:

- **Macrophages**
  White .blood cells are the mainstay of the immune system. Some white blood cells, known: as macrophages, play a function in innate immunity by surrounding, ingesting, and destroying invading bacteria and other foreign organisms in a process called phagocytosis.
- **Lymphocytes**
  Lymphocytes are specialized white blood cells whose function is to identify and destroy invading antigens. Some lymphocytes mature in the bone marrow and are called B lymphocytes. Other lymphocytes, called T lymphocytes, or T cells, mature in the thymus gland

- **Antigen Receptors**
  Each lymphocyte, as it matures, makes an antigen receptor that is, a specific structure on its surface that can bind with a matching structure on the antigen like a lock and key.
- **Antigen-Presenting Cells**
  When, an antigen enters a body cell, certain transport molecules within the cell attach themselves to the antigen and transport it to the surface of the cell, where they "present" the antigen to T lymphocytes.

Q. What are the types of immune system?

The immune system can be divided into two functional divisions.
(1) Innate immune system and (2) Adaptive immune system

Innate Immune System
Innate, or nonspecific, immunity is the body's first and second, generalized line of defense against all invaders. Innate immunity is furnished by barriers such as skin, tears, mucus, and saliva, as well as by the rapid inflammation of tissues that takes place shortly after injury or infection.

Adaptive Immune System

This is the third line of defense which comes in to play simultaneously with the second line of defense. This comprises of B and T lymphocyte or cells which comes from bone marrow and thymus gland respectively.

Q. What includes in the first and second line of defense in the body?

- The skin and mucous membrane with their secretions are the first line of defense which stops majority of the infectious microorganisms.
- When microorganisms intrude inside the body they encountered a second line of defense comprises of phagocytes, antimicrobial proteins and inflammatory response.

Q. What are the functions of natural killer cells?

Natural Killer cells
These are small population of lymphocytes, distinctly different from the lymphocyte involved in the adaptive defense mechanisms. They secrete a cytolytic substance called perforin that disintegrate, destroy the infected cell. These cells also secrete chemical that enhance the inflammation.

Q. What are the functions of Adaptive Immune System?

The adaptive immune system mounts two types of attacks termed as
1) **Humoral immunity** and 2) **Cell mediated immunity**

Humoral Immunity:
"Immunity provided by the antibodies secreted in the circulatory system by **B cells** is termed as humoral immunity". This is particularly helpful in bacterial invasion. Infection is cured by the some of the B cells called **plasma cells** which secrete antibodies in to the circulation.

Cell Mediated Immunity (CMI):
"This includes the second family of lymphocytes called T cells, which do not secrete antibodies". They mediate immunity by killing infected cells, and aiding in inflammation. This is important in the defense against tumor cells and fungi and parasites.

Q. What are cytokines and interferons?

Cytokines (Lymphokines)

T cells synthesize and secrete polypeptides called cytokines that enhances certain cellular responses to antigens. Cytokines interleukin I and II stimulate and proliferate **T** cells repectively. Certain cytokines shut off the immune response. Other cytokines like colony stimulating factors (CSF's) stimulates the production of leukocytes in the red bone marrow, causes B cells to grow and mature and activate macrophages.

Interferons

Interferons are hormone like polypeptides that certain cells produce including lymphocytes and fibroblasts. Interferons inhibit viral multiplication and increase the activity of the natural killer cells. Once released from the virally infected cells, interferon binds to receptors on uninfected cells, stimulating them to synthesize proteins that block replication of a variety of viruses.

Q. What are primary and secondary immune responses?

Primary Immune Response

The first exposure of an antigen to the immune system elicits formation of clones' effector cells to develop specific immunity. This response of the immune system is termed as **primary immune response**. Beginning from the infection to the development of maximum effector cells takes about 5 to 10 days.

Secondary Immune Response

If re-infection occurs by the same pathogen the immune system respond quicker in 3 to 5 days with the help of immunological memory of the immune system this is called **secondary immune response**. This response is bases upon the long lasting memory cells produced with the short lived effecter cells of the primary immune response

Q. Describe the active and passive immunity.

Active Immunity

"Immunity acquired by own immune response is called active immunity if it is the consequence of a natural infection". It can be acquired by artificially by vaccination. In this case it is said to be Artificial Active Immunity.

Passive Immunity

"If antibodies transferred to one person were derived from another of the same species it is termed as passive immunity". Fro example, a pregnant woman passes some of her antibodies to her fetus through placenta.

Passive immunity can also be transferred artificially by introducing antibodies. It can be derived from those animals or human beings which are immune to that disease and then termed as Artificial Passive Immunity. For example rabies is treated in man by injecting antibodies derived from persons who have been already vaccinated against rabies.

Q. Define Immunization.

Immunization

Immunization is a process of inducing immunity as a preventive measure against the certain infectious disease. The incidence of a number of diseases (e.g. diphtheria, measles. etc.) has

declined dramatically since the introduction of effective immunization programmers.

Descriptive questions

Q. Describe the mechanism of ascent of sap through root pressure theory and Transpiration Pull.

Root Pressure: A Mechanism to "Push" Xylem Sap Up the Plant

When transpiration is low, active transport of ions into the xylem decreases the stele's (the root stele is basically everything surrounded by the endodermis primarily the xylem and the phloem) water potential and causes water to flow into the stele. This osmotic water uptake increases pressure which forces fluid up the xylem this is called **root pressure.**

- Water passively flows into the roots, pushing the water up against gravity
- Water that reaches the leaves due to root pressure is often forced out, causing a beading of water upon the leaf tips known as **guttation** (exudation of water droplets at leaf margins opening called **hydathodes**).
- In most plants, however, root pressure is not the primary mechanism for transporting the xylem
- Root pressure is not the major mechanism driving the ascent of xylem sap. It can not keep up with transpiration and it can only force water up a few meters.

Transpiration Pull (Adhesion-Cohesion-Tension theory)

Water Movement in Xylem through TACT Mechanism

Four important forces combine to transport water solutions from the roots, through the xylem elements, and into the leaves. These TACT forces are:

- Transpiration
- Adhesion
- Cohesion
- Tension

Transpiration involves the pulling of water up through the xylem of a plant utilizing the energy of evaporation and the tensile strength of water.

Adhesion is the attractive force between water molecules and other substances. Because both water and cellulose are polar molecules there is a strong attraction for water within the hollow capillaries of the xylem.

Cohesion force within xylem gives it a tensile strength equivalent to that of steel is the attractive force between molecules of the same substance. Water has an unusually high cohesive force again due to the 4 hydrogen bonds each water molecule potentially has with any other water molecule. It is estimated that water's cohesive wire of similar diameter.

Tension can be thought of as a stress placed on an object by a pulling force. This pulling force is created by the surface tension which develops in the leaf air spaces. In other words, as the water surface becomes more curved tension increases. According to Campbell "Tension is a negative pressure i.e. a force that pulls water from locations where the water potential is greater." The bulk flow of water to the top of a plant is driven by solar energy since evaporation from leaves is responsible for transpiration pull.

Q. Describe the translocation of organic solutes.

Definition

"The transport of the products of photosynthesis by phloem to the rest of the plant is called Translocation".

Explanation

In angiosperms, sieve-tube specialized cells of phloem that function in translocation. Sieve-tube cells (Phloem) are arranged end-to-end forming long sieve tubes. Porous cross walls called sieve plates are in between the membranes and allow water to move freely along the sieve tubes. Phloem sap contains primarily sucrose, but also minerals, amino acids and hormones.
The phloem transport is also referred as source to sink transport

Source-to-sink transport

Phloem sap movement is not unidirectional; it moves through the sieve tubes from source to a sink organs.

- **Source:** An organ of a plant where sugar is produced by photosynthesis or by the breakdown of starch (usually leaves)
- **Sink:** An organ of a plant that consumes or stores sugar (growing parts of plant, fruits, non green stems and trunks, and others).

Sugar flows from source to sink

- Source and sink depend on season. A tuber is a sink when stock pilling in the summer, but its a source in the spring.
- The sink is usually supplied by the closest source.
- Direction of flow in phloem can change, depending on locations of source and sink.

Phloem loading and unloading

There are steps involve in the movement of photosynthetic products with in the leaf.

- Sucrose produced in the cytosol of mesophyll cells (source) of leaf and translocated into sieve-tubes before it can be translocated to a sink this step is called Phloem loading.
- This occurs with in the vein of a leaf and called **short distance transport** and solutes travels only two or three cell diameter.
- In some plant species, the sugar may move through the symplast from mesophyll cells to sieve members.
- Sucrose in sieve elements moved away from the source tissues to the long distance sink reservoirs this process ids termed as **phloem unloading**.
- In some plants, sucrose is unloaded from phloem by active transport. While in other species diffusion moves the sucrose from the phloem into the cells of the sink.
- Both symplastic and apoplastic routes may be involved.
- The source and sink may be reversed depending on the season, or the plant's needs. Sugar stored in roots may be mobilized to become a source of food in the early spring when the buds of trees, the sink, need energy for growth and development of the photosynthetic apparatus.

Q. Describe the mechanism of phloem translocation.

OR

Q. Describe the pressure flow or mass flow Hypothesis (Munch Hypothesis).

The accepted mechanism needed for the translocation of sugars from source to sink is called the pressure flow hypothesis. Phloem translocation or Pressure Flow Hypothesis was proposed by **Ernest Munch** in 1930 according to him "**The flow of solution in the sieve elements is driven by a pressure gradient is produced due to differences in osmotic pressure between sources and sink".**

Explanation

- As glucose is made at the source (by photosynthesis) it is converted to sucrose (a dissacharide). The sugar is then moved into companion cells and into the living phloem sieve tubes by active transport. This process of loading at the source produces a hypertonic condition in the phloem.
- Water in the adjacent xylem moves into the phloem by osmosis. As osmotic pressure builds the phloem sap will move to areas of lower pressure.

- At the sink osmotic pressure must be reduced. Again active transport is necessary to move the sucrose out of the phloem sap and into the cells which will use the sugar converting it into energy, starch, or cellulose. As sugars are removed osmotic pressure decreases and water moves out of the phloem.
- Phloem sap flows up to 1 meter per hour, too fast for just diffusion or cytoplasmic streaming. The flow is by a bulk flow (pressure-flow) mechanism; buildup of pressure at the source and release of pressure at the sink causes source-to-sink flow.

Mechanism:

- At the source end, phloem loading causes high solute concentrations.
- Water potential decreases, so water flows into tubes creating hydrostatic pressure.
- Hydrostatic pressure is greatest at the source end of the tube.
- At the sink end, the water potential is lower outside the tube due to the unloading of sugar; osmotic loss of water releases hydrostatic pressure.
- Xylem vessels recycle water from the sink to the source.

Q. Explain the structure and function of Human Heart.

The human heart is the most powerful organ in the circulatory system. It works continuously like a muscular pump and keeps the blood in circulation.

Shape and position:

The heart is conical in shape and is located between the lungs directly behind the sternum.

Structure:

Heart is covered by a double layered membrane called Pericardium filled with pericardial fluid and consists of four chambers. Two upper thin walled atria and two lower thick walled ventricles. Two large veins, superior and inferior vana cava enter the right atrium and two pairs of pulmonary veins; open in to the left atrium. Similarly two large arteries emerge out. One from the right ventricle and pulmonary aorta and the other from the left ventricle, Systemic aorta.

Atriums:

Internally, the right atrium is separated by a ventricle through inter-atrial septum. The right atrium opens in to the right ventricle by an aperture guarded by a tricuspid valve. The atrium opens into the left ventricle by the aperture guarded by a bicuspid valve. Semilunar valve guards the emergence of the pulmonary and systemic aorta. These valves prevent backward flow of blood and allow it to move in forward direction.

Ventricles:

The right and left ventricles are also separated by a thick muscular inter-ventricular septum. The walls of the ventricles have papillary muscles for the attachment of delicate fibers chordea tendinae which are attached to the cusps of the valves. These fibers do not let the valves open back into the atria when the ventricles contract. The left ventricle is narrower then the right ventricle because of more muscular walls and it has to pump the blood into the lungs only (pulmonary circulation) while the left ventricle pump the blood to the entire body (systemic circulation).

Path of blood in the heart:

- The anterior vanacava and the inferior vanacava carrying deoxygenated blood enter the right atrium.
- The right atrium sends blood through an atrio-ventricular valve to the right ventricle.
- The right ventricle sends blood through the pulmonary semilunar valve in to the pulmonary trunk and the pulmonary arteries to the lungs.

- The pulmonary veins carrying oxygenated blood from the lungs enter the left atrium.
- The left atrium sends blood through an atrio-ventricular valve to the left ventricle.
- The left ventricle sends blood through the aortic semilunar valve into the body proper.

Q. Explain in detail the Cardiovascular Disorders (CVD).

"Diseases of heart blood vessels and circulation are termed as Cardiovascular disorders".

a) Atherosclerosis:

"It denotes thickening and loss of elasticity of arterial walls".
It is a slowly progressive disease of arteries characterized by formation of **atheromatous plaques** which cause narrowing of lumen impairing blood flow.

Atheromatous Plaques: - "It is a raired yellowish white intimal lesion protruding into vessel lumen". It is also called Atheroma.

Major Causes:

- Increasing age, Male, Family history, Hypertension
- Hyperlipidemia (high cholesterol, high triglycerides)
- Cigarette smoking, Diabetes

Minor causes:

- Obesity, Physical inactivity, Stress, Alcohol
- High Carbohydrate intake, Post menopausal estrogen deficiency
- Low density Lipoprotein (LDL).

Effects:
It can cause "Angina Pectoris". In which patient presents with severe pain in the chest radiating towards left shoulders, arms or jaws. It occurs due to decreased blood supply to heart because of atherosclerosis in coronary artery.

a) Hypertension:
"Sustained high blood pressure is known as hypertension." It is also known as silent killer. If the systolic blood pressure is above 140 and the diastolic blood pressure is about 90 at least two readings on separate occasion is considered hypertension.

Causes:

- Heredity, High intake of salts in the diet, Alcohol, Smoking
- Obesity, Kidney disorders, Adrenal glands disorder

Effects:

- Stroke, Heart attack, Atherosclerosis

b) Thrombus Formation:
"When atheromatous plaques destroy endothelium of blood vessels, platelets start adhering to site of injury causing clot formation which block blood vessel."

Effects:
It impairs blood supply to related organ. Due to lack of oxygen and nutrients, function of organ is deranged.

Embolus: - "If a clot dislodges from its site of origin and travels in blood stream, called embolus".

c) Coronary Thrombus:

"Narrowing of one of coronary arteries due to thrombus formation is called coronary thrombosis". It impairs blood supply to heart muscles so cutting oxygen and nutrients, thus that portion become necrosed and finally infracted.

Effects:

Myocardial infarction (Heart attack)

d) Myocardial infarction----Heart attack

"Acute ischemic necrosis (death of the part of heart muscles) of an area of myocardium is known as myocardial infarction". This is also known as heart attack.

Explanation:

When an area of heart muscle is deprived of oxygen and nutrients due to impairment of blood supply as a result of coronary thrombosis or embolism, that area is died and heart muscles are necrosed or infracted.

e) Stroke and prevention

"Damage to part of brain due to blockage of its blood supply or rupture of blood vessels".

Effects:

It causes impairment of

- Sensations
- Movement
- Any function controlled by that part of brain.

Prevention of Stroke

- Keep blood pressure at normal range.
- Avoid smoking, much salt and fat intake.
- Exercise should be made regularly.
- Make life easy and tension free.

Haemorrhage:

"It is defined as the escape of blood from the vessels". The massive accumulation of blood within a tissue is called **haematoma.**

Prevention of heart diseases:

Heart diseases can be presented by following measures:

- Keeping blood pressure normal through proper diet.
- Weight reduction
- Reduction in Alcohol use
- Stop smoking
- Salt restriction
- Avoid stress
- Avoid fatty diet (like cake, pastries).
- Use of cocking oil not ghee
- Daily brisk walking of at least thirty minutes
- Daily exercises.

Q. Describe the innate immune system in detail

The immune system can be divided into two functional divisions.

(1) Innate immune system and (2) Adaptive immune system

Innate Immune System

Innate, or nonspecific, immunity is the body's first, generalized line of defense against all invaders. Innate immunity is furnished by barriers such as skin, tears, mucus, and saliva, as well as by the rapid inflammation of tissues that takes place shortly after injury or infection. These innate immune mechanisms hinder the entrance and spread of disease but can rarely prevent disease completely.

It comprises of following defense lines

- **First line of Defense (Skin and Mucous Membranes)**

The skin mucous membrane with their secretions are the first line of defense which stops majority of the infectious microorganisms. While most of which can enter through the mucus membranes that lines the. digestive, respiratory and urino-genital tracts however these areas are protected by mucous membranes.

- **Second Line of Defense (Lysozyme, Gastric Juice etc)**

When microorganisms intrude inside the body they encountered a second line of defense; comprises of phagocytes, antimicrobial proteins and inflammatory response.

(a) **Phagocytes**: These are certain type of WBC which can ingest, internalize and destroy the particles including infectious agents. These are Neutrophils, Monocytes which can be developed in to macrophage and called antigen presenting cells. Some other WBCs are called natural killer cells that destroy virally infected cells of the body by releasing specific proteins which causes lysis of the cell.

(b) **Antimicrobial Proteins**: These are mainly lysozyme, complement proteins and interferons.
- **Lysozyme**: Is an enzyme present in tears, saliva and mucus secretion and cause lysis of bacteria.
- **Complement Proteins**: Serve as chemoattrants for macrophages and promote phagocytosis of bacteria.
- **Interferons**: These are secreted by virally infected cells or some lymphocytes to induce a state of antiviral resistance in uninfected tissues of the body.

(c) **Inflammation**: It is the body's reaction to an injury or by the entry of microorganisms. It is characterized by redness, heat, swelling and pain in the injured tissues. At the site of injury phagocytes eat up microorganisms dirt, cell debries etc. forming pus.

(d) **Natural Killer cells:** These are small population of lymphocytes, distinctly different from the lymphocyte involved in the adaptive defense mechanisms. They secrete a cytolytic substance called perforin that disintegrate, destroy the infected cell. These cells also secrete chemical that enhance the inflammation.

Q. Describe in detail the Adaptive Immune System.

Adaptive Immune System

This is the third line of defense which comes in to play simultaneously with the second line of

defense. This comprises of B and T lymphocyte or cells which comes from bone marrow and thymus gland respectively.

The foreign proteins or organism in side the body are consider as antigen and immune system respond to antigen by antibodies which are lymphocytes and soluble proteins.

The adaptive immune system mounts two types of attacks termed as

2) **Humoral immunity** and 2) **Cell mediated immunity**

Humoral Immunity:

"Immunity provided by the antibodies secreted in the circulatory system by **B cells** is termed as humoral immunity". This is particularly helpful in bacterial invasion.

- The antibody serves as antigenic receptor to which antigen attaches and form antigen-antibodies complex.
- B cells divide and enlarged and form **Plasma cells** (effector cells) which secrete antibodies into the circulation that help to eliminate that particular antigen.
- A plasma cell is an antibody factory it has a huge golgi apparatus and at the peak of infection plasma cell may produce 2000 antibody molecules a second.
- Some of the effector cells do not secrete antibody and called memory cells and preventing the body for re-infection.
- Moreover antibodies neutralize the toxins released by bacteria and also cause agglutination of the microorganisms.

Cell Mediated Immunity (CMI):

"This includes the second family of lymphocytes called T cells, which do not secrete antibodies". They mediate immunity by killing infected cells, and aiding in inflammation. This is important in the defense against tumor cells and fungi and parasites. Cells contribute in this immunity are;

Helper T cells (T_h), Cytotoxic T cells (Tc), Suppressor T cells (Ts) and Memory T cells (T_m).

(a) **Helper T cells (T_h)** identify the site of action of antigen by its own "Major Histo-compatibility complex (MCH) Class II (molecules on the surface of macrophage or B cells). These cells stimulate B cells to produce antibodies. A type of T_h CD_4 is the prime target of HIV. MCH class II antigens occur on the surface of antigen presenting cells, thymus cells, and activated T cells.

(b) **Cytotoxic T cells (Tc)** recognize a combination of antigenic fragment and surface maker molecules called MHC Class I. Class I antigens are within cell membranes of all body cells except red blood cells. Tc recognizes nonself antigens that cancerous cells or virally infected cells display on their surfaces near MHC protein. Tc cells binds with antigen, proliferate and releases a protein called **perforin** that destroy the cancerous and virally infected cells.

(c) After the infection is conquered, another group of T cells called **suppressor T cells (Ts)** seems to shut off the immune response in both B cells and cytotoxic T cells.

(d) **Memory T cells (Tm)** are among the many T cells produced upon the initial exposure to an antigen, but they include only those cells not responding to the antigen at that time. These cells provide for a no-delay response to any future exposure to the same antigen, with immediate differentiation into cytotoxic T cells.

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