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IJSO STAGE-I & II

BIOLOGY

PREFACE

Dear Student,

In the current competitive environment, there are certain students who always aspire for more. These students are those who have extremely good fundamentals and do not face any problem in attempting the regular school book problems. This study material is for those students.

This material is aimed at equipping the students with first and second stage of International Junior Science Olympiad (IJSO) i.e. National Standard Examination in Junior Science (NSEJS) and INJSO (Indian National Junior Science Olympiad). The best use of this material is for those students who have natural interest in problem solving and want to aspire for more.

As this material is exam oriented rather than class oriented, there is no specific class wis target. However, based on our prior experience, this material can be best utilized by students of class VIII, IX and X.

We hope you this material in its accuracy and appropriateness.

Team Resonance.

Pre-foundation Career Care Programmes (PCCP) Division

Every effort has been taken to make our study material error free, however any suggestion to improve is welcome in this regard.

Subject : BIOLOGY IJSO STAGE-I & II

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CELL & CELL DIVISION

INTRODUCTION

We know that all living creatures are made of cells. The cell is the basic unit of life. The study of structure of cell constitutes a separate branch of biological sciences called **cytology**.

Cell biology deals with the study of cells from morphological, biochemical, physiological, developmental, genetic, pathological and evolutionary points of view.

(a) Definition of cell

A cell is the structural and functional unit of all living organisms. It is the building block of all living organisms and the smallest unit of life capable of performing all living functions.Role of microscope in the discovery of cell Cells are so small (microscopic) that they cannot be seen with the naked eye. It was, therefore, natural that their existence could not be detected by man until he invented magnifying aids in the form of microscopes.

- An English scientist, **Robert Hooke**, discovered the cell in 1665 while examining thin sections of cork under his simple microscope. He used two lenses for achieving greater magnification.

(b) Robert Hooke: (1635-1703)

The word 'cell' was first coined by him, who explained the same in his book '**Micrographia**' in 1665. Hooke saw empty honey-comb like structure, while examining a thin section of bottle cork under his self made monocular microscope.

- In 1674, **Anton Van Leeuwenhoek** discovered free living cells like bacteria, spermatozoa and also observed somer organization within cells, particularly the nucleus in some red blood cells.

(c) Anton Van Leeuwenhoek: (1632 - 1723)

- Leeuwenhoek prepared a light microscope (with single biconvex lens) which is comparable to today's compound microscope. However the compound microscope is much advanced than the microscope of Robert Hooke and Leeuwenhoek.

(c) Working of a microscope :

- The object on a glass slide is kept on a stage bearing a central hole under an objective lens.
- Light is reflected through the specimen with the help of a mirror and condenser from below the stage.
- Through eyepiece at the top of microscope one can see the magnified image of the object.
- Focusing is done by adjustors (coarse and fine) fitted in the microscope.
- Eyepieces (5X, 10X, 15X) and objectives of high (40X, 100X) and low (10X) powers are available.

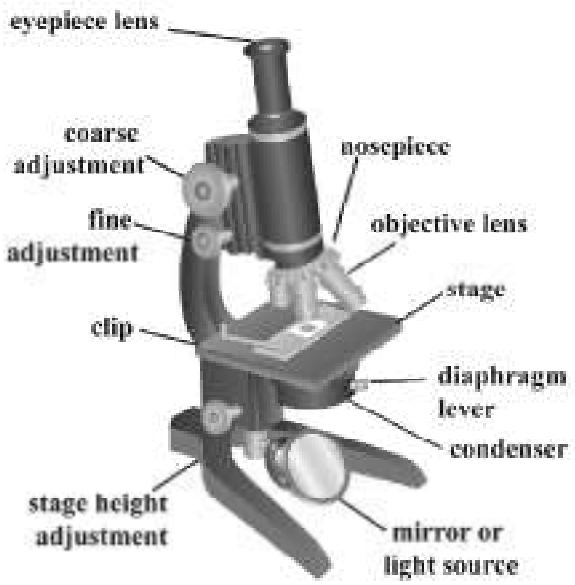


Fig. Compound microscope

CELL THEORY

- In 1839, Schleiden and Schwann studied and concluded that all animals are also composed of cells but are different from plant cells.
- In 1855, **Rudolf Virchow** further expanded the cell theory as "*omnis cellula e cellula*" i.e. all cells arise from pre-existing cells, just as an animal arises only from an animal and a plant only from a plant.

(a) Cells are the morphological and physiological units of all living organisms except viruses.

(b) New cells originate only from the pre-existing cells and continuity is maintained through the genetic material.

(c) The smallest unit of life is the cell, i.e. every organism starts its life as a single cell. All living organisms are composed of cells and their products.

(a) Cell shape

The shape of a cell is related to its functions. Some of the cells (e.g, *Amoeba* and leucocytes) exhibit change in their shapes, while others do not exhibit such change and in such cases cell shape is more or less fixed. Cells may be oval, round, plate-like, tubular, cylindrical, branched and so on. The cell shape is said to be controlled by several factors like function, age, cell wall, external pressure, location, tension, viscosity, etc.

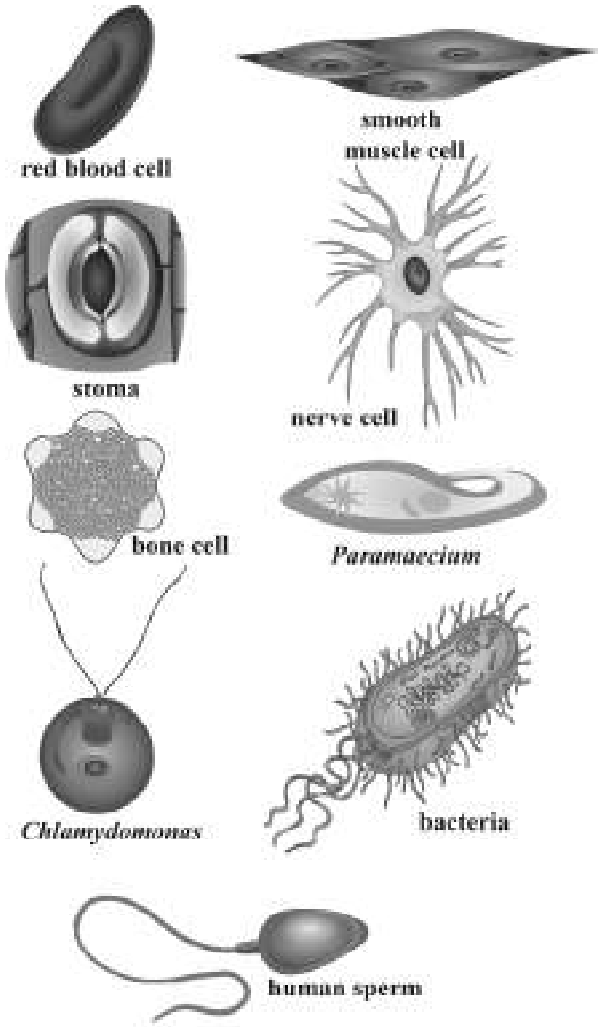


Fig. Cells of various shapes

(b) Cell size

There is a great variation in the size of cells of the living world. The most common type of cells measure from 10 to 100 μ.

- Mycoplasma, a bacterium known as PPLO (Pleuropneumonia-like organism) is the smallest known cell.
- An ostrich egg is the biggest animal cell.
- The nerve cells are the longest in human body, measuring up to 90 cm in length.
- In plant kingdom, *Acetabularia* (an alga) consists of a single cell which measures about 6 to 10 cm in length.

(c) Cell number :

The number of cells in an organism varies with the size of organism. Unicellular organisms have a single cell. In the multicellular organisms the number of cells is indefinite. You do not necessarily need a microscope to

(d) Structure of a generalised cell

Though various kinds of cells show specific differences, yet they all show some basic structural plan of a "generalized cell". A generalized cell consists of three essential parts:

(a) plasma membrane
(b) cytoplasm and
(c) nucleus.

(d) Plasma membrane

Plasma membrane is the outer living boundary of the cell. This is also called **cell membrane** or **plasmalemma**. The term cell membrane was coined by **C.Nageli**

(e) Structure

S.Jonathan Singer and **Garth Nicolson** in 1972 proposed a 'Fluid mosaic model' to describe the structure of the plasma membrane. According to this model, the plasma membrane contains a bimolecular lipid layer, both surfaces of which are interrupted by protein molecules. Some proteins are attached at the polar surface of the lipid (i.e. the **extrinsic** or **peripheral proteins**), while others (i.e. **integral** or **intrinsic proteins**) either partially penetrate the bilayer or span the membrane entirely to stick out on both sides (called **trans-membrane proteins**).

On account of the fluidity of lipids and proteins, and the mosaic arrangement of protein molecules, this model of the membrane plasm is known as the "**fluid mosaic model**". The fluid mosaic model is applicable to all biological membranes in general, that are dynamic and everchanging structures. The proteins serve as enzymes catalyzing chemical reactions within the membrane and as pump substances across it. There are also unbranched or branched chains of sugars attached to lipids and proteins on the external surface.

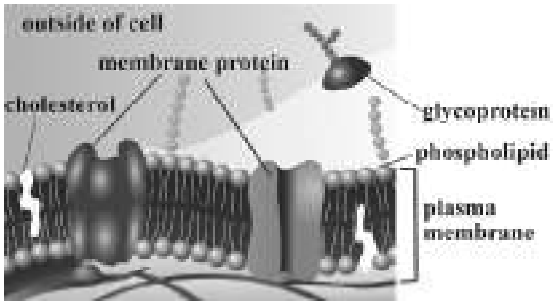


Fig.Fluid mosaic model

(f) Functions

- The main function of the plasma membrane is to control selectively the entrance and exit of water and other materials such as salt, ions, glucose, amino acids, oxygen, etc., and the removal of waste products like CO_2 by passive transport and that of salts, and ions by active transport.
- It provides protection to the internal contents of the cell.
- It infolds and extends to ingest solid and liquid materials, thereby facilitating the bulk transport of materials.

(a) The process of intake of large-sized solid substances by the cell is known as **phagocytosis** .

(b) The process of intake of fluid material through the plasma membrane, is known as **pinocytosis**

- In animal cells, plasma membrane is involved in adhesion, recognition and in the formation of vesicles, cilia, flagella, microvilli, etc.

A note on passive and active transport

- **Passive transport** is a type of diffusion in which an ion or molecule crossing a membrane moves down its electrochemical or concentration gradient. No metabolic energy is consumed in passive transport. There are two types of passive transports: Diffusion and Osmosis.

(a) Diffusion takes place from a region of higher concentration to a region of lower concentration. Within a cell, concentration of CO_2 is higher due to metabolic activities. Outside the cell, concentration of CO_2 is lower and the concentration of O_2 is higher. Thus, CO_2 moves out of the cell, and oxygen enters the cell through the plasma membrane by diffusion. Thus, diffusion plays an important role in exchange of gases between the cells and their external environment.

(b) Osmosis is also defined as a process involving the movement of water molecules from a less concentrated solution towards a more concentrated solution across a semipermeable membrane. The process by which the water molecules enter into the cell is known as **endosmosis**, while the reverse process associated with the exit of the water molecules from the cell is known as **exosmosis**.

- **Active transport** is the movement of a substance across the cell membrane at the expense of metabolic energy. The energy is provided by adenosine triphosphate (ATP) produced by oxidative phosphorylation in the mitochondria during cellular respiration. Active transport is a rapid process and is usually unidirectional. Some membrane proteins act as carrier molecules and transport the substance to the other side of the membrane

CELL THEORY

Plant cells have an additional protective wall outside the plasma membrane, called the cell wall. Cell wall was first discovered by Robert Hooke in 1665. It is a relatively thick, non-living and rigid envelope. It is permeable and is made up of cellulose (a kind of carbohydrate).

The cell wall is absent in animal cells. The plant cell wall which varies in thickness from 10 μm to 0.1 mm is formed of three parts - middle lamella, the primary wall and the secondary wall.

- The middle lamella is the cementing layer and is common to two cells.
- The primary wall is the first formed thin elastic wall. It is formed of cellulose microfibrils and the polysaccharide pectin.
- The secondary wall occurs inner to the primary wall in the mature and non-dividing cells only. It is thicker and chemically formed of **cellulose** and **hemicellulose**.

Functions

- It determines the shape of the plant cells.
- It prevents desiccation (drying up) of cells.
- It protects the plasma membrane and internal structures of cells.
- It helps in the transport of various substances in and out of cells.

CYTOPLASM

Cytoplasm, also called 'cytosol' is the jelly-like homogenous substance present within the cell between the outer plasmamembrane surrounding the cell and inner nuclear membrane surrounding the nucleus. It contains 80% water, salts, dissolved nutrients and waste products. The inner granular mass is called the endoplasm and the outer clear agranulated layer is called ectoplasm. All cell organelles in a eukaryotic cell like the nucleus, endoplasmic reticulum, ribosomes, Golgi complex and mitochondria are suspended in the cytoplasm.

(a) Function

- Cytoplasm is a seat of metabolic processes like biosynthesis of fatty acids, sugars, proteins etc.
- It is also a storehouse of raw materials needed for metabolism in both cytoplasm and the nucleus.
- It distributes the nutrients, metabolites and enzymes within the cell.
- It brings about exchange of materials between the cell organelles.
- It also exchanges materials with the imemdiate environment of the cell namely the extracellular fluid.

(b) Cell organelles :

Eukaryotic cells contain many membrane bound organelles each with a specific structure and function. These are collectively referred to as endomembrane systems.

The endomembrane system consists of the endoplasmic reticulum, the Golgi apparatus, lysosomes, nuclear envelope, vacuoles and plasma membrane. Peroxisomes, mitochondria, and chloroplasts do not communicate with the organelles of the endomembrane system and therefore they are not part of it. Mitochondria and chloroplasts are integral parts of the cell yet they contain their own DNA. They are enclosed by their own membranes whose

function is independent of that of other membranous organelles. They were infact parasitic bacteria that later became symbiotic. Perixisomes are not budded off from the endomembrane system.

ENDOPLASMIC RETICULUM (ER)

The cytoplasmic matrix is traversed by a complex network of inter-connecting membrane bound vacuoles or cavities. These vacuoles or cavities often remain concentrated in the endoplasmic (granulated) portion of the cytoplasm, therefore, known as **endoplasmic reticulum**.

(a) Structure

Ultrastructure of the ER reveals that they are formed of three types of elements - cisternae, vesicles and tubules.

- Cisternae are narrow, two layered unbranched elements found near the nucleus. They lie one upon the other and are interconnected.
- Vesicles are oval or rounded elements found scattered in the cytoplasm. Both cisternae and vesicles are studded with ribosomes and are mainly found in protein forming cells.
- Tubules are wide branched elements found mainly near the cell membrane. These are without ribosomes and are more in lipid forming cells.

(b) Endoplasmic reticulum is of two types

1. Rough endoplasmic reticulum (RER) has ribosomes attached to its outer surface giving a rough appearance. It is well developed in protein synthesizing cells like pancreatic and liver cells.
2. Smooth endoplasmic reticulum (SER) has no ribosomes attached to its surface. It is continuous with rough ER. It is found in glycogen rich regions. This is engaged in synthesizing lipids, steroids, carbohydrates and phospholipids.

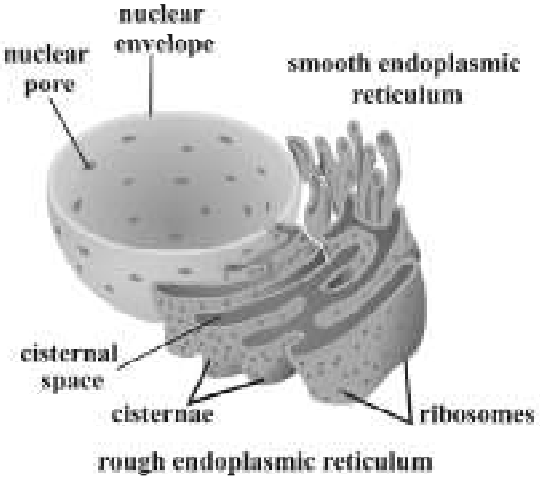


Fig. Endoplasmic reticulum

(c) Functions

- ER increases the surface area of the cytoplasm for various metabolic activities of the cell.
- It gives internal support to the colloidal matrix i.e. cytoplasm.
- It functions as an intracellular transport system for various substances.
- Materials synthesized can be stored in different parts of ER.
- Protein synthesis occurs on the surface of rough ER by ribosomes. These proteins are either used within the cell or exported outside the cell.
- Synthesis of lipids in collaboration with Golgi complex occurs on the surface of the smooth ER. Smooth ER helps in the synthesis of sex hormones like testosterone in the testis and estrogens in ovary.

GOLGI APPARATUS

The Golgi complex, like the endoplasmic reticulum, is a canalicular system with sacs, but unlike the endoplasmic reticulum it has, flattened, membrane-bound vesicles which lack ribosomes. They were discovered by **Camillo Golgi** The Golgi apparatus in plant cells and lower invertebrates are usually referred to as dictyosome and Golgi body respectively.

(a) Structure

Golgi apparatus is group of membrane-bound structures. When examined under an electron microscope, they show a stack of parallel, flattened sacs called **cisternae**, some conspicuous **vacuoles** and clusters of very small **vesicles** (bladder-like structures).

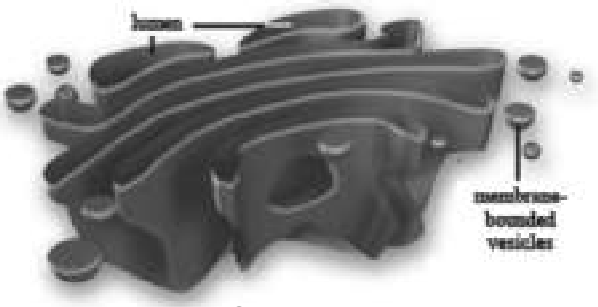


Fig. Golgi apparatus

Functions

- Golgi bodies package the proteins synthesized in the ribosomes.
- In plant cells they form the cell plate during cell division. They synthesize the cell wall polysaccharides.
- They set aside digestive enzymes in tiny membrane-bound vesicles which become lysosomes.
- They add sugars to some proteins and synthesize some polysaccharides for the cell membrane.
- Acrosome of sperm is formed by the Golgi apparatus.

LYSOSOME

Lysosomes were first reported by **Christian de Duve** in 1955. They occur in most animal cells and in the meristematic cells of few plants. They are absent in bacteria and mature mammalian erythrocytes.

(a) Structure

Lysosomes are tiny, membrane-bounded, vesicular structures of the cytoplasm which perform intracellular digestion of the cell.

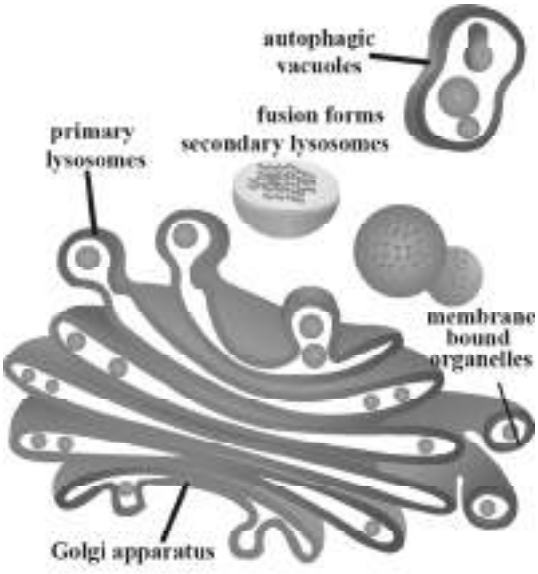


Fig. Golgi apparatus and Lysosomes

They are polymorphic, i.e., of four types – primary lysosomes, secondary lysosomes, residual bodies and autophagic vacuoles. Lysosomes regularly engulf bits of cytosol containing waste (foreign material and worn out cell organelles), which are digested there. Lysosomes contain digestive enzymes capable of digesting proteins, carbohydrates, lipids and nucleic acids.

(b) Functions

- Lysosomes are involved in digestion of microorganisms like bacteria entering the cell by phagocytosis.
- In certain pathological conditions, the lysosomes start digesting the various organelles of the cells and this process is known as **autolysis**. Hence, lysosomes are called **digestive bags**.
- Lysosomes are sometimes called **suicide bags** because the enzymes they contain could digest the whole cell if they burst.
- Lysosomal enzymes are used in the process of apoptosis i.e., programmed cell death of body tissues. For example, the gradual disappearance of tail in the tadpole of frog during metamorphosis is due to lysosomal enzymes.

RIBOSOMES

The ribosomes were first observed in plant cells by **Robinson** and **Brown** in 1953 in bean roots. They were observed by **George Palade** in animal cells in 1953.

Ribosomes are found both in prokaryotes and eukaryotes with the exception of mature sperm and RBCs. Ribosomes are also found mitochondria and chloroplasts.

(a) Structure

Ribosomes are extremely small bodies found either in the free state in the cytoplasm or attached to the surface of the ER. They are composed of ribonucleoprotein (ribonucleic acid and protein). According to the size and the sedimentation coefficient, two types of ribosomes have been recognized.

1. 70S ribosomes are comparatively smaller in size with two subunits (30S + 50S). These are found in prokaryotic cells as well as in the mitochondria and plastids of eukaryotic cells (Mitochondrial DNA is now found to be 55S).
2. 80S ribosomes have two subunits (40S + 60S). They occur in eukaryotic cells of the plants and animals.

(a) Functions

Ribosomes are the sites of protein synthesis. They provide space and enzymes for the synthesis of proteins. Hence, they are known as **protein factories**.

MITOCHONDRIA

Mitochondria were first observed by **Kolliker** who teased them out of muscle cells of insects. The present name mitochondria was given by **Carl Benda.**

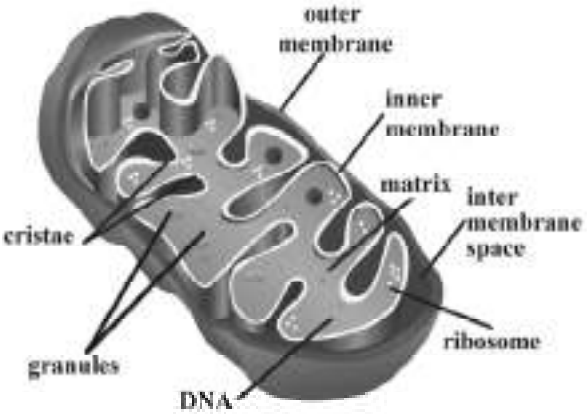


Fig. Mitochondrion

(a) Structure

Mitochondria are tiny structures of variable shapes - cylindrical, spherical or rod-shaped. The average size of mitochondria is 0.2 μm to 2 μm. A mitochondrion consists of two parts - limiting membrane and inner mass or matrix.

(i) **Limiting membrane :** It consists of an outer membrane and an inner membrane. The latter shows many infoldings into the cavity, which are called **mitochondrial crests** or **cristae**. Thus, its inner surface area is several times more than that of the outer membrane.

(ii) **Matrix :** It is a dense gel-like substance which fills the internal cavity of the mitochondria. Mitochondria have their own DNA and ribosomes and are able to make some of their proteins. Mitochondria are found in eukaryotic cells but not in prokaryotic cells and red blood cells of mammals.

(b) Functions

Mitochondria are the respiratory organelles of the cells. During oxidation a large amount of energy is released which is used by mitochondria for synthesis of the energy rich compound, **adenosine triphosphate (ATP)**. Hence mitochondria are called the **power-houses of the cell**. The ATP energy is used by the cell for performing various activities.

ATP can be considered as the master molecule of the cell that provides the energy for various biochemical process hence is called the **energy currency** of the cell.

PLASTIDS

The term plastid was introduced by **E.Haeckel**. It was used by **Schimper**. The plastids are the cytoplasmic organelles that are found only in plant cells and some unicellular organisms such as *Euglena*. Based on the structure, type of pigment present and function, plastids are classified into three types:

1. Leucoplasts 2. Chromoplasts
3. Chloroplasts

Leucoplasts are colourless plastids found in cells of roots not exposed to light. They are devoid of pigments. They are involved in the synthesis and storage of various kinds of carbohydrates (starch), oil and protein granules.

Chromoplasts are coloured plastids containing carotenoids and other pigments. Chromoplasts impart colour to fruits and flowers which attract insects for pollination. **Chloroplasts** are most widely occurring plastids of the plants. They occur in most of the green algae and higher plants.

(a) Structure

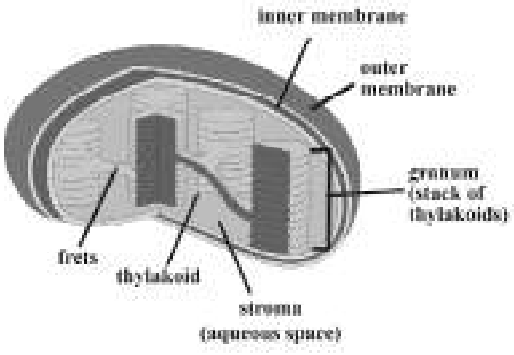


Fig. Chloroplast

Chloroplasts are the most important of all the plastids, since they carry out photosynthesis. Like mitochondria, they also have double membrane but no cristae. The space enclosed within the chloroplast is filled with a jelly like fluid called **stroma** or matrix. Located in the stroma are present numerous double membrane layers called **thylakoids**. The photosynthetic pigments such as chlorophyll a, chlorophyll b, carotenes and xanthophylls are present along the innerside of the thylakoids. These pigments occur in photosynthetic units called photosystems. A number of thylakoids are organized like a pile of coins to form a **granum**. The grana lying adjacent to each other are connected by **stromal lamellae** or **frets**. Plastids, like mitochondria have their own DNA and ribosomes.

(b) Functions

Photosynthesis is one of the most fundamental biological functions. Through the chlorophyll contained in the chloroplasts, the green plants trap the energy of sunlight and transform it into chemical energy. This energy is stored in the chemical bonds produced during synthesis of carbohydrates like starch.Describe at least two common characteristics of chloroplasts and mitochondria. Have you ever wondered what chlorophyll actually looks like? Try this experiment to find out for yourself.

1. Soak a big green leaf from a plant or tree in boiling water for two minutes (ask an adult to help you).
2. Immerse the leaf in a glass containing 70% alcohol. Keep the glass in a container of warm water for about an hour.
3. See the solution turn green! That's the chlorophyll removed from the leaf. See how the bright colour of the leaf has changed.

CENTRIOLES (CENTROSOME)

Centriole (Gr., *centrum* = center) was first discovered by **Van Beneden** and its structure was elaborated by **Theodor Boveri.** Centrioles are found in all animal cells except the mature mammalian RBCs. They are absent in prokaryotes, fungi and higher plants like gymnosperms and angiosperms.

(a) Structure

Centrioles are barrel shaped organelles found in the cells of animals and protists. They occur in pairs, usually at right angles to each other near the nucleus. The region surrounding the pair of centrioles is referred to as centrosphere.

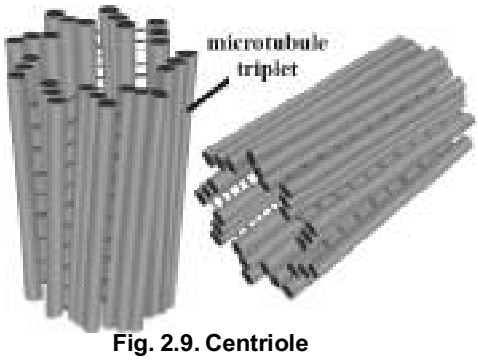


Fig. 2.9. Centriole

Each centriole is a short cylinder with a 9 + 0 pattern of microtubule triplets - that is, a ring having nine sets of peripheral triplets with none in the middle.

(b) Functions

- At the time of cell division, centrioles move to the opposite poles and form asters that organise into spindle fibres during the process of cell division.
- Centrioles give rise to cilia and flagellae in animal cells.

VACUOLES

Vacuoles are single-membrane-bound, fluid-filled spaces found in the cytoplasm of plant cells. In animal cells vacuoles are smaller in size and lesser in number compared to plant cells. In some plant cells, only one large prominent vacuole is present. The major portion of a mature plant cell is occupied by vacuole.

(a) Structure

In plants, the vacuoles are bound by a thin semi-permeable membrane called tonoplast. Vacuole contains cell sap which includes water, dissolved mineral salts, carbohydrates, proteins, etc. The cell sap keeps the cell turgid.
The vacuole of a mature plant cell is formed by enlargment and fusion of small vacuoles present in the meristematic cells. These small vacuoles arise from the ER and Golgi apparatus.

(b) Functions

- Plant cell vacuoles store organic compounds.
- Vacuoles also store inorganic ions like K^+ and Cl^-.
- They contain hydrolytic enzymes that help in digestion of stored macromolecules.
- Vacuoles are used to deposit metabolic wastes of plant cells.
- Vacuoles store pigments like anthocyanins responsible for the colour of the flowers.
- In animal cells, vacuoles are often associated with the maintenance of water balance.

NUCLEUS

The nucleus is the most conspicuous and largest organelle controlling all the vital activities of eukaryotic cells. The nucleus was first discovered and named by **Robert Brown.**

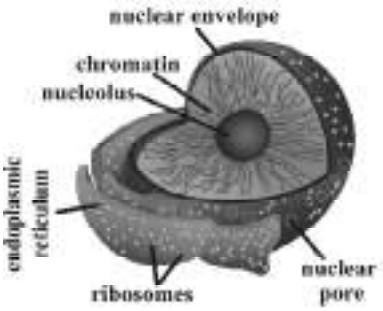


Fig. Nucleus

In a young cell, it occupies a central position. In mature plant cells with the formation of the vacuole, it is shifted to one side. Usually, a single nucleus is present in each cell (uninucleated), but some cells may have more than one nucleus (multinucleated). In bacteria and blue-green algae, a true nucleus is absent, but nuclear material is present. The nucleus is absent in mature mammalian RBCs and in the sieve tube cells in phloem tissue of plants.

(a) Structure

- The contents of the nucleus is enveloped by a double membranous structure called **nuclear envelope** or **karyotheca**. It separates the nucleus from the surrounding cytoplasm.
- Numerous pores are present in this membrane to allow the transport of materials between the nucleus and the cytoplasm. These pores are called **nuclear pores**.
- The colourless dense sap present inside the nuclear envelope is known as **nuclear sap** or **karyolymph** or **nucleoplasm**.
- Which organelle contains instructions for cell function ?
- Inside the nucleus is a tangled mass of thread-like structures called **chromatin**. It is formed of **deoxyribonucleic acid** (**DNA**) and **proteins**. When a cell starts to divide, the tangled mass of chromatin also called the chromatin network condenses into thin, long threads and finally into rod-like bodies called **chromosomes**. The chromosomes contain the DNA molecule that carry the entire genetic information of an organism. Fragments of DNA molecule are called **genes**. Genes are passed from parents to offsprings through sperms and eggs. This is why a gene is called a **hereditary unit** and DNA is called the **hereditary material**.
- **Nucleolus** is a spherical organelle inside the nucleus. It is not covered by a membrane. More than one nucleolus may be found in a cell. Nucleoli are very large in cells that are active in protein synthesis. Their role is to synthesize and to assemble RNA molecules and numerous proteins that make up the ribosome.Describe the composition of chromatin and of nucleoli and the functions of each.

(b) Functions

- The nucleus is the storehouse of genes. Genes control the production of enzymes without which there cannot be any metabolic activity.
- It regulates the cell cycle.
- It is related to the transmission of hereditary characters from parent to offspring.
- The nucleolus synthesizes molecules necessary for the production of ribosomes.

PROKARYOTES AND EUKARYOTES

- Organisms are grouped into prokaryotes and eukaryotes based on their cellular organisation.
- Prokaryotic cells (*pro* - primitive; *karyon* - nucleus) are without an organised nucleus and membrane bound organelles.
- Eukaryotic cells (*eu* - true; *karyon* - nucleus) have an enveloped nucleus and membrane bound organelles.

Prokaryotes, which include bacteria and blue-green algae, appeared about 3500 million years ago. All other organisms are eukaryotes and they probably evolved from prokaryotes. There are some structural differences between prokaryotic and eukaryotic cells.

Table : Differences between prokaryotic and eukaryotic cells

Feature	Prokaryotic cell	Eukaryotic cell
Cell size	Generally small, 1-10 μm.	Generally large, 5 - 100 μm.
Cell wall	Non-cellulosic contain peptidoglycan..	Cellulosic (in plants only).
Nucleus	Lacks true nucleus; circular DNA lies naked in the cytoplasm; nucleolus, nuclear membrane and nucleoplasm are not present.	True nucleus bound by a nuclear membrane, contains linear DNA; nucleolus and nuclear membrane present; nucleoplasm distinct.
Cell organelles	Membrane-bound organelles like Golgi bodies, plastids, mitochondria and ER are absent.	Membrane-bound organelles present.
Ribosomes	Smaller and randomly scattered in the cytoplasm (70S).	Bigger, can be free or attached to the ER (80s).
Cell division	Divides by simple fission, spindle is not formed, no mitosis and meiosis.	Divides by mitosis or meiosis.

THE PLANT AND ANIMAL CELL

The basic structure of cells is similar in plants and animals though there are some differences. The differences are given below :

Table : Differences between plant and animal cells

	Plant cells	Animal cells
1.	Usually larger, with distinct outlines.	Usually smaller, with less distinct boundaries.
2.	Plant cells usually have a regular shape.	Animals cells are usually spherical in shape.
3.	The plasma membrane of a plant cell is surrounded by a rigid cell wall made up of cellulose.	Cell wall is absent.
4.	Cytoplasm not so dense.	Cytoplasm denser and more granular.
5.	Plastids are present.	Plastids are absent.
6.	Vacuoles prominent, one or more.	Vacuoles, if any, are small and temporary concerned with excretion or secretion.
7.	Plant cells have many simpler units of Golgi complex, called dictyosomes.	Animal cells have a single highly elaborate Golgi complex.
8.	Centrosome is not present.	Centrosome is present.

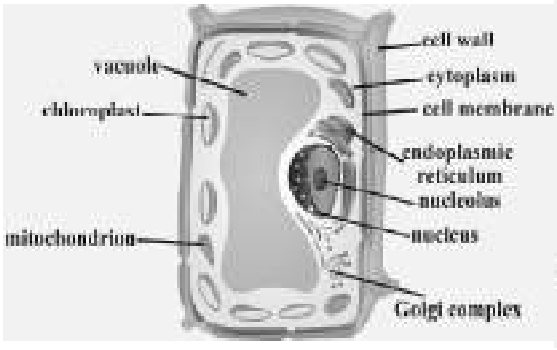


Fig. A typical plant cell

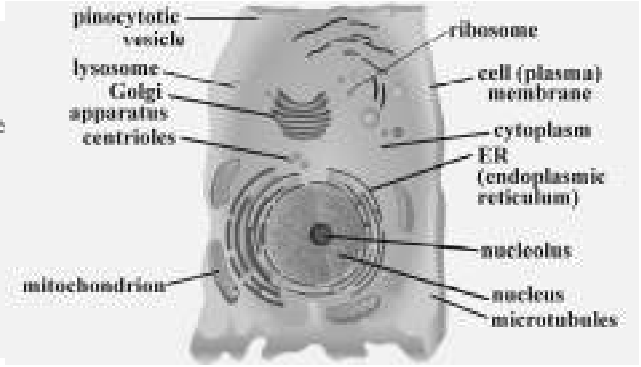
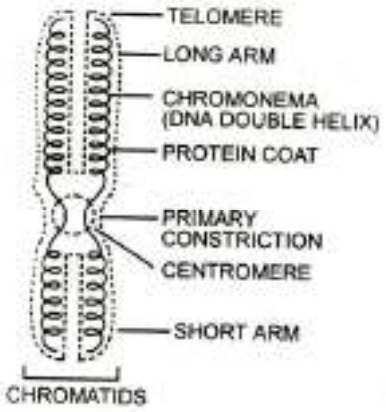


Fig. A typical animal cell

There is not a single activity in the body of an organism which is not carried out by the cells. But cells, of course, are specialized for particular function.

STRUCTURE OF CHROMOSOME

Chromosomes are the vehicles of heredity which possess DNA and are enclosed inside the nucleus. They are capable of self reproduction and maintaining morphological and physiological properties through successive generations. Each chromosome consists of two strands which are called as **chromatids.**The two chromatids of a chromosome are joined together at a point called as **centromere**.

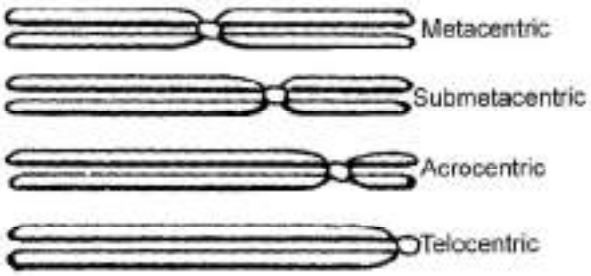


A metaphase chromosome.

(a) Size and Shape of Chromosomes :

(i) Size : Size of chromosomes is variable in different organisms, different tissues and at different stages of the cell cycle.

(ii) Shape : It is usually determined by the position of its centromere. On this basis chromosomes can be of following types :



Types of chromosomes.

(A) Metacentric : They are V – shaped. These have centromere in the middle of the chromosomes so that the two arms are almost equal.

(B) Submetacentric : They are L shaped. In them centromeres are slightly away from the midpoints, so that the two arms are slightly unequal.

(C) Acrocentric : They are J-shaped with centromere at subterminal position. The two arms are considerably unequal.

(D) Telocentric : They are I-shaped, having terminal centromere. Only one arm is formed.

Knowledge Booster

- These shapes can be observed during anaphase stage of cell division.
- The overall study (size and number) of chromosomes can be done during metaphase stage of cell division.

(b) Composition of Chromosomes :

- Chemically the eukaryotic chromosomes are composed of DNA, Proteins (basic - Histones) and small amounts of RNA.

(c) Number of Chromosomes :

- Each species has a fixed number of chromosomes in it's cells. In an ordinary human cell 23 pairs of chromosomes are present. So, there are two chromosomes, of each kind. These two chromosomes of same kind are called as **homologous chromosomes.**
- A cell which has the complete set of chromosomes with two of each kind is called as **diploid cell.** In other words a diploid cell has two sets of chromosomes, thus having two chromosomes of each type.
- The gametes (or sex cells) of human beings are different from their other body cells because they contain only half the number of chromosomes. A cell which has half the number of chromosomes, is called as **haploid cell.** In other words a haploid cell has only one copy of each type of chromosomes.
- Human gametes called **sperm and egg** have only 23 chromosomes which is half the number of chromosomes than other body cells. So, a gamete is a haploid cell.

Knowledge Booster

Females produce two similar gametes and therefore called as **homogametic** and males produce dissimilar gametes and therefore called as **heterogametic**. During spermatogenesis two types of sperm cells will be produced one which contains X-chromosome and the other which contains Y chromosome. During oogenesis each egg cell contain one X-chromosomes.

- If X – chromosome of male fuses with X-chromosome of female it will produce a **female child.**
- If Y – chromosome of male fuses with X-chromosome of female it will produce a **male child**.

(d) Properties of Chromosomes :

The chromosomes must possess five important properties :

(i) Replication : Synthesis of new DNA molecule which is identical to the parent DNA molecule.

(ii) Transcription : Synthesis of RNA molecule which is complementary to the DNA molecule.

(iii) Change in appearance.

(iv) **Repair :** It means correction of damaged parts of DNA.

(v) **Mutation :** Sudden development of genetic changes.

(e) Giant Chromosomes :

These are extremely large compared to normal chromosomes . Such giant chromosomes occur in some animal cells .Two types of giant chromosomes are -

(i) **Lamp Brush Chromosomes :** Occurs in the oocytes (germ cells in the ovary) of amphibians and in some insects . They are extermely large synapsed homologous chromosomes. A lamp brush chromosome consists of an axis from which paired loops extend in opposite directions, giving the appearance of a lamp brush.

(ii) **Polytene chromosomes :** These giant chromosomes are found in the salivary gland cells of fruit fly (Drosophila).They consist of 5 long and 1 short arm radiating from a central point called chromocentre. It is formed by fusion of centromeres of all the 8 chromosomes found in the cells. The arms show characteristic dark bands and light bands. Some of the dark bands temporarily swell up and form enlargements called chromosomal puffs or **Balbiani rings.**

(f) Functions of Chromosomes :

(i) They carry hereditary characters from parents to offsprings.

(ii) They help the cells to grow, divide and maintain itself by synthesis of proteins. Thus they bring about continuity of life.

(iii) They undergo mutation and thus contribute to the evolution of animals.

(iv) They guide cell differentiation during development.

(v) They also control metabolic process.

CELL DIVISION

◆ Cell division was first observed by **Prevost** and **Dumas** (1824) in zygote of frog and also by **Nageli** in plant cell (1842).

Knowledge Booster

A typical human cell divide once approximantely 24 Hr. But duration of cell cycle is variable from one organism to another like yeast divided in approx 90 minutes.

◆ **Cell Cycle :** It is a series of programmed cyclic changes by which the cell duplicates its contents and divides into two parts.

◆ It was described by **Howard** and **Pelc** (1953).

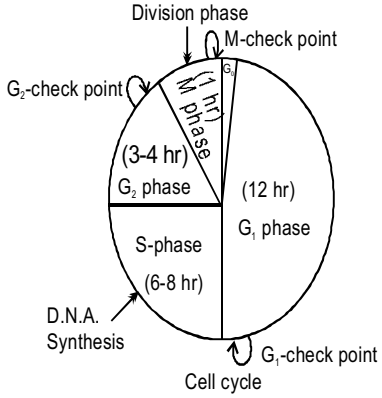
◆ It is divided into two phases :

(i) Long non dividing (I – phase) or interphase.

(ii) Short dividing M – phase.

Knowledge Booster

Check point cell cycle check points are control mechanisum that ensure the fidelity of cell division.
(i) G_1-checkpoint or restriction checkpoint.
(ii) G_2 -checkpoint .
(iii) M-check point or mitotic spindle checkpoint



(i) **Long non dividing (I – phase) or interphase :** It is a complex of changes that occurs in a newly formed cell before it is able to divide. It involves replication of DNA and synthesis of nuclear proteins and duplication of centriole. Synthesis of energy rich components also takes place. This occurs in three stages i.e.

- **G_1** (First growth phase): In this phase the cell increases in size and synthesis of RNA, carbohydrates, proteins and lipids occur.

Knowledge Booster

G_0 stage or Quiscent stage or Resting stage
- Cell neither prepare to divide nor dividing
- Differentiated cell eg.Heart cell, muscle cell & nerve cell are arrested at G_0 phase.

- **S** (Synthesis phase) : This is DNA replication, centriole replication phase.

Knowledge Booster

- In S-phase
  2C = 4C
  2N = 2N
- Where 2C – No. of DNA
  2N – No. of chromosome

- **G_2** (Second growth phase): This is the phase of DNA repair and synthesis of RNA and spindle proteins (tubulin) duplication of cell organelle.

(ii) **Short dividing M – phase :** It is the phase of cell division. It consists of karyokinesis (nuclear division) and cytokinesis (cytoplasmic division).

- **Cell division is of three types :**

Cell Division

Mitosis | Meiosis | Amitosis

(a) Mitosis :

- Term mitosis was given by **Flemming** (1882).
- It is also called as somatic division as it occurs during formation of body cells.
- It is studied in plants, in meristems and in animals in bone marrow, skin and base of nails.
- It is an equational division in which a parent cell divides into two identical daughter cells, each of them contains the same number and kind of chromosomes as are present in parent cell.

- **It occurs in two steps :**

(i) Karyokinesis (nuclear division)

(ii) Cytokinesis (cytoplasmic division)

(i) **Karyokinesis :** Division of nucleus. It is divided in four steps :

(A) **Prophase : Longest phase,** In this Chromatin fibres condense to form chromosomes. They shorten and become distinct with each having two chromatids attached to centromere. Centrosomes reach the poles and form spindle fibres.Nucleolus and nuclear membrane disappears.

Knowledge Booster

At the end of prophase all cell organelles are also disappear & all cell organelles are reform at telophase stage

(B) **Metaphase :** Chromosomes attach to spindle fibres that arise from each pole and lie at the equator, forming a metaphasic plate. Chromosomes **are shortest and thickest in this stage.**

Knowledge Booster

Centromere is assembly of kinetocore & spindle fibre attach to kinetochores of chromosome.
Metaphase of mitosis : Chromosome are allign at equator.

(C) **Anaphase : Shortest phase,** In this phase centromere of each chromosome divides to form two daughter chromosomes. They remain attached to poles through spindle fibres and start moving towards pole and become shortened. They appear in different shapes.

- V – Shaped (Metacentric)
- L – Shaped (Submetacentric)
- J – Shaped (Acrocentric)
- I – Shaped (Telocentric)

Knowledge Booster

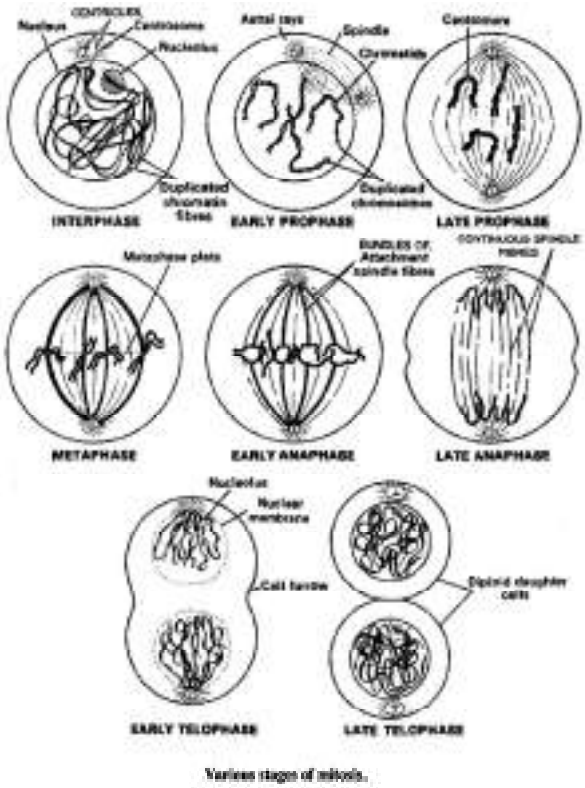
Metaphase-I of Meiosis : Homologous chromosome are allign at either side of equator
Metaphase II of meiosis : Chromosome allign at equator.

(D) **Telophase :** Nucleus is reconstituted, chromosomes uncoil, elongate and form chromatin fibre. Nucleolus and nuclear envelope reappears forming two daughter nuclei.

(ii) **Cytokinesis :** It is referred to the division of cytoplasm. It begins towards the middle of anaphase and completes with the completion of telophase. By this the complete cytoplasm including matrix as well as organelles divides equally. In animals it occurs by formation of cleavage furrow in the middle by constriction in plasma membrane. In plants it occurs by cell plate formation.

Knowledge Booster

In animal - Cytokinesis is done by the furrow method & from out side to inside.
In plant - Cytokinesis in done by the cell plate method & from inside to out side.
Many golgi vesicles, spindle microtubule & fragments of E.R arrange at equator and form phragmoplast. They make cell plate.
Cell plate represent the middle lamellae between the wall of two adjacent cell.



Various stages of mitosis.

(b) Meiosis :

- Term meiosis was given by **Farmer and Moore** (1905).
- It occurs only once in the life cycle of organisms during gametes formation.
- It is a double division in which a diploid cell divides twice to form four haploid cells.
- It can be studied in anthers of unopened flowers in plants and in testis of grasshopper in animals.

◆ It comprises of two divisions (with short or no interphase between them) :

(A) Meiosis – I **(B)** Meiosis – II

(A) Meiosis – I : Also called as reductional division. Diploid state changes to haploid state. It occurs in four steps.

◆ **Prophase – I :** It is the longest phase of meiosis. It has following stages :

◆ **Leptotene :** Chromatin fibres condense to form chromosomes. In diploid organisms there are two chromosomes of each type which are called as **"homologous chromosomes".**

◆ **Zygotene :** Homologous chromosomes join by synapsis and form bivalents which are actually **tetrads**. Pairing proceeds in zipper like fashion forming **synaptonemal complex**.

◆ **Pachytene :** There occurs exchange of segments between non sister chromatids of bivalents and is called as **crossing over**. **Chiasmata** is formed in pachytene.

Knowledge Booster

Crossing over is an also enzyme mediated process & enzyme that is involve in crossing over for breaking - Endonuclease, for joining ligase. (Both enzyme endonuclease and ligase are collectively called Recombinase)

◆ **Diplotene :** Synaptonemal complex is dissolved. At some places non sister chromatids of two homologous chromosomes remain attached forming, **chiasmata**.

◆ **Diakinesis :** Chiasmata shifts towards ends, and complete separation of homologous chromosomes takes place (Terminalization) and nucleolus disappears.

Knowledge Booster

Prophase is longest phase Anphase is smallest phase Leptotene is longest phase of Prophase I & also known as Bouquet stage.

◆ **phase – I :** Spindles are formed in bivalents form a double whorl or double metaphase plate.

◆ **Anaphase – I :** Chiasmata disappears, homologous chromosomes separate by disjunction forming dyads. They move towards poles and form two groups of haploid chromosomes.

◆ **Telophase – I :** Chromosomes elongate, nucleoplasm & nuclear envelope reappears.

(B) Meiosis – II : It is also called as equational division and maintains the haploid number of chromosomes. During interphase (if occurs) no replication of DNA takes place.

- **Prophase – II :** Chromatin fibres shorten and form chromosomes. Nuclear envelope and nucleolus start disappearing.
- **Metaphase – II :** Chromosomes form single metaphasic plate by arranging themselves on equator.
- **Anaphase – II :** Centromere divides into two and separates two chromatids of chromosome into two independent daughter chromosomes or chromatids.
- **Telophase – II :** The four groups of chromosomes organize themselves into 4 haploid nuclei. Chromatin fibres are formed, nucleolus and nuclear envelope are reappeared.

Can You think Why ?

- Why meiosis-II is not called as mitosis.
- Which stages of mitosis and meiosis are same.

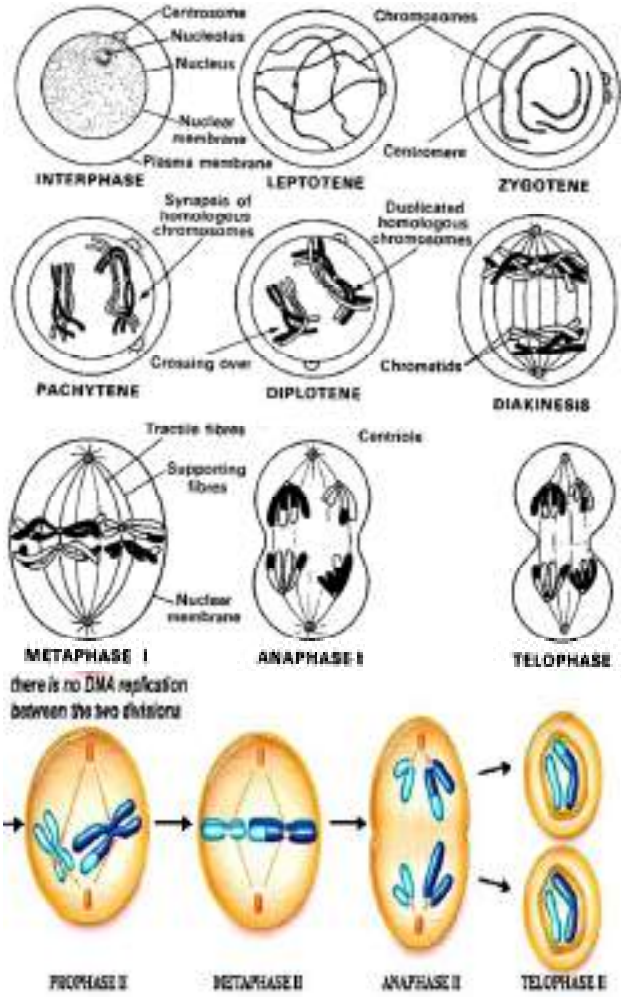
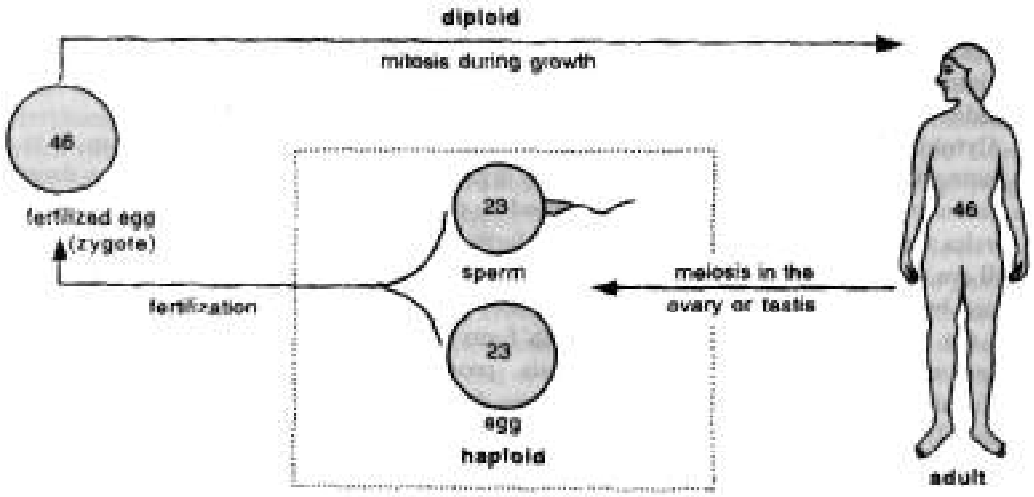


Fig. Various Stages of Meiosis

- **Significance of mitosis :** It is essential for growth, repair, maintenance of chromosome number etc.
- **Significance of meiosis :** It produces variations, differentiation, and essential for sexual reproduction. It maintains the chromosome number in each generation of living organisms.

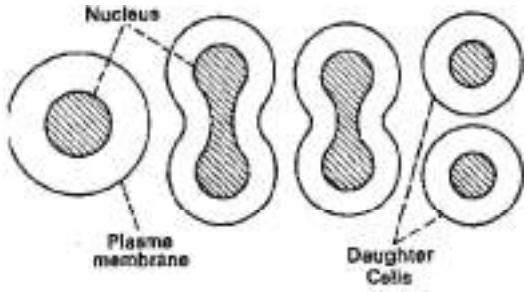


The human life cycle showing the role of two types of cell divisions-mitosis and meiosis

DIFFERENCES BETWEEN MITOTIC & MEIOTIC CELL DIVISION		
S.no.	**Mitosis**	**Meiosis**
1.	It occurs in all somatic cells / vegetative cell (n, 2n, 3n)	It occurs in reproductive cells / germ cells (2n & never in n)
2.	In the resultant daughter cells, the number of chromosomes remains the same (i.e., diploid), hence, called equational division.	In resultant daughter cells, the number of chromosomes reduces to half (i.e., haploid), hence, called reductional division.
3.	By mitosis two daughter cells are produced	By meiosis four daughter cells are produced.
4.	During mitosis no crossing over takes place	During meiosis crossing over takes place.
5.	Daughter cells have identical chromosomes which are also identical to that of parent cell (i.e. remains constant)	Chromosomes of the daughter cells are with combined components (genes) of both parents (i.e., genetic variability occurs)

(c) Amitosis :

- It is also known as **Direct** or **Incipient** cell division.
- First described by **Remak** (1841).
- It is a very simple cell division. It occurs without spindle formation and appearance of chromosomes, also the nuclear membrane remains intact. Both cell and its nucleus elongate, constrict in middle and break off into nearly equal halves.
- It occurs in abnormal case. It occurs in prokaryotes (E.g. Bacteria, cyanobacteria etc.) and eukaryotes (E.g. Amoeba, Yeast, Foetal membrane cells, Endosperm cells of seed, Diseased cell and Old tissues).



Stages in amitosis

EXERCISE-1

1. Eukaryotic ribosomes are
(A) 30s (B) 50s
(C) 80s (D) 70s

2. Plastids that are white in colour (pigment free)
(A) chloroplast (B) lysosome
(C) leucoplast (D) chromoplast

3. Striking difference between a plant cell and an animal cell is due to the presence of
(A) mitochondria (B) plasma membrane
(C) cell wall (D) ribosome

4. In prokaryotic cell
(A) nucleus is developed
(B) membrane bounded organelles are present
(C) double membrane bounded organelles are absent
(D) none of these

5. A typical plant cell contains
(A) cell wall (B) plastids
(C) large vacuole (D) all of the above

6. In which cell centriole is absent ?
(A) Plant cell (B) Animal cell
(C) Both of the above (D) None of above

7. Mitochondria are concerned with
(A) kreb cycle (B) C_4 cycle
(C) glycolysis (D) none of the above

8. Which of the following organelle is the site of kreb cycle ?
(A) Ribosomes (B) Lysosomes
(C) Mitochondria (D) Nucleus

9. Mitochondria are absent in
(A) prokaryotic cells (B) RBC of mammals
(C) eukaryotic cells (D) (A) and (B) Both

10. Mitochondria stores energy in the form of
(A) heat energy (B) ATP
(C) light energy (D) none of the above

11. The correct sequence of different phases of mitosis is

(A) Anaphase $\longrightarrow$ Metaphase $\longrightarrow$ Prophase $\longrightarrow$ Telophase $\longrightarrow$ Interphase

(B) Interphase $\longrightarrow$ Telophase $\longrightarrow$ Metaphase $\longrightarrow$ Anaphase $\longrightarrow$ Prophase

(C) Metaphase $\longrightarrow$ Anaphase $\longrightarrow$ Telophase $\longrightarrow$ Interphase $\longrightarrow$ Telophase

(D) Interphase $\longrightarrow$ Prophase $\longrightarrow$ Metaphase $\longrightarrow$ Anaphase $\longrightarrow$ Telophase

12. After mitosis, the number of chromosomes in the daughter cells shall be
(A) $\frac{1}{4}$ of parent cell
(B) $\frac{1}{2}$ of parent cell
(C) double of parent cell
(D) same as parent cell

13. Mitosis is usually studied in smears or sections of
(A) root tips (B) shoot tips
(C) floral buds (D) all of the above

14. Cytoplasmic structures involved in cell division is
(A) mitochondria (B) ribosome
(C) lysosome (D) centriole

15. The cell size doubles in a stage of cell cycle called as
(A) M (B) G_1 (C) S
(D) G_2

16. The stage at which DNA/chromosome replicates is
(A) prophase (B) interphase
(C) metaphase (D) telophase

17. G_1, S and G_2 are stages of
(A) interphase (B) prophase
(C) metaphase (D) anaphase

18. In plant cells, cytokinesis occurs by
(A) cell plate (B) invagination
(C) furrowing (D) all of these are correct

19. Nuclear envelope reappears at
(A) metaphase (B) anaphase
(C) cytokinesis (D) telophase

20. As compared to mitosis, meiosis has
(A) exchange of chromatid segments
(B) no telophase
(C) daughter cells similar to parent cells
(D) duplication of chromosomes occur during anaphase

21. Pairing of homologous chromosomes is called as
(A) chiasmata formation
(B) synapsis
(C) disjunction
(D) crossing over

22. In acrocentric chromosomes, position of centromere is-
(A) terminal (B) middle
(C) subterminal (D) none of these

23. Chromosomes having equal or almost equal arms are called
(A) metacentric (B) acrocentric
(C) polycentric (D) acentric

24. Chromosomes other than sex chromosomes are called as
(A) allosomes (B) autosomes
(C) microsomes (D) none of the above

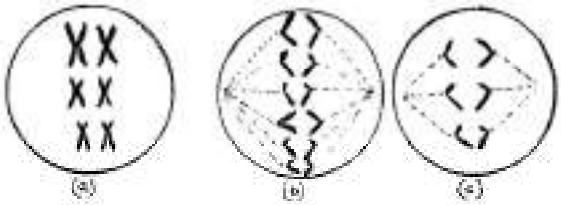
25. In humans the number of chromosomes in a diploid cell is
(A) 23 (B) 46
(C) 44 (D) 30

EXERCISE-2

COMPETITIVE EXAM QUESTIONS

1. The number of chromosomes can be counted at **(IJSO/2009)**
(A) anaphase (B) interphase
(C) metaphase (D) prophase

2. The cells in the following figure were all taken from the same individual (a mammal). Identify the cell division events happening in each cell. **(IJSO/stage II/2009)**



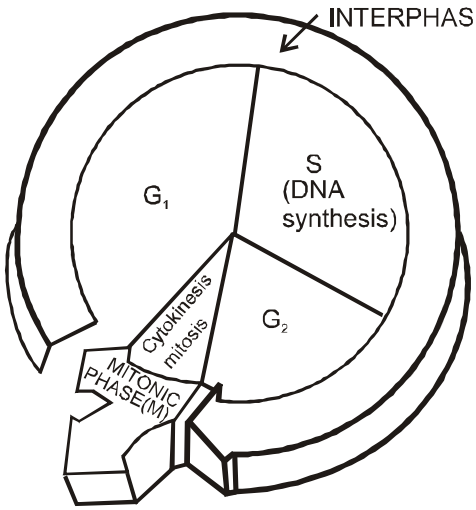
(A) (a) Meiotic Metaphase I, (b) Mitotic Anaphase, (c) Meiotic Anaphase II
(B) (a) Mitotic Metaphase, (b) Mitotic Anaphase, (c) Meiotic Anaphase II
(C) (a) Mitotic Metaphase, (b) Mitotic Anaphase, (c) Meiotic Anaphase I
(D) (a) Meiotic Metaphase II, (b) Meiotic Anaphase I, (c) Meiotic Anaphase II

3. The signal for mitotic division is generated when the ratio of volume of nucleus to that of cell becomes -
(IJSO/stage I/2010)
(A) less than a certain value.
(B) greater than a certain value.
(C) reaches a certain value.
(D) closer to one.

4. When a cell fails to communicate with other cells in multicellular organism, it
(IJSO/stage I/2010)
(A) becomes cancerous
(B) enters mitotic phase
(C) chooses to die
(D) is eaten up by other cells

5. The process involved in healing of the wound is
(IJSO/stage I/2011)
(A) Meiosis I and II (B) mitosis
(C) Meiosis I (D) meiosis II

6. Considering the action of colchicine, it may be considered for the treatment of:
(IJSO/stage I/2012)
(A) Hairtall (B) Anemia
(C) Cancer (D) Bacterial infection

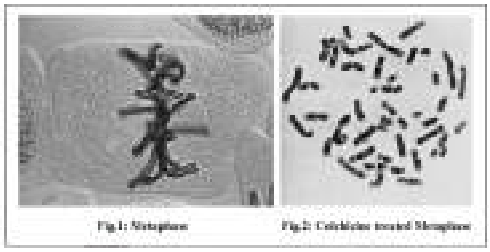


Read the following carefully and answer the questions from 36 to 39
student treats some onion root tips with colchicine that is responsible
arresting cell division at the metaphase stage (by dissolving spindle fibres) and further prepared a slide of the root tip staining with acetoorcein (stains chromatin) and observed under high power of compound microscope. He is well aware of the cell cycle given alongside.

7. Which of the following is not true about his observation ?
(IJSO/stage I/2012)
(A) Most cells are in Interphase
(B) Most cells are in the metaphas
(C) No cells are in anaphase or telophase
(D) Chromosomes could be observed better than a slide prepared without colchicine treatment.

8. Why did the student choose root tips of onion
(IJSO/stage I/2012)
(A) Roots grow fast and considerable length of tips can be used.
(B) Root tip~ are easy to smear and stain.
(C) Root tips have meristematic tissue.
(D) Cell division occurs only at the root tips in plants

9. Chromosomes in metaphase get arranged at the equatorial plate. When these cells are treated with colchicine, cell division is arrested and the cells never enter anaphase. If we were to compare treated cell at metaphase and an untreated cell in the same phase, we notice that chromosomes are more dispersed and do not arrange themselves on the equatorial plate in the treated cells
(IJSO/stage II/2012)



Using the information, which of the folloiwng will be affected by colchicine ?
(A) Centromere (B) Spindle fibre
(C) Centriole (D) Arms of chromosomes

10. If Brain is controlling unit of an organism, then at cellular level which cell organelle can be comparable to Brain ?
(IJSO/stage I/2013)
(A) Chloroplast (B) Ribosome
(C) Nucleus (D) Lysosome

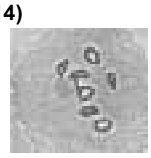
11. Most of the cellular RNA is synthesised and stored respectively in :
(IJSO/stage I/2014)
(A) cytoplasm and ribosomes.
(B) ribosomes and cytoplasm.
(C) ribosomes and nucleus
(D) nucleus and ribosomes

12. The erythrocytes separated from human blood were mixed with certain fluids on a slide and observed under the microscope. Which of the following will be the expected result ?
(IJSO/stage I/2014)
(A) With serum the cells clump and coagulate.
(B) With distilled water the cells swell and eventually
(C) With sea water the cells undergo no apparent change.
(D) With tap water cells shrink and appear cremated. burst.

13. In the cells of oil seeds which of the cell organelles have to more active :
(IJSO/stage I/2014)
(A) Mitochondria
(B) Rough endoplasmic Reticulum
(C) Smooth endoplasmic Reticulum
(D) Nucleoli

14. A human T lymphocyte in the mitotic metaphase stage will contain how many DNA molecules? (Exclude the DNA of mitochondria)
(IJSO/stage II/2014)
(A) 23 (B) 46
(C) 184 (D) 92

15. The given diagram represents a dividing cell stained with giemsa. From the options given below, identify the correct stage of cell division.
(IJSO/stage II/2014)



(A) Leptotene (B) Zygotene
(C) Pachytene (D) Diakinesis

16. Stem cells in animals are pluripotent cells as they possess the potential of giving rise to many types of cell lineage. Presence of stem cell in a differentiated tissue gives it potential to regenerate. From the combination of tissues presented below, predict the best combination of tissues containing maximum and minimum amount of stem cells respectively :
(IJSO/stage II/2014)
(A) Brain and kidney (B) Kidney and brain
(C) Brain and liver (D) Liver and brain

17. Which of the following is NOT produced by the endoplasmic reticulum ?
(IJSO/stage II/2015)
(A) Lipids (B) Proteins
(C) Monosaccharides (D) Hormones

18. Genetic material (DNA) in plants occurs in which ofthe following cell organelles ?
(IJSO/stage II/2015)
(A) Nucleus
(B) Nucleus and chloroplast
(C) Nucleus, chloroplast and mitochondria
(D) Chloroplast and mitochondria

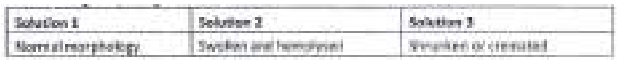
19. What might be the purpose of the student ?
(IJSO/stage II/2015)
(i) Observing chromosomes
(ii) Observing stages of cell division
(iii) Comparing number of cells in various stages of cell division
(iv) Preventing further growth of the root tips.
(A) (i) & (ii) (B) (ii) & (iii)
(C) (i) & (iv) (D) (iii) & (iv)

20. Mitochondrial equivalent in prokaryotic bacterial cell is **(IJSO/stage I/2015)**
(A) ribosomes
(B) thylakoid
(C) cytoplasmic plasma membrane
(D) cyanosomes

21. Which of the following option is not true about the viruses ?
(IJSO/stage I/2015)
(A) Viruses have either DNA or RNA as these genetic material.
(B) Viruses will not infect bacteria, fungi and algae.
(C) Viruses use host machinery to produce their own proteins.
(D) Viruses are useful in the preparation of vaccines.

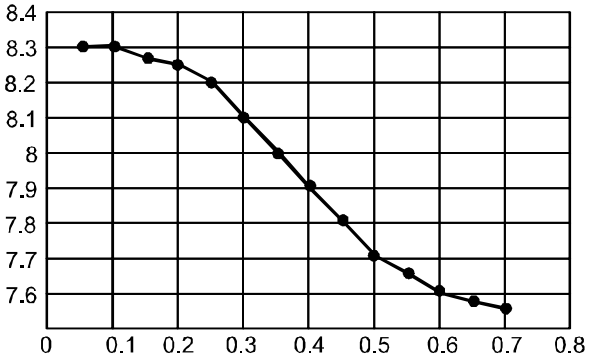
22. Gram positive bacteria will have one of the specific characters. Identify it.
(IJSO/stage I/2015)
(A) They have more peptidoglycon in their cell walls.
(B) They show red colour on gram staining.
(C) Flagella found all over the body.
(D) They will have mesosomes as the extension of cell membrane.

23. When a red blood cell was placed in an animal cell (RBC) in 3 different solutions, the following morphological observations were made under a microscope. The above three solutions can be classified in the order of
(IJSO/stage I/2015-16)



(A) isotonic, hypotonic and hypertonic
(B) hypotonic, isotonic and hypertonic
(C) hypotonic, hypertonic and isotonic
(D) isotonic, hypertonic and hypotonic

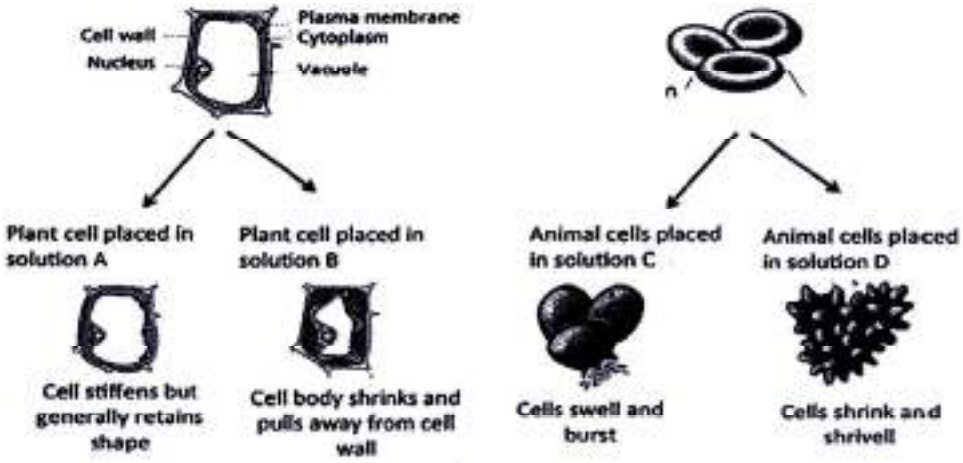
24. Thin cuboidal strips are made by slicing a potato. They are all made to be exactly 8 cm long and 2 mm wide. Each strip is placed in sugar solutions of different concentration. After soaking it for 5 hours, their lengths are measured again. The following graph show the results of the experiment. What concentration of sugar solution is isotonic with the contents of the cells of the potato.
(IJSO/stage I/2015-16)



(A) 0.2 (B) 0.4
(C) 0.6 (D) 0.1

25. In an experiment, plant and animal cells were placed in different solution (A, B, C and D) as shown below. The outcome of placing them in these solution is also indicated in the figure. **(IJSO/stage II/2016)**

Diagram



Identify the nature of the solution A, B,C and D.

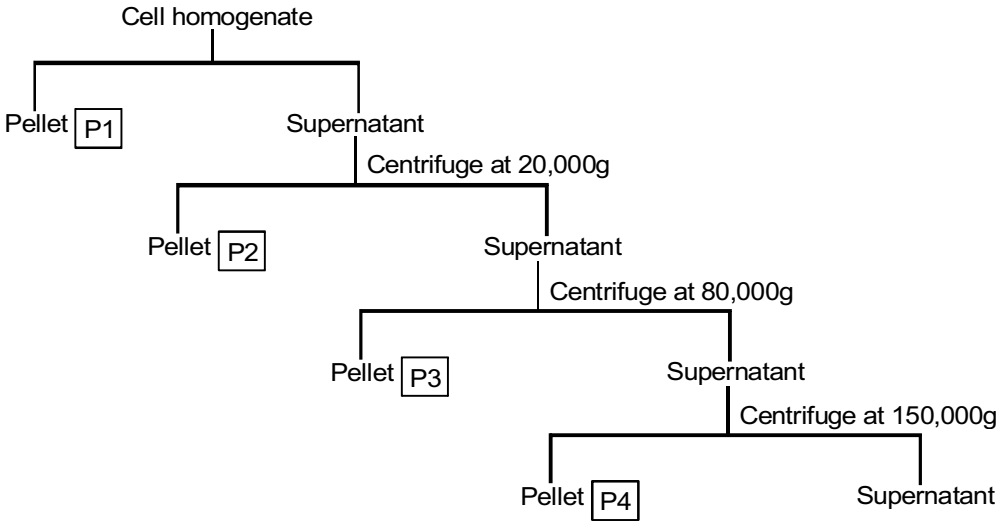
(A) A and C are hypotonic, B and D are hypertonic

(B) A and C are hypertonic, B and D are hypotonic

(C) A and D are hypotonic, B and C are hypertonic

(D) A and D are hypertonic, B and C are hypotonic

26. By the process of mechanical breaking such as homogenization in a blender homogenizer, the membranes of cell can be broken to make a cell homogenate. Sub-cellular organelles such as nuclecus. Mitochondria, ribosome particles and membrane fraction remain present in the homogenate. The different organelles from the above homogenate can be separated from on other by a process called as cell fractionation. Since, these organelles vary in their size ; they can be selectively pelleted (sedimented) by differential centrifugation. Experiments on cell fractionation have established the required relative centrifugal force (RCF) to pellet selectively one organelle while the other organelles remain in the supernatant. In the repeated centrifugation process of organelle isolation, the organelles are separated on the basis of their size, where the larger organelles are pelleted at low RCF (g) and smaller organelles are pelleted at higher RCF(g). Given below is a scheme of such an isolation process.
(IJSO/stage II/2016)



(I) Predict which organells(s) from the following: nuclei, mitochondria and ribosome, will be present in P1, P2 and P4 pellet fraction. P3 contains the membrane fractions.

P1_____

P2_____

P3 Membrane Fraction

P4_____

(II) Different organelles can selectively be stained by taking into consideration their composition and function. Below is a chart of different type of stains used for staining different organelles. Predict which stain can be used for staining the P1, P2 and P3 fractions. independently.

Stain	**Specificity**
Redox dyes	ATP generation centers
Hematoxylin (basic dye)	DNA and RNA
Acidic stain	Lysosome
Lipophilic stains	Lipid containing organelles

P1_____

P2_____

P3_____

(III) Slim tea presently used for shaping body, contains 2,4-Dinitrophenol (DNP) which acts as a proton ionophore, an agent that can shuttle protons (hydrogen cation) across biological membranes. It dissipates the proton gradient across membranes, collapsing the proton motive force that the cell uses to produce most of its ATP (chemical energy). Now in the cell the energy of the proton gradient is lost as heat instead of producing ATP. With this information, predict membranes of which sub-cellular organelles(s) of a plant and a animal cell will be mostly affected by consumption of slim tea.

(IV) A person unknowingly consumed some poisonous substance. Which sub-cellular organelle of the patient would contain the maximum concentration of the toxin ?

27. In a hypothetical situation, a cell was found to lack rough endoplasmic reticulum. Which one of the following activities was all likely absent in this cell?
(A) Transcription
(B) Translation
(C) Synthesis of secretory
(D) Manufacture of fat molecules or lipids

28. Following are some statements about mitochondria and chloroplasts :
I. Mitochondrion has double stranded DNA that replicates independently while chloroplast does not have the same.
II. Both mitochondria and chloroplast have double staranded DNA that replicates independently.
III. Both mitochondria and chloroplast have single stranded DNA replicating independently.
IV. Mitochondria and chloroplasts have both RNA and ribosomes.

Which of the above statements are correct ?
(A) Both I and IV (B) both III and IV
(C) both II and III (D) both II and IV

ADAPTATION

DEFINITION

Adaptations may be defined as the characteristics of living forms to develop, over a period of time with certain morphological, anatomical, physiological, and ecological features which enable them to survive and reproduce within the limits of a particular environment, e.g. fish, whales, aquatic plants are adapted to live in water, birds and bats in air and camels in deserts.

(a) Aquatic Adaptations

Aquatic adaptations are shown by those organisms that live in water. Various water bodies are ponds, lakes, rivers, streams and oceans. The abiotic factors that organisms experience in water are the availability of light and oxygen, pressure fluctuations, resistance to movements, salt concentrations and so on. Accordingly plants and animals adapt to these physical factors.

Some plants and animals live in fresh water while others are seen in sea water. Organisms living in a particular habitat are adapted only for that habitat. Organisms get their mineral requirements from the type of water in which they live. That is why plants occurring in fresh water are not seen in sea water.

- **Hydrophytes :** Typical hydrophytes grow in water or water rich substratum. Since the aquatic environment remains uniform, the hydrophytes, particularly the sub-merged and floating forms have less adaptations than xerophytic plants. Their adaptations are chiefly in response to excess water, decreased oxygen supply and low temperatures. On morphoecological basis hydrophytes have been divided into following groups :

(i) **Free-floating hydrophytes :** These are not rooted below.They remain in contact with water and air but not soil.They float freely on the surface of water. Root system is not developed. Root pockets are found in many species. Some air-storing region is present in larger species.

- **Examples.**Lemna Wolffia, Salvinia, Azolla, Pistia , Trapa etc.

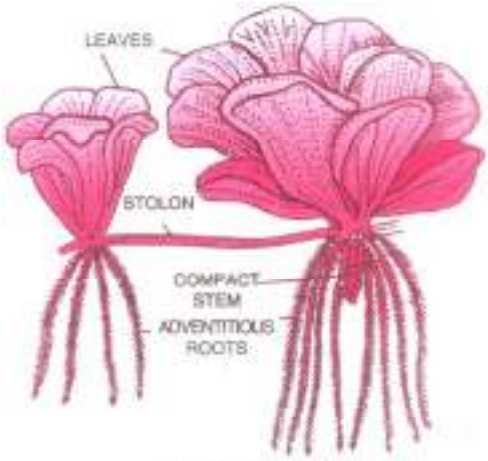
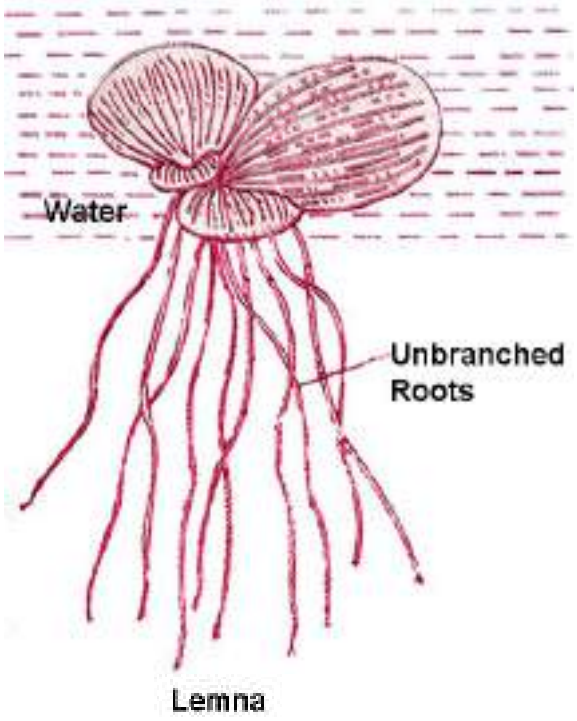


Fig. *Pistia sp.*



Lemna

(ii) **Floating leaved, rooted hydrophytes :** These are anchored at the bottom, but their leaves float on the surface of water. The leaves have long petioles. Leaves have cuticle, stomata and waxy coating on the upper surface. Some plants show heterophily.

- **e.g.** Eichhornia,Victoria, Marsilea etc.

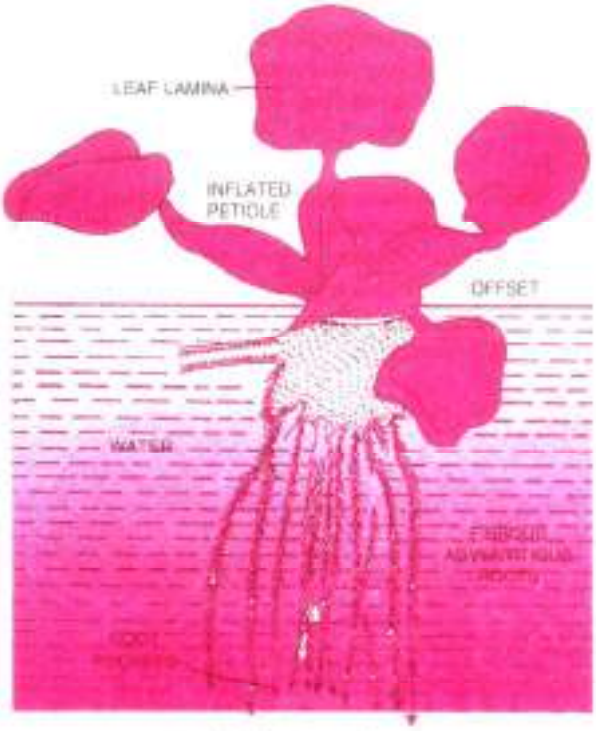


Fig. *Eichhornia crassipes.*

(iii) **Submerged floating hydrophytes.**These plants are though completely sub-merged in water but not anchored in the mud. They are devoid of roots. Examples-Utricularia,Ceratophyllum.

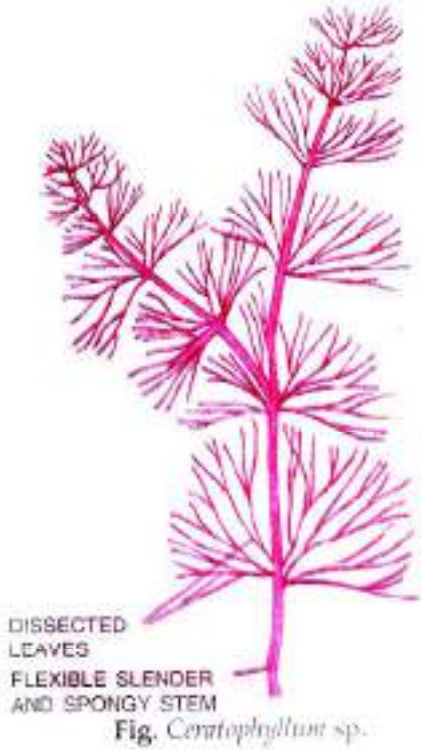
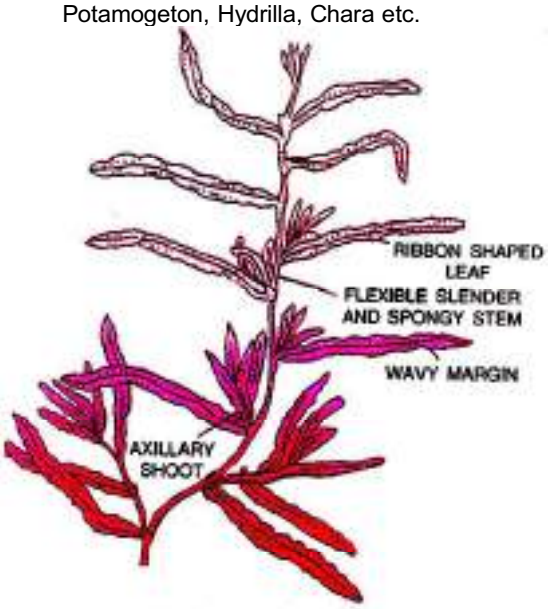


Fig. *Ceratophyllum sp.*

(iv) **Sub-merged rooted hydrophytes.**They remain completely sub-merged in water and are anchored at the bottom.The leaves are either ribbon-shaped or greatly dissected.The stems are with long internodes soft and spongy, Examples- Vallisneria, Potamogeton, Hydrilla, Chara etc.



Potamogeton

◆ **Characteristics of Hydrophytes**

- **Morphological characters.**

(i) Roots either absent (Wolffia, Utricularia) or poorly developed (Hydrilla)
(ii) Root caps are replaced by root-pockets (Eichhornia, Pistia).
(iii) In some cases floating roots may develop in addition to normal roots (Jussiaea).
(iv) The submerged parts are generally surrounded by mucilage for protection.
(v) The submerged leaves are either ribbon-like or finely dissected.
(vi) Floating leaves are generally large, broad and thick.
(vii) Heterophily is common in partially submerged plants (Ranunculus).
(viii) In some hydrophytes, the petioles of leaves are spongy due to the presence of air cavities.

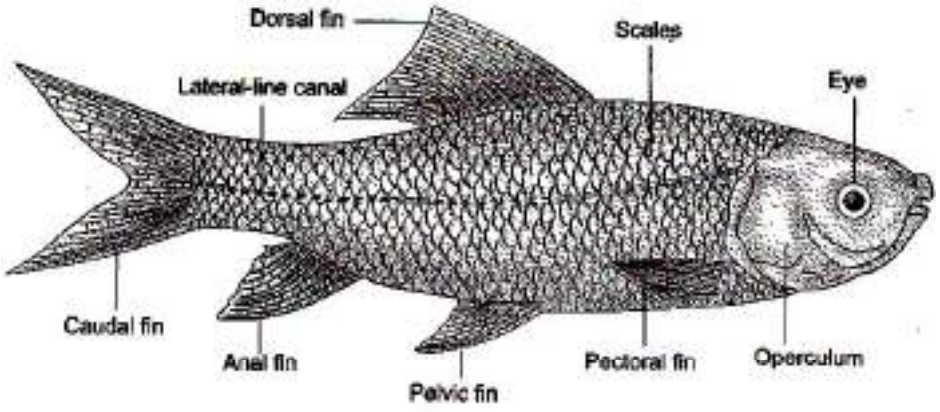
- **Anatomical Characters.**

(i) The cuticle is either absent or poorly developed.
(ii) Epidermis in hydrophytes is meant for absorption not for protection.
(iii) The cortex is wide and bear large air spaces.
(iv) Lack of sclerenchyma (reduction in mechanical tissue).
(v) Vascular tissue is poorly developed.
(vi) Stomata are generally absent in the submerge organs. If present they are functionless.In the floating leaves stomata are usually restricted to upper surface.
(vii) In amphibian plants, dimorphism is exhibited by the leaves that diverge from the stem below the water level, composed do those that diverge above water.

Fig. T.S. Stem of *Hydrilla*.

◆ **Aquatic adaptations in animals :** These adaptations are shown by those animals which live in water i.e., water is their home or habitat. Animals may live in water primarily or they have shifted to water habitat later on as a secondary adaptation. Accordingly, these animals show the following modifications :

- They have a streamlined body that helps in swimming in water **e.g. fish**. Streamlined body gives least resistance to swim in water.
- Locomotion is either by webbed feet **e.g. ducks, frogs** or by fins **e.g. fish.** The fins at the sides helps in acquiring speed and in changing direction.
- Respiration occurs with the help of gills. Gills are the organs that help the animal to get oxygen from water. Gills have a large surface area that helps in this process by providing a layer of contact.
- Some fish and water insects carry air bladder as a hydrostatic organ in their bodies that help in providing the buoyancy to the animal in water.
- Hair and skin glands like sweat & oil-glands are absent **eg. in whales.**



Fish

(b) Terrestrial Adaptations :

Terrestrial adaptations are shown by those organisms that live on land. Land provides a vast variety of physical factors such as soil, temperature, humidity, wind, light etc. Unlike water bodies, habitat on land becomes discontinuous as it is interrupted by streams, rivers, oceans, mountain etc. Organisms that live on land get enough amounts of light and oxygen. But they get wide fluctuations in temperature on land. The availability of water is also not uniform on land. On the basis of availability of water and temperature, these regions are categorised on land :

◆ **Xeric adaptations :**

(i) **Xeric adaptations in plants :** Plants that live in xeric conditions or scarcity of water are known as xerophytic plants.

- The xerophytes can be grouped into three categories.

(A) **Ephemerals :** They are drought esscapers or drought evaders found in the habitats of prolonged dry season. They live only for a few weeks in the wet season of the year.They emerge during the early spring or rainy season, grow, flower and produce seeds in a short span of wet conditions.The dry season of the year is tide over in the form of seeds which are resistant to drought. So these plants are drought escaping rather than drought-resistant. **e.g.** *Argemone mexicana, Solanum xanthocarpum* etc.

(B) **Succulents :** Such plants are called as drought resisting plants. The succulents are able to store large amounts of water in their bodies. Succulance results from the proliferation of parenchymatous cells accompanied by an enlargement of vacuoles, and reduction in the size of intercellular spaces. It may occur in stem, leaves, or roots.The plants store water in considerable amounts during the short rainy season in their enlarged cells which is then utilized economically during drought period. Stomata remain closed during day time checking the loss of water.The CO_2 released in respiration is utilized in photosynthesis internally. **e.g.**-opuntia, Euphorbia etc.

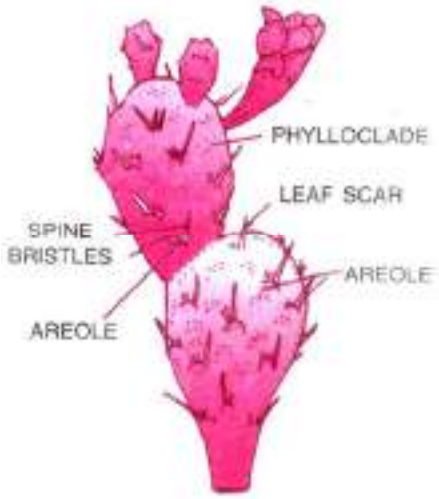


Fig. *Opuntia* sp.

Fig. *Euphorbia royleana*.

(C) Non-succulents : These are the true xerophytes because they experience dryness both internal and external.They are perennials and are characterised by many morphological and biological modification, which enable them to withstand dry condition.They have extensive root system and many characteristics to reduce transpiration like waxy coatings on leaves, sunken stomata, leaf blades reduced, thin rigid, leathery or scaly, rolling and folding of leaves etc. **e.g.**Nerium etc.

Fig. *Nerium* sp.

◆ **Characteristics of Xerophytes**

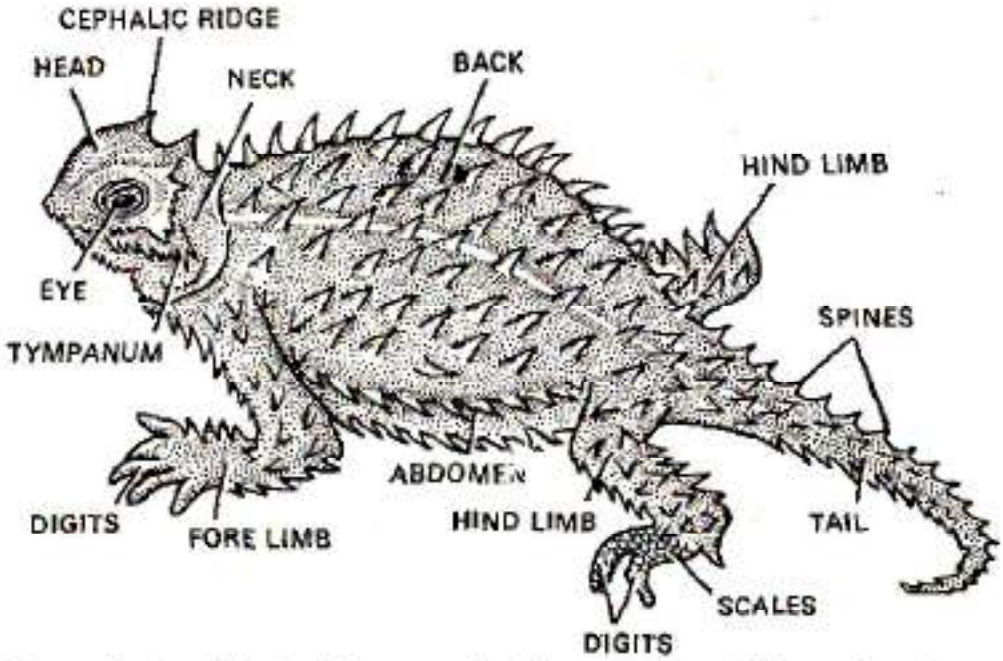
• **Morphological characters**

1. The root system is extensive, penetrating very deep. Root hairs and root caps are very well developed.
2. The leaves are reduced in area to check transpiration .The leaves may be modified into phyllodes (Acacia sp.) or succulent (Aloe).
3. The stems are usually stunted, hard, rigid and covered with thick bark.
4. The stem may be modified into phylloclades (Opuntia, Euphorbia).

• **Anatomical Characters.**

1. The plant parts are covered with wax or hairs.
2. Plant parts are covered with thick cuticle.
3. Stomata are sunken.They may be further covered with hairs e.g. Nerium and Capparis.
4. Stomata are restricted only to lower side of leaf.
5. Hypodermis is sclerenchymatous.
6. Mucilage cells may be present e.g. Bryophyllum.
7. Epidermal cells may have silica crystals.
8. Upper surface of leaf is shining.
9. Osmotic pressure of cell sap in high.
10. The xerophytes which contain fleshy leaves and stems are called malacophyllous.
11. In xerophytes like Calotropis, Euphorbia, Asclepias etc., latex producing tubes (laticiferous canals) are present.
12. Vascular tissue is very well developed.

(ii) Xeric adaptation in animals : Animals that live in deserts show xeric adaptations. Some of these adaptations are given below : Since these animals live in excessive heat, so they developed a protective covering around the body to check dessication or water loss by evaporation. Moloch, the desert lizard has hygroscopic skin to absorb water.



The spiny toad.It's body is covered with spines to avoid loss of water

- They may have water sacs in their stomach wall **e.g. camel.**
- Most of these animals are nocturnal (active during night) so they avoid the day temperature.
- For defence, they have poisons or some other mechanism. Snakes, spiders, scorpions have poison glands or **stings.**
- Some of the desert insects can make use of metabolic water.
- Some of the desert animals like rats and snakes dig holes and burrows in the sand and live within. In holes and burrows the temperature is less and it is moist also. These animals come out at night only when the deserts are cooler. So these animals avoid the excessive heat of the day.
- These animals, either become active when water is available and remain dormant for rest of the time or adapt for water storage and water conservation.
- Certain animals like desert rabbit and wood rat derive water by eating succulent plants.
- Body temperature of certain animals, **e.g. Camel,** fluctuates with the atmosphere which reduces the water loss through sweating.
- Some undergo **aestivation** (summer sleep).

◆ **Mesophytes :** Mesophytes are the plants growing in the habitats of moderate climatic conditions.

- The root system of mesophytes is well developed, branched and provided with root cap.
- Shoot system is well organised. The stem is generally aerial, branched, straight, thick and hard.
- Leaves are thin, broad in middle, dark green and of variable shape and measurement.

◆ **Polar–Region Adaptations :** Polar regions are characterized by heavy and snowy winters. The plants found here are of short height. The animals seen here are white or light in colour. This enables them to match the colour of the background (camouflage) ; and also to regulate the temperature of the body (thermal regulation). The animals can store fat in their body in summers so that it can be consumed in winter months. During winter months, animals also hibernate. This reduces their metabolic activities to the minimum.

(c) Amphibious Animals :

There is yet another category of animals which live on land but they go to water for laying eggs or they live in water and come to land for reproduction. Their life-cycle is not completed in one habitat alone, **e.g.** in the life cycle of frog or toad water is essential to lay eggs and for the larvae (tadpoles) to develop. Similarly, the life cycle of mosquito requires both water and land. Such animals are known as amphibious animals (animals showing two modes of habitats). Their different stages show characteristics particular to the habitat in which they are found.

(d) Adaptations in Halophytic Plants :

The plants which grow in saline habitats are called halophytes.These habitats show the presence of high concentration of salts like NaCl, $MgCl_2$ and $MgSO_4$etc. High salt concentration changes the chemical properties of soil solution and the plants are unable to absorb the water. Thus, the habitat is physiologically dry. The littoral swamp forest is more common and extensive form of halophytic habitat occuring in all

tropical seas.The halophytes of the temperate regions are mostly herbs but in tropical and sub-tropical regions, the sea shore occupies a dense woodland of trees comprising of halophytes forming mangroove forests.The common species found in these forests are Avicennia, Rhizophora etc.

◆ **Characteristics of mangrooves :**

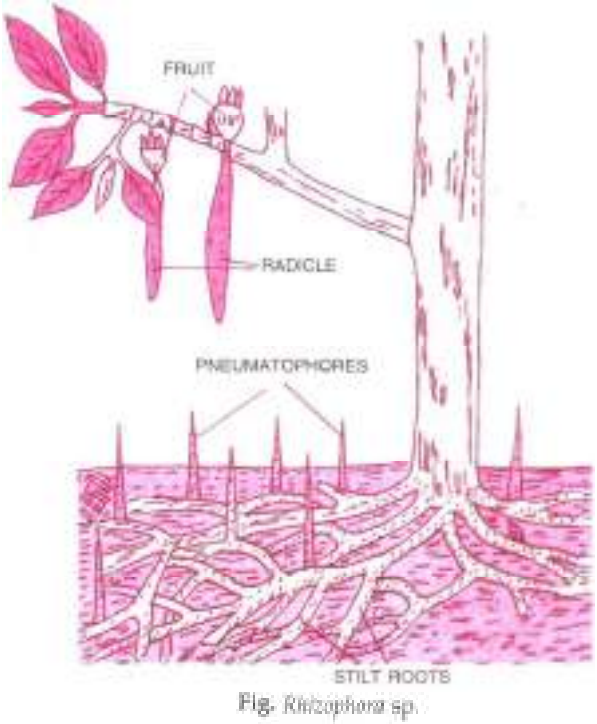


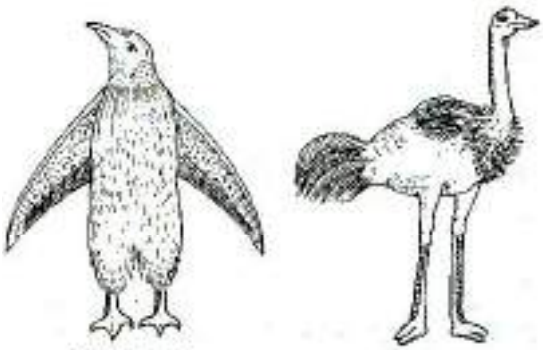
Fig. Rhizophora sp.

1. **Pneumatophores :** These are negatively geotropic lateral roots.They arise from the submerged horizontal roots. These roots are respiratory in function.They are provided with numerous pores or respiratory spaces in their upper part, through which exchange of gases takes place (Avicennia, Sonneratia).
2. **Vivipary :** It is a phenomenon shown by mangroove plants. The seed germinates inside the fruit while the latter is still on the parental tree and its nourished by it. The radicle elongates to a certain length and swells up at the lower end. The seedling at this stage separates from the parent plant and falls vertically down, in such a way that the radicle presses into the mud keeping the plumule and cotyledons above the saline water (Rhizophora).
3. **Succulency :** Most of the halophytes are succulent. They store water and mucilage. Leaves are highly cutinised and palisade tissue is well-developed. The other type of halophytes are found in salt deserts. These habitats possess sandy and heavy soils having excess of salts. Usually the plants are shallow rooted because the saline soils remain water-logged for most of the year and small amount of air is present in the upper portion only. In sandy soils, however, the root system is deep.The plants appear during rainy season when the salt concentration is relatively lower. Examples-Salsola.

(e) Adaptations in Birds :

Birds include a variety of forms which can be divided into the following two main groups :

(i) **Flightless birds :** These are usually large and have strong legs. They have reduced wings and curly feathers. **Ostrich** is a huge bird with only two toes in each foot. It is one of the fastest runner. On an average the ostrich weighs about 125 kg and its egg is the largest cell. **Emu** of Australia has three toes in each foot. **Penguins** have their wings modified into swimming paddles. They live in the cold sea water of southern pole. Most penguins do not build nests but incubate their eggs in fold of skin between their feet.


(a) Penguin (b) Ostrich

(ii) **Flying birds :** They are most of the modern birds and are found in all the parts of the world. These animals are adapted for the aerial mode of life. They have a streamlined body covered with feathers. Forelimbs are modified into wings. The bones are light, hollow, spongy and contain many air cavities. They have lungs for breathing. Nervous system and sense organs are well developed. Examples : bat, eagle, sparrow, penguin. Some common flying birds are pigeon, kite, cuckoo, house sparrow, crow, parrot, dove, sunbird, cattle egret, swifts, kingfisher, bulbul etc. The humming bird is the smallest flying bird.

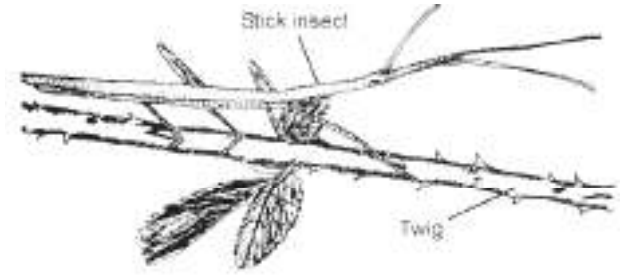
◆ **Some Important Points :**

- The vegetation growing in tundra and on the ice covered high hill tops is known as **cryophytes.**

(a) Cryophytes are generally grasses , herbs, mosses and lichens. Trees are almost absent.
(b) They reproduce during summer seasons only.

- **Oxylophytes** are plants growing on acidic soil.
- **Chasmophytes** are plants growing in rock crevices.
- **Hibernation (winter-sleep)** is the period of dormancy during winter.
- **Aestivation (summer sleep)** is the period of dormancy during summer months so as to escape from scorching heat of sun.
- Plants growing on burnt soil are called as **pyrophilous.**

- Plants growing on rocks are called as **lithophytes.**
- Plants growing in bright light are called sun plants or **heliophytes**, while plants growing in partial shade or low intensity light are called shade plants or **sciophytes**.
- **Camouflage** (Cryptic appearance) is the ability to blend with the surrounding or background. Examples of camouflage are Praying Mantis, Dead Leaf Butterfly etc.



Stick insect *Chitarchus hookeri* by its shape and colour as well as by its habit of remaining still, deceptively looks like a twig

- **Mimicry** is the resemblance of one species with another in order to obtain advantage, especially against predation. e.g. Several palatable butterfly mimic as non - palatable butterfly to fool their predators
- The animals living on trees are called **arboreal** e.g. Monkey.

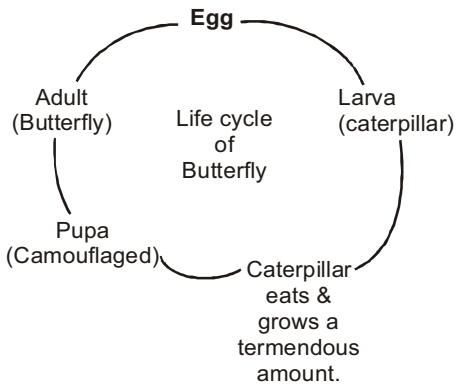
Knowledge Booster

Neoteny : An evolutionary trend to be born earlier so that development is cut off at an earlier stage and juvenile characteristics are retained in adults of the species. **e.g.**The adult axolotl, a salamander, retains larval external gills.

Larva :

- Larva may be given shelter from predators.
- Reduce competition for resources with the adult population.

Knowledge Booster



EXERCISE-1

Aquatic Adaptation in Plant

1. Which of the following statement is true about the habitat ?
(A) It is a place where conditions for the existence of an organism occur
(B) It includes both biotic and abiotic compounds
(C) It represents the address of an organism
(D) All are correct

2. Adaptations occur in nature due to
(A) conscious effort by an organism
(B) use and disuse of an organ
(C) changes that take place in the genes of reproductive units
(D) homeostasis

3. Oily covering and air spaces in leaves is an adaptation of
(A) aquatic plants (B) xeric plants
(C) mesophytic plants (D) none of these

4. The delicate, flexible and thin stem is the characteristic feature of
(A) mesophytes (B) hydrophytes
(C) halophytes (D) xerophytes

Aquatic Adaptation in Animal

5. Branchial respiration is found in
(A) terrestrial animals (B) aquatic animals
(C) aerial animals (D) arboreal animals

6. The organism that lives on land but requires aquatic habitat to lay eggs is
(A) Frog (B) Camel
(C) Hydra (D) Snake

Terrestrial Adaptations in Plant

7. Sunken stomata and reduced leaf is an adaptation of
(A) mesic plants (B) mesic animals
(C) xeric plants (D) aquatic plants

8. Phylloclade is a feature of
(A) Vallisneria (an aquatic plant)
(B) Maize (a terrestrial plant)
(C) Cactus (a xerophytic plant) (D)
Mango (a tall tree)

9. Viviparity is found in
(A) Hydrilla (B) Nerium
(C) Rhizophora (D) Aloe

10. Plants growing in oxygen deficient soil have
(A) no roots
(B) longer root system
(C) aerial root system
(D) shallow root system

11. Plants growing on burnt soil are called as
(A) heliophilous (B) hydrophilous
(C) pyrophilous (D) pyriform

12. The xerophytic plants do not have
(A) sunken stomata
(B) needle like leaves
(C) air cavities in stems
(D) very long roots

13. Xerophytes have long roots
(A) due to light
(B) to give mechanical support
(C) to draw water from deep water beds
(D) none of the above

14. Plants growing in saline water are called as
(A) mesophytes (B) halophytes
(C) xerophytes (D) hydrophytes

Terrestrial Adaptations in Animal

15. Winter sleep can also be called as
(A) hibernation (B) migration
(C) aestivation (D) none of these

16. Change in colour of some organisms according to the background, to protect themselves is called as
(A) mimicry (B) moulting
(C) camouflage (D) none of these

17. Camel is the best adapted to desert habitat as
(A) it can drink 50 liters of water at a time which is evenly distributed in all its tissues.
(B) it excretes very small amount of water during urination.
(C) it can regulate its body temperature at a wider range
(D) all are correct

Adaptation in Birds

18. Organisms that live on trees are called
(A) aerial (B) arboreal
(C) terrestrial (D) aquatic

19. In aerial animals the forelimbs are modified into
(A) wings (B) hind limbs
(C) body (D) air – chambers

EXERCISE-2

COMPETITIVE EXAM QUESTIONS

1. Sting of a honeybee represents modification of **(IJSO/Stage-1/2011)**
(A) Ovipositor
(B) abdominal bristles
(C) abdominal appendage
(D) Motion of a satellite around the earth

2. Lamina of a palm tree is dissected so as to adapt to **(IJSO-stage-I/2011)**
(A) intense light
(B) high wind velocity
(C) scarcity of moisture
(D) high temperature

3. Considering the root system, the plant that has adapted to the arid conditions is **(IJSO stage-I/2011)**
(A) hydrilla (B) sunflower
(C) hibiscus (D) khus

4. Mud flats with mangrove plants export a lot of organic matter to waters in contact. This is primarily because : **(IJSO/Stage-1/2012)**
(A) there are fewer consumers in mangrove community
(B) excreta of animals in mangrove community is richer in fibers
(C) detritivores are lacking in mangrove community
(D) aerobic decomposers cannot survive in water-logged mud

5. Neoteny or larva becoming large and developing into adult retaining larval features is common in amphibians since they are adapted to survive: **(IJSO/Stage-1/2012)**
(A) in fresh water bodies where temperature and/or iodine content is less
(B) on insecb that fail to supply enough nutrients
(C) on a high protein diet that induces early maturation
(D) in dark places and lack of light induces early sexual maturation

6. Sting of a honeybee represents modification of - **(IJSO stage-I/2012)**
(A) Ovipositor
(B) abdominal bristles
(C) abdominal appendage
(D) Motion of a satellite around the earth

7. On a field trip in North America, students noticed that when threatened, Horned lizards (Genus : phrynosoma) squirt blood at the attackers.When the professor asked what could have been the reason behind such behaviour of Horned lizards, one student said that certain sensory receptors had fired and triggered a neuronal reflex culminating in increasing the pressure in their sinus cavities until the blood vessels in the corners of the eyes burst. Another student said that it was just an act to frighten off the predator.Thus it can be said that
(IJSO/Stage-1/2013)
(A) The first response is correct, while the second is incorrect
(B) Both explanations are reasonable and can be scientifically tested.
(C) The first response is biological, while the second is philosophical.
(D) The first explanation is testable as a scientific hypothesis, while the second is not.

8. Axolotl, the Mexican salamander, show's 'neoteny' or larva becoming sexually mature (adult). Which of the following characters indicate larval features in it ?
(**IJSO/Stage-1/**2014)
i. Naked skin
ii. External gills
iii. Lidless eyes
iv. Laterally compressed tail
v. Clawless digits
(A) Only ii and iv (B) Only i, ii, iv and v
(C) only ii, iii, iv & v (D) i, ii, iii,iv and v

9. Snakes, the cold blooded animals, flick their bifid tounge often to :
(IJSO/Stage-1/2014)
(A) sense vibration in earth
(B) sample air for chemoreceptors
(C) sense the nature of substratum
(D) sense the temperature of air

10. The largest of the jelly-fishes grow over 1 meter in diameter and can survive without any skeletal support due to : (IJSO/Stage-1/2014)
(A) rapid beating of cilia creating an upthrust.
(B) the botton dwelling habit.
(C) upwelling currents in water
(D) high salinity and subsequent buoyancy of sea water

11. Most of the insects have egg, larva, pupa and adult stages in the life cycle. This is primarily due to ;
(IJSO/Stage-1/2014)
(A) relatively short adult phase
(B) terrestrial habitat they have adapted to
(C) flying mode of locomotion majority have
(D) eggs storing little reserved food.

12. Seema was observing cross section of an unknown plant material which as per her observation was a ' Submerged Hydrophyte". Which of the following features must have been observed by her to reach this conclusion ?
(IJSO/Stage-II/2016)
I. Water storage tissuesII. Large air spaces
III. Absence of vascular tissues
IV. Salt glands
V. Sunken stomata
VI. Thick cuticle.
(A) I, IV and V (B) III and V
(C) II and III (D) Only V

PROTOPLASM

INTRODUCTION

All the living organisms are essentially formed of numerous coordinated compartments called as cell. Every cell basically formed of two functional regions that is plasma membrane and protoplasm.The ground substance of protoplasm, after removing nucleus, all the cell organelles and cell inclusions, is called hyaloplasm / cytoplasm. It consist of high water contents containing various compounds of biological importance, some of which are soluble in water e.g. glucose, amino acids, minerals etc. while some of these are insoluble in water e.g. lipids.

PROPERTIES OF PROTOPLASM

◆ **Physical Properties :**

(i) Protoplasm is a polyphasic colloidal system.

(II) Its specific gravity is slightly above that of water.

(III) Its viscosity has been found to be like that of glycerin.

(Iv) It has power of responding to external stimuli, like heat, electric shocks, application of chemicals etc.This property of protoplasm is called **Irritability.**

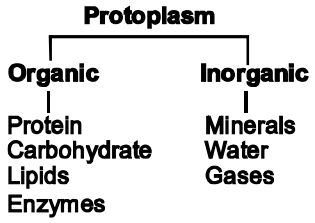
(v) It exhibits streaming movement e.g. rotatory movements in the leaves of aquatic plants like Hydrilla and Vallisneria.

(vi) Amoeboid movement of the protoplasm can also be noticed in myxomycetes and Amoeba.

(vii) In general, the pH of cytoplasm is slightly acidic i.e. 6.8, however pH of the nucleoplasm is 7.6 to 7.8.

◆ **Chemical Properties :** The collection of various types of biomolecules of a cell collectively form **cellular pool.** Elements do not occur in free form but combines to form organic molecules and inorganic molecules. Organic and inorganic compounds occur in a ratio of 9 : 1. Cellular pool is mainly constituted by :

- Inorganic materials include salts, minerals and water. These materials generally occur in aqueous phase which contains molecules and ions dissolved in water.
- Organic compounds as carbohydrates, lipids, amino acids, proteins, nucleic acids and vitamins. These molecules usually occur in aqueous and non–aqueous phase.



(a) Inorganic Compounds :

◆ The inorganic substances include salts, minerals and water.

(A) Minerals: These occur in ionic state and form only 1-3 % of cellular pool. Cellular functions fail to occur in the absence of proper ionic balance in the cell cytoplasm and extracellular fluid.

- A compound which releases H^+ ion when dissolved in water is called as an acid, e.g., HCl, H_2SO_4 etc. and base releases OH^- ion, e.g., NaOH, KOH etc.
- Salt is a compound formed, when an acid and a base react with each other.
- A cell has many salts of Na^+, K^+, Ca^{++} and Cl^-, HCO_3^-, PO_4^{-3} etc.
- A large amount of minerals also occur as hard deposits as crystals within the cell.
- The salt concentration in cells and in body fluids is of great importance for normal cell functioning.

(B) Gases: Oxygen, carbon dioxide , nitrogen and other gases are also present in protoplasm.

(C) Water : Water is not an organic molecule because it does not contain carbon. The bonding properties of water account for some of its characteristics, which are very important to living organisms.

(i) Water is the main component of cell contents and body fluid.

(ii) It is neutral with pH 7. It ionises to H^+ and OH^- ion. Phospholipids, nucleic acids and proteins by accepting or donating H^+ ions from water contain specific ionic state.

(iii) It forms an average 55 to 60% of living material.

(iv) Water dissolves more substances in it than any other liquid due to it's highest known **dielectric constant** (the measure of capacity to neutralize the attraction between electric charges).Only polar molecules dissolve in water.

(v) It is generally non toxic to the cell. Colloids like starch, glycogen and protein remain dispersed in water in cell cytoplasm.

(vi) It is a medium of heat exchange and transfer.

(vii) It participates in chemical reactions both as a reactant and a product. It forms an ideal medium for chemical reactions, because dissolved molecules can make intimate contact.

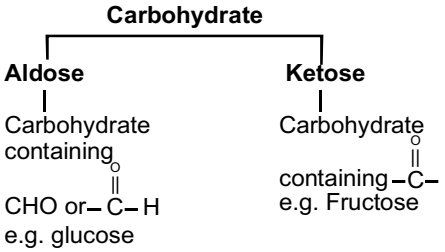
(viii) It acts as a lubricating and protective fluid.

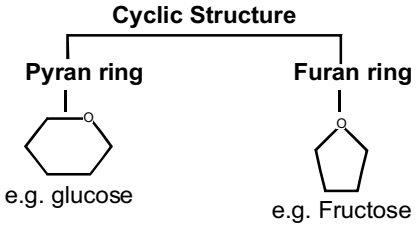
(b) Organic Compounds :

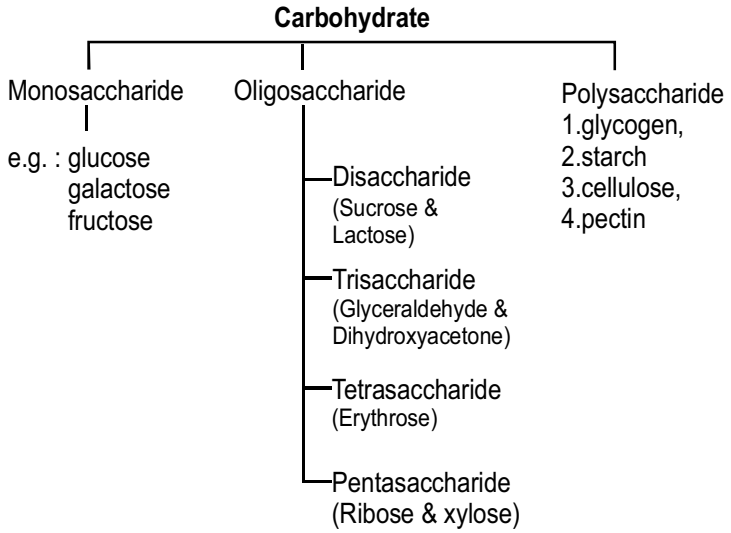
A large series of covalent compounds are formed with the help of carbon, hydrogen and some other elements. These are called as organic compounds. Their special properties distinguish them from inorganic compounds found in living bodies.

(i) Carbohydrates :

- Carbohydrates can be chiefly composed of carbon, hydrogen and oxygen. In this hydrogen and oxygen atoms are present in a ratio of 2 : 1. As in carbohydrates hydrogen and oxygen are present therefore these are also termed as **hydrates of carbon.**
- Carbohydrates have general formula as $\mathbf{C_n H_{2n} O_n}$.
- Carbohydrates are widely distributed in plant tissues and in animal tissues. In animals they are in the form of glucose and glycogen. In plants they are in the form of cellulose and starch.
- One gram of carbohydrate yields about 4 kilocalories of energy.
- Carbohydrates can be defined chemically as aldehyde or ketone derivatives or the poly hydric (more than one – OH group) alcohol and their derivatives.



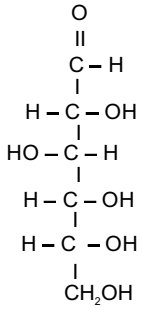




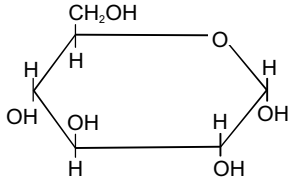
(A) Monosaccharides : These sugars cannot be hydrolyzed into simpler forms. They have the general formula $\mathbf{C_n H_{2n} O_n}$. The simplest types of **monosaccharides** are **glyceraldehyde and dihydroxyacetone.** Depending upon the number of carbon atoms present, these can be further subdivided into trioses (**e.g. Glyceraldehyde**), tetrose (**e.g. Erythrose**), pentoses (**e.g. Ribose, Deoxyribose**) etc. Generally if free –H is present at carbon 1 the sugar is an **aldose** but if a CH_2OH group is substituted, the sugar is a **ketose.** They have reducing property due to the presence of aldehyde or ketone group present in them. Some examples are as follows :

- **Glucose :** It is a hexose. It 's formula is $C_6 H_{12} O_6$ .It is normally found in fruit juice and formed in the body by the hydrolysis of starch, cane sugar, maltose and lactose. Glucose is said to be the sugar of the body. It is a principal sugar in blood, serving the tissue as a major metabolic fuel. Normal level of blood glucose is 80 –120 mg / 100 ml of blood. When the blood sugar level exceeds the threshold value i.e. 180 mg / 100 ml, glucose begins to appear in the urine. This condition is called as **glycosuria.**

Structure of glucose



Glucose simple chain



Ring structure of glucose

- **Note :** The simple ring structure of glucose is given by **Haworth**.
- **Fructose :** Fructose or fruit sugar is also known as **levulose.** Similar to glucose it is a ketohexose and less readily absorbed by tissue cells. It is obtained by the hydrolysis of cane sugar.
- **Galactose :** It is found in milk sugar or lactose along with glucose. It is synthesized in the mammary glands and combines with glucose to make the lactose of milk. In the liver it can be changed to glucose and thus used in the body. It is a part of glycolipids and glycoproteins.

(B) Disaccharides : The disaccharides are sugars composed of two molecules of the same or different monosaccharides, united by a **glycosidic linkage.** They have a general formula $C_n (H_2O)_{n-1}$. These include maltose, lactose , sucrose.

- **Maltose:** They consist of two glucose residues. It's occurrence have been reported in germinating cereals and malt. It is the major product of enzymatic hydrolysis of starch.
- **Lactose:** It is found in milk to the extent of about 5%. Upon hydrolysis it yields a mixture of galactose and glucose.
- **Sucrose :** A single molecule of sucrose consists of one glucose and one fructose molecule. It is the common sugar of commerce and the kitchen. It is derived commercially from either cane sugar or occurs in varying amount in a variety of fruits, seeds, leaves , flowers, roots and in maple sugar.
- On hydrolysis it yields an equimolar mixture of glucose and fructose.

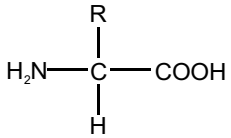
(C) Polysaccharides : Polysaccharides (**Glycans**) are those which yield more than six molecules of monosaccharides on hydrolysis. It's general formulae is $(C_6 H_{10} O_5)_n$. It's examples are as follows :

- **Cellulose :** It is the chief constituent of the frame work of plants, constituting 50% or more of all carbon in vegetation. It is a linear and unbranched homopolysaccharide of about 6000 to 10,000 β- D Glucose molecules.
- Mammals do not have **cellulase** enzyme and therefore cannot digest wood & vegetable fibers.
- Purest form of cellulose is found in cotton which is about 90%.
- **Starch :** It is the most important food source of carbohydrates and is found in cereals, potatoes, legumes and other vegetables. Chemically, the starch is formed of two glucose polymers : **α-Amylose** (an unbranched but spiral chain of about 200-2000 α-Glucose molecules) and **Amylopectin** (a branched chain of about 2000-20,000 α-Glucose molecules.). Natural starch is insoluble in water and gives a blue colour with iodine solution. Branching starts from **25 number of glucose.**
- **Glycogen :** The counterpart of starch in the animal body is glycogen thats why it is also called as animal starch, which occurs in significant amount in liver and muscles. Glycogen is non – reducing sugar which gives red colour with iodine. It is a branched homopolysaccharide formed of about 30,000 α-D-Glucose molecules. Branching starts from **9 to 12 number of glucose.**
- **Note : Glycosidic linkage:** The linkage between the hydroxyl groups of two monosaccharide molecules with the release of one molecule of water.

◆ **Biological significance of carbohydrates :**

- Carbohydrates serve as an important structural material in some animals and in all plants, where they constitute the cellulose framework.
- Carbohydrates are essential for life. Almost all animals use them as respiratory fuel. In animal cells, carbohydrates are in the form of glucose and glycogen, which serve as an important source of energy for the vital activities.
- Carbohydrates play a key role in the metabolism of amino acids and fatty acids.
- Some carbohydrates have highly specific functions **e.g. ribose** in the nucleoprotein of the cells, **galactose** in certain lipids and the **lactose** of milk.

(ii) Protein : The name protein is derived from the **Greek word proteios,** which means**"Of the first rank".** This was coined by **Berzelius** in 1838. Proteins are the complex nitrogenous substances found in the cells of animals and plants. Chemically proteins are polymers of molecular units called as **amino acids.** These polymers contain carbon, oxygen, nitrogen and hydrogen atoms. Usually sulphur atoms are also present .Certain proteins contain phosphorus or some trace metal elements, such as copper, iron etc. in addition to the other elements. The proteins have high molecular weight. One gram of protein yields 4 kcal of energy. The amino acids found in a molecule of protein are linked together by **peptide bonds.** The general structure of a amino acid is represented by the following formula :

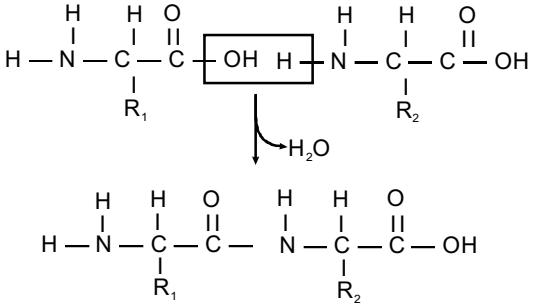


The **R group** is variable in different amino acids. Amino acids can react with acid and base both, this is due to the presence of carboxyl and amino groups in them. There are about 20 amino acids that take part in the formation of proteins. Amino acids also show **zwitter** ion effect. The 20 amino acids are further divided into three groups :

- **Essential amino acids :** They are 8 in number. They are not synthesized in a human body and are obtained from food etc. are called as essential amino acids.
- **Non – essential amino acids :** They are 10 in number. They are synthesized in a human body and are termed as non – essential amino acids.
- **Semi–essential amino acids :** They are two in number and needed by growing children and lactating and pregnant women.

ESSENTIAL AMINO ACIDS	NON-ESSENTIAL AMINO ACIDS	SEMI-ESSENTIAL AMINO ACIDS
Isoleucine	Alanine	Arginine
Leucine	Aspargine	Histidine
Methionine	Aspartic acid	–
Phenylalanine	Cysteine	–
Threonine	Glutamic acid	–
Tryptophan	Glutamine	–
Valine	Glycine	–
Lysine	Proline	–
–	Serine	–
–	Tyrosine	–

- **Note : Peptide bond :** Polypeptide and simple protein consist entirely of long chain of amino acids linked together by peptide bonds formed between the carboxyl group of one amino acid and the amino group of other amino acid. A molecule of water is released out during bond formation.



Peptide bond formation

◆ **Biological significance of proteins :**

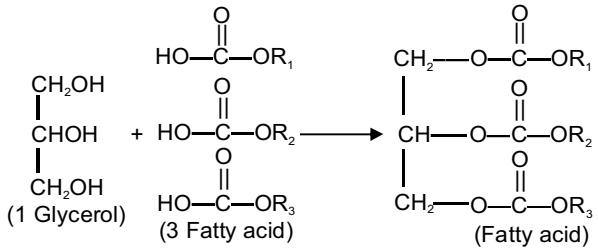
- They act as a structural components of cell. They are essential for growth and repair of the body.
- All the enzymes are made up of proteins. They help to catalyze various reactions occurring in our body.
- They play important roles as hormones, antibodies, etc.
- Haemoglobin , the respiratory pigment of animals is a conjugated protein composed of colourless basic protein the **globin** and **haem.**
- **Glycine** is **simplest** amino acid.
- **Arginine** is used to form **urea** in liver.
- **Arginine** and **lysine** is present in **histone** protein.
- **RuBisCO** is abundant protein among biosphere.
- **Collagen** is abundant protein among animals.

(iii) Lipid : Term lipid was coined by **Bloor**. Fats and their derivatives are collectively known as lipids (**In greek Lipos = fat**). The principal component associated with most lipids are the **fatty acids**. The lipids are a heterogenous groups of substances which have the common property of being relatively insoluble in water and soluble in non – polar solvents such as **ether**, **chloroform** and **benzene.** They consist of comparatively less oxygen. One gram of fat yields **9 kilocalories** of energy. Similar or different fatty acids participate in the composition of a fat molecule. The lipids include fats, oils, ghee, waxes and related compounds.

Fatty acid

Saturated f.a (fatty acid containing single bond) **e.g.** ghee

Unsaturated f.a (fatty acid containing double bond) **e.g.** oil.



- **Note :** Lipids generally consist of a **single molecule of glycerol** and **three molecules of fatty acids** joined together by **ester bonds.** Therefore these are also termed as **triglycerides.** Three molecules of water are released during the formation of triglycerides.

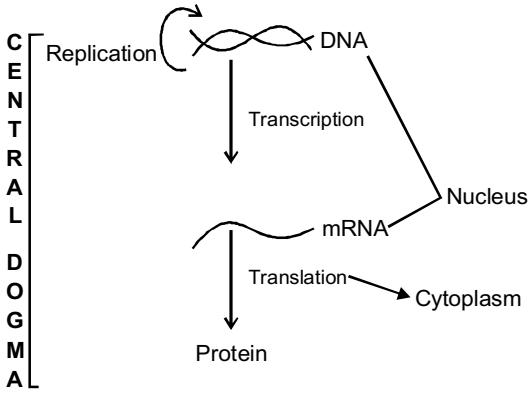
◆ **Biological significance of lipids :**

- They takes part in the synthesis of steroids, hormones, vitamin D, bile salts etc.
- They act as a solvent for fat soluble vitamins i.e. vitamin A , D, E and K.
- They act as storage compounds in animals, in the fruits and seeds of plants and in other organism.
- They act as structural cellular components particularly in cell membranes. They are found in the form of **phospholipids, glycolipids** and **sterols**.
- They act as **insulators.** They provide electrical and thermal insulation. They are deposited beneath the skin and other internal organs to reduce the heat loss. They also work as shock absorbers and other mechanical impacts.
- Our body require ω^3 **fatty acid** which is mostly found in **Cod liver oil** of fish and unsaturated fatty acid are healthy for us.
- **Brown fat** act as **insulator** of heat in polar bear which help them to survive in colder region.

(iv) Nucleic acids : These are the hereditary materials of living organisms. There are two types of nucleic acids :

Nucleotide = sugar + N_2 base + PO_4^{3-}

Nucleoside = sugar + N_2 base



(A) DNA (Deoxyribose nucleic acids) : DNA is coiled macromolecule made of two antiparallel chains held together by hydrogen bonds. DNA has diameter of 20 Å. One turn of spiral has a distance of 34 Å and distance between two adjacent nucleotides is 3.4 Å.

- **Nucleotides :** A single nucleotide consist of following parts :
- **Pentose sugar :** It is a 5 - carbon containing sugar which is ribose is RNA and deoxyribose in DNA.
- **Nitrogen bases :** There are two types of purines which include adenine (A), and guanine (G) and pyrimidines which include thymine (T), uracil (U) and cytosine (C). In DNA adenine, thymine, guanine and cytosine present while in RNA uracil is present in place of thymine.
- **Phosphate group :** PO_4^{-3} group in the form of H_3PO_4

(B) RNA : (Ribonucleic acid) Structure of RNA is fundamentally the same as DNA but there are some differences. The differences are as follows.

- In place of deoxyribose sugar of DNA, there is a presence of ribose sugar in RNA.
- In place of nitrogen base, **thymine** present in DNA there is a nitrogen base **uracil** in RNA.
- RNA is made up of only one polynucleotide chain i.e. RNA is single stranded.
- In RNA, polynucleotide chain runs in 3' $\rightarrow$ 5' direction.
- **Exception :** RNA found in Reo–virus is double stranded i.e. it has two polynucleotide chains.
- **Types of RNA-** A cell contains three types of RNA :

1. **Ribosomal RNA (r – RNA) :** This RNA is 80% of the cell's total RNA. It is the most stable form of RNA. It is found in ribosomes and it is produced in nucleolus. They are present as 80 – S type of ribosome in eukaryotic cells and 70 – S type of ribosome in prokaryotic cells. It is the site of protein synthesis.

2. **Transfer RNA (t – RNA) :**

- It is 10 – 15% of total RNA
- It is synthesized in the nucleus by DNA.
- It is also known as soluble RNA.
- It is also known as adapter RNA.
- It is the **smallest RNA**. At the time of protein synthesis it acts as a carrier of amino acids.
- It has the most complex structure.

3. **Messenger RNA (m – RNA) :** The m – RNA is 1 – 5 % of the cells total RNA. The m – RNA is produced by genetic DNA in the nucleus. This process is called as **transcription,** m – RNA is also called as **template RNA.** It acts as the template for protein synthesis.

(v) Enzymes : Enzymes are protein catalysts for biochemical reactions in the living cells. **The** substance which increases reaction rate is called as **catalyst** and the phenomenon is called as **catalysis.** The term enzyme is derived from **Greek word** which means **'in yeast'** because the yeast cells were the first to reveal enzyme activity in living organisms. Enzyme was first introduced by **W. Kuhne in 1878. Berzelius** was the first to define and recognize the nature of catalyst. In **1926 J.B Sumner** isolated the enzyme **urease** as a crystalline protein for the first time. Enzymes could be intracellular and extracellular enzymes**.** When the enzymes remain and function inside the cells, they are called as **endoenzymes** or **intracellular enzymes.** The enzymes which leave the cell and function outside the cell are called **extra cellular enzymes.**

- During **evolution tRNA** acts as enzyme , so if RNA used as enzymes called **ribozyme** and for this reason that world is called **RNA world**.

◆ **General properties of enzymes :**

- They remain unaltered at the end.
- They are required in small quantities.
- They accelerate the rate of reaction.
- They are proteinaceous in nature.
- Enzymes are highly specific towards substrate.
- Certain enzymes exhibit the property of reversibility.

(vi) Pigments : The coloured substance found in the living being is called as pigment. The beauty of nature is due to animals, birds and flowers having different pigments. The living beings depend on sun for energy. The green pigment in nature is called as **chlorophyll**, can only store light energy obtained from the sun, in the form of chemical energy. Thus, chlorophyll is the **nutritional basis of life** on earth. The colour of our skin is due to the pigment **melanin**. **Haemoglobin** and **haemocyanin** pigments play an important role in transportation of oxygen in the body of living beings. Pigments belong to the group **carotenoid** are found in both plants and animals.

BIOCHEMICAL REACTIONS

The reactions undergoing inside a living cell to sustain life are called as biochemical reactions. The biological system can't use heat liberated in biological reactions

directly as they are isothermic so the biological systems use chemical energy (ATP) to perform various living processes. Biochemical reactions are **catabolic** (**breakdown/exergonic reactions**) and **anabolic** (**synthetic reactions**), collectively they are called as **metabolic reactions**.

EXERCISE-1

Protoplasm

1. Term protoplasm was introduced by
(A) Purkinje (B) Schultze
(C) Sutton and Boveri (D) Van Mohl

Carbohydrates

2. Which of the following is a disaccharide ?
(A) Galactose (B) Fructose
(C) Maltose (D) Dextrin

3. Which of the following is not a carbohydrate ?
(A) Starch (B) Glycogen
(C) Wax (D) Glucose

4. To get quick energy one should use
(A) carbohydrates (B) fats
(C) vitamins (D) proteins

5. Which is not a polysaccharide ?
(A) Sucrose (B) Starch
(C) Glycogen (D) Cellulose

6. Which of the following is a monosaccharide ?
(A) pentose sugar (B) hexose sugar
(C) glucose (D) all of the above

7. Glycogen is a / an
(A) polymer of amino acids
(B) polymer of fatty acids
(C) unsaturated fat
(D) polymer of glucose units

8. In which form, food stored in animal body ?
(A) Glucose (B) Glycogen
(C) Cellulose (D) ATP

9. Sucrose is composed of
(A) glucose & fructose
(B) glucose & glycogen
(C) two molecules of glucose
(D) glycogen & fructose

Proteins

10. The most abundant protein in human body is
(A) collagen (B) myosin
(C) actin (D) albumin

11. Which amino acid is non essential for a human body ?
(A) Glycine (B) Phenylalanine
(C) Arginine (D) Methionine

12. Which of the following nitrogen base is not found in DNA ?
(A) Thymine (B) Cytosine
(C) Guanine (D) Uracil

13. Maximum amount of calories comes from **(CE VIII)**
(A) carbohydrates (B) fats
(C) proteins (D) vitamins

14. The amino acids which are not synthesized in the body are called as
(A) non–essential (B) essential
(C) deaminated (D) all of them are correct

15. Proteins are the polymers of
(A) amino acids (B) natural protein
(C) enzymes (D) nucleic acids

Lipids

16. Long chain molecules of fatty acids are obtained by
(A) polymerisation of two carbon compounds
(B) decomposition of fats
(C) polymerisation of glycogen
(D) conversion of glycogen

17. Fats in the body are formed when
(A) glycogen is formed from glucose
(B) sugar level becomes stable in blood
(C) extra glycogen storage in liver and muscles is stopped
(D) all of the above

Nucleic acid

18. Nucleic acids are made up of
(A) amino acids (B) pentose sugars
(C) nucleosides (D) nucleotides

19. Circular and double stranded DNA occurs in
(A) golgi body (B) mitochondria
(C) nucleus (D) cytoplasm

20. The process of m-RNA synthesis on a DNA template is known as
(A) translation (B) transcription
(C) transduction (D) transformation

21. Double helix model of DNA was proposed by
(A) Watson and Crick
(B) Schleiden and Schwann
(C) Singer and Nicholson
(D) Kornberg and Khurana

22. Which element is not found in nitrogen base ?
(A) Nitrogen (B) Hydrogen
(C) Carbon (D) Phosphorous

23. DNA polymerase is needed for
(A) replication of DNA (B) synthesis of DNA
(C) elongation of DNA (D) all of the above

24. Duplication of DNA is called as
(A) replication (B) transduction
(C) transcription (D) translation

25. Ligase enzyme is used for
(A) denaturation of DNA
(B) splitting of DNA into small fragments
(C) joining fragments of DNA
(D) digestion of lipids

26. Similarity in DNA and RNA is
(A) both are polymers of nucleotides
(B) both have similar pyrimidine
(C) both have similar sugar
(D) None of the above

27. In which stage of cell cycle, DNA replication occurs
(A) G_1–phase (B) S – Phase
(C) G_2 – phase (D) M – phase

Vitamins

28. Orange juice contains plenty of
(A) vitamin C (B) vitamin A
(C) vitamin D (D) vitamin E

Enzymes

29. Chemically enzymes are
(A) fats (B) carbohydrates
(C) hydrocarbons (D) proteins

EXERCISE-2

COMPETITIVE EXAM QUESTIONS

1. Bacteria cannot survive in a highly salted pickle because
(IJSO/Stage-1/2011)
(A) they become plasmolysed and consequently die.
(B) they do anaerobic respiration.
(C) water is not available to them.
(D) of all the reasons mentioned above.

2. Maximum vitamin A content is likely to be found in the extract of
(IJSO/Stage-1/2011)
(A) sprout of pulse (B) cod liver
(C) white muscles (D) rose petals

3. The ointment prescribed for burns usually contains, among other ingredients,
(IJSO/Stage-1/2011)
(A) vitamin A (B) vitamin B
(C) vitamin D (D) vitamin E

4. Unsaturated fatty acids contain
(IJSO/Stage-1/2012)
(A) atleast one double bond
(B) two double bonds
(C) more than two double bonds
(D) no double bond

5. When the pH of the environment of a protein is changed, it is said to be denatured. This is due to
(IJSO/Stage-1/2013)
(A) breakage of peptide bonds
(B) breakage of disulfide links
(C) loss of tertiary structure
(D) breakdown of R groups

6. Identify the correct order of sequence from exterior to interior.
(IJSO/Stage-1/2013)
(A) Cell → Nucleus → Chromosome →DNA →Protein
(B) Nucleus → Cell → Chromosome → DNA → Protein
(C) Cell → Nucleus → DNA → Chromosomes → Protein
(D) Cell → Nucleus → Protein → DNA → Chromosome

7. Which of the following sugars tastes most sweet ?
(IJSO/Stage-1/2014)
(A) Ribose (B) Fructose
(C) Sucrose (D) Lactose

8. In an mRNA the codons are read linearly and each codon consists of three consecutive nucleotides which codes for one amino acid. During a deletion mutation, a deletion of three consecutive bases in the coding region of a gene cannot result in one of the following.
(IJSO/Stage-2/2014)
(A) Deletion of a single amino acid without any other change in the protein.
(B) Replacement of two adjacent amino acids by a single amino acid.
(C) Replacement of a single amino acid by another without any other change in sequence of the protein.
(D) Production of a truncated (shorter) protein.

9. A short length linear DNA molecule has 110 thymine and 110 guanine bases. The total number of nucleotide in the DNA fragment will be :
(IJSO/Stage-2/2014)
(A) 110 (B) 880
(C) 440 (D) 220

10. T.H. Morgan discovered that all the genes in Drosophila are linked to four pairs of linkage groups which correspond to 4 pairs of chromosomes. Sometimes, the linkage of some genes, present at some specific distance, is broken and they show independent assortment. The most possible reason for braek in the concept of linkage would be :
(IJSO/Stage-2/2014)
(A) Transposition
(B) Recombination
(C) Translocation
(D) Sister-chromatid exchange

11. The following technique that can be used for deciphering the arrangement of nucleotides in genes.
(IJSO/Stage-2/2015)
(A) karyotyping
(B) nucleic acid sequencing
(C) DNA finger printing
(D) transcription

12. In biology, Polymerase Chain Reaction (PCR) refers to which of the following option ?
(IJSO/Stage-2/2015)
(A) In vitro multiplication of nucleic acids molecules.
(B) In vivo multiplication of nucleic acids molecules.
(C) Continuous protein synthesis from peptide.
(D) Synthesis of mRNA from DNA in vitro.

13. Each chromosome contains
(IJSO/Stage-2/2015)
(A) one long DNA molecule
(B) one long RNA molecule
(C) one long sequence of amino acids
(D) a single gene for a protein

14. If DNA was made of 6 nucleotides instead of 4, what are the total number of triplet codons possible ?
(IJSO/Stage-2/2016)
(A) 24 (B) 18 (C) 64 (D) 216

NUTRITION

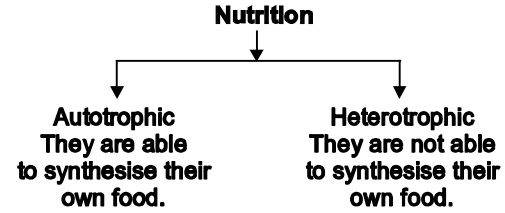
NUTRITION

"Nutrition" is a process of intake as well as utilization of nutrients by an organism. It also includes breakdown of nutrients into smaller molecules and their absorption. Food provides us nutrition and energy. It contains different types of nutrients in varying amounts according to the need of our body.

- **Nutrients : These are the substances required by our body for its growth, repair, work and maintenance. Different types of nutrients are carbohydrates, fats, proteins, vitamins, minerals etc. Our daily energy need may vary according to our occupation, age, sex and under some specific conditions.**

MODES OF NUTRITION

There are several modes of nutrition on the basis of which organisms are classified as follows :



(a) Autotrophic :

(Auto = self, trophic = food) It is a mode of nutrition in which organisms prepare their own food. Inorganic molecules like CO_2 and H_2O are converted into organic molecules like carbohydrates in the presence of sunlight and chlorophyll. **e.g. Green plants**. Autotrophs are further categorized as :

(i) **Photoautotrophs :** Those which utilize sunlight for preparing their food **e.g. green plants.**

(ii) **Chemoautotrophs :** Those which utilize chemical energy for preparing their food. e.g**. Purple sulphur bacteria.**

(b) Heterotrophic :

(Hetero = different ; trophic = food) It is a mode of nutrition in which organisms derive their food from some other animals or plants. They cannot prepare their own food **e.g. Human being**, animals.

- **On the Basis of Mode of Feeding Heterotrophs are Categorised as :**

(i) **Holozoic :** It is a mode of nutrition in which ingestion,digestion,absoption & assimilation takes place inside the body. **e.g. Amoeba , Human** etc.

(ii) **Saprotrophic :** They absorb organic matter from dead and decaying organisms with the help of their enzymes. **e.g., Bacteria , Fungi** etc.

(iii) **Parasitic :** They derive/absorb their nutrition from other living plants or animals. e.g**. Plasmodium, Round worm** etc.

NUTRITION IN PLANTS

- Plants are photoautotrophic in nature. They prepare their own food hence they are called as **producers**.
- They contain a green pigment called chlorophyll which entrap solar energy which is then converted into chemical energy which is utilized in preparation of food and the process is called as **"Photosynthesis".**

(a) Photosynthesis :

(i) **Definition :** The synthesis of organic compounds like glucose from simple inorganic molecules like CO_2 & H_2O by the cells of green plants having chlorophyll in the presence of sunlight is called as photosynthesis.

(ii) **Equation of photosynthesis :**

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

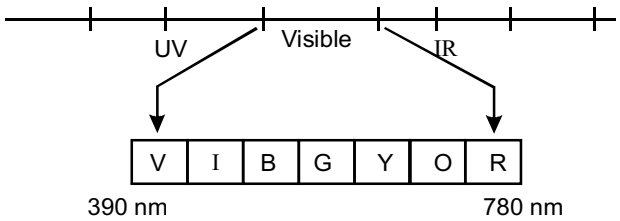
(iii) Steps of photosynthesis : Photosynthesis is a two step process.

(A) Light reaction **(B) Dark reaction**

(b) Essentials of photosynthesis :

(A) Sunlight : For plants sun is the basic source of radiant energy.

- Plants utilize the light in the visible region of solar spectra (electromagnetic spectrum) which comes under the range of 400 nm – 700 nm wavelength.
- Visible region consists of white light which is a mixture of 7 lights of different wavelengths.
- Maximum photosynthesis occurs in **red region**
- There is minimum photosynthesis in green region because green parts of plants reflect almost whole of the green light.



(B) Chlorophyll : These are the green pigments present in chloroplast. They are found in green leaves in the maximum amount as well as in other green aerial parts of plant. There are six different types of chlorophyll :chl a, b, c , d, e and bacteriochlorophyll. Amongst them chlorophyll a and chlorophyll b are the most commonly occurring chlorophyll.

Chlorophyll 'a' $\Rightarrow C_{55}H_{72}O_5N_4Mg$

Chlorophyll 'b' $\Rightarrow C_{55}H_{70}O_6N_4Mg$

- Besides chlorophyll certain other/ accessory pigments are also present in plants like :

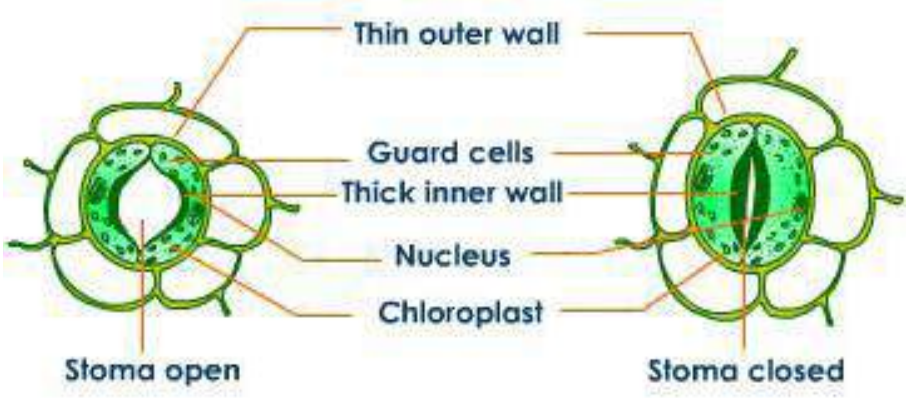
(i) **Carotenes** : Orange in colour **e.g. Carrot.**

(ii) **Xanthophylls** : Orange yellow in colour **e.g. Maize.**

(iii) **Phycobilins** : Different colours like red,violet **e.g. Blue-green algae, red algae** etc.

(c) Raw Materials of Photosynthesis :

(A) **Carbondioxide :** Terrestrial plants obtain carbon dioxide from the atmosphere through the small openings present on leaves called as stomata. **'Stomata'** are the small pores present on the surface of leaves.



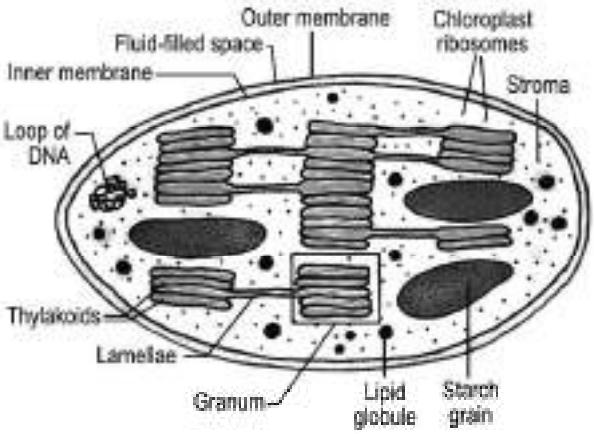
They help in exchange of gases and transpiration. Stomatal opening is guarded by the presence of guard cells (kidney shaped). Aquatic plants obtain CO_2 dissolved in water through their general body surface so they perform more photosynthesis than terrestrial plants.

(B) **Water :** Plants roots absorb water from the soil by the process of osmosis (endosmosis). This water is transported to leaves by a special type of tissue called as **xylem.**

- Plants utilize carbon dioxide during photosynthesis and release it during respiration and both processes occur simultaneously. The intensity of light at which amount of CO_2 used during photosynthesis becomes equal to the amount of CO_2 released during respiration by plants is called as **Compensation point.**
- Compensation point occurs at low light intensity that is during early morning and during evening hours.

(d) Site of Photosynthesis :

- Site of photosynthesis is different in prokaryotes and eukaryotes.
- **In prokaryotes :** Photosynthesis occurs in lamellar chromatophores.
- **In eukaryotes :** Photosynthesis occurs in chloroplast
- **Chloroplast :** Contain green pigment, called as chlorophyll.
- Chloroplast was discovered by **Schimper.**
- Number of chloroplasts is variable in different species of plants.
- In lower plants like algae they are 1 or 2 in number.
- In higher plants their number varies from 40 – 100 or more per palisade cell.



Internal structure of chloroplast

- Chloroplast also have variable shapes, for example in algae cup shaped, ribbon shaped etc. While it is discoidal in higher plants.
- **Structure of chloroplast** :

(a) (Chloro-glass greeen; plaslose moulded) are green plastid which help in synthesis of organic food.

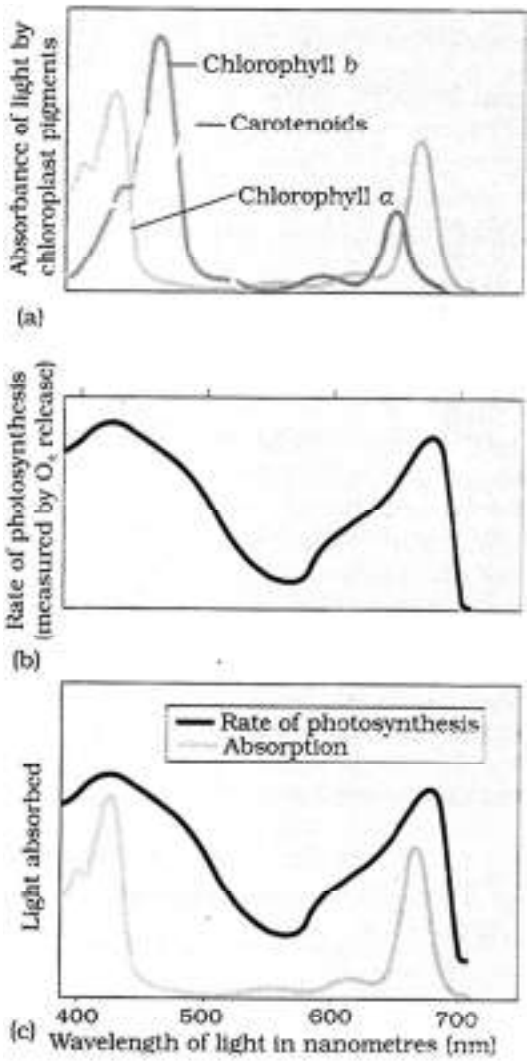
(b) They are distributed uniformly in the cytoplasm of plast cell. They are well developed in all the green plants.

(c) In green cell of higher plants the size of discoid chloroplast ranges from 4-10 µm in length and 2-4 µm in breath.

A chloroplast consist of proteins 50-60%, lipids -25-30%, chlorophyll 5-10%, carotenoids and other pigment 1-2%, RNA-2-3%, DNA upto 0.5%, vitamin and certain metal ion in traces.

- **Electron microscopic structure of chloroplast :** Chloroplast is covered by a double membranous structure called chloroplast envelop. The space separating the two membranous about 100-200Å thick.

- **Stroma** : Protein aqueous matrix in the chloroplast is the matrix or stroma. It is colloidal and contain many enzymes, DNA, RNA & 70s ribosome. It is site for dark reaction.
- **Grana** : Lameller like structure found in stack of 2-100 thylakoids laid in piles one on top of another. The main function of thylakoids is to perform the light reaction.
- **Nature of Light :** Action & Absorption spectrum
- **Absorption Spectrum :** The curve representing the pigment is called absorption spectrum.
- **Action spectrum :** Curve showing rate of photosynthesis at different wavelength of light is called action spectrum.



- **Photosynthetically active radiation (PAR) :** Spectrum between 400 nm and 700 nm is called photosynthetically active radiation (PAR).
- **Steps of photosynthesis** : Photosynthesis occurs in following 2 phases :

(a) Light reaction : (Photochemical phase)

(b) Dark reaction : (Calvin cycle)

DIFFERENCE BETWEEN LIGHT & DARK REACTION		
S.NO.	**Light reaction**	**Dark reaction**
1.	Complete in thylakoid	Complete in stroma
2.	Light energy is trapped by chlorophyll to make ATP & $NADPH_2$	utilize the assimilatory power to fix the CO_2

- **Photosystems and light Harvesting complex :**
- **Pigment system** : Photochemical process are believed to be associated with two different specific group of pigments. It is of 2 type PS-I & PS-II
- **PSI :** It constitute pigments, like chl-b, chl-a carotenoids and p_{700}
- **PS-II** : It consist chl-a, chl-b, phycobillins & P_{680}.

DIFFERENCES BETWEEN PS-I AND PS-II.	
PS-I	**PS-II**
(a) Its reaction centre of PS-I is P_{700}	The reaction centre of PS-II is P_{680}
(b) PS-I can go for cyclic photophophorylation independentally	It perform non-cyclic photophosphorylation with PS-I
(c) Pigment of PSI are located in non appressed part of grana and stroma lamellar	Pigments of PS-II are found in appressed portion of grana lamellae
(d) It receives e^- from PS-II during non-cyclic photophosphoxylation	It receives e^- due to photolysis of water
(e) It participates in cyclic and non cyclic photophosphorylation	It is involved only in noncyclic photophosphyration
(f) Molecular O_2 do not evolved (in cyclic)	O_2 is evolved (non cyclic)

a. Light Reaction of photosynthesis : It involve photophosphorylation operate in thylakoid membrane. It operates as :

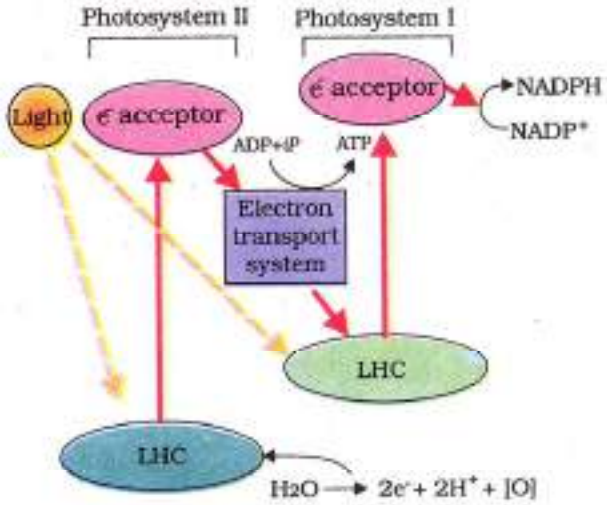


Figure Z scheme of light reaction

(B) Cyclic pathway :

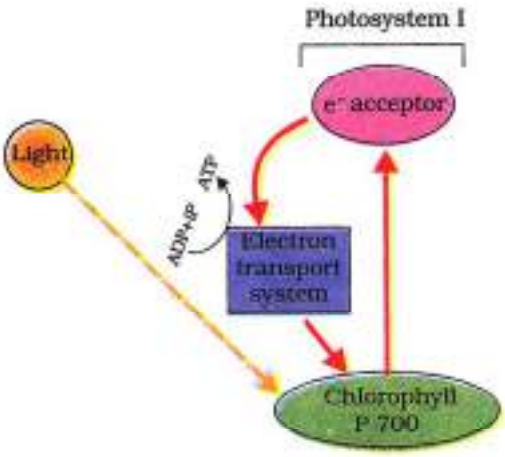


Figure Cyclic photophosphorylation

◆ **Products of light reaction :**

(a) By cyclic pathway = 2ATP (2×6=12)

(b) By noncyclic pathway = 1ATP, 2$NADPH_2$ & O_2 (1×=6) (2×6=12)

- Each cycle runs 6 times.

(II) Dark reaction :

- It is also called as thermochemical reaction.
- It was discovered by Melvin calvin and Benson therefore it is also called as **Calvin Benson cycle**

◆ **Site** : Stroma of chloroplast.

◆ **Raw materials :** They require CO_2 , $NADPH_2$, ATP and enzymes.

◆ **Products -** Glucose

◆ **It involves three basic steps :**

(A) Carboxylation : In this step CO_2 is assimilated by acceptors like RUBP (in C_3 Plants) , PEP (in C_4 Plants) with the help of enzymes i.e. RuBisCO (Ribulose-1,5-bisphosphate carboxylase oxygenase) & PEPCo (Phosphoenol pyruvate carboxylase) respectively.

(B) Synthesis of glucose : In this phase captured CO_2 is assimilated into glucose.

(C) Regeneration of RuBp

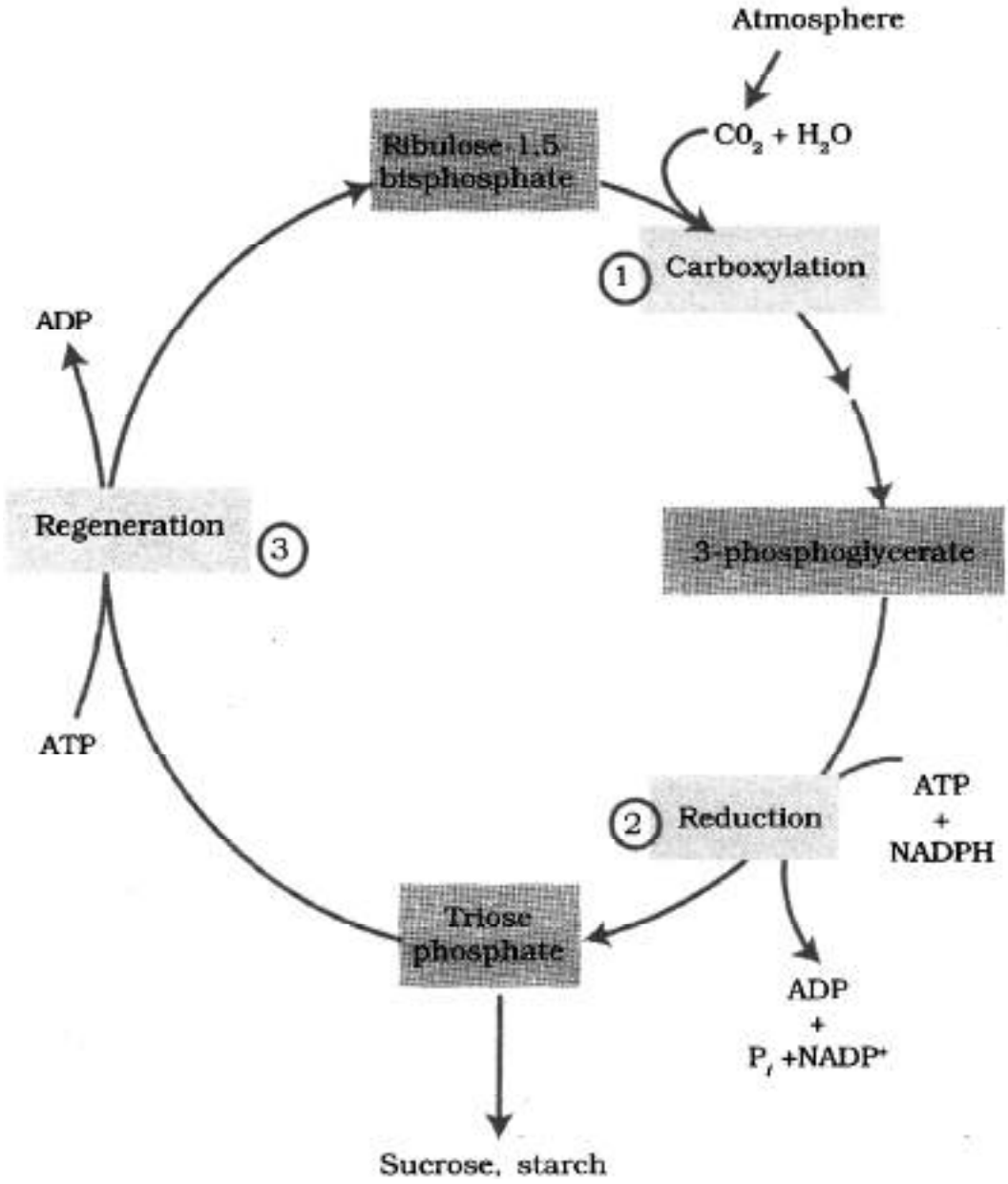


Figure The Calvin cycle proceeds in three stages : (1) carboxylation, during which CO_2 combines with ribulose-1,5-bisphosphate; (2) reduction, during which carbohydrate is formed at the expense of the photochemically made ATP and NADPH; and (3) regeneration during which the CO_2 acceptor ribulose-1,5-bisphosphate is formed again so that the cycle continues

◆ **C-2 pathway/photorespiration/glycolate pathway :**

→ In this cycle RUBisCO react with O_2.

→ C_2 cycle operates in the following manner

(a) Light increases ; CO_2 decreases ; over production of O_2, RUBisCO activity for decreased CO_2.

OR

Temperature increases

→ Stomata get closed which restrict entry of CO_2, RUBisCO activity increases.

→ For operating photorespiration carbon from the protein pool of the cell are utilized. This is why photorespiration is harmful to plant cells.

- **C4-pathway :**

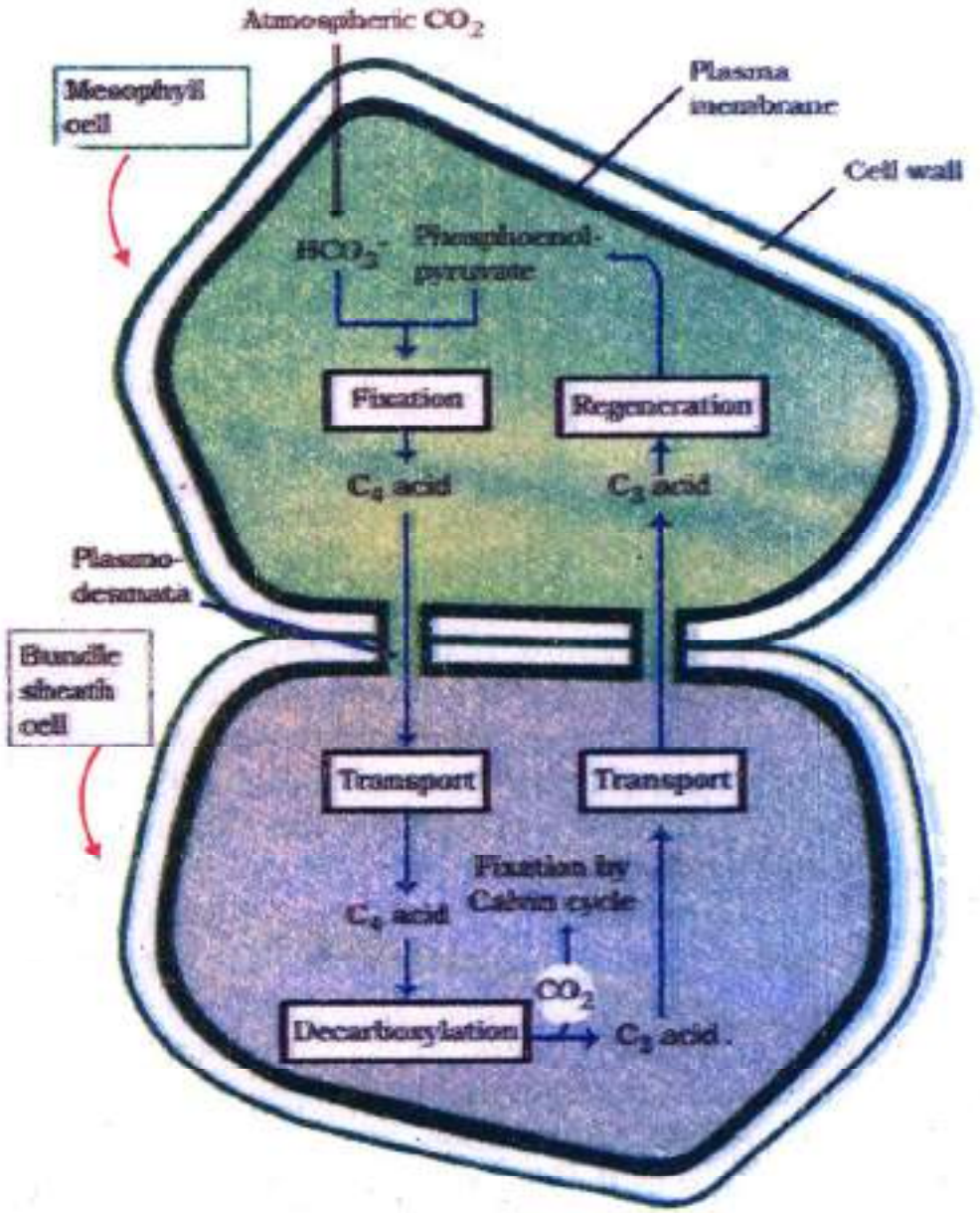


Figure:Diagrammatic representation of the Hatch and Slack Pathway

- **Significance of C4-Plants** :

(a) More efficient plants in picking up CO_2 ever in low conc. because of high affinity of PEP

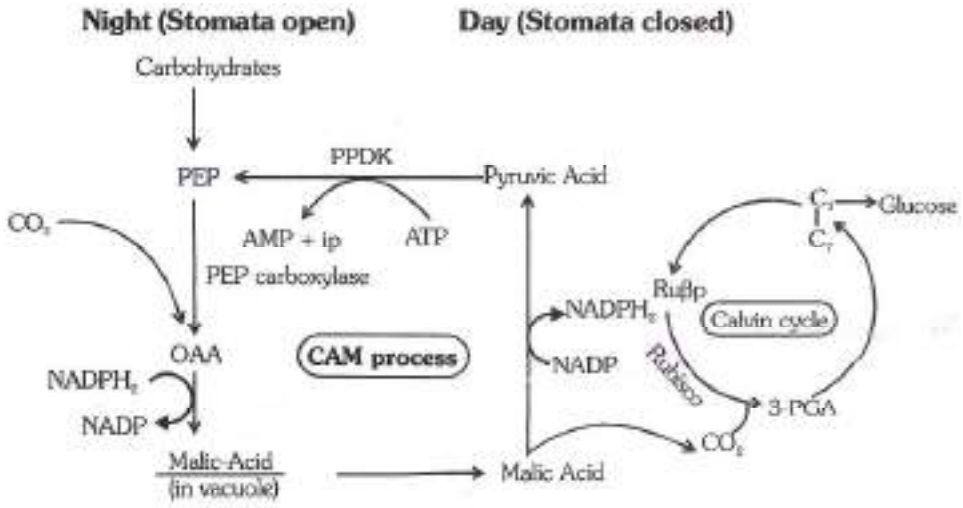
(b) They can tolerate excess of saline conditions.

DIFFERENCE BETWEEN C3 & C4 PLANTS :		
S.NO.	**C3 Plants**	**C4 Plants**
1.	Kranz anatomy absent	Present
2.	Initial CO_2 acceptor : RuBP	PEP
3.	First stable compound 3PGA	OAA
4.	Carboxylating enzyme RuBisCO	In mesophyll $\rightarrow$ PEPCO In bundle sheath $\rightarrow$ RuBisCO
5.	Optimum temperature $\rightarrow$ 15-25°C	30-40°C

◆ **Crassulacean Acid Metabolism (CAM) Plants :**

→ The crassulaceae is the family of succulants like bryophyllum.

→ Such plants contain large amount of organic acids like malic acids/oxalic acids. They fix carbon in the form of 4C-organic acids, but they fix CO_2 at night and reduce CO_2 via the calvin cycle using $NADPH_2$ form during day. Their stomata closed during day and open in night for in flow of CO_2. In this way they reduces transpiration.



CAM pathway

• **Note : Bacterial Photosynthesis -** It is a special kind of photosynthesis which takes place in certain bacteria. In this process also solar energy is utilised for the synthesis of carbohydrates and H_2S is the hydrogen donor instead of water as in normal photosynthesis. So O_2 is not liberated in bacterial photosynthesis.

NUTRITION IN ANIMALS

Animals are heterotrophic in nature . They are directly or indirectly dependent on plants to obtain their food

◆ The mode of nutrition may be parasitic or saprotrophic but usually animals are holozoic.

◆ All the basic steps of holozoic nutrition are same in unicellular to multicellular organism.

◆ Holozoic nutrition in animals consists of following 5-steps

(i) Ingestion : The process of intake of food.
(ii) Digestion : It is the breakdown of large and complex molecules into simpler, smaller and soluble forms.
(iii) Absorption : Taking up of the digested food through intestinal wall to blood or body fluid.
(iv) Assimilation : In this process absorbed food is taken by body cells.
(v) Egestion : The process by which undigested matter is expelled out.

(a) Nutrition in Amoeba :

◆ It is a unicellular organism living in water.

◆ Mode of nutrition is **holozoic.**

◆ The process of obtaining food is by **phagocytosis** (cell eating)

◆ Steps involved in nutrition in amoeba are :

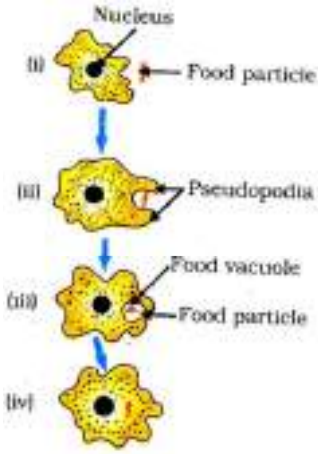
(i) Ingestion : Since it is unicellular so a single cell is responsible for carrying out all the vital activities. Food is ingested with the help of **pseudopodia.** Animal engulfs the food particle lying near it by forming pseudopodia around it and forming a **food vacuole** which is considered as its **temporary stomach.**

(ii) Digestion : The enzymes from surrounding cytoplasm enter the food vacuole and break down the food into smaller & soluble forms. It is intracellular in Amoeba.

(iii) Absorption : The digested food is now absorbed by cytoplasm by simple diffusion.

(iv) Assimilation : The food absorbed in amoeba is used to obtain energy from respiration, for its growth and reproduction.

(v) Egestion : Undigested food is thrown out of the cell.



ig: Nutrition in amoeba

(b) Nutrition in Human Beings :

◆ Humans are holozoic and follow same 5- steps of nutrition.

◆ Humans have highly evolved and complicated digestive system consisting of an alimentary canal and different types of digestive glands.

◆ **Alimentary canal :** Long, hollow, tubular structure consisting of various organs for digestion. Alimentary canal consists of following organs :

(i) Mouth : It is a small slit through which food is ingested.

(ii) Buccal cavity : Mouth opens into a chamber called as **buccal cavity.** It has following components:

1. Hard palate: Roof of buccal cavity is called hard palate.

2. Tongue: At the floor of this cavity thick muscular structure is present called tongue. It helps in chewing, swallowing, tasting and speaking. Tongue has various types of taste papilla.

3. Teeth: Jaws present in buccal cavity are provided with four different types of teeth (**Heterodont**) :

Incisors	:	For cutting
Canines	:	For tearing
Premolars	:	For grinding
Molars	:	For grinding

◆ Dental formula of humans : In human beings two set of teeth appear during their life time (**Diphyodont**) -

(A) Milk teeth : These are temporary , arise at 6 – 11 month age, 20 in number

$$\frac{\text{Half upper jaw}}{\text{Half lower jaw}} = i\frac{2}{2}, c\frac{1}{1}, pm\frac{0}{0}, m\frac{2}{2}$$

(B) Permanent teeth : In adults

$$\frac{\text{Half upper jaw}}{\text{Half lower jaw}} = i\frac{2}{2}, c\frac{1}{1}, pm\frac{2}{2}, m\frac{3}{3}$$

5. Three pairs of major salivary glands are found in mouth which release their secretions into the buccal cavity. They secret salivary amylase for starch digestion, so digestion of starch starts from here.

• **Note:** Mouth continues in a funnel shaped pharynx. It is the common passage between respiratory and digestive tract.

(iii) Oesophagus : Also called as food pipe . It leads the food from mouth to stomach. Oesophagus has highly muscular walls, no digestion occurs here.

(iv) Stomach : It is a 'J' shaped bag present on left side of abdomen. It contains several branched and tubular glands present on the inner surface of its wall, which secrete gastric juice.

(v) Small Intestine : It is a coiled and narrow tube having 3 regions : duodenum, jejunum , ileum.

• On the inner wall of small intestine numerous finger like projections are found which are called as **villi**, they increase the surface area of absorption.

• Duodenum is proximal part of small intestine, receives secretion from liver and pancreas.

(vi) Large intestine : Small intestine opens into large intestine from where the undigested food material is passed to anus through rectum. It is divided into three parts : **Caecum, Colon and Rectum.**

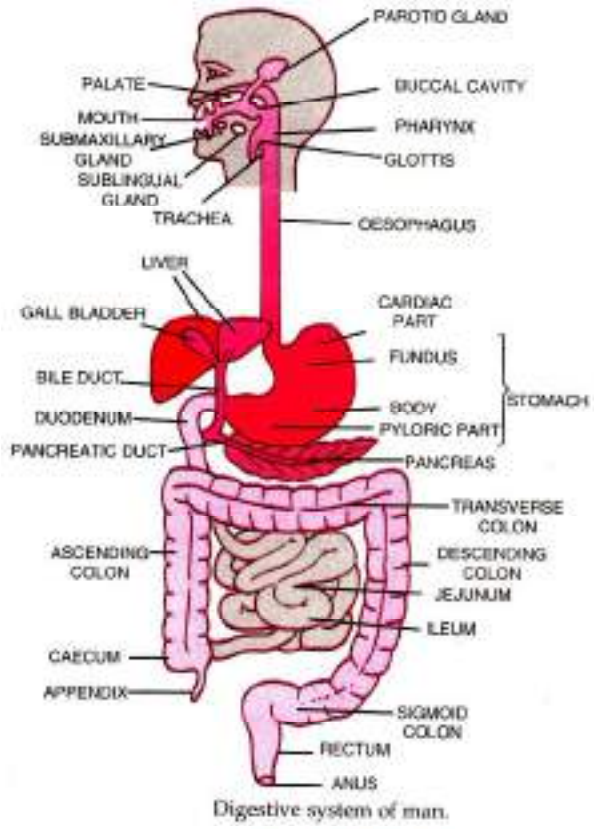


Fig. Digestive System of Human

◆ **Digestive glands :** They secrete enzymes / hormones which help in digestion. The digestive glands include:

(i) Salivary glands : It produces saliva. In rabbit, 4 pairs of salivary glands are present while in man only three pairs of salivary glands are present. They help in chemical digestion. They secrete an enzyme called **salivary amylase** or **ptyalin**. It helps in digestion of starch.

(A) Parotid glands : largest glands present just below the external ear. In this glands, virus causes mumps disease. (Parotid duct/Stenson's duct)

(B) Submaxillary glands / Submandibular glands : These lie beneath the jaw-angles. (Wharton's duct)

(C) Sublingual glands : Smallest glands which lie beneath the tongue and open at the floor of buccal cavity.(Duct of Rivinus)

◆ There are some minor salivary glands also like on palate.

(ii) Gastric glands : Present in stomach. They secrete hydrochloric acid, protein digesting enzymes and mucus. Present in the mucosa of the stomach.

These are of 3 types :

(A) Cardiac glands : secrete an alkaline mucus.

(B) Pyloric glands : secrete an alkaline mucus.

(C) Fundic glands : each gland has 5 types of cells.

1. **Peptic/Zymogen cells** - secrete pepsinogen, prorennin
2. **Oxyntic cells** - secrete HCl
3. **Goblet cells -** secrete mucus
4. **Argentaffin cells -** produces serotonin somatostatin and histamine
5. **G-cells -** secrete and store the hormone gastrin.

(iii) Liver : It consists of a large right lobe, a small left lobe and two small lobes called quadrate lobe and caudate lobe behind the main lobes. On the right lobe lies gall bladder, which, temporarily stores bile juice, secreted by the liver. It is the largest gland, secretes bile into the small intestine.

Bile juice contains no enzyme but possesses bile salts and bile pigments (**bilirubin**-yellow and **biliverdin**-green).

Bile is alkaline in nature and helps in digestion of fats, it also helps in absorption of fats.

◆ **Functions of liver :**

- Formation of glucose from excess organic acids.
- Storage of vitamins : A, D, E, B. Synthesis of vitamin A from carotene.
- Secretions of blood anticoagulant named **heparin**.
- Synthesis of blood or plasma proteins, fibrinogen and prothrombin
- Secretion of bile, detoxification of harmful chemicals.
- Elimination of pathogens and foreign particles through phagocytic cells called **Kupffer's cells.**

(iv) Pancreas : It lies parallel and below the stomach. It secretes pancreatic juice into small intestine. Pancreatic juice contains trypsin and pancreatic amylase. Besides these two enzymes pancreas secretes two hormones also i.e. insulin and glucagon, so it has both exocrine as well as endocrine functions. Both bile and pancreatic juice are released into the duodenum by a common duct.

(v) Intestinal glands : They secrete intestinal juice and mucus.

- **Process of Nutrition :** This system involves following process :

(i) Ingestion : Intake of food is done through mouth, food is then chewed and masticated and sent to oesophagus through pharynx by swallowing.

(ii) Digestion : Saliva secreted in buccal cavity starts digestion of starch into maltose. This partially digested food is then passed to stomach by oesophagus through peristaltic movements. Food is churned in stomach for about three hours and broken down into smaller pieces. Due to presence of hydrochloric acid, medium of stomach becomes acidic. In acidic medium protein digestive enzyme pepsin breaks down proteins into peptones. Gastric lipase is also secreted here which partially break down lipids.

- Secretion of gastric juice is stimulated by the sight , smell or thought of food.
- Now the partially digested food moves to small intestine i.e. in the duodenum. Duodenum receives the secretion from liver and pancreas through a common duct which contains bile and pancreatic juice, and alkaline in nature. So the digestion and emulsification of fats occurs at this place.
- Here in the duodenum fats are emulsified by bile, remaining proteins are digested by trypsin and starch by pancreatic amylase.

  NOTE : Duodenal wall secretes bicarbonate ions which make the medium alkaline.
- This partially digested food now enters into the ileum where intestinal juice i.e. **"Succus entericus"** is secreted. At this place digestion is completed.

  Carbohydrates $\longrightarrow$ Glucose

  Proteins $\longrightarrow$ Amino acids

  Fats $\longrightarrow$ Fatty acids and glycerol

(iii) Absorption : After digestion molecules are broken down into simpler water soluble forms now they are to be utilized, so they pass through the walls of small intestine which contains blood capillaries and enters into the blood. Fat is absorbed by lymph capillaries.

◆ **NOTE :** Walls of small intestine have tiny finger like projections called **villi,** they increase the surface area for absorption.

(iv) Assimilation : The process of utilization of food is called assimilation. The nutrients dissolved in blood are carried to all parts of the body where they are utilized :

(A) For building up and replacement of cells.
(B) For obtaining energy. This energy is released by the process of oxidation during respiration.

(v) Egestion : The undigested food along with water (about 75%) and excess of digestive enzymes is then collected in large intestine where water is absorbed and remaining waste is expelled out or egested through anus. Colon absorbs water and transports excess of ions as Ca^{+2} ,Mg^{+2} etc. from blood to large intestine. The faeces are formed of 75% water, 25% solid matter which contains roughage 30%, fats 20%, inorganic

matter 15%, proteins 2% and bacteria 3% .Brown colour of faeces is due to **stercobilins**.

TABLE : DIGESTIVE GLANDS, THEIR SECRETIONS & ACTION

Name of Gland	Secretion	Enzyme	Site of action	Substrates	Products
Salivary gland	Saliva	Salivary amylase	Buccal cavity	Starch	Maltose, Isomaltose.
Gastric glands	Gastric Juice	(a) Pepsin (Pepsinogen inactive)	Stomach	Protein	Peptones
		(b) Rennin (Prorennin inactive)	Stomach	Casein	Paracasein
		(c) Hydrochloric acid	Stomach	Pepsinogen	Pepsin
Pancreas	Pancreatic Juice	(a) Pancretic Amylase	Small intestine	Starch, Glycogen	Maltose, Isomaltose
		(b) Trypsin (Trypsinogen inactive)	Small intestine	Proteins	Peptides
		(c) Chymotrypsin (Chymotrypsinogen inactive)	Small intestine	Casein (milk)	Paracasein
Intestinal gland (Crypts of Lieberkuhn)	Intestinal Juice	(a) Enterokinase (Hormone)	Small intestine	Trypsinogen (inactive)	Trypsin (active)
		(b) Aminopeptidase	Small intestine	Peptides	Smaller peptides Amino acids.
		(c) Dipeptidases	Small intestine	Dipeptides	Amino acids.
		(d) Isomaltase	Small intestine	Isomaltose	2 Glucose
		(e) Maltase	Small intestine	Maltose	2 Glucose
		(f) Sucrase	Small intestine	Sucrose	Glucose, Fructose
		(g) Lactase	Small intestine	Lactose	Glucose, Galactose
		(h) Lipase	Small intestine	Triglycerides	Monoglycerides, Fatty acids.
Liver	Bile (Bile salts + pigments)	No enzymes	Duodenum	Fats	Fat droplets

TABLE : VITAMINS NECESSARY FOR NORMAL CELL FUNCTIONING					
S.No.	Deficiency Disease	Deficient Nutrient	S.No.	Deficiency Disease	Deficient Nutrient
1	Xerophthalmia	Vitamin A (Retinol)	10	Megaloblastic anaemia	Folic acid and Vitamin B_{12}
2	Night-blindness	Vitamin A (Retinol)	11	Pernicious anaemia	Vitamin B_{12} (Cyanocobalamine)
3	Rickets (in children)	Vitamin D (Calciferol)	12	Scurvy	Vitamin - C (Ascorbic Acid)
4	Osteomalacia (adults)	Vitamin D (Calciferol)	13	Osteomalacia	Calcium
5	Sterility	Vitamin E (Tocopherol)	14	Anaemia	Iron
6	Bleeding disease	Vitamin K (Phylloquinone)	15	Goitre	Iodine
7	Beri beri	Vitamin B_1 (Thiamine)	16	Fluorosis	Excess of fluorine
8	Cheilosis	Vitamin B_2 (Riboflavin)	17	Kwashiorkor	Proteins
9	Pellagra	Vitamin B_3 (Niacin)	18	Marasmus	Proteins and food calories

EXERCISE-1

Nutrition in Plants

1. Plants are
(A) autotrophic (B) heterotrophic
(C) saprophytic (D) holozoic

2. The organisms that can perform photosynthesis are
(A) bacteria , fungi, mycoplasma
(B)green algae, photosynthetic bacteria ,cyanobacteria
(C) cyanobacteria, fungi, rickettsias
(D) brown algae, green algae, fungi

3. Which wavelength of light carries out photosynthesis in bacteria ?
(A) Blue (B) Red `
(C) Far red (D) Ultraviolet

4. Structural component of chlorophyll among the following is -
(A) Mg (B) Mn
(C) Fe (D) Zn

5. Photosynthesis will be highest when the plant is exposed to
(A) continuous strong light
(B) continuous weak light
(C) alternate strong and weak light
(D) intermediate light

6. The role of chlorophyll in photosynthesis is to
(A) absorb light and to decompose water photochemically
(B) accept the electron from oxygen
(C) accept electron from carbon dioxide
(D) none of the above

7. The dark reaction in photosynthesis is called so because it
(A) can occur more rapidly at night
(B) does not require light energy
(C) cannot occur during day time
(D) can occur only in shade

8. The first step in dark reaction of photosynthesis is
(A) formation of ATP
(B) attachment of CO_2 to a pentose sugar
(C) excitement of electron of chlorophyll by a photon of light
(D) ionization of water

9. During photosynthesis , when PGA is changed into PGAL, which type of reaction occurs ?
(A) Oxidation (B) Reduction
(C) Electrolysis (D) Hydrolysis

10. In leaves, production of starch and not glucose, is often used as a test of photosynthesis, because
(A) starch is always formed in photosynthesis
(B) starch is formed before glucose in photosynthesis
(C) starch is more easily detected than glucose
(D) glucose is always formed in photosynthesis.

Nutrition in Animal

11. In amoeba the digestion of food is
(A) extracellular (B) intracellular
(C) intercellular (D) none of the above

12. In amoeba absorption of the digested nutrients occurs in
(A) cytoplasm
(B) plasma membrane
(C) contractile vacuole
(D) pseudopodia

13. Thorough mastication of food is essential because
(A) mastication of food makes the teeth stronger
(B) it makes the process of swallowing of food easier
(C) by this process bigger pieces of food are broken down into smaller pieces
(D) bigger pieces of food are broken down into smaller pieces and saliva is properly mixed with them

14. Ptyalin enzyme is secreted by
(A) salivary gland (B) mouth
(C) oesophagus (D) stomach

15. Enzyme which breaks up starch into sugar is-
(A) hydrolase (B) amylase
(C) lipase (D) nuclease

16. Largest gland in the body is
(A) liver (B) pancreas
(C) gastric gland (D) adrenal

17. Bile is stored in -
(A) gall bladder (B) bile duct
(C) liver (D) pancreas

18. Which one does not produce any digestive enzyme ?
(A) Pancreas (B) Liver
(C) Stomach (D) Duodenum

19. Food is stored in the liver and muscles as
(A) glycogen (B) starch
(C) fat (D) cholesterol

20. Pepsin digests
(A) proteins in stomach
(B) carbohydrates in duodenum
(C) proteins in duodenum
(D) fats in ileum

21. Fat present below the skin surface in our body, acts as a barrier against
(A) loss of salts from the body
(B) loss of essential body fluids
(C) loss of heat from the body
(D) entry of harmful micro–organisms from the environment

22. The most important function of villi in the small intestine is -
(A) to provide strength to the intestine
(B) to provide space for capillaries
(C) to provide increased surface area for absorption of digested food
(D) to provide habitat for bacteria

23. The digestion of food is completed in the
(A) ileum (B) duodenum
(C) stomach (D) large intestine

24. Which of the following statements is/are true about ATP molecules ?
(i) A molecule with a high energy phosphate bond.
(ii) A protein which brings about oxidation.
(iii) A higher nucleoside.
(A) (i) and (ii) (B) (ii) and (iii)
(C) (i) and (iii) (D) only (i)

EXERCISE-2

COMPETITIVE EXAM QUESTIONS

1. Partial remove of liver is not harmful because
(KVPY / 2007)
(A) Liver being a large organ can suffice the functions even if a part is removed
(B) Liver is not a very essential organ of the body
(C) Liver has regenerative capacity and will grow after partial hepatectomy
(D) The function of liver can be taken over by kidneys

2. A patient given broad spectrum antibiotic suffered from vitamin deficiency because
(KVPY / 2007)
(A) Antibiotic inactivated the vitamins
(B) Antibiotic inhibited the synthesis of vitamins
(C) Antibiotics killed the commensals in the gut which produced vitamins
(D) Antibiotics killed the vitamin producing cells in liver

3. During photosynthesis, light energy,
(KVPY / 2007)
(A) Is converted to chemical energy
(B) Is converted to kinetic energy
(C) Is the catalyst
(D) Dissociates CO_2 directly

4. On a normal sunny day, rate of photosynthesis (per unit time) is maximum during,
(KVPY / 2007)
(A) Early morning
(B) Between late morning to before noon
(C) Midday
(D) Late evening

5. Why is it advisable to take antibiotics if someone is suffering from gastric ulcers ?
(KVPY / 2008)
(A) Antibiotics reduce gastric acid secretion
(B) antibiotics prevent ulcers from being infected
(C) Antibiotics reduce gastric enzyme secretion
(D) Gastric ulcers are caused by bacteria

6. In the lunch, you ate boiled green vegetables, a piece of cooked meat, one boiled egg and a sugar candy. Which one of these foods may have been digested first ?
(KVPY / 2008)
(A) Boiled green vegetables
(B) The piece of cooked meat
(C) Boiled egg
(D) Sugar candy

7. The amount of CO_2 is greater at night than during the day because,
(KVPY / 2008)
(A) The rate of respiration is higher at night.
(B) More CO_2 is produced because it is colder during the night.
(C) Photosynthesis during the day uses up some of the CO_2 produced by respiration.
(D) More glucose is available for respiration during the night

8. Bile salts,
(KVPY / 2009)
(A) break down polypeptide chains
(B) emulsify fats and solubilize them
(C) digest fats
(D) help breakdown of polysaccharides

9. Ascorbic acid is a/an.
(KVPY / 2009)
(A) Strong inorganic acid (B) Hormone
(C) Vitamin (D) Enzyme

10. Dietary fibers are composed of.
(KVPY / 2009)
(A) Cellulose (B) Amylase
(C) Proteins (D) Unsaturated fats

11. Which organ secretes enzymes that are active at a low pH ?
(IJSO/stage II/2009)
(A) Mouth (B) Pancreas
(C) Stomach (D) Liver

12. What is needed in photosynthesis to convert carbon dioxide into organic molecules ?
(IJSO/stage II/2009)
(A) Light and hydrogen from the splitting of water
(B) Light and oxygen from the splitting of water
(C) ATP and hydrogen from the splitting of water
(D) ATP and oxygen from the splitting of water

13. The ointment prescribed for burns usually contains, among other ingredients.
(IJSO/stage II/2010)
(A) vitamin A (B) vitamin B
(C) vitamin D (D) vitamin E

14. A child having protruding belly, bulging eyes, thin and curved legs and peeling skin is likely to be suffering from
(IJSO/stage II/2010)
(A) kwashiorkor (B) rickets
(C) marasmus (D) xerophthalmia

15. If the glands in the pharyngeal bulb of earthworm are inactivated, digestion of which of the following is affected ?
(IJSO/stage II/2011)
(A) proteins (B) carbohydrates
(C) lipids (D) nucleic acids

16. The feature indicating omnivorous nature of man is
(IJSO-Stage-I/2011)
(A) presence of canines and molars
(B) long intestine and vestigial appendix
(C) ability to taste salty and sweet material
(D) spacious stomach and caecum

17. Complete digestive juice having enzymes to digest all types of organic materials is secreted by -
(IJSO-Stage-I/2011)
(A) salivary gland and pancreatic gland.
(B) gastric gland and pancreatic gland.
(C) salivary gland and intestinal gland.
(D) pancreatic gland and intestinal gland

18. Human body cannot digest carbohydrate in the form of -
(IJSO-Stage-I/2012)
(A) sugars (B) starch
(C) cellulose (D) glycogen

19. The biochemical analysis to confirm CAM in a given plant is
(IJSO-Stage-I/2012)
(A) titratable acid number
(B) iodine number
(C) activity of transaminases
(D) total reducing power

20. The general indigestion experienced by a patient suffering from obstructive jaundice is due to :
(IJSO-Stage-I/2014)
(A) the lack of emulsification of lipids
(B) the acceleration of intstinal peristalsis reducing the retention time for food
(C) the low pH in the intstine not supporting optimal activity of enzymes.
(D) the diffusion of bile pigments in blood suppressiong secretion of digestive juices

21. Which of the following can be categorized as a parasite in true sense ?
(IJSO/Stage-2/2014)
(A) The female Anopheles mosquito sucks blood from human
(B) Human foetus developing in uterus draws nourishment from mother
(C) Head louse lives on human scalp and lays eggs on hair.
(D) The cuckoo lays eggs in crow's nest for subsequent parental care.

22. The equation given below represents the process of photosynthesis
(IJSO/Stage-2/2015)

$$6CO_2 + \xrightarrow{(i)} \xrightarrow[\text{sunlight}]{\text{chloropyll}} C_6H_{12}O_6 + \xrightarrow{(ii)}$$

Identify (i) and (ii)

(A)

(i)	(ii)
$6H_2O$	$6O_2$

(B)

(i)	(ii)
$6H_2O$	$6H_2O$

(C)

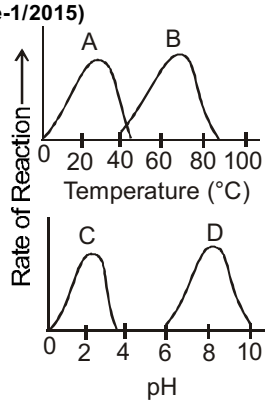
(i)	(ii)
$4H_2O$	$4O_2$

(D)

(i)	(ii)
$4O_2$	$4H_2O$

23. The following graphs represent acitivities of different enzymes (A to D) at different temperature and pH :

(IJSO/Stage-1/2015)



Observe the graphs carefully and infer which of the following options given below (most likely) represents correctly the combinations A.B.C. and D.

(A) A-enzyme of thermophilic bacteria B-typical human enzyme : C-pepsin (stomach enzyme) : D-Trypsin (intestinal enzyme)

(B) A-enzyme of thermophilic bacteria B-typical human enzyme : C-Trypsin (intestinal enzyme) : D-Trypsin (stomach enzyme)

(C) A-a typical human enzyme : B-enzyme of thermophilic bacteria : C-Trupsin (intestinal enzyme): D-pepsin (stomach enzyme)

(D) A-a typical human enzyme : B-enzyme of themophilic bacteria : C-pepsin (stomach enzyme) : D-Trypsin (intestinal enzyme)

24. In humans, the digestion of carbohydrates happens/ takes place in the following parts of the digestive system :

(IJSO-Stage-I/2015)

(A) Mouth, stomach and small intestine

(B) Small intestine alone

(C) Mouth and small intestine

(D) Stomach and small intestine

25. Photosynthesis in plants is carried out in

(IJSO-Stage-I/2015)

(A) leaves

(B) leaves and stems

(C) leaves, stems and aerial roots

(D) stems and roots

26. The "chief cells" of stomach secrete hydrochloric acid. Consider a hypothetical situation in which the "chief cells" are destroyed resulting in complete inhibition of acid secretion in stomach. In comparison to normal person, which one of the following is most likely to happen in the stomach during the above condition ?

(IJSO-Stage-II/2016)

(A) Digestion of proteins will increase

(B) Digestion of fats will start.

(C) Digestion of carbohydrates will continue

(D) Digestion of fat will decrease.

27. Rhodoferax fermentans is a species of photosynthetic bacteria . From your knowledge about bacteria in general, identify the components that CANNOT be present in this organism.

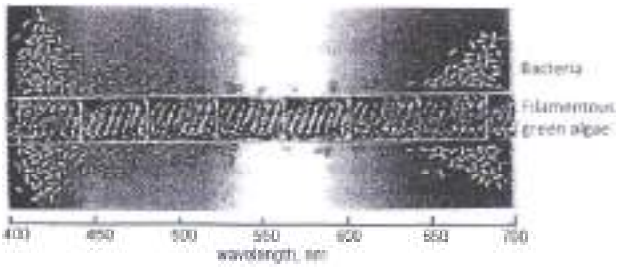
(IJSO-Stage-II/2016)

(A) chloroplasts (B) ATP

(C) Ribosomes (D) Cell wall

28. In 1883, Theodor W. Engelmann carried out an experiment to determine which wavelengths of light are most effective in driving photosynthesis. He illuminated a filamentous alga with white light that had been passed through a refreacting prism, exposing different segments of algae to different wavelength of light. He used aerobic bacteria that concentrate near an oxygen source indicating different rates of O_2 release. The picture below illustrates the result of the experiment.

(IJSO-Stage-II/2016)



(i) From the above figure which of the following wavelength(s) (nm) of light drive the highest rate of photosynthesis :

(i) 400 (ii) 425 (iii) 500

(iv) –550 (v) 600 (vi) –680

(vii) 700

(ii) What colors of the spectrum are absorbed in the wavelengths chosen by you in the above answer ?

(iii) Which pigment in the leaves absorb the colors in the answer to (B) above ?

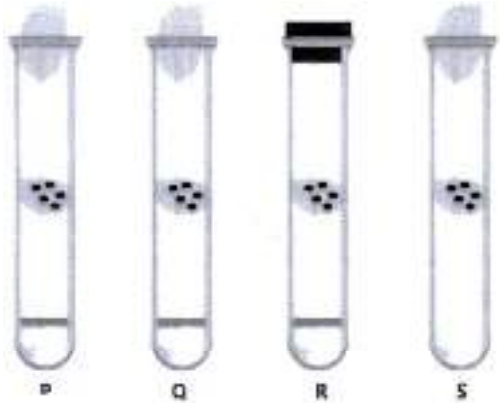
(iv) Plant leaves appear green in color because pigments in leaves _____ violet blue and red light and _____ green light. [Choose between absorb and transmit to fill in the blank.

(v) Can photosynthesis occur in red light ? Yes/No.

(vi) Why was oxygen sensing bacteria used in this experiment ? Answer with the help of a chemical equation representing photosynthesis.

(vii) The ability of a pigment to absorb various wavelengths of lights can be measured with an instrument called a _____[Fill in the blank]

29. During the study of factors affecting germination. Lata used 4 tubes P, Q, R and S. Seeds of green gram were subjected to different condition as described below : **(IJSO-Stage-II/2016)**



P- Seeds soaked in water were kept on moist cotton wool and placed in a tube with water. The tube was closed with loose cotton wool and kept at 25ºC.

Q- Same arrangement as above (P) but tube stored at 4ºC

R- Seeds soaked in water was kept on moist cotton wool and placed in a tube with pyrogallol instead of water. Pryogallol removes oxygen. The tune was closed tightly with a wooden block and kept at 25ºC

S- Dry seeds kept on dry cotton wool, kept at 25ºC without adding water.

Every experiment should have controls. A control can be positive or negative. Negative control is a condition where the phenomenon (germination of seeds in this example) is not expected to happen while in positive control the phenomenon is expected to happen with respect to the parameter being tested.

(I) Which tube will have the highest frequency of germination
(i) P (ii) Q (iii) R (iv) S

(II) Which tube serves as a positive control ?
(i) P (ii) Q (iii) R (iv) S

(III) Which tube works as negative control for oxygen?
(i) P (ii) Q (iii) R (iv) S

(IV) In the above experiment in influence of which of the following factor(s) on germination is/are being tested ?

(i) O_2 and H_2O only

(ii) CO_2 and pyrogallol only

(iii) O_2, H_2O and temperature

(iv) Only H_2O

(V) What is most likely to happen to the frequency of germination in tube R if the wooden block is replaced with loose cotton wool ?

(i) No change in germination frequency

(ii) Increase in germination frequency

(iii) Decrease in germination frequency

RESPIRATION

RESPIRATION

The sum total of all the vital activities is called as metabolism.Vital activities refer to all the physiochemical activities of a cell. It has two aspects

(I) Anabolism : It includes metabolic processes by which complex cellular compounds are synthesized from simple compounds, **e.g. Photosynthesis**

(II) Catabolism : It includes metabolic processes by which larger molecules are broken down into simpler molecules, **e.g. Respiration.** Respiration is an important catabolic process responsible for the production of energy.

(a) Definition :

The process by which assimilated food is oxidised and energy is released is called as respiration. In this process oxygen from air is taken in, this oxygen oxidizes food molecules present in the body cells and energy is released slowly. This energy is stored in the form of ATP molecules inside the cell for further use and the waste products i.e. CO_2 and H_2O are eliminated out of the body.

$$\text{Food + oxygen} \xrightarrow{\text{Oxidation}} CO_2 + H_2O + \text{Energy (ATP)}$$

It is called as aerobic respiration.

(b) Difference Between Breathing and Respiration :

(i) Breathing involves taking in of oxygen and releasing out of carbon dioxide so it is a physical process while respiration is a biochemical process which, alongwith breathing involves oxidation of food.

(ii) Breathing involves lungs so it is an organ system level process while respiration besides being at organ system level, also occurs at cellular level.

(iii) Breathing itself do not release energy while respiration results in the release of energy which is then stored in form of ATP.

(iv) Breathing is a part of respiration while respiration is not a part of breathing but it involves breathing.

(c) Step of respiration :

(i) External respiration : Exchange of gases between an organism and its environment.

(ii) Internal respiration : Exchange of gases between tissue cells and extracellular environment.

(iii) Cellular respiration : Involves oxidation of food alongwith release of energy, inside cell.

(d) Types of Respiration :

(i) Aerobic : It is oxidation of food which takes place in presence of molecular oxygen.

$$\text{Food} \xrightarrow[\text{in cytoplasm}]{\text{Glycolysis}} \text{Pyruvic acid} \xrightarrow[\text{Kreb cycle in mitochondria}]{\text{In presence of } O_2} 6CO_2 + 6H_2O + 38 \text{ ATP / } 36 \text{ ATP.}$$

It is called as aerobic respiration.

(ii) Anaerobic respiration : When oxidation of food material does not require molecular oxygen or it occurs in absence of molecular oxygen, it is called as anaerobic respiration.

$$\text{Food} \rightarrow \text{Pyruvic acid} \rightarrow \begin{cases} \xrightarrow[\text{(During fermentation)}]{\text{In yeast}} 2C_2H_5OH + 2CO_2 + 2\text{ ATP} \\ \xrightarrow[\text{(During vigorous exercise)}]{\text{In muscles}} \text{Lactic acid} + 2\text{ATP} \end{cases}$$

- **Fermentation :** The process of breakdown of complex organic molecules into simpler inorganic molecules, in absence of oxygen, by microorganisms.This process is used for preparation of alcoholic beverages in presence of yeast in the absence of oxygen. Glucose and fructose are converted into ethanol by this process. It is a type of anaerobic respiration.

DIFFERENCES BETWEEN AEROBIC AND ANAEROBIC RESPIRATION

AEROBIC	ANAEROBIC
It occurs in all living cells of higher plants.	It occurs in bacteria, certain fungi, germinating seeds & fleshy fruits, muscles.
It requires oxygen.	Oxygen is not required.
The end products are CO2 and H2O.	The end products are alcohol & CO2 or lactic acid.
The oxidation of one molecule of glucose produces 38 ATP / 36 ATP molecules.	The number of ATP molecules produced is only 2.
All the reactions except the reactions of glycolysis take place inside mitochondria.	All the reactions take place in cytoplasm.
Organic compounds are completely oxidised & high amount of energy is released.	Organic compounds are incompletely oxidised and very small amount of energy is released.
Non toxic to plants.	Toxic to higher plants.

RESPIRATION IN PLANTS

- In plants exchange of gases takes place from leaves, stems and roots individually.
- Exchange of gases in plants occurs by simple diffusion.

(i) Respiration in roots :

- In young roots, the epidermal cells are extended to form root hair. These root hair remain in direct contact with the air present in between the soil particles. The oxygen from this air enters into the root hairs by simple diffusion and reaches to other cells of root for respiration.
- In older roots a protective layer of dead cells is present which have tiny openings called as **lenticels**. Diffusion of oxygen and removal of CO_2 takes place through these pores.

(ii) Respiration in stems :

In herbaceous plants, stem have small openings in their epidermal cells called as **stomata**, the oxygen from air enters through stomata and carbon dioxide is released from the same.

- In hard and woody stems of big plants and trees, lenticels are present in place of stomata through which exchange of gases takes place.

(iii) Respiration in leaves :

- Surface of leaves possess numerous tiny pores called as stomata in their epidermal cells, exchange of gases takes place through stomata and when CO_2 concentration in cell increases stomata open and CO_2 is released out.

RESPIRATION IN ANIMALS

- Animals have different types of organs for respiration due to which mode of respiration varies according to the organism but the basic mechanism is same.
- From phylum Protozoa to Ctenophora respiration is by general body surface.
- In phylums Platyhelminthes to Nematodes mostly are anaerobic & endoparasites.
- In phylum Annelida cutaneous respiration occurs.
- From phylum Arthropoda till Mammals various respiratory organs like trachea, gills and lungs are developed.

S.NO.	TYPE OF RESPIRATION	ORGANS INVOLVED	EXAMPLE
1.	Cell surface respiration	General body surface	Amoeba, Paramecium
2.	Tracheal respiration	Trachea & tracheoles	Insects
3.	Branchial respiration	Gills	Aquatic animals (Fishes)
4.	Cutaneous respiration	Skin	Frog
5.	Pulmonary respiration	Lungs	Amphibians, reptiles, birds
6.	Buccal respiration	Buccal cavity	Frog

- **Some important characteristics of respiratory organs of animals are :**

- They have large surface area to get enough oxygen.
- They have thin walls for easy diffusion and exchange of gases.
- They have rich blood supply for transport of respiratory gases.

(a) Respiration in Amoeba :

In unicellular organisms like amoeba and in some lower multicellular animals like sponges and cnidarians, respiration or exchange of gases occurs through general body surface as these cells are in direct contact with an aquatic environment so the oxygen dissolved in water diffuses into the cell and brings about oxidation of food, at the same time carbon dioxide released is expelled out of the cell by the same process.

(b) Respiration in Earthworm :

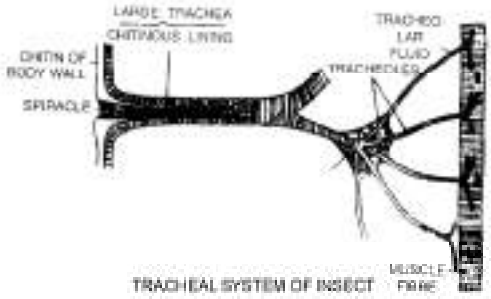
In organisms like earthworm and leech exchange of gases occurs through their skin as their skin is very thin and moist. It is rich in blood supply so the oxygen is absorbed by moist skin of earthworm and is transported to all the cells of body through blood. The carbon dioxide from body cells diffuses into the blood and expelled out through skin.

(c) Respiration in Fish :

- In fish exchange of gases occurs through gills so the respiration is said to be **branchial.**
- Gills are present on both the sides of its head, they are covered by gill covers.
- During breathing fish takes in water through its mouth and pass it over the gills.The oxygen present in water is extracted by gills and water is removed out through gill slits. This oxygen is now absorbed by blood and carried to all parts of the body and at the same time carbon dioxide is released from the blood and comes back to the gills and is expelled out into the surrounding water.
- Same type of respiratory pattern is followed in some other aquatic organisms like prawns.

(d) Respiration in Grasshopper :

- In insects there occurs a system of tiny holes and air tubes all over the body. These tiny holes or openings are called as **spiracles.** This whole system facilitates the exchange of gases and is called as **tracheal system**.
- During breathing oxygen of air enters in the spiracle and reaches to each and every part of grasshopper's body through trachea and tracheoles and carbon dioxide produced during respiration is carried back by trachea and tracheoles to the spiracles and is expelled out of the body of insect.
- The same mechanism is followed in other insects like houseflies, mosquitoes, bees etc.

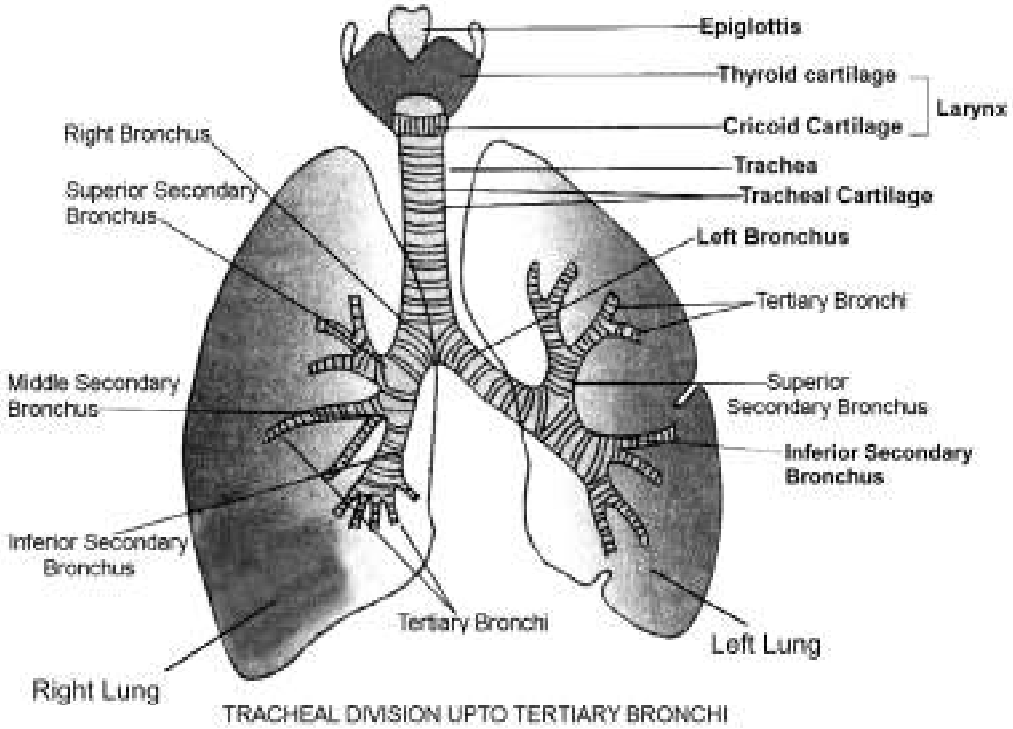


TRACHEAL SYSTEM OF INSECT

(e) Respiration in Humans :

- **Human respiratory tract :**

(i) External nostrils : First part of respiratory system. It opens into nasal cavity and is meant for inhalation of air from outside.



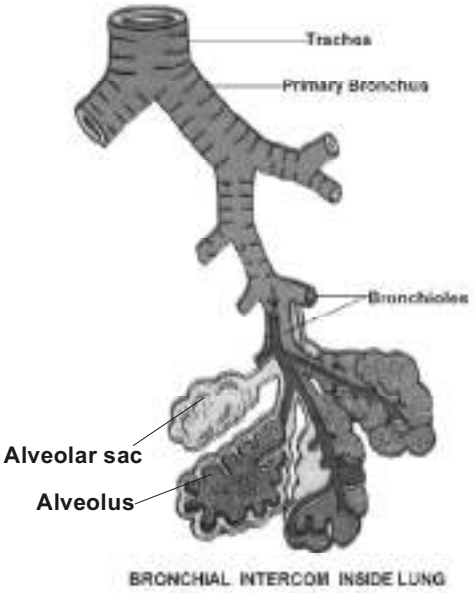
TRACHEAL DIVISION UPTO TERTIARY BRONCHI

(ii) Nasal cavity : This cavity is separated from oral cavity by means of a hard and bony palate. It is lined by **Pseudostratified ciliated columnar epithelial** cells which are rich in mucus, it brings about warming, moistening and sterilization of air. It contains hair and mucus which entrap the dust particles.

(iii) Internal nares : Nasal cavity opens into it and it leads to pharynx.

(iv) Pharynx : It is a common part between both alimentary canal and respiratory system.

(v) Larynx : It is an enlarged, upper part of trachea which is also called as **'voice box'**. It produces voice by passage of air between vocal cords. It contains three different types of cartilages. Among them a 'c' shaped thyroid cartilage protruding out in neck region is called **Adam's Apple**.



BRONCHIAL INTERCOM INSIDE LUNG

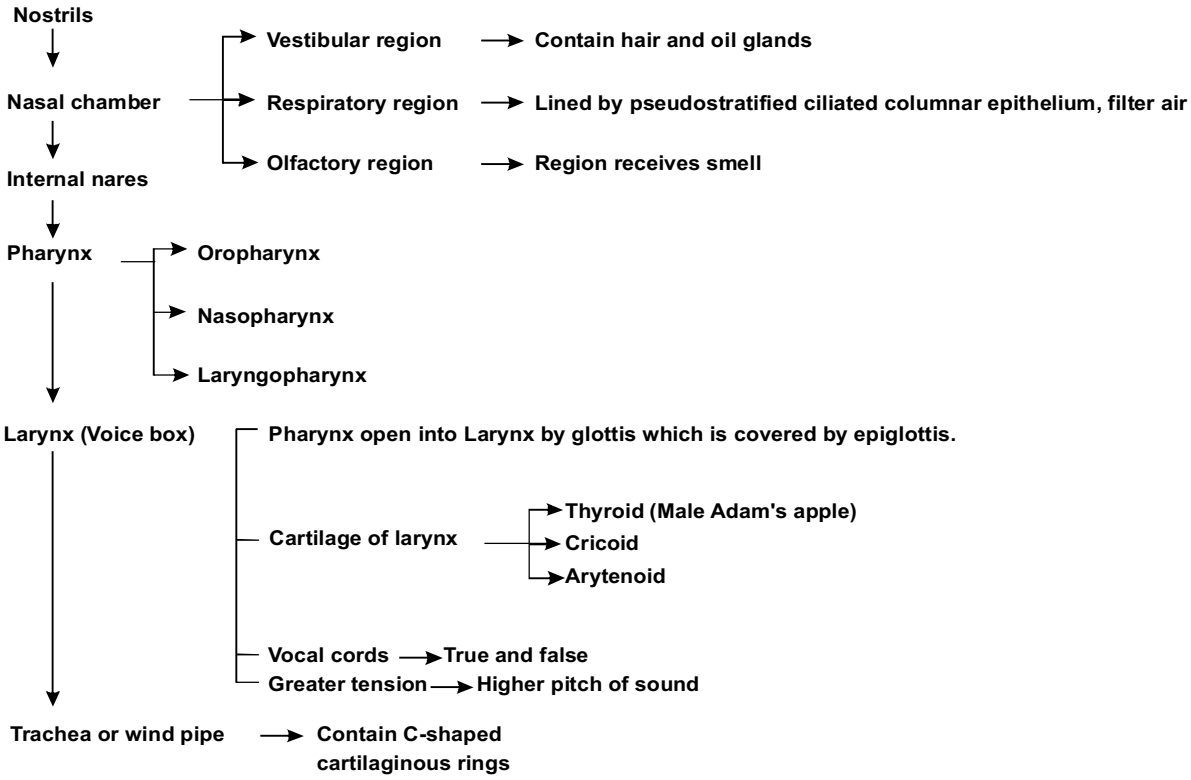
(vi) Trachea : It is also called wind pipe. It is 10-12 cm long tube. It's walls are supported by 16 – 20 'c' shaped cartilagenous rings which prevent them to collapse when air is absent in them.

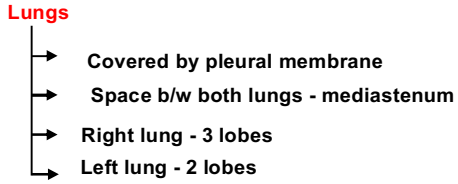
(vii) Bronchi : Trachea is branched into two bronchi left and right each of which enters into the lungs.

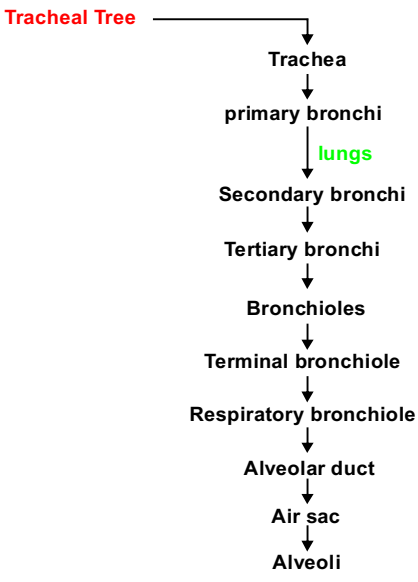
(viii) Lungs : These are two light weight spongy pouches covered by a membrane called **Pleura**. Bronchi are further branched into several bronchioles. At the end of bronchioles **alveolar sacs** or **alveoli** are present which are rich in blood capillaries and thin walled.

(ix) Diaphragm: It is a sheet of muscles that lies below the lungs and separates thoracic cavity from abdominal cavity.

Respiratory System of man







(f) Mechanism of Respiration :

◆ Mechanism of respiration includes 3 steps :

1. Mechanism of Breathing
2. Transportation of gases and mechanism of Gaseous exchange
3. Cellular respiration

1. Mechanism of breathing : It includes

(i) Inhalation: During breathing in of air the diaphragm and muscles attached to the ribs contract due to which there occurs expansion of chest cavity. It results increase in volume of chest cavity thus the air pressure decreases and air from outside rushes into the lungs and alveolar sacs get filled with air containing oxygen. The oxygen present in air diffuses into the blood and CO_2 from blood diffuses out into alveolar sac.

(ii) Exhalation : During breathing out of air the diaphragm and muscles attached to ribs relax, which brings about contraction in chest cavity. Its volume gets reduced and CO_2 is pushed out from lungs into the air through trachea and nostrils.

- The two types of muscles that help in breathing are:
  a. Diaphragm muscles
  b. Intercostal muscles (Present between ribs)
- Diaphragm becomes flat during inspiration and becomes convex during expiration.

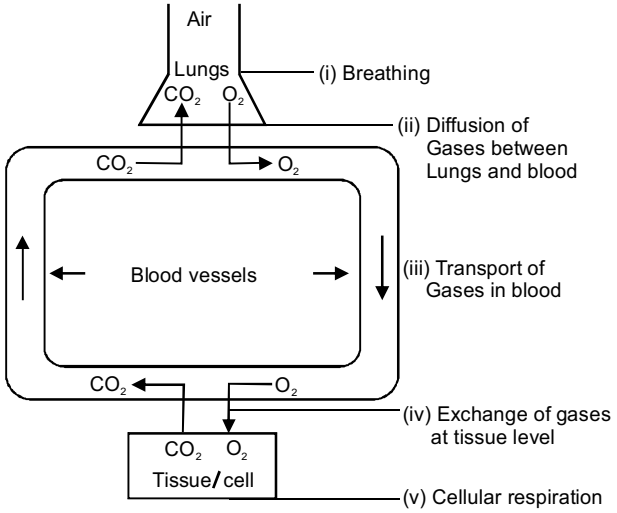
2. Transportation of gases and Mechanism of Gaseous Exchange Between Tissues and Blood : The air enters into the lungs through nostrils, trachea than bronchi from here it enters into the bronchioles, and than it moves into thin walled alveolar sacs or alveoli. Alveoli are rich in blood capillaries. At this place oxygen from air diffuses into the blood and is transported to all the cells and tissues of body. This oxygen now diffuses into the cells and is utilized for the oxidation of food and production of energy in mitochondria. As a result of this carbon dioxide is produced in cells, due to this increased concentration of CO_2 ,it diffuses into the blood and is brought back to alveoli and expelled out of the lungs through trachea and nostrils.

- Blood is the medium for the transport of oxygen from the respiratory organ to the different tissues and carbon dioxide from tissues to the respiratory organs.

(i) Transport of oxygen: There are two ways for oxygn transport. As much as 97 per cent of the oxygen is transported from the lungs to the tissues in combination with haemoglobin and only 3 percent is transported in dissolved condition by the plasma.

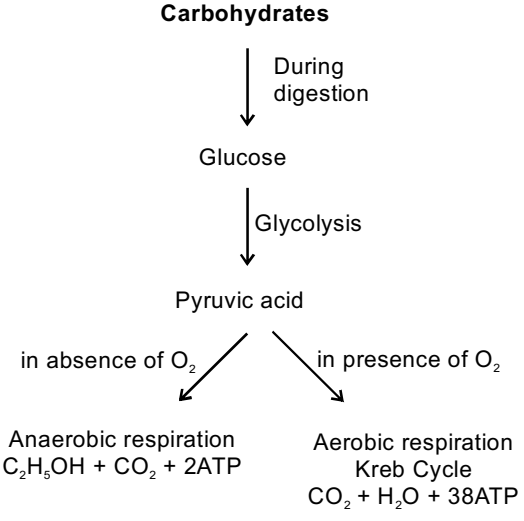
(ii) Transport of Carbon dioxide: Carbon-dioxide is transported from the tissues to the lungs by three methods. When a respiring tissue releases carbon-dioxide, it is first diffused in the blood. From here it diffuses into the red blood cells. About 23% of carbon dioxide entering into the erythrocytes combines with the globin (protein) part of haemoglobin to form **carbaminohaemoglobin**, which is transported to the lungs. About 70% of carbon-dioxide is transported in the form of bicarbonates dissolved in water. Only 7% is transported in dissolved form in plasma.

- **Note:** A normal person has about 15 grams of haemoglobin per 100 ml of blood. One gram of haemoglobin binds about 1.34 ml of O_2. Thus, 100 ml of blood carries about 20 ml of oxygen.



3. Cellular Respiration : It refers to the oxidation of food taking place inside the cell. As this process is at cellular level so it is called cellular respiration. It takes place in three steps :

(i) Glycolysis
(ii) Kreb Cycle
(iii) Electron Transport System



(A) Glycolysis : Glycolysis also called **EMP (Embden Meyerhof Parnas) pathway** :

- **Site-**cytoplasm of cell.

(i) In this cycle glucose is converted into pyruvic acid in presence of many enzymes and co-enzymes.

(ii) Oxygen is not required during glycolysis.

(iii) 1 molecule of glucose gives rise to 2 molecules of pyruvic acid.

(iv) In this process 4 molecules of ATP are formed among them 2 ATP molecules are utilized thus net gain of 2 ATP molecules.

(v) 2 NAD molecules are reduced to 2 $NADH_2$, which later produces 6ATP molecules.

(vi) Net production of ATP in glycolysis is **2ATP + 6ATP = 8 ATP.**

(vii) There is no production of CO_2 during this process.

- **NOTE :** After glycolysis, pyruvic acid is converted into acetyl Co-A with the release of CO_2 and the process is called as **'oxidative decarboxylation'**. It occurs in mitochondria of the cell. Besides this 2 NAD molecules are reduced to 2 $NADH_2$, which later produces **6ATP** molecules.

(B) Kreb Cycle :

Site : Mitochondria of cell

(i) Also called aerobic oxidation.

(ii) Discovered by **Sir Hans Kreb**.

(iii) Another name **TCA cycle (tricarboxylic acid cycle)** or **Citric acid cycle**.

(iv) It brings about the conversion of pyruvic acid, fatty acids, fats and amino acids into CO_2 and water by oxidation.

(v) It is the common path for oxidation of carbohydrates, fats and proteins.

(vi) It starts with acetyl Co-A which is then converted into several intermediate compounds with the release of **ATP**, hydrogen atoms (**$NADH_2$ and $FADH_2$**) and then Acetyl Co-A is regenerated back.

(vii) For each glucose molecule the Kreb's cycle occurs twice, so produces **2 ATP, 6 $NADH_2$** and **2 $FADH_2$**. Therefore it accounts for total **24 ATP** molecules.

(C) Electron Transport System or ETS :

- **Site :** Mitochondria of cell

(i) In this hydrogen atoms produced during oxidation of various intermediates during Glycolysis, Oxidative- decarboxylation and Kreb cycle are first broken into protons and electrons.

(ii) These protons and electrons after passing through a series of coenzymes and cytochromes combine with oxygen to form water molecules.

(iii) During these series of events 1 $NADH_2$ releases 3ATP molecules and 1 $FADH_2$ gives 2ATP molecules which were produced during kreb cycle and glycolysis.

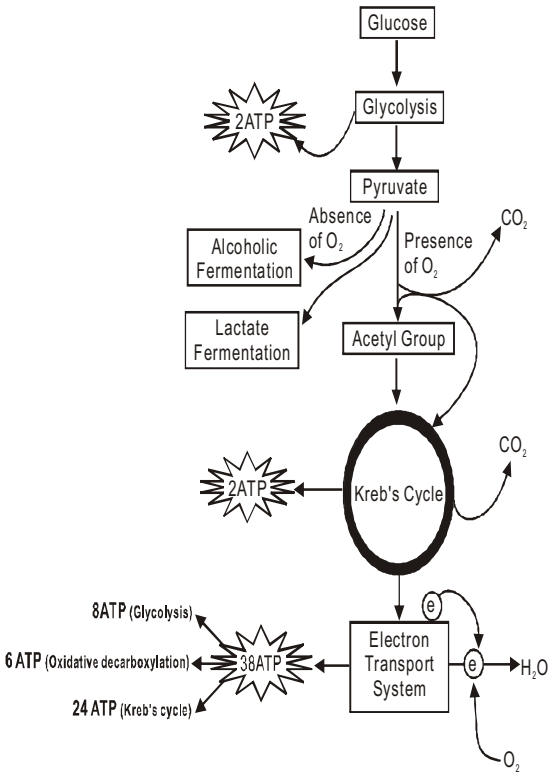
- **Note :** The net gain of ATP molecules during respiration is 38ATP molecules among them:

  (A) 8ATP from glycolysis

  (B) 6 ATP from conversion of pyruvic acid into acetyl Co-A.

  (C) 24 ATP from kreb cycle

- Besides this CO_2 and H_2O are also released.



(d) Control of Respiration :

Respiration is controlled by the respiratory centre situated in medulla oblongata of brain.

(i) Breathing occurs involuntarily.

(ii) Under normal conditions rate of breathing is 12-18 times per minute. During vigorous exercise, the demand of oxygen increases due to which rate of breathing increases by about 20-25 times.

(iii) The total area for gas exchange covered through 300 million alveoli is about 36-72 m^2 in each lung. The total area for gas exchange provided by our 750 million alveoli in two lungs is 100 Sq.m.

(e) Respiratory quotient :

It is defined as the ratio of the volumes of CO_2 liberated to the volume of O_2 used during respiration.
R.Q. (Respiratory quotient.) =

$$\frac{\text{Volume of } CO_2 \text{ evolved}}{\text{Volume of } O_2 \text{ absorbed}} = \frac{CO_2}{O_2}$$

Value of RQ depends upon the type of 'Fuel substance' being utilized for energy production.

- When carbohydrate are the respiratory substrate. R.Q. = 1
- When fats are respiratory substrate, R.Q. = 0.7
- When proteins are respiratory substrate, R.Q. = (0.5 – 0.9).
- For Anaerobic respiration, RQ = ∞

DIFFERENCES BETWEEN RESPIRATION & PHOTOSYNTHESIS	
RESPIRATION	**PHOTOSYNTHESIS**
It is a catabolic process.	It is an anabolic process.
Carbohydrates are broken down (oxidized).	Carbohydrates are synthesised.
Energy is liberated in the form of ATP.	Light energy is stored in the form of glucose or chemical energy.
The amount of CO_2 in the air increases during respiration.	The amount of CO_2 in the air decreases during photosynthesis.
It takes place in all the living cells, both green and non-green	It takes place only in chlorophyllous cells.
Dry weight of plant decreases.	Dry weight of plant increases.
Oxidative phosphorylation occurs.	Photophosphorylation occurs.
O_2 is utilized & CO_2 and H_2O are formed.	CO_2 and H_2O are used while O_2 is evolved.
$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy.	$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyl}]{\text{Sunlight}}$ $C_6H_{12}O_6 + 6O_2 + 6H_2O$.

DIFFERENCES BETWEEN RESPIRATION AND COMBUSTION		
S.NO.	**RESPIRATION**	**COMBUSTION**
1.	It is a biochemical process.	It is a chemical process.
2.	It takes place at normal temperature.	It takes place at high temperature.
3.	Respiration is a slow process completed in several steps.Thus, the energy is also liberated in several steps and remain stored in the form of ATP.	Combustion is fast process in which the energy is liberated only in one step resulting in increase in temperature and production of fire.
4.	A series of respiratory enzymes are involved.	No enzymes are involved.

◆ **Some Respiratory Disorders :**

1. **Emphysema :** It occurs due to infection, smoking etc. It occurs due to obstructions in bronchioles caused by breaking of alveolar septa. Bronchiodialators and O_2 therapy are used for curing this disease.
2. **Asthma :** Air passages are narrowed and lead to obstruction in breathing.
3. **Pneumonia :** Lymph and mucus accumulate in alveoli and bronchioles. It occurs due to bacterial and viral infection.
4. **Bronchitis :** Swelling in living membranes of respiratory tract due to excessive smoking.
5. **Tuberculosis :** Bacterial infection in lungs.
6. **Pleurisy :** Inflammation of lung membrane (pleura) is called as pleurisy.

◆ **Mountain sickness :** It is also known as altitude sickness. At sea level the concentration of oxygen is about 21% and the barometric pressure averages 760 mm Hg. As altitude increases, the concentration remains the same but the number of oxygen molecules per breath is reduced. At 12,000 feet the barometric pressure is only 483 mm Hg, so there are roughly 40% fewer oxygen molecules per breath. In order to oxygenate the body effectively, breathing rate (even while at rest) has to be increased. This extra ventilation increases the oxygen content in the blood, but not to sea level concentrations. The fall in oxygenation of blood produces the symptoms of mountain sickness. These symptoms include breathlessness, headache, dizziness, nausea, vomiting, mental fatigue and a bluish tinge on the skin, nails and lips.

◆ Sudden contraction of diaphragm along with loud closure of glottis causes **Hiccough**.

◆ Sudden and violent expulsion of air through mouth and nose is called **sneezing**.

◆ **Volume and capacity of Lungs:**

(i) Tidal volume : It is the volume of air inspired or expired in relaxed position. It is around 500 ml per breath.

(ii) Residual volume : It is the volume of air left in the whole respiratory tract after forceful expiration. It is 1.5 liters.

(iii) Total lung capacity : Maximum amount of air the lungs can hold after forceful inspiration. It is called total lung capacity. It is about 5-6.0 liters.

(iv) Vital capacity : Maximum amount of air which can be breathed out through forceful expiration after a forceful inspiration. It is called vital capacity. It is 3.4-4.8 liters.

◆ Vital Capacity is more in athletes, mountain dewellers, non smokers.

◆ In breathing inhalation and exhalation is repeated 15 to 18 times in a minute and about 500 ml of air per breath is breathed in and out from lungs. In 24 hours, we breath in 15000 liters of air.

◆ **Carbon monoxide effect :** Carbon monoxide binds with haemoglobin about 230 times more readily than oxygen. When a person inhales carbon monoxide, it diffuses from the alveolar air to the blood and binds to haemoglobin forming

carboxyhaemoglobin. The latter is a relatively stable compound and cannot bind with oxygen molecules. So, the amount of haemoglobin available for oxygen transportation is reduced. The resulting deficiency of oxygen causes headache, dizziness, nausea and even death.

EXERCISE-1

1. The percentage of O_2 in inhaled air is about
(A) 21% (B) 16% (C) 79% (D) 4.4%

2. In human lungs. How many lobes are there ?
(A) 2 in left and 3 in right lungs
(B) 3 in left and 2 in right lungs
(C) 3 in each lungs
(D) 2 in each lungs

3. At high altitudes where there is less oxygen, the human body adapts itself by
(A) producing more red blood cells
(B) producing more white blood cells
(C) producing more blood platelets
(D) producing less number of RBC.

4. Structure which prevents the entry of food into the wind pipe is -
(A) pharynx (B) glottis
(C) epiglottis (D) gullet

5. Pyruvic acid is reduced to lactic acid anaerobically in -
(A) liver (B) muscles
(C) brain (D) skin

6. The covering of the lung is called
(A) Pericardium (B) Perichondrion
(C) Pleura membrane (D) Peritoneum

7. Which of the following shows branchial respiration ?
(A) Man (B) Fish (C) Snake (D) Birds

8. Which of the following is a characteristic of respiratory organ ?
(A) Thin walled (B) Vascular
(C) Moist (D) All of the above

9. In leaves the structure involved in gaseous exchange is -
(A) stomata (B) lenticle
(C) leaf surface (D) simple pores

10. During day time plants absorb-
(A) oxygen (B) nitrogen
(C) carbon dioxide (D) none of these

11. The end products of aerobic respiration are-
(A) sugar and oxygen
(B) CO_2, H_2O and energy
(C) water and energy
(D) none of these

12. The intermediate between glycolysis and TCA cycle is -
(A) pyruvic acid (B) glucose
(C) oxaloacetate (D) acetyl-Co-A

13. Respiratory quotient is
(A) CO_2 / O_2 (B) O_2 / CO_2
(C) CO_2 / N_2 (D) N_2 / CO_2

14. Oxygen is carried by-
(A) leucocytes (B) erythrocytes
(C) platelets (D) none of these

15. Epiglottis guards the opening of-
(A) eustachian tube (B) glottis
(C) larynx (D) internal ear

16. Skin is an accessory organ of respiration in-
(A) humans (B) frog
(C) rabbit (D) lizard

17. The blood coming out of lungs is richer than that entering into lungs in
(A) CO_2 (B) O_2
(C) both (D) none of these

18. The exchange of gases between the external air and the blood occurs in the.
(A) bronchus (B) bronchiole
(C) trachea (D) alveoli

19. Maximum amount of energy is released by the
(A) conversion of glucose into lactic acid
(B) conversion of glucose into pyruvic acid
(C) oxidation of glucose to carbon dioxide and water
(D) conversion of sucrose to glucose

20. When there is an increase of carbon dioxide in the blood
(A) heart beat is increased
(B) heart beat is decreased
(C) breathing rate and heart beat are increased
(D) breathing rate is decreased and heart rate is increased

EXERCISE-2

COMPETITIVE EXAM QUESTIONS

1. Of the following products, which is produced by both anaerobic respiration and aerobic respiration in humans ?
(IJSO/stage II/2009)
I. Pyruvate **II.** ATP **III.** Lactate
(A) I only (B) I and II only
(C) I, II and III (D) II and III only

2. If and when proteins are oxidized during respiration the energy yield is lesser than when carbohydrates or lipids are oxidized. This is primarily due to the fact that they have.
(IJSO/stage II/2012)
(A) relatively more oxygen
(B) relatively less carbon
(C) nitrogen that is not oxidized
(D) relatively less hydrogen

3. The actual path followed by a glucose molecule in the process of aerobic respiration for production of 36 or 38 ATP would be : **(IJSO/stage-II/2014)**
(A) Cytoplasm ——— mitochondrial matrix ——— oxysomes
(B) Cytoplasm ——— cytoplasm ——— F1 particles
(C) Mitochondrial matrix ——— F1 particles ——— oxysomes
(D) Mitochondrial matrix ——— oxysomes ——— cytoplasm

4. Raju Sharma, a 10th standard student participated in 100 meter sprint. During running he developed painful muscle contraction and fell down. The physical education teacher rushed to him and gave a hot water massage. Raju Sharma slowly recovered from the cramp. The teacher explained the physiology behind the cramp and the sudsequent relief. Identify the right explanation.
(IJSO/stage-I/2015)
(A) Because of the quick movement, the muscles looses its elasticity and are stressed. The inflammation developed during this process causes cramp. After hot water massage the inflammation subsides and the pain gets relieved.
(B) During vigorous physical activity, aerobic respiration in the muscles increases which leads to the accumulation of more CO_2 in the muscles. This causes cramps. Later CO_2 was relieved upon hot water massage resulting in pain relief.
(C) During vigorous physical activity, lactic acid accumulates in the muscles due to anaerobic respiration. This causes the cramps. Hot water massage improves the circulation of blood and O_2 in the muscles. As a result lactic acid is converted into CO_2 and water. Thus the pain gets relieved.
(D) During quick movements, the nerves will not co-operate with the muscles. There is a stimulus which is taken to spinal cord and the effector function was done by motor neurons which cause cramp. On hot water massage the stimulus was subsided. Thus the pain gets relieved.

5. The various parts of the human respiratory system are given below:
(i) Nasal passage (ii) Pharynx
(iii) Wind pipe (iv) Bronchus
(v) Bronchioles (vi) Alveoli
Identify the right sequence of air passage dunng exhalation.
(IJSO/stage-I/2015)
(A) vi, v, ii, iv, iii, I (B) vi, iv,v, iii, ii, i
(C) vi, v, iv, iii, ii, i (C) vi, v, ii, iii, iv, i

6. Which of the following is NOT produced by microbial activity ?
(IJSO/stage-I/2015)
(A) Yoghurt (B) Bread
(C) Vinegar (D) Antiseptics

7. During gaseous exchange in the alveoli, what happens to nitrogen ?
(IJSO/stage-I/2016)
(A) There is no net nitrogen exchange, as nitrogen is filtered out by the alveoli.
(B) The nitrogen is absorbed by the alveolus to form amino acids.
(C) The nitrogen is filtered out by the alveolus, as the nitrogen molecule is too large to cross the gaps in the capillaries
(D) There is no net nitrogen exchange, as the blood is saturated with nitrogen

8. Which of the following is true about ATP(
(IJSO/stage-I/2016)
(A) It is derivative of one of the nitrogenous bases that form DNA
(B) It splits into ADP and phosphate, and the energy produced is used by muscle cells to contract
(C) It is produced in both aerobic and anaerobic conditions.
(D) All of the above

9. Which one of the following statements is true about the fate of glucose, following oxidation in the presence and in the absence of oxygen?
(A) In absence of oxygen, glucose undergoes only up to glycolysis and pyruvate is converted to lactate, while in the presence of oxygen glucose undergoes only up to glycolysis and pyruvate is converted to acetyl-CoA in the cytosol.
(B) In absence of oxygen, glucose undergoes only up to glycolysis and pyruvate is converted to ethanol, while in the presence of oxygen glucose undergoes only up to glycolysis and pyruvate is converted to acetyl-CoA in the mitochondria.
(C) In absence of oxygen glucose undergoes only up to glycolysis and pyruvate is converted to acetyl-CoA, while in the presence of oxygen glucose undergoes only up to glycolysis and pyruvate is converted to lactate in the muscle.
(D) In absence of oxygen glucose undergoes only up to glycolysis and pyruvate is converted to lactate, while in the presence of oxygen glucose undergoes only up to glycolysis and pyruvate is converted to ethanol in bacterial cell.

TRANSPORTATION

TRANSPORTATION IN HIGHER PLANTS

The higher plants have specialized system for the transportation of materials inside the body. The transportation of materials is carried out by means of vascular tissues of the plants. The vascular tissues act as pipes or vessels. Through these vessels or pipes, water, minerals, salts, food etc. are transported in the plant body. In plants the medium of transportation is water. Water and food flows through the xylem (tracheids and vessels are the constituents of xylem) and phloem (sieve tubes and companion cells) respectively for various metabolic activities.

Tracheids and vessels are nonliving parts of xylem while sieve tubes and companion cells form the living parts of phloem. The terrestrial (land) plants absorb water and mineral salts through their roots. The area of young roots where most of the absorption takes place is the root hair zone. Root hair are the extensions of the epidermal cells. Root hair are delicate and do not live more than two days.

The root hair have sticky walls by which they adhere tightly to soil particles. The root hair absorb water from soil by the process of osmosis but take in mineral salts by diffusion.

- **In plants transportation can be categorized into two types :**

(a) Ascent of sap:

The water and mineral salts are transported from the roots to the leaves, flowers and other parts of the plant. The upward movement of cell sap (water and minerals) through the xylem is called **"ascent of sap"**.

(b) Translocation :

Phloem translocates the manufactured food (sugar) or starch from the leaves to the different parts of the plant including the roots.

- **Mechanism of Ascent of Sap :** The most suitable mechanism to explain Ascent of Sap is **Transpiration Cohesion Theory.** To undestand this theory, it is essential to know about transpiration.
- **Transpiration :** Most of the water absorbed is lost through the aerial parts of the plant into air by a process called **"transpiration".** Only two percent of total water absorbed is used up in various metabolic activities in the plant body. Transpiration is the loss of water from the living tissues of the aerial parts of the plant in the form of water vapours.There are three types of transpiration :
  - **(i) Cuticular transpiration** (through cuticle)
  - **(ii) Lenticular transpiration** (through lenticles)
  - **(iii) Stomatal transpiration** (through stomata)
- **Importance of transpiration :**

(A) It controls the rate of absorption of water from the soil.
(B) It is responsible for ascent of sap.
(C) It regulates the temperature of the plant.

- **Disadvantage of transpiration :**

(A) Most of the water absorbed by roots is lost by transpiration without serving any purpose. The energy spent by the plants in transpiration is wasted. So transpiration is a necessary evil.

- **Transpiration Cohesion Theory :** The main loss of water is through stomatal transpiration. Turgor pressure in the mesophyll cells of the leaf forces water outwards through the cell wall. Water evaporates from the surface of the cells into the air spaces of the spongy tissues and then passes into the outer atmosphere through the pores or stomata. The cell sap of mesophyll cells becomes concentrated by losing water and causes a drop in turgor pressure.

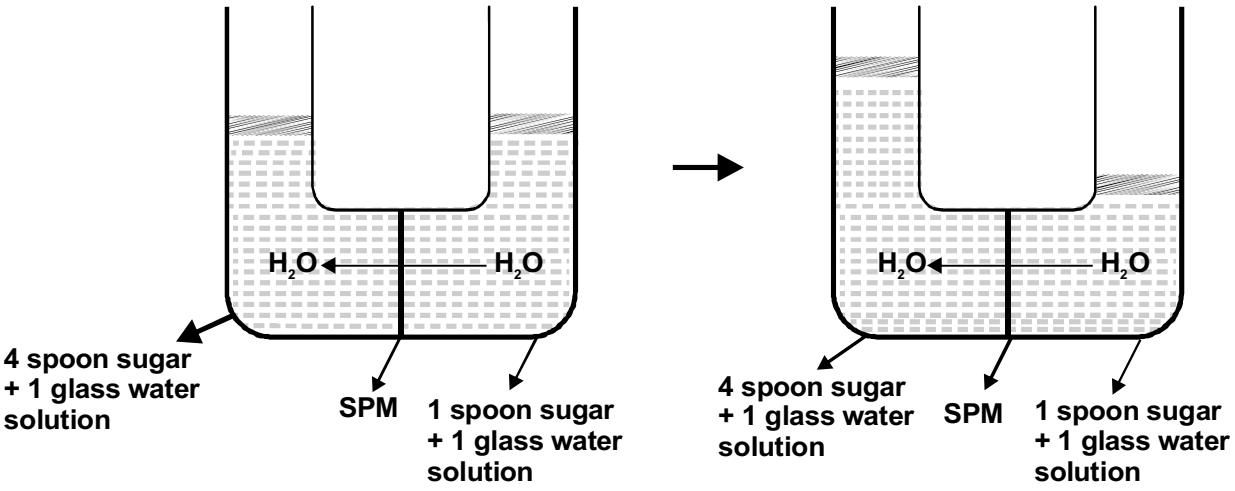
  As a result water is sucked from adjoining mesophyll cells and ultimately from vascular tissues. This tension is transmitted all the way down to the unbroken column of water through the stem to the absorbing parts of the root. The molecules of the water show cohesion (mutual attraction) and molecules of water and vessel wall show adhesion (affinity for water). Due to these adhesive and cohesive forces, water column does not break and pulled upward by the force called as **"transpiration pull".**

  The whole process can be compared with a person (transpiration pull) pulling a bucket full of water (forces on water column) from a well with a rope (column of water due to cohesion).

- **Diffusion :** The movement of atoms or ions or molecules from higher concertation to lower concentration region is called diffusion. It continues till equilibrium is not established between 2 regions.
  Diffusion rate : Gas > liquid > solid.
- **Diffusion pressure :-** The diffused molecules or ions exert a pressure, on the substance or medium in which diffusion takes place, konwn as diffusion pressure.
- **Osmosis :-** "It is defined as special diffusion of solvent molecules".

  Or

  Movement of solvent molecules from the region of higher concentration to lower concentration. Through a semi permeable membrane is called osmosis.



◆ **Osmotic pressure (OP) :-** The pressure developed in a solution which resists entry of solvent molecules into it when both solution and solvent are separated by SPM.

- OP is due to presence of solute into solution.
- OP of pure water is zero.
- OP is measured by "osmometer".
  Hydrophytes < Mesophytes < Xerophytes < Halophytes
- H_2O moves from lower OP to higher OP.

◆ **Significance of osmosis :-**

(a) Root hairs absorb water from soil by osmosis.
(b) Opening and closing of stomata.
(c) Conduction of water from one cell to another cell in plant occurs through osmosis.

◆ **Turgor Pressure & Wall Pressure :-** The pressure that is exerted by cell content against the cell wall is called TP(Turgor Pressure).

- The TP ancounter balanced by an equal but opposite pressure of the thick cell wall on the protoplasm. This is called wall pressure. So, TP & WP are equal, but opposit to each other.
  TP = WP
- TP of flaccid cell is zero.
- Increase value of TP is found in fully **turgid** cell.

◆ **Significance :**

(a) It is essential to maintain different shape of cell.
(b) It maintain structure of cell orgenelle.
(c) It controls opening and closing of stomata.

◆ DPD :- The difference between DP of solution and its pure solvent at particular temp is called DPD.

It was first used by B.S. Mayer.

- Its also known as demand of water in cell.
- DPD $\propto$ cone. of solute.
  DPD = OP - TP
  So in another terms difference between OP and TP of slution is called DPD.
- Its also known as suction pressure.

DPD of normal cell = OP-TP.

- In fully turgid cell = DPD = OP – TP
  OP = TP
  DPD = O
- In flaccid cell :
  DPD = OP – TP
  here TP = O
  So DPD = OP
- In plasmolysed cell
  DPD = OP – TP
  TP = –Ve
  DPD = OP – (–TP) = OP + TP

◆ Demand of Water : Plasmolysed cell > Flaccid cell > partially turgid cell > Fulling turgid cell.

- **Water potential (ψ_w) :**

- Difference between free energy of molecules of pure water and free energy of the solution is called water potential of the system.
- Its value is max. for pure water and lower down on addition of solute.
- Its represent by ψ_w (psi) / ψ_w and measured in bars / pascals.
- Its equal to DPD, but oppsite in sign, so its value is negative.
  ψ_w = – DPD and DPD = OP – TP
  $\psi_w = \psi_s + \psi_p$ (ψ_s= solute potential, ψ_p = pressure potential)
  ψ_s = – OP ψ_p = TP

Knowledge Booster

Movement of H_2O molecule
High DP→Low DP
Low OP→High OP
Low DPD→High DPD
High ψ_w → low ψ_w
High TP→ low TP
Concentrated solution←Dilute solution.

◆ **Plasmolysis :–** When a plant cell placed in a Hypertonic solution them, H_2O molecules diffused out from the cell, as a result of this protoplasm detached from cell wall and starts shrinking This. is called plasmolysis.

◆ **Significance :-**

(a) Various food items like fishes, meat jams and jellies can be preserved by plamolysis.
(b) It helps in removing of weeds by putting salts in their roots.

◆ **Permeability :-** Exchange of material throughout the membrane is called permeability.

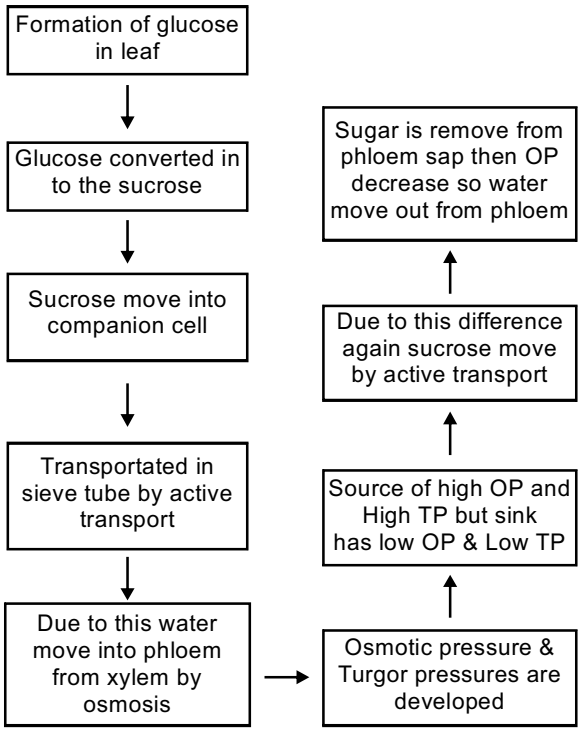
(a) Permeable membrane : It allows both solvent and solute eg = cell wall.
(b) Semipermiable membrane : It allows only solvent molecule through it e.g. parchment paper, gall bladder membrane
(c) Selective permeable membrane : It allows movement of only selected solute and solvent molecule to pass through it e.g. plasma membrane.
(d) Impermeable membrane : It doen't allow any molecule to pass through it. e.g. rubber membrane cutinised cell membrane.

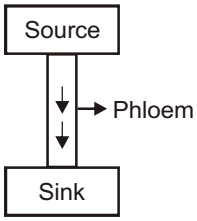
◆ **Types of Solution :**

(a) Isotonic solution : If the concentration of outer solution is equal to cell sap concentration, then its called isotonic solution.
(b) Hypotonic solution : If concentration of outer solution is less as compared to cell sap on concentration, then its called hypotonic solution.
(c) Hypertonic solution : If concentration of outer solution is higher than that of cell sap concentration , then its called hypertonic solution.

◆ **Transportation of Food :**

(a) Food is transported by vascular tissue phloem.
(b) In phloem movement of food is multidirectional. and in the form of sucrose.
(c) It can be explained by **mass flow hypothesis** proposed by **"munch"**.
(d) It is described as :-





TRANSPORTATION IN ANIMALS

- Among animals two types of circulatory systems are found :

(A) Open circulatory system **(B)** Closed circulatory system

TABLE : DIFFERENCES BETWEEN OPEN AND CLOSED CIRCULATORY SYSTEM

CHARACTERS	OPEN CIRCULATORY SYSTEM	CLOSED CIRCULATORY SYSTEM
Occurrence	In some annelids, most of molluscs and arthropods.	In most of annelids, cephalopods, molluscs and all vertebrates.
Position of blood	Blood does not remain confined in the blood vessels and comes in lacunae or sinuses.	Blood remains confined in the blood vessels.
Blood pressure	Blood flows at low pressure and cannot be regulated.	Blood flows at high pressure and can be regulated.
Velocity of blood	Blood flows at a low velocity.	Blood flows at a high velocity.
Exchange of materials	Direct exchange between blood and body cells.	Exchange occurs through the tissue fluid.
Respiratory pigment	When present, it is dissolved in blood plasma.	Always present and is usually present in RBCs e.g. vertebrates.
Efficiency	Less efficient as blood takes more time to complete one circulation.	More efficient as blood circulation is completed in short period.

- **Transportation in humans :** In humans there is a circulatory system (Closed circulatory system) that uses blood or lymph as carriers of materials (fluid exchange medium) and the heart as the pumping organ to help in circulation. Circulatory system consists of blood vascular system (blood as carrier) and lymphatic system (lymph as carrier).

(a) Blood Vascular System :

The higher multicellular animals with higher metabolic rates possess a well developed blood vascular system. This system helps in the quicker supply of nutrients and oxygen to the body tissues and also in the rapid disposal of toxic waste materials and carbon dioxide. The blood acts as the circulatory fluid. Blood vascular system consists of blood, blood vessels and heart.

(i) Blood : The blood is a specialized kind of living connective tissue which is made to circulate, by the muscular pumping organ called as **heart.** In adult human beings there is 5.5 to 6 liter of blood. The blood consists of fluid part (the plasma)and blood corpuscles . The red blood corpuscles (RBCs), white blood corpuscles (WBCs) and blood platelets are present in the plasma. The formation of blood is called **"Haemopoiesis".**

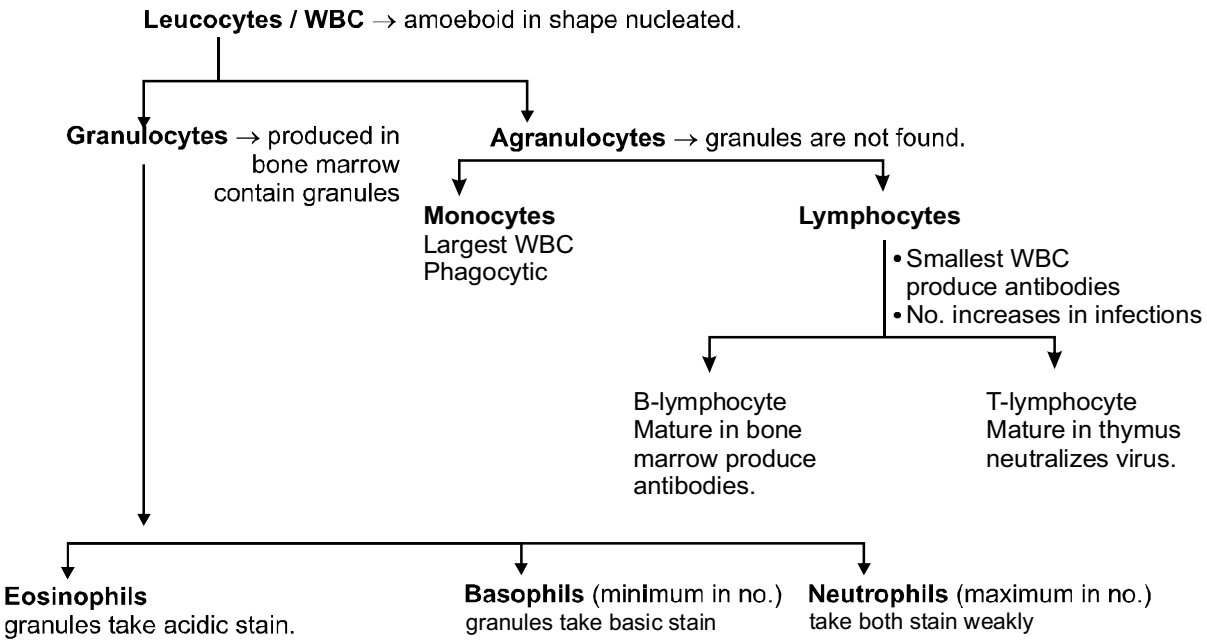
- **Plasma :** The plasma consists of water (90% & above) inorganic and organic substances. In the plasma, RBCs, WBCs and blood platelets float. Inorganic salts (0.9%) are also present. The organic substances are glucose, amino acids, proteins, hormones, digested and waste excretory products. The blood proteins (7%) are **fibrinogen, albumin, globulin and prothrombin.**
- **Note : Serum** is plasma from which fibrinogen is removed.(Plasma–Fibrinogen = Serum.)
- **Blood Corpuscles :**

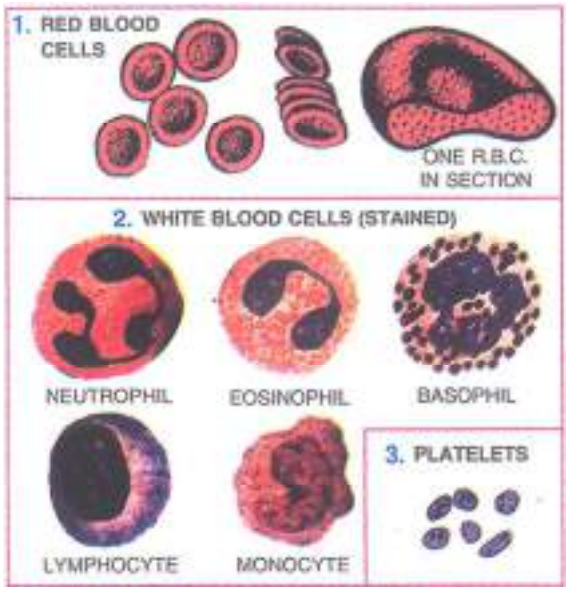
(A) Red Blood Corpuscles (RBCs) or Erythrocytes : The number of RBCs is about 5.5 million per mm^3 of blood. The total number of RBC is about 30 billion. Each RBC is a **biconcave disc-like structure devoid of nucleus.** The mammalian erythrocytes do not possess nuclei, mitochondria and endoplasmic reticulum. The erythrocytes contain haemoglobin. Haemoglobin consists of globin (protein) and Fe^{2+} porphyrin complex (haem). 100 ml of blood contains 15 g of haemoglobin. If the amount of haemoglobin in blood is less, the person suffers from anaemia. The haemoglobin carries oxygen to the different cells of the body and brings carbon dioxide from the cells. The life span of a RBC is 120 days.

(B) White Blood Corpuscles (WBCs) or Leucocytes The number of leucocytes is comparatively fewer i.e. $1mm^3$ of blood contains 5000 – 10000 leucocytes in humans. The total number of WBCs is about 75 millions. The number of leucocytes increases in infections like **pneumonia, blood cancer** (Leukaemia) etc. These are large in size and contain nucleus. White blood corpuscles are of two types :

1. **Granulocytes :** Contains granules in the cytoplasm. They are of three types: Eosinophils, Basophils and Neutrophils.
2. **Agranulocytes :** Monocytes and lymphocytes are two different types of agranulocytes. **Lymphocytes** secrete antibodies which destroy microbes. The **monocytes** are phagocytic in nature.

Flow Chart





(C) Blood platelets : These are small and without nuclei. Their number varies from 0.15 to 0.45 million per mm^3 of blood. Their normal life span is one week. These help in blood clotting at the site of injury by liberating **thromboplastin.**

- **Functions of Blood :** Blood performs the following functions :

1. **Transportation of nutrients :** The digested and absorbed nutrients like glucose, amino acids, fatty acids are first transported to the liver and then to all the tissues for their storage, oxidation and synthesis of new substances.
2. Transportation of respiratory gases : The respiratory gases (oxygen, carbon-dioxide) are transported by the blood. Oxygen is transported from the respiratory surface (lung, skin and buccal cavity) to the tissues and carbon dioxide from the tissues is taken to the respiratory organ for its removal.
3. **Transportation of excretory products :** Different wastes from the different parts of the body are collected by the blood and then taken to the organs (kidneys, lungs, skin and intestine) from where they are excreted.

4. **Transportation of hormones :** Hormones are produced by endocrine glands. These hormones have target organs (place to act). These are carried by the plasma of blood and bring about the coordination in the working of the body.
5. **Maintenance of pH :** The plasma proteins act as buffer system and maintains required pH of the body tissues.
6. **Regulation of body temperature :** The blood flows in all the parts of body, so it equalizes the body temperature. It carries heat from one place to another place in the body.
7. **Transportation of metabolic intermediates :** The blood carries metabolic intermediates from one tissue to another for further metabolism. In the muscle cells due to anaerobic respiration lactic acid is produced. This lactic acid is carried to the liver for further oxidation.
8. **Water balance :** The blood maintains water balance to constant level by distributing it uniformly in the body.
9. **Protection from diseases :** The WBCs (neutrophils and monocytes) engulf the bacteria and other disease causing organisms by phagocytosis. The B- lymphocytes produce antibodies to neutralize the action of toxins produced by pathogens.
10. **Clotting of blood :** Blood forms a clot at the site of injury and thus prevents the further loss of blood.
11. **Support.** Blood flows under pressure in arteries. Due to this tissue become stiff as in the case of erection of nipples, clitoris and penis.

◆ **Blood Clotting :** At the site of injury of the blood vessels, the platelets induce blood coagulation through the release of **thromboplastin** (thrombokinase). Thromboplastin changes prothrombin of blood plasma into thrombin. Thrombin converts soluble protein fibrinogen to insoluble fibrin. Fibrin forms a network which entangles RBCs and blood platelets to form plug or **clot** over the injured area. Blood clotting is usually completed within 2-3 minutes.

Injured tissue + Blood platelets $\longrightarrow$ Thromboplastin released

Prothrombin $\xrightarrow[Ca^{++}]{\text{Thromboplastin}}$ Thrombin

Fibrinogen (Soluble) $\xrightarrow{\text{Thrombin}}$ Fibrin (Insoluble)

Fibrin + Red blood corpuscles $\longrightarrow$ Clot of blood

◆ **Blood Groups : Landsteiner** discovered that blood of different individuals did not match each other but there were biochemical differences. He discovered Antigens A and B and blood groups **(ABO systems).** Antigen (agglutinogen) is a glycoprotein present on RBCs. For each antigen there is a corresponding antibody. Thus there are two antibodies (agglutinin) a and b occurring in the blood plasma. There are four types of blood groups depending on the presence or absence of these antigens.

TABLE : BLOOD GROUP : ANTIGEN AND ANTIBODY

Blood group	Antigen present on RBCs	Antibody in plasma
A	A	b
B	B	a
AB	AB	None
O	None	a, b

Blood is a life saving fluid. It is often needed during accident and operation. The transfusion of blood is only done when blood group is known. These groups are A,B, AB and O. Blood of O group is a universal donor i.e. it can donate blood to any group (A, AB, B and O) but it can receive blood from O blood group. A B group is a universal recipient (receiver). It can receive blood from any group (A, B, AB, O) but it can donate to AB group only.

◆ **Blood Transfusion :** The transfusion of blood from a healthy person to a patient suffering from blood loss due to injury or surgical operation is called as **"blood transfusion".** For this all major hospitals have **blood banks** where blood is collected from voluntary and professional donors. Before preservation the blood is tested for its blood group and Rh factor. Though theoretically a patient may be able to receive blood of two or more types, it is always advisable to have the donor blood of the same group as that of the recipient. The blood of donor is always cross matched before transfusion to exclude any chance of incompatibility. When blood from a donor is added to blood of the recipient, it is necessary to avoid bringing together corresponding antigen and antibody. This causes clumping of RBCs. Thus antigen A in RBCs of group A individuals reacts with antibodies of plasma of group B individuals. This phenomenon is called **"agglutination".**

TABLE : HUMAN BLOOD GROUPS AND TRANSFUSION

Blood group of donor	Blood group of recipient			
	O	A	B	AB
O	✓	✓	✓	✓
A	×	✓	×	✓
B	×	×	✓	✓
AB	×	×	×	✓

✓ **Compatible**
× **Incompatible**

◆ **Rh factor :** Rh factor is also a type of antigen found on RBCs. Rh factor (in blood) can be genetically determined. Most of the people (more than 85%) are Rh-positive (Rh^+) while a few are

Rh negative (Rh^-). Both people lead normal life. If an Rh^- woman marries with an Rh^+ man then Ist pregnancy is normal but in 2nd pregnancy the mother with Rh^- blood may lose the baby due to incompatibility of Rh factor. This is known as Erythro blastosis foetalis. By new techniques and procedures, now the child can be saved.

(ii) Blood Vessels : These are hollow tubes through which the blood flows.

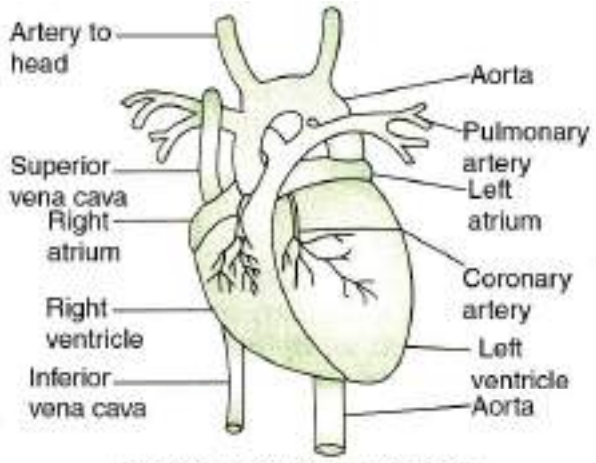
1. **Arteries :** These are thick walled and deep seated blood vessels which generally carry the oxygenated blood away from the heart to various body parts.
2. **Veins :** These are thin walled and superficially located blood vessels which generally carry deoxygenated blood from the body parts to heart.
3. **Capillaries :** These are thinnest blood vessels and connect the branches of arteries and veins which make the diffusion of various substances possible.

TABLE : DIFFERENCES BETWEEN ARTERIES AND VEINS

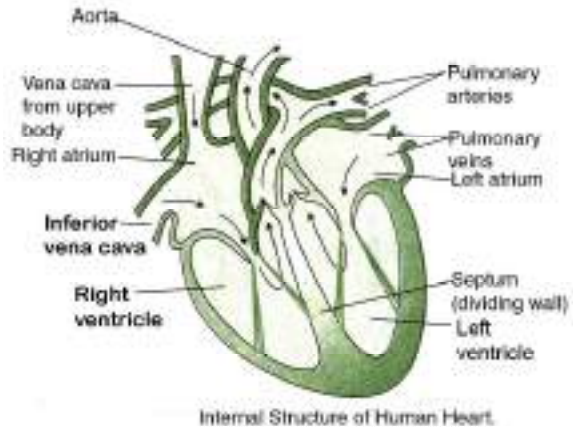
S.NO.	ARTERIES	VEINS
1	Mostly deeply located	Close to skin
2	Carry blood from heart to different organs.	From different organs to heart.
3	Blood flows at a high pressure with rhythmic contraction and dilation.	Blood flow under low pressure without rhythmic contraction and dilation.
4	Wall is non-collapsible, thick and strong	Collapsible, thin and weak.
5	Have no internal valves.	Valves are present.

(iii) Heart :

- Heart is a hollow muscular organ that lies obliquely in the thoracic region in a cavity between the two lungs that is **pericardial cavity**. It is lined by 2 layers outer and inner pericardial membranes. These are filled with a fluid called **"pericardial fluid".** It protects the heart from shock and injury.
- **Note:** Heart is 2 chambered in fishes **(Venous heart)**, 3 chambered in amphibians, incompletely 4 chambered in reptiles and 4 chambered in birds and mammals.
- Heart is made up of **4 chambers** : upper 2 chambers are auricles/atrium and the lower 2 chambers are ventricles. Auricles are the receiving chambers and ventricles are the pumping chambers. Walls of ventricles are thicker as they have to pump the blood.
- Partition between right and left auricle is called **"interauricular septum"** and between right and left ventricles is **"inter ventricular septum".**



External View of Human Heart.



Internal Structure of Human Heart.

- Four pulmonary veins enter into left auricle, two from each lung bring oxygenated blood. There is one auriculoventricular aperture with a bicuspid or mitral valve in left auricles which opens into left ventricle.
- Left ventricle has aortic valve having 3 semilunar cusps for large artery i.e. dorsal aorta which takes the oxygenated blood to all body parts.
- Right auricle has openings for superior venacava that brings deoxygenated blood from head, neck and upper limbs, inferior venacava receives deoxygenated blood from rest of the body and lower limbs. A coronary sinus that drains venous blood from heart muscles into right auricle. Blood enters in to right ventricle through tricuspid valve.
- Right ventricle has pulmonary valve having 3 semilunar cusps for pulmonary artery carrying deoxygenated blood to lungs.
- **Note :** During foetal condition a flap valve called "**foramen ovale**" is present at interauricular septum after birth this foramen closes remain as a depression called as **fossa ovalis**. If it remains after birth it results "a hole in the heart".

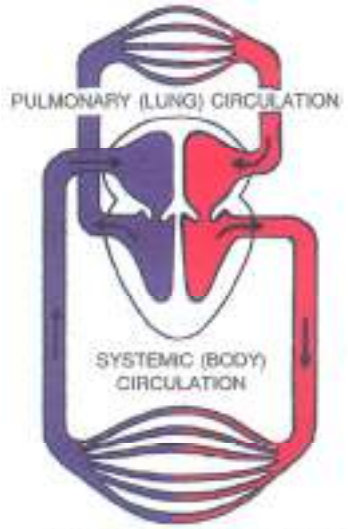
- **Types of circulation :**

1. **Single circulation :** In this, blood passes once through the heart to supply once to the body. It is found in fishes which have two chambered (one auricle and one ventricle).
2. **Double circulation :** In double circulation, the blood passes twice through the heart to supply once to the body.

- Double circulation involves two circulations :

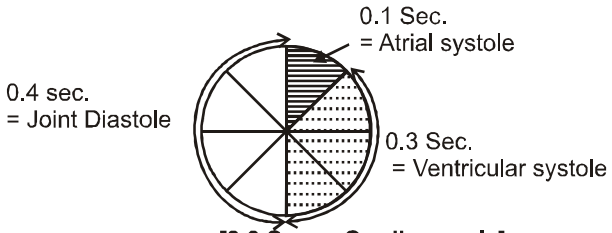
(i) Systemic circulation : Blood completes its circulation from left ventricle to right auricle through the body organs.

(ii) Pulmonary circulation : Blood completes its circulation from right ventricle to left auricle through the lungs.



General plan of double circulation of blood in the human body.

Cardiac Cycle : The series of events which occur during one heart beat is called as cardiac cycle.



[0.8 Sec. = Cardiac cycle]

◆ **Heart Sounds :**

(i) The first sound " LUBB" is produced when the atrio-ventricular valves get closed sharply at the start of ventricular systole.

(ii) The second sound "DUPP" is produced when at the beginning of ventricular diastole, the semilunar valves at the roots of aorta and pulmonary artery get closed.

◆ **Blood Pressure :** It is the pressure of the flow of blood in the aorta and its main arteries. The blood pressure varies according to the contraction and relaxation of the heart. In the condition of contraction or systolic phase (Lubb sound) it is about 120 mm of Hg. This is called **"systolic pressure"**. In the relaxation or diastolic phase (Dupp sound) it is about 80 mm of Hg and is called **"diastolic pressure".** The normal blood pressure of man (20 years) is 120/80. Fats and anxiety increases the blood pressure. The maximum normal blood pressure (systolic) should not exceed 150 in males and 140 in females.The blood pressure is measured by **"Sphygmomanometer".**

◆ **Detection of Normalcy of Heart Beat :** The muscle fibres of heart are specialized at certain parts called **sinoatrial node** (**SA node** or **pacemaker**) that generate tiny electrical currents which cause the normal heart beats. The **"electrocardiograph" (E.C.G.)** is the device to record these electrical changes. Electrocardiogram is a record of electrical behaviour of heart and remains constant in a normal man. Doctors use the E.C.G. for detection of various heart diseases. Sometimes the sinoatrial node (SA node or pacemaker) gets damaged and fails to generate cardiac impulses at normal rate. It becomes abnormally slow and irregular and ventricles fail to pump the required amount of blood. It can be corrected by the surgical grafting of an **artificial pacemaker instrument** in the chest of the patient. This instrument stimulates the heart electrically at regular intervals to maintain the beats.

(b) Lymphatic System :

The lymphatic system comprises the lymph, lymphatic capillaries (simply lymphatics), lymphatic vessels and nodes. Lymph serves as the middle man between the blood and organ for exchange of any Material. The lymph is the tissue fluid present in the intercellular spaces in the tissues. So it is also called as **"extracellular fluid".** The lymph resembles the blood except that the lymph is devoid of R.B.Cs, blood platelets and some plasma proteins. Lymphatic system runs parallel to the veins. The **lymphatic capillaries** are present in the form of network under epithelial surface .The ends of lymphatic capillaries are blind. The lymphatic capillaries unite to form lymphatic vessels and these vessels resemble with the veins. The lymphatic vessels possess the valves which prevent back flow of lymph. Neighbouring body muscles help in the flow of lymph. The small lymphatic vessels unite to form large vessels. Larger lymphatic vessels unite to form large ducts i.e. **right lymphatic duct** and **thoracic duct.** Right lymphatic duct opens into right subclavian vein and left thoracic duct opens in to left subclavian vein. Before the lymph reaches the blood, it always passes through the **lymph nodes.** The lymph nodes are enlargements of the lymphatic vessels. Lymphocytes and other plasma cells are present in the lymph nodes. The lymph is cleaned or filtered by lymph nodes. These cells also kill the germs and produce antibodies.

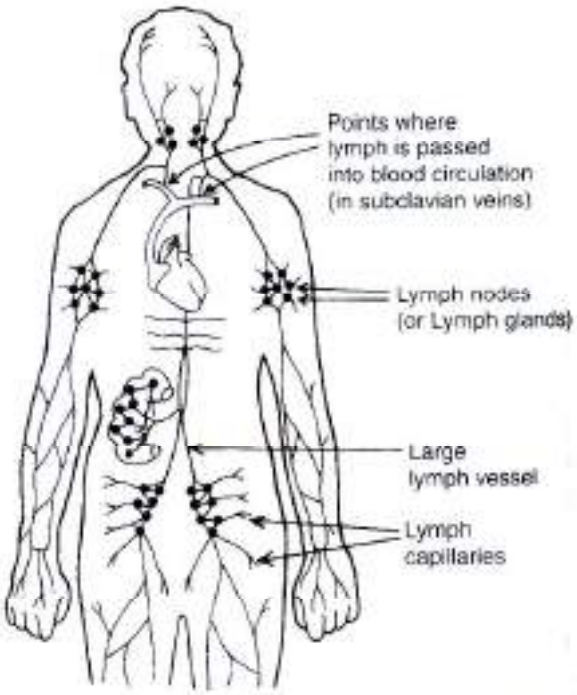


Diagram of human lymphatic system

◆ **Functions of Lymph :**

(i) It provides immunity through lymphocytes.

(ii) Fats are absorbed through lymph vessels in the intestine.

(iii) It supplies digested food and oxygen to various parts of the body.

(iv) It helps in removal of waste products like parts of dead cells.

(v) It returns proteins and excess tissue fluid to the blood from the tissue spaces.

EXERCISE-1

1. The clotting of blood requires –
(A) Vit K and Calcium
(B) Vit K and Potassium
(C) Calcium and Potassium
(D) None of the above

2. The erythrocytes of A, B, AB and O blood groups have distinct components on the surface. They are –
(A) Lipid (B) Fats
(C) Carbohydrates (D) Antigen

3. Which are not true cells in the blood ?
(A) Platelets (B) Monocytes
(C) Basophils (D) Neutrophils

4. The first heart sound is produced when :
(A) intraventricular pressure decreases
(B) semilunar valve snaps shut
(C) bicuspid and tricuspid valve close quickly
(D) diastole begins

5. Mitral valve in mammals guards the opening between–
(A) Stomach and intestine
(B) Pulmonary vein and left auricle
(C) Right atrium and right ventricle
(D) Left atrium and left ventricle

6. Bundle of HIS is a network of -
(A) Nerve fibres found throughout the heart.
(B) Muscle fibres distributed throughout the heart walls
(C) Muscle fibres found only in the ventricle wall
(D) Nerve fibres distributed in ventricles.

7. The walls of right ventricle are less muscular as compared to those of the left ventricle of a heart because
(A) the right ventricle receives blood from the body
(B) the right ventricle sends blood to the head
(C) the right ventricle pumps blood to lungs.
(D) the right ventricle pumps blood to the alimentary canal.

8. Tick the wrong statement –
(A) RBC are of red colour and WBC of white colour
(B) Red colour of RBC is because of haemoglobin
(C) Iron is necessary for synthesis of haemoglobin
(D) Erythrocytes are called suicidal bags

9 The path of water and minerals in plants during 'transpiration pull' is–
(A) root hair $\rightarrow$ root xylem $\rightarrow$ endodermis $\rightarrow$ root cortex $\rightarrow$ stem xylem $\rightarrow$ leaf xylem
(B) root hair $\rightarrow$ root cortex $\rightarrow$ endodermis $\rightarrow$ root xylem $\rightarrow$ stem xylem $\rightarrow$ leaf xylem
(C) endodermis $\rightarrow$ root hair $\rightarrow$ root xylem $\rightarrow$ root cortex $\rightarrow$ stem xylem $\rightarrow$ leaf xylem.
(D) root hair $\rightarrow$ endodermis $\rightarrow$ root xylem $\rightarrow$ root cortex $\rightarrow$ stem xylem $\rightarrow$ leaf xylem

10. Osmosis is defined as the process in which -
(A) water diffuses from lower concentration to higher concentration of solution
(B) solutes diffuse from lower concentration to higher concentration of solution
(C) active transport of ions takes place
(D) passive transport of ions takes place

11. Systolic pressure of heart is higher than diastolic pressure, because -
(A)* blood is forcefully pumped into arteries by the heart during systole and not during diastole
(B) arteries offer resistance to the flowing of blood during systole only
(C) arteries contract during systole only.
(D) volume of blood in heart is greater during systole than during diastole.

12. Persons suffering from high blood pressure should take the following precaution to avoid excessive rise in their blood pressure –
(A) sleep as much as possible
(B) avoid standing
(C) increase their weight
(D) avoid emotional disturbances and excitement.

13 A vein differs from an artery in having–
(A) narrower lumen
(B) strongly muscular wall
(C) pigmented wall to give it a dark appearance
(D) valves to control direction of flow of blood.

14. Both pulmonary and renal arteries–
(A) contain oxygenated blood
(B) have internal valves
(C) deliver CO_2 to the organs they supply
(D) have thick wall and narrow lumen

EXERCISE-2

COMPETITIVE EXAM QUESTIONS

1. In a wound, 'pus' is a,
(KVPY / 2007)
(A) A mixture of destroyed germs, killed leucocytes and damaged tissue cells
(B) Concentrated blood plasma
(C) Thick mucus secretion
(D) Concentrated secretion of the sebaceous gland

2. In an experiment to monitor the ascent of sap, the following treatments were carried out to a twig dipped in water. In which case wilting will be observed ?
(KVPY / 2007)
(A) Bark removed
(B) Pith removed
(C) Twig cut into half
(D) Glucose added to water

3. Root pressure on a tree is typically about 2-6 atm. This is sufficient to raise the water level upto a few feet. Tall trees get water at the top due to,
(KVPY / 2007)
(A) Capillary rise and suction
(B) A pump operating in the growing tree
(C) Fed by rain water
(D) Water content in the atmosphere

4. A cancer which is not a tumor is,
(KVPY / 2008)
(A) Lymphoma (B) Leukemia
(C) Prostate cancer (D) Oral cancer

5. Arteries do not have valves but veins do, because
(KVPY / 2008)
(A) Arteries have a narrower lumen than veins
(B) Arteries have thicker walls than veins
(C) Arteries carry oxygenated blood whereas veins carry deoxygenated blood
(D) Valves prevent backflow of blood in veins

6. An individual has O blood group if his/her blood sample.
(KVPY / 2009)
(A) Clumps only when antiserum A is added
(B) Clumps only when antiserum B is added
(C) Clumps when both antiserum A and antiserum B are added
(D) Does not clump when either antiserum A or antiserum B is added

7. In humans, Rhesus conditions can arise when,
(KVPY / 2009)
(A) father is Rh^+ and mother is Rh^-
(B) father is Rh^- and mother is Rh^+
(C) either father or mother is Rh^+
(D) either father or mother is Rh^-

8. Saturated dietary fats increase the risk of heart disease by
(KVPY / 2009)
(A) widening arteries by thinning their walls
(B) narrowing veins by carbohydrate deposition
(C) narrowing arteries by fat deposition
(D) narrowing arteries by carbohydrate deposition

9. The one that CANNOT be used for DNA fingerprints is -
(IJSO / 2009)
(A) leucocytes (B) erythrocytes
(C) hair bulbs (D) sperms

10. Thebecian valve is present
(IJSO / 2008)
(A) in between left atrium and left ventricle
(B) in between right atrium and right ventricle
(C) in the middle part of right atrium
(D) at the base of inferior vena cava

11. What is required to form a blood clot ?
(IJSO/stage II/2009)
I. Platelets **II.** Clotting factors.
III. Antibodies **IV.** Fibrinogen
(A) I and II only (B) I, II and III only
(C) I, II and IV only (D) I, II, III and IV

12. Which is the correct sequence of blood flow in normal human circulation ?
(IJSO/stage II/2009)
(A) Pulmonary vein $\rightarrow$ right atrium $\rightarrow$ aorta $\rightarrow$ vena cava
(B) Vena cava $\rightarrow$ pulmonary vein $\rightarrow$aorta $\rightarrow$right atrium
(C) Vena cava $\rightarrow$ right atrium $\rightarrow$pulmonary vein $\rightarrow$aorta
(D) Pulmonary vein $\rightarrow$vena cava $\rightarrow$aorta $\rightarrow$ right atrium

13. Which of the following pigments is different from others ?
(IJSO/stage II/2010)
(A) cyanoglobin (B) myoglobin
(C) haemoglobin (D) cytochrome

14. A desert room cooler cools better on hot and dry day due to
(IJSO/stage II/2010)
(A) increase in the rate of evapouration
(B) decrease in the rate of evapouration
(C) decrease in the rate of vapourization
(D) increase in the rate of diffusion

15. The pH of blood is maintained within the range 7.36 - 7.42 by
(IJSO/stage II/2012)
(A) CH_3COONH_4
(B) CH_3COONa/CH_3COOH
(C) $HCO_3/–CO_3$
(D) CH_3COOH

16. The relationship between respiration and photosynthesis is truly intricate. What will be the effect on the number of mitochondria and chloroplasts in a plant species occuring in higher altitude as compared to the same plant species in lower altitudes ?
(IJSO Satge-2 / 2012)
(A) number of mitochondria and number of chloroplasts will remain unchanged
(B) number of mitochondria in high altitude variety will be more
(C) number of chloroplasts in high altitude variety will be more
(D) both number of mitochondira and number of chloroplasts will be less in high altitude variety

17. A heart is said to be myogenic when it has pacemaker.
(IJSO Satge-2 / 2012)
(A) originating in motor nerves present in the heart muscles.
(B) originating in motor nerves present near the heart.
(C) made up of specialized muscle tissues and located in the heart itself.
(D) made up of specialized muscle tissues and located near the heart.

18. In angiosperm plants, companion cell is associated with which one of the follwoing elements ?
(IJSO Satge-2 / 2013)
(A) Sieve tube (B) Tracheids
(C) Vessels (D) Xylem fibre

19. The erythrocytes separated from human blood were mixed with certain fluids on a slide and observed under the microscope. Which of the following will be the expected result ?
(IJSO Satge-2 / 2014)
(A) With serum the cells clump and coagulate.
(B) With distilled water the cells swell and eventually burst.
(C) With sea water the cells undergo no apparent change.
(D) With tap water cells shrink and appear cremated.

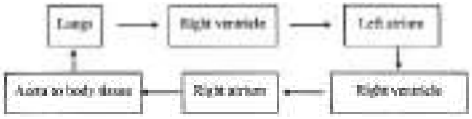
20. Which of the following has been proved to contribute to the transport of water in vascular plants ?
(IJSO Satge-2 / 2014)
i. Positive root pressure
ii. Hyrophilic cell walls
iii. Capillarity
iv. Transpirational pull
v. Cohesion between water molecules
(A) i, ii, iii, iv and v (B) only i, iii and v
(C) only i, ii, iv and v (D) only ii, iv and v

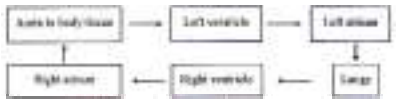
21. Use of excessive NKP fertilizers has resulted in :
(IJSO Satge-1 / 2014)
i. Reduction in number as well as species of nitrogen fixing bacteria
ii. Increase in number as well as types of denitrifying bacteria
iii. Increase in the proportion of coarse particles in soil.
iv. Increase in number as well as types of ammonifying microbes
v. Increase in number as well as types of nitrifying bacteria
(A) only i, ii and iii (B) only ii, iv and v
(C) only i and ii (D) i, ii, iii, iv and v

22. Seeds trapped in crevices of rocks soak in water, swell and cause fragmetnation of rock.The process involved is termed.
(IJSO Satge-1 / 2014)
(A) osmosis (B) imbibition
(C) tyndall effect (D) water potential

23. Students were studying cellular processes such as osmosis and plasmolysis. To make them understand the concept better, the teacher asked them to study the effect of a given solution on a specific plant cell. They placed the plant material in a given solution and studied the pattern of movement of water for about two hours duration. It was observed that there was no net movement of water during this period from the cell into the solution or vice a versa. Which of the following condition must be true in the given situation ?
(IJSO Satge-I/ 2015)
(A) Turgor pressure is more than the wall pressure.
(B) Turgor pressure is equal to the wall pressure.
(C) Turgor pressure is less than the wall pressure.
(D) Turgor pressure is zero and wall pressure has a negative value.

24. Which of the following sequence depicts the flow of blood in human circulatory system?
(IJSO Satge-I/ 2015)
(A)

(B)


(C)

(D)


25. Among the following, which is not true about vaccines ?
(IJSO Satge-I/ 2015)
(A) Vaccines contain dead microbial cells or their parts.
(B) Vaccines contain antibiotics to prevent diseases.
(C) Vaccine contain special proteins which evoke immune system against disease.
(D) Vaccines contain inactivated micro-organisms.

26. How many times would a red blood cell pass through the heart during one complete cycle ?
(IJSO Satge-I/ 2016)
(A) Once (B) Twice
(C) 4 times (D) 72 times

27. Which of the following does NOT contain living cells ?
(IJSO Satge-I/ 2016)
(A) Bone tissue (B) Xylem sieve tubes
(C) Phloem (D) Epidermis

28. If atmospheric humidity decreases, transpiration rate
(IJSO Satge-I/ 2016)
(A) Decreases because the concentration gradient between the mesophyll and the atmophere decreases.
(B) Stays the same because active transport does not depend on humidity
(C) increases because of the higher concentration gradient between the air spaces of the mesophyll and the atmosphere
(D) Decreases because the concentration of water vapour decreases

29. Choose the right combination of heart types and animals.

(A)

2 chamber	Sardine fish
3 chamber	Amphibians
4 chamber	Reptiles

(B)

2 chamber	Sardine fish
3 chamber	Gharial reptiles
4 chamber	Owl / birds

(C)

2 chamber	Gharial reptiles
3 chamber	Birds / owl
4 chamber	Human

(D)

2 chamber	Birds
3 chamber	Gharial reptiles
4 chamber	Fish sardine

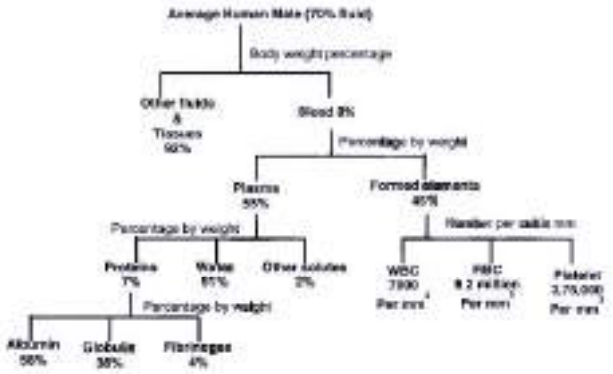
30. Ingestion, digestion, absorption, assimilation and egestion are the steps in food processing in our body. Majority of absorption takes place in small intestine (villi) and which is transported to different organs through the circulatory system. Starting with villi, which of the following is the correct sequence of organs that the absorbed food passes through ?
(IJSO Satge-II/ 2016)
(A) Liver → Other organs → Heart
(B) Heart → Liver → other organs
(C) Hear → Other organs → Liver
(D) Liver → Heart → Other organs

31. In an experiment involving treatments to demonstrate transpiration, six experimental setups were as follows:
i. Woody plant with only leaves coated with Vaseline jelly.
ii. Woody plant with only stem coated with Vaseline jelly
iii. Woody plant without any coating of Vaseline jelly
iv. Herbaceous plant with only stem coated with Vaseline jelly
v. Herbaceous plant with only leaf coated with Vaseline jelly
vi. Herbaceous plant without any coating of Vaseline jelly

Cobalt chloride ($COCl_2$) paper (changes from blue to pink when wet) was attached to the leaves and stem. The plants were cell watered and kept under adequate sunlight. The following were proposed :

	Colour change of $CoCl_2$ paper on	
Plants	Leaves	Stem
I	Blue	Blue
II	Pink	Pink
III	Pink	Blue
IV	Blue	Blue
V	Blue	Pink
VI	Pink	Blue

Which of the above is/are correct ?
(A) I, II and V (B) Only II
(C) III, IV and VI (D) Only V

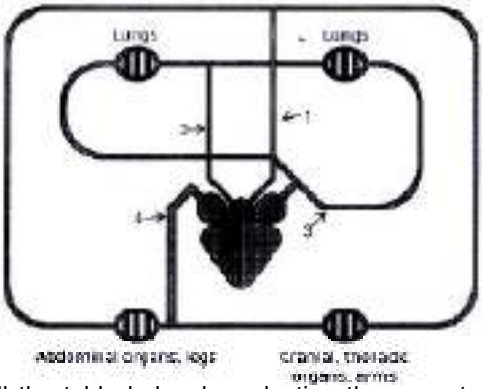


Composition of blood an Indian male

[WBC : 7000/mm^3, RBC : 5.2 million/mm^3, Platelets : 3,75,000/mm^3 of blood]

32. A The figure above represents the composition of human blood for an Indian individual weighing 70 kg.Assume the total fluid to be 70% of the total body weight and average density of whole blood = 1060 g/l. With there considerations now calculate the following :
I) Calculate the volume of blood present in a person weighing 70 kg. **[1.0]**
II) Calculate the total number of nuclear DNA molecules that will be present in the blood cells of the human. Consider that the human is genetically normal. **[1.0]**
III) Calculate the total number of moles of albumin present in the total human blood as shown in the above figure.(M.W.of albumin is 66kDa and assume that 1 a.m.u = 1g) **[2.0]**

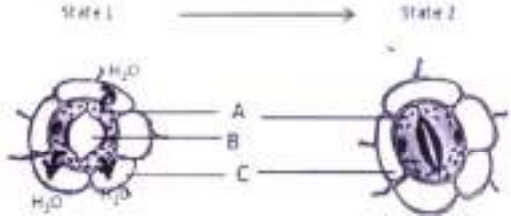
33. B The following is a schematic representation of the circulatory system of humans.



Fill the table below by selecting the correct option regarding composition of blood an direction of blood flow in regions labeled 1,2, 3 and 4 [2,0]

Label	Composition of blood (choose between oxygenated or deoxygenated)	Direction of flow (choose between away from or towards the heart)
1		
2		
3		
4		

34. (For question III - VI, provide only the correct option number in your answer sheet.)



I. Which of the following statements is TRUEor FALSE for state 1 and state 2 ? **[0.75]**

a) State 1 is observed specifically on the adaxial surface of mesophytic leaf during day time

b) State 2 is obtained when guard cells absrob moisture from- stomatal space.

c) Uneven thickness of guard cell wall favours the stomatal movement.

II. Consider the above figures and fill in the blanks. The labeled region designated as 'A' in the figure above is/are the epidermal cell(s) with (i) _____ (chloroplast / rhodoplast / leucoplast). In daylight (the region labeled as 'A') makes carbohydrates by the process of (ii)_____(chemosynthesis / photosynthesis / respiration). This (iii)_____(increases / decreases) the water potential of (the region 'A'). Water enters cell by (iv) _____(endosmosis / diffusion / pinocytosis) where by water moves from (v)_____(higher / lower) water potential to (vi)_____(higher / lower) water potential. Now, The region 'B' reaches state 1 due to (vii)_____(increase / decrease) in turgidity.

III. Closing of stomata is likely to cause the following physiological changes **[0.25]**

a) Decrease in the rate of photosynthesis.

b) Decrease in the rate of transpiration

c) Decrease in the rate of nitrogen fixation.

d) Decrease in the rate of water uptake

IV. Which one of the following represents the correct statement about the tonicity of environment around cell A in state 1 ?

a) The environment is hypertonic with respect to cell A.

b) The environment is hypotonic with respect to cell A.

c) The environment is isotonic with respect to cell A.

V. Water Potential is the difference in the free energy or chemical potential per unit molar volume of water in a system compared to that of pure water at the same temperature and pressure. Water potential of pure water at normal temperature and pressure is zero. This value is considered to be the highest. The presence of solid particles reduces the free energy of water and decreases the water potential. Therefore, water potential of a solution is always less than zero or it has negative value. If the water potential (Ψ) of guard cell placed in distilled water is measured as 0.0 MPa and the water potential (Ψ) of O.IM glucose solution is - 0.23 MPa, what will be result if guard cells are placed in O.IM glucose solution. **[0.25]**

(A) Glucose will flow into guard cells
(B) Water will flow into the guard cell
(C) Water will flow out from the guard cell
(D) Nothing will happen as the process will also depend on energy input.

VI. When chemical "X" is sprayed on plants, it results in wilting. The probable explanation for this is: **[0.75)**

(a) Stoma remains in state 1 for an extended period of time.

(b) Stoma remains in state 2 for an extended period of time.

(c) The stomatal pore gets blocked by the chemical.

EXCRETION

There are various metabolic activities which take place inside the living organisms. All these activities are chemical reactions. As a result in animal body several end products are formed which are of no use to the cells. These are called as **metabolic wastes.** These must be removed from the body for proper functioning of the body. The elimination of these metabolic waste products from the body is called as **excretion.** Waste materials are ammonia, urea, uric acid, carbon dioxide, pigments, salts, digestive wastes, excess of water etc. Ammonia, urea, uric acid are waste nitrogenous products.The excretory products are both volatile & non-volatile. These are removed from the body by different methods.

TABLE : FEATURES OF NITROGENOUS WASTES

S.NO.	NAME	TOXICITY IN TISSUES	SOLUBILITY IN WATER	MODES OF EXCRETION	EXAMPLES
1.	Ammonia	High	High	Ammonotelism	Aquatic invertebrates, bony fish, tailed amphibians.
2.	Urea	Medium	Medium	Ureotelism	Land invertebrates, cartilaginous fish, amphibians, mammals.
3.	Uric acid	Low	Poor	Uricotelism	Land insects, land reptiles, birds.

TABLE EXCRETORY ORGANS OF DIFFERENT ANIMAL GROUPS

S.NO.	ANIMAL GROUPS	EXCRETORY ORGANS
1.	Protozoans (e.g. Amoeba, Paramaecium)	Plasma membrane.
2.	Sponges (e.g. Sycon)	Plasma membrane of each cell.
3.	Cnidaria (e.g. Hydra)	Plasma membrane of each cell.
4.	Platyhelminthes (e.g. Planaria)	Flame cells (Solenocytes).
5.	Nemathelminthes (e.g. Ascaris)	H-shaped excretory system of canals and renette cells.
6.	Annelids (e.g. Neries, Earthworm)	Nephridia; chloragogen cells (yellow cells) in earthworm.
7.	Arthropods (a) Prawn (b) Most insects (c) scorpion and spiders	Antennary / Green glands Malpighian tubules, coxal glands, hepatopancreas and nephrocytes.
8.	Molluscs (e.g. Unio, Pila)	Kidney, In Unio kidneys are called organs of Bojanus.
9.	Echinoderms (e.g. Starfish)	Dermal branchiae and tube feet.
10.	Hemichordates (e.g. Balanoglossus)	Glomerulus.

HUMAN EXCRETORY SYSTEM

As a result of various metabolic processes going on in our body a number of waste products are formed. These have to be eliminated as they are toxic to the body.

◆ **The waste products include :**

(i) **Carbon dioxide** which is liberated during respiration; and is eliminated by the lungs.

(ii) **Nitrogenous metabolic wastes**, such as urea and uric acid produced in the liver from excessive proteins.

(iii) **Bile pigments :** Bile pigments **(e.g., bilirubin)** derived by the breaking down of haemoglobin of the erythrocytes, in liver.

(iv) **Excess salts, water and vitamins :** Concentration of these substances above the required level, is harmful to the body.

◆ **Organs of excretion :** In humans the excretory organs can divided into two broad categories:

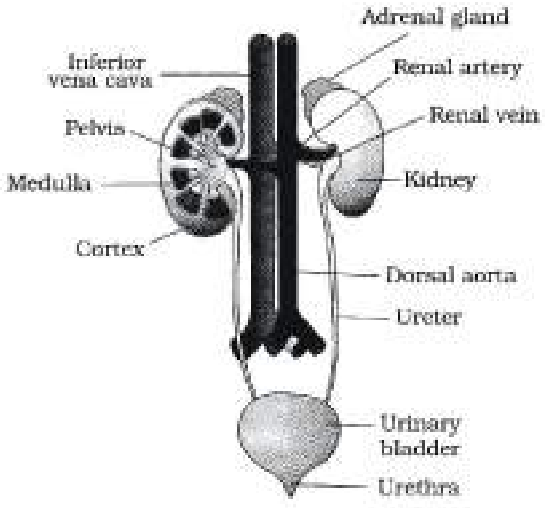
1. **Accessory or Secondary excretory organs:** These include-

(A) Lungs : Carbon dioxide produced by the oxidation of glucose or other food substances in the tissues is removed by the blood. This carbon dioxide is carried to the lungs through the blood vessels (veins) where it diffuses into the alveoli and out through the respiratory tract. Water vapour in small amount is also exhaled during expiration from the lungs.

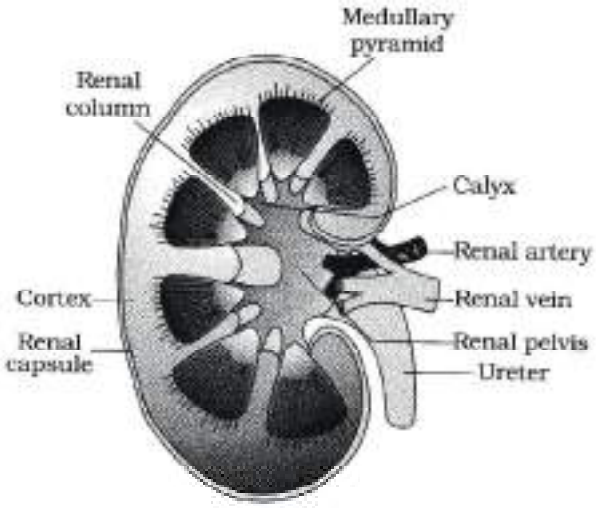
(B) Skin : Substances like soluble food matter, oxygen, water, dissolved mineral salts, traces of urea and uric acid diffuse from the thin walls of capillaries into the walls of the sweat glands. Oxygen and food substances are used for metabolic activities of the cells of sweat glands but the remaining metabolic wastes are excreted out of the gland through the sweat duct which opens on the surface of the skin through sweat pore. Sweat contains 99% water, traces of salts, urea and uric acid However, after heavy exercise, lactic acid forms a major constituent of sweat. Profuse sweating may lead to sodium deficiency, leading to muscle cramps. An adaptation of prevention of water loss is the impermeability of our skin to water. However, in aquatic animals, skin is the major excretory organ. They excrete ammonia through their skin by diffusion as ammonia is highly soluble in water.

2. Main or Primary excretory organ : Kidneys.

- The excretory system of man consists of two kidneys, two ureters, urinary bladder and urethra.
- **Kidney :**
- The kidneys are reddish-brown bean shaped structures present in the upper part of the abdominal cavity, on either side of the vertebral column.
- Each kidney is made up of large number of coiled tubes called **nephrons** (**uriniferous** or **renal tubules**).
- These filter the nitrogenous waste materials and excess of water and salts from the blood and form the urine.
- **Ureters :** These are a pair of long ,narrow, thin walled and tubular structure which starts from the kidney, run downward and open in urinary bladder.
- **Urinary bladder :** It is a thin walled, elastic, pear-shaped and distensible (able to swell) sac present in lower part of abdomen.
- The urinary bladder stores the urine. When the muscles around the urinary bladder contract, the urine is excreted out through a small opening called the urethra.
- **Urethra :** It is muscular and tubular structure which extends from the urinary bladder to the outside. It carries the urine to the outside.



Excretory System of Human



L.S. of Kidney

- **Structure of Nephron :** Structurally a nephron has following 5 parts:

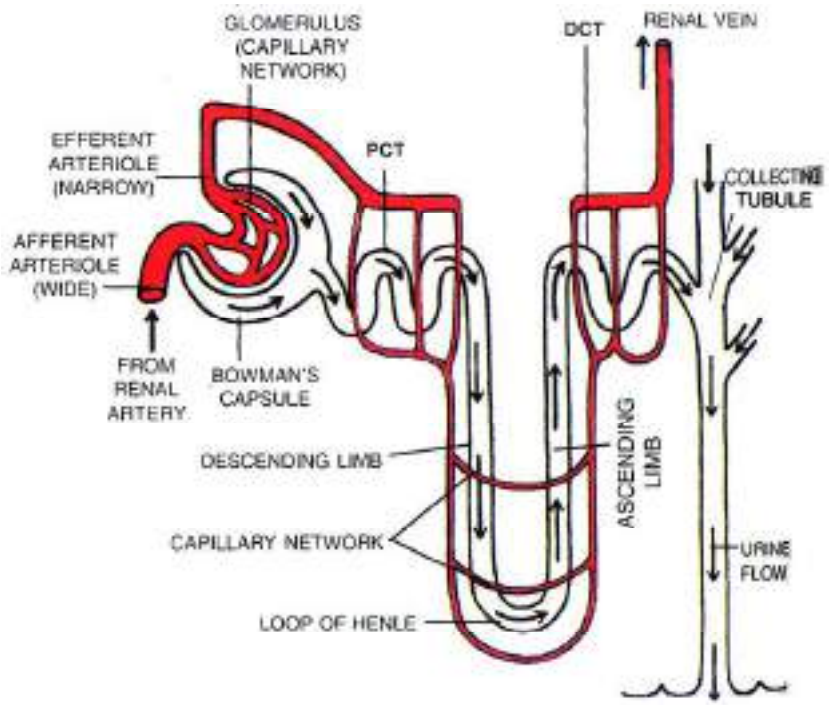


Figure : Structure of Nephron

(i) Bowman's capsule : It is a single-cell thick, double walled cup-shaped structure present in the cortex region of the kidney. The cup-shaped capsule contains a network of capillaries called **Glomerulus.** Glomerulus and Bowman's capsule are together called as **Renal corpuscle/ Malphigian body.**

(ii) Proximal convoluted tubule (PCT) : It starts after the Bowman's capsule and is greatly twisted. The whole PCT lies in the cortex region.

(iii) Henle's loop : Henle's loop is a U-shaped tubule located in the medulla region. It consists of

(A) a thin-walled descending limb in the medulla

(B) a thick-walled ascending limb in the medulla. Henle's loop is long in those animals which pass hypertonic urine.

(iv) Distal convoluted tubule : The ascending limb continues into the distal convoluted tubule which forms several coils in the cortex.

(v) Collecting duct : Collecting tubule receives distal tubules of several uriniferous tubules. Several such tubules unite to form a large collecting duct. The collecting ducts are held together and converge to form a **pyramid.** The pyramid opens into the pelvis which leads into the ureter.

- **Formation of urine :** Main function of nephron is to form urine. There are three main processes involved in the urine formation:

(i) Glomerular ultrafiltration : The blood flows through the glomerulus under great pressure which is much greater than in the capillaries elsewhere. The reason for this greater pressure is that the efferent (outgoing) arteriole is narrower than the afferent (incoming) arteriole. This high pressure (hydrostatic pressure) causes the liquid part of the blood to filter out from the glomerulus into the renal tubule. This filtration under extraordinary force is called ultrafiltration.

During ultrafiltration almost all the liquid part of the blood (plasma along with most of its organic and inorganic substances including urea, glucose, amino acids, etc.) comes out of the glomerulus and passes into the funnel shaped cavity of the Bowman's capsule .The fluid entering the renal tubule is called the **glomerular filtrate**. The glomerular filtrate consists of water, urea, salts, glucose and other plasma solutes. The thicker part of the blood left behind in the glomerulus after ultrafiltration, namely, the two kinds of corpuscles, proteins, and other large molecules are carried forward through the efferent arteriole. Thus, the blood proceeding away from the glomerulus is relatively thick.

(ii) Tubular reabsorption : Glomerular filtrate contains a lot of useful materials like glucose, salts such as that of sodium and water.
These substances are reabsorbed from the renal tubule at various levels and in varied proportions. But their reabsorption is only to the extent that the normal concentration of the blood is not disturbed. This is called selective absorption.

(iii) Tubular secretion : During this process substances like creatinine, potassium (K^+), hydrogen (H^+), NH_4^+, urea, foreign substance (pigments, drugs like penicillin) etc. are actively secreted into different parts of nephron (PCT, Henle's loop and DCT). This passage involves the activity of the cells of the tubular wall, and hence it is called tubular secretion.

- All these processes involved in urine formation require energy, hence the oxygen demand of the kidneys is 6 to 7 times higher than what is required by muscles.
- **Urine excretion** - Final urine passes into collecting ducts to the pelvis and through the ureter into the urinary bladder by ureteral peristalsis (waves of constriction in the ureters) and due to gravity. Urine is expelled from the urinary bladder through the urethra (in the penis in males, and directly in females) by relaxation of the urinary bladder into sphincter muscles located at the opening of the urinary bladder into the urethra under impulse from the nervous system. Such a process is called **micturition**.

◆ **Counter Current Mechanism in human**

- Mammals have the abil;ity to produce a concentrated urine.
- The Henle's loop and vasa recta play a significant role in this.
- The flow of filtrate in the two limbs of Henle's loop is in opposite directions and thus forms a counter current.
- The flow of blood through the two limbs of vasa recta is also in counter current patten.
- The proximity between the Henle's loop and vasa recta, as well as the counter current in them help in maintaining an increasing osmolarity towards the inner medullary interstitium, ie.e., from 300 $mosmol^{-1}$ in the cortex to about 1200 $mosmolL^{-1}$ in the cortex to about 1200 $mosmolL^{-1}$in the inner medulla.
- This gradient is mainly caused by NaCl and urea. NaCl is transported by the ascending limb of Henle's loop which is exchanged with the descending limb of vasa recta.
- NaCl is returned to the interstitium by the ascending portion of vasa recta.
- Similarly, small amounts of urea enter the thin segment of the ascending limb of Henle's loop which is transported back to the interstitium by the collecting tubule.
- The above described transport of substances facilitated by the special arrangement of Henle's loop and vasa recta is called the counter current mechanism
- This mechanism helps to maintain a concentration gradient in the medullary interstitium.
- Presence of such interstitial gradient helps in an easy passage of water from the collecting tubule thereby concentrating the filtrate (urine.)

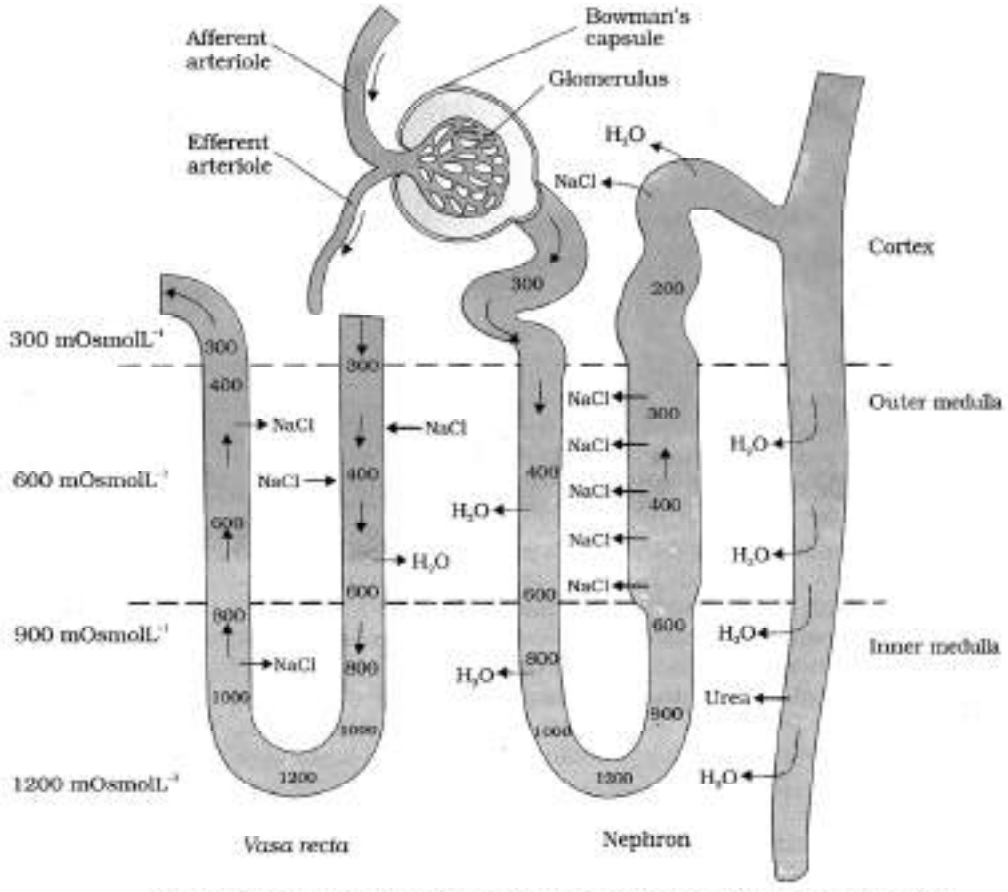


Figure Diagrammatic representation of a nephron and *vasa recta* showing counter current mechanisms

Knowledge Booster

"Counter current system in which transport between the inflow and the outflow is passive."
Example of counter current mechanisms :

a) Tongue of gray whale.
b) Flippers of whales and dolphins.
c) Legs of mammals and birds in cold environment.
d) Body - Responses to cold (in warm blood animals)

CHEMICAL COMPOSITION OF URINE

Normal human urine consists of about 95% water and 5% of solid wastes. Besides the normal constituents, certain hormones and medicines like the antibiotics and excess vitamins are passed out with urine. Organic compounds (gm/l) : Urea – 2.3; Creatinine – 1.5; Uric acid – 0.7. Inorganic Compounds are Ammonia – 0.6, NaCl, KCl. Normally a man excretes 1000-1750 ml of urine daily, depending upon the water intake, diet, climate, mental state and physiological condition. Tea, coffee, alcohol and other beverages increase the formation of urine.

ARTIFICIAL KIDNEY

In case of loss or damage of one kidney, the other kidney performs the function of both the kidneys and the person can lead a normal life. But the failure of both the kidneys leads to death. Artificial kidney is a **dialysis** machine which cleans blood of waste products, thus acting like a kidney.

Diseased kidney may be replaced with healthy one by **kidney transplantation.** To lead a normal life, one healthy kidney is more than enough. Therefore, a healthy person can donate his one kidney to a patient who has both kidneys impaired.

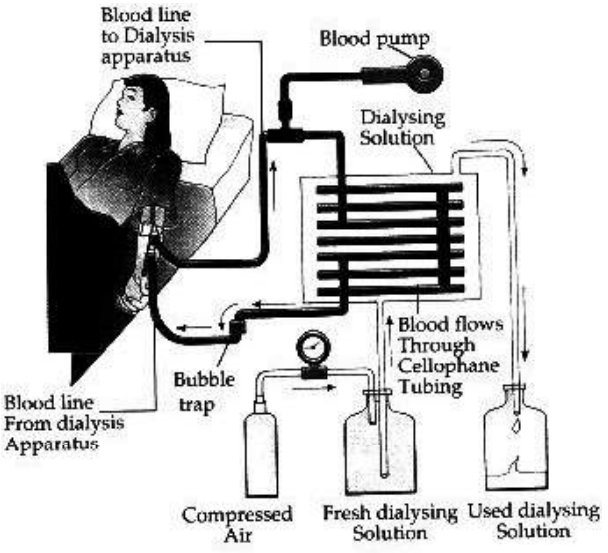


Figure : Artificial kidney

EXERCISE-1

Nitrogenous wastes

1. A man takes large amount of proteins. He is likely to excrete a great amount of–
(A) Urea (B) Sugar
(C) Uric acid (D) None of these

Organs of excretion

2. Kidney of a mammal resembles contractile vacuole of amoeba in expelling out–
(A) salt (B) glucose
(C) excess water (D) urea and uric acid

3. Which of the two organs of the body are most Important for homeostasis ?
(A) Skin and liver
(B) Liver & thyroid gland
(C) Liver and Kidneys
(D) Kidneys and spleen

4. Urea is transported by -
(A) Blood plasma (B) Leucocytes
(C) Haemoglobin (D) Erythrocytes

5. In mammals, the urinary bladder opens into -
(A) uterus (B) urethra
(C) vestibule (D) ureter

6. Urea is produced from ammonia in the body of rabbit or man in–
(A) liver (B) urinary bladder
(C) kidneys (D) blood

7. Kidney of a mammal resembles contractile vacuole of amoeba in expelling out–
(A) salt (B) glucose
(C) excess water (D) urea and uric acid

8. Kidneys regulate the amount of -
(A) salts (B) hormones
(C) proteins (D) enzymes

Urine Formation

9. The urine under normal conditions does not contain glucose because
(A) The normal blood sugar is fructose
(B) Glucose of blood is not filtered in the glomerulus
(C) Glucose in glomerular filtrate is reabsorbed in uriniferous tubules
(D) Glucose in glomerular filterate is converted into glycogen

10. During ultrafiltration from the capillaries of the glomerulus in to Bowman's capsule, which of the following substances do no filter but remain in the blood ?
(A) Water and glucose
(B) Urea and blood proteins
(C) Blood proteins and blood cells
(D) Fats and salts

11. Filtration of blood occurs in –
(A) Bowman's capsule (B) loop of Henle
(C) neck of nephrons (D) renal papillae

12. In which part of excretory system of mammals can you first use the term "urine" for contained fluid–
(A) Bowman's capsule (B) loop of Henle
(C) collecting tubule (D) urinary bladder

EXERCISE-2

COMPETITIVE EXAM QUESTIONS

1. Haemodialysis is a treatement option for patients with malfunctions of
(KVPY / 2009)
(A) Kidney (B) Heart
(C) Liver (D) Lungs

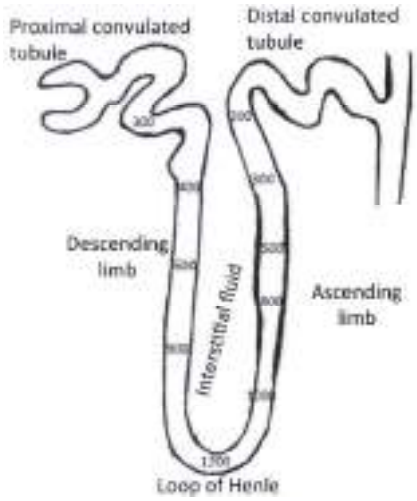
2. Podocytes are exclusively located in
(IJSO / 2008)
(A) liver (B) heart
(C) kidney (D) spleen

3. Where in the kidney does ultra filtration take place ?
(IJSO/stage II/2009)
(A) Glomerulus (B) Loop of Henle
(C) Proximal tubule (D) Collecting ducts

4. Urea is the principle excretary waste in larval as well as adult phases of :
(IJSO/stage I/2014)
(A) Cockroach (B) Crab
(C) Frog (D) Starfish

5. What is the mechanism used by the kidneys to remove waste products from the body ?(2016)
(A) Nephrons convert nitrogenous waste to uric acid and pass it out as urine.
(B) Nephrons actively transport uric acid and other nitrogenous waste A into the proximal and distal convoluted tubules, ,from where it is collected to form urine.
(C) The blood is filtered to retain cells and large plasma proteins with in the blood. The remaining filtrate passes through the proximal and distal convoluted tubules,where needed substances are reabsorbed. by active transporte.
(D) Nephrons filter out the nitrogenous waste which is passed through the proximal and distal convoluted tubules and collected by the collecting duct as urine

6. The nephron is a basic unit of kidney which is made of Bowman's capsule, Proximal convoluted tubule, loop of Henle and distal convoluted tubule. The proximal convoluted tubule absorbs major amount of water, glucose, other essential elements from the filtrate but still around 180 litre of filtrate passes through loop of Henle daily, out of which only 1 - 2 liters is thrown out of body in the form of concentrated urine. Hence Loop of Henle player a liters is thrown out of body in the form of concentrated urine. Hence loop of henle plays a crucial role in reabsorption of water and salts. The loop of Henle is located in medulla part of kidney and consist of descending and ascending limb. The ascending one has thicker wall which are non permeable to water. It is important factor for creating concentration gradient throughout the loop's length. The filtrate entering the loop has 300 units study the diagram and answer the following question. ***(IJSO/stageII/2016)***



(I) The concentration of filtrate increases as it passes down the descending tubule due to reabsorption of _____ in the intersitial fluid :
(a) NaCl (b) Water
(c) Amino acids (d) Glucose

(II) In ascending tubule the filtrate shows decrease in concentraion as it reaches distal convoluted tubule This is because of :
(i) active transport of water from interstital fluid to ascending tubule.
(ii) active transport of salts from ascending tubule to interstital fluid.
(iii) passive transport of salts from interstital fluid to ascending tubule.
(iv)passive transport of water from interstitial fluid to ascending tubule

(III) In an animal 'X', Loop of Henle is shorter than normal length. The result would be :
(i) It will excrete lesser amount of concentrated urine.
(ii) It will excrete same amount of urine without any difference.
(iii) It will excrete large amount of dilute urine.
(iv) It will excrete lesser amount of dilute urine

(IV) What is the likely habitat of such animal 'X'?
(i) Aquatic
(ii) Hot, Arid desert
(iii) Polar
(iv) Grasslands

(v) An artificial kidney is a device to remove nitrogenous waste products from the blood during dialysis. The device contains tube that are suspended in a tank filled with dialyzing fluid. The patient's blood is passed through these tube. During this passage, waste products from the blood pass into the dialyzing fluid.
The tubes of the artificial kidney are_____,while the dialyzing fluid is _____to the blood. The waste products from the blood pass into the dialyaing fluid by _____transport. "
(i) Semipermeable, isotonic, passive
(ii) Permeable hypotonic , active
(iii) Permeable, isotonic, passive
(iv) Semipermeable hypotonic active.

Living organisms respond and react to their external environment.

- Plants do not have any special structure for perception of stimuli. In plants control and coordination is performed by chemical substances known as plant hormones or phytohormone. Phytohormones are of five types namely Auxins, Gibberellins, Cytokinins, Abscissic Acid (ABA) and Ethylene.
- Multicellular animals except sponge have specialized cells called neurons for responding to stimuli. Neuron or nerve cell is the structural and functional unit of the nervous system. Nervous system includes brain, spinal cord and nerves. Nervous system and Endocrine or hormonal system control and coordinate body functions in animals.

CONTROL AND COORDINATION IN PLANTS

Movement of plant towards the direction of stimulus is called **tropism**. Bending of shoot towards light is called positive phototropism. Root of plants show negative phototropism. Downward movement is in response to gravitational force is called geotropism. Roots of plants shows positive geotropisms, stems show negative geotropism.

Other movements in plants which are caused by external stimuli but are not directional are called **nastic movements** (such as in touch-me-not plant).

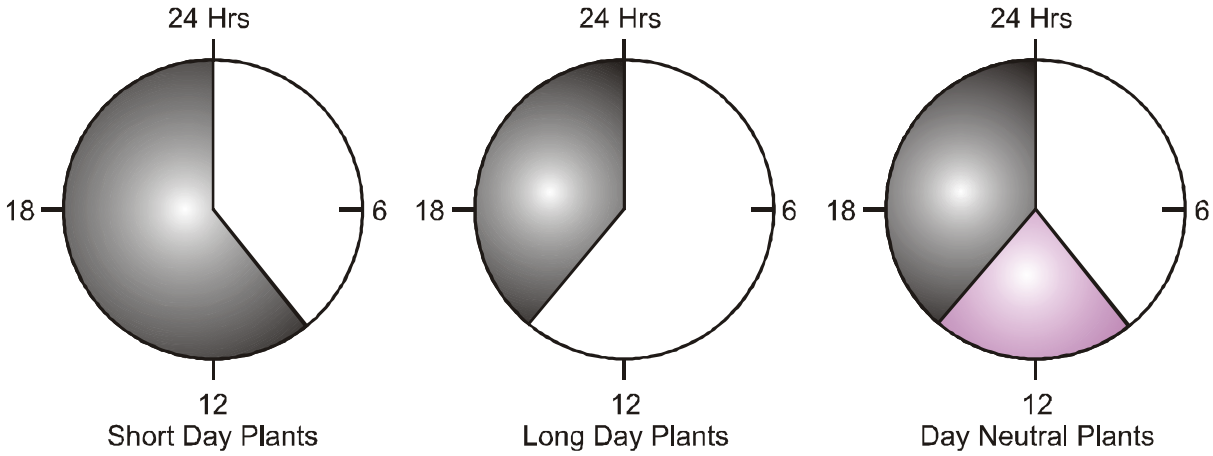
PHOTOPERIODISM

Flowering and germination of seeds in plants is controlled by duration of day light (photoperiod). This phenomenon is called photoperiodism.

On the basis of length of photoperiod requirements of plants, they have been classified into.

(i) Short day plants — Xanthium, Sugarcane
(ii) Long day plants — Spinach, Radish
(iii) Day neutral plants — Cotton, Sunflower

Response of plants to photoperiodic stimulus is due to a specialized pigment **phytochrome**.



Requirement of light and dark periods during 24 hours for flowering in short day, long day and day neutral plants.

- **Plant growth Regulators (PGR'S) :** The PGR's can be broadly by divided in to two groups on the basis of their function.
- **Function :**

i) **Plant growth Promoters :** These type of chemicals are involve in growth promoting activities like cell division, cell elongation, flowering etc. e.g. auxins, gibberellins, cytokinins.

ii) **Plant growth inhibitor :** These type of chemicals are involve in growth inhibiting activities like dormancy , abscission etc. e.g.ethylene, ABA.

(a) **Auxin :** Discovered by C.Darwin & F. Darwin First isolated from human urine.

S.NO.	NATURAL AUXIN	SYNTHETIC AUXIN
1.	Indol acetic acid (IAA)	Naphthalene acetic acid (NAA)
2.	4–cl-IAA	2,4–D (2, 4 - dichloro Phenoxy acetic acid)

- **A compound is consider as auxin if -**

(i) It causes cell elongation
(ii) It increase rate cell division.
(iii) Formation of adventious roots from cut part stem propogation.
(iv) Parthenocarpic fruit.
(v) Increase production of ethylene.

Knowledge Booster

Tryptophan is precursor of auxin.

- **Function of auxin :**

(i) Increase the stem length.
(ii) Increase the cell division & elongation.
(iii) Promote the root initiation.
(iv) Maintain the dormancy
(v) Inhibit the the abscission layer formation.
(vi) 2, 4-D is use as weedicides (for dicotyledonous weed mainly)
(vii) Promote flowering .
(viii) Show phototrophism (growth in respect to light)
ix) Induce vascular differentiation (formation of xylem & phloem).

(b) Gibberellins :

- Most of GA are the tetra cyclin diterpene.
- It means terpenes (Secondary metabolites of plant) are precursor of GA.
- Discovery of GA –
  E.Kurosaua reported it in rice plant in Japan. These rice plants have a specific disease called foolish seedling disease or Bakane disease.

Foolish seedling disease
↓
Caused by fungal pathogen Gibberella fujikuroi.
↓
due to it rice plant become too tall
↓
Fall down in H_2O (loding)

Can you think why ?

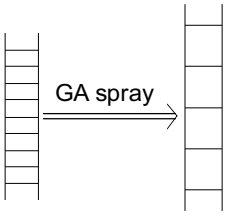
How can length of dwarf plant increased ?

Knowledge booster

100 types of GA are reported in fungi higher plants. They denote as GA_1, GA_2, GA_3. Most active form is GA_1.

- Function of GA

(i) Lengthring of internodes ⇒



(ii) Apple $\xrightarrow{\text{GA spray}}$ perfect shape of fruit and fruit sets are formed.
Grapes $\xrightarrow{\text{GA spray}}$ Size of grapes is increase.
(iii) induce parthenocarpy
(iv) Breaking of Dormancy.
(v) Promote flowering and seed germination.
(vi) Beer production and malting process.

Can you think why ?

How can you say the ABA act as antagonistic to the GA.

vii) Increase the rate of fermentation so that it is used in Bakery.

Can you think why ?

If we spray GA on sugarcane and Cabbage than it is benificial for suagrcane but not for cabbage.

(c) Cytokinins (CK) :

- They are adenine (Purine) derivative.
- "Kinetin & (6-furfuxyl amino purine) is first discovered cytokinin - it is discover by miller and F - skoog. in auto claved herring sperm DNA.
- "Kinetin" is not natural cytokinin it is synthetic analogous of cytokinin.
- "Zeatin" is most abundantly accuring Natural cytokinen. It first isolated from corn - kernels (endosperm of maize).
- Cytokinin are synthesised in regions where rapid cell division occur like root apices, developing shoot buds young fruits etc.

Knowledge Booster

Cytokinin is also known as " Coconut milk factor.

◆ **Function of Cytokinin :**

- Increase the number of leaves.
- Increase the amount of chlorophyll in leaves.
- Increase the cell division.
- Breaking of dormancy.
- Promote the nutrient mobilization.
- Cytokinin have specific effect an cytokinesis
- Promote the cell division with auxin.
- Show "Richmond lang effect" (Cytokinin delay the senescence).
- Disappearance of chlorophyll and degradation of protein are two main symptom of protein and cytokinins delay these process.
- Cytokinine promote the nutrient **mobilisation.**

Can You think Why ?

How can CK help in cell division with auxin ?

(d) Ethylene :

- Only gaseous PGR.
- Also called "fruit ripening hormone".
- Methionine is the **precursor** of C_2H_4.
- Ethylene show the "Triple response".

(i) Horizontal growth of seedlings.
(ii) Increase lateral growth by radial swelling or swelling of axis.
(iii) Apical hook formation in dicot seedlings.

- **Function of ethylene :**

(i) Promote senescence & abcission of mainly leaves and flower.
(ii) Main effect on fruit ripening.
(iii) Breaking of seed or bud dormancy.

(iv) Promote seed germination.

Can You think Why ?

- How can C_2H_4 help in fruit ripening ?
- Do you know about the "Climatic fruit"?
- Why C_2H_4 is mostly use in agriculture ?
- Ethylene promotes root growth and root hair formation.
- Initiate flowering in pine apple and lichi.
- Ethephon (2-chloroethyl phosphoric acid) is use in artificial fruit ripening .

Knowledge booster

C_2H_4 promotes female flowering in Cucumbers.

(e) ABSCISIC ACID (ABA) :

- Also known as Dormant or Terpoline acid or stress hormone.
- Discovered by Addicott and his co-worker they discover ABA in young cotton ball.
- First ABA isolate from dormant seed or bud.

Can you think why ?

Why ABA is known as stress hormone ?

- **Function of ABA**

(i) Maintain the dormancy.
(ii) Cause the senescence.
(iii) Promote the abscission.
(iv) Act as plant growth inhibitor.
(v) Inhibit the seed germination.

Character	Auxin	GA	CK	ABA	C_2H_4
Stem elongation	↑↑	↑↑	No effect or ↓↓	No effect	↓↓
Cell division & cell elongation	↑↑	↑↑	↑↑ with auxin	↓↓	No. effect
Root initiation	↑↑	No effect or inhibit	↓↓	No effect	↑↑
Seed germination	↓↓	↑↑	↑↑	↓↓	↑↑
Seed germination	↓↓	↑↑	↑↑	↓↓	↑↑
Dormancy	maintain	Break	Break	maintain	Break
Abscission	↓↓	No effect	↓↓	↑↑	↑↑
Senescence	delay	No effect	delay	Promote	Promote
Apical dominance	↑↑	No effect	↓↓	No effect	No effect
Parthenocarpy	↑↑	↑↑	No effect	No effect	No effect

CONTROL AND COORDINATION IN ANIMALS

Animals receive external information through specialized structure called sense organs (receptors). These are photoreceptors for light, phonoreceptors for sound and olfactoreceptors for smell. Control and coordination is achieved by two systems (a) endocrine system (b) nervous system

DIFFERENCES BETWEEN EXOCRINE & ENDOCRINE GLANDS.		
S.NO.	**EXOCRINE GLANDS**	**ENDOCRINE GLANDS**
1.	Exocrine glands have ducts.	Endocrine glands are ductless.
2.	These glands discharge their secretions into the ducts.	These glands discharge their secretions directly into the blood.
3.	These glands are present near the site of action. **Examples :** Sweat and oil glands of skin, salivary glands, etc.	These glands are present far away from the site of action. **e.g.** Pituitary, thyroid, hypothalamus, etc.

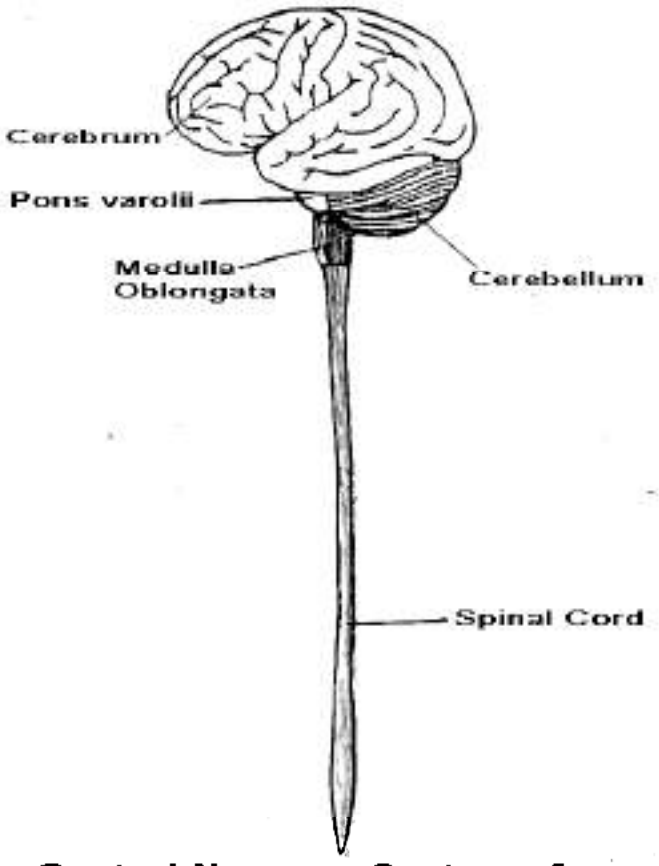
DIFFERENT ENDOCRINE GLANDS, THEIR LOCATION IN THE BODY & THE HORMONES SECRETED BY THEM.			
S.NO.	**DIFFERENT ENDOCRINE GLANDS**	**LOCATION**	**HORMONES SECRETED**
(A)	Pituitary	Located below Hypothalamus	→ Anterior lobe → Somatotropic hormone(SH/GH) (Growth Hormone); → Follicle stimulating hormone(FSH); → Leutinizing hormone(LH); → Adrenocorticotropic hormone(ACTH); → Thyroid stimulating hormone(TSH); → Prolactin → Middle → Melanocyte stimulating hormone (MSH) → Posterior lobe → Vasopressin/Anti Diuretic Hormone (ADH); → Oxytocin
(B)	Pineal gland	Located between cerebral hemispheres.	→ Melatonin; → Serotonin
(C)	Thyroid	It surrounds the larynx & upper part of the trachea in the neck	→ Thyroxine; → Calcitonin
(D)	Parathyroid	Situated on lobes of the thyroid gland.	→ Parathormone
(E)	Thymus gland	Located in the upper part of the thorax near heart.	→ Thymosin
(F)	Pancreas	Pancreas lies below the stomach in a bend of the duodenum.	→ Insulin,Glucagon and Somatostatin (Islets of Langerhans)
(G)	Adrenal gland	Located on the top of kidneys.	→ Adrenal cortex → Mineralo corticoids; → Sex hormones; → Gluco corticoids → Adrenal medulla → Adrenaline; Noradrenaline
(H)	Gonads	→ Ovaries (Female) - Located in pelvic cavity in abdomen. → Testes (Male) extra-abdominal in position	→ Estrogen; → Progesterone; → Relaxin → Testosterone

SUMMARY OF THE EFFECT OF HYPERSECRETION AND HYPOSECRETION OF SOME IMPORTANT ENDOCRINE GLANDS.			
GLANDS	**HORMONES**	**HYPERSECRETION**	**HYPOSECRETION**
1. Pituitary	**GH**	Gigantism In child; Acromegaly in adulthood	**Dwarfism** in child.
	ADH		**Diabetes insipidus**
2. Thyroid	**Thyroxine**	Exophthalmic goitre (Grave's Disease)	**Cretinism** in young, **Myxoedema** in adults.
3. Parathyroid	**PTH**	Decalcification of bones; increase calcium level in blood.	**Parathyroid Tetany ;** low calcium and high phosphate levels.
4. Adrenal	**Mineralocorticoid** (aldosterone)	Hypertension, Conn's disease.	Addison's disease.
	Glucocorticoid (cortisol)	Cushing's disease	–
	Adrenaline	–	–
	Noradrenaline	Hypertension	Increases blood pressure.
5. Pancreas	**Insulin**	Decrease in blood glucose level.	Increase in blood glucose level - **hyperglycemia; diabetes mellitus.**

NERVOUS SYSTEM

- Nervous system in vertebrates is highly evolved and comprises of
  1. Central Nervous System **2.** Peripheral Nervous system **3.** Autonomic nervous system
- **Central Nervous System (CNS) :** It lies along the main (longitudinal) axis of the body. In turn the CNS comprises of -

(i) Brain or encephalon situated in the head.
(ii) Spinal cord or myelon, which is a long and narrow structure located in the neck and trunk



Central Nervous System of man

DIFFERENT PARTS OF BRAIN AND THEIR FUNCTIONS		
PARTS OF BRAIN	**SUB-DIVISIONS**	**FUNCTIONS**
1. Fore Brain	**(a)** Olfactory lobes	Sense of smell.
	(b) Cerebrum (largest and most complex part of brain).	Centre for memory and intelligence.
	(c) Diencephalon : Thalamus & Hypothalamus	Centre for emotions, sweating, fatigue, sleep, thirst, pain, hunger, body temperature, fear etc.
2. Mid Brain	Cerebral peduncles or Crura cerebri (fibre tracts)	Receive sensory impulses from eyes, ears and muscles of head. Relay impulses back and forth between the cerebrum, cerebellum, pons and medulla.
3. Hindbrain	**a)** Cerebellum	Controls the rapid muscular activities such as running, typing etc. Controls body posture
	b) Pons varolii	Relay impulse between medulla oblongata and upper parts of brain. It contains centres that work with those of medulla oblongata to regulate respiratory rate.
	c) Medulla oblongata	**i)** It controls various involuntary movements of the body. **ii)** It has a respiratory centre to regulate respiration. **iii)** It has reflex centre for swallowing, vomiting, peristalsis, salivation, coughing, sneezing etc.

- **Peripheral nervous system :** It consists of nerves, which extend between the central nervous system and the sense organs or body's effectors (muscles, glands, etc.) or both. It carries information to and from the CNS. It mainly controls the voluntary activities of the body. Peripheral nervous system consists of two sets of nerves -

1. **Cranial nerves :** 12 pairs of nerves (They arise from or join the brain.)
2. **Spinal nerves :** 31pairs of nerves (They arise from spinal cord). They are classified into 5 groups-
   Cervical : 8 Pairs
   Thoracic : 12 Pairs
   Lumbar : 5 Pairs
   Sacral : 5 Pairs
   Coccygeal : 1 Pairs

- **Autonomic Nervous System :** It consists of nerves which connect the visceral receptors and effectors with the CNS through the cranial and spinal nerves. It controls involuntary activities of the body. It in turn has two components-
  1. Sympathetic nervous system
  2. Parasympathetic nervous system
- The action of sympathetic & parasympathetic nervous system is antagonistic to each other. Both interact and maintain homeostasis inside the body.

FUNCTIONS OF AUTONOMIC NERVOUS SYSTEM		
ORGAN	**FUNCTION OF SYMPATHETIC SYSTEM**	**FUNCTION OF PARASYMPATHETIC SYSTEM**
Heart	Accelerates heart beat	Slows heart beat
Arteries	Constricts arteries & raises blood pressure	Dilates arteries & lowers blood pressure
Urinary bladder	Relaxes bladder	Constricts bladder
Muscles of iris	Dilate pupil	Constricts pupil

REFLEX ACTION AND REFLEX ARC

You must have experienced a sudden withdrawl of a body part which comes in contact with objects that are extremely hot, cold, pointed or animals that are scary or poisonous. The entire process of response to a stimulus, that occurs involuntarily, i.e., without conscious effort or thought and requires the involvement of a part of the central nervous system is called a **reflex action.**

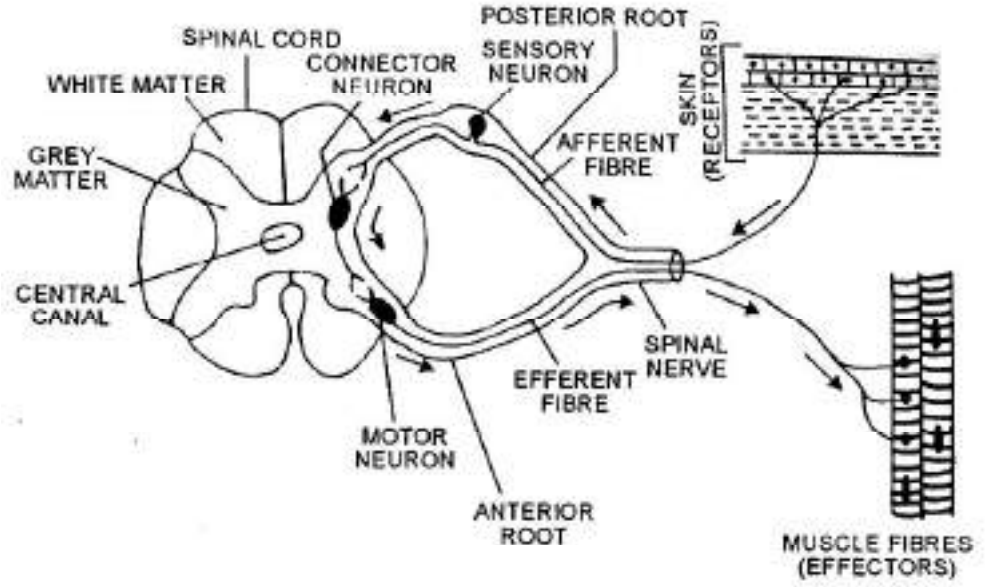


Fig. Diagrammatic Presentation of Reflex Action (Showing Jerk Reflex)

Mammals show a wide range of reflexes which can be broadly classified into two types : unconditioned and conditioned reflexes.

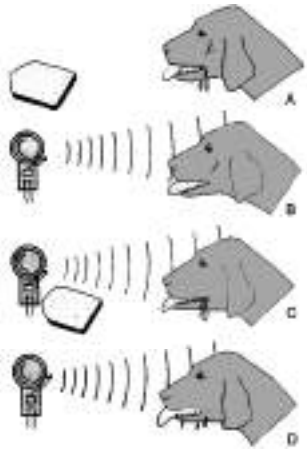
- **Unconditioned reflexes :** Even when the body has no past experience of a stimulus it still responds spontaneously and such responses or actions are called unconditioned reflexes. These are responses to a natural unconditioned stimulus. The examples of unconditioned reflexes are the blinking of an eye when a particle of dust touches the eyelids, excitement of the salivary glands after seeing the food, etc. Other reflex actions are shown in the Table.

TABLE SHOWING DIFFERENT UNCONDITIONED REFLEX ACTIONS.

REFLEX	STIMULUS	RESPONSE
Blinking	Foreign body on surface of eye.	Eyelids close and eye "waters".
Swallowing	Food touches sensitive spot at back of pharynx.	Peristaltic waves pass down oesophagus.
Sneezing and coughing	Foreign particle irritating lining of nose or larynx.	Chest muscles and diaphragm contract and relax violently to produce a gust of air.
Knee-jerk	Sharp tap of tendon below knee-cap of crossed leg.	Leg 'kicks' up.

These reflexes are said to be unconditioned or inborn because they are a natural part of an animal's make up. Another class of reflex produced by the previous experience of an animals is considered below.

- **Conditioned reflexes.** When a reflex which does not naturally exist had becomes a part of the animal behaviour. Such a reflex is said to be conditioned. Conditioned reflex were first demonstrated by the Russian physiologist, **Pavlov.** The cerebrum controls the conditioned reflexes.



Pavlov's Experiment on Dog to Show Conditional Reflex.

DIFFERENCES BETWEEN UNCONDITIONED AND CONDITIONED REFLEXES	
UNCONDITIONED REFLEXES	**CONDITIONED REFLEXES**
Unconditioned reflexes are inborn (hereditary).	Conditioned reflexes are acquired after birth.
Learning does not form the basis of unconditioned reflexes. **Examples :** Breast feeding and swallowing in newly born babies, blinking of eyes, sneezing and coughing and knee-jerk, etc.	Learning forms the basis of conditioned reflexes. **Examples :** Withdrawal of limb when it is touched by hot things, typing, riding a bicycle, knitting etc.

Knowledge Boosters

The smallest cranial nerve is **trochlear** in humans. The largest cranial nerve is **trigeminal** in humans.

EXERCISE-1

Control & Co-ordination in Plant

1. Apical dominance is not affected by :
(A) Indole acetic acid (B) Gibberellins
(C) Auxin (D) Indole butyric acid

Control & Co-ordination in Plant
Endrocrime System

2. The first hormone discovered was :
(A) Thymosine (B) Secretin
(C) Duodenum (D) Thyroxine

3. Hormones are :
(A) Chemically all are steroid
(B) Stored in body in liver and thyroid
(C) Harmful only in excess
(D) Similar so that hormones of one species perform the same function in other species

4. While dwarfism and cretinism suffering child are somewhat of the same height, the main difference is that :
(A) Cretins have normal intelligence while dwarf do not
(B) Cretins are mentally retarded
(C) The head of cretin is especially large
(D) The dwarf have elongated chin

5. Hyperactivity of which gland result in acne at the time of adolescence :
(A) Pituitary (B) Sebaceous gland
(C) Sweat gland (D) All of these

6. The production of which hormone in adults leads to a gorilla - like appearance called as Acromegaly :
(A) Adrenaline (B) Growth hormone
(C) Thyroxine (D) Testosterone

7. Find the odd one out in the series given below :
Salivary gland; Gastric glands; Tear gland; Thyroid gland
(A) Salivary gland (B) Gastric glands
(C) Tear gland (D) Thyroid gland

8. Effect of thyroxine on B.M.R. is :
(A) Increases (B) Decreases
(C) Uncertain (D) No effect

9. Hormone responsible for embryo implantation and formation of placenta is :
(A) Adrenaline (B) Estradiol
(C) Estrogen (D) Progesterone

10. A woman started developing male characteristics. It may be due to :
(A) Overproduction of adrenal androgens
(B) Overproduction of estrogen
(C) Damage to mammary glands
(D) Damage to posterior pituitary

11. Which hormone would be secreted when a mad dog is running after you :
(A) Testosterone (B) Adrenaline
(C) Thyroxine (D) Thymosin

12. The hormone which reduces the sodium loss through urine and sweat is :
(A) Calcitonin (B) Aldosterone
(C) Parathormone (D) Thyroxine

Nervous System

13. The dendrites of typical vertebrate neuron, compared to neuron's axon are generally :
(A) Longer (B) Larger in diameter
(C) More mylinated (D) More branched

14. Which sequence best describes a simple reflex arc such as the knee-jerk reflex ?
(A) Sensory neuron $\rightarrow$ interneuron
(B) Sensory neuron $\rightarrow$ interneuron $\rightarrow$ motor neuron
(C) Sensory neuron $\rightarrow$ motor neuron $\rightarrow$ interneuron
(D) Sensory neuron $\rightarrow$ effector cell $\rightarrow$ motor neuron

15. Which of the following is not a structure in the hind brain :
(A) Medulla oblongata (B) Hypothalamus
(C) Cerebellum (D) Pons

16. The part of Hind brain that is responsible for hand eye coordination is the :
(A) Pons (B) Cerebrum
(C) Medulla oblongata (D) Cerebellum

17. How many pairs of cranial nerves are there in a human :
(A) 8 (B) 12 (C) 25 (D) 31

18. Sympathetic nervous system induces :
(A) Heart beat
(B) Secretion of saliva
(C) Secretion of digestive juices
(D) All of these

19. Pineal body attaches to :
(A) Diencephalon
(B) Cerebellum
(C) Ventral side of cerebellum
(D) Lateral side of cerebrum

20. Which of the following is not a reflex action :
(A) Coughing (B) Sneezing
(C) Reading (D) Sweating

EXERCISE-2

COMPETITIVE EXAM QUESTIONS

1. When a cell fails to communicate with other cells in multicellular organism, it -
(IJSO-Stage-I/2012)
(A) becomes cancerous
(B) enters mitotic phase
(C) chooses to die
(D) is eaten up by other cells

2. On a field trip in North Ameerica, students noticed that when threatened, Horned lizards (Genus: phrynosoma) squirt blood at the attackers.When the professor asked what could have been the reason behind such behaviour of HOrned lizards, one student said that certain sensory receptos had fired and triggered a neuronal reflex culminating in increasing the pressure in their sinus cavities until the blood vessels in the corners of the eyes burst.Another student said that it was just an act to frighten off the predator.Thus it can be said that **(IJSO-Stage-I/2013)**
(A) The first response is correct, while the second is incorrect
(B) Both explanations are reasonable and can be scientifically tested.
(C) The first response is biological, while the second is philosophical.
(D) The first explanation is testable as a scientific hypothesis, while the second is not.

3. People residing in coastal area usually do not face the problem of Thyroxin hormone deficiency because their food intake will be rich in one of hte following minerals. **(IJSO/Stage-1/2013)**
(A) sodium (B) chlorine
(C) Iodine (D) Phosphorus

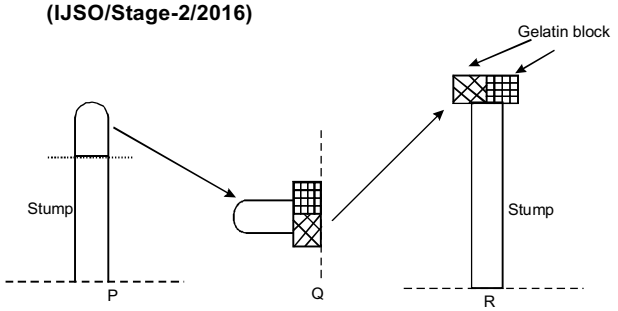
4. Suresh accidentally touched silencer of his two wheeler while parking and withdrew his leg Immediately. Identify the correct order of the flow of message to the brain ?
(IJSO/Stage-1/2013/)
(A) Receptor $\rightarrow$ Sensory neuron $\rightarrow$ CNS $\rightarrow$ Motor neuron $\rightarrow$ Effectors
(B) Sensory neuron $\rightarrow$ CNS $\rightarrow$ Motor neuron $\rightarrow$ Effectors $\rightarrow$ REceptors
(C) CNS $\rightarrow$ Motor neuron $\rightarrow$ Effectors $\rightarrow$ Receptors $\rightarrow$ Sensory neuron
(D) Effectors $\rightarrow$ Receptors $\rightarrow$ Sensory neuron $\rightarrow$ Motor neuron

5. Which of the process increases in the absence of light in plants ?
(IJSO/Stage-2/2014)
(A) Rate of uptake of minerals
(B) Rate of uptake of water
(C) Rate of ascent of sap.
(D) Elongation of internodes

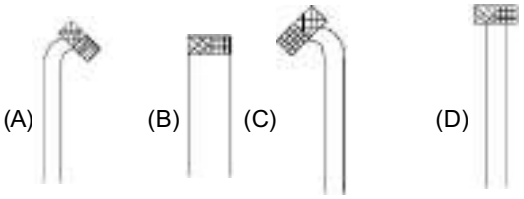
6. One set of plants was grown at 12 h day and 12 h night period cycles and it flowered. While for another set of the same plant, the night period was interrupted by a flash of light at mid night and it did not flower. The plants used for the above set of experiments are
(IJSO/Stage-2/2014)
(A) Long day plant (B) Day neutral plant
(C) Short day plant (D) Darkness neutral plant

7. Which of the following statements is true regarding communication in neurons
(IJSO/Stage-2/2016)
(A) Free electrons are moved along the plasma membrane of the axon and control the expression of neurotransmitters
(B) A chemical signal travels along the axon and is converted into an electric impulse at the synapse
(C) An electric impulse travels along the length of the axon. The electric impulse is converted to a chemical signal at the synapse,
(D) An electrical signal is converted to a chemical signal by the Myelin sheath before it reaches the synapse

8. Plants show phototropism, wherein shoots respond by bending towards light. The plant hormone auxin is responsible form this phototropic effect. An experiment was carried out where the tip of growing seedling was cut was and placed horizontally with its cut end in equal contact with two gelatin blocks as show in the figure (P) below. Auxin diffuses into the gelatin blocks. After some time the gelatin blocks were placed on seedling stump as shown in the figure (R) . The complete experiment was carried out in dark condition.
(IJSO/Stage-2/2016)



Which one of the following represent the correct result after a few days ?



REPRODUCTION

◆ **Reproduction** is a process by which a living organism is able to produce more of its own kind. The ability to reproduce, i.e. to produce a generation of individuals of the same species, is one of the essential characteristics of living beings.

TYPES OF REPRODUCTION

◆ There are three types of reproduction :

1. **Asexual Reproduction :** It is a type of reproduction in which only one parent is involved and there is no formation and fusion of gametes. Cell division involved in asexual reproduction is **mitosis** while meiosis plays no role in this. Since no meiosis takes place, offsprings are exact copy of their parents and since new individuals are formed from the somatic part of the organism, it is also known as **somatogenic reproduction.**
2. **Vegetative Reproduction :** The vegetative parts of a plant body such as root, stem, leaf, etc. produce new plant. Vegetative propagation is common in plants like orchids, ornamental plants and grasses.
3. **Sexual Reproduction :** It is a type of reproduction in which two parent organisms are involved. It involves formation of haploid gametes by the process of **meiosis.** Later on there is fusion of two types of gametes derived from different parents. This process is called **fertilization.** After fertilization single diploid cell formed is known as zygote which contains information from both the parents. Zygote undergoes further development by the process of mitosis to form new offspring. Since meiosis is involved in this type of reproduction therefore offsprings are genetically not like their parent.

ASEXUAL REPRODUCTION

◆ In this method certain body cells undergo repeated mitotic divisions and give rise to two or more new organisms of the same kind.

• **Different methods are :**

(i) Fission (Binary eg Amoeba and Multiple e.g., Plasmodium)

(ii) Budding (e.g., Yeast, Hydra)

(iii) Fragmentation (e.g.,Spirogyra)

(iv) Spore formation (e.g., Fungi)

(v) Regeneration (e.g., Planaria, Starfish)- This is not generally a method of reproduction, rather a method of repair and replacement of damaged body parts.

(vi) Tissue culture (e.g., Orchids)

(vii) Parthenocarpy (e.g., Banana, Grapes)

VEGETATIVE PROPAGATION IN PLANTS

(a) Vegetative propagation by roots : e.g. Dahlia, sweet potato, etc.

(b) Vegetative propagation by stems : Vegetative propagation by stems is of two types :

(i) By subaerial stems : Runner e.g. Grasses, **Sucker** e.g. Mint, **Offset** e.g. Eichornia, **Stolon** e.g. Strawberrry.

(ii) Underground Stems : Tuber e.g. Potato. **Rhizome** e.g. Ginger, **Bulb** e.g. Onion. **Corm** e.g. Colocasia.

(c) Vegetative propagation by leaves : e.g. Bryophyllum

SEXUAL REPRODUCTION

It is a type of reproduction including formation and fusion of gametes. **R.** *Camerarius* described sexual reproduction for first time in plants. He was first scientist to produce hybrid. Flower is reproductive part of plant that is also considered as modified shoot. Flower has usually four whorls. out of them calyx and corolla are non-essential whorls of flower whereas Androecium and gynoecium are called essential whorls of flower.

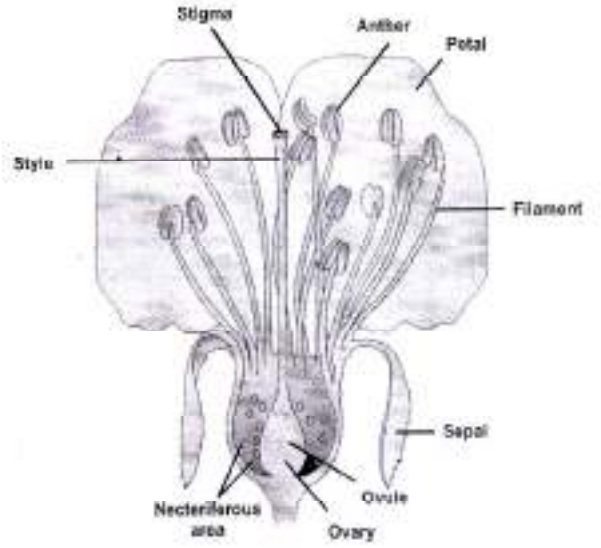


Fig : A diagrammatic representation of L.S. of flower

(a) Stamen or microsporophyll :

Stamen is structural and functional part of Androecium.The fertile portion of stamen is called anther.Each anther is usually made of two lobes connected by a connective.A typical anther consists of four microsporangia (Tetrasporangiate) and such anther is called dithecous or bilobed.

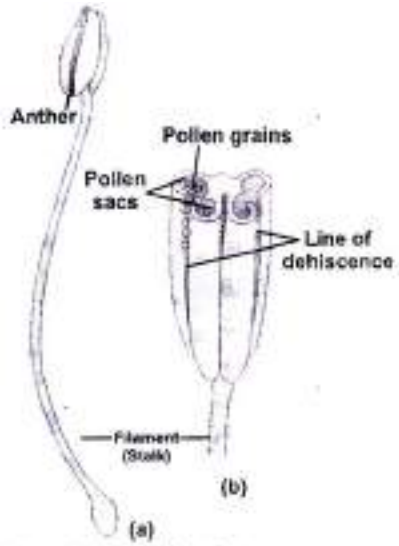


Fig : (a) A typical stamen (b) Three-dimensional cut section of an anther

- **Structure of anther :** It involves anther wall and sporogenous tissues.

1. Anther wall : It consists of following parts

A. Epidermis : It is first formed layer of anther wall. It is protective in function.

B. Endothecium : It lies inside epidermis.The endothecial cells develop a fibrous thickening containing α-cellulose. It appears in the form of radial bands arising from the inner tangential wall. Its help in dehiscence of the anther.

C. Middle layers : It is the third wall layer of the anther.The number of middle layers generally ranges from 1-4 but rarely there are several middle layers. The middle layers degenerate at maturity of the anther.They are nutritive in function. Store food material is starch.

D. Tapetum : It is the inner most wall layer of the anther surrounds sporogenous tissue. Its cells are large multinucleate and polyploid.

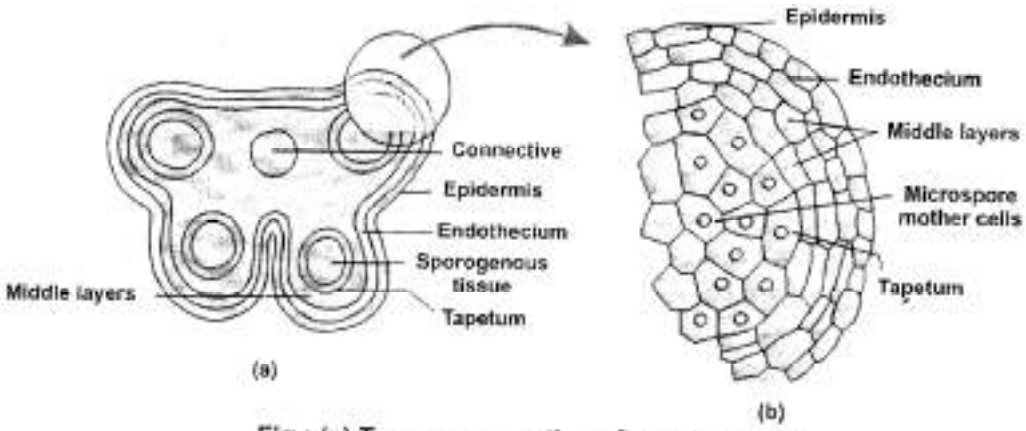


Fig : (a) Transverse section of a mature anther; (b) Enlarged view of one microsporangium showing wall layers

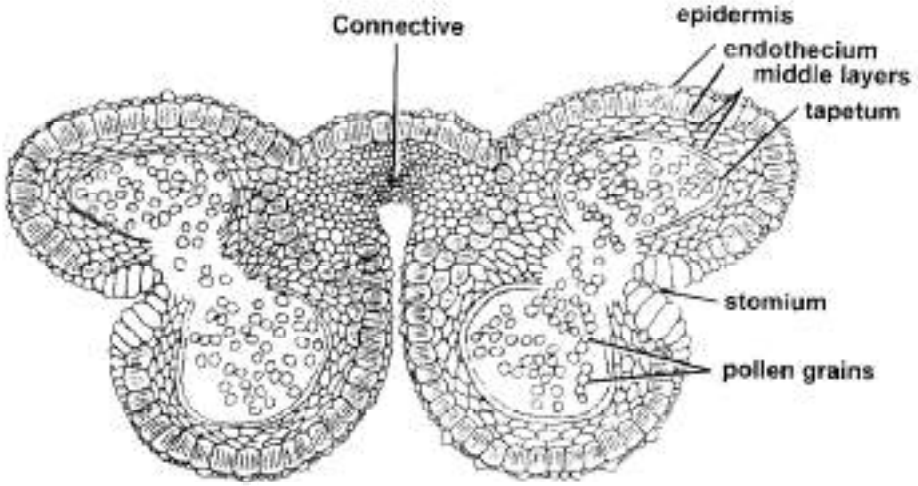


Fig. Anther : T.S. of mature dithecous anther

2. **Sporogenous tissues :** When the anther is young, a group of compactly arranged homogenous cells called the sporogenous tissue occupies the centre of each microsporangium.

◆ **Microsporogenesis :** The formation and differentiation of microspores (pollen grains) is called microsporogenesis. In the cavity of microsporangium the microspore mother cells divide meiotically to produce pollen tetrads.Cytokinesis may occur after each meiotic division (successive type) thus isobilateral tetrad of microspores is formed. **e.g.** monocots or it occurs after both meiotic (I and II) division (simultaneous type) thus tetrahedral tetrad of microspores is formed.

◆ **Structure of microspore or pollen grain :** Pollen grains are generally spherical measuring about 25-50 micrometers in diameter. The cell wall of microspore consists of two layers, outer is exine and inner is intine. The outer exine is made up of sporopollenin.

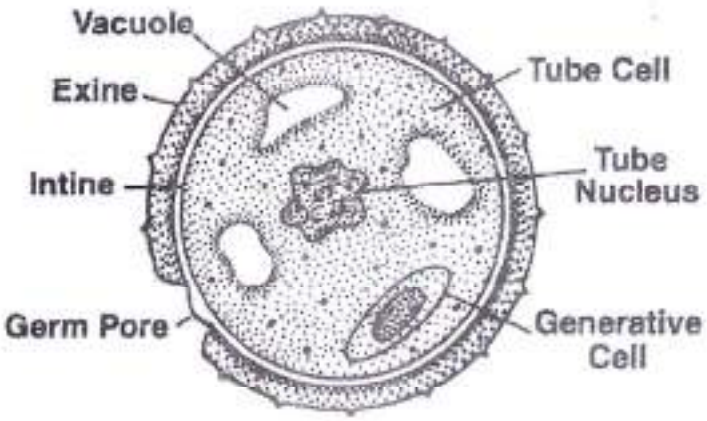


Fig. Structure of pollen grain

◆ **Development of male gametophyte**

(i) **Prepollinaton development :** Development of male gametophyte from pollen grain is called microgametogenesis, pollen grain develops in anther so it is called precautious or insitu germination.Cell of microspore divides mitotically to form large tube cell and small generative cell. Male gametophyte is partially developed pollen grain. It is haploid (n) struc‘

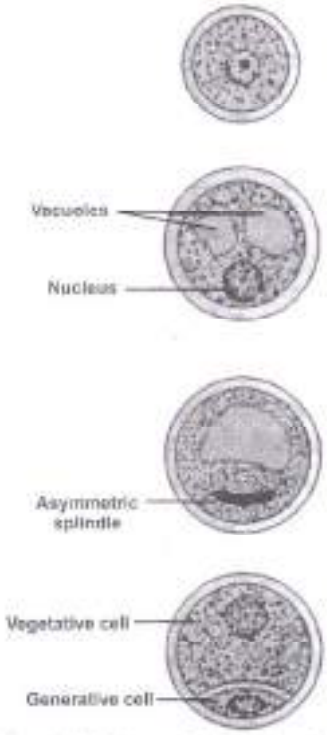


Fig : (a) Enlarged view of a pollen grain tetrad:
(b) stages of a microspore maturing into a pollen grain

(ii) Post pollination development :

- After falling of pollen grain on stigma, pollen-grain absorbs water and nutrients of the stigamatic secretion through its germs pores.The exine bursts and the **tube cell** comes out in form of **pollen tube**
- Growth of pollen tube is apical and regulated by carbohydrates, boron and calcium and stimulated by gibberellins and auxins. Best temperature for growth of pollen tube is 20º–30º C.
- The **generative nucleus** divides mitotically to form **two male gametes.**
- The male gametes are non-motile and amoeboid. They are slightly unequal in size.
- The function of pollen tube is to carry gamete. In the pollen tube, tube nucleus enters first which is vestigeal and soon disintegrate.The tube nucleus guides the passage of the pollen tube.

(b) Carpel or megasporophyll :

Carpel is structural and functional part of Gynoecium. It consists stigma, style and ovary. Ovary contains ovules or megasporangia.

- **Structure of ovule or Megasporangium :**
- Ovule is a outgrowth of **placenta.** Each ovule is connected to its placenta by a stalk called **funicle.** The point of association of the funicle with the main body of the ovule is called **hilum.**
- Main body of a ovule is called nucellus which consists of a mass of parenchymatous tissue.
- Each ovule has one or two protective envelopes called integuments. Integuments encircle the ovule except at the tip where a small opening called the micropyle is organised. Opposite the micropylar end, it the chalaza, representing the basal part of the ovule.

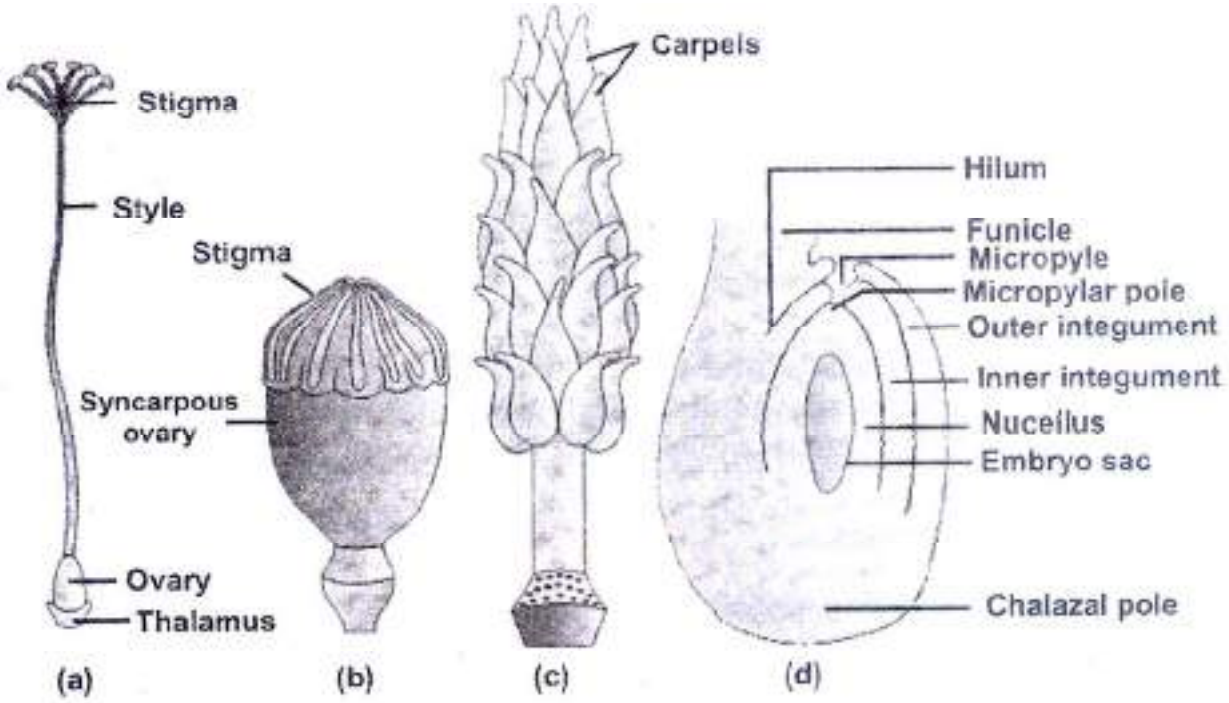


Fig : (a) A dissected flower of Hibiscus showing pistil (other floral parts have been removed); (b) Multicarpellary, syncarpous pistil of Papaver ; (c) A multicarpellary, apocarpous gynoecium of Michelia; (d) A diagrammatic view of a typical anatropous ovule

◆ **Megasporogenesis :** The process of formation of megaspores from the megaspore mother cell is called megasporogenesis. Ovules generally differentiate a single megaspore mother cell (MMC) in the micropylar region of the nucellus . It is a large cell containing dense cytoplasm and a prominent nucleus. The MMC undergoes meiotic division. Meiosis results in the production of four megaspores.

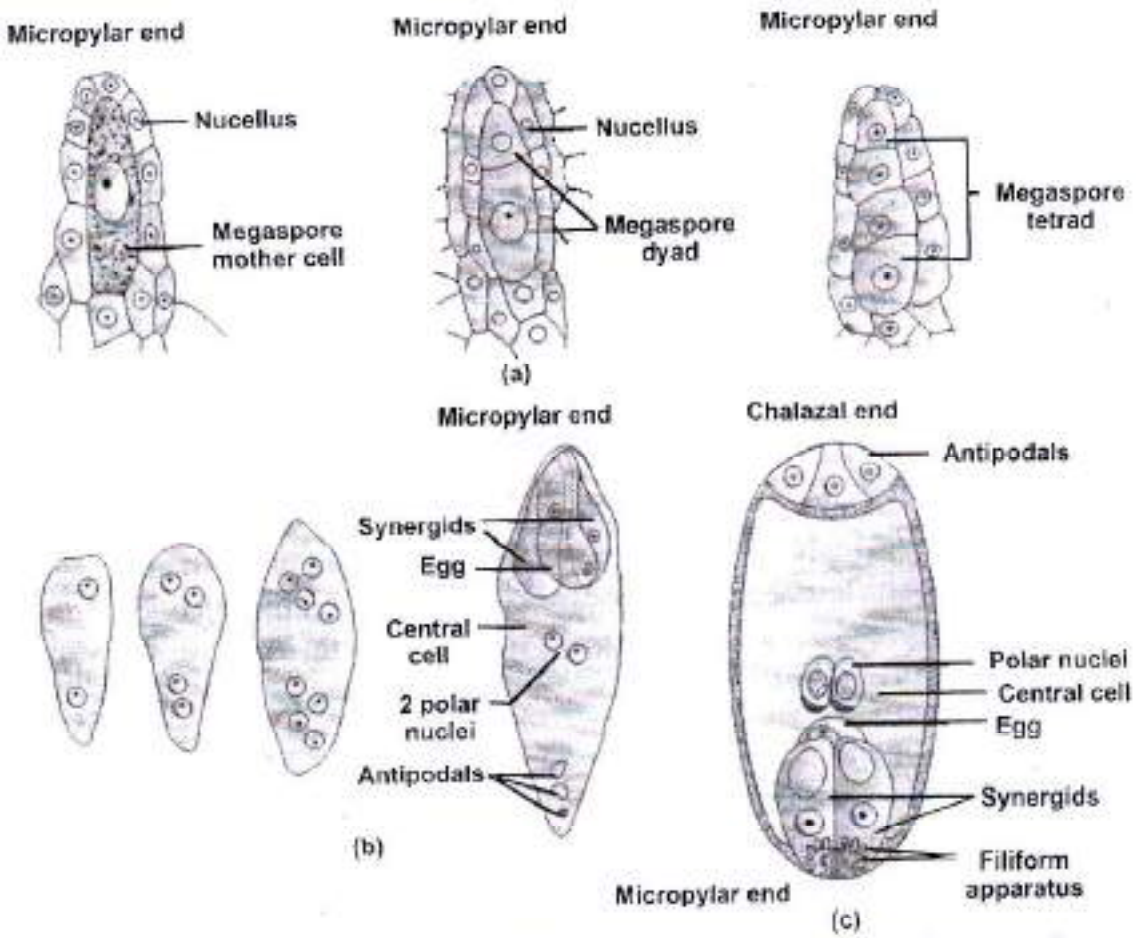


Fig : (a) Parts of the ovule showing a large megaspore mother cell, a dyad and a tetrad of megaspores; (b) 1,2, 4, and 8-nucleate stages of embryo sac and a mature embryo sac; (c) A diagrammatic representation of the mature embryo sac

◆ **Structure of embryo sac :** The embryo sac develops from one megaspore. It develops from chalazal megaspore. Nucleus of functional megaspore divides by three mitotic division to form 8 nuclei. This embryo sac is 7 celled and 8 nucleated.

(i) Three cells at chalazal end form antipodals (n) or vegetative cells of female gametophyte.

(ii) Three cells at micropylar end form egg apparatus. One is egg cell (n) and two are synergids(n) or cooperative cells. Each synergid has filiform apparatus that secretes some chemical substance for attracting pollen tube towards micropyle.

(iii) Two nucleic (one from each pole) in the centre are called polar nuclei (n) which are fused to form diploid secondary nucleus just before fertilization.

Knowledge Booster

Chalaza : A place from where funicle and integuments arise is called Chalaza.
Micropyle : Integument is absent just opposite to the chalaza, so that a narrow passage (pore) is formed which is called micropyle.

POLLINATION

◆ The transfer of pollen grains from anther of a flower to the stigma of the same or different flower of the same species is called pollination. Pollination is of two types.

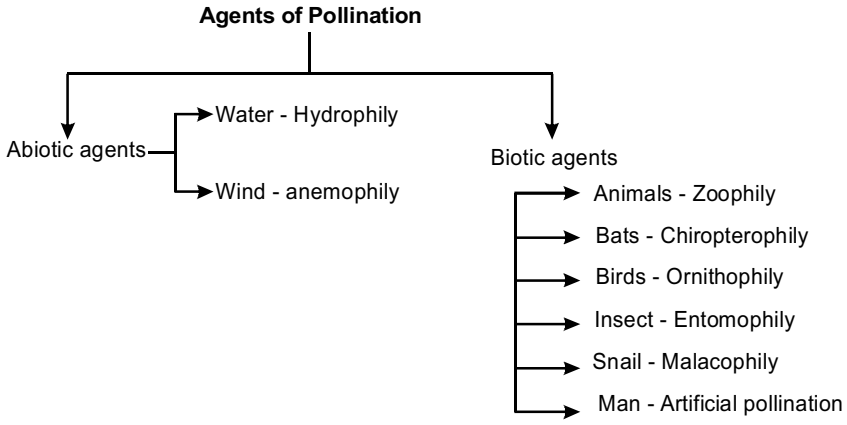
(A) Self pollination
(B) Cross pollination or Allogamy

(A) Self pollination : It is of two types
(I) Autogamy
(II) Geitonogamy

(I) Autogamy : Transfer of pollen grains from the anther of a flower to the stigma of the same flower is called autogamy.

(II) Geitonogamy : Pollination occurs between the two flowers of the same plant (genetically self pollination and ecologically cross pollination).

B. Cross pollination : Transfer of pollen grains from anther to the stigma of a different plant. This is the only type of pollination which during pollination brings genetically different types of pollen grains to the stigma.



FERTILIZATION

Fusion of male & female gametes to form diploid Zygote is called Fertilization. Fertilization was discovered by strasburger.

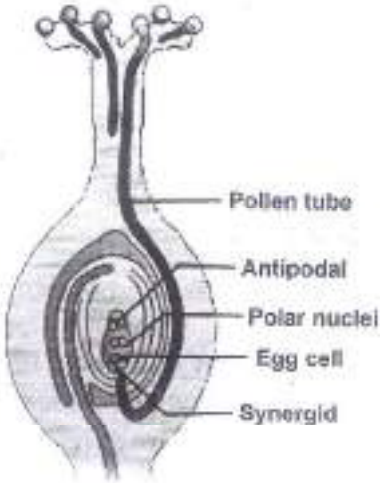


Fig : Longitudinal section of a flower showing growth of pollen tube

- **Entry of pollen tube in embryo sac :** In most of the plants, pollen tube enters in the embryo sac through one degenerated synergid.

Knowledge Booster

Porogamy : In this, pollen tube enters into the ovule through the micropyle. It is known as porogamy.It is found in most of Angiosperms (Capsella).
Chalazogamy : In this method, the pollen tube enter into the ovule through the chalaza.**e.g.**Juglans

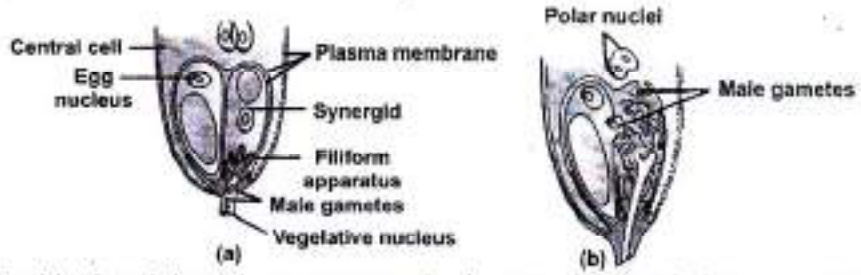


Fig : (a) enlarged view of an egg apparatus showing entry of pollen tube into a synergid; (b) Discharge of male gametes into a synergid and the movements of the sperms, one into the egg and the other into the central cell

◆ **Double fertilization**

- Pollen tube discharges its two male gametes in embryo sac. One male gamete (n) is fused with egg cell (n) to form diploid zygote (2n). It is called True fertilization or syngamy.
- Second male gamete (n) is fused with diploid secondary nucleus (2n) to form Triploid primary endosperm nucleus (3n) It is called triple fusion or vegetative fertilization.
- Thus fertilization occurs two time so that it is called double fertilization. It is unique feature of angiospermic plants that is absent in other groups of plants.

◆ **Significance of Double fertilization :**

(i) Viable seeds are formed due to it.
(ii) Embryo can not develop without endosperms that is formed by fertilization.
(iii) Ovary is converted in fruit after it.
(iv) It maintains the diploid number of Chromosomes in offsprings.

ENDOSPERMS

Endosperm development precedes embryo development. The primary endosperm cell divides repeatedly and forms a triploid endosperm tissue.The cells of this tissue are filled with reserve food materials. and are used for the nutrition of the developing embryo.

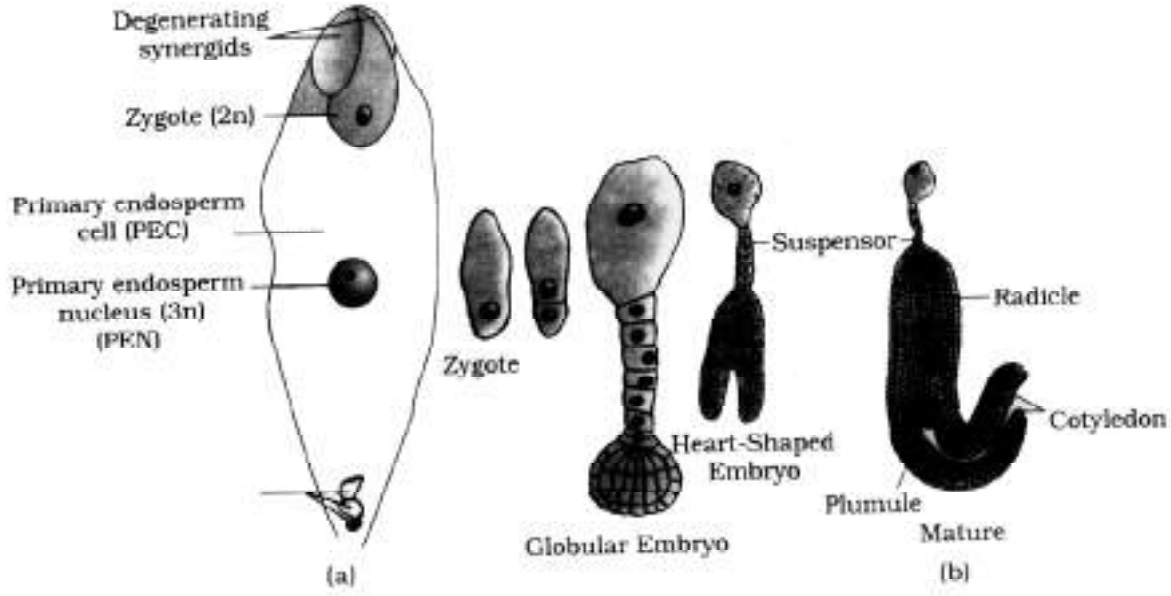


Figure (a) Fertilised embryo sac showing zygote and Primary Endosperm Nucleus (PEN); (b) Stages in embryo development in a dicot [shown in reduced size as compared to (a)]

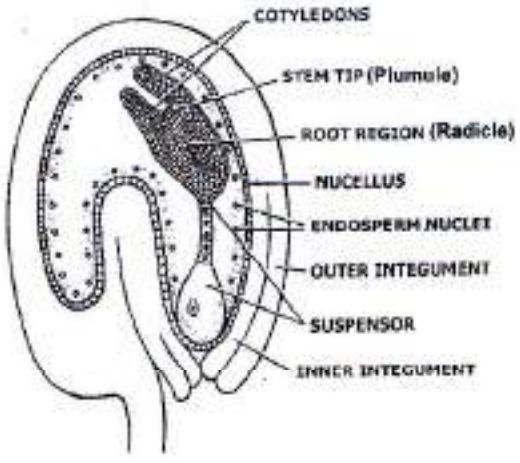


Fig. T.S. of ovule with young embryo

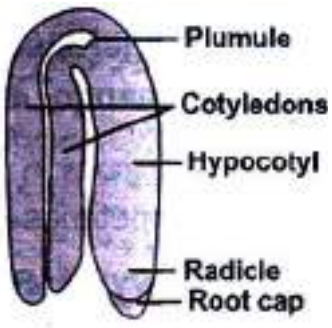


Fig : A typical dicot embryo

SEED

The fertilized ovule forms seed. On the basis of absence or presence of endosperm, the seeds are of two types.

(a) Non endospermic or exalbuminous seeds :

Endosperm is completely consumed during development of the embryo, thus the seeds are called nonendospermic or exalbuminous Ex : Dicots (gram, pea, groundnut).

(b) Endospermic or albuminous seeds :

Endosperm not consumed during development of the embryo e.g. Sunflower, Castor bean.

(c) Perispermic seeds :

Some time, some part of nucellus remains unused which is present in the form of thin layer around the endosperm is called perisperm. e.g. Black pepper.

Knowledge Booster

Vivipary : Sometimes seeds germinate within the fruit while attached to plant. Such type of germination is called vivipary Ex: Rhizophora.

SEXUAL REPRODUCTION IN HUMAN BEINGS

The reproductive systems in human beings become functional (or start functioning) at a definite age called puberty. Generally boys attain puberty at the age of 13 to 14 years while girls reach puberty at a comparatively lower age of 10 to 12 years. On attaining puberty, the **male gonads** called **testes** starts producing **male gametes** called **sperms** and the **female gonads** called **ovaries** start producing **female gamete** called **ova** (or eggs). In addition to producing sex cells (or gametes) male and female gonads (testes and ovaries) also produce and secrete sex hormones with the onset of puberty. The testes produce the **male sex hormone** called **testosterone**, and the ovaries produce **two female sex hormones**, **oestrogen** and **progesterone**. The sex hormones play following important role in the process of reproduction.

(i) The sex hormones control the process of gametogenesis. In other words, the sex hormones control the production of gametes like sperms and ova.

(ii) The sex hormones maintain the structure and functions of accessory sex organs. The testes and ovaries are the primary sex organs. All other organs associated with the process of reproduction (like penis, seminal vesicles, vagina, uterus, and fallopian tubes, etc.) are accessory sex organs.

(iii) The sex hormones develop the secondary sexual characteristics (or male and female features). For example, in males (or boys) the sex hormones develop secondary sexual characteristics such as : low pitch voice (or deeper voice), growth of hair on chest and in the armpits, growth of moustache and beard and development of muscles. In females (girls), the sex hormones develop the secondary sexual characteristics such as : high pitch voice (or shrill voice), growth of hair in armpits and development of mammary glands (or breasts).

◆ **Male Reproductive System :**

(i) **Primary Sex Organs**. Primary sex organ of male is a pair of testes (singular testis). They are present in a small pouch called scrotum and scrotum is present in extra-abdominal cavity. Scrotum has temperature 1 – 3 lower than body temperature which favours the formation of sperms.Testes produce sperms.

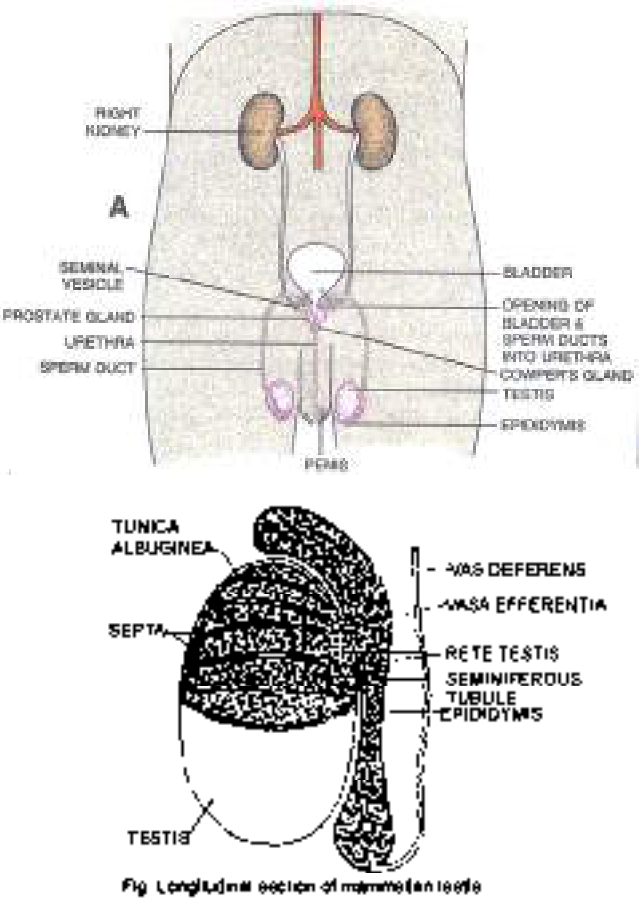


Fig : Structure of human male reproductive system

(ii) Duct system :

(a) Vasa efferentia : Testis is connected to epididymis through a fine tubule called as vasa efferentia. They help in conduction of sperms.

(b) Epididymis : They are long tubules which lie compacted along the testis from their upper ends to lower back side. Its walls are muscular and glandular to provide or secrete nutritive fluid which provides nourishment to the sperms.

(c) Vas deferens : Vasa efferentia from epididymal duct finally opens into vas deferens.

(d) Ejaculatory duct : They are short, straight, muscular tubes, each formed by the union of vasa deferens and duct of seminal vesicles.

(e) Urethra : It arises from urinary bladder forming a urinogenital canal. It carries urine, sperm and secretion of seminal vesicles, prostrate and cowper's glands.

(f) Penis : It is a male copulatory organ which also passes urine.

- **Accessory glands** : These are three types of glands.
  (a) Seminal vesicle
  (b) Cowper's gland
  (c) Prostate gland
- Secretions of these glands provides nourishment and mobility to sperms.
- **Copulatory organ :** Penis is a copulatory organ for the transfer of the sperms to female reproductive tract. Semen = Sperms + Secretion of accessory glands.

◆ **Female Reproductive System :** The human female reproductive system consists of the following organs.

(i) Ovaries : Ovary is divided into 2 parts : - Outer part is cortex made up of dense connective tissue with reticular fibres, ovarian follicles and few blood vessels while inner or central part is medulla made up of less dense connective tissue with elastic fibres, numerous blood vessels. Cortex also consists of large mass of yellow cells termed as corpus luteum, formed in an empty follicle after the release of it's ovum.

◆ The cells of corpus luteum secrete the hormones

(A) Progesterone during pregnancy.
(B) Relaxin at the end of pregnancy.

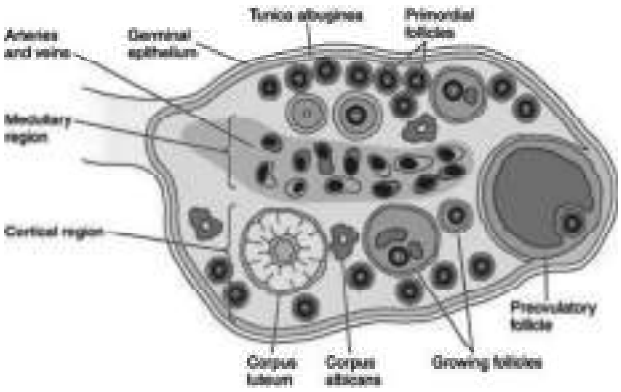


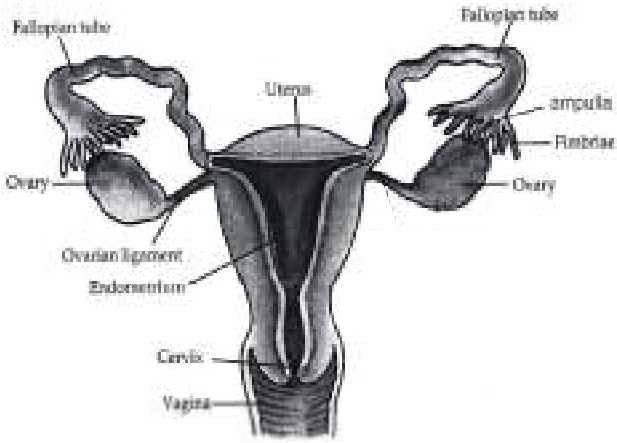
Fig. Structure of Ovary

(ii) A pair of Fallopian tubes (which are also called oviducts)**:** Oviduct provide site of fertilisation.

(iii) Uterus: It is large , highly elastic muscular sac specialized for the development of the embryo.

(iv) Cervix : Lower narrow cervix that projects into the vagina.

(v) Vagina : It is a large, median, elastic, muscular tube. It is also called as "Birth canal".



Female reproductive system

MENSTRUAL CYCLE

The reproductive cycle in the female is called menstrual cycle. The first menstruation begins at puberty and is called menarche. In human females menstruation is repeated at an average interval of about 28/29 days, and the cycle of events starting from one menstruation till the next one is called the menstrual cycle. During this cycle, a series of changes occur in the ovary and uterus. These changes are termed menstrual changes.In human beings, menstrual cycle ceases around 50 years of age; that is termed as menopause.

◆ It comprises of 4 phases :

(i) Menstrual phase
(ii) Follicular phase or proliferative phase / Post-Mens-trual
(iii) Ovulatory phase
(iv) Luteal phase/Secretory phase

1. **Menstrual phase :** (4-7 days) Corpus luteum degenerates and level of LH & progesterone get reduced. The endometerium degenerates.
2. **Proliferative phase (10 - 14 days) :** This is mainly influenced by FSH and estrogen. During this phase repairing of endometrium lining takes place.
3. **Ovulatory phase :** (14th day of cycle) Ovulation take place.
4. **Secretory phase :** (10 days) After ovulation LH stimulates remaining cells of ovarian follicles to develop into corpus luteum and it secretes progesterone. During this phase uterine glands produce watery mucus.

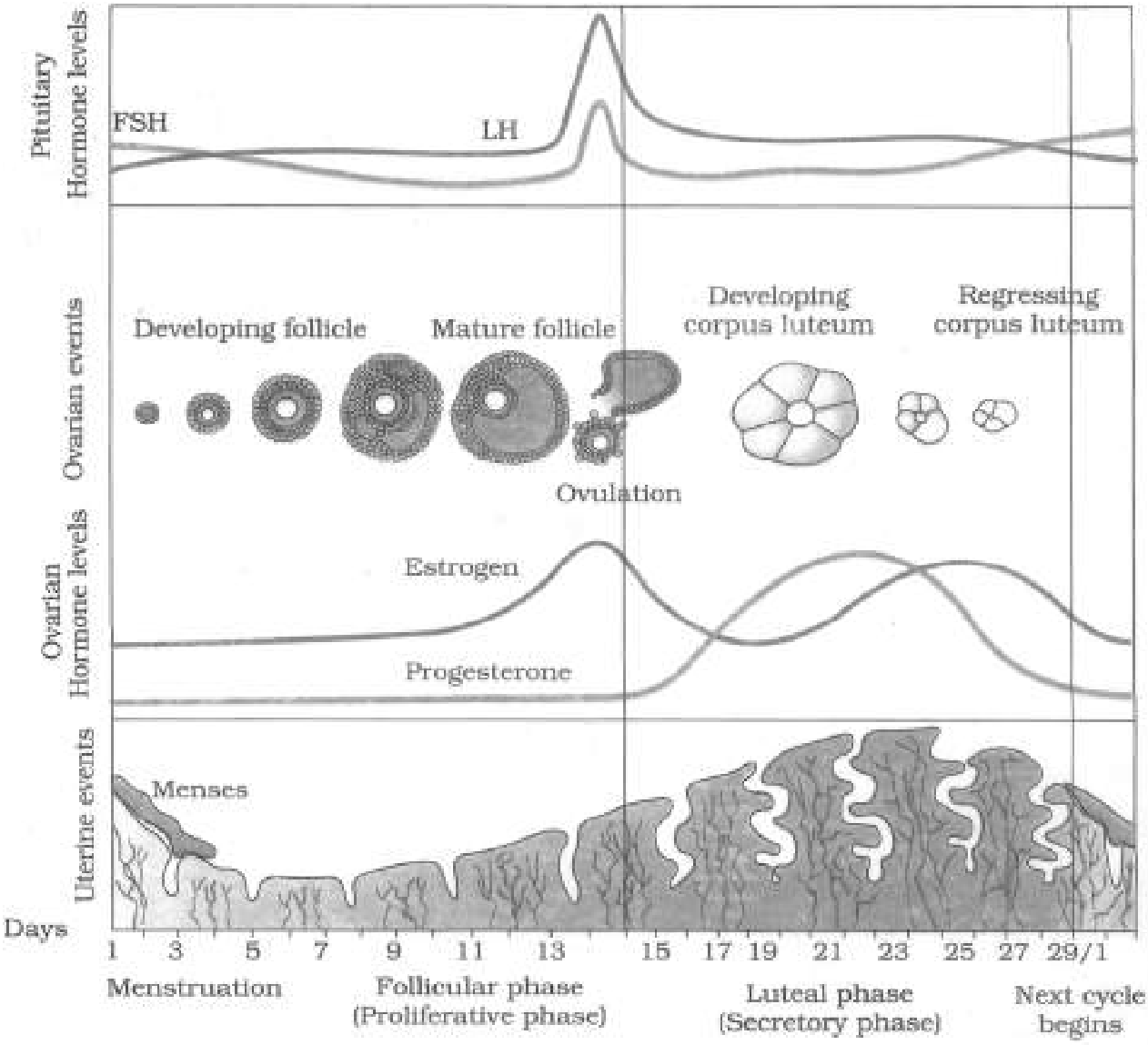
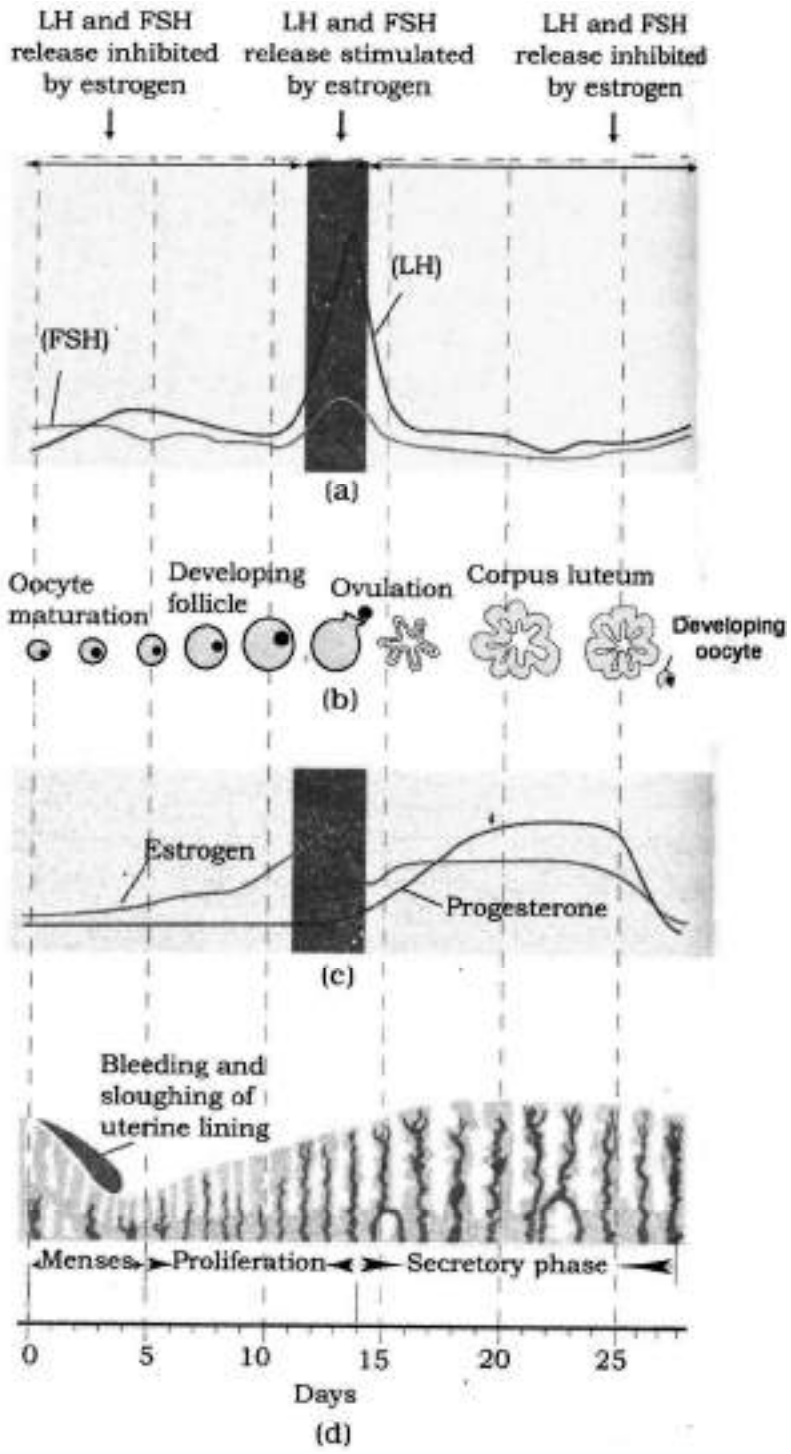


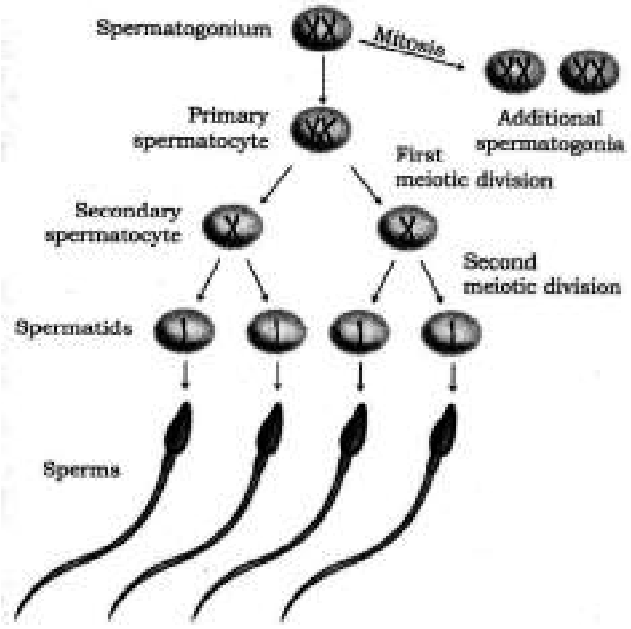
Figure Diagrammatic presentation of various events during a menstrual cycle



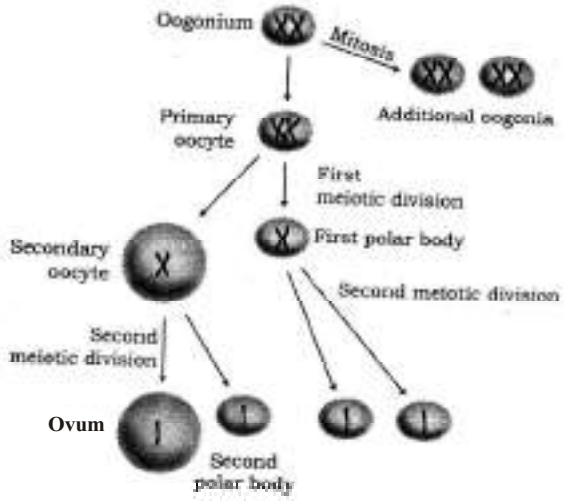
Menstrual cycle showing hormonal relations :
(a) Gonadotropin, (b) Ovarian cycle, (c) Ovarian hormones, (d) Uterine cycle

GAMETOGENESIS

The formation of gametes is called gametogenesis.The formation of male gamete / sperm is called spermatogenesis. The formation of ovum is called oogenesis.



Spermatogenesis



Oogenesis

Knowledge Booster

Parturition : Parturition is the act of expelling the fully formed youngone from the mother's uterus at the end of gestation. Hormones involved oxytocin and relaxin. **Colostrum :** After birth, the breasts does not release milk but colostruum for 2 or 3 days. This is a thin, yellowish, opalescent fluid, often called foremilk. It transfers antibodies from the mother to the baby to combat infection.

EXERCISE-1

Reproduction in Plants

1. Reproduction is necessary to maintain :
(A) Continuity of life
(B) Maintainance of species or race
(C) Both A and B are correct
(D) None of these are correct

2. Vegetative propagation helps a plant grower in :
(A) Growing a plant similar to the parent plant genetically
(B) Quick propagation of plants
(C) Combination of desirable traits of two plants
(D) Both A and B

3. Which of the following is propagated by means of cuttings ?
(A) Sugarcane (B) Coffee
(C) Citrus (D) All of these

4. Ovary in a tomato flower had numerous ovules but fruit has approximately 40 seeds at maturity, the remaining ovules were :
(A) Used in making fruit wall
(B) Converted into juicy liquid
(C) Destroyed
(D) Ejected out of ovary

5. The odd one is :
(A) Micropyle (B) Embryo sac
(C) Nucellus (D) Pollen grain

6. Where do pollination and fertilization takes place :
(A) Stigma & Style
(B) Style & stigma
(C) Stigma & ovule
(D) Stigma & pollentube

7. A phenomenon is termed as parthenogenesis when :
(A) Artificial fertilization occurs
(B) Egg is fertilized by a sperm
(C) Egg undergoes cleavage without fertilization
(D) Sperm dies before fertilization

8. Double fertilization is :
(A) Fusion of two male gametes with egg
(B) Fusion of one male gamete with egg and the other male gamete with the polar nuclei.
(C) Both are correct
(D) Both are incorrect

9. Microscopic structure in a flower that contains the polar nuclei is :
(A) Pollen tube
(B) Pollen sac
(C) Embryo sacs
(D) Male-gametophyte

Reproduction in Animals

10. Seminiferous tubules are composed of :
(A) Spermatogonia
(B) Glandular epithelium
(C) Sensory epithelium
(D) Germinal epithelium

11. Mitochondria of a sperm occur in its :
(A) Middle piece (B) Head
(C) Acrosome (D) Tail

12. Relative sizes of egg cell, morula blastula & gastrula are :
(A) Egg cell is smallest & gastrula cell is largest
(B) Egg cell is the largest and gastrula cell is smallest
(C) Egg cell is largest & morula cell is the smallest
(D) All are of equal size

13. Release of oocyte from ovary is :
(A) Gestation (B) Ovulation
(C) Parturition (D) Implantation

14. Graffian follicle are found in :
(A) Testis of mammal
(B) Ovary of frog
(C) Ovary of cockroach
(D) Ovary of mammals

15. Loss of reproductive capacity in women after age of 45 years is
(A) Menstruation (B) Ageing
(C) Menopause (D) Menarche

16. Which of these is true :
(A) Nutritional as well as genetic factors are important for growth
(B) Initially girls grow faster than boys
(C) In adolescence, voice of boys become low pitched while voice of girls turns high pitched.
(D) All of these

EXERCISE-2

COMPETITIVE EXAM QUESTIONS

1. The body of hydra is cut transversely into three pieces and the middle piece is kept up side down on the substratum. Then,
(IJSO/Stage-1/2010)
(A) it fails to regenerate into an independent hydra.
(B) it would form tentacles and foot in the same locations as oriented.
(C) it would form tentacles and foot at the original upper and lower ends.
(D) it will form a hydra with tentacles at both the ends.

2. The tissue whose activity is important in vegetative propagation of a plant grafting is -
(IJSO-Stage-I/2010)
(A) meristem (B) phloem
(C) cambium (D) pith

3. Genome of a sexually reproducing organism is
(IJSO-Stage-I/2011)
(A) all the chromosomes present in the diploid cell.
(B) total number of chromosomes present inthe haploid cell.
(C) total number of genes present in a cell.
(D) totality of DNA present in the haploid cell.

4. Which of the following is NOT a usual floral pigment ?
(IJSO-Stage-I/2011)
(A) Betacyanins (B) Anthocyanins.
(C) Carotenes (D) Betaxanthins.

5. The body of hydra is cut transversely into three pieces and the middle piece is kept upside down on the substratum. Then,
(IJSO-Stage-I/2011)
(A) it fails to regenerate into an independent hydra.
(B) it would form tentacles and foot in the same locations as oriented.
(C) it would form tentacles and foot at the original upper and lower ends.
(D) it will form a hydra with tentacles at both the ends.

6. The tissue whose activity is important in vegetative propagation of a plant grafting is-
(IJSO-Stage-I/2011)
(A) meristem (B) phloem
(C) cambium (D) pith

7. Of the follOWing the combination of processes related to sexual reproduction are:
(IJSO-Stage-I/2012)
i. Conjugation ii. Fragmentation i i i . Gamete formation iv. Zygote
(A) i, iii and iv (B) i, ii and iv
(C) ii, iii and iv (D) only iii and iv

8. The combination of the following structures possessing a single set of genome is:
(IJSO-Stage-I/2012)
i. Ovary ii. Anther
iii. Egg iv. Zygote
v. sepal vi. Petal
vii. Pollen
(A) i,ii, iv, and vi (B) ii, iii, iv and vii
(C) only iii and vii (D) only ii, iii and vii

9. Plants with inferior ovary always bear -
(IJSO-Stage-I/2012)
(A) pseudocarps (B) berries
(C) aggregate fruits (D) seedles fruits

10. In some societies, "Women were solely held responsible for giving birth to female baby" assuming no role for men. But scientific advancement has proved men equally responsible for the birth of either sex. Armed with this information which of the following would be the most appropriate scenario for the birth of female child ?
(IJSO-Stage-I/2013)
(A) Ovum with X chromosome and Sperm with Y chromosome is FEMALE
(B) Ovum with Y chromosome and Sperm with Y chromosome is MALE
(C) Ovum with x hcromosome and Sperm with X
(D) Ovum with X chromosome and Sperm without chromosome is FEMALE

11. In pregnant women, foetus's physiological functions like nourishment, respiration and excretion are taken up by
(IJSO/Stage-1/2013)
(A) Stomach of mother (B) Placenta
(C) Umbilical cord (D) Uterus

12. In some societies, "Women were solely held responsible for giving birth to female baby" assuming no role for men. But scientific advancement has proved men equally responsible for the birth of either sex. Armed with this information which of the following would be the most appropriate scenario for the birth of female child ?
(IJSO/Stage-1/2013/)
(A) Ovum with X chromosome and Sperm with Y chromosome is FEMALE
(B) Ovum with Y chromosome and Sperm with Y chromosome is MALE
(C) Ovum with x cromosome and Sperm with X is FEMALE
(D) Ovum with X chromosome and Sperm without chromosome is FEMALE

13. In a plant, 30 megaspore mother cells are generated. If all the ovules are fertilised, how many sees are expected to be formed ?
(IJSO/Stage-1/2014)
(A) 60 (B) 30 (C) 90 (D) 120

14. Most of the insects have egg, larva, pupa and adult stages in the life cycle. This is primarily due to ;
(IJSO/Stage-1/2014)
(A) relatively short adult phase
(B) terrestrial habitat they have adapted to
(C) flying mode of locomotion majority have
(D) eggs storing little reserved food.

15. Which of the following statements regarding pollen grain is correct ?
(IJSO/Stage-2/2014)
(A) Tapetum nourishes the developing pollen.
(B) Sporogenous tissue in the anther is haploid
(C) Endothesium produces the microspores.
(D) Only pollen cannot produce a complete plant in any condition

16. During fertilization in amphibians, the fusion of egg and sperm plasma is preceded by
(IJSO/Stage-2/2014)
(P) Release of enzymatic contents from the acrosomal vesicle through exocytosis.
(Q) Binding and interaction of the sperm to vitelline membrane.
(R) Chemo-attraction of the sperm to the egg by soluble factors secreted by egg.
(S) Release of the sperm nucleus into the ooplasm.
Which of the following is the correct sequence?
(A) P-Q-S-R (B) Q-P-R-S
(C) R-P-Q-S (D) R-Q-P-S

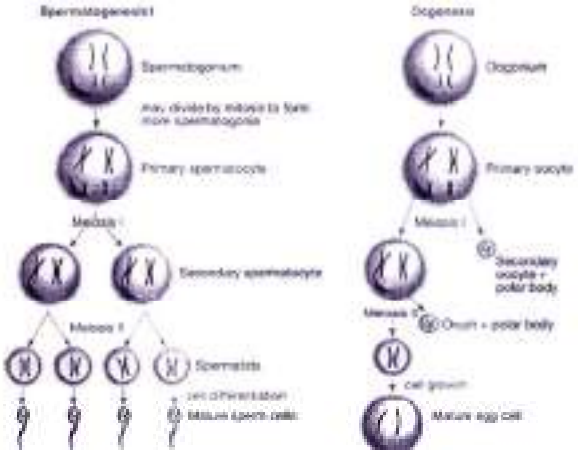
17. In maize plant grafting cannot be done successfully because in this plant :
(IJSO/Stage-2/2015)
(A) Cambium present is inactive
(B) Cambium is Absent
(C) Cambium is short lived
(D) Cambia of stock and scion are incompatible

18. Regeneration in animal kingdom is observed in which of the following animals?
(IJSO-Stage-I/2015)
(A) Frog (B) Planaria
(C) Birds (D) Snakes

19. The testes of man lie in a small muscular pouch called scrotum located outside the abdominal cavity; choose the correct reason.
(IJSO-Stage-I/2015)
(A) Sperm formation in testes requires a higher temperature than the normal body temperature.
(B) Seminal vesicles requires lower temperature to produce nutrients for sperm.
(C) Sperm formation in testes requires a lower temperature than the normal body temperature.
(D) Sperm produced in scrotum is easily released out without going into abdominal cavity.

20. The dry mass (mass excluding water) of a seed in the process of germination :
(IJSO/Stage-1/2015)
(A) increases over time until the first leaves appear
(B) decreases over time until the first leaves appear
(C) Stays constant unit the first leaves appear
(D) first increases and then decreaes until the first leaves appears

21. A. Spermatogenesis and oogenesis are processes of formation of the male and the female gametes as shown below.



Answer the following question, related to gamete formation.

(I) If accidentally the primary oocyte is fertilized with a sperm, the resulting zygote will have how many sets of chromosomes: **[0.5]**
a) n b) 2n c) 3n d) 4n

(II) The middle piece of the sperm contains: **[0.5]**
a) Mitochondrial DNA only
c) Nuclear DNA only
b) No DNA at all
d) Nuclear and mitochondrial DNA both

III) The most plausible reason for the formation of polar bodies during oocyte development is **[0.5]**

a) to retain large quantity of cytoplasm in the oocyte.
b) to retain chromosomes in the oocyte.
c) to retain both chromosomes and cytoplasm in the oocyte.
d) to retain the egg membrane which is essential for fertilization.

IV) Which one of the following statements is true regarding normal oocyte development ? **[0.5]**

a) Primary oocytes are produced after a female attains puberty (post puberty).
b) primary oocytes are already produced in the ovary when a girl is born.
c) Primary oocytes are produced in the ovary just before the female attains puberty (pre puberty).

21. B. 'Triple parent' is a novel concept of creating embryos using DNA from three people. This technique can prevent passing of genetic diseases due to defects in mitochondria from a mother to her babies. This technique involves removing the nuclear DNA from a healthy female donor's eggs and replacing it with the nuclear DNA of the prospective mother. After fertilization, the resulting child would inherit the mother's nuclear DNA and the donor's healthy mitochondrial DNA. If approved for use, the technique would allow a woman to give birth to a baby who would inherit the normal nuclear DNA but not the defective mitochondrial DNA.

I) The concept of a triple parent involves :

a) Three females and no requirement of male
b) One male and two females in which the other parent (female donor) is not genetically involved
c) One male and two females all contributing genetically
d) One female and two females all contributing genetically **[0.5]**

II) Give below are few statemen s regarding triple parent technique. Mark them as true (T) or false (F), by identifying them as either correct or incorrect statements. **[2.5]**

a) This technique can also be useful for father with defective mitochondrial genes.
b) This technique will not work for mother or father with defective nuclear genes.
c) The child produced by the technique will contain some foreign genes from a third parent.
d) The chance of transmission of foreign gene to the next generation (by normal reproduction involving two parents) will be almost zero if the triple parent technique generates a male.
e) The offspring produced by the triple parent technique will be affected if the third parent has a genetic defect in the nuclear genes.

Transmission of traits from one generation to another generation is known as **heredity**. These characters are fixed for a particular individual.

VARIATIONS

It is concerned with the differences between the individuals of same species and also between the offsprings of the same parents.
Variations could be of two types :

(i) Somatic Variation **(ii)** Germinal Variation

(i) Somatic Variation : It affects the somatic cells of an organism. It is neither inherited from parents nor transmitted to next generations. It is acquired by individuals during their life and is lost with death. So it is called as **acquired variation.**

◆ Somatic variations are due to :

(a) Environment

(b) Use and disuse of organs

(c) Conscious efforts

(ii) Germinal Variation :- This variation affects the germ cells of an organism and is consequently inheritable, it is received by the individual from the parents and is transmitted to the next generation. Also called as **blastogenic variation.**

◆ **Significance of Variations :**

1. Variation enables the organisms to adapt themselves to the changing environment. This enables the organisms to face the struggle for existence in a better way.

2. It forms raw material for evolution.

3. Helps in improving the races of useful animals and plants.

4. It is the basis of diversity.

5. It also leads to the occurrence of new traits.

TERMS USED IN GENETICS

◆ **Genetics:** It is the branch of biology that deals with the study of heredity and variation.

(i) Gene : Basic unit of inheritance, located on a chromosome. Mendel had used the term 'factor' for it before 'genes' were identified.

(ii) Allele : Alternative form of a gene; there are two alleles of a gene which govern the expression of a pair of contrasting character. For example, blue colour and black colour of eyes are two alleles of the eye colour gene.

(iii) Homozygous : A condition in which the two members of an allelic pair are similar in a diploid organism.

(iv) Heterozygous : A condition in which two members of an allelic pair are dissimilar.

(v) Phenotype : The physical or external appearance of an organism, regardless of its genetic constitution. For example, tall and dwarf plants, smooth and wrinkled seeds.

(vi) Genotype : The genetic constitution of an organism.

(vii) Dominant characteristic : Any characteristic that appears in the F_1 generation offspring from a cross between parents possessing contrasting characteristics such as tallness and dwarfness in pea plants.

(viii) Recessive characteristic : Any characteristic present in the parental generation that does not appear in the F_1 generation but reappears in the F_2 generation.

(ix) Monohybrid cross : A cross (hybridization experiment) in which a single pair of contrasting character is studied at a time. For example, a cross involving tall and dwarf plant is a monohybrid cross.

(x) Dihybrid cross : A cross involving two pairs of contrasting characters. For example, a cross involving round and yellow seeded plant with wrinkled and green seeded plants.

(xi) Offspring : Organism produced as a result of sexual reproduction; same as progeny.

(xii) F_1 generation (First filial generation) : The offspring produced by the parental generation.

(xiii) F_2 generation (Second filial generation) : The offspring produced by the F_1 generation.

(xiv) Pure variety : Breeding characteristics that appear unchanged generation after generation.

(xv) Pedigree : Ancestral record of an organism.

(xvi) Back Cross : When F_1 individuals are crossed with one of its parents either dominant or recessive, the cross is called back cross.

(xvii) Test Cross : When F_1 individuals are crossed with its pure recessive parent, the cross is called test cross. The result of it is always 1:1.

(xviii) Checker Board / Punnett Square : It is a square divided into smaller squares which shows the probable result of cross, both phenotypic and genotypic. Forked line or branching system is also used to know phenotypic and genotypic probabilities.

MENDEL'S EXPERIMENT AND LAWS OF INHERITANCE

Gregor Johann Mendel is called as Father of genetics. With the help of his experiments on garden pea(*Pisum sativum*), he was able to formulate laws which explain the manner of inheritance of characters.

Mendel's work was not recognized at that time, in 1900, Mendel's laws were rediscovered by three different scientists :

(a) Hugo de Vries- Holland

(b) Karl Correns-Germany

(c) Erich von Tschermak -Austria

- Mendel chose garden pea as plant material for his experiments, since it has following advantages :-

1. Well defined characters

2. Bisexual flowers

3. Predominantly self - pollination

4. Easy hybridization

5. Cross fertilization is possible

6. It has short life cycle.

◆ **Traits Choosen By Mendel For His Experiment :** There are seven traits choosen by Mendel for his experiments :-

◆ **Crossing Technique Employed By Mendel :**

1. Selection of Parents

2. Formation of pure line by self pollination

3. Emasculation (Removal of anther)

4. Bagging (protection from undesired pollination)

5. Pollination (By dusting pollens)

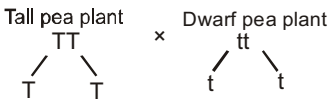
SEVEN PAIRS OF CONTRASTING TRAITS OF GARDEN PEA STUDIED BY MENDEL			
S.No.	**Characters**	**Dominant**	**Recessive**
1	Plant size	Tall (T)	Dwarf (t)
2	Shape of seeds	Round (R)	Wrinkled (r)
3	Colour of seed	Yellow (Y)	Green (y)
4	Colour of flower	Violet (V)	White (v)
5	Shape of pod	Inflated (I)	Constricted (i)
6	Colour of pod	Green (G)	Yellow (g)
7	Position of flower	Axillary (A)	Terminal (a)

♦ **Monohybrid cross:** It involves the study of inheritance of one pair of contrasting characters. e.g. cross between pure tall and pure dwarf plants to obtain F_1 generation and following results were obtained:

(A) In the F_1 generation it was found that only one of the trait was expressed and not the other.

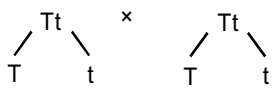
- The trait which got expressed is called as dominant, where as the one which was not expressed is called as recessive trait.

(B) The F_2 generation was obtained by self pollination, the dominant and the recessive traits obtained were in the ratio of 3 : 1 i.e. 75% of the offsprings which appeared in F_2 generation had dominant trait, while 25% had recessive trait. This ratio of 3 : 1 is also known as Mendelian monohybrid ratio.



In F_1 all are tall

($F_1 \times F_1$)



	T	t
T	TT	Tt
t	Tt	tt

In F_2 we will get 3 : 1 ratio (Phenotypic)

(C) Mendel further found that the phenotypic ratio of 3 : 1 of dominant to recessive form of a trait was actually a genotypic ratio of 1 : 2 : 1 of pure dominant, hybrid and pure recessive forms.

- The traits which remain hidden in F_1 generation got expressed in F_2 generation. This was later on proved in F_3 generation.
- **Dihybrid Cross :** Mendel also performed dihybrid crosses. A dihybrid cross is a cross between two sets of plants involving two pairs of contrasting characters. For example, a cross between plants having yellow and round seeds (YYRR) with plants possessing green and wrinkled seeds (yyrr) is a dihybrid cross.
- The results of such a cross were as follows :

P generation

Yellow and round Seeds (YYRR) X Green and wrinkled Seeds (yyrr)

F_1 generation Yellow and round seeds (YyRr)

↓ Selfing

	Ratio
F_2 generation Yellow round (YR)	**9**
Yellow wrinkled (Yr)	**3**
Green round (yR)	**3**
Green wrinkled (yr)	**1**
	16

9 : 3 : 3 : 1 phenotypic ratio in the F_2 generation is obtained in a dihybrid cross, and is called the **Dihybrid ratio.** If we analyse the result of a dihybrid cross, two additional combinations (yellow and wrinkled seeds and green and round seeds) are obtained. It means that yellow/green seed character and round/wrinkled seed character are independently inherited. In other words, the inheritance of one pair is not affected by the presence of the other (also termed as the **law of independent assortment).**

YYRR × yyrr

YR YR yr yr

Gametes	yr	yr
YR	YyRr	YyRr
YR	YyRr	YyRr

All F_1 plants are yellow and round seeded

YyRr × YyRr

YR Yr yR yr YR Yr yR yr

Gametes	YR	Yr	yR	yr
YR	YYRR	YYRr	YyRR	YyRr
Yr	YYRr	YYrr	YyRr	Yyrr
yR	YyRR	YyRr	yyrr	yyRr
yr	YyRr	Yyrr	yyRr	yyrr

In F_2 generation :

Phenotypic ratio is 9 : 3 : 3 : 1

Genotypic Ratio is 1 : 2 : 1 : 2 : 4 : 2 : 1 : 2 : 1

- **Mendel's Laws Of Inheritance :**

1. **The principle of Dominance** :- When two homozygous individuals with one or more sets of contrasting characters are crossed, the characters that appear in the F_1 hybrids are dominant characters and those which do not appear in F_1 are recessive characters.
2. **The principle of Segregation :-** [Law of purity of gametes] :- The law of segregation states that when a pair of contrasting factors or genes or alleles are brought together in a heterozygous condition, the two remain together without being contaminated but when gametes are formed from them the two separate out from each other. This is also known as **Mendel's first law of heredity.**
3. **The principle of Independent Assortment :** If the inheritance of more than one pair of characters is studied simultaneously, the factor or genes for each pair of characters assort out independently. It is known as **Mendel's second law of heredity.**

GENE

(i) The term 'gene' was introduced by **Johanssen** for Mendelian factor.

(ii) Chemically gene is formed of nucleotides. In other words, gene is subunits of DNA.

(iii) Genes are transmitted from parents to their offsprings generation after generation.

(iv) Genes are located on chromosomes at specific position called **locus**.

STRUCTURE OF DNA

DNA was first isolated by **Friedrich Miescher** (1869) from the pus cells. He named it as **nuclein**. The structure of DNA was proposed by **Watson, Crick** and **Wilkins** in 1953. The model, proposed by these scientists is called 'Double Helical model'. It is the best accepted model of DNA.

(i) According to this model, DNA is a large polymer. Its units are called **deoxyribo-nucleotides**.

(ii) A deoxyribo-nucleotide consists of three components :

(a) Deoxyribose sugar ($C_5H_{10}O_4$),

(b) Phosphate group and

(c) Any one nitrogenous base (Any one of the four types of bases - Adenine, Guanine, Cytosine and Thymine). So depending upon the nitrogenous bases, the nucleotides in DNA can be of four types.

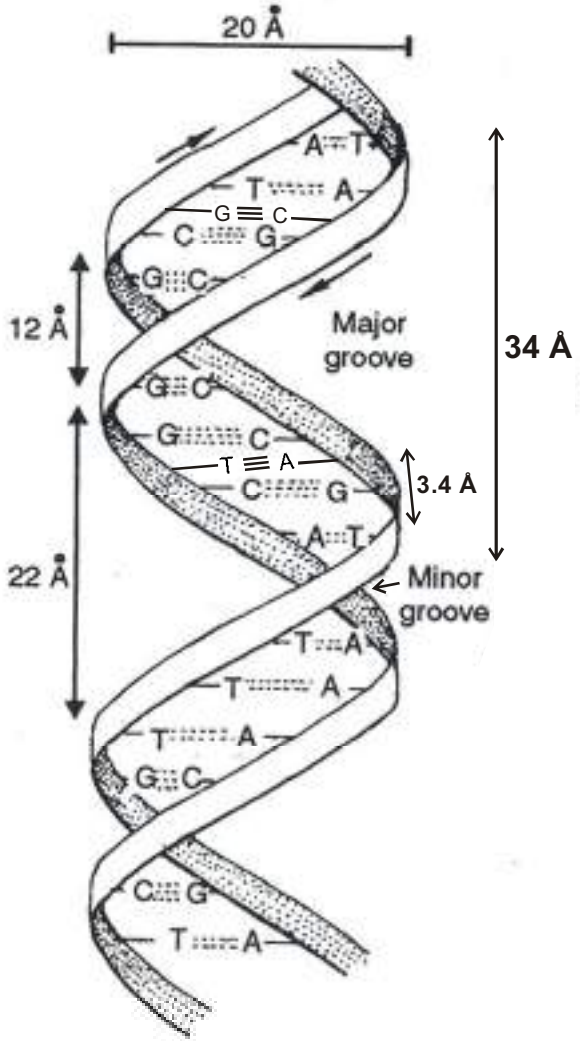


Fig : Double Helical Structure of DNA Molecule

◆ **Double Helical Structure of DNA Molecule**

(iii) The deoxyribo-nucleotides are joined together by **phosphodiester bonds** and form a polynucleotide chain. These chains have two ends. One end is called 5' end, while other is called 3' end.

(iv) A DNA molecule has two such polynucleotide chains, which run in opposite or antiparallel direction.

(v) One chain runs in 3' to 5' direction while other in 5' to 3' direction. So each strand in the DNA molecule possesses a polarity with 3'and 5' ends.

(vi) Two chains are held together by weak Hydrogen bonds, which are established between the opposite complementary bases (A and T, C and G) of the two chains. There are 2 – H bonds between A and T while 3 – H bonds between C and G.

(vii) Two strands, to acquire maximum stability get coiled or twisted to form the characteristic DNA structure. They twist around a central axis.

(viii) Normal distance between the two base pairs is 0.34 nm.

(ix) The distance between each turn of coil is 3.4 nm. Each turn contains 10 base pairs.

(x) The diameter of the DNA molecule is 2 nm.

◆ **Note :** RNA has uracil in place of thymine and consists of single polynucleotide chain.

MULTIPLE ALLELES

1. Blood group (ABO) is regulated by multiple alleles in Human beings

2. Multiple alleles are multiple alternative or alleles of the same gene which occur in the population of same species.

A haploid individual has only one allele and diploid individuals have two alleles

TYPES OF BLOOD GROUPS			
Blood Group	**Genotype**	**Antigen**	**Antibody**
A	$I^A I^A, I^A I^o$	A	b
B	$I^B I^B, I^B I^O$	B	a
AB	$I^A I^B$	A&B	Nil
O	$I^o I^o$	Nil	a, b

CO-DOMINANCE

In co-dominance, both the genes of an allelomorphic pair express themselves equally in F_1 hybrids. It means a heterozygote for codominant genes exhibits both the characters side by side. **e.g.** Codominance of blood group alleles in man.

INCOMPLETE DOMINANCE

It was discovered by **Correns**, 1903. It is a post Mendelian discovery. Incomplete dominance is the phenomenon of neither of the two alleles being dominant so that expression in the hybrid is a fine mixture or some what intermediate between the expressions of two alleles in their homozygous states. Incomplete dominance is not blending inheritance because parental characters reappear in F_2 generation. In Snapdragon (Dog Flower, *Antirrhinum majus*) and **Four O'Clock (*Mirabilis jalapa* ; Correns, 1903)** there are two types of pure breeding plants, red flowered and white flowered. On crossing the two, F_1 , plants or hybrids possess pink flowers. On selfing them F_2 generation has 1 red : 2 pink : 1 white flowered plants with phenotypic ratio beings similar to genotypic ratio. Pink flower colour is due to incomplete dominance of red flower trait over white flower trait.

- **Linkage :** Linkage is the phenomenon of certain genes (present on the same chromosome) to remain together and get inherited block (as a single unit) through generations. It was discovered by **Morgan** (1910). Linkage is an exception to the principle of independent assortment. The genes which remain together on the same chromosome are called linked genes.

MUTATIONS

Mutation is a phenomenon which results in alteration of DNA sequences and consequently results in changes in the genotype and the phenotype of an organism. In addition to recombination, mutation is another phenomenon that leads to variation in DNA. One DNA runs continuously from one end to the other in each chromatid, in a highly supercoiled form. Therefore loss (deletions) or gain (insertion/ duplication) of a segment of DNA, result in alteration in chromosomes. Since genes are known to be located on chromosomes, alteration in chromosomes results in abnormalities or aberrations. Chromosomal aberrations are commonly observed in cancer cells.

SYNDROME	KARYOTYPE	SPECIAL POINT
Down's Syndrome	45 + XY	**1.** Trisomy (three copies) of 21st chromosome
		2. Also Called Mongolism
Patau's Syndrome	45 + XY	**1.** Trisomy of 13th chromosome
Edward's Syndrome	45 + XY	**1.** Trisomy of 18th chromosome
Turner's Syndrome	44 + X	**1.** Sex linked Syndrome
		2. Sterile female
Klinefelter's Syndrome	44 + XXY	**1.** Trisomy in Sex chromosomes
		2. Sterile Male
		3. Sex linked Syndrome
Philadelphia Syndrome	—	**1.** Deletion of Segment of 22nd chromosome
		2. Leukemia in patient
Cri-du-chat Syndrome	—	**1.** Deletion of Segment of 5th chromosome

◆ **Methods of study of Human genetics :**

- **Pedigree Analysis :** A family tree or pedigree is drawn for families having genetically transmitted diseases or traits. Its construction is based on information gathered about all members of the family over many generations. This pedigree is represented with certain standard symbols. Some of these symbols are given in Fig. For carrying out simple Mendelian analysis involving recessive or dominant allele, certain clues or simple rules are sought from the pedigree. In the case of recessive allele, for example, characteristic condition can appear in the progeny of apparently unaffected parents Moreover, two affected individuals cannot have unaffected child. Quite often, such recessive alleles are revealed by close marriages, such as cousin marriages. Simple pedigree analyses have extensively used not only in medical research but also in the day-to-day counselling of prospective parents who would like to be guided about the possibilities of transmitting a diseased condition to their children. Very often a single pedigree analysis does not offer the conclusions that can be drawn from a designed cross producing large number of offspring. In such case, several independent pedigrees involving the same trait are analysed so as to draw consistent conclusions.

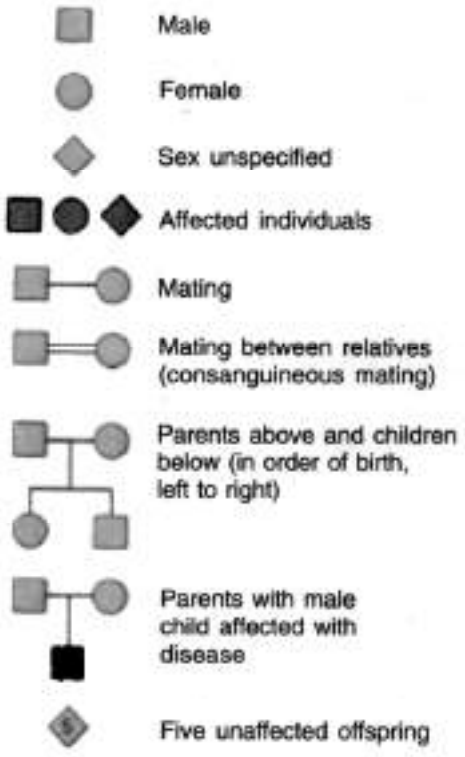


Fig. Symbols for Pedigree analysis

ORIGIN OF LIFE

Several theories have been put forward to explain the origin of life on earth.

S. NO.	THEORY OF EVOLUTION	PROPOSED BY	SPECIAL POINTS RELATED TO THEORY
1.	Special creation	Father Suarez (1600)	Life is created by God with in 6 days
2.	Spontaneous Generation/Abiogenesis Theory	Aristotle (384 – 322 B.C.)	Life comes from living organisms as well as from non-living / organic matter spontaneously. Eg. Mice from Human sweat, Frog from Mud etc.
3.	Catastrophism	Cuvier (1800)	Life is continuously created &destroyed and recreated in different forms.
4.	Cosmozoic / Panaspermia	Richter	Life reached on earth by germs spores or cosmic dust from other planet.

◆ Modern Theory or Abiotic theory or Chemical Evolution :

- Most accepted modern theory (Naturalstic theory) Given by A.I. Oparin (Russia) and Haldane (England) Book - Origin of life
- According to oparin and Haldane " Life originated abiogenetically first but biogenetically ever since."
- "Chemical evolution through physio-chemical process" was the main theme and also called materrialistic theory of oparin + Haldane.
- First life originated as single cell in oceanic water (salty water).
- According to oparin and Haldane life orignated (up to Eukaryotic cell) into 8 steps or phases -

1st Phase : Atomic phase

Only atoms of each element were present -
In earth core -Heavy metals (Fe, Cu, Ni, Pb)
In earth crust - Si, Na, K , Mg , Al, P, F, Cl
In atmosphare -H, He, Ar, N, O, C

2nd Phase : Molecular phase and formation of simple inorganic compound like -

H_2O-Vapour, NH_3-Ammonia } Water and Ammonia were probably first compound of primitive earth.

H_2 - most reactive, 90% and make early enviroment highly reactive.

3rd Phase Formation of first simplest organic compound

$CH_4, NH_3, H_2,$ water vapour $\xrightarrow[\text{Ray, lightning and thundering}]{\text{U.V.Rays, Cosmic}}$ Simple A.A,Fatty acid, simple sugar N_2 base.

Due to formation of above organic compound it was become possible to originate life or it was first step towards protoplasm synthesis.

Prebiotic Soup - Hot dilute mixture of simple organic compound in sea water termed as prebiotic soup by **Haldane.**

4th Phase Formation of two important protobiont or Protocells or Prebiotic structure and origin of in dividuality.

Knowledge Booster

- **Coaservates -** Term given by oparin and made up of protein and polysaccherides.
- Proteinoid Microsphere - Sydney fox
  - **(i)** Once organic Molecules (Coacervate and Microsphere) formed, they accumulated in water because their degradation was extremely slow in the absence of Enzymes or Catalysts.
  - **(ii)** Two important unique feature of protobiont are -
    - They had separate combinations of molecules from surrounding and can maintain their internal environment but can't reproduce.
    - They were membraneless or have no lipid covering.

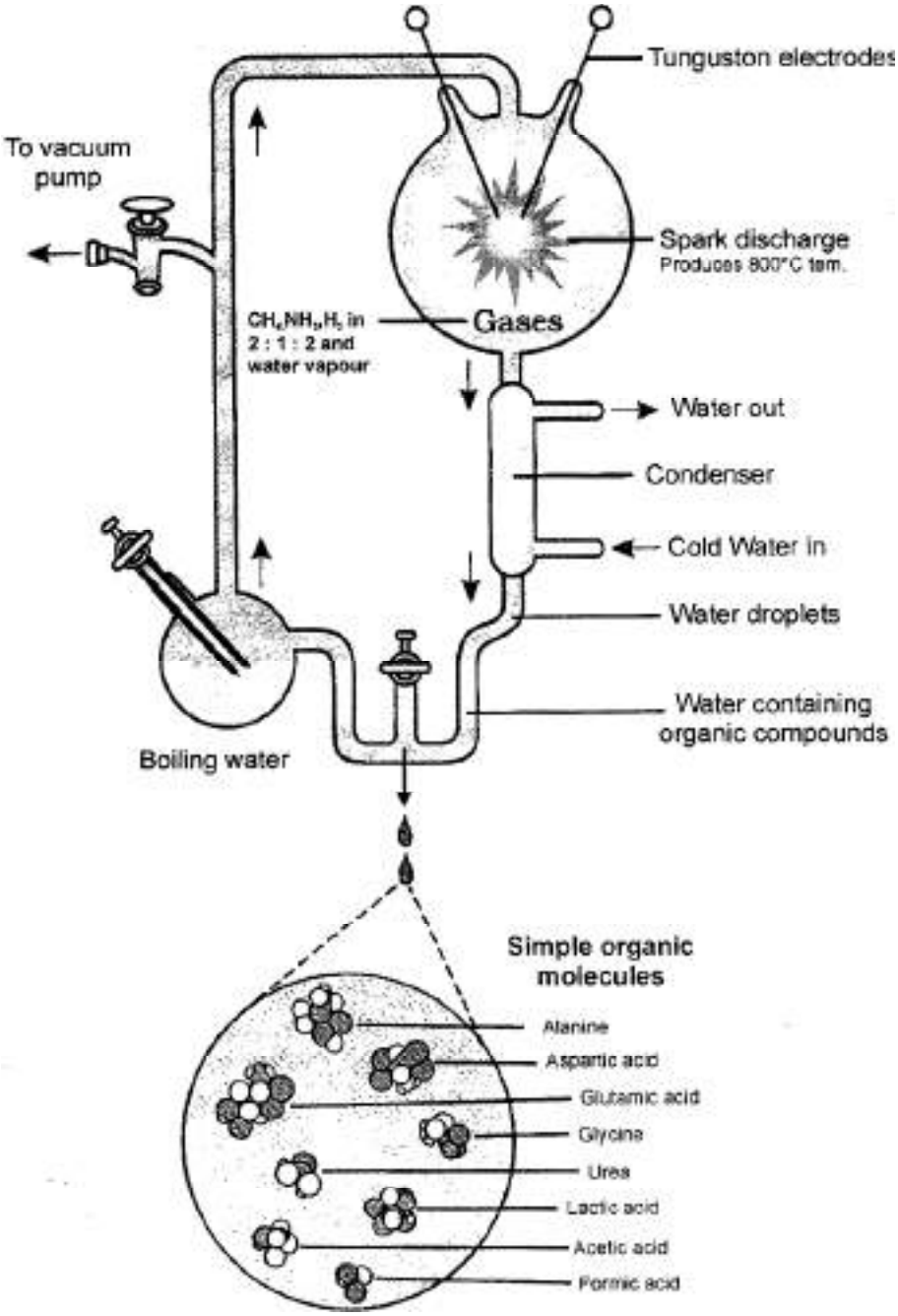
5th Phase : Origin of genes, Autocatalytic system means premordial life (3.7 billion years ago in precambrian Era) Eobiont. RNA were replicator as well as Enzyme.

6th Phase : Origin of first cellular form of life (Anerobic Heterotrophic bacteria) about 3.5 billion year ago. There were chemoheterotrophic bacteria that used organic contents of premordial soup. There were membrane bound primitive prokaryotic cellular organism. Drop in tempreture stopped synthesis of organic molecuels in the oceanic water bodies.

7th Phase : Origin of first autotrophic form of life.First of photo-autotrophic organism O_2 evolved so that reducing environment gradually changed into oxydising one. Ozone formed and accumulated at the height of 11-16 (from poles).CH_4 and NH_3 disappeared because they reacted with O_2 to form CO_2 and N_2

8th Step origin of Eukaryotic cell. Eukaryotic cell formed about 1.5 billion (1500 Million) year ago due to mutation in prokaryotes. Some scientist explains that symbiotic association of different types of prokaryotes give rise to Eukaryotes.

- **Experiment of Stanley Miller and Harold Urey**: Urey and Miller made an experiment to proove operin and Haldane theory by Electrical spark Chamber using CH_4,NH_3,H_2 (2 : 1 : 2) and water vapour in 800° C temperature.



EVOLUTION

- The term evolution has been derived from the Latin word 'evolve' which means to unroll.
- The evolution is of two types (i) chemical evolution (ii) organic evolution.
- Chemical evolution states that life originated upon earth as a result of several physiochemical changes. Where as organic evolution can be defined as sequence of gradual development of complex form of life from simple form of life over the course of geological time (millions of year) scale.

TABLE : DIFFERENCES BETWEEN FEATURES OF CHEMICAL AND ORGANIC EVOLUTION

S. no.	Features	Chemical evolution	Organic evolution
1.	Definition	It is the formation of the complex organic compounds from simple compounds or elements.	It is the formation of complex form of life from simple form of life.
2.	Time of occurrence	It occurred at the time of origin of life.	It is still occurring.
3.	Reversibility	Irreversible.	Reversible.

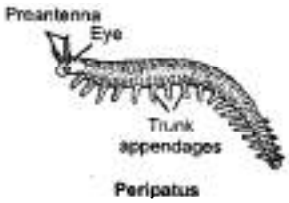
EVIDENCES OF ORGANIC EVOLUTION

(a) Evidences from connective links :

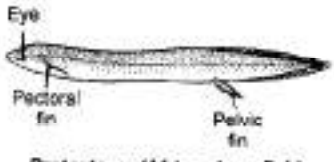
"An organism, having characteristics of two taxanomic groups is called as connective link. These connective links play an important role in systematic and stabilising monophylentic evolutionary line or in other words, phylogenetic tree stand mainly on the basis of connective links."

- **e.g.**

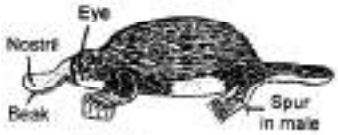
(i) Lung fish shows connection between fishes and amphibians.



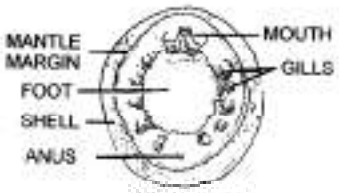
Peripatus



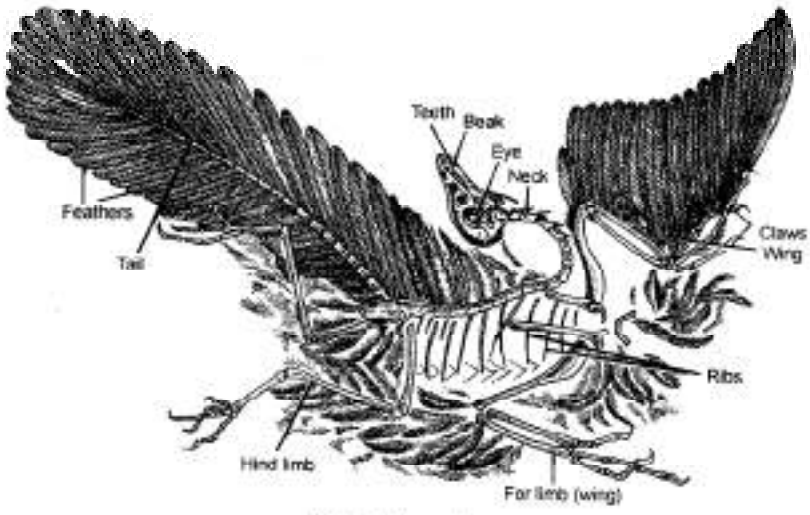
Protopterus (African lung-fish)



Duck-billed platypus



Neopilina



Fossil Archaeopteryx

(ii) Amphibians are the connecting links between fishes and reptiles.

(iii) Viruses are connecting links between living and non–living.

(iv) Euglena is connecting link between plants and animals.

(v) Proterospongia is connecting link between protozoa and porifera.

(vi) Peripatus is connecting link between Annelida and Arthopoda.

(vii) Archaeopteryx (fossil) is connecting link between reptiles and Birds.

(b) Evidences from Fossils :

Fossils : The fossils can be defined as remains or impression of the hard parts of the past individual in the strata of the earth.

- **Fossilisation (Formation of fossils) :** The plants or animals are preserved and fossilized when they are buried in the lava of volcano, in the ice, in swamps, in an oil rich soil, in rocks, etc. Dead remain of aquatic animals and plants settle down at the bottom. Remains of terresterial organisms are also brought to sea and big lakes by rivers and streams. Mud and sand settle down continuously at the bottom. Sedimentation (deposition of layers) of mud and sand occurs. Fine mineral particles may penetrate the dead bodies. Decay and disintegration of organic remains take place to leave only the harder parts, impressions, casts etc. The segmented mud and sand harden with time to form rocks.

- **Determination of the age of a fossil:** There are two components to this estimation.

(i) **Relative method**: If we dig into the earth and start finding fossils, it is reasonable to suppose that the fossils we find closer to the surface are more recent than the fossils we find in deeper layers.

(ii) **Radio-active dating :** The age of a fossil can be calculated based on the property of a radio-active element uranium to transform into lead through several intermediate stages. Therefore, by calculating the amount of lead in a rock, one can approximately estimate the age of the rock and thus the age of the fossil present in it can be calculated.

◆ **Type of fossils :**

(i) **Unaltered or preserved fossil :** Complete body of an organism burried in polar snow.
Snow : Large body sized animal

- e.g. The fossil of elephant like mammals "mammoth" was found and average calculated age was 25 thousand years.

(ii) Petrified fossil - Only hard part of the body (teeth, bone, shell of mollusc, skeletun of arthropod) present between layers of stratified rock. Ex. Fossils of Apeman, Neanderthal, Cromagnon.

(iii) Printed fossil or moulded fossil - The print of animal or plant body in stratified rocks. Ex. Archaeopteryx.

◆ **Living fossil :** Only existing representative of a group means all the member of a group extincted but the only surviving member of that group is called Living fossil. Ex. Limulus - King Crab (An Arthropod)

◆ **Latimeria -** Coelocanths (Bony Fish)

(c) Evidences from vestigial organs

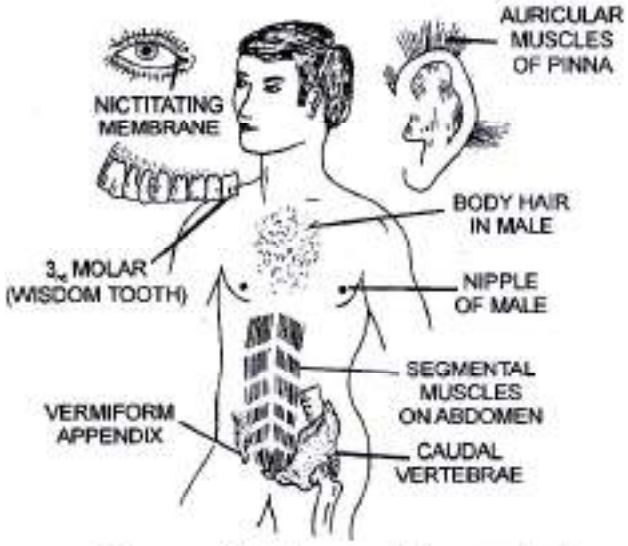
"The structure that have lost some or all the funcitons that they used to perform earlier in their ancestor" called vestigial organ. Vestigial organ also offer on evolutionary explanation of such rudimentary vestiges (non-functioning organ) by stating that adaptations to new environment of the organism have made these structures redundant.

- **e.g.**

✧ Presence of pelvic girdle in Whale, Python,
✧ The rudiment of the hind limbs of python and greenland whale
✧ Rudiments of body hair in whale.
✧ Residual and non-functional wings in Ostrich, Emu, Kiwi, Dodo (Recently extincted)
✧ Rudiment of the reptilian jaw apparatus.
✧ 2nd and 4th digit of horse (1st and 5th digit completaly degenerated while 3rd digit developed in hoof)

◆ **Vestigial organ of human :**

- Plica semiluneris.
- Muscles of ear pinnae
- Body hairs
- Tail vertebrae
- Vermiform appendix
- 3rd molar teeth or wisdom teeth



Some vestigial organs in human body

(d) Evidences from comparative anatomy :

(A) Homology and Homologous organs - Organs which are similar in origin, structure, anatomy but different in function called homologous organ and study of such organ is called **Homology.**

Knowledge Booster

Divergent evolution or adaptive radiation - Represented by homology.
Common descendents or ancestry – Represented by homology.

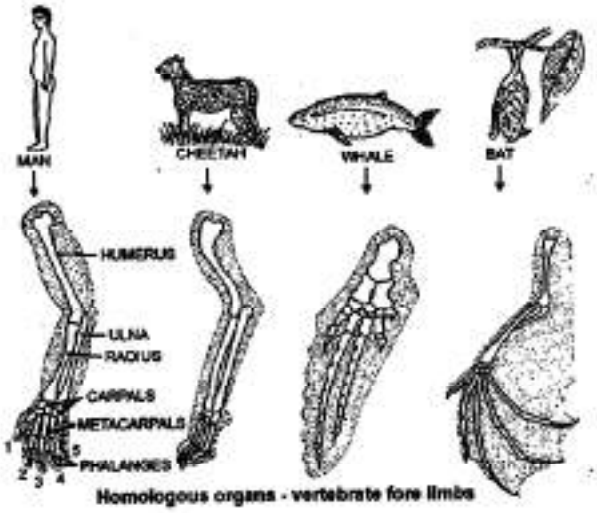
- **e.g.**

(i) Hands of man, fore limbs of horse - wings of birds, wing of bat, flippers of whale have similar anatomy (Humerus, radius - ulna, carpels metacarpels phalanges in their fore limb) but adapted for different functions.

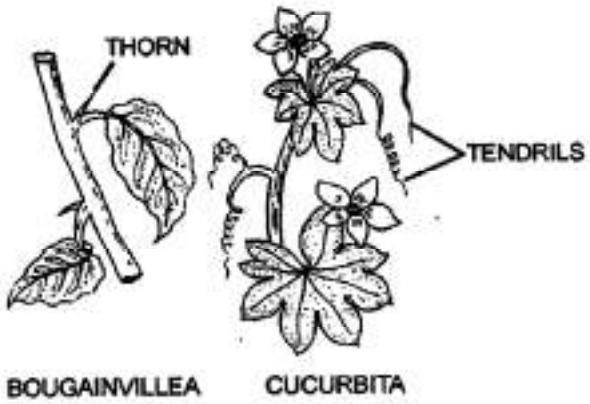
(ii) Hearts and brain of all vertebrae (have same basis structural plan).

(iii) Thorn and tendrils of bougainvillea and Cucurbita (Both are axillary in origin but perform different function.

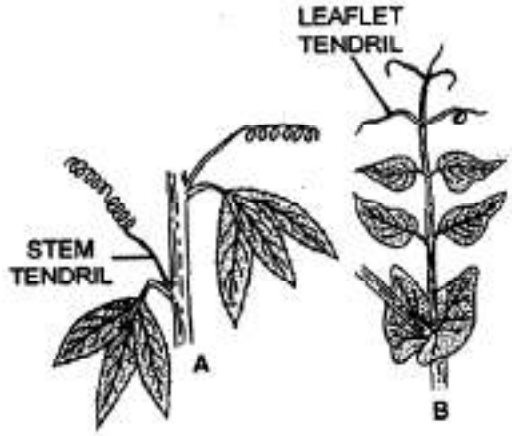
◆ **Note -** Molecular homology - Similarities in protein and genes. performing a given function among diverse orgnism give clues of common ancestry (Homology)



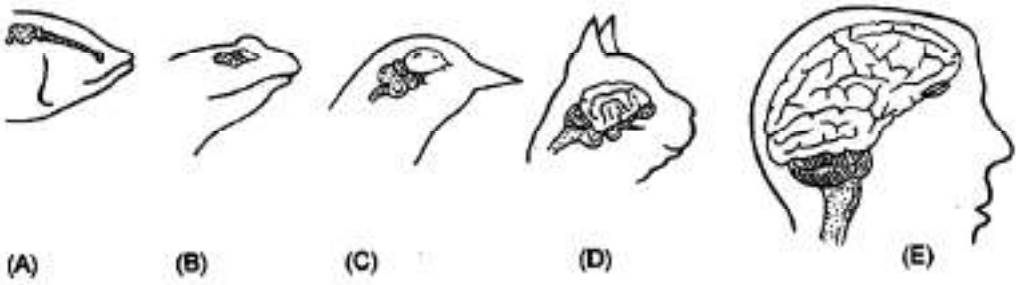
Homologous organs - vertebrate fore limbs



Homologous structures.
Thorns and tendrils in plants



Analogous Organs. Tendrils of different origin. A, stem tendrils of passiflora; B. leaf tendrils of Pisum sativum.



Homologous structures : vertebrate brain (a) fish, (b) frog, (c) bird, (d) cat and (e) human being

(B) Analogy and analogous organs – Organ which are different in origin, structure and anatomy but similar in function are called analogous organs and study of such organs is called **Analogy.**

◆ **Convergent or parallel evolution –** Represented by analogaus organ **Ex.**

✓ Eyes of human and octopus (differ in retinal position)

✓ Flippers dolphin (mammal) and penguin (bird)

✓ Wing of birds and butterfly

✓ Sweet potato (Modified root) and potato (Modified stem) but both are meant for storage of food.

(e) Evidences from biogeography :

"Geographical distribution of species is called biogeography" or "Study of distribution of animals and plants on the earth is biogeography"

◆ **Pangaea -** Earth without realms or earth in single piece and at carboniferous period (palaeozoic era).

◆ **Realms -** Due to various geographical changes huge single land mass (earth in single piece) broken in to pieces (continents) and separated by seas, which prevent the migration of animal and separated by seas, which prevent the migration of animal and forced them to remain endemic (restricted area or continent). The earth is divided into many continents by six major biogeographical region called realm.

(i) Palaearctic realm
(ii) Oriental realm
(iii) Australian realm
(iv) Ethopian realm
(v) Nearctic realm
(vi) Neotropical realm

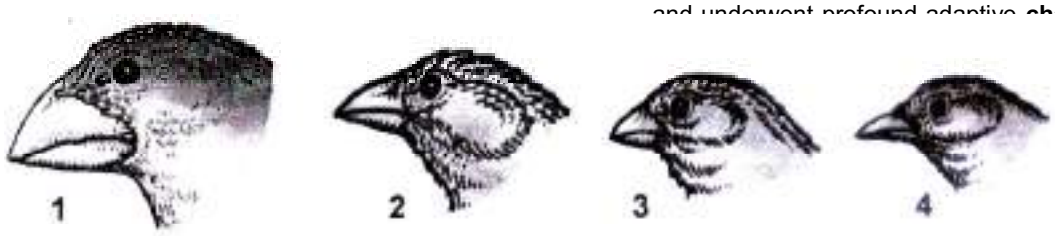
(A) Adaptive readiation — This process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitat) is called adaptive radiation. Ex.Darwin finches, Marsupials of Australia

• **e.g.(1) Adaptive radiation of darwin's finches :**

✧ Darwin visited to **Galapagos Island** by ship (voyage) H.M.S Beagle. Galapagos Island consisted of about **twenty two** different island that have **many endemic** plant and animal species.

✧ He observed small **black coloured** many varieties of finches on same island.

✧ All varieties evolved and radiated by a single ancestral seed-eating ground finch (root finch). Essense is ancestral seed eating ground finch radiated to different geographical area (habitat) and underwent profound adaptive **changes** and



Variety of beaks of finches that Darwin found in Galapagos island

✧ Ancestral seed-eating **root** ground finch radiated to different geographical areas and underwent profound adaptive changes and specially in beak.

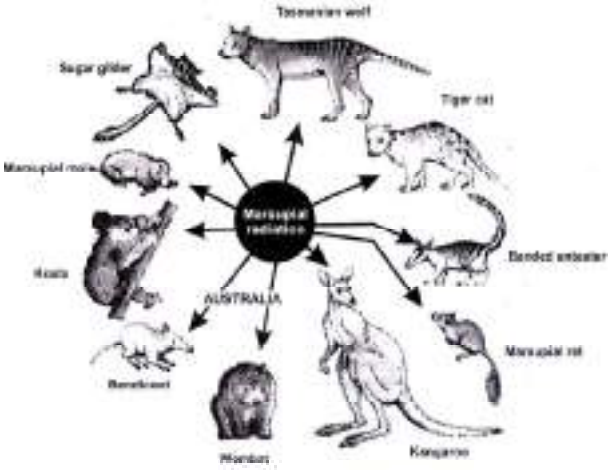
Do you like to know reason

Darwin realised that such questions could be explained on the ground that form an ancestral group, living in a particualr geographical area, descendant populations could radiate into other area where the new environmental conditions brought about the suitable adaptation by evolution. He reasoned that after originating from a common ancestral seed-eating stock the finches radiated to different geographical areas and underwent profound adaptive changes, especially in the patterns of beak. Living in isolation for long period of time new kinds of finches emerged that could function and survive in the new habitats. Such an evolutionary process, giving rise to new species adapted to new habitats and ways of life, is called **adaptive radiation.**

• **e.g. (2)** Adaptive radiations of marsupials of Australia :

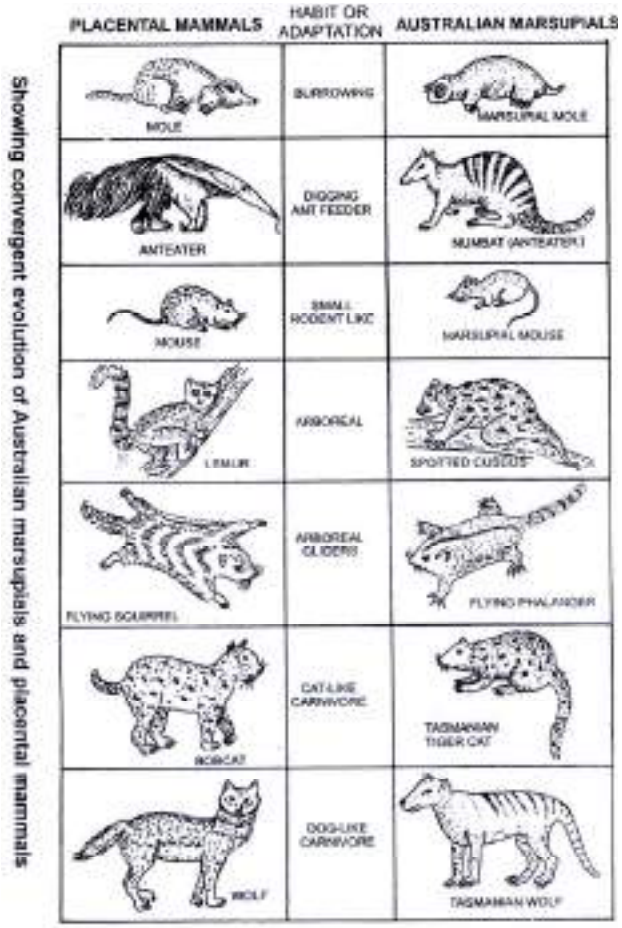
✧ Further more, **Australia** is the **home** to the great diversity of **marsupials** (Pouched mammals) but relatively few placental mammals.

✧ A number of marsupials, each different from other evolved from an ancestral stock but all with in the Australianisland.



Adaptive radiation of marsupials of Australia

(B) Adaptive convergence (convergent evolution) : **"**When more than one adaptive radiation appeared to have occured in a isolated geographical area or development of similar adaptative function structure in unrelated groups of organism is called adaptive conver gence" Ex.1 – Placental mammals and Australian marsupials (placental wolf and Tasmanian marsupial wolf)



Do you like to know reason

Some of the marsupials of Australia resemble equivalent placental mammals that live in similar habitats of other continents. Australia, separated from other continents more than 50 million years ago. Most likely, marsupials arrived in Australia before its separation from Antarctica and evolved in isolation earlier than placental mammals.Natural selection has favoured changes that made the two groups more alike. In other words, their phenotypes have converged.**e.g.**Various aquatic vertebrate thats are not closely related but adapted to survive in aquatic habitat.

Reason : Convergent evolution is mainly due to similar adaption for survival in different groups of animals inhabitting in a similar habitat.

Ex. Wings of Insects, Bird, Bat

(f) Evidences from adaptation and natural selection :

◆ **e.g.**

1. Pepered moth

Cryptic colouration of pepered moth (Biston bittularia) show best example of **genetic basis** of **natural selection**

- Observation supporting evolution by adaptation and natural selection comes from **England.**
- Before industrialisation set (about 1850) **–** More white winged moths and few dark winged moth (Melanised moths) on **white lichen covered tree bark.**
- After industrialisation set (in 1920) **–** The proportion got reversed means more dark (Melanised) moth and less white winged moths.

Easy way to Memorize

Before industrialization (Tree trunk covered with white lichen)
- More population of white winged moths in white background because of white coloured lichen covered tree bark
- Less population of dark winged moth in contrasting background because predator easily spot them and picked away.

After industrialization (Sooty or black coloured tree trunk because of industrial smoke and lichen destroyed because of SO_4 in smoke)
- Less population of white winged moth in contrasting background because predator easily spot them and picked away
- More population of black winged moths in black background because of smoke and soot emitted by chimnies of industries that make tree trunk black or dark.

◆ **Explanation -** During post industrialisation period, the tree trunk become dark due to industrial smoke and soots and it was easy to spot a moth by predator in a **contrasting background** under such environmental condition the **white winged** moth did not survive due to predators but dark winged may easily survive be cause of cryptation or camouflage, and it was done by adaption and natural selection at gene level.

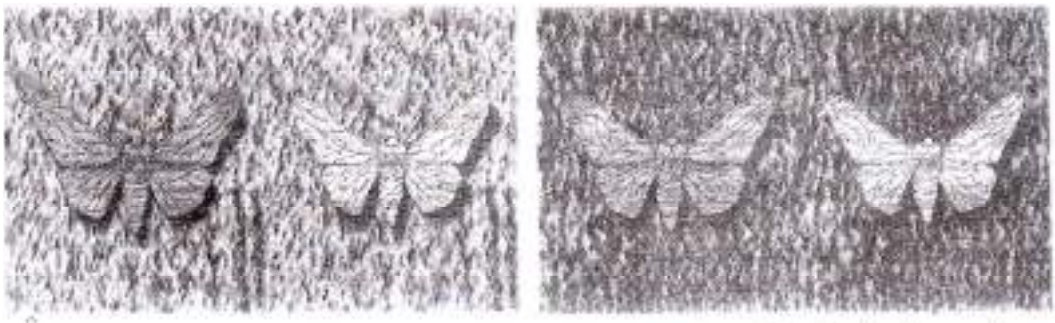


Figure showing white - winged moth and dark - winged moth (melanised) on a tree trunk cryptic colouration in biston bitularia (a) In unpolluted area (b) In polluted area

◆ Note : It can't be said that all moth become dark winged but most of them do this hence moths that were able to camouflage themselves (hide in the background) survived and increase in population size. In other words, where industrialisation did not occured (Rural areas) the count of dark winged moth was low and in industrial areas the count of dark winged moth was high means mixed population was present in England. Remember that no variant is completely wiped out. **e.g.–**(2) Resistant varieties of microbes due to anthropogenic action -

(i) Excess use of herbicides, pesticides etc has only resulted in selection and development of new resistant varieties of insects, fungus microbes in a much lesser time scale.

(ii) This is also true for other microbes against which we employ antibiotic or drugs in order to cure an eukaryotic organism. Many antibiotic resistant varieties of sehigella dysentry are found.

◆ **Note –** Such type of evolution is not directional but purposefull.

(g) Evidences from comparative physiology and biochemistry :

- **Chemical composition of protoplasm —** Chemical composition in all organisms (primitive to complex organism) is almost similar.
- **Genetic material -** In all true livings, D.N.A is genetic material.
- **Enzyme action —**

✓ Trypsin (protein digestive enzyme) present from protozoa to mammalia.

✓ Amylase enzyme (starch digestive enzyme) present from porifera to mammalia.

- **Thyroxin hormone –** Thyroxin hormone secreted in all vertebrates and thyroxin hormone of one vertebrate group show similar effect in the other vertebrate groups.
- **Haemoglobin —** Morphologically much closer and similar group shows more closeness in Hb crystal shape and size, sequence of closeness in **Hb crystal** in as following order.

Pig→Tree shrews → Lemur → Loris → Monkey → Ape → Man

- More difference in pig and man Hb crystals
- More close ness (simillarity) in ape and man Hb crystals.

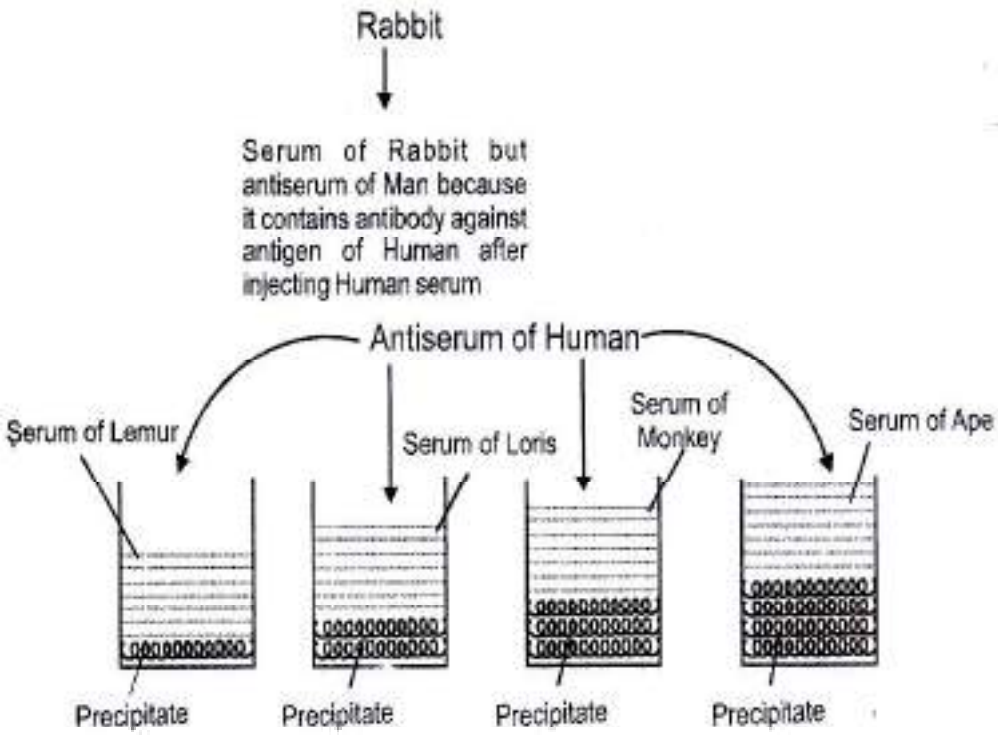
◆ **Cytochrome-C :**

- It is a protein present in mitochondria that contain 104 to 112 amino acids.
- Examination or observation in amino acids sequence in cytc is almost similar from 70 to 80 (11 amino acid) in polypeptide chain in human, Rabbit, Birds, Reptiles, Amphibia, fishes.
- Polypeptide chain differ in single amino acid in chimpanzee and man.

◆ **Metabolic ATP :** In all organism ATP works as energy currency and energy carrier.

◆ **Comparative serology :**

- Study of serum is called serology.
- Blood plasma - Fibrinogen = Serum.
- Transparent, yellow coloured fluid appers on wound after blood coagulation called serum.



- When reaction between serum and antiserum occures then a white precipitate is obtained and the amount of precipitate is more in closely related species while less in fartherly related ones.
- Amount of precipate with Lemur is least while maxium with Ape, it indicates that Ape is close relative of Human that Lemur.

(h) Evidences from classification :

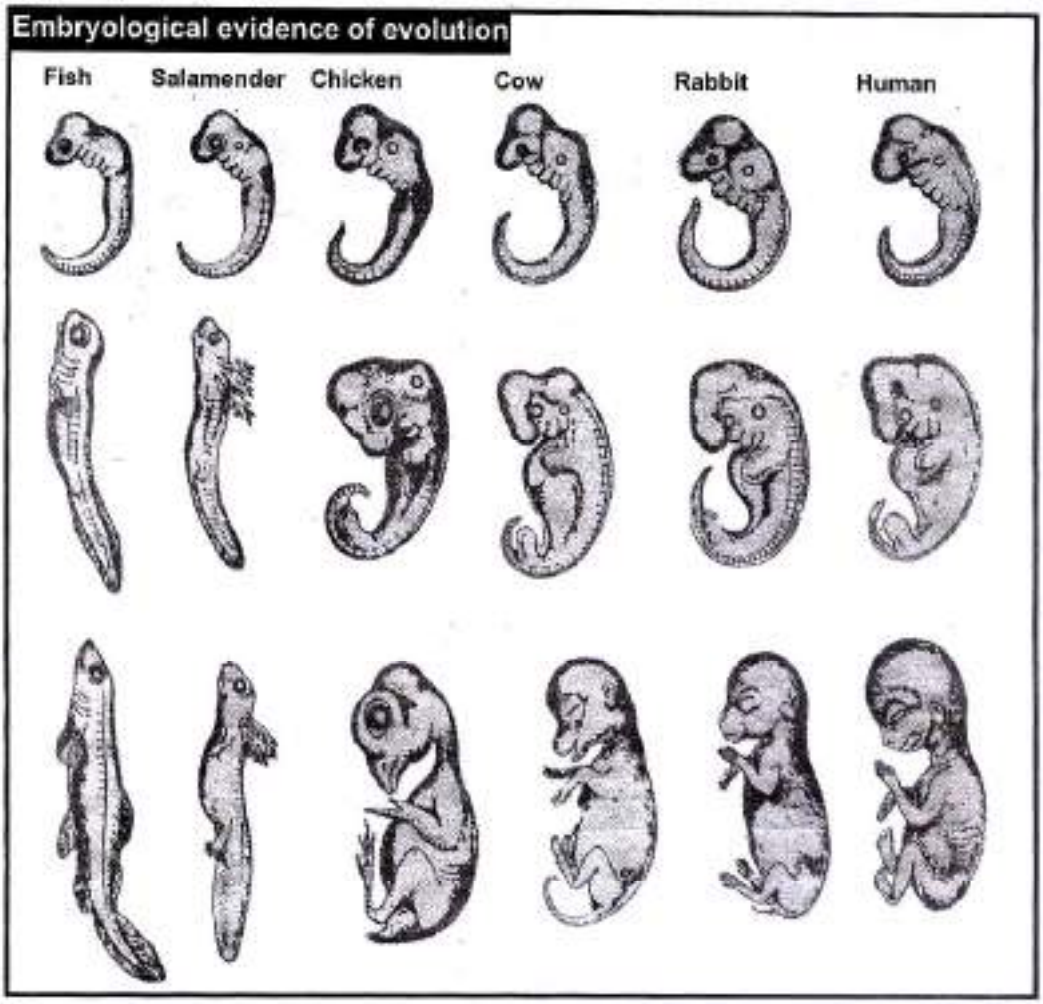
Phylogenetic classification proves ancestral Lineage or evolution phylogenetic system of classification depend upon connective links and because of non-availability of all link or missing of some connective link, not a single phylogenetic classification is complete.Present phylogenetic systems of classification are actually mixture of natural and phylogenetic.

(i) Evidences from embryology :

(i) Study of embryo and all developmental stages is called embryology (ontogeny)

(ii) Father of embryology **- Aristotle** He first studied the embryo and placenta in Shark and Whale.After that he find that shark have no placenta but whale and Dolphins have it. That was the reason he classified whale and Dolphins with mammals.

(iii) Father of modern embryology **- Van Baer**



- Simplest character → Simple character →Complex character → at the end of gestation , species specific character develops like hairs (found only in mammals) feathers (Found only in birds)

  Biogenetic law/Recapitulation : by Haeckel "Ontogeny recapitulates phylogeny" or "ontogeny repeats phylogeny"

- **Ontogeny :** Development of the embryo or all the developmental stages of an organism.
- **Phylogeny :** Ancestral sequence or evolutionary history of an organism or an species or a group of organism.

Explanation —Embryonic stages of more advance animals repeats the young or adult stages of premitive and less developed animals.

- **Examples of recapitulation :**

  (i) Morphological recapitulation -

  - Larva of many insects have legs on all body segment but in adult they get restricted only as 3 pair legs on thoracic region. It indicate that advance insect had originated from centipede like organism.
  - Tadpole larva of frog resemble with adult fishes in morphology. It indicates that amphibia originated from fish like ancestors.

S.NO.	ADULT FISH	TADPOLE OF FROG
1.	Respiration - Gills	Gills
2.	Swimming - Tall fin	Tail fin
3.	Habitat - Complete aquatic	Herbivores
4.	Habitat - Complete aquatic	Comple aquaitic

(3) Tadpole **Larva** of **Herdmania** (urochordate) shows chordate character like notochord, dorsal hollow spinal cord and tail. However adult herdmania does not posses above mentioned chordate character hence adult shows ancestral character.

(4) Seedling of Acasis (Babool) tree initiallly develops simple leaves which later transform in to compound leaves

(5) Another example of modern day Oaks -

Oaks
- **Oaks of southern U.S.A -** Evergreen & retain their foliage leaves through out the year, are more primitive than northern oak.
- **Oaks of Northern U.S.A -** Deciduous and shed their leaves during winter.

- Fishes – NH_3
- Tadpole – NH_3 and recapitulates fish while adult frog-urea.
- Chick embryo – First NH_3 and recapitulates fish then urea and recapitulate amphibia and adult excrete uric acid.

(iii) Anatomical Recapitulation –

- Anatomical recapitulation seen in development of vertebrate heart.
- Adult fish – Two chambered, (1A + 1V)
- Tadpole of frog – Two chambered (1A + 1V) while adult frog with (1A + 2V)
- Reptiles – In embryo first 2 chambered then 3 chambered and adult with 3½ chambered
- Aves and Mammalia – In embryo first 2 chambered then 3 chambered and 3½ chambered while adult with 4 chambered (2A + 2V)

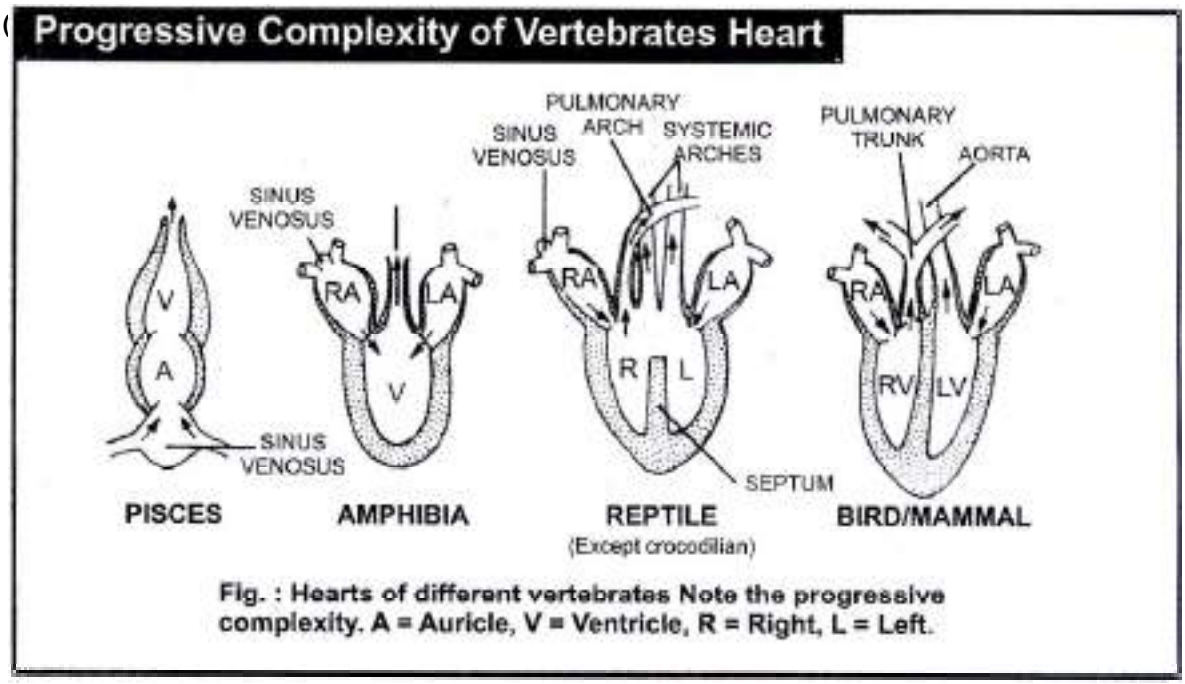


Fig. : Hearts of different vertebrates Note the progressive complexity. A = Auricle, V = Ventricle, R = Right, L = Left.

PROCESS OR MECHANISMS OF EVOLUTION

(a) Theory of Lamark (Lamarkism)

- **French naturalist** Lamark said that evolution of life form had occurred but **driven** by **use** and **disuse of organs.**
- **Actual theory of Lamark –** Inheritance of acquired character and was based on use and disuse of organs.
- Lamark explained his thoery on following points -

(a) Tendency to increase in size
(b) Direct effect of environment
(c) Use and disuse of organs
(d) Inheritance of aquaired character.

- **Examples for Support of His theory**

(i) African Giraffe - Elongation of neck and passing this acquired character to succeeding generation

(ii) Snakes - Gradual degeneration and disappearence of Limbs.

- **Supporter of Lamarkism:**

(i) Exp. of Sumner on Rat - He reared and domesticated rats for many generation in two different environmental condition.

- **Rat of Hot environment -** Tail and ear pinnae enlarged and this acquired character passed on to next generation (Inherited).

- **Rat of cold environment -** Tail and ear pinnae shortened and this acquired character passed in to next generation (Inherited)

(ii) Exp. of Kammerer on Salamander : Salamander is a tail less amphibia (Apoda) with black-yellow patches on skin. Cammerer reared and domesticated in two different environment.

◆ **Criticism of Lamarkism : (by Weismann)**

1. Weismann was the great criticizer of theory of use and disuse or Inheritance of acquired characters.
2. **Germplasm Theory** given by **Weismann** in order to disprove the theory of use and disuse or Inheritance of acquired characters.
3. **Experiment :** Weisman experimented on white mouse he continued cutting the tail of new born mice for many generations, yet there was no hereditary effect and even upon the length of tail.

◆ **Neo-Lamarkism :** Some modification made in Lamarkism and represented as following - "Genetic or chromosomal changes may occurs due to change in environment or use and disuse. There changes effects some physical and chemical changes in germplasm means leads to change in genes of germplasm and reaches to next generation." **e.g.**

Potato Beetle $\xrightarrow[\text{Cosmic rays}]{\text{X-rays}}$ change in genetic material of germplasm $\rightarrow$ such changes passes to next generation.

(b) Theory of Darwin (Darwinism) : by Darwin

1. T.R. Malthus : Wrote essay on population and it **influenced Darwin** to postulate the theory of natural selection.
2. Alfred Russell Wallace :

- Visited to S. America and S. East-Asia. He studied the population essay of T.R. Malthus.
- **Survival of fittest :** After the study of Malthus essay Wallace gone the Idea of survival of fittest and also wrote on essay by using a title – "On tendency of varieties to depart indefinitely, from their original type." and send it to Darwin.

3. **Darwin :**

- **Birth :** Shrewsbury (England) Feb. 12, 1809.
- **Education :** Edinbura (England) – Doctarate in health, and appointed as Naturalist.Galapagos Island. Finch bird was the main fauna of his interest.
- **Belief follower :** Before world survey he believed in **Thory of Special creation.**
- **Analysis of Visit :** He started to think about origin and evolution of life and clearly understood that struggle for existence occurs in nature and through struggle, Natural selection is possible.
- **Book :** After receiving the reading Wallace latter Darwin published a book with common name of Darwin and Wallace - "On the origin of species by means of natural selection" and was rated next to Bible or was second famous book after Bible.
- **Special :** He start thinking about evolution and announced evolution as following - "Descent is recent with changes" or "Descent from common Ancestors with Modifications" or Branding descent and Natural selection.
- Darwin gas WAllace chart in his bool origin of species by natural selection.

4. **Wallace Chart :** Given by Darwin with, common name of Wallace.

(a) (i) Enormous fertility rate then after
(ii) Constant population of each species } Struggle for existance

(b) (i) Struggle for existence
(ii) Variations and their inheritance } Natural selection or Survival of fittest

(c) (i) Survival of fittest
(ii) Continuous environmental change } Continuous natural selection is mae that lead to origin of new species (evolution)

◆ **Criticism of Darwinism** Great criticiser Hugo De Vries.

- **Greatest weakness:** He was unable to explain the cause, origin and inheritance of variations.
- **Raw Material for evolution:** He regarded all small and continuous variations, which may be acquired by organism during their life time due to environmental effect but somatic ones never play this role.
- **Theory of pangenesis:** As it is cleared that Darwin was failed to explain the origin of variations at genetic level as well as their transmission to next generation. In 1868 Darwin put forward his own theory of inheritance, the theory of pangenesis. According to this theory every organ of the body produce minute hereditary particles, called Pangenes or Gemmules for example live Gemmules from liver, leg Gemmules from leg, and so forth. He thought the Gemmules were carried through the blood form every organ of the body and were collected together into the gametes.

- Certain useful or harmful variations are brought about by mutation (Sudden changes in genetic material) and Darwin knew about these sudden changes (Mutation) and called these sports, but Darwin either ignored these observations or kept silence.
- The variations of Darwin originated by natural selection are gradual (not in single step) and certain variations such as electric organ of Torpedoes, light producing organs of luminescent organism (Glow worm) etc., are functional and useful only in their perfected state (in fully developed state not in under developed state) and could not be originate through natural selection while only possible through mutation.
- Darwin was also unable to explain how does set of coordinated organ evolved through natural selection.

◆ **Neodarwinism :** Neodarwinism is a modified form of Darwinism along with recent researches of Weismann, Mendel, Devries, Huxley, Gates, Stebbins etc. They performed many experiments to remove the objections against Darwin's theory.

◆ The salient fetures of neodarwinism are as follow -

- Rapid multiplication : All organism multiply in geometrical ratio.
- Limited food and space : Food and space are limited .
- Struggle for existence : it is of three types. Intraspecific, Interspecific and environmental.
- Genetic Variation : They are inheritable variation which can occur due to the following reasons.

(a) Mutation : They are discontinuous variation which develop due to permanent changes in genotype.

(b) Generecombination : They are new combination of genes which are usually caused by crossing over.

(c) Hybridisation and gene migration : It is crossing of organisms which are genetically different in one or more traits.

(d) Genetic drift : It is the eliminaion or addition of the genes of certain characters when some animals in population migrate or dies or immigrate. It changes the gene frequency of remaining population.(Change in frequency of gens in a gene pool is called genetic drift)

Knowledge Booster

- **Natural Selection :** If differential reproduction (some individuals produce more, some only few and still others none) continuous for many generations, genes of the individuals, which produce more offspring will become predominant in the gene pool of the population . Thus natural selection occurs through differential reproduction in successive generation.
- **Isolation :** Isolation is a segregation of populations by some barriers which prevent interbreeding.The reproductive different form others so as to constitute a new species.
- **Origin of new species –** An isolated population of a species independently develops different types of mutations.They latter accumulate its gene pool After several generation the isolated population becomes genetically and reproductively different from others so as to constitute a new species.

◆ **Example of Natural selection :**

- Industrial mechanisms
- Drug resistance.
- Sickle cell anaemia and malaria.
- Malaria and G-6-PD deficiency

(c) Mutation theory of Hugo De Vries :

According to De Vries "sudden, stable, inherited characters which are completely different from their parents called mutation."

(1) In 1901 Dutch Botanist Hugo De Vries rediscovered Mendalian law with two other scientists and put forward his views regarding the evolution and formation of new species.

(2) Exp. Material: Evening primrose (Oenothera Lamarkiana)

(3) Term Mutation: Given by Hugo De Vries

(4) Key concept of Mutation theory: Hugo De Vries believed that mutation causes origin of new species and hence he used the term Saltation.

(5) Saltation means single step large mutation (Variation originates in single steps and in full form.) and just opposite to adaptation and natural selection of Darwin (Variations are small and gradual, directional).

(6) Useful mutations are selected by natural white Lethal and harmful mutations are eliminated.

◆ **Evidences in favour of Mutation theory**

(1) Mutations are one of the sources of variations and become the cause of evolution.

(2) This theory explains both progressive and retrogressive evolution (as seen in Herdmania).

(3) Ancon sheep is a short-legged variety which appeared suddenly in Massachusetts in 1791 was due to first natural mutation.

(4) Hornless cattle developed as sudden (Mutation) from the horned cattle first in 1989.

(5) Hairless cats, double toed cats had developed through mutation.

◆ **Criticism of Mutation Theory** (Great criticiser Morgan)

(1) T.H. Morgan (Father of experimental genetics), experimented on fruit fly (Drossophila) and defined Mutation as following- "Heritable chemical changes in genetic material are mutation".

(2) Different Varieties of Oenothera obtained by De Vries were the result of numerical changes in chromoosome that is not chemical change hence these varieties was not the result of mutation.

(3) Most of the mutations are harmful and lethal then how do they help an organism to develop in progressive direction. They will only help in retrogressive development. That is completely against the evolution.

(4) Mutations are generally recessive while traits participating in evolution are usually dominant.

(5) It can not explain **mimicry** and **living fossils.**

MODERN THEORY OF EVOLUTION

(a) Population Genetics and Hardy Weinberg law :

"Under certain conditions of stability, allelic frequencies remain constant form generation to generation in sexually reproducing organism", proposed by two scientist hardy and Weinberg and the law are called Hardy-Weinberg law.

(1) Population genetics: Application of Mendilian genetics to Darwinion natural selection.
(2) Hardy-Weinberg law: Hardy Weinberg equilibrium that define the genetic structure of a non-evolving population.
(3) Genetic Equilibrium: If all other factors remain constant then the frequency of a particular gene and allele will remain constant in a population through generation to generation and such kind of genetic stability is called Genetic equilibrium.

◆ **Salient features of Hardy-Weinberg law :**

(1) Frequency of a gene/allele is calculated that is remain constant in a population, generation to generation and any change in frequency indicates the evolution. .
(2) Hardy-Weinberg law gives a tool to determine when evolution is occurring.
(3) If all other factors remain constant then the frequency of a particular gene and allele will remain constant in a population through generation to generation and such kind of genetic stability is called genetic equilibrium.
(4) The degree of evolutionary change is predicted by this law means evolution is departure from Hardy - Weinberg equilibrium.

◆ **Applications of Hardy-Weinberg law :** Hardy-Weinberg explained the gene/allele frequency as well as the frequency of individuals of particular genotype through a mathematical formula in a large size population inhabiting in stable environmental conditions-
$(p+q)^2 = p^2 + 2pq + q^2$
p+q = 1 (Means sum total of all the allelic frequency is 1)
p = frequent of dominant gene of a trait
q = frequency of recessive gene of first trait that is expressed by p or frequency of recessive allele of gene p
p^2 = Frequency of homozygous dominant individuals
q^2 = Frequency of homozygous recessive individuals
2pq = frequency of heterozygous individuals
If the above equation with its components compared with albanic trait p = A (Frequency of Dominant gene)
q = a Frequency of recessive gene
p^2 = N (AA) Frequency of Homozygous normal individuals
$q^2 = a^2$ (aa) frequency of homozygous albanic individuals
2pq = 2Aa (Frequency of Heterozygous normal individuals)

◆ **Surety of Hardy-Weinberg law Hardy :** Weinberg law is only tree and applicable in following conditions.
i. Population must be large (not small)
ii. Must be random mating (not selective) and free gene flow iii. Mutation must occur
iv. Gene flow, gene migration and genetic drift must be avoided.
v. Hybridization and gene recombination must be avoided.

◆ **Source of Variation :** (Five Factors affect Hardy - Weinberg equilibrium)

(i) Gene Migration or Gene flow
(ii) Genetic Drift
(iii) Mutation
(iv) Genetic Recombination
(v) Natural Selection

(i) Gene migration or Gene flow:

(1) When migration of a section of population to another place occurs, gene frequencies change in the original population as well as in the new population or in other words new genes/alleles are added to the new population (immigration) and these are lostfrom old population (emigration). If this gene migration happens multiple times then called gene flow.

(2) Some times the change in allele frequency is so different in the new sample of population (new population that is formed by immigration) that they become a different species (origin of new species means evolution occurred due to gene migration).

(3) Genetic drift: If the same changes occurs by chance then called genetic drift. The original drifted population (changed from original type) becomes founders for preceding generation and the effect is called founder effect.

(ii) Genetic Drift: (Sewall wright effect) - "Drift is a binomial sampling errors of the gene pool." Sampling errors (error in gene pool of next generation mean gametic error) by chance often lead to the elimination of certain alleles and fixation of other and it ultimately cause the loss of genetic diversity.The random changes in the allele frequency occurring by chance alone are called genetic drift.

(iii) Mutation:

(1) Mutation according to Hugo De Vries: Sudden heritable changes. Single step large mutation (saltation) brings speciation according to Hugo De Vries.

(2) Mutation according to Morgan: Chemical change in genetic material which are heritable.

(3) Mutation according to Darwin: Darwin used the term sports for mutation.

(4) Mutation according to Bateson: Saltatory or discontinuous Variations.

(5) Mutations are non-directional, random originate during adaptation and environmental impact with little adaptive value. Mutations are.

- Most of the mutations are harmful or with no effect (neutral)
- If the environment changes, however previously harmful or neutral alleles may become advanta geous.
- Mutation rates are very slow (one mutation in billions occurs) nevertheless, these mutation rate are sufficient to create considerable genetic variation.

(6) Mutations are pre-adaptive - Experiently proved by J.Lederberg and E. Lederberg.

◆ **Replica Plate Exp. of J.Lederberg and E.Lederberg :** According to J.Lederberg and E. Lederberg mutation are preadaptive, means they appear without exposure to the environment in which they would be advantageous to the organism. Actually the preadapted mutations express themselves only after exposure to the new environment to which the organism is to adapt themselves. The new environment does not induce their formation.

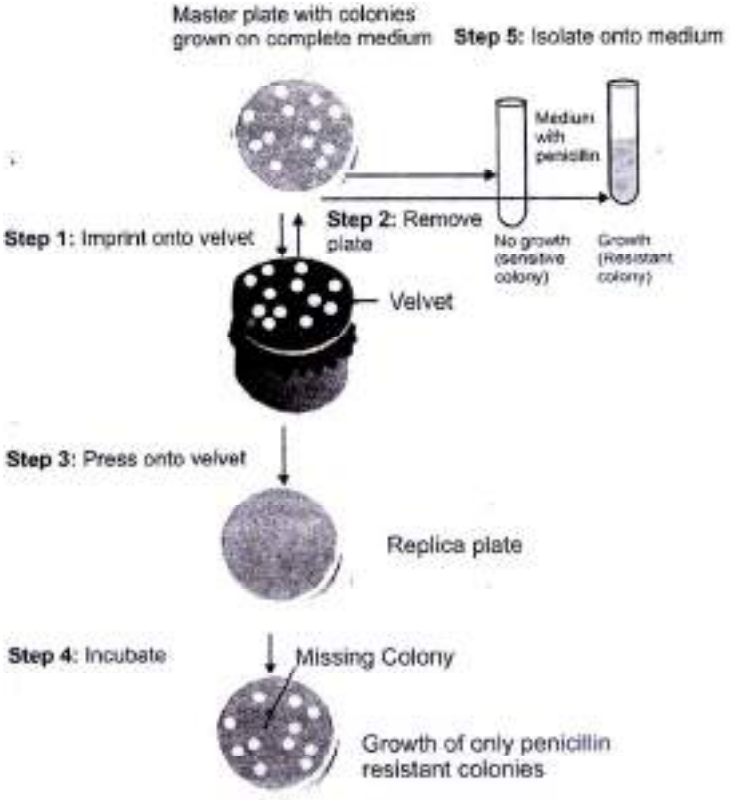


Fig.: Replica plate experiment of Lederberg and Lederberg

iv) **Natural Selection :** Microbial experiments show that pre-existing advantageous mutations when selected will result in observation of new phenotypes.Over few generations, this would result in speciation. Natural selection is a process in which heritable variations enabling better survival are enabled to reproduce and leave greater number of progeny. A critical analysis makes us believe that variation due to mutation or variation due to recombination during gametogenesis or due to gene flow or genetic drift results in changed frequency of genes and alleles in future generation. Coupled to enhance reproductive success, natural selection makes it look like different population. Natural selection can lead to -

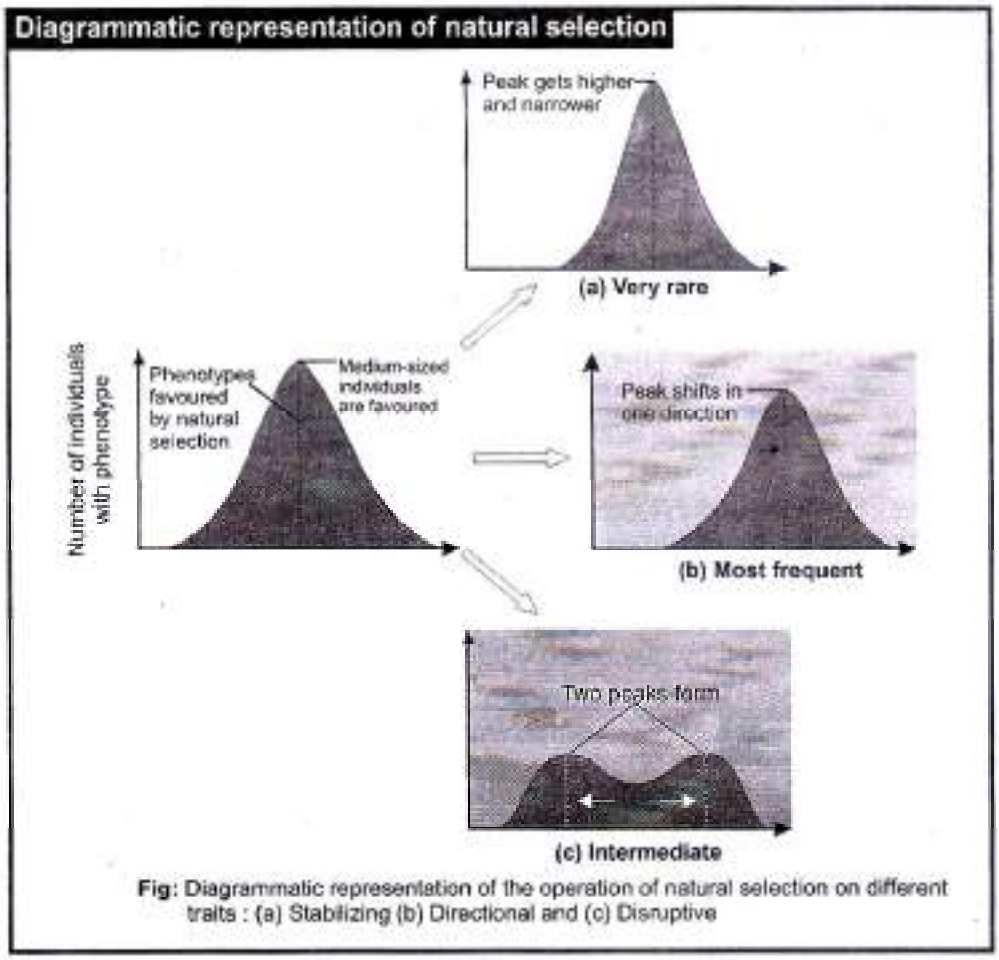


Fig: Diagrammatic representation of the operation of natural selection on different traits : (a) Stabilizing (b) Directional and (c) Disruptive

(a) Stabilisation - In which more individuals acquire mean character value.

(b) Directional change - More individuals acquire value other than the mean character value.

(c) Disruption - More individuals acquire peripheral character value at both ends ofthe distribution curve

(a) Stabilizing selection (normalizing selection) : Natural selection that acts to maintain the connsistency of a species over successive generations. It involves selection against the extremes of the range of phenotypes for a particular characteristic. For example, babies' whose birth weight is substanntially below or above the average of 3.6 kg historically have a greater mortality than babies of average birth weight (although medical advances have now greatly reduced this pattern of selection in humans)

(b) Directional selection : Natural selection that favours the establishment of one particular advantaageous mutation within a population, resulting in a change in phenotype in that direction An example of directional selection is the increase in darker forms of the peppered moth (Biston betularia) that occcurred in industrial areas, where the moths with darker wing coloration are better camouflaged that those with lighter wings against polluted tree trunks (INDUSTRIAL MELANISM).

(c) Disruptive selection : Natural selection that favours the extremes of a phenotype In a population It often operates when an environmental factor shows distinct variations, for example high temperature In summer and low temperatures in winter with no intermediate forms. In this case the population will be variously adapted to withstand both high and low temperatures.

(c) Speciation :

(L. species - particular kind) it is the evolution of one or more new species from the pre-existing ones. An important requirement of speciation is the separation of the gene pool of the evolving population from other populations of the parent species so as to stop the gene flow.

- **Genetic Drift :** It is random change in the allele number and allele frequency in a gene pool generally caused by small size of the population due to destruction of a major part of population or separation of a segment of from the rest. Chance leads to elimination of certain alleles and preponderance of others.
- **An Illustration to understand possible development of a species in various directions :** A group of twelve red beetles living in bushes with green leaves. Beetles in the populations can generate variations because these are reproducing sexually. Crow can eat the beetles. The more beetles the crow eat, the fewer beetles are left for reproduction.

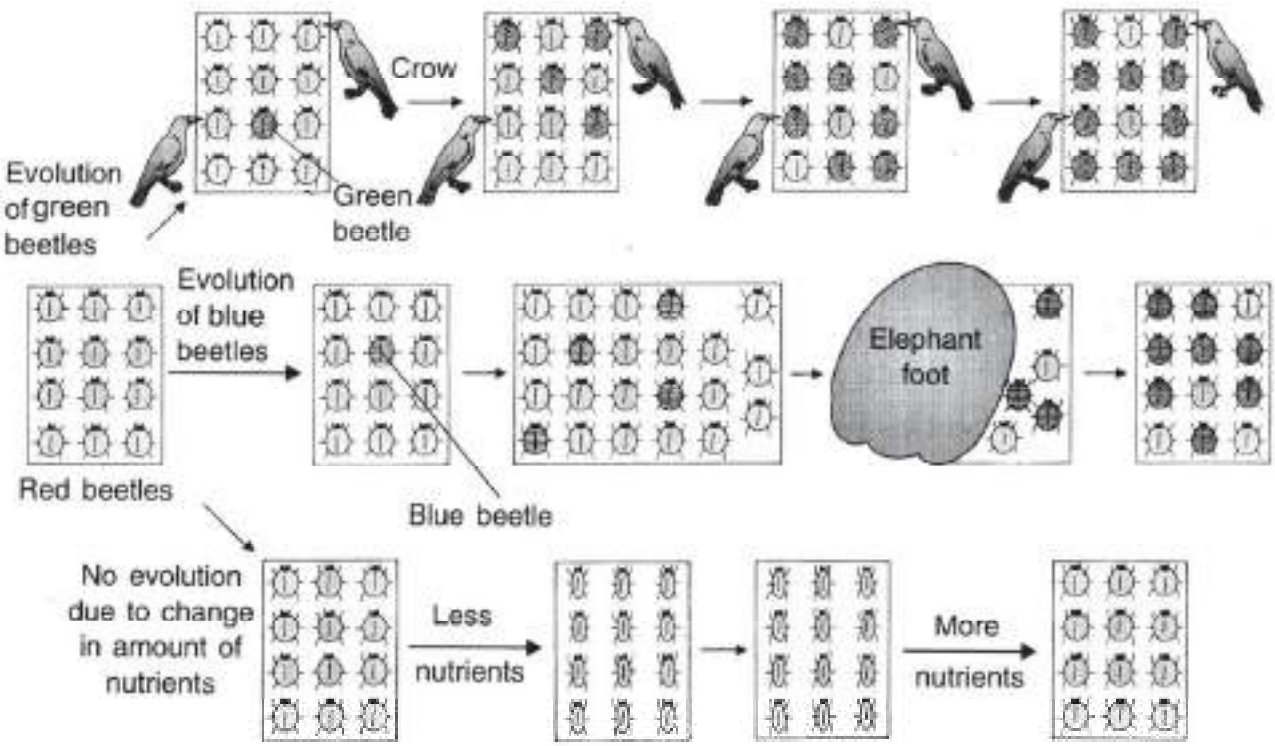


Fig : An illustration to show evolution in different directions.

- **Case - I :** Suddenly green beetle arises in red beetles colony which can easily hide in plants, so crow can't see them & their population as compared to red beetles will increase by time. This is an example of Natural selection.
- **Case - II :** Suddenly blue beetles arises in red beetle colony. Red beetles are killed by elephant foot but population of blue beetles grows slowly and therefore blue beetle are more in number after sometime. This is an example of Genetic drift.
- **Case - III :** Because of poor nourishment average weight of beetles decreases. This change is not inherited over generations. This is an example of somatic variation.
- **Mechanism of speciation :** On the basis of period taken in speciation, there are two type of mechanism of speciation :
  1. **Gradual speciation :** It is the gradual divergence of population due to accumulation of variations over a long period of time. It is again of two type.
  - **(A) Allopatric speciation :** This occurs when an original population becomes separated into two or more sub population due to development of certain geographical barriers. e.g. Darwin's finches
  - **(B) Sympatric speciation :** It occurs within same geographical area within original population. But sub population become reproductively isolated by ecological isolation or other methods. e.g., Pig frog and Gopher frog in different habitats.

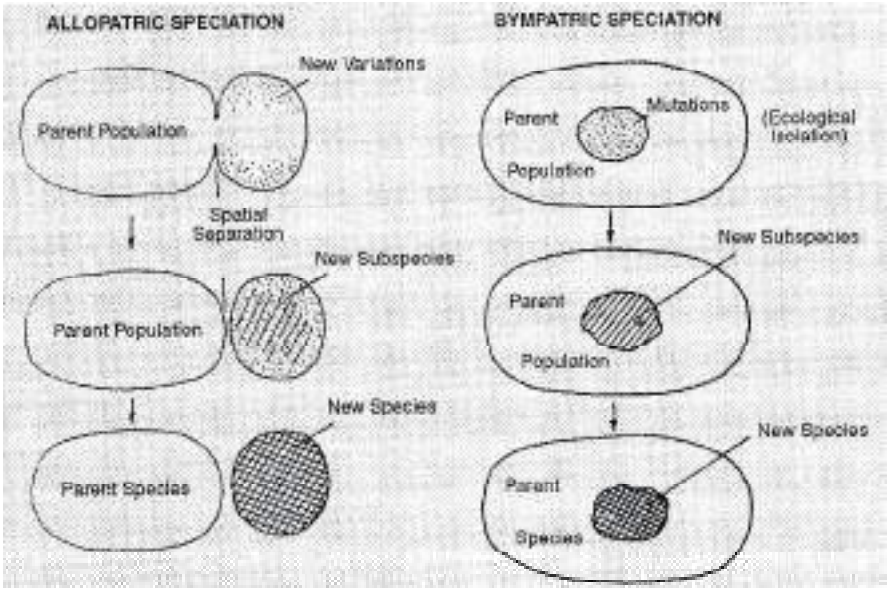


Fig : Modes of speciation.

2. **Instantaneous speciation :** It is the sudden development of new species.

HUMAN EVOLUTION

- The study of Human evolution and culture is known as Anthropology, which deals with fossil, prehistoric and living man.
- The sequential arrangement of stages in evolution is known as Geneology.
- **Man belogns to :**

Phylum	--	Chordata
Sub-phylum	--	Vertebrata
Class	--	Mammalia
Order	--	Primates
Sub order	--	Anthropoidea
Super family	--	Hominoidea
Family	--	Hominidae
Genus	--	Homo
Species	--	Sapiens

- **Human ancestory :** The arrangement of fossils in evolutionary sequence includes :

Tree shrews
↓
Prosimian early anthropoids
↓
Dryopithecus
↓
Ramapithecus
↓
Australopithecus
↓
Homo habilis
↓
Homo erectus
↓
Homo neanderthalensis (Java man)
↓
Homo sapiens fossilis (Cro-magnon man)
↓
Homo sapiens sapiens (Modern man)

- **Primates** : Primates are found in the North American sediments from lower to upper Eocene time. Primates are placental mammals with nails, with clavicles, with orbits encircled by bone; possessing a brain. The primate order contains two sub orders : **Prosimians** and **Anthropoids**.
- **Prosimians** includes tree shrews, lemurs and tarsiers.
- **Tree shrews** are certainly the most primitive of primates. Tree shrews are at present known only in the oriental region; where they are widely distributed. Lemurs are arboreal, primitive animals found both in Africa and Asia. Lemurs are generally nocturnal, hence, their eyes are large.
- **Anthropoids** includes old world monkey, apes and man.
- **Common Characteristics of Old World Monkey, Apes and Man :**

(A) Reduced tail or absent.
(B) Erect posture with increase in the mentality.
(C) Pinna comparatively smaller in size.
(D) Increase in brain capacity.
(E) Decrease in number of lumbar vertebrae.
(F) Menstrual cycle occurs in females.

The **gibbon** is the smallest of the anthropoid apes. Evolution of man takes place in **Pleistocene** period. Dryopithecus was the common ancestor of humans and apes that lived an arboreal life in Asia as well as in Africa.

(i) **Australopithecus (The first man-ape) :** Its fossils were described by **Raymond Dart** in 1925 from South Africa.

(iii) **Homo Erectus : Middle Pleistocene Man :** Java and Peking man collectively named as Homo erectus by **Mayer**

(vi) Neanderthal Man (Neanderthalensis) :

(vii) Cro-magnon Man (Homo Sapiens Fossilis) :

(viii) Modern Man (Homo Sapiens Sapiens) : Developed after last glacial period i.e., about 10, 000 years ago. Cranial capacity is about 1450-1600 cc. These were the first settlers who started living a settled life. Modern man undergoes cultural evolution, primarily fabrication and use of tools.

(A) Palaeolithic age : Stone age, age of cave painting in latter period.

(B) Mesolithic age : Age of domestication of animals and learning, reading, writing, development of language.

(C) Neolithic age : Age of agriculture and knowledge.

Knowledge Booster

(1) Dryopithecus - Arose about 15 Million ago, more ape-like, walked like Chimpanzee and Gorilla. It is supposed as **common ancestor** of **Ape** and **man.**

(2) Ramapithecus - Arose about 15 million yr ago, walked like apes. It was more man - like hence called oldest human ancestor and direct line towards human evolution.

(3) Few Hominids fossils of Ethiopia and Tanzania – Few fossils of man like bones have been discovered (excavated) in Ethiopia and Tanzania. These revealed hominid features leading to the belief that about 3-4 million yr ago, man like primates walked in eastern Africa. Similarity and difference in fossil bones, possibly they were two types.
1st type – Australopithecines
2 nd type – Homo habilis

(4) Australopithecines -
- They were Man like primates walked in east African grassland about 2 million yr ago.
- They were probably not taller than 4 feet but walked up right.
- Many evidences reflects that they hunted with stone weapons but essentially ate fruit mean hunting was their way to entertain and amusement but they actually were veg etarian.

(5) Homo habilis - It was first human being the hominid with 650-800 cc brain capacity. It was first tool maker or Handy man but after being hunter it probably did not eat meat.

(6) Homo erectus -
- Arose about 1.5 million yr ago with cranial capacity 900 - 950 cc (Java ape man).
- Homo erectus used fire and probably eat meat.

(7) Neanderthal-
- Arose about 1, 00,000 - 400000 year back, near east and central Asia.
- Cranial capacity-1400 cc
- Neanderthal used hides to protect their domestic animals and himself.
- First burial funeral of their dead started by Neanderthal.

(8) Homo sapiens-
- Arose during ice age between 75,000-10,000 year back near Caspian Sea.
- Homo sapiens
- Agriculture and human settlements started about 10,000 year back.

EXERCISE-1

Mendel's Experiment and Laws of inheritance

1. The haploid set of chromosomes or genes of an organism is called :
(A) Genome (B) Karyotype
(C) Chromosome (D) None of the above

2. Second division of meiosis is :
(A) Reductional division (B) Multiplied division
(C) Equational division (D) None of these

3. Which of the following statements is false :
(A) Recessive allele is unable to express it's effect in heterozygous state
(B) Dominant allele express itself in heterozygous state
(C) Homozygous individual produces two types of gametes
(D) Heterozygous individual show hybrid vigour

4. Mendel's laws of heredity can be explained with the help of :
(A) Mutation (B) Meiosis
(C) Cloning (D) Both A and B

5. A recessive trait in Garden Pea is :
(A) Wrinkled seeds (B) Tall stem
(C) Round seeds (D) Coloured seed coat

6. How many types of gametes are expected from the organism with AABBCC :
(A) One (B) Two
(C) Four (D) Eight

7. Mendel's primary contribution to our understanding of genetic inheritance was :
(A) The idea that genes are found on chromosomes
(B) Providing a mechanism that explains patterns of inheritance
(C) Describing how genes are influenced by the environment.
(D) The discovery of alleles.

8. Marriage between close relatives should be avoided because it induces more :
(A) Recessive alleles to come together
(B) Mutations
(C) Multiple births
(D) Blood group abnormalities

9. A woman has a rare abnormality of eye that has been found to be dependent on a single dominant gene P. The woman's father had abnormal eyes but mother had normal eyes : If woman marries a man with normal eyes what proportion of her children will have abnormal eyes.
(A) 25 (B) 50%
(C) 75% (D) 100%

Structure of DNA

10. Eukaryotic chromosome is made of :
(A) DNA (B) DNA + proteins
(C) DNA + lipids (D) RNA

11. Genes are formed of :
(A) RNA (B) DNA
(C) DNA & RNA (D) DNA & proteins

12. Segment of DNA which can shift positions are :
(A) Transposons (B) Jumping genes
(C) Introns (D) Both (A) & (B)

13. DNA is associated with basic protein :
(A) Albumin (B) Nonhistone
(C) Histone (D) Both (A) and (C)

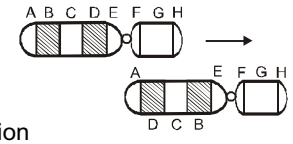
14. Flow of information during translation is :
(A) mRNA $\rightarrow$ Protein (B) DNA $\rightarrow$ mRNA
(C) mRNA $\rightarrow$ DNA (D) DNA $\rightarrow$ Protein

Mutation

15. Mutations are commonly :
(A) Dominant (B) Codominant
(C) Recessive (D) Incomplete

16. Mark the correct match :
(A) Haemophilia – Lack of chromosome
(B) Turner syndrome – Lack of X – chromosome (XO)
(C) Down's syndrome – Extra X chromosome (XXY)
(D) Klinefelter's syndrome – Extra X-chromosome (XXY)

17. Given in the figure is chromosomal mutation. It is



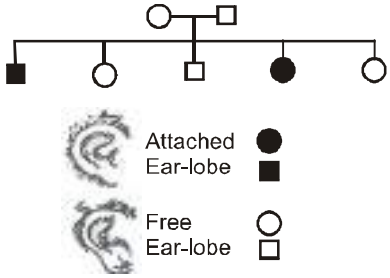
(A) Duplication
(B) Inversion
(C) Deletion
(D) Reciprocal translocation.

Methods of study of Human Genetics

18. A girl has blood group A and her brother has blood group B. Which combination of genotypes cannot belong to their parents
(A) I^AI^B I^AI^A (B) I^AI^B I^AI^B
(C) I^OI^O I^AI^B (D) I^BI^O I^AI^O

19. Which one of the following phenotypic features of Man can be affected only by the genotype?
(A) Height
(B) Intelligence
(C) Skin colour
(D) Number of different blood group antigens

20. From the pedigree chart find out the correct one.



(A) Parents are homozygous
(B) Parents are heterozygous
(C) Parents are homozygous recessive
(D) Trait is Y-linked.

21. Genes located on Y-chromosomes are :
(A) Mutant genes
(B) Sex-linked gene
(C) Autosomal genes
(D) Holoandric genes

22. What is the pattern of inheritance for a sex-linked allele ?
(A) Every affected person has an affected parent.
(B) Unaffected parents can produce children who are affected.
(C) Unaffected mothers have affected sons and daughters who are carriers.
(D) None of the above

EXERCISE-2

1. The allele for red flower colour (R) in a certain plant is co-dominant with the allele for white flowers (R'). Thus a plant with the genotype RR' has pink flowers. Tall (D) is dominant to dwarf (d). What would be the expected phenotypic ratio from a cross of RR' dd plants with R'R'Dd plants ?
(IJSO/stage II/2009)
(A) 9 : 3 : 3 : 1
(B) 50 % pink 50% white, and all tall
(C) 1 : 1 : 1 : 1, in which 50% are tall, 50% dwarf, 50% pink and 50% white
(D) 3 : 1

2. Like sickle cell anaemia, the other genetic disorder related to blood pigment is
(IJSO/stage II/2011)
(A) leukemia
(B) phenylketoneuria
(C) thalassemia
(D) xeroderma pigmentosis

3. If the distance between genes - W. X. Y, and Z on a chromosome are as follows : from W-Y is 18 units, W-X is 26 units, W-Z is 40 units, X-Y is 8 units and X-Z is 14 units, the sequence of W, X, Y, Z genes on the chromosome would be :

(IJSO-Stage-I/2012)

(a) W, Y, X, Z (b) X, Y, W, Z

(c) Y, W, X, Z (d) W, X, Y, Z

4. The family pedigree of Queen Victoria shows a number of haemophilic descendents as

(IJSO-Stage-I/2012)

(A) she herself was haemophilic

(B) haemophilia is autosomal recessive disorder.

(C) haemophilia is sex linked recessive disorder and Queen Victoria was a carrier.

(D) haemophilia is caused by contact and therefore it was seen it the royal family descendents.

5. Heterosis is the

(IJSO-Stage-I/2012)

(A) superiority of male percent over the hybrid.

(B) superiority of female parent over the hybrid.

(C) superiority of hybrid over the parents.

(D) superiority of both the parents over the hybrid.

6. Genome of a sexually reproducing organism is

(IJSO-Stage-I/2012)

(A) all the chromosomes present in the diploid cell.

(B) total number of chromosomes present in the haploid cell.

(C) total number of genes present in a cell.

(D) totality of DNA present in the haploid cell.

7. In usual course, the progeny varies from its parents due to

(IJSO-Stage-I/2012)

(A) mutation

(B) pleiotropic effect

(C) chromosomal recombination

(D) independent assortment.

8. Down's syndrome is a result of

(IJSO-Stage-I/2012)

(A) XO genotype

(B) XXY genotype

(C) Trisomy (chromosome 12)

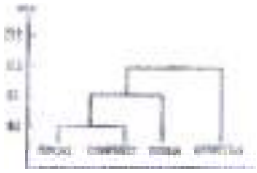
(D) Trisomy (chromosome 21)

9. A lady has 4 kids with blood group AB and 1 kid with blood group O. If the father of these kids have blood group B, what is the possible genotype of the lady ?

(IJSO-Stage-I/2013)

(A) I^AI^B (B) I^A1^0 (C) I^AI^A (D) I^BI^B

10. Given here is a phylogenetic tree (family tree) of greater apes.Which of the following statements cannot be true from the tree ? (mya-million years ago) **(IJSO/Stage-1/2013)**



(A) Humans did not evolve from chimpanzees.

(B) Humans and chimpanzees are evolutionary cousins.

(C) Orangutans evolved much earlier then Humans.

(D) Humans are highly evolved among great apes.

11. Given below are few forces of evolution.Which of the following would be the best combination of primary forces of evolution ?

(IJSO/Stage-2/2014)

(A) Variation and mutation

(B) Mutation and isolation

(C) Variation and migration

(D) Migration and random genetic drift

12. Few statements related to genetic drift are given below. Find out the incorrect statement among the four.

(IJSO/Stage-2/2014)

(A) There is a random change in the allele frequency in a given population.

(B) It is significant only in large population.

(C) It is a mechanism for evolution of new species.

(D) It may or may not help a species to adapt

13. A plant (parantal) hearing red flowers is self pollinated and two kinds of progeny are obtained: plants with red flowers and plants with white flowers in a ratio of 3 : 1. Based on this observation which one of the following statements regarding genes controlling the flower colour is correct ?

(IJSO/Stage-2/2015)

(A) The parental plant had one kind of allele for the flower colour

(B) Two genes control the flower colour

(C) The parental plant had two different alleles for the flower colour.

(D) All progeny plants with red flower colour have the same genotype as that of the parent

14. Cabbage. Broccoli. Brussels sprouts are all derived from one species of wild mustard by the selection of desired traits. This has been developoed by a process of : **(IJSO/Stage-2/2015)**

(A) Inheritance of acquired character

(B) Natural selection

(C) Adaptive selection

(D) Artificial selection

15. Virulent forms (Methieillin-resistant) of the bacterium Staphylococcus ourcus (MRSA) is a human pathogen. Some of these strains cause "flesh-eating disease" and are resistant to multiple antibiotics. The strory of origin of these strains began in 1943 with the use of penicillin as an antibiotic. By 1945, 20% of the S aureus strains in hospital were resistant to penicillin. In 1959. doctors began using the powerful antibiotic methicillin in. But within two year methicillin-resistant strains appeared followed by multidrug resistant strains. Which one of the following statements regarding development of multi-drug resistance in MRSA. is correct ?

(IJSO/Stage-2/2015)

(A) Antibiotics helped in the selection of bacteria with mutations in the DNA conferring drug resistance which was already present in the population

(B) Antibiotics triggered DNA modification in the host cells that induced resistance among bacterial cells.

(C) Antibiotics first led to specific mutation in the DNA of the bacteria conferring drug resistance that was later selected for

(D) MRSA would have developed in the same rate even if antibiotics were not used.

16. The following technique that can be used for deciphering the arrangement of nucleotides in genes. **(IJSO/Stage-1/2015)**

(A) karyotyping

(B) DNA finger printing

(C) nucleic acid sequencing

(D) transcription

17. Female fruit flies with normal wings were mated with males having vestigial wings. All progeny had normal wings. Based on this observation the following conclusion (s) were proposed :

I. Vestigial wing is a recessive character as compared to normal wing.

II. Alleles for normal and vestigial wings segregate from each other.

III. While flies with normal wings are heterozygous for the alleles controlling the character, flies with vestigial wings are homozygous.

Which of the above statement (s) is/are correct from the above observations ?

(IJSO/Stage-II/2016)

(A) Only I (B) Only III

(C) I and II both (D) II and III both

18. The ABO blood group in humans was first identified by Karl Lansteiner. The four blood groups were identified based on whether blood corpuscles (RBCs) clump (agglutinate) or do not clump in the presence of serum of another individual. Blood groups are defined based on the molecules (antigens) present on RBCs i.e. A blood group has antigen A, B blood group has B antigen, AB blood group has both A and B antigen, while O blood group has neither A or B antigen. The serum contains antibodies. However, a normal person will not have antibodies for the antigen present on his own RBC. Agglutination occurs during transfusion if serum contains the antibody against the antigen present on the RBC. In the experiment by Landsteiner (Landst.) he mixed the blood corpuscles from five of his colleagues and himself with serum collected from them as shown in the table below. A '+' sign indicated agglutination and '–' indicates lack of agglutination.

Serum	Blood corpuscles of					
	Dr. St	Dr. Plecn.	Dr. Strul.	Dr. Erdh.	Zar	Landst.
Dr. St	–	+	+	+	+	–
Dr. Plecn.	–	–	+	+	–	–
Dr. Strul.	–	+	–	–	+	–
Dr. Erdh.	–	+	–	–	+	–
Zar	–	–	+	+	–	–
Landst.	–	+	+	+	+	–

Deduce the blood group of landsteiner (Landst.)

(IJSO/Stage-II/2016)

(A) A (B) B (C) O (D) AB

19. Drosophila melanogaster (fruit fly) is a favorite among geneticists to study inheritance of characters. Like other insects the life cycle of Drosophila consists of larvae, pupae and adults (see below).

It can be easily maintained in the laboratory, has a short lifecycle, produces large number of progeny and has only four pairs of chromosomes. The inheritance of eye color and shape, have been studied by any geneticists. The eye shape could be round or slit-like (called Bar eyed).

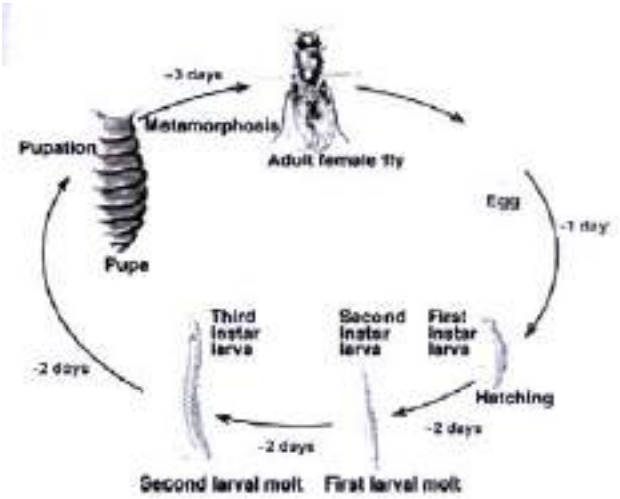
The allele that controls the Bar-eyed phenotype (B) is dominat over that which controls round shape (b). Although found in the laboratories, the occurrence of Bar-eyed fruit fly in nature is extremely rare.

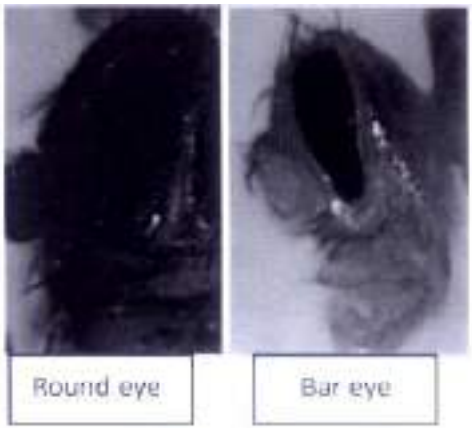
(i) A geneticist wanted to study the inheritance of eye shape in Drosophila. Which one of the following is the necessary prereguisite to study inheritance of any character ? **[1.0]**

a) Life cycle should be short.

b) A homozygous line for the character should be available.

c) Variation in character should be available in the population.





(ii) From the information given in the write-up which of the following statement(s) is/are correct ? **[0.5]**

a) Bar eye is a mutant character because it is dominant over round.

b) Bar eye is a mutant character because it is found rarely in the nature.

c) Round eye is a mutant type character because it is recessive to Bar.

(iii) A bar-eyed Drosophila could be homozygous (BB) or heterozygous (Bb) for the gene controlling the bar-eye shape. In order to differentiate between the two genotypes a geneticist should cross it to a fly with the genotype **[0.5]**

a) BB b) Bb c) bb

(iv) Variations in phenotypes in Drosophila can be generated in the laboratory by mutagenesis. X-ray is a known mutagen. In order to generate mutants in Drosophila which one of t e following stages in its life cycle should be treated with X - Ray ?

(a) Egg (b) Larvae

(c) Pupae (d) Adult

(v) The following is a hypothetical situation. A geneticist studies the inheritance of eye shape and color in a newly identified insect. Like Drosophila there are two eye shapes in this insect: round and bar. Round is dominant in this case. There are two eye colors: red and white, where red is dominant over white. Genes for eye-color and eye shape are present on the autosomes.

a) A cross is made between a red, round-eyed and bar, white-eyed insect. What will be the phenotype of the F_1 progeny ? **[0.5]**

b) When the F_1 progeny were crossed, the following F_2 progeny (phenotype: numbers) was obtained:

Red, round eyed : 899

Red, bar eye : 301

White, round eyed: 293

White, bar eyed: 107

Based on the above data do the genes for eye color and shape show independent assortment ? Yes / No. **[1.0]**

c) Calculate the ratio obtained from the given F_2 progenies provided as above to prove your choice in (ii). **[1.0]**

ECOLOGY

ENVIRONMENT

The aggregate of all the external conditions and influences affecting the life and development of an organism in its natural habitat is called environment (F environ = around).The individual conditions, such as light, prey or predator , around on organism are termed factors of the environment.

(a) Ecosystem :

It is the sum total of interacting biotic & abiotic factors that are capable of independent existence. The term **ecosystem** coined by **Tansley (1935)**.

◆ **Ecosystems are of two types :**

(i) **Terrestrial ecosystem : Ex: Forest, Grassland, Desert.**

(ii) **Aquatic ecosystem : Ex: Sea, freshwater ecosystem.**

◆ On the basis of development, ecosystem involves two types :

(a) **Natural ecosystem :** It is formed naturally with out human interferance : **Ex: forest, ocean.**

(b) **Anthropogenic or man made ecosystem or Artificial–ecosystem :** It is formed by human activities. **Ex : Agriculture land, Garden, Aquarium.**

◆ **Ecosystems are of four types on the basis of size :**

(a) **Megaecosystem :** Large sized **– Ex: sea.**

(b) **Mesoecosystem (Macroecosystem) :** Medium sized **Ex: forest Grassland, Desert.**

(c) **Microecosystem :** Small sized **Ex: Pond, Lake.**

(d) **Nano ecosystem :** Very small sized**–Ex: Kitchen graden, Log of wood, Aquarium**

◆ **Ecosystem – open system :**

- **Ecosystem is open system :** It receives input of solar energy and nutrients from external source that are distributed in various components.
- Either ecosystem/individual performs out put of waste substance & energy in the external environment.

(b) Components of Ecosystem :

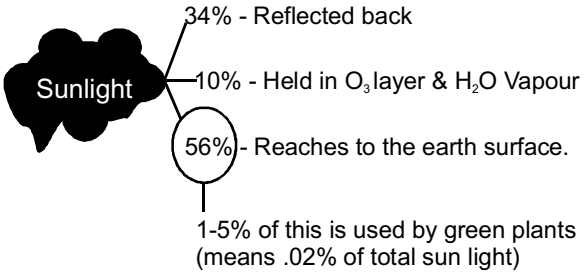
(1) Abiotic **(2) biotic**

(1) Abiotic components : Includes.

1. Temperature 2. Light
3. Water 4. Soil

1. Light : Main source of light is Sun.

Sun light = Light + Heat



◆ **Effect of light on Plants :**

1. Increase transpiration rate
2. Regulate opening & closing of stomata
3. Increase photosynthesis rate
4. Chlorophyll production
5. Photoperiodism

◆ **Effect of light on Animals :**

1. Increase metobolic rate
2. Effect on reproduction of animals
3. Development of animal
4. Pigmentation

2. Temperature : Effect of temperature on plants and animals :

1. On Metabolism
2. On reproduction (thermoperiodism)
3. Effect of growth & development.
4. Effect on colouration
5. Effect on BMR

Some Rules :

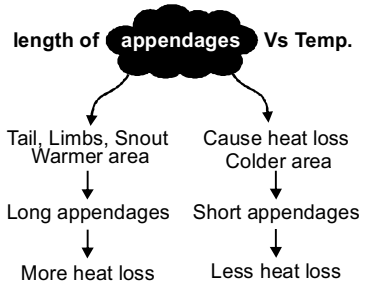
1. Bergman's rule : Applicable to aves and mammals.

Warmer area	**Colder area**
Small body size	Large body size

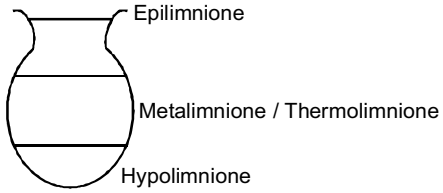
It get reversed for poikilotherms

Warmer area	Colder area
↓	↓
Large body size	Small body size

2. Allen's rule :



- **Thermal stratification of H_2O body**



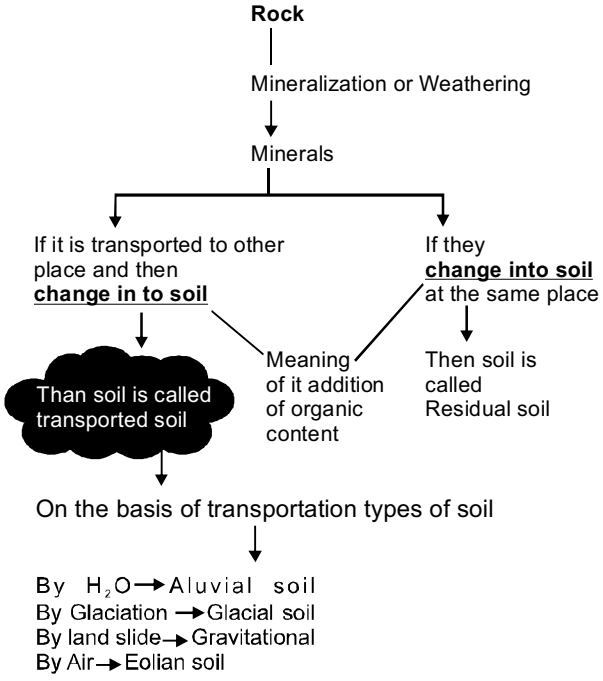
- **Types of animal according to temperature :**

Homoiotherm or Endotherm or Warm blooded	They maintain their body temperature constant respect to environment	Mammals aves some reptiles.
Poikilotherm or Ectotherm or Cold blooded or Heterotherm	They can change their body temperature accoding to surrounding environmental temperature.	Amphibian fishes some reptiles.

Knowledge Booster

Steno - Narrow range Stenothermal (for temperature), Stenohaline (range of salinities)
Eury - Wide range : Eury thermal.

3. **Soil :** Soil is the mixture of Organic & Inorganic content that can support plant growth living form.Organic content of soil are humus microflora other biomolecule. Inorganic content of soil comes from mineralization of rock. On the basis of transportation



4. **Water :** Water is the most important factor influencing the life of organisms. In fact, life on earth originated in water and is unsustainable without water. Its availability is so limited in deserts that only special adaptations make it possible to live there. The productivity and distribution of plants is also heavily dependent on water.

(2) Biotic components : It involves living beings that can be differentiated into three categories.

(a) Producers
(b) Consumers
(c) Decomposers.

(a) Producers (Autotrophs) : They are able to synthesize their own food by photosynthesis in the presence of sunlight. **Ex: Green plant, photosynthetic bacteria, Blue green algae Phytoplanktons are main producers in aquatic ecosystems whereas rooted plants in terrestrial ecosystem.** Rooted plants of shallow water are called macrophytes.

(B) Consumers (Heterotrophs) :

- They are unable to synthesize their own food directly or indirectly.
- They depend upon producers for obtaining nourishment.
- Consumers can be differentiated into following catagories.

(1) Primary consumers / Herbivores :

- They obtain their nutrition from producers. **Ex: Cow, Goat, Sheep, Horse, Deer, Rat, Rabbit, Grasshopper, Buffalo, Zebra, Elephant, Zooplanktons.**
- They are also known as **key industry animals** because they convert plant material into animal material.

(2) Secondary consumers / Primary carnivores : They obtain their nutrition from primary consumers. **Ex: Frog, Fox, jackel, Hyaena, Wolf, Wild cat, Snake, Small fishes.**

(3) Tertiary consumers / secondary carnivores : They obtain their nutrition from secondary consumers or primary consumers.

- They can not be preyed by other animals hence they are also called **top consumers Ex: Eagle (hawk), Kite, Vulture, Peacock, Lion, Tiger, Crocodile shark.**

(c) Decomposers : These are microscopic organisms like Bacteria and fungi that degrade or decompose dead organic matter or dead parts of animals and plants they are also called **reducers**.

- They are also called **microconsumers**. They are also called **osmotrophs**.

◆ **Relationship in Biotic factors** :

1. Intra species relation ship ⇒ Relation ship which are present in animal of similar species.
   A) Intra species co-operative relationship.
   B) Intra species Non-co-operative relationship.

2. Inter species relationship – Relationship which are present between the animals of different species.
   (a) Neutralism
   (b) Negative Interaction
   (c) Positive Interaction

INTER SPECIES RELATIONSHIP

- Neutralism (0,0)
- Positive Interaction
  1. Mutaulism (+,+)
  2. Commensalism (+,0)
  3. Proto co-operation (+,+)
- Negative Interaction
  1. Exploitation (+,–)
  2. Antibiosis (–,0)
  3. Competition (–,–)

FOOD CHAIN

◆ It is straight single system of individuals through which food energy travels in the ecosystem. It is a sequence of individuals of an ecosystem through which food and its contained energy pass with each member becoming food of the next member of the sequence.

◆ **Food chains are of three types.**

(a) Parasitic food chain : It starts from large organisms and ended on parasite/small organism.
Tree → Birds → Parasite

(b) Detritus food Chain : It starts from dead organic matter that is eaten by detrivores (Ex: earthworm) the later is prayed by pr. carnivores that is captured by secondary carnivores.

Detritus → Earthworm → frog → snake
↓ ↓
Sparrow **Falcon / Hawk**
Peacock
↓
Falcon

(c) Grazing food chain or predatory food Chain : It starts from producers

(1) Terrestrial ecosystem :

- Grass → Grasshopper → frog → Snake → Peacock / hawk
- Grass ⟶ Deer ⟶ Wolf ⟶ Lion / Tiger
- Grass ⟶ Rabbit ⟶ Fox ⟶ Wolf ⟶ lion / Tiger
- Grass ⟶ Rat ⟶ Fox ⟶ lion / Tiger,
- Grass ⟶ Deer ⟶ Tiger / lion,
- Grass ⟶ Elephant.

(2) Aquatic ecosystem :

- Phytoplanktons → zooplanktons →small fishes → Large fishes.
- Phytoplanktons → Zooplanktons → Crustaceans
  ↓
  Predatory insects
  ↓
  Small fishes
  ↓
  Large fishes
  ↓
  Crocodile
- Phytoplanktons → Zooplanktons → Crustaceans
  ↓
  Small fishes
  ↓
  Birds – kingfisher

FOOD WEB

It is a network of food chains which are interconnected at various trophic levels as to form various feeding connections among member of biotic community.

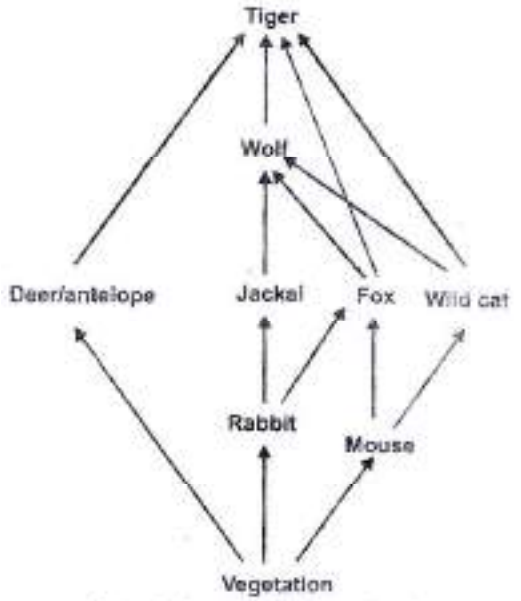


Fig: A Terrestrial food web.

ECOLOGICAL PYRAMIDS

(a) Pyramid of Biomass :

- It is graphic representation of amount of biomass per unit area in different trophic levels of food chain.

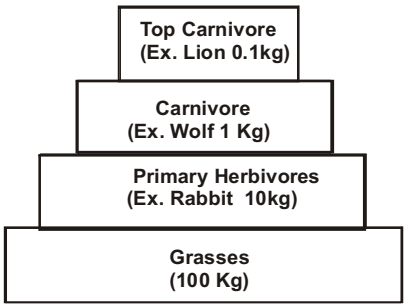


Fig: Pyramid of biomass in grassland–Upright

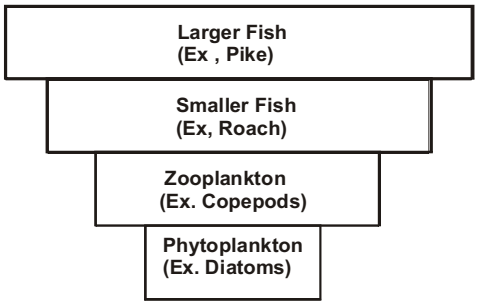


Fig: Pyramids of Biomass in pond ecosystem–Inverted

(b) Pyramid of energy :

- It is graphic representation of amount of energy trapped per unit area and time in different trophic levels of a food chain. It is always upright in all the ecosystems.

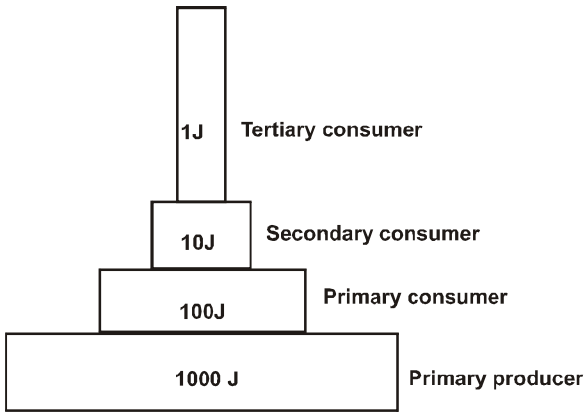


Fig.Pyramid of energy - Always upright

ENERGY FLOW

- It is unidirectional in an ecosystem sunlight → producers → consumers → Decomposers.
- Sun is then only source of energy for all ecosystems on earth the **incident solar radiation less than 50% of it is PAR (Photosynthetically Active Radiations) -**
- **1– 5% Incident solar radiations or 2 – 10% PAR** is trapped by **photosynthetic organisms** to form organic food during photosynthesis.
- The loss of energy by respiration is 20% in producers therefore the net primary productivity is 0·8-4% of incident solar radiation or 1·6 – 8% of PAR.

NUTRIENT CYCLING

- They are exchanges, storage and transfers of Biogenetic nutrients so they can utilize again and again.
- Biochemical cycling is circulation or transportation of biogenetic nutrients between abiotic and biotic components of Biosphere.
- Biogenetic nutrients are essential elements required to organisms for their body building and metabolism.
- Organisms obtain them from earth and after their death they return back to the earth.
- Reservoir pool is a pool of biogenetic nutrients through which they are slowly transferred in the cycling pool.
- According to **Odum, (1963)** three types of cycles are operating in an ecosystem. These are

(i) Hydrological cycle i.e water cycle

(ii) Biogeochemical cycles Ex : carbon & nitrogen cycles.

(iii) Sedimentary cycles such as those of sulphur, Phosphorus etc.

- Biogenetic elements (Macro,micro,& other element) flow from the environment into and out of the plant in a cyclic manner. This flow of nutrients from abiotic to biotic components of the ecosystem and vice-versa constitute the **biogeochemical cycles.**

1. Carbon cycle : The concentration of CO_2 is 0.03% in atmosphere, which is utilized by producers in photosynthesis for making food. It has been estimated that about 4×10^{13} CO_2 is annually fixed by producers during photosynthesis

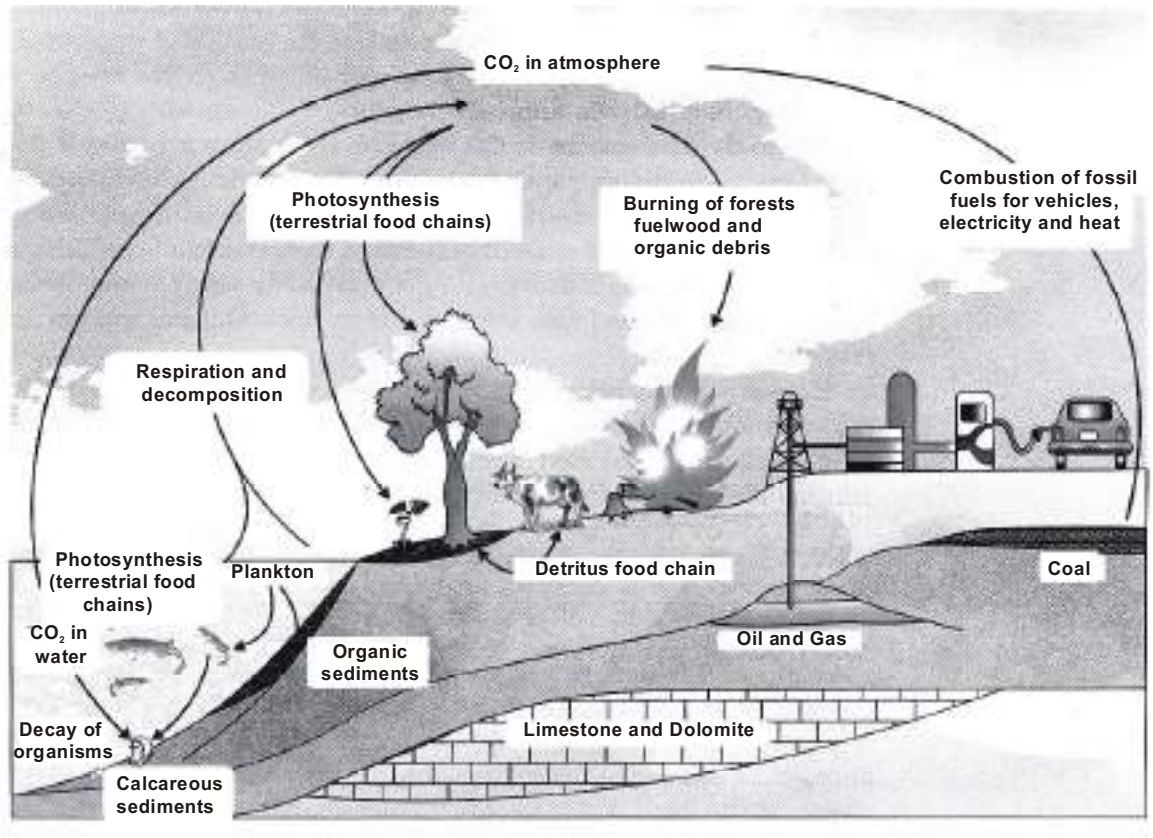


Fig : Simplified model of carbon cycle in land

- From producers, it is shifted to consumers and then through decomposers into atmosphere.
- After death, the producers, consumers and decomposers are converted into fossil fuel (coal, petrol).
- Living organisms release CO_2 in atmosphere during respiration.
- CO_2 may get dissolved in water. The lime rocks also contribute to CO_2 in water. The aquatic producer use this CO_2 for photosynthesis and return it by respiration.
- CO_2 is returned to the atmosphere by combustion of fossil fuel & also by volcanic activity.

2. Phosphorus Cycle :

- The producers absorbs soluble phosphate from soil which is transferred to consumers by herbivores and then to decomposer as organic phosphate by death & decay of producers & Consumers.
- The phosphorus in lakes appear in three forms - inorganic, particulate organic & dissolved organic form.
- In soil, there are two main supply pools of phosphorus-inorganic & insoluble organic, The dissolved phosphate are very less.
- The inorganic phosphate are lost in erosion & the soluble by leaching. The phosphorus in ocean basin is lost by sedimentation.
- The ocean phosphate is recovered by geological process when these sediments are exposed to newly elevated surface.

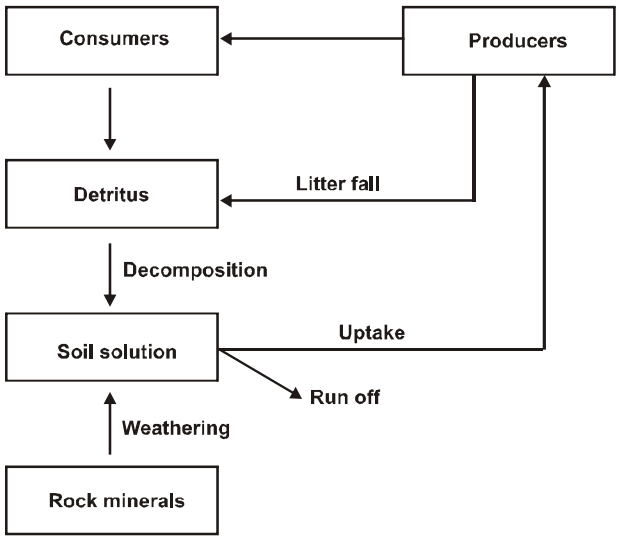


Fig: Phosphorus cycle–A simplified model

- Mining process also recovers phosphates. As a result of weathering of these exposed rocks, inorganic phosphorus is added to soil.

3. Nitrogen Cycle : Nitrogen is an essential component of amino acids, proteins, enzymes and nucleic acids of the protoplasm.Reservoir pool of nitrogen is atmosphere which contains about 78.08% of nitrogen in gaseous state. But it cannot be used directly and is changed into nitrites and nitrates and then utilized.

◆ **Steps of nitrogen cycle are :**

(A) Nitrogen fixation : It involves the conversion of free diatomic nitrogen (N_2) into nitrites and nitrates.It occurs in two ways :

◆ **Physical nitrogen fixation :**

- Atmospheric nitrogen fixation in the presence of photochemical and electrochemical reactions induced by thundering and lightening.
- Industrial nitrogen fixation in the industries at high temperature and high pressure.

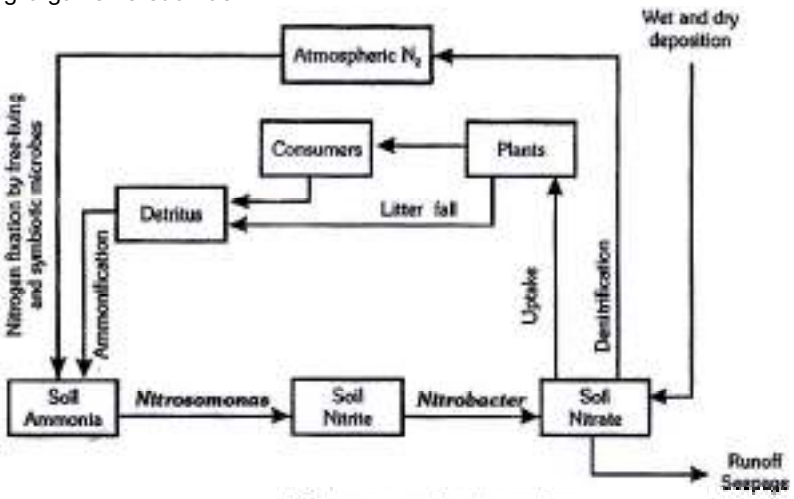
◆ **Biological nitrogen fixation :**

- Biological nitrogen fixation occurs in the presence of certain living organisms such as.
- **Rhizobium** bacterium in the root nodules of legumes.
- **Azotobacter** bacterium in the soil.
- **Anabaena** (blue green algae) in water in the paddy fields.
- **Azospirillum** bacterium in loose association with the roots of maize, sorghum etc.

(B) Ammonification : It involves the decomposition of proteins of dead plants and animals to ammonia in the presence of ammonifying bacteria like *Bacillus ramosus*

(C) Nitrification : It involves the oxidation of ammonia to nitrites (NO_2^-) and nitrates (NO_3^-) in the presence of nitrifying bacteria like *Nitrosomonas* (Ammonia to nitrite), *Nitrobacter* (Nitrite to nitrate) etc. Plants absorb the nitrites and nitrates from the soil through their roots and convert them into organic compounds (e.g. proteins) of protoplasm by the process called nitrogen assimilation.

(D) Denitrification : It involves reduction of ammonium compounds, nitrites and nitrates to molecular nitrogen in the presence of denitrifying bacteria like *Thiobacillus denitrificans*.



Nitrogen cycle in nature

POLLUTION

◆ Any undesirable change in the physical, chemical or biolgical features of air, land and water is called **pollution** Any physical, chemical or biotic components/agents or nonliving substance that are responsible to bring about an undesirable change in the environment is called **pollutant**. **Eg: heat, noise, SO_2 etc.**

◆ **Types of pollutants :**

(1) On the basis of persistence or form of occurrence :

(i) Primary pollutants : They remain in the environment in the same form in which they are released **e.g. : CO, Glasses, Plastic, DDT.**

(ii) Secondary pollutants : These are synthesized by the reaction amongst the primary pollutants. **Eg: PAN (peroxyacyl nitrates), O_3.**

(2) On the basis of natural degradation :

(i) Biodegradable : These are decomposed by natural action or micro organisms. **Eg: Sewage, Livestock, Garbage.**

(ii) Non biodegradable : They do not decompose naturally or their degradation is quite slow. **Eg: plastics, broken glass, DDT, cans, phenolic compounds.**

(3) On the basis of quantity or nature :

(i) Qualitative pollutants : These do not occur in nature but are added in nature only by human activites. **E.g. :- DDT, fungicides, herbicides.**

(ii) **Quantitative pollutants :** These become pollutants only when their concentration reaches beyond a threshold value in the environment. **Eg: CO_2.**

TYPES OF POLLUTION

1. On the basis of origin :

(i) **Natural :** It is due to natural sources like carbon monoxide from plants and animals, nitrogen oxides, ozone from volcanic eruptions, methane by cattle and paddy fields, emission of natural gas, ultraviolet rays. It is about 99.95% of pollution.

(ii) **Man made or anthropogenic :** It is due to human activites like burning of fossil fuels, deforestation, sewage effluents, mining, fertilizers, pesticides. It is about 0.05% of pollution.

2. On the basis of physical nature of the pollutants :

(a) Air pollution :

It is any undesirable change in the quality of air due to addition of foreign particles or gases or pollutants in the air is called air pollution that have adverse effect on man, animals and vegetation.

◆ **Causes of Air Pollution :** There are two main categories of air pollutants

(i) Gases

(ii) Particulate matter

◆ 52% pollution takes place through CO, 18% by SO_2, 12% by Hydrocarbons, 10% by Particulate matter, 6% by Nitrogen oxides and 2% by others.

(a) Primary Air pollutants and their effect :

(1) CO :

- **Source :** Incomplete combustion of fossil fuel, metallurgical operation plants as well as animals. Other sources are cigaratte, 50% CO emission by Automobiles.
- In human **CO** combines with **haemoglobin** in blood and form **carboxyhaemoglobin** that reduces oxygen carrying capacity of blood.
- CO causes headache, Giddiness, cardiovascular malfunctioning, Asphyxia.

(2) Hydrocarbons or VOC, (Volatile organic carbons) :

- **Source :** Released by combustion of fossil fuel or by naturally.
- Benzene is carcinogenic.
- **PAH (Polynuclear aromatic Hydrocarbons) and formaldehyde** cause irritation of eyes, burning in mucous membrane, bronchial constriction, excessive secretion of mucus, tearing of alveoli.
- **Methane** is released in atmosphere by **paddy field (40%)**, Cattles or by combustion of fossil fuel in vehicles, industries, kitchen etc. In atmosphere methane is converted in to CO_2 so, Methane is green house gas.

(3) SO_2:

- **Source :** It is released by melting of metallic ores containing sulphur, paper making, refining of petroleum volcanic eruption, burning of petroleum, coal industries, motor vehicles thermal plants. In the atmosphere SO_2 oxidises to SO_3 and combines with water to form **H_2SO_3 and H_2SO_4**. It is the cause of **acid rain**.
- It causes chlorosis and necrosis of vegetation, in human it causes irritation to eyes and injury to mucous membrane and respiratory tract (asthma, bronchitis, emphysema). It is also responsible for discoluration and deterioration of buildings, sculptures, painted surfaces, fabrics, paper, leather.
- **Point to Remember :**

(1) Lichen is indicator of SO_2 pollution.

(2) The reported threat to Tajmahal of Agra from nearby oil refinery of Mathura is on account of SO_2.

(4) Oxides of Nitrogen (NO_x) :

- **Source :** Formed naturally by biological and nonbiolgical activities from nitrates, nitrites, electric storms, high energy radiations and solar flares. Combustion process of industries, automobiles, incinerators, forest fire, denitrifying bacteria and nitrogen fertilizers.
- Nitrogen oxides produce necrosis, defoliation, lesions, die back and death of many plants. They form **photochemical smog** along with **Hydrocarbons** in the presence of sun light. They form **HNO_3** that causes **acid rain**. In human it causes eye irritation, blood congestion, respiratory troubles, lung edema. They form **brown air** in traffic congested city.

(5) Particulate matter : It involves following types

(i) **Settleable :** It is larger than **10μm**, persist in air for less than one day.

(ii) **Suspended :** Diameter is **less than 10μm** remain suspended for weeks **Eg: dust (more than 1μm), aerosol (less than 1μm), mist (liquid, more than 1μm), flyash, soot, smoke, spores, fibres, pollen grains. Suspended particulate matter (SPM)** of **2.5μm or less** in troposphere cause breathing problems like chronic bronchitis, bronchial asthma & even death.

◆ Secondary Air pollutants and their effects :

- These are produced by reaction amongst the primary pollutants.

1. Smog (smoke + fog) : It is opaque or dark fog containing condensed water vapours, smoke, gases (SO_2, H_2S, NO_2 etc.) dust. The term **smog** coined by **Des voeux, (1911).** Smog is of two types.

(i) **Classical smog (London smog) :** It is dark brown and opaque formed in **reducing atmosphere**. It requires **low temperature, oxides of sulphur, smoke, dust particles, H_2S fuel combustion of coal.**

- It was first reported in London in 1952. About 4000 people died in London in 1952 due to inhalation of H_2SO_4 vapour with fog.

(ii) Photochemical smog(Los Angeles smog) : It is grey / yellowish brown and opaque formed in **oxidising atmosphere.** It is **light induced smog.**

- It requires **high temperature, solar energy, oxides of nitrogen and hydrocarbons** combining from automobile exhausts. It forms around mid day of summer months in congested metropolitan cities. It has **O_3, PAN, oxides of nitrogen (NO_x).**
- **PAN** inhibits the **photosystem II**, spoil enzyme systems, inhibit the chlorophyll formation in plants. Irritation in eyes & respiratory distress in human.
- **O_3** corrodes the heritage building surface and damages marble statue.

EFFECT OF AIR POLLUTION

(a) Acid Rain :

- Term acid rain was coined by **Robert August**.
- It is other form of precipitation with a **pH of less 5.** (pH of Normal rain is 5·6 – 6·5).
- Acids of Atm is deposited over earth in two forms. **(i)** Wet deposition **(ii)** Dry deposition
- **Causes of acid rain :** Large scale emission of Acidic gases in to the atmosphere from thermal power plants, industries & automobiles. The common emissions are SO_2, NO_X. volatile organic carbons (VOC_S) and Hydrogen chloride, NO_X are also formed in atmosphere through lightening.
- SO_2 & NO_X are converted into sulphuric acid & Nitric acid by combining with O_2 & water in atmosphere.
  $2SO_2 + O_2 \longrightarrow 2SO_3$
  $SO_3 + H_2O \longrightarrow H_2SO_4$
  $2NO + [0] \longrightarrow N_2O_5$
  $N_2O_5 + H_2O \longrightarrow 2HNO_3$
- Acid rain demages plants by direct effect on foliage and growing points-Chlorosis, Necrosis, Defoliation, Dieback.
- Acid rain corrodes metals, marble, Painted surfaces slate, stone,The phenomenon is called **'stone leprosy'**

(b) Ozone Deplection :

- Ozone layer is found in stratosphere as ozonosphere at altitude of **23-25km** over equator.
- **'Bad ozone'** lies in **troposphere** that harms plants & animals **'Good ozone'** is formed in upper part of atmosphere called the **stratosphere.**
- It absorbs ultraviolet radiation from the sun.
- UV rays are injurious to living organisms. These rays are absorbed by DNA & proteins of living beings and high energy of UV rays breaks the chemical bonds with in these molecules. Ozone is continuously formed by the action of UV rays on molecular oxygen, and also degraded in to molecular oxygen in the stratosphere. The balance between production & degradation of ozone has been disrupted due to enhancements of ozone degradation by CFCs (chlorofluoro carbons).

- **Ozone Hole :**

- Depletion in the concentration of ozone over a restricted area as spring time decline over antarctica is called ozone hole.
- Ozone hole discovered over antarctica by Farmen at 1985 & also coined this term. It is quite large (23 million square km in 1992 and 28·3 million square km in 2000).
- These substance are responsible to destroy ozone present in the stratosphere.
- The **major ODS** are **CFCs (14% of total depletion), Nitrogen oxides (3·5% depletion), Sulphur dioxide, Halon, Carbon Tetra Chloride, Methyl Chloroform, Chlorine** etc, some of them are released by jets flying in the stratosphere & rockets being fired into space.
- Maximum ozone depleting potential or ODP is of CFCs due to release of chlorine by it.
  A single chlorine atom converts 1 lakh molecules of ozone into oxygen (reaction discovered by Molina and Rowland), chlorine action over ozone is chainmictic.
- Consequently, Chlorofluorocarbons (CFCs) are being replaced by hydrofluorocarbons (HFCs) and Hydrochlorofluorocarbons ($HClFC_5$), CCl_4, halon & methyl chloroform also deplete ozone by a similar method. Nitric oxide (NO) and other gases released by jets directly react with ozone to form oxygen.

(i) $CFCl_3 \xrightarrow{UV-C} CFCl_2 + Cl$

(ii) $CFCl_2 \xrightarrow{UV-C} CFCl + Cl$

(iii) $Cl + O_3 \longrightarrow ClO + O_2$

(iv) $ClO + O_3 \longrightarrow Cl + 2O_2$

- **Effects of ozone depletion :**

(i) It causes skin cancers.
(ii) Cornea absorbs UV-B radiations and produce **snow blindness** (cornea becomes inflamed), cataract
(iii) Many land animals would become blind.
(iv) Damage to nucleic acids will increase resulting in higher number of mutations.

(c) Global Environmental Changes :

In addition of green house gases and pollutants in the atmosphere are responsible for the global climate change.

(1) Green house effect : Warming effect for keeping earth warm due to presence of certain radiatively active gases in the atmosphere is called green house effect. It was reported by Fourier (1827) & the term green house effect coined by Arrhenius. The gases which are transparent to solar radiation, but retain and partially reflect back long wave heat radiations are called green house gases (GHGs). Eg : CO_2, CH_4, CFCs, N_2O They inhibit a part of long radiations emitted by earth to escape into space. Although green house gases radiate a part of this energy back to the earth. The phenomenon is called green house flux. The latter maintains mean annual temperature of earth at 15ºC. In its absence it will fall to –18º C. The concentration of green house gases has started rising that causes enhanced green house effect followed by increasing the mean global temperature. It is called global warming.

(2) Global Warming : Increasing concentration of green house gases causes rise in atmospheric temperature that was about some 2.5ºC since industrial revolution and 0.6ºC in the twentieth century. there will be melting of polar ice caps and mountain snow caps. The effect of global warming are as follow.

(i) Change in Sea Level : Rise in temperature will increase sea level due to thermal expansion of sea water, melting of glaciers and Greenland ice sheet. The whole of Maldives, several thousands of other islands, 11.5% of Bangladesh and several important cities of the world will be submerged.

(ii) Effect on Weather and Climate : Frequency of droughts and floods will increase.Odd climate changes would become common. Change in rainfall pattern.

(iii) Effect on Atmosphere : Warming of troposphere and cooling of stratosphere and thermosphere.

We can control global warming by cutting down use of fossil fuel, reducing deforestation, planting trees. improving efficiency of energy usage, slowing down the growth of human population.

◆ **International efforts for mitigating global change:**

(i) Montreal protocol : Montreal (canada ; 16 september) 27 industrialised countries agreed to limit use and production of ozone depleting substances like chlorofluorocarbonds to half the level of 1986 with an aim to protect ozone layer.

(ii) Kyoto Protocol (Dec. 1997) : International conference held in Kyoto (Least polluted city of world), japan concerning with mitigation of climate changes caused by green house gases obtained commitments from different countries for reducing overall greenhouse gas emission at a level 5% below 1990 level by 2008-2012. Kyoto Protocol was endorsed at CoP - 3)

(iii) World earth Summit 2002 : At Johannesburg (S. Africa) on sustainable development without depletion of Biodiversity.

(b) Water Pollution :

◆ The water pollution is caused by the addition of organic and inorganic chemicals as well as the biological materials which change the physical and chemical properties of water. This harmful process is called as water pollution.

◆ The water pollution is caused by many sources such as sewage matter, industrial wastage, agricultural wastage, domestic wastage, hot water of thermal plants and nuclear reactors etc. Water pollution can be caused by the following man made sources :

(i) Household detergents : The household detergents include the compounds of phosphate, nitrate, ammonium and alkylbenzene sulphonate etc. harmful substances which are gathered in water. Alkyl benzene sulphonate (ABS) is not degradable, so that its concentration increases which is harmful for aquatic life.

(ii) Domestic sewage & its effects :

- It contains Human and animal wastes, industrial effluents, Detergents. Raw sewage has variety of pathogen and Micro-organisms. The former initiates growth of micro-organism that represent sewage fungus.
- The decomposition of organic waste by microbial activity is called putrescibility. Degree of impurity of water due to organic matter is measured in terms of BOD.
- **BOD (Biochemical oxygen Demand) :** Amount of oxygen in milligrams required for five days in one litre water at 20Cº for micro-organisms to metabolise organic waste.
- **COD (Chemical oxygen Demand) :** It is amount of oxygen required to oxidized all the reducing substances present in water BOD also involves in COD. Both BOD and COD decrease the amount of dissolved oxygen or DO in water, The value of DO in less polluted water is 8 mg/L and < 4 mg / L in highly polluted water.

(iii) Eutrophication :

- Nutrient enrichment of a water body due to natural aging is called eutrophication. Nutrients present in sewage, agriculture wastes and fertilizers cause dense growth of plants and planktonic algae. It is called algal bloom.
- Algal blooms and floating plants cut off light from submerged plants. The latter die, there is drastic decrease in oxygen replenishment inside water. It causes organic loading of water, decreased oxygen level also kills aquatic animals, further adding to organic loading.

◆ **Note :** World's most problematic aquatic weed Eichornia crassipes (Terror of Bengal) is the another example of eutrophication.

(iv) Biomagnification/Biological magnification : Persistent pesticides like DDT and Heavy metals like Hg are accumulated in tissue in increasing concentration along the food chain is called Biological/Biological amplification. The highest level is found in top consumer.

(C) Soil Pollution :

It is change in soil due to removal or addition of substances and factors that decreases its productivity, quality of plants and ground water. It involves following types.

(i) Positive soil pollution : The quality of soil is decreased due to addition of undesirable substances e.g. : industrial wastes, agrochemicals.

(ii) Negative soil pollution : Reduction in soil productivity is caused by erosion and over-use.

(iii) Landscape/third pollution : It is conversion of fertile land into barren one by dumping wastes (Eg: ash, sludge, garbage, rubbish, industrial wastes, broken cans, bottles, etc) over it.

- Polyethylene carry-bags, petbottles, waste plastic sheets are non-biodegradable materials that persist in soil for long periods. Soil deterioration and decrease the natural microflora occur due to Excessive use of fertilizers. Flyash from thermal power plants pollute the surrounding land. Mine dust deteriorates top soil and contaminates the area with toxic metals and chemicals.

(D) Noise pollution :

- Unwanted / unpleasant loud sound of 80 dB or more is called noise pollution. Frequency of sound is measured in Hz and unit of sound level is deciBel (dB). Range of human hearing is 50 Hz to 15000 Hz.
- Moderate conversation produces 60 dB sound, loud conversation 70 dB, scooter 80 dB, truck/ bus 90 dB, jet aeroplane 150 dB, rocket 180 dB.
- **Effect of Noise pollution :**

(i) It causes anxiety, stress and emotional disturbances.
(ii) A sudden loud sound may permanently damage ear drum or dislocates ear ossicles.
(iii) It may cause insomnia or sleeplessness.
(iv) In causes headache by dilating blood vessels of the brain, dilating the pupil of eye, high blood pressure by increasing cholesterol level in the blood.
(v) It can impair the development of nervous system of unborn babies which leads to abnormal behaviour in their life.

(E) Radioactive wastes : Initially, nuclear energy was used for generating electricity. The use of nuclear energy has two very serious inherent problems. The first is accidental leakage. Eg: Three Mile Island and Chernobyl incidents, second is safe disposal of radioactive wastes. Radiation, that are released by nuclear waste, is extremely damaging to biological organisms & cause mutations. After sufficient pre-treatment, nuclear waste are stored in shielded containers and buried within the rocks, about 500 m deep below the earth's surface.

EXERCISE-1

Environment

1. The ecosystem of earth is known as
(A) Biome (B) Community
(C) Biosphere (D) Association

2. The best arrangement of an energy system consisting of hawks, mice snakes and grasses is
(A) Grass→mice→snake→hawk
(B) Grass→snake→hawk→snake
(C) Grass→snake→hawk→snake
(D) Mice→snake→hawk→grass

3. Energy flow in ecosystem is
(A) Unidirectional (B) Bidirectional
(C) Multidirectional (D) None of the above

4. The pyramid of number for forest ecosystem is
(A) Upright (B) Inverted
(C) Both of above (D) None of above

5. A food chain consists of -
(A) Producers, carnivores and decomposers
(B) Producers, herbivores and carnivores
(C) Producers and primary consumers
(D) Producers and decomposers

6. Biotic components of an ecosystem form
(A) Consumes (B) Producers
(C) Biosphere (D) Decomposers

7. Pyramid of energy is always
(A) Inverted (B) Upright
(C) Spindle shaped (D) None

8. Decomposers are
(A) Autotrophs (B) Heterotrophs
(C) Autoheterotrops (D) Organotrophs

9. Pyramid of biomass in forest is
(A) Inverted (B) Always upright
(C) Irregular (D) Regular

10. Nitrogen is a critical element in an ecosystem because
(A) It is labile element
(B) Its abundant amount present in atmosphere
(C) Nitrogen fixation takes place through microorganisms
(D) It is an essential plant element.

Pollution

11. Most hazardous metal pollutant of automobile exhaust is
(A) mercury (B) copper
(C) cadmium (D) lead

12. Increase skin cancer and higher mutation rates are generally the consequence of
(A) CO_2 (B) ozone depletion
(C) biomagnification (D) acid rain

13. Carbon monoxide is a major pollutant of
(A) water (B) air
(C) noise (D) soil

14. As compoared to tap water, the BOD of a water body polluted with sewage would be
(A) high (B) low
(C) normal (D) nil

15. One of them is an indicator for water quality
(A) Escherichia coli (B) Beggiatoa
(C) Cadothrix (D) Azospirillum

16. DDT spraying on the crops results in the pollution of
(A) soil and water (B) air and soil
(C) crops and air (D) air and water

17. Major pollutant present in the jet plane emission is
(A) CCl_4 (B) SO_2
(C) SO_3 (D) fluorocarbon

18. Montreal Protocol was aimed to
(A) To reduce green houe gases
(B) Limit the production and use of ODS
(C) Mitigate climatic change
(D) Implement Agenda 21

19. Arrange CFC, CH_4, N_2O and CO_2 in decreasing order according to their contribution in green house effect
(A) $CO_2>N_2O>CFC>CH_4$
(B) $CFC>CO_2>CH_4>N_4O$
(C) $CH_4>CFC>N_2O>CO_2$
(D) $CO_2 > CH_4>CFC>N_2O$

20. Which of the following conference obtained commitments from different countries for reducing overall green house gas emission at a level 5% below 1990 level by 2008-2012.
(A) Kyoto Protocol, 1997
(B) Earth Summit, Rio-de-janeiro, 1992
(C) Montreal Protocol, 1987
(D) Helsinki Declaratio, 1989

21. Some reliabel indicators of air pollutants ($SO_4$and noxious gases) are
(A) Lichens and mosses
(B) Ferns and Cycas
(C) 'Neem' tree and Eichhornia
(D) Green algae and aquatic liverworts

22. What is B.O.D
(A) The amount of O_2 utilised by organisms in water
(B) The amount of O_2 utilized by micro organisms for decomposition
(C) The total amount of O_2 present in water
(D) All of te above

EXERCISE-2

Passage for Q (1–3) : In a field one summer's day a Grasshopper was hopping about, chirping and singing to its hearts's content. An Ant passed by, bearing along with great toil an ear of pea he was taking to the nest. "Why not come and chat with me, " said the Grasshopper, "instead of to toiling and moliing in that way ? " "I am helping to lay up food for the winter," said the Ant, "and recommend you to do the same." "Why bother about winter?" said the Grasshopper ; "We have got plenty of food at present." But the Ant went on its way and continued its toil. When the winter came the Grasshopper had no food an found itself dying of hunger - while it saw the ants distributing every day corn and grain from the stores they had collected int he summer. Then the Grasshopper kenw : It is best to prepare for days of need

1. In the passage given above there seems to be a factural error with respect to the ant carrying the food to the nest.The most probable reason for this mistake would be
(A) Pea pod is too heavy for an ant to carry to its nest.
(B) Pea cannot be carried by an ant in the summber because it is a Rabi crop.
(C) Ant couldn't have passed by easily since it is the favourite food of grasshoppers.
(D) Grasshoppers avoid coming out in summber and thus there cannot be grasshopper in the story.

2. What could be the most plausible reason that all the ants that toiled and moiled int he summer were happy and content in the winter ?
(A) Ants were probably happy since their food was not shared with Grasshopper.
(B) Ants need not worry to work anymore since they had food stocked.
(C) Ants were happy since they enjoyed working together in summer.
(D) Food that was procured was efficiently distributed and managed so that all the ants were fed equality.

3. Grasshopper was at fault in this story mostly because
(A) Of its attitude towards ants who were working tirelessly.
(B) Of not having a forethought to store food for the upcoming winter season.
(C) Of chirping and singing to its heart's content in the summer.
(D) It should have asked ants for the food and managed to surpass the winter somehow.

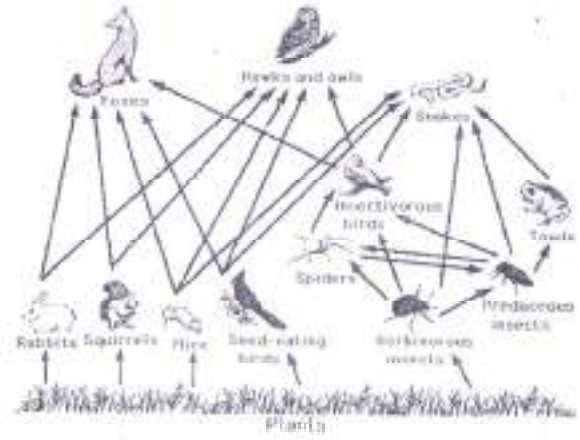
4. Besides drip irrigation, an effective way of economizing farm irrigation without hampering metabolic processes of plants would be the use of **(IJSO/Stage-2/2011)**
(A) humidifiers.
(B) sun screen nettings
(C) organic fertilizers / manures.
(D) antitranspirant sprays

5. Green house effect is related to
(IJSO/Stage-2/2012)
(A) Ozone layer depletion
(B) Carbon dioxide emission and absorption
(C) Nitrogen radiation
(D) Oxygen radiation

6. A film of oil on every water surface arrests the growth in mosquito population since:
(IJSO/Stage-2/2012)
(A) it blocks sunlight and mosquito larvae cannot get food
(B) mosquito larvae suffocate
(C) mosquito eggs cannot float on oil
(D) mosquitoes fail to mate if water surface is not available

Study the following diagram and answer the questions 7 to 11 :

(IJSO/Stage-2/2012)



7. Which of the following are tertiary consumers ?
(IJSO/Stage-2/2012)
(A) Snake, toads and spiders
(B) Foxes, Hawks and Snakes
(C) Rabbit, Squjrrels and MIce
(D) Spiders, Predacious insects and herbivorous insects.

8. The shortest and the longest food chains have____ and _____ number of organisms respectively.
(A) 2 and 6 (B) 2 and 5
(C) 3 and 5 (D) 3 and 6

9. An insecticide is sprayed to protect the plants. Which of the following statements is true?
(A) Toads and insectivorous birds will prosper as they will get ample supply of dead insects.
(B) Herbivores will be greatly affected, plants will be safe and carnivores will move to other areas and will not be affected greatly.
(C)Some insects will die, some will become resistant and prolifer more and top carnivore will be affected most.
(D) Some insects will die, but there will be no long term effects as the pesticides will get washed away.

10. What should be the preferred food of snakes to ensure minimum loss of solar energy.
(A) Mice (B) Toads
(C) Insectivorous birds (D) Faxes

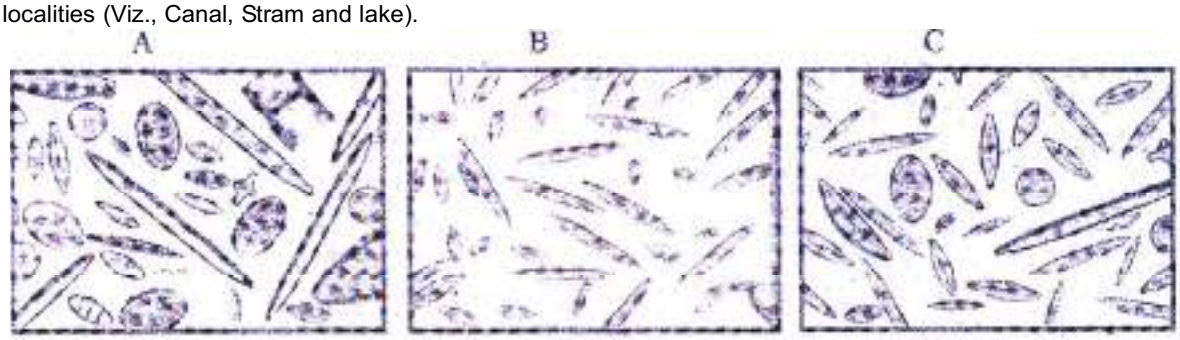
11. Organisms having low chances of survival produce larger number of offsprings to ensure their survival. Which of the following can be a characteristic feature of such organisms.
(A) Short lifecycle
(B) Better defense strategies
(C) Large body size
(D) Good parental care

12. Dwarfness is desirable agronomic character since such cereals :
(IJSO/Stage-2/2012)
(A) Produce grains faster
(B) Produce grains of better quality
(C) Prove easier to harvest
(D) Require lesser nutrients and water

13. After hearing to an influential lecture on "how to conserve environment by avoiding usage of plastic"? Ghan Shyam resolved that he should also contribute towards protecting the environment from plastic menace. Can you suggest him the first step how should he go about doing this effectively
(IJSO/Stage-2/2013)
(A) He should urge his parents to stop using plastic materials at home.
(B) He should write a letter to the local civic body against selling plastic materials around his locality.
(C) He should practice minimising plastic usage himself.
(D) He should ask his teacher to advice people on his behalf to stop usage of plastics.

PassageQ(14-17) : Diatoms are the most common photosynthetic aquatic microorganisms group of algae which are unicellular and can exist as colonies inthe shape of filaments or ribbons, fans, zigzags or stars depending on the quality of the water. Diatom communities are a popular tool for studies of water quality and pollution management. Karthik from Bangalore recently went on a field trip from Bangalore to Mysore. On the way he stopped his car at a sewage canal, a lake and a mountain stream and collected water samples from all the these places for his lab work. After a careful analysis of his water samples. he observed that diatoms came with varying size/shape and the size/shape increases has (have?) sometihing to do with the water quality.

14. Below are the diatoms observed under a microscope by Karthik. Help him to recognise the correct order of sample localities (Viz., Canal, Stram and lake).



5

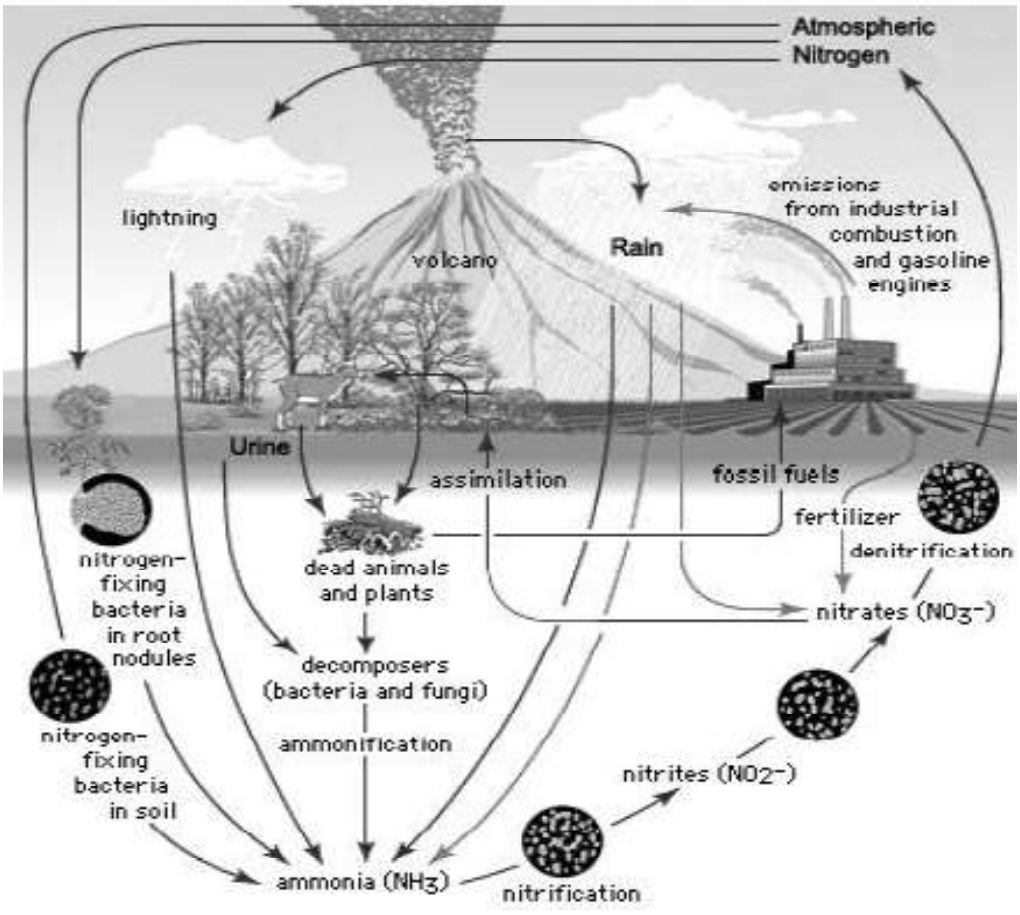
(A) A-Mountain stream, B - Sewage Canal, C - Lake
(B) A - Sewage Canal, B - Lake, C - Mountain Stream
(C) A - Lake , B - Mountain stream, C - Sewage Canal
(D) A - Mountain stream , B - Lake, C - Sewage canal

15. What is the take home message from the above experiment
(IJSO/Stage-1/2013)
(A) Diatoms come in different sizes and shapes
(B) The difference in size and shapes from different water samples, is suggestive of the intensity of water pollution.
(C) Karthik enjoyed collecting samples from different locations,
(D) Nothing can be inferred from the above experiment.

16. The term Biodiversity refers to
(IJSO/Stage-1/2013)
(A) Species Diversity (B) Genetic diversity
(C) Ecosystem diversity (D) All of the above

17. Which of the following places having same number of species is considered most biodiverse ?
(IJSO/Stage-1/2014)
(A) species belonging to more taxa
(B) many of the species economically important
(C) many of the species endemic
(D) species adapted to greater number of habitats

18. Observe the Nitrogen cycle given below and answer the following questions.
(IJSO/Stage-2/2014)



i. Beginning with free atmospheric nitrogen, arrange the following processes of nitrogen cycle in proper order.

(a) Ammonification (b) Nitrogen fixation
(c) Denitrification (d) Nitrification

ii. State whether the following statements are true (T) or false (F).

(a) Plants get their nitrogen supply as nitrates and ammonium ions dissolved in water.
(b) Ammonification refers to conversion of free nitrogen to ammonia.
(c) Nitrogen is fixed only by microorganisms.
(d) *Rhizobium* and *Azotobacter* are both found in root nodules of leguminous plants.
(e) Much of the efforts of nitrogen fixing organisms are neutralized by the action of denitrifying bacteria.
(f) Volcanic eruption adds free nitrogen to the atmosphere.

iii. If, in an experiment, all Nitrogenase enzymes in a field are inactivated by irradiation, what will be the immediate vital effect of it ?

(a) No Fixation of nitrogen in leguminous plants of the field.
(b) No Fixation of atmospheric nitrogen at all.
(c) No Conversion of nitrate to nitrite in leguminous plants of the field.
(d) No Conversion of nitrates to ammonia in soil of the field.

iv. Plants having mutualistic relation with nitrogen fixing bacteria would receive nitrogen in the form of _____ from the bacteria.

(a) Ammonium ions
(b) Amino acids
(c) Nitrates
(d) Nitrites

19. Greenhouse gases absorb (and trap) outgoing infared rediation (heat) from Earth and contribute to global warming. A molecular that acts as a greenhouse gas, generally has a permanent dipole moment and sometimes for other reasons. Going only by the condition of permanent dipole moment, in the list of gases given below, how many can be potential greenhouse gases ?

Water, Sulphur dioxide, Boron trifluoride, Carbon monoxide, Carbon dioxide, Nitrogen, Oxygen, Methane hydrogen sulphite, ammonia.

(IJSO/Stage-1/2015)

(A) Five (B) Six
(C) Seven (D) Four

20. Every major city in India has a pollution control board to monitor air and water pollution. The following data is from three different localities in Bangalore city from the year 2015.

(IJSO/Stage-1/2015)

Locality	Annual average of SO_2 in the air (volume/volume)
P	16.3 mL/m^3
Y	16.3 ppb (m^3/m^3)
Z	16.3 ppm (m^3/m^3)

ppb stands for parts per billion and ppm stands for parts per million.These are different units to express.concentration.They are very similar to percentage (which is actually parts per hundred). Based on the above data, which place will you choose to live in?

(A) All localities are equally polluted, so I have no preference.
(B) P is the more polluted tha Y and Z, hence I will live in either Y or Z.
(C) Locality Y is least polluted , hence I will live in Y.
(D) Z and Y are more polluted than P, hence I will live in P.

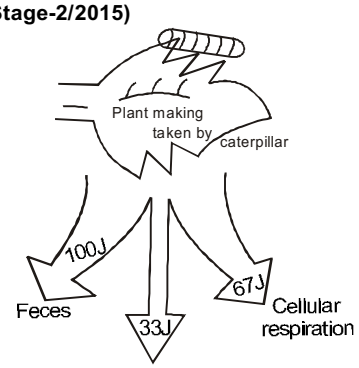
21. Endemic species refers to

(IJSO/Stage-1/2015)

(A) threatened wild animals and plants which belong to different areas.
(B) species which are capable of inter breeding.
(C) those species of flora and fauna which are found exclusively in a particular area.
(D) all the plants and animals mentioned in the red data book.

22. The following question refers to energy transfer between trophic levels in an ecosystem. Primary production is the amount of light energy converted to chemical energy (organic compounds) by the autotrophs in an ecosystem during a given time period. Net Secondary production is the amount of chemical energy is consumers' food that is converted to their own new biomass during a given period of time. The following figure represents the partitioning of energy by a catepillar eating a leaf and consuming 200 J of energy.

(IJSO/Stage-2/2015)

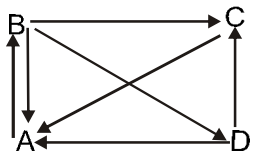


What percentage of the energy in the caterpillar's food is actually used for secondary production ?

(A) 16.5 (B) 33.0
(C) 33.5 (D) 50.0

23. Study the following ray diagram in which : 'A' represents atmosphere, 'B' represents green plants, 'C' represents decomposers and 'D' represents animals. **(IJSO/Stage-2/2015)**

The above ray diagram represents



(A) Energy flow through the given ecosystem.

(B) Interconnections among different food chains in the given ecosystem.

(C) Movement of carbon among A, B, C and D

(D) Movement of nitrogen among A, B, C and D

24. The figure shows a food web, where A, B, C, D etc. are different species. And the direction of the arrows symbolizes the direction of flow of nutrients An increase in the population of which specie:; is likely to decrease the population of species A

(IJSO/Stage-2/2016)

(A) Species D (B) Species F

(C) Species G (D) Species E

25. Plants absorb nitrates from the soil, which are most essential to produce :

(IJSO/Stage-2/2016)

(A) Proteins (B) Carbohydrates

(C) Fats (D) Cell wall

DIVERSITY OF LIVING ORGANISMS

PART-1

DIVERSITY AND CLASSIFICATION

Since inception on earth, about 4.2 billion changes and diversifications on account of evolution. According to an estimation, about 5 to 30 million species of living organisms are present on the earth. Diversity means = variety. Different places on the earth have their own typical kinds of living beings. Biodiversity refers to all the diverse plants, animals and microorganisms on the earth, which differ from one another in external appearance, size, colour pattern, internal structure , nutrition, behavior and habitat."

KNOWLEDGE BOOSTER

- Term "Biodiversity" was coined by" Walter G. Rosen" in 1986.
- The warm and humid tropical regions of the earth between the tropic of Capricorn and the tropic of Cancer, are rich in diversity of plant and animal life. This is called the region of "megadiversity"

TAXONOMY

(Gr. taxis-arrangement ; nomos-law). The functional branch of biology dealing with the identification classification and nomenclature of living organisms is called taxonomy. Carolus Linnaeus (1707-1778) is known as "Father of taxonomy".

- **Taxonomic Hierarchy :**

Hierarchy, is defined as an arrangement of items (objects, names, values, categories, etc.) in which the items are represented as being "above", "below" or "at the same level as" one another.

It is the framework by which taxonomic groups are arranged in definite order from higher to lower categories.

- **The hierarchial order of classifying organisms is : Kingdom→ Phylum/Division → Class → Order → Family → Genus → Species**

S.No.	Categories	Features
1.	Species	A group of organisms capable of interbreeding to produce offspring.
2.	Genus	It is a group of closely related species with common ancestory.
3.	Family	A number of genera having several common characters form of family.
4.	Order	A number of families having common characters are placed in Order.
5.	Class	Similar orders are place together in a class.
6.	Phylum (or Division)	Many classes with some common characters are included in Phylum.
7.	Kingdom	It is the highest category of taxonomic studies.All animals are included in kingdom Animalia and all plants are included in kingdom Plants are included in kingdom Plantae.

Taxon : It refers to any rank or category in the hierarchial order of classification. e.g. Kingdom, phylum etc.The highest taxon is **kingdom** while the lowest taxon is **species**.Species are the basic unit of classification.

IDENTIFICATION

It is defined as the determination that a praticular organism is similar to some other known individual.

CLASSIFICATION

- **Classification is the arrangement of organisms into sets or groups according to the similarities and dissimilarities present between them.**
- **This diversity gives rise to the need of classification. So, "Diversity needs classification".**

(a) Significance of Classification :

- It establishes hierarchy of groups of organisms on the basis of their common features.
- It makes the systematic study easier.
- It is essential to understand the interrelationship amongst different groups of organisms.
- It serves as a base for the development of other biological sciences as well as different fields of applied biology like public health, environment etc.

(b) System of Classification :

(i) Artificial system : Biological classification in early times were based upon single habitarily chosen character suiting the convenience of taxonomist.

- e.g. On the basis of habitat and ability to fly.

(ii) Natural system : It was based on morphological and anatomical similarities and differences.

(iii) Phylogenetic system : It was based on evolutionary sequence as well as genetic relationship amongst the organisms.Charles Darwin showed that living organisims evolved by the process of descent with modifications

NOMENCLATURE

It is the system of naming an individual.

- Nomenclature is done on the basis of a set of rules stated in the ICN i.e. International Code of Nomenclature.

(i) Binomial nomenclature : It is a system of naming the organisms in such a way that each of their names contain two components, first is genus and the second one is species.

- e.g. Scientific name of human is *Homo sapiens*. Scientific name of crow is *Corvus splendens*. *Homo* and *Corvus* are the genus while *sapiens* and *splendens* are the names of species.

- This system was introduced by Carolus Linnaeus(Karl van Linne) in his book Systema Naturae who is also called Father of Taxonomy.

- **Certain convections are followed while writing the scientific names**
- The name of the genus begins with a capital letter.
- The name of the species begins with a small letter.
- When printed, the scientific name is given in italics.
- When written by hand , the genus name and the species name have to be underlined separately.

CLASSIFICATION OF ORGANISMS

(i) Two kingdom system : It was given by Carolus Linnaeus in 1758. Organisms were divided into Plant Kingdom and Animal Kingdom. Fungi, Bacteria and Euglena could not find an appropriate position.

(ii) Three kingdom system : It was given by Ernst Haeckel(1894). In this Kingdom Protista was also included along with plant kingdom and animal kingdom.

(iii) Four kingdom system : It was given by **Copeland.** Kingdom Monera was also included in this system of classification.

(iv) Five kingdom system : It was given by Robert Whittaker(1959). According to him organisms were divided into five kingdoms.

- **Basis of five kingdom Classification**

- Complexity of structure
- Mode of nutrition
- Level of organization

(A) Kingdom Monera : Unicellular, prokaryotic, microscopic, most ancient, can live in deep oceans, hot springs, deserts, high salt concentrations etc. They include bacteria, filamentous and photosynthetic blue green algae (Cyanobacteria) etc.

(B) Kingdom Protista : Unicellular, colonial, eukaryotic. They include photosynthetic algae, decomposers (slime moulds) and protozoa (predators) etc.

(C) Kingdom Fungi : Unicellular or multicellular eukaryotic organisms, they are heterotrophic, parasitic or saprotrophic.

(D) Kingdom Plantae : They are multicellular, eukaryotic, autotrophic (photosynthetic), some are heterotrophic and parasitic.

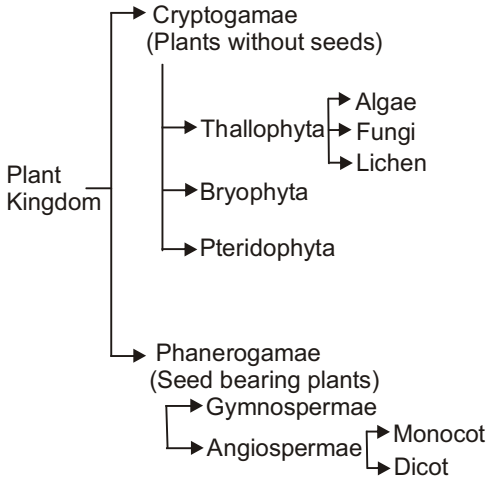
- They include photosynthetic algae, green plants etc.

(E) Kingdom Animalia : Multicellular, eukaryotic, heterotrophic.

- Carl Woese (1977) modified the five kingdom classification by dividing the Monera into Archaebacteria (or Archaea) and Eubacteria (or Bacteria).This is known as six kingdom classification.

PLANT CLASSIFICATION

- Plant kingdom was divided in two sub kingdoms by Eichler.



(a) Sub kingdom Cryptogamae :

(Cryptos = hidden gamous = marriage) :

- These are also called as lower plants, flowerless or seedless plants.
- Their reproductive organs are hidden.

(i) Division Thallophyta :

- **Thallus :** Undifferentiated plant body i.e. absence

of root, stem & leaves.

- Their is no vascular system.
- Reproductive organs are single–celled and there is no embryo formation after fertilization.

KNOWLEDGE BOOSTER
➡ In Thallophytes, asexual reproduction generally take place by spores. Sex organs are simple single-celled, (the male sex organs are called as antheridia and female sex organ called oogonia) and their is no embryo formation after fertilization.

- Three classes of thallophyta are :

(A) Class Algae :

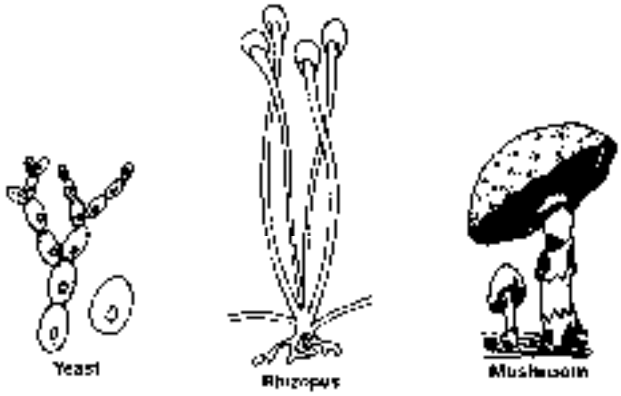
- **Characters :**
- These are aquatic or terrestrial, fresh water or marine. Autotrophic, photosynthetic containing various pigments like chlorophyll, carotenoids, xanthophylls etc.
- Unicellular, colonial, filamentous & multicellular.
- Cell wall of cellulose and stored food is starch.
- e.g. Blue green algae (*Nostoc*),*Anabaena* Green algae (*Ulothrix*, *Chara, Cladophora, Ulva, Spirogyra*) Brown algae, Red algae etc.

Spirogyra

(B) Class Fungi :

- **Characters :**
- These are heterotrophic.
- They lack chlorophyll but have cell wall of chitin (fungus cellulose) and reserve food material consists of glycogen.
- They can be parasitic or saprotrophic
- Their body is filamentous called as mycelium.
- e.g. Moulds (*Rhizopus*), Yeasts (*Saccharomyces*), Mushroom, (*Agaricus*), *Aspergillus,Penicillium*

Fungi lack chlorophyll and is heterotropic but still considered as plant because of the presence of cell wall and absence of centriole.



Yeast

Rhizopus

(C) Lichen :

- **Characters :**
- It is a symbiotic relationship between algae and fungi.
- Algal part is phycobiont and fungal part is mycobiont.
- They grow on rocks, tree trunks, grounds etc.
- e.g. *Parmellia*, *Alectoria* etc.

Lichen

(ii) Division Bryophyta :

- **Characters :**
- Bryophytes are also known as amphibians of plant kingdom.
- These are the simplest and the most primitive land plant.
- They have flat plant body which differentiate into stem, leaf and root like structure (Rhizoids).
- Main plant body is attached to substratum by means of rhizoids.
- There is no specialized tissue for the conduction of water and other substances from one part of the plant body to another.

KNOWLEDGE BOOSTER
➡ Bryophytes lie in water (aquatic) and land (terrestrial) but they require water for fertilization, so they are known as amphibians of plant kingdom.

Liverwort

- Sex organs are jacketed & multicellular.
- Fertilization produces embryo.
- They show heteromorphic type of alternation in generation.
- e.g. Liverworts (*Riccia*, *Marchantia*), hornworts (*Anthoceros*) and mosses (*Funaria*).

(iii) Division Pteridophyta :

- **Characters :**
- They are seedless vascular plants, primitive tracheophytes or vascular cryptogams.
- Plant body is differentiated into true stem, leaves & roots. they are the most evolved cryptogams
- Vascular tissues are present.
- Fruits are absent

Equisetum (Horsetail)

DIFFERENCES BETWEEN BRYOPHYTA AND PTERIDOPHYTA		
S.No.	**Bryophyta**	**Pteridophyta**
1.	True stem and true leaves are always absent.	True stem and true leaves are present.
2.	Fixation is carried out by rhizoids.	Fixation is carried out by roots.
3.	Bryophytes are nonvascular in nature.	Pteridophytes are vascular plants.

- e.g. Ferns (*Dryopteris*, *Pteris*), Club moss (*Lycopodium*), Horsetail (*Equisetum*),*Marsilea.*

(b) Sub Kingdom : Phanerogamae :

(Phaneros = visible : gamous = marriage.)

This is the highest group of plants which includes flowering and seed bearing plants. They reproduce sexually by means of seeds.The flowering plants are of two types :

a) Gymnosperms

b) Angiosperms

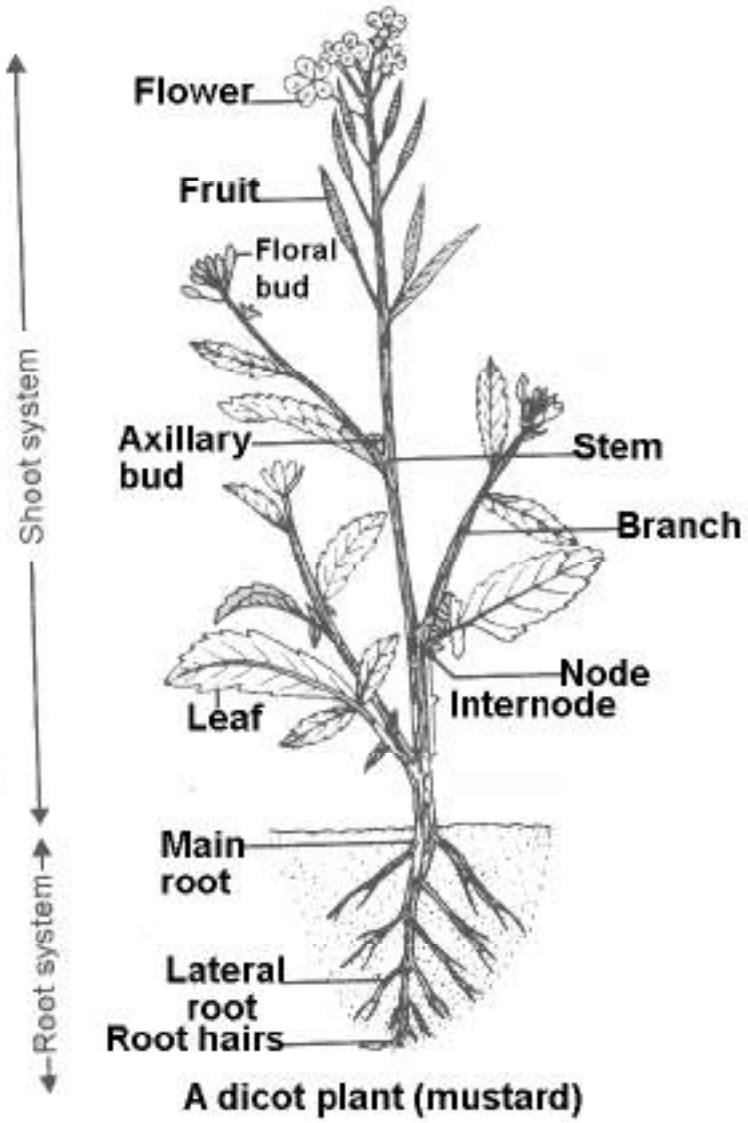
Cycas

(i) Division Gymnospermae :

- Characters :
- Gymno-means naked and sperma- seed.
- Seeds are not enclosed in fruits. These are naked seeded.
- They have well developed vascular system but xylem lacks vessels and phloem lacks companion cells.
- They occupy an intermediate position between the pteridophytes and the angiosperms.
- Plants are commonly tall trees or shrubs.
- The flowers are represented by unisexual cones, often both cones are present on the same plant.
- e.g. *Cycas*, *Pinus* (commonly known as pine)

(ii) Division : Angiospermae :

- **Characters :**
- Angio means covered & sperma means seed.These are seed bearing plants.
- These are represented by trees, herbs, shrubs.
- Body well differentiated into root, stem and leaves.
- They have highly developed vascular system. Seeds remain enclosed in ovary.Plant embryos in seeds have structures called cotyledons. cotyledones are called "seed leaves".
- It is divided into two classes on the basis of number of cotyledons.



A dicot plant (mustard)

(A) Class : Dicotyledonae :

- Their seeds have 2 cotyledons in the embryo.
- Leaves are dorsiventral and show reticulate venation.
- Tap root is present, e.g. Neem, Peepal, Mango, Pea, Mustard.

Monocot plant (maize)

(B) Class : Monocotyledonae

- Their seeds have one cotyledon in embryo.
- Leaves are isobilateral with parallel venation.
- Fibrous root system is present, e.g. Wheat, Maize, Onion.

DIFFERENCES BETWEEN ALGAE AND FUNGI

S.no.	Algae	Fungi
1.	Green, blue green, red brown coloured.	Colourless.
2.	Contain chlorophyll and other pigments.	Chlorophyll is absent.
3.	Autotrophic.	Heterotrophic.
4.	Body made up of true parenchyma.	Pseudo-parenchyma (a false tissue) present.
5.	A cell-wall of true cellulose is present.	Cell wall contains chitin, cellulose, pectose etc.
6.	Reserve food is starch.	Reserve food is glycogen and oil.
7.	Aquatic.	Found at damp and moist places.

DIFFERENCES BETWEEN BRYOPHYTES AND PTERIDOPHYTES.

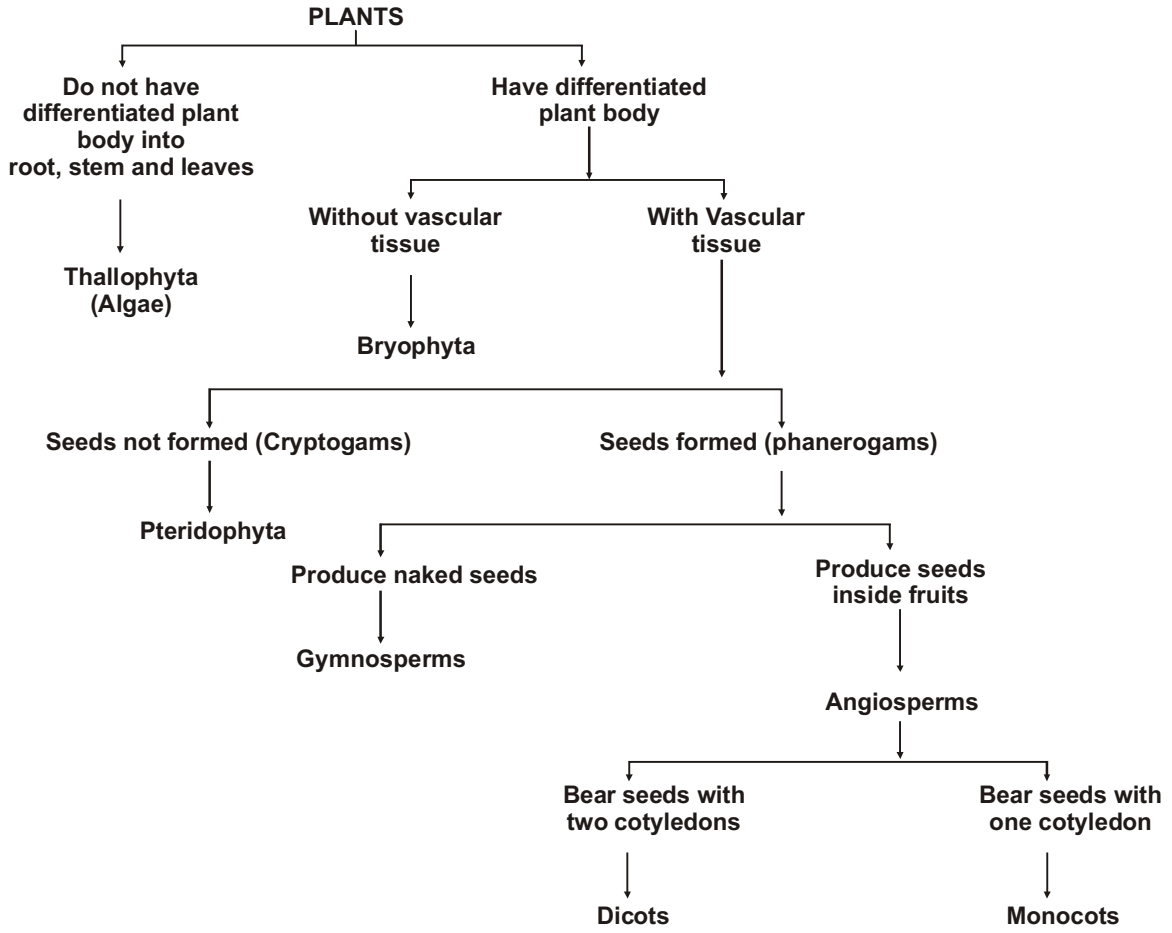
S.no.	Character	Bryophytes	Petridophytes
1.	Size	Bryophytes are very small in size.	Pteridophytes are herbaceous.
2.	Vascular tissue	They do not contain vascular tissue (xylem and phloem).	They bear the vascular tissues.
3.	Differentiation	They are not divided into roots, stem and leaves.	Plant body is differentiated into roots, stem and leaves.

DIFFERENCES BETWEEN GYMNOSPERMS AND ANGIOSPERMS.

S.no.	Characters	Gymnosperms	Angiosperms
1.	**Nature of seeds**	**Naked** as no fruit formation.	**Enclosed** inside the fruit.
2.	**Reproductive organs**	Sporophylls form cones.	**Flowers.**
3.	**Xylem**	Only tracheids but no vessel.	Vessels present.
4.	**Phloem**	No companion cell.	Companion cell present.
5.	**Ovules**	Not enclosed in ovary.	Enclosed in ovary.
6.	**Examples**	Cycas and Pinus.	**Monocots** and **Dicots.**

SOME DISTINGUISHING CHARACTERS OF DICOTS AND MONOCOTS.			
S.no.	**Plant organ**	**Dicots**	**Monocots**
1.	**Root**	Tap, Adventitious or both.	Only adventitious.
2.	**Stem**	Vascular bundles arranged in ring with central pith.	Vascular bundles scattered.
3.	**Leaves**	Mostly with reticulate venation.	Usually parallel venation.
4.	**Cotyledons**	Two	One
5.	**Floral parts**	Five or multiple of 5, rarely 4.	Three or mulitiple of 3, rarely 4, never 5.

CLASSIFICATION OF PLANTS



ANIMAL KINGDOM

- **Basis of Classification :**
- Organization and differentiation of cells to form tissues and organs.
- Body symmetry.
- Formation of body cavities and blood vascular system.
- Features of embryonic development.

(a) Level of Organisation in living beings :

It is structural differentiation of animal body.

(i) **Cellular level of Organisation :** Tissues do not differentiate. Different types of cells are present, e.g., porifera (sponges).

(ii) **Tissue Level of Organisation :** Multicellular body cells organised into tissues but organs are absent e.g., Coelenterata.

(iii) **Organ Level of Organisation :** Cells are organised into tissues and tissues into organ but organ systems are absent, e.g., Platyhelminthes.

(iv) **Organ System Level of Organisation :** Cells are organised into tissues, tissues into organs and organ into organ systems e.g., Nematoda and higher animals.

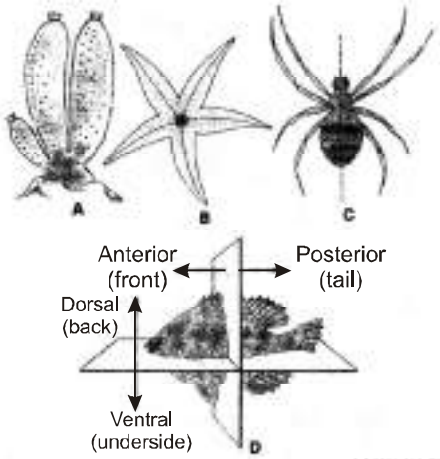
(b) Body Symmetry :

It is similarity in arrangement of parts. Absence of repetition or similarity is called asymmetry. Symmetry is of two types, radial and bilateral.

(i) **Radial Symmetry :** The body is cylindrical or discoid when similar parts occur all around the central axis. Any vertical plane passing through, the central axis will divide the body into two equal halves, e.g., many sponge, coelenterates and echinodermates. Head is generally absent.

(ii) Bilateral Symmetry : The body has a head. Organs and limbs are paired. They are arranged laterally. Body is divisible into two equal halves by only one plane (mid-sagittal plane). Bilateral symmetry is found in Platyhelminthes, Nematoda, Annelida, Mollusca, Arthropoda and chordata.

DIFFERENCE BETWEEN BILATERAL AND RADIAL SYMMETRY		
S.No.	**BILATERAL SYMMETRY**	**RADIAL SYMMETRY**
1	Limbs and organs are paired.	Limbs and organs occur all around the central axis.
2	Cephalization is present.	Cephalization is absent.
3	The body can be divided into two equal halves by only one plane called mid-sagittal plane.	The body can be divided into two equal halves by any vertical plane passing through the central axis.
4	**Examples.** Fish, Frog, Earthworm, Human.	**Examples**. Hydra, Starfish.



Diagrams showing body symmetry A-Asymmetry in Sponges ; B-Radial symmetry in Starfish : C-Bilateral symmetry in Spider: D--Fish-a bilaterally symmetrical animal having front (anterior) end, tail (posterior) end and back (dorsal), underside (ventral) side.

- **Cephalization :** It is development of head in the anterior part of the animal body.

(c) Germ or Germinal Layers :

They are the germinal layers that differentiate in the embryo. All tissues and organs of the animal body develop from them. Germinal layers can be two or three in number. On this basis, the animals are of two types, Diploblastic and Triploblastic.

(i) Diploblastic Animals : Animals having two germinal layers, outer **ectoderm** and inner **endoderm.** Mesoderm is absent e.g. Porifera, Coelenterata.

(ii) Triploblastic Animals : Animals having three germinal layers-outer **ectoderm,** middle **mesoderm** and inner **endoderm,** e.g., Platyhelminthes to Chordata.

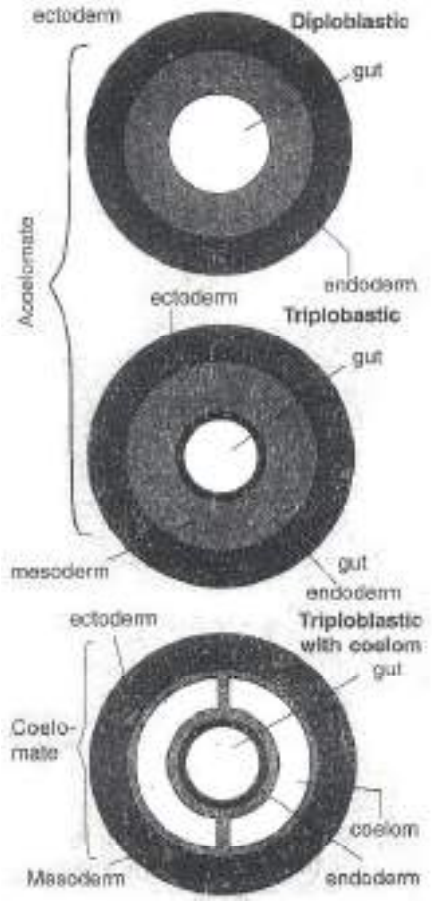


Fig. Diploblastic and triploblastic bodies have two and three cell layers respectively.

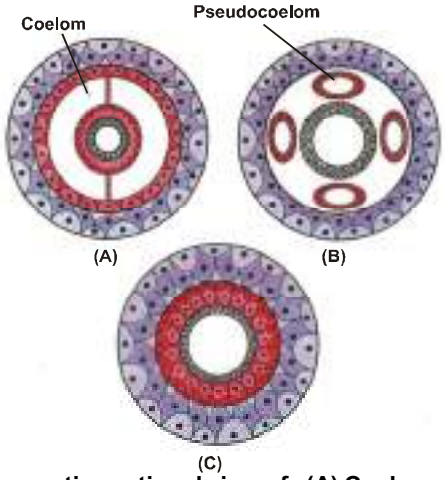
(d) Coelom (Body Cavity):

It is mesoderm lined fluid filled space that occurs between alimentary canal and body wall which provides shock proof environment to various body organs. Depending upon the absence or presence of coelom animals are of three types-acoelomate, pseudocoelomate and eucoelomates.

(i) **Acoelomate :** Coelom is absent e.g., Porifera, Coelenterata, Platyhelminthes.In Platyhelminthes a mesoderm is present but it does not form cavity.

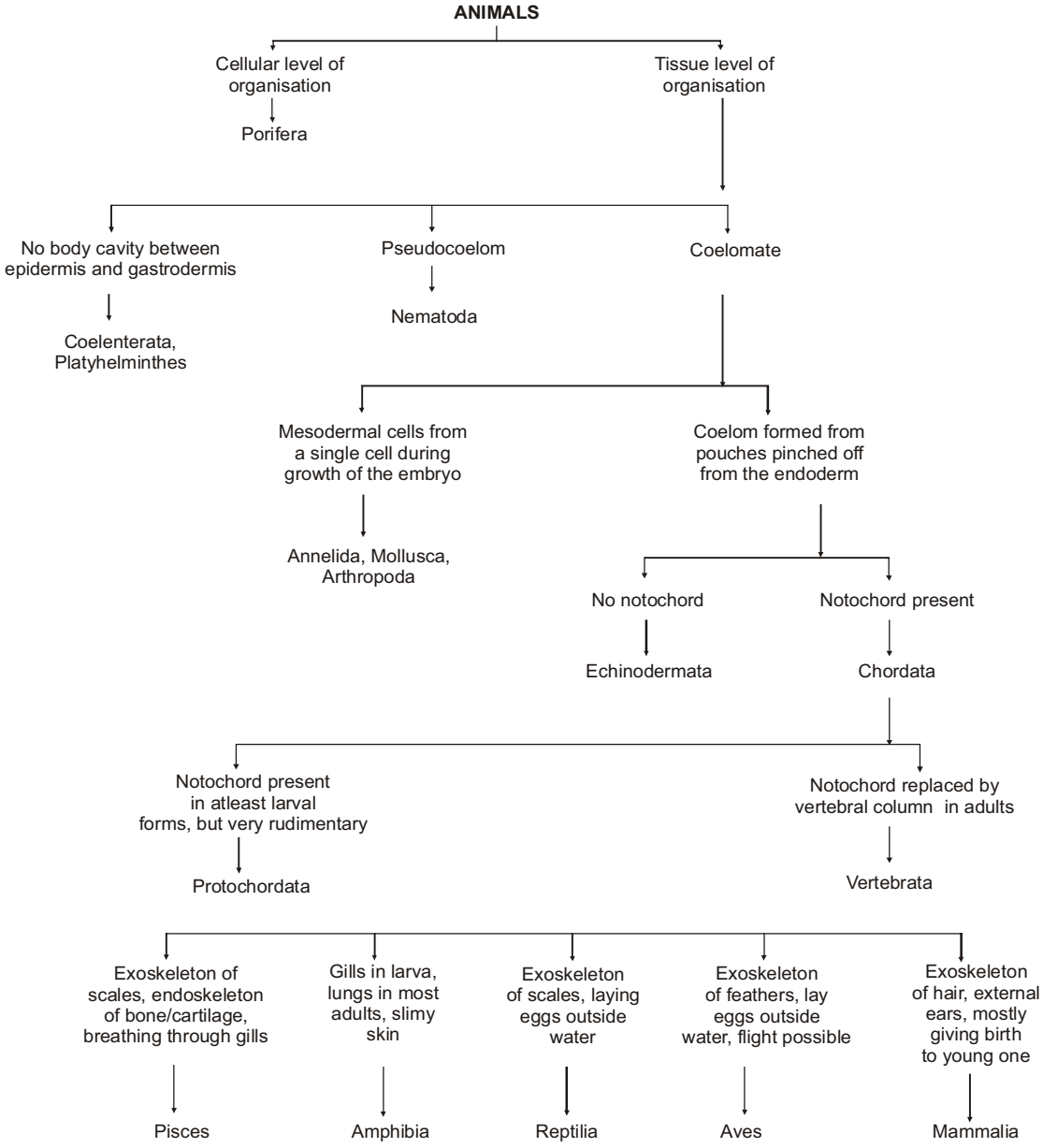
(ii) **Pseudocoelomate :** A cavity called **pseudocoelom** is present which is not lined by mesoderm. It is generally endodermal in origin. Mesoderm occurs but forms small separate pouches e.g., Nematoda.

(iii) **Coelomate or Eucoelomate :** A true coelom lined by mesoderm is present. On the basis of origin, true coelom is of two types, schizocoelom and enterocoelom.



Diagrammatic sectional view of : (A) Coelomate (B) Pseudocoelomate (C) Acoelomate

Flow Chart : Classification of Animals



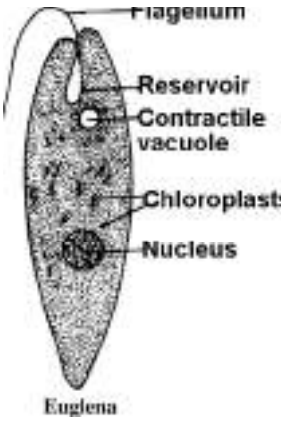
NON CHORDATES

(a) Phylum Protozoa :

♦ **Characters :**

- They are unicellular, eukaryotes.
- These are the simplest & the most primitive animals. Their body organization is of "Protoplasmic Level".
- They are of different shapes i.e. irregular, elongated or rounded.
- They have different types of locomotory organs like cilia, flagella, pseudopodia (false feet) etc.
- Nutrition is of different types like holozoic, holophytic, mixotrophic.

Amoeba



Euglena

- Digestion is intracellular & it takes place in food vacuole.
- Excretion & respiration occurs through general body surface by the process of simple diffusion.
- Reproduction may be sexual or asexual.
- e.g., *Amoeba*, *Entamoeba*, *Plasmodium*, *Euglena*, *Paramoecium*.

(b) Phylum Porifera :

♦ **Characters :**

- These are pore bearing organisms i.e. with porous body.

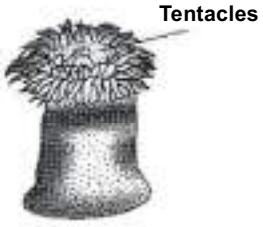
- Also called as sponges.
- Aquatic, mostly marine habitats.
- These are sessile and sedentary (attached to substratum) asymmetric or with radial symmetry.
- Sponges are diploblastic.
- Occur in different shapes i.e. vase–like, rounded, sac like etc.
- Body perforated by numerous pores called ostia which opens into a canal system having canals and chambers lined with choanocytes and have a large sized water outlet called oscula.
- Their cavity is called spongocoel.
- Endoskeleton is made of needle like spicules made of calcium carbonate and silica or spongin.
- Hermaphrodite, asexual reproduction by budding.
- e.g., *Sycon, Spongilla, Euplectella.* (Venus flower basket)

(c) Phylum - Coelenterata or Cnidaria :

♦ **Characters :**

- These are sac like structures. They have a body cavity called gastrovascular cavity or coelenteron. It has single opening for ingestion and egestion both.
- Aquatic, mostly marine.
- Multicellular, diploblastic, radially symmetrical.

Cnidaria



SEA ANEMONE

- They have special structures called tentacles, cnidoblast or nematocyst cells. They are specialized for stinging. They paralyse the prey by releasing poison.
- Asexual reproduction by budding and sexual reproduction by gametes.
- Some of them have exoskeleton of $CaCO_3$ .They are called Corals, they live in colonies and when they die they form coral reefs, or islands. e.g. *Hydra*, Jelly fish.

  Physalia , Sea-anemone etc.

KNOWLEDGE BOOSTER

- Cnidoblast - Helps in paralysing the prey by injecting poison. e.g. Hydra : Fresh water coelenterate.
- Physalia : Portugese man of war
- Aurelia - Jelly fish.
- Millepora - Coral.

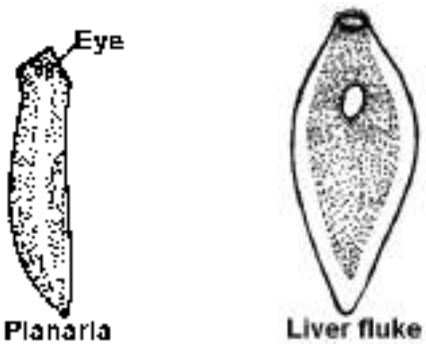
(d) Phylum Ctenophora :

- **Characters :**
- Body is transparent with radial symmetry.
- They possess comb plates that are ciliated and 8 in number. These help in locomotion. They also possess tentacles.
- Marine, solitary and free swimming. e.g. *Cestum.*

(e) Phylum Platyhelminthes :

(Platys = Flat; helminth = worm)

- **Characters :**
- Generally called as flatworms.
- Bilaterally symmetrical, triploblastic, dorsoventrally flattened.
- Acoelomates.
- Their digestive cavity has a single opening with mouth only and anus is absent.
- They possess hooks and suckers.



- They have flame cells or protonephridia for excretion.
- Mode of nutrition is parasitic.
- Reproduction is of both types i.e. asexual and sexual
- These are hermaphrodite. e.g. *Planaria, Fasciola* (liver fluke) , *Taenia solium*, Blood fluke.

Hermaphrodite i.e. male and female reproductive organs are present in same animal.

(f) Phylum – Nematoda (Aschelminthes):

- **Characters :**
- Also called as roundworms.
- Bilaterally symmetrical, unsegmented triploblast ic.
- These are pseudocoelomic.
- Their alimentary canal is tubular having both mouth and anus.
- Most are free living, some live in moist soil, some are fresh water while some are marine.
- Some are parasites on plants & animals.
- They lack circulatory system. Female ascaris is longer than male ascaris it has curved tail.
- Reproduction is sexual and sexes are separate. e.g. *Ascaris* (round worm), Filarial worm (elephantiasis).

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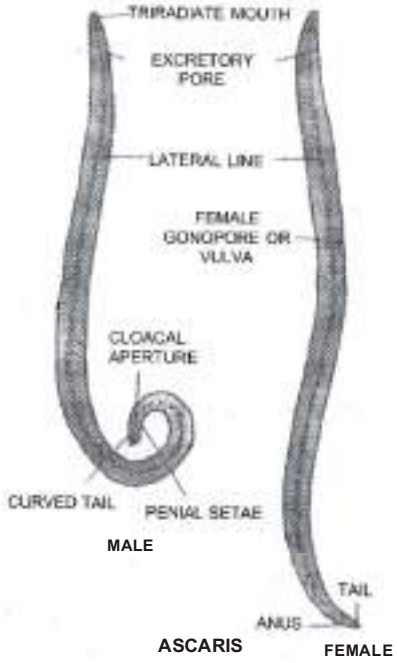
- Alimentary canal straight and complete with mouth and anus in nematodes. They are unisexual organisms.

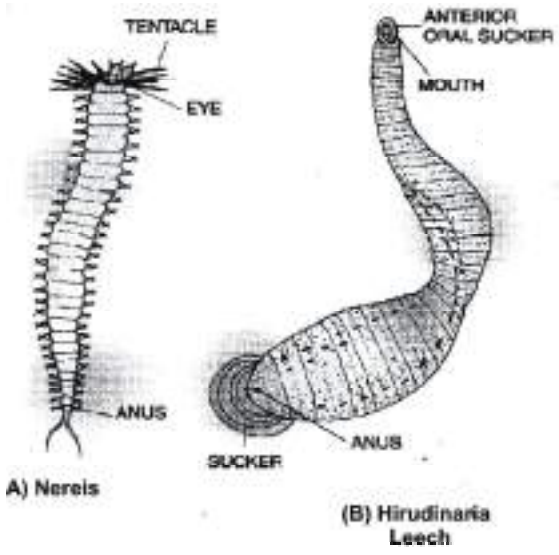


Ascaris - A; male ; B : female.

(g) Phylum : Annelida

(Annulus = ring ; segments)

- **Characters :**
- Their body is triploblastic, bilaterally symmetrical, soft, elongated, vermiform, cylindrical.
- Body is metamerically segmented. .
- Exoskeleton is absent, body is covered by thin cuticle.



Earthworm

- **Eucoelomata** i.e. they have true body cavity which first appeared in this phylum.
- Well developed alimentary canal is present.
- They have closed circulatory system.
- Locomotion is with the help of chitinous projections called chaetae (setae).
- Excretion by nephridia.
- Nervous system has dorsal brain.
- Most are aquatic, marine or fresh water. Some are terrestrial.
- They reproduce sexually e.g. Earthworm, Leech, Nereis, Sea mouse etc.

KNOWLEDGE BOOSTER

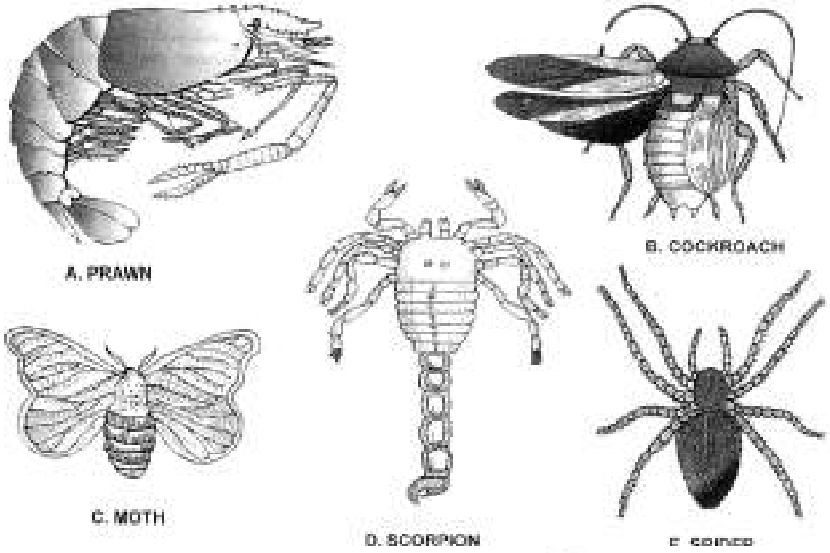
- In Annelids, body is metamerically segmented i.e. body is divided externally by transverse grooves as well as internally by septa,
- These segments are called metameres.
- Locomotion by parapodia or Chitinous setae which are segmentally arranged.

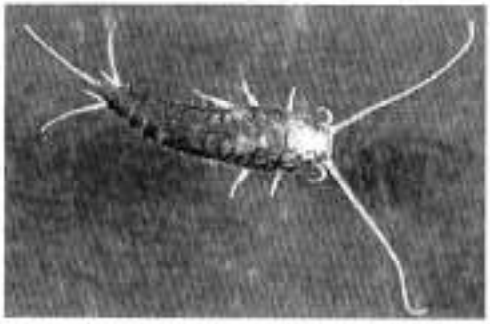
(h) Phylum : Arthropoda

(Arthros → jointed , poda = legs)

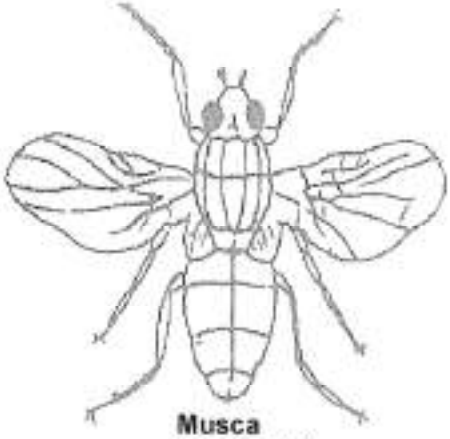
Characters

- These are the organisms with jointed appendages.
- This is the largest phylum in animal kingdom.
- Body triploblastic, bilaterally symmetrical and externally segmented.





Lepisma
(silver fish)
(F)



Musca
(house fly)
(G)

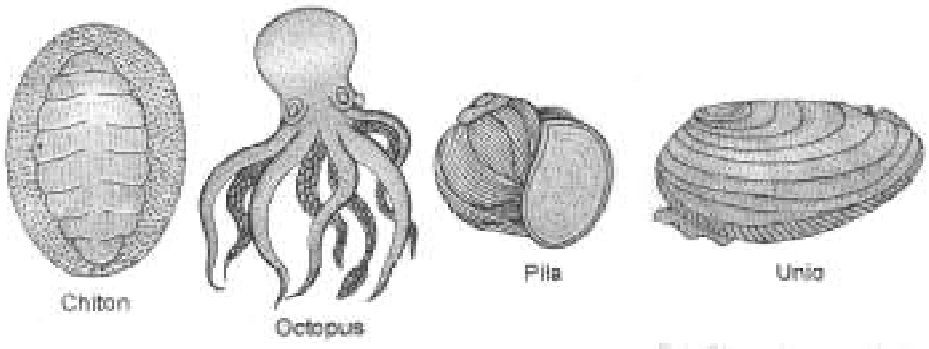
- They have an exoskeleton made up of protein and chitin (Moulting → Periodic shedding off of the exoskeleton to induce the growth).
- They have a complete alimentary canal with mouth & anus.
- Respiration occurs through general body surface, gills, trachea and book lungs.
- They have an open circulatory system with dorsal heart & arteries.
- Body cavity is called haemocoel.

- Excretion by coelomducts, malpighian tubules, green glands, coxal glands.
- Sexes are separate.
- Each segment has paired lateral and jointed appendages. e.g. *Palaemon* (prawn), *Cancer* (crab), *Periplanata* (cockroach), *Anopheles* (mosquito) & *Aranea* (spider), *Apis* (Honey bee), *Lepisma, Palamnaeus (scorpion) Scolopendra (centipede), Musca (House fly) Butterfly.*

(i) Phylum Mollusca : (Molluscs = soft)

♦ **Characters :**

- It is the second largest group of animals, body soft, unsegmented, asymmetrical & without appendages Neopilina is a segmented mollusca.
- Bilateral symmetry in some mollusca like pila due to torsion (twisting) during growth , the adult are asymmetrical.
- Body divided into a head, foot and visceral mass. A thin skin covering the body is called as mantle, which secretes a calcareous shell.



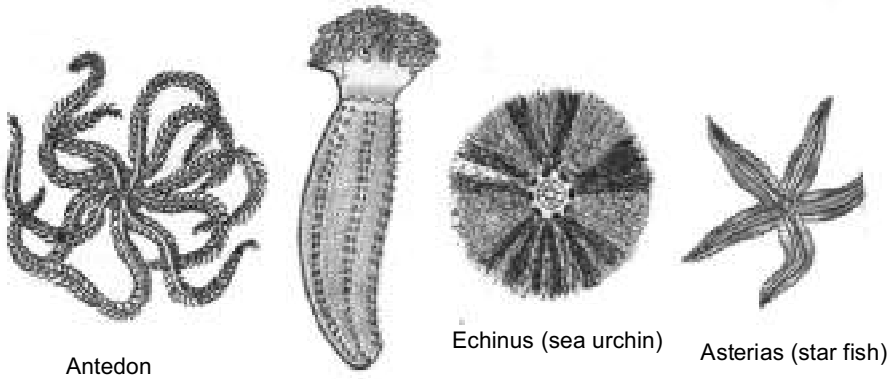
- Body cavity is haemocoel.
- Respiration by gills (Ctenidial) in aquatic forms but in terrestrial forms space between mantle and body wall called as mantle cavity act as lungs.
- For ingestion they have tongue like structure "radula" they also possess a digestive gland called hepatopancreas.
- Open circulatory system.
- Excretion by metanephridia present near heart.
- Reproduction is sexual and sexes are separate. e.g. *Chiton* (8 Calcareous pieces), *Pila*, *Helix* (torsion univalve), *Dentalium* (tusk like shell), *Unio*, *Mytilus* (Bivalve), *Octopus*, *Tropedo*, *Sepia*, Indian pearl oyster

(j) Phylum Echinodermata :

(Echinos = spines Derma = skin)

♦ **Characters :**

- These are marine animals, their body is triploblastic, eucoelomata, unsegmented.
- Their body has spines arising from exoskeleton of calcium.
- Adults are radially symmetrical while larvae are bilaterally symmetrical.
- Head is absent, oral and aboral surfaces have five radial ambulacra.
- Water vascular system is the charactristic feature of this phylum.
- Excretory organs are absent.



- A complex system of water containing tubes and bladders passing through pores of skin called water vascular system is present. From this tube like structure arise, these tubes look like feet and are called as tube feet that helps in locomotion
- Reproduction can be asexual, sexual or by re-generation.
- e.g. *Asterias* (star fish), *Echinus* (sea urchin), *Holothuria* (sea cucumber), *Antedon* (feather star)

SUBPHYLUM : VERTEBRATA OR CRANIATA

Majority of chordates are included in this phylum.

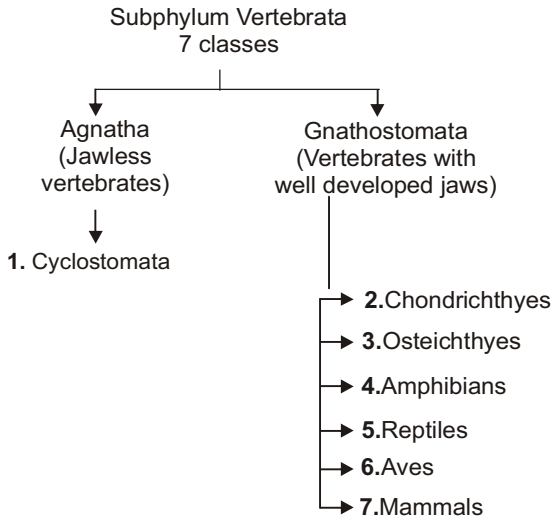
♦ **Characters :**

- They are advanced animals, having a cranium (brain box) around the brain. Nervous system is well developed.
- Notochord is replaced by a vertebral column (backbone) in the adults. Endoskeleton is highly developed.
- There are two pairs of limbs or appendages.
- Head is well differentiated.
- The heart is situated ventrally. The circulatory system is closed consisting of blood vascular system and lymphatic system. Red coloured pigment haemoglobin is present in red blood corpuscles.
- Respiratory organs may be gills (in aquatic animals), skin, buccopharyngeal cavity (in amphibians) or lungs (in land animals).
- Excretion occurs through kidneys.
- Sexes are separate.

VERTEBRATES VERSUS INVERTEBRATES

S.NO.	VERTEBRATES	INVERTEBRATES
1.	Vertebral column (backbone) to support the body.	Lack vertebral column (backbone).
2.	Possess endoskeleton.	Lack endoskeleton.
3.	Usually possess a post-anal tail.	Tail is absent.
4.	Position of heart is ventral.	Position of heart, if present, is dorsal.
5.	Nerve cord is tubular and dorsal in position.	Nerve cord (spinal) is solid and ventral in position.
6.	Red blood cells (RBCs) contain haemoglobin.	Generally, haemoglobin is absent. If present, it remains dissolved in blood.
7.	Two pairs of limbs (appendages) are present.	Limbs (appendages) consists of more than two pairs.

- This subphylum is subdivided into seven classes. They are :



(a) Class Cyclostomata :

(Gr. Cyclos = circular, Stome = mouth ; the circular mouthed fishes)

These are the most primitive vertebrates.

♦ **Characters :**

- Animals are jawless and possess a circular mouth.
- They are ectoparasites on fish and use mouth to stick to fish ; the mouth is therefore suctorial.
- Notochord is present in the form of a cylindrical rod.
- Head and brain are poorly developed.
- Cartilagenous endoskeleton is present.
- Respiration occurs through gills contained in pouches.
- Heart is two–chambered consisting of one auricle and one ventricle.
- Gonad is single and fertilization is external. e.g. *Petromyzon* (lamprey), *Myxine* (hag fish).


Petromyzon

(b) Super Class Pisces

♦ **General feature**

- True fishes are included in the class
- They respire through gills.
- Their body is stream lined and and covered by scales / plates.
- They have muscular tail and fins for movement.
- Endo skeleton is either made up of cartilage or bone.
- They are unisexual and lay eggs.
- They are cold blooded.
- Heart is 2 chambered.

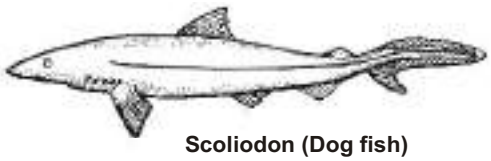
KNOWLEDGE BOOSTER

➡ Cold blooded / Poikilotherms: There body temperature does not remain constant and varies with atmospheric temperature.

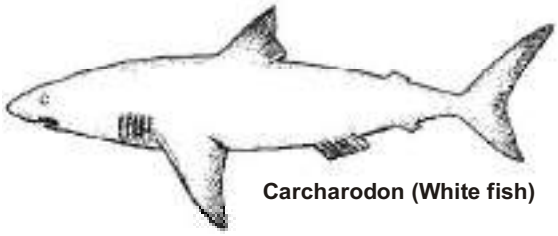
PISCES

Chondrichthyes — (Cartilageinous fishes)

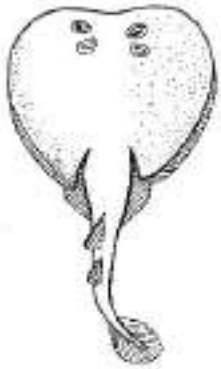
Osteicththyes — (Bony fishes)



Scoliodon (Dog fish)



Carcharodon (White fish)



Torpedo (Electric fish)

Clarias (Magur)

Anguilla (Freshwater eel)

Hippocampus (See horse)

Wallagonia (Lachi)

Exocoetus (Flying fish)

Fig. Differences between Chondrichthyes and Osteichthyes

S.NO.	CHONDRICHTHYES	OSTEICHTHYES
1.	Mouth ventral.	Mouth terminal.
2.	Tail fin asymmetrical (heterocercal).	Tail fin symmetrical (homocercal).
3.	5-7 pairs of gills are present.	4-5 pairs of gills are present.
4.	Gills are naked.	Gills are covered by operculum.
5.	Cloacal aperture is present.	Anus and urinogenital apertures are separate.
6.	No swim bladder.	Swim bladder usually present.
7.	Fertilization is internal.	Fertilization is external.
8.	e.g. Scoliodon – Dog fish, Trygon - Sting ray, Torpedo - Electric ray, Rhineodon - Whale shark.	e.g. Labeo rohita - Rohu or Indian carp, Anabas - Climbing perch, Caulophyryne jordani- Angler fish, Hippocampus - Sea horse, Pterois valitans -Lion fish, Exocoetus - Flying fish, Synchiropus splendidus - Mandarin fish.

(d) Class Amphibia :

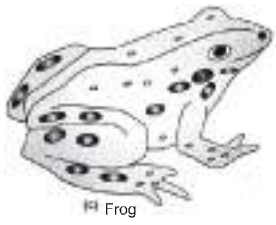
(Gr. amphi = both, bios = life, the vertebrates leading two lives / dual life)

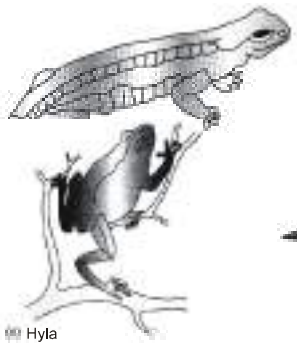
KNOWLEDGE BOOSTER

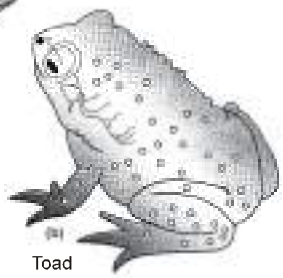
➡ Amphibians are the first vertebrate which come out of water but these are not able to live on land permanently.These depend on water for their reproduction.

♦ **Characters :**

- They are amphibious in nature ; found in fresh water and moist places.
- Skin is smooth or rough, rich in glands which keep it moist ; skin with pigmented cells, i.e.,chromatophores.
- Body is without scales.
- Endoskeleton is mostly bony, notochord does not persist in adults.
- Head and trunk are distinct ; neck and tail may or may not be present.
- Limbs tetrapods (four – limbed), digits without nails
- Respiration occurs by lungs, skin or buccal lining, gills are present at least during larval stage for respiration.
- Excrete either ammonia (by tadpole) or urea (by adults).
- Heart three chambered with two auricles and a ventricle, red blood corpuscles are large, biconvex, oval and nucleated.
- Brain is not much developed, cranial nerves are 10 pairs.
- Sexes are separate, i.e., dioecious, male without copulatory organ.
- Eggs with gelatinous covering, usually laid in water.
- Fertilization is external.
- Development is indirect with a tadpole larva which undergoes metamorphosis to become adult.
- e.g. Salamanders, frogs & toads. Salamandra (Salamander), *Necturus* (mud puppy), *Triturus* (newt), *Rana* (frog), *Bufo* (toad).


Frog


Hyla


Toad

(e) Class Reptilia :

(L. reptare = to creep ; creeping vertebrates).

KNOWLEDGE BOOSTER

➡ Reptiles are first successful terrestrial animals but some are aquatic. Body is divided into head, neck, trunk and tail.

♦ **Characters :**

- Two pairs of pentadactyl limbs are present ; but in snakes limbs are reduced or absent.
- Body is covered with epidermal horny scales.
- Skin is dry, impermeable and devoid of glands.
- Respiration takes place by lungs only. Gills are absent.
- Heart is incompletely four – chambered, having two auricles and incompletely divided ventricle. In crocodile, heart is completely four chambered.
- Sexes are separate.
- Fertilization is internal (characteristics of land animals).
- There is no larval stage in development. e.g. *Testudo* (tortoise), *Chelone* (turtle) *Draco* (flying lizard), Chameleon, *Hemidactylus* (wall lizard), *Naja* (cobra) etc.

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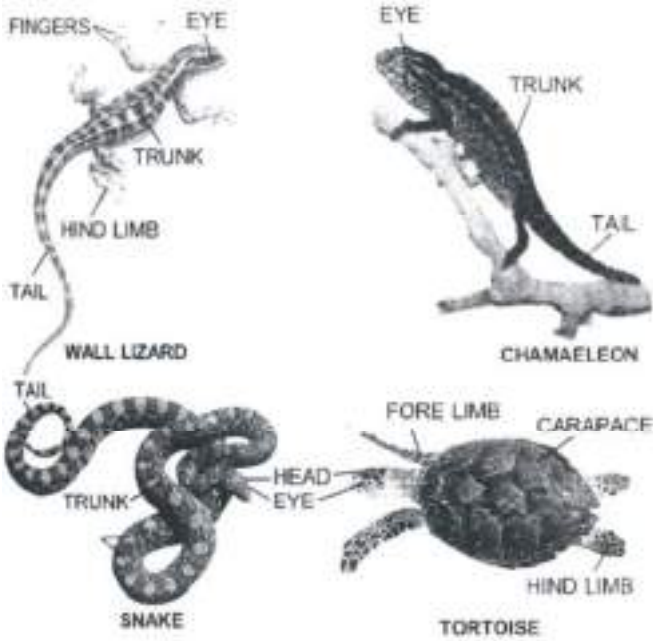
- The only poisonous lizard is Heloderma all other are non-poisonous.
- Varanus is the largest living lizard present in the world.



DIFFERENCES BETWEEN AMPHIBIA AND REPTILIA		
S.no.	**Amphibia**	**Reptilia**
1.	Skin is smooth and moist.	Skin is dry and cornified.
2.	Scales are absent.	Scales are present over the body.
3.	Digits do not possess claws.	Digits end in claws.
4.	Heart is three chambered.	Heart is incompletely four chambered.
5.	Fertilization is external.	Fertilization is internal.
6.	**Examples :** Frog, Toad.	**Examples** : Lizard, Snake, Tortoise.

(f) Class Aves : (L. Aves = birds)

- The birds are described as 'feathered reptiles' that have developed the power of flight.
- **Characters :**

- The body is covered with soft feathers (feathery exoskeleton). called Plumage
- The body is divisible into head, neck, trunk and tail.
- There are two pairs of limbs. The fore limbs are modified to form wings (in flying birds) or are reduced (as in non–flying birds). Hind limbs are strongly developed for perching, walking.
- Endoskeleton is light. The bones have air cavities (Pneumatic bones). This makes the bird light.
- Jaws are modified to form a strong beak.
- Teeth are absent.
- Respiration is by lungs only. Lungs have additional bag like membranous extensions called as air sacs.
- Heart is completely four chambered.
- Sexes are separate.
- Birds are oviparous, i.e. egg laying.
- Fertilization is internal. Fertilized eggs are laid with a yolk (stored food) and with a hard calcareous shell.
- Like reptiles and mammals, they have the embryonic membranes namely the amnion, chorion, yolk – sac and allantois.
- High degree of parental care is exhibited.
- There is no larval stage in development. e.g. *Columba* (pigeon), *Pavo* (peacock), *Corvus* (crow), *Passer* (sparrow). *Struthio* camelus(ostrich), *Kiwi* and *Penguin* are flightless birds.White Stork (Ciconia ciconia) Male Tufted duck (Aythya fligula)

KNOWLEDGE BOOSTER

- Sound producing organ at the junction of trachea and bronchi of birds is called syrinx.
- Penguins, Emu, Ostrich and Kiwi are flightless birds.
- Archaeopteryx is the connecting link between reptiles and birds.

(g) Class Mammalia :

(L. mamma = breast ; the mammals)

- Mammalia is the most evolved group of organisms and are found in diverse habitats ranging from deserts, polar ice caps, oceans, mountains, forests and grasslands.
- They are named mammals as all of them possess mammary glands (milk producing glands). Mammals are the only animals which feed their young ones with milk.

♦ **Characters :**

- Skin is covered with an exoskeleton of hair. Hair are provided with sweat glands which help in the regulation of body temperature. In aquatic mammals, hair being negligible, the subcutaneous layer of fats provides insulation.
- Mammals have two pairs of pentadactyl limbs.
- The body cavity is unequally divided into two parts by a muscular partition called as diaphragm.
- Eyes are provided with movable lids.
- Ears have fleshy external ears or pinnae.
- Teeth are embedded in sockets (thecodont). Two sets of teeth develop in the life time of a mammals Milk teeth and permanent teeth (diphyodont).
- Teeth are of different types (heterodont).
- Respiration occurs by lungs.
- Heart is four chambered. R.B.Cs are non nucleated and usually circular.
- Sexes are separate. Gonads are paired. Testes lie commonly in the scrotal sacs outside the abdomen.
- Fertilization is internal. Eggs are small , microscopic without shells and are retained in uterus of female for development.
- Embryonic membranes (amnion, chorion, yolk sac and allantois) present.
- They give birth to living young ones and are called as viviparous.
- The young ones are fed on milk from mammary glands.

♦ **Important Groups of Mammals :**

- Mammals are divided into three main groups :

(i) Egg-laying mammals (monotremes) : These mammals show characters of both reptiles and mammals. They lay hard shelled eggs (oviparous)

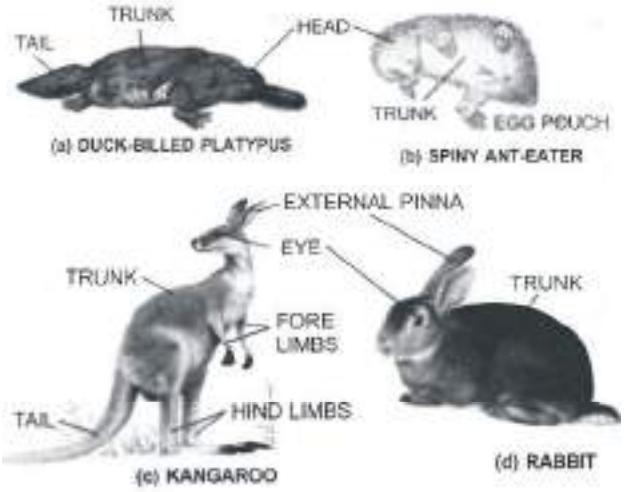
- **e.g. Spiny ant eater, Duck – billed platypus**

(ii) Marsupial mammals (pouched mammals):

- Pouched or marsupial mammals (Latin marsupium = pouch) They are viviparous.
- The young ones, when born, are cared in pouch called marsupium present on the mother's abdomen.
- In the pouch, they feed on the mother milk e.g. *Kangaroo* (Macropus), Kola bear.

(iii) Placental mammals (true mammals) : These mammals with true placenta.

- The embryo is retained in the uterus.
- These are the very successful group of land animals, occurring in diverse climatic conditions. e.g. Mole, bat, lion, tiger, camel, giraffe, whale, dolphin, monkey, humans etc.



A COMPARATIVE SUMMARY OF THE VERTEBRATES						
S.No.	**Character**	**Pisces**	**Amphibia**	**Reptilia**	**Aves**	**Mammalia**
1.	Habitat	Aquatic	Terrestrial & aquatic	Terrestrial	Arboreal	Terrestrial, aquatic & arboreal.
2.	Body Temperature	Cold-blooded	Cold-blooded	Cold-blooded	Warm-blooded	Warm- blooded
3.	Exoskeleton	Slimy scales	Absent	Dry & Scaly	Feathers, claws	Hairs, nails etc.
4.	Respiratory organ	Gills	Gills, lungs & skin	Lungs	Lungs	Lungs
5.	Locomotory organs	Fins	Limbs	Limbs	Wings and legs	Limbs
6.	Heart	2-chambered	3-chambered	Incompletely four chambered	4-chambered	4-chambered
7.	Propagation	Oviparous	Oviparous	Oviparous	Oviparous	Viviparous
8.	Fertilization	External	External	Internal	Internal	Intra-uterine

EXERCISE-1

1. Which of the following are first true terrestrial animals :
(A) Amphibia & reptilia (B) Reptilia
(C) Aves (D) Mammals

2. Skin is devoid of glands in :
(A) Amphibians (B) Reptiles
(C) Both A & B (D) Mammals

3. Which of the following reptile can change it's colour of body :
(A) Snake (B) Draco
(C) Chameleon (D) Phython

4. Which of the following is a poisonous snake :
(A) Viper (B) Seasnake
(C) Krait (D) All of the above

5. Birds are :
(A) Endothermal (B) Warm blooded
(C) Both A & B (D) Ectothermal

6. Which of the following is exclusively mammalian character :
(A) Four chambered heart
(B) Diaphragm
(C) Presence of external ear
(D) Both B & C are correct

7. In the flying birds, the quill feathers are useful for :
(A) Giving shape to the bird
(B) Giving external heat
(C) Flight in air
(D) Preventing loss of heat from the body

8. Which of the following class is without epidermal scale ?
(A) Fish (B) Aves
(C) Mammals (D) Amphibian

9. Whale is kept in class :
(A) Pisces (B) Mammalia
(C) Aves (D) Amphibian

10. The heart is completely divided into 4 chambers in :
(A) Reptiles (B) Mammals
(C) Aves (D) Both (B) and (C)

Environment

11. Classification reflecting the evolutionary interrelationships of organisms is called
(A) phylogenetic classification
(B) artificial classification
(C) natural classification
(D) numerical classification

12. Principles and rules of classification are studied under
(A) Systematics
(B) Natural classification
(C) Nomenclature
(D) Taxonomy.

13. Two kingdom classification was given by
(A) Linnaeus (B) Haeckel
(C) Copeland (D) Whittaker

14. Three kingdom classification was proposed by
(A) Linnaeus (B) Haeckel
(C) Whittaker (D) Lamarck

15. Five kingdom classification was proposed by
(A) Linnaeus (B) Whittaker
(C) John Ray (D) Lamarck

16. Thallophyta includes
(A) fungi and bacteria
(B) algae, fungi, animals and lichens
(C) algae, fungi and lichens
(D) algae and fungi

17. Flowering plants are included under
(A) cryptogams (B) phanerogams
(C) bryophytes (D) pteridophytes

18. Which of the following has an embryo but lacks vascular tissue ?
(A) Bryophyta (B) Pteridophyta
(C) Gymnosperms (D) Angiosperms

19. Algae differ from bryophytes in
(A) Aquatic habitat
(B) Thalloid plant body
(C) Pyrenoids
(D) Unicelled sex organs

20. The most primitive vascular plants are –
(A) bryophytes (B) pteridophytes
(C) gymnosperms (D) angiosperms

21. A branch of biology which deals with the identification, nomenclature and classification of organisms is called
(A) Morphology (B) Ecology
(C) Taxonomy (D) Phytogeography

22. Who is known as father of taxonomy ?
(A) Mendel (B) Linnaeus
(C) Darwin (D) Crick

23. Binomial nomenclature was introduced by
(A) John Ray
(B) A.P. deCandolle
(C) A.L.de Jussen
(D)Carolus Linnaeus

24. The basic unit of classification is
(A) variety (B) species
(C) genus (D) family

25. A group of freely interbreeding organisms constitutes a
(A) species (B) genera
(C) family (D) class

26. According to binomial nomenclature, the scientific name of an organism must consists of two words. These are
(A) species and tribe (B) genus & species
(C) order and family (D) genus and family

27. Which taxonomic term may be substituted for any rank in the classification ?
(A) Class (B) Geuns
(C) Species (D) Taxon

28. Cryptogams include
(A) thallophytes (B) bryophytes
(C) pteridophytes (D) all of the above

29. Algae are characterized by
(A) pyrenoids
(B) aquatic habitat
(C) unicellular sex organs
(D) all of the above

30. In Whittaker's classification, unicellular organisms are grouped under
(A) protista (B) porifera
(C) fungi (D) protozoa

31. The most important character of chordata is :
(A) Dorsal hollow nervous system
(B) Vertebral column
(C) Kidneys
(D) None of the above

32. Herdmania is member of :
(A) Hemichordata (B) Urochordata
(C) Cephalochordata (D) Vertebrata

33. Which one of following belongs to hemichordata :
(A) Doliolum (B) Pyrosoma
(C) Balanoglossus (D) All of the above

34. All chordates possess :
(A) Exoskeleton
(B) Limbs
(C) Skull
(D) Axial skeletal and rod of notochord

35. Which is an exclusive chordate character :
(A) True coelom
(B) Pharyngeal gill slits
(C) Bilateral symmetry
(D) Triploblastic

36. Which of the following is not the basic feature of chordata
(A) Pharyngeal gills slits
(B) Presence of contractile vacuole
(C) Post anal tail
(D) Dorsal nerve cord

37. Mesoglea is characteristic of
(A) platyhelminthes (B) aschelminthes
(C) cnidaria (D) mollusca

38. Organ system grade of body organization is found in : –
(A) Sponges (B) Protozoa
(C) Arthropodes (D) Platyhelminthes

39. Polymorphism is exhibited by
(A) *Hydra* (B) *Physalia*
(C) *Octopus* (D) *Crab*

40. Comb jellies belong to
(A) Scyphozoa (B) Hydrozoa
(C) Ctenophora (D) Both A and B

41. Platyhelminthes are called
(A) round worms (B) flat worms
(C) blind worms (D) none of the above

42. In Platyhelminthes, the excretory organs are
(A) nephridia
(B) malpighian tubules
(C) flame cells (solenocytes)
(D) green glands

43. Platyhelminthes are
(A) coelomates
(B) pseudocoelomates
(C) haemocoelomates
(D) acoelomates

44. The common name for Ascaris is
(A) shipworm (B) pinworm
(C) tapeworm (D) round worm

45. Metamerism is characteristic feature of
(A) Chordata (B) Annelida
(C) Mollusca (D) Nematoda

46. The excretory organs of Annelida are
(A) nephridia (B) statocysts
(C) archeocytes (D) none of the above

47. Which one is mismatched ?
(A) Flagella .....Euglena
(B) Pseudopodia .....Amoeba
(C) Cilia .....Paramecium
(D) Flagella ..... Plasmodium

48. Contractile vacuole is present in
(A) Amoeba (B) Euglena
(C) Paramecium (D) All of the above

49. Choanocytes are unique to
(A) Protozoa (B) Porifera
(C) Mollusca (D) Echinodermata

50. Cnidaria is characterised by
(A) nematoblasts (B) coelenteron
(C) tissue level of organisation (D) all of the above

51. Which of the following coelenterate is known as "Portuguese man of war"
(A) Hydra (B) Aurelia
(C) Physalia (D) Metridium

EXERCISE-2

1. The correct order of evolutionary advancement among the plants is
(IJSO/Stage-2/2010)
(A) spirogyra → diatom hornwort → fern
(B) blue green alga → liverwort → fern → seed bearing plant
(C) liverwort → cyanobacterium → moss → gymnosperm
(D) red alga → fern → moss → liverwort

2. Which one of the following is NOT poisonous ?
(IJSO/Stage-2/2010)
(A) spider (B) platypus
(C) millipede (D) centipede

3. The animal in which coelomic fluid has a significant role in locomotion is
(IJSO/Stage-2/2010)
(A) earthworm (B) leech
(C) crab (D) sea cucumber

4. An animal with chitinous exoskeleton, haemocoel and gills belongs to
(IJSO/Stage-2/2010)
(A) ascheminthes (B) Arthropoda
(C) echinodermata (D) urochordate

5. Cycas is classified as gymnosperm because of.
(IJSO/Stage-2/2010)
(i) presence of naked seeds.
(ii) lack of vessels in the xylem.
(iii) presence of sieve tubes.
(iv) fruit formation.
The correct reason is
(A) (i) and (iv) (B) (i) and (iii)
(C)(i) and (ii) (D) (ii) and (iii)

6. The set of annelid characters that are shared by leeches is (i) setae for locomotion, (ii) metameric segmentation, (iii) indeterminate number of segments, (iv) presence of clitellum, (v) hermaphroditism
(IJSO/Stage-2/2011)
(A) (i), (iii), (iv) and (v) (B) (ii) and (v)
(C) (i), (iii) and (v) (D) (ii), (iv) and (v)

7. With reference to human beings, the correct order of taxonomical classification is
(IJSO/Stage-2/2011)
(A) chordata, primata, mammalia, hominidae.
(B) chordata, mammalia, primata, hominidae.
(C) chordata, primata, hominidae, mammalia.
(D) chordata, mammalia, hominidae, primata

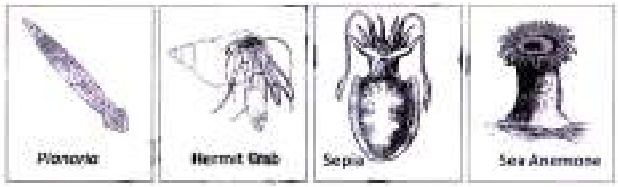
8. Wuchereria is an example of :
(IJSO/Stage-2/2013)
(A) Arthropods (B) Annelida
(C) Arthropoda (D) Nematoda

9. Which one of he following is said to produce seeds exposed and they are called naked seed plant
(IJSO/Stage-2/2013)
(A) Deodar & Pinus
(B) Marsilea & Nostoc
(C) Maize & Garden Pea Plant
(D) Spirogyra & Funaria

10. The pteridophytic that is considered to have led to the evolution of gymnosperms is :
(IJSO/Stage-2/2014)
(A) homospory
(B) furcate venation
(C) heterospory
(D) sporophylls distinct from vegetative leaves.

11. Which of these is a mollusc ?
(IJSO/Stage-2/2016)
(A) Lobster (B) Scorpion
(C) Crab (D) Octopus

12. A group of biology students on excursion to Goa beaches collected the following animal samples.



While they were putting the animals in the jar with sea water, they noticed that one of the animal's 1/3rd body part was missing. The injured animal (with only 2/3rd of its body) was brought to the lab and was allowed to grow in the laboratory in appropriate condition. To their surprise the lost body part of the animal had regenerated. Which of the above animal would have been collected ?
(A) Planaria (B) Hermit crab
(C) Sepia (D) Sea anemone

13. Fishes such as Salmon are called as anadromous fish. They are born in fresh water. However, then they migrate to the sea and spend most of their life in the sea. They return to fresh water to spawn. On the contrary, catadromous fishes such as Eels do the opposite. They live in fresh water for their entire life. They migrate to the sea to spawn.

Which one of the following strategies will Salmon adopt in order to manage the problem of osmoregulation when it is in the sea ?
(A) Salmon drinks profusely in sea and it drinks feebly in fresh water.
(B) It produces large volume of dilute urine in sea water
(C) In sea water, gills filter NaCl which is absorbed selectively into its body.
(D) The mode of excretion of Salmon is changed from ammonia to uric acid.

14. In a hypothetical experiment the outer tissues of the woody part of the stem of a dicotyledonous plant is removed in the form of a ring, leaving only the xylem and pith intact. Which one of the statements is most likely to be correct?

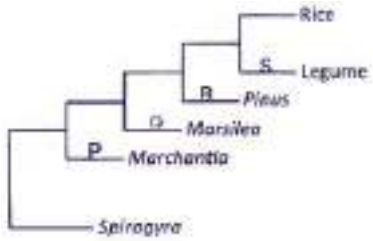
(A) Water transport from the root to leaves will be obstructed but food transport from leaves to stem will be unhindered.

(B) Water transport from root to leaves will not be obstructed but food transport from leaves to stem will be hindered.

(C) Water transport from root to leaves will not be obstructed but food transport down the leaves stops at the ring.

(D) Water transport from leaves to root is obstructed but food transport down from the leaves stops at the ring.

15. The chart represents the relationship between some platns. In the scheme (P) to (S) represent characters which distinguish one exmaple from the rest



(i) to (v) below represent some characters related to (P)-(S), but not necessarily in that order :

i. Without vascular tissue
ii. Seeds have two cotyledons
iii. Seeds have one cotyledon
iv. Do not produce seeds
v. Naked seeds

Which one of the following is a correct match between (P to S) with (i to v).

(A) (P)-(i);(Q)-(iv); (R)-(v); (S)-(ii)
(B) (P)-(iv);(Q)-(i); (R)-(v); (S)-(ii)
(C) (P)-(i);(Q)-(v); (R)-(iv); (S)-(iii)
(D) (P)-(i);(Q)-(iv); (R)-(v); (S)-(iii)

WHY DO WE FALL ILL

PART-1

HUMAN HEALTH & DISEASE

Every living organism, may be plant or animal, requires food (nutrition) for its survival, maintainence, growth and development.Nutrition is required in specific amounts. Proper dietary habits lead to sound health and proper mental development.

- A person is said to be healthy if one :

- has no symptoms of disease and anxiety.
- has no physical deformity.
- has no mental problems and social tensions.
- has no psychological tensions.
- has all the body organs functioning properly.
- has purposeful life.
- has sufficient balanced diet.

The most widely accepted definition is (1947) World Health Organisation's description that states **"Health is a state of physical, mental and social well being and not merely the absence of disease or infirmity".**

(a) Significance of Health :

- Good health is "Healthy body with a healthy mind and healthy attitude".
- Good health increases our efficiency for doing work. The increased efficiency of a man due to good health contributes to his own progress, the progress of community and the progress of nation as a whole.
- Good health also makes a man happy and cheerful. It allows a person to have the initiative for betterment.
- Good health is a condition for our purposeful existence in this world.

(b) Community & Personal Health :

- For personal health and community health, one should keep the environment clean.
- Good economic condition, social equality and harmony, a good civic sense all will lead to a better community health.
- So, community health can be defined as "All the personal health along with the environmental services for the improvement of health of community."
- It comprises of all efforts for maintaining, protecting & improving the health of the people.
- WHO is doing remarkable work in community health.

(c) Difference Between Personal Health and Community Health :

S.NO.	PERSONAL HEALTH	COMMUNITY HEALTH
1.	The state of physical, mental & social well being of an individual is called personal health.	It is maintenance, protection & improvement of health of the whole community.
2.	Only the individual maintains his/her health.	The whole community remains healthy.
3.	An individual can maintain his health by - **(a)** Eating balanced diet. **(b)** Observing personal and domestic hygiene. **(c)** Consuming clean food, clean water and clean air. **(d)** Proper exercise, relaxation and good habits.	Community health can be achieved by - **(a)** Provision for treated and safe drinking water. **(b)** Proper disposal of sewage and wastes. **(c)** Providing medical facilities. **(d)** Control of communicable diseases. **(e)** Health education.

- The various activities involved in maintaining community health are as follows :

(i) Maintaining proper sanitation of the environment by -

- Providing clean and safe drinking water.
- Providing good sewage and rain water disposal systems (through underground pipes).
- Proper garbage disposal.
- Strict enforcement of antipollution laws, management of different types of environmental pollution by Central and State Control Boards.

(ii) Providing proper facilities for prevention and control of diseases such as :

- Preventive vaccinations against a number of diseases like Tuberculosis, Diphtheria, Whooping cough, Tetanus, Measles, Hepatitis, Polio, Mumps, etc.
- Spraying mosquito and germ killing chemicals (insecticides, pesticides etc.) at regular intervals.

(iii) Providing health education : To educate people about the mode of transmission of diseases and mechanism to control communicable diseases, importance of balanced diet, effects of bad habits like alcoholism, addiction etc.

(iv) **Establishment of health care services :** Primary Health Centres, District Hospitals, Community Health Centres, Medical Colleges, All India Institutes, Regional Hospitals, etc.

(v) **Prevention of food adulteration (Degradation in the food quality).**

e.g. **(a)** Addition of artificial colours in pulses.
(b) Addition of Sudan (Red colour) in Chilly powder.

(vi) **Providing maternity and child care centres :** So that mortality rate among children is reduced to a great extent. Provision of family planning advice and medical care to school going children.

WHAT IS A DISEASE ?

- A disease can also be defined as a disorder or deviation in the physical, physiological or any other function of the body or mind, caused either due to nutritional deficiency, genetic disorder, pathogenic invasion or any other reason.

A great physician, Hippocrates (460 – 359 B.C.), was the first to look for scientific explanation for disease; He is remembered today as "Father of Medicine".

(a) Distinction Between Healthy and Disease Free :

- The term disease is used when we find a specific and particular cause for discomfort.
- We may not be knowing the main cause of the discomfort, but still we can use the term disease.
- A person may not be suffering from any disease but may be in poor health.
- This is particularly true for social and mental health, where we can be in poor health without there being a cause in the form of an actual disease.
- This is the reason why, when we think about health, we think about societies and communities.
- On the other hand, when we think about disease, we think about individual sufferers.

DIFFERENCES BETWEEN HEALTHY AND DISEASE FREE STATE		
S.NO.	**HEALTHY**	**DISEASE FREE**
1.	It is the state of physical, mental and social well being	It is the state of absence of any body discomfort.
2.	It depends upon the person and one's environment including society.	It depends upon the person alone.
3.	A person can be unhealthy even in the absence of disease.	A person would be disease free in the absence of discomfort.

- **Terms related to dieases :**
- **Infection :** The entry of the pathogen in the body is called infection.
- **Incubation period :**The interval between infection and appearance of first symptom of the disease is called incubation period.
- **Antibiotic :** Antibiotics are chemicals that kill or stop the growth of certain kinds of microbes.
- **Pathogen :** Disease causing microoragnism is called pathogen
- **Vaccine :** A vaccine is a suspension of disease - producing micro-organisms which is modified by killing or weakening (attenuated) so that the suspension will not cause disease.
- **Antibodies :** These are special chemicals found in the blood which act against the germs or their secretions.
- **Antigen :** Antigens are proteins or other harmful chemicals that are present on surface of invaders.

(b) Manifestation of Diseases :

- Manifestation of disease give rise to various sign and symptoms -
- Symptoms are evidences of the patient's feeling of being wrong. For example, headache, loose motions or a wound with pus are symptoms which may indicate the occurrence of discomfort. Headache may be due to examination stress, meningitis.
- The sign give an indication of the presence of a particular disease. The physicians will also get laboratory tests done to identify the disease further.

(c) Acute and Chronic Diseases :

The manifestation of diseases are different depending upon a number of factors.
On the basis of duration a serious disease can be acute or chronic.

- **Acute disease :** Acute disease is the one which has a short duration by relatively severe course.
- Most people with acute illness can expect to return to normal health.
- A case of cough and common cold is an example of an acute illness which lasts only for a few days.
- Afterwards the patient becomes well without any bad effect, loss of weight, feeling of tiredness or short of breath, but in some cases acute disease like acute liver abscess can cause death.
- **Chronic disease :** Chronic disease is the one which is long lasting is usually slow to develop, often having a major effect on health, reducing the person's ability to do work efficiently, learning in school or doing work.
- The patient will also lose weight and feel tired all the time. Examples of chronic diseases include tuberculosis, diabetes, asthma, hypertension, kidney disease, depression, etc.

DIFFERENCES BETWEEN ACUTE & CHRONIC DISEASES			
S.no.	**Characters**	**Acute diseases**	**Chronic diseases**
1.	Duration	It is of shorter duration.	It is of longer duration
2.	Persons	Every person suffers from an acute disease at one time or the other.	Only some persons suffer from chronic diseases.
3.	Body Damage	Being of short duration, it does not damage any organ.	It does damage the affected organ due to prolonged duration.
4.	Recovery	The recovery is generally complete after the treatment.	The recovery is seldom complete even after treatment.
5.	Effect	There is neither loss of weight nor feeling of weakness.	There is often a loss of weight accompained by feeling of tiredness.
6.	Loss	Interruption of work and loss of efficiency are of short duration. Example :- Diarrhoea, Typhoid.	Interruption of work and loss of efficiency are prolonged. Example : - Tuberculosis, Diabetes.

(d) Causes of Diseases :

The various causes of diseases are

(i) Pathogens : They are disease causing organisms like bacteria, viruses, fungi, protozoans, worms, etc.

- The pathogens are transferred to human beings through air, contaminated food, water, soil and animals.
- Pathogens are primary cause of infectious diseases.

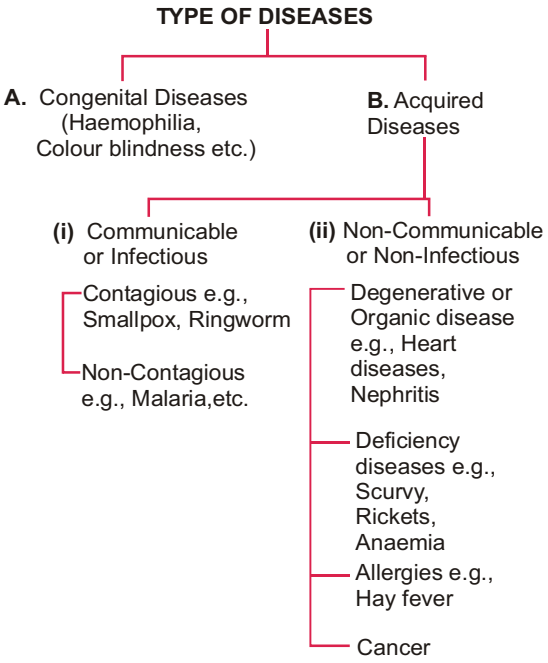
(ii) Lack of nutritious diet : It is a second level cause of disease as absence of nutritious diet makes a person unhealthy.

- Unhealthy persons are susceptible to various diseases in comparison to healthier persons. Another contributory cause can be poor immunity which increases the proneness of individual to a particular disease.

(iii) Lack of public services : Government should provide clean drinking water, good sewage disposal, proper garbage disposal, etc. If the public services are poor, there are more chances of contamination of food and water.

- Poor people, due to poverty, live in unclean surroundings where even basic amenities are lacking. These people may suffer more from diseases. So, as it is evident from the above discussion, there are three level causes of diseases.
- These are infection with pathogen (1st level), lack of nutritious diet and poor immunity (2nd level) and lack of public services (3rd level).

TYPES OF DISEASES



(a) Congenital Diseases :

- Congenital diseases are present right from the birth. They are caused either due to genetic disorders or environmental factors during development or due to combination of these factors.
- These diseases pass on from generation to generation e.g. haemophilia, colour blindness, sickle cell anaemia, Down's syndrome, albinism etc.

(b) Acquired Diseases :

- These disease are acquired by an organism after birth and are not inheritable i.e., do not pass on from one generation to another.

- **These are further classified into two categories :**

(i) Communicable or Infectious diseases : These diseases are caused by pathogens/infectious agents such as bacteria, viruses, fungi, protozoans, worms, etc. e.g. Tuberculosis, Malaria, Diarrhoea etc.

S.NO.	NAME OF DISEASE	CAUSATIVE ORGANISM	MODE OF TRANSMISSION	SYMPTOMS
1.	Malaria	Plasmodium species	By the bite of female mosquito	Chilliness, severe headache, rising temperature , profuse sweating.
2.	Polio myelitis or crippling disease	Polio virus (smallest virus)	Spread through faeces, contaminated food and water by flies	High fever, headache, backache, rashes appear on the skin that turn into postules, on drying leave pock marks.
3.	Hepatitis	Hepatitis virus A, B,C , D, E & G	**Hepatitis - A** Oral faecal route through contaminated food and water.	High temperature headache, fatigue, loss of appetite, nausea, vomiting, dark-yellow urine.
			Hepatitis - B Blood transfusion and through wounds, needles, razor etc.	Malignant cancer of liver cells, hepatocellular carcinoma.
4.	Rabies (Hydrophobia)	Rabies virus	Bite of rabied dog through the saliva	Headache, high fever saliva, runs from mouth fear from water (hydrophobia)
5.	AIDS	HIV	Intimate sexual contact blood transfusion, contaminated needles and syringes, organ transplantations from mothers.	Flu like illness, weight loss, fever, loss of appetite diarrhoea unexplained bleeding, loss of memory.
6.	Tuberculosis	Mycobacterium tuberculosis	Contact with nasal discharge , sputum of patient.	Infection of lungs followed by cough, sputum containing blood , pain in chest, loss of weight
7.	Typhoid	Salmonella typhi	Contaminated food and water.	Continued fever, slow pulse, dry coated tongue, soap-like stool.
8.	Diarrhoea	E. coil, Shigella sps., campylobacter Salmonella sps.	Contaminated food and water, oral faecal route.	Frequent loose motions, vomitting dehydration.

(ii) Non-Communicable or Non-Infectious diseases : These diseases can't spread through infected persons to healthy persons.

Non-infectious diseases
Diabetes
Cancer
Asthma
Arthritis
Marasmus
Kwashiorkor
Scurvy
Obesity

DIFFERENCES BETWEEN COMMUNICABLE AND NON-COMMUNICABLE DISEASES		
S.no.	**Communicable diseases**	**Non-communicable diseases**
1.	These spread from an infected person to a healthy person.	These do not spread or transmitted from infected to a healthy person.
2.	They are caused by pathogens (e.g., bacteria, viruses, protozoans etc.)	They are caused due to deficiency of nutrients, malfunctioning of some organs of the body, allergy, abnormal growth of tissues etc.
3.	Example : Malaria, smallpox, cholera, tuberculosis etc.	Examples : Cancer, heart diseases, epilepsy, marasmus, etc.

INFECTIOUS DISEASES

(a) Infectious Agents :

The various infectious agents are – bacteria, viruses, protozoans, helminthes (worms) and fungi.

(i) Bacteria : They are unicellular, prokaryotic, microscopic organisms.

- They reproduce very quickly. Some common diseases caused by bacteria are typhoid, cholera, tuberculosis, anthrax, diphtheria, tetanus, etc.

(ii) Viruses : They are submicroscopic organisms. They cannot reproduce by themselves because they do not have their own metabolic machinery.

- They utilise the metabolic machinery of the host cell and multiply.
- The various diseases caused by viruses are Common cold, Influenza, Dengue fever, AIDS, Measles, Mumps, Polio, Small pox, Chicken pox, etc.

(iii) Protozoans : They are microscopic unicellular, eukaryotic organisms. The various diseases caused by protozoa are malaria (caused by Plasmodium), kala-azar (caused by Leishmania), etc.

(iv) Helminthes : Helminthes are multicellular worms which are mostly present in intestine.

- They cause taeniasis (caused by tapeworm), ascariasis (caused by round worm), elephantiasis (caused by filaria worm, hence also known as filariasis), etc.

(v) Fungi : They are also multicellular, eukaryotic, heterotrophic organisms. They cause ring worm, athlete's foot and other skin infections.

- **Various Pathogens & Diseases caused by them**

S.No.	Type of Pathogens	Common diseases caused by them
1.	Viruses	Common cold, Influenza, Measles, Mumps, Polio, Rabies, Small pox, Chicken pox, Yellow fever, AIDS etc.
2.	Bacteria	Cholera, Typhoid, Tuberculosis, Tetanus, Diphtheria, Pneumonia,
3.	Rickets	Typhus fever, Tick fever etc.
4.	Protozoa	Malaria, Amoebic dysentery, Sleeping sickness etc.
5.	Fungi	Ringworm, Athlete's foot etc.
6.	Worms	Filariasis, Ascariasis, Cysticercosis, Pinworm
7.	Mites	Scabies

(b) Reason For Categorization of Infectious Agents :

It is important to categorise infectious agents because each group of organisms have some common traits and many similar biochemical pathways. As a result, a drug that blocks one of the biochemical pathways peculiar to one group would be effective against many members.

(c) Means of Spread/ Epidemiology :

Infectious diseases are called communicable diseases because they can spread from affected persons to a healthy person.

- The means of communication or spread are different for different pathogens.

1. **Direct transmission :** In these methods pathogens are transmitted from an infected person to a healthy person directly without any intermediate agents. These modes include

(i) Direct contact with an infected person e.g., chicken-pox, smallpox, measles etc.

(ii) **Droplet infection :** Pathogens spread by way of sneezing, coughing, spitting and talking as in common cold, influenza, diphtheria, tuberculosis, pneumonia etc.

(iii) Contact with soil : As in tetanus.

(iv) Animal bites : As in rabies.

(v) Transplacental transmission : from mother to foetus e.g., German measles , syphilis etc.

2. **Indirect Transmission :** The pathogens of certain diseases enter the human body through some intermediate agents. These intermediate agents include:

(i) **Carriers of Vectors :** e.g., Housefly carries the pathogens of cholera, typhoid, dysentery, female Anopheles is the vector of malaria while human body louse spreads typhus.

(ii) **Vehicle - borne method :** Food, water, ice, blood etc. act as vehicles for carrying pathogens in human body e.g., cholera, typhoid, AIDS etc.

(iii) **Air-borne method :** As in epidemic typhus pathogens reach the human body through air and dust.

(iv) **Fomite-borne method :** Contaminated articles such as garments, handkerchief, towels, utensils, toys, door handles, taps, soaps, surgical instruments, etc. can also transfer pathogens to a human body.

(v) **Unclean hands :** They may transfer pathogens of large number of diseases to our body.

(d) Pathogenicity :

Pathogens can harm their hosts in a number of ways such as by (i) destruction of body tissues and (ii) release of toxins or poisons which may be endotoxins.The entry of the pathogen in the body is called infection,. After entering into the body, the pathogens multiply till they produce enough toxins to make the symptoms of the disease appear.The interval between infection and appearance of first symptoms of the disease is called **incubation period.**

DISEASE EFFECTS

(a) Organ or Tissue Specific Effects :

Microorganisms enters the body through different points like nose, mouth, sex organs etc. which decides the organ or tissue that micro organism invades.

- At the same time the signs and symptoms of an infectious diseases also depends upon the tissue being invaded. e.g. If bacteria causing tuberculosis enters through nose, it invades respiratory passage & lungs & its symptoms are cough and breathlessness, but in some cases they may infect other organs also.

(b) Common Effects :

This category includes effects like inflammation in which swelling, reddening and pain in infected area and increase in body temperature occurs.

- These effects arise due to the active involvement of immune system to provide defence to body by producing some specific chemicals from WBC's, against that microbes and this is not confined to a particular organ or tissue but seen in whole body.

(c) Severity of Effects :

It directly depends upon the no. of microorganisms. If microbes are smaller in number their effects are minor and can be overcome by our immune system in a lesser time but if the number of micro organisms inside the body is very high the effects are more severe and long lasting.

TREATMENT OF INFECTIOUS DISEASES

The basic concept behind the treatment process is to target the biochemical pathways occurring inside an organism. For this certain drugs like antibiotics are prepared to alter or stop the biochemical reaction of the microbes at some stage to stop them to produce infections, toxins or to kill them or to check their further growth and multiplication.

- There are two ways in which these diseases are treated they are :

(i) **Reducing the symptoms :** By this, infection is not cured but some of the symptoms like fever, pain, aches, inflammation can be reduced to make the patient full comfortable. This is done by medicines like pain killers etc.

(ii) **Killing infectious agents :** This can be done by targeting the biochemical pathways of infectious agents using specific drugs.

(a) Drugs :

Usually medicines are used to kill the microbes. It aims at directing / blocking the biochemical pathways used by these pathogens.

(i) **Antibiotics :** Antibiotics are chemicals that kill or stop the growth of certain kinds of microbes. They help our body to fight against diseases.

The development of antibiotics began with the discovery of penicillin by Sir Alexander Flemming in 1928. Flemming noticed that an agar plate inoculated with bacterium *Staphylococcus aureus* had become contaminated with a mould. He further noticed the presence of a clear zone in the agar plate in which breakdown of the bacterial cells had occurred. Detailed studies led to the isolation of an inhibitory substance from the mould. As the mould was identified as *Penicillium*, Flemming called the antibiotic penicillin. Soon other antibiotics were isolated. Some well known antibiotics are streptomycin, gramicidin and tetracycline. The antibiotics have been obtained from either bacteria or fungi.

- Protozoan infections are treated by different types of drugs.
- Antifungal drugs are useful against all types of fungi.
- Vermicides are used for overcoming worm infection.

PREVENTION OF INFECTIOUS DISEASES /PROPHYLAXIS

Prevention of spread of communicable diseases is called as prophylaxis. Preventive measures are the precautionary steps to check the transmission of communicable diseases.

- They include :

(i) Health education
(ii) Isolation of patients from healthy persons
(iii) Proper sanitation
(iv) Eradication of vectors and carriers
(v) Sterilization of articles used by the patients
(vi) Immunization (vaccination)
(vii) Provision of safe water supply
(viii) Proper disposal of excreta
(ix) Personal hygiene
(x) Community hygiene

(a) Specific Methods :

- These methods are disease specific. Specific prevention is provided by the immune system when it produce some specific molecules called antibodies to fight against specific invading microbes or their products.
- When we suffer from a mild form of disease, our immune system forms antibodies against the invading antigens. At the second infection of that disease, the immune system responds faster to destroy the antigens as there are antibodies that already recognize them.As a result, we don't suffer from the severe form of the disease.For example, if we have had mild chickenpox once, we will not suffer from its severe form later. This forms the basis of immunization.

(b) Immunization :

It is the process of stimulating the body to produce antibodies by artifical means. It can be done with the help of vaccines.

- **Vaccines :** It is a preparation of weakened - infectious agents or their products that can be injected or given orally to prevent specific diseases.This doesn't actually cause the disease but this would prevent any subsequent exposure to the infecting microbes from turning into actual disease.

  Now a day vaccines are available against tetanus diphtheria, whooping cough, polio, chickenpox, measles, mumps, typhoid, hepatitis and many other diseases, Many of these vaccines are given to children under the public health programme of childhood immunization.

HISTORY

Two centuries ago, an English physician named Edward Jenner, realised that milkmaids who had cowpox did not catch smallpox even during epidemics Cowpox is a very mild disease. Jenner tried deliberately giving cowpox to people and found that they were now resistant to smallpox .

- **Some common vaccines :**

- DPT vaccine, for protection against diphtheria, whooping cough and tetanus
- BCG vaccine, for protection against tuberculosis
- Polio (OPV) vaccine
- Typhoid vaccine
- Measles vaccine
- TT vaccine, against tetanus

NON INFECTIOUS / NON COMMUNICABLE DISEASES

These diseases which remain confined to a person. They are neither present at birth nor spread from one person to another. The diseases are caused due to some specific factors. They may be caused due to improper functioning of an organ (short sighted, hypertension, arthritis), hormonal imbalance (diabetes, dwarfism), allergy, cancer, inadequate diet (anaemia, goitre), etc.

- **These diseases are of following types :**

- **Deficiency diseases :** Caused due to lack of some nutrient materials in our body like vitamins, minerals, protein etc.
- **Degenerative diseases :** Caused due to ageing or malfunctioning of any organ or part of body.
- **Allergies :** Caused due to hypersensitivity of an organism to certain type of material like pollen grains, dust etc.
- **Cancer / Tumour :** This occurs due to uncontrolled growth of cells. Cancer can be cured in early stages.
- **Mental disorders**
- **Occupational diseases : e.g.** Lung cancer in asbestos factory workers.
- **Addiction :** Caused due to excessive intake of drugs tobacco, alcohol (fatty liver) etc.

- **Some importants points :**

- **Inflammation :** An active immune system recruits many cells towards affected tissue to kill off the disease causing microbes . This recruitment process is called inflammation .As a part of this process, there are local effects such swelling and pain, and general effects such as fever.
- **Peptic ulcer :** It is caused by bacteria Helicobacter pylori. It was discovered by two Australians Marshalland Warren and received Nobel prize for physiology & medicine in 2005.
- **Pulse polio programme :** The aim of this programme it to eradicate polio from our country. It was first held in our country in December, 1995. Polio vaccine called Oral Polio Vaccine (OPV) is given to children orally (through the mouth) , as per the National Immunisation Schedule (NIS).

EXERCISE

OBJECTIVE DPP - 17.1

1. AIDS day is on
(A) May 1 (B) December 20
(C) June 1 (D) December 1

2. Antibodies are
(A) lipids (B) genes
(C) proteins (D) carbohydrates

3. Which of the following statements is correct ?
(A) Degenerative diseases are non communicable
(B) Allergy is caused by droplet infection
(C) Cholera is a viral disease
(D) AIDS can be prevented by vaccination.

4. Remain healthy means .
(A) free of infection by pathogen
(B) tension free mental status
(C) living in a pollution free environment
(D) All of the above

5. Diseases occurring due to infected articles of a patient are called .
(A) Air borne (B) Water borne
(C) Fomite borne (D) Food borne

6. World health day is on -
(A) 1st May (B) 7th April
(C) 30th June (D) 5th December

7. Typhoid is caused by -
(A) Shigella (B) Giardia
(C) Escherichia (D) Salmonella

8. Pulse polio programme is organised in our country for
(A) curing polio (B) eradicating polio
(C) spreading polio (D) none of the above

9. Community health aims at
(A) better health and family planning
(B) better hygiene and clean environment
(C) removing communicable diseases
(D) all of the above

10. Head quarter of World Health Organisation (WHO) is located at
(A) New York (B) Geneva
(C) London (D) Paris

11. Droplet infection is a mode of -
(A) direct transmission
(B) indirect transmission
(C) pathogen spread through mosquitoes
(D) fomite transmission

12. A person has developed interferon in his body. He seems to carry infection of -
(A) Tetanus (B) Malaria (C) Measles (D) Typhoid

13. Health is -
(A) complete physical well being
(B) mental well being
(C) social well being
(D) all of the above

14. Dislocation is a disease caused by -
(A) biological agent (B) social agent
(C) physical agent (D) chemical agent

15. A carrier is a human being that -
(A) functions as a reservoir of infection
(B) possesses pathogen but is not harmed
(C) contains antibodies sufficient enough to balance the antigen
(D) all of the above

16. Malaria is a -
(A) Infectious diseases
(B) Non-infectious diseases
(C) Communicable diseases
(D) None of these

17. Specific defence mechanism against disease comprises -
(A) physical barrier (B) lysozyme
(C) phagocytes (D) immune system

18. The antigen present in pathogen is -
(A) a specific protein involved in metabolism
(B) polysaccharide synthesized by it in the host
(C) a specific protein or polysaccharide present on its coat
(D) Both (A) and (B)

19. Pathogens are destroyed by -
(A) kidneys (B) liver
(C) adipose tissue (D) lymphatic tissues

20. A noninfectious unnatural and unusual reaction to a substance or condition is -
(A) immunity (B) allergy
(C) infection (D) toxin

21. AIDS is casued by
(A) Bacteria (B) Fungi
(C) HIV (D) Allergy

22. Which of these is not a chronic disease
(A) Tuberculosis (B) Asthma
(C) Common cold (D) None of these

EXERCISE-2

1. Bacteria cannot survive in a highly salted pickle because
(IJSO/Stage-2/2010)
(A) they become plasmolysed and consequently die.
(B) they do anaerobic respiration.
(C) water is not available to them.
(D) of all the reasons mentioned above.

2. BCG vaccine is used to prevent
(IJSO/Stage-2/2011)
(A) tuberculosis
(B) blood cancer, cholera and gonorrhoea.
(C) leprosy.
(D) goitre.

3. The colonial form of algae is
(IJSO/Stage-2/2011)
(A) Chlamydomonas (B) Chara
(C) Porphyra (D) Volvox

4. While playing football, Dimple fell down and was badly wounded on her left. The Doctor prescribed her antibiotics for a week which should have healed her of the wound in a week. However, Dimple's wound did not heal in a week.What among the following could have been the reason for inability of the wound to heal in the prescribed time frame given by the doctor ?
(IJSO/Stage-2/2013)
(A) Prescribed medicine's date was expired.
(B) Dimple wouldn't have taken the full course of the antibiotics.
(C) Both a & b could be the reason
(D) Doctor's inability to prescribe the correct medicine for the wound.

5. What is the major difference between Bacteria and Virus
(IJSO/Stage-2/2013)
(A) Viruses are precursors to bacteria
(B) Viruses lack proteins that are present in bacteria
(C) Viruses use host machinery to reproduce unlike bacteria
(D) Viruses have proteins whereas bacteria do not,

6. Most of the microbes employed is commercial fermentation for prducing antibodies are:
(IJSO/Stage-2/2014)
(A) yeast (B) thread bacteria
(C) eubacteria (D) ascomycete fungi

7. The algae belonging to which group can sustain normal growth at the greater depth of ocean ?
(IJSO/Stage-2/2014)
(A) Red algae (B) Blue-green algae
(C) Brown algae (D) Green algae

8. Which of the following is NOT produced by microbial activity ?
(IJSO/Stage-2/2015)
(A) Yoghurt (B) Bread
(C) Vinegar (D) Antiseptics

9. Gram positive bacteria will have one of the specific characters. Identify it.
(IJSO/Stage-2/2015)
(A) They have more peptidoglycon in their cell walls.
(B) They show red colour on gram staining.
(C) Flagella found all over the body.
(D) They will have mesosomes as the extension of cell membrane.

10. Among the following, which is not true about vaccines ?
(IJSO/Stage-2/2015)
(A) Vaccines contain dead microbial cells or their parts.
(B) Vaccines contain antibiotics to prevent diseases.
(C) Vaccine contain special proteins which evoke immune system against disease.
(D) Vaccines contain inactivated micro-organisms.

11. Which of the following option is not true about the viruses ?
(IJSO/Stage-2/2015)
(A) Viruses have either DNA or RNA as these genetic material.
(B) Viruses will not infect bacteria, fungi and algae.
(C) Viruses use host machinery to produce their own proteins.
(D) Viruses are useful in the preparation of vaccines.

12. Antibodies play an important role in defending the body against infections by which of the following mechanisms.
(IJSO/Stage-2/2016)
(A) They engulf the bacteria and make them harmless
(B) They bind to the surface of pathogens, so that they can be easily identified and removed by other cells of the immune system
(C) They enter the pathogen and prevent cell division
(D) They are highly reactive and chemically react with the DNA of the pathogen

13. Penicillin cannot be used to treat influenza because :
(IJSO/Stage-2/2016)
(A) It only helps to bring the temperature down, and dles not reduce the infection
(B) The penicillin is broken down by the organism
(C) Viruses do not have cell walls
(D) Reproduction of protozoans is not affected by penicillin

14. Vaccines prevent infections by pathogens by : (2016)
(A) Presenting the body's immune system with antigens in a controlled manner/.so that it is prepared to counter the pathogen producing it when it attempts to infect the body
(B) Affecting the reproductive cycle of the invading pathogen
(C) Binding to antigens on the surface of the pathogen and inactivating it
(D) Affecting the metabolic pathways of the pathogen

15. In liver transplantation, the first three months 'after' transplantation is when the patient requires the most care and post-surgery monitoring. Which of the following statement is most suitable up to three months for a patient who has undergone liver-transplantation recently ?
(A) She will require no drugs but only care and follow ups.
(B) She will be treated with immunosuppressive drugs only.
(C) She will be treated with antibiotics only.
(D) She will be treated with combination of immunosuppressive drugs and antibiotics

ANSWER KEY

1.CELL DIVISION

EXERCISE#1

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A.	C	C	A	B	C	B	C	B	B	D	D	D	D	D	D
Q.	16	17	18	19	20	21	22	23	24	25					
A.	B	A	A	D	A	B	C	A	B	B					

EXERCISE#2

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A.	C	A	A	C	B	C	D	C	B	C	D	B	C	D	D
Q.	16	17	18	19	20	21	22	23	24	25	27	28			
A.	D	C	C	B	C	B	A	A	B	A	C	D			

2.ADAPTATION

EXERCISE#1

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A.	D	C	A	B	B	A	C	C	C	C,D	C	C	C	A	A	C	D	B	A

EXERCISE#2

Q.	1	2	3	4	5	6	7	8	9	10	11	12
A.	A	B	D	D	A	A	B	D	B	D	D	C

3.PROTOPLASM

EXERCISE#1

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A.	A	C	C	A	A	D	D	B	A	A	A	D	B	B	A
Q.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
A.	B	C	D	B	B	A	D	D	A	C	A	B	A	D	

EXERCISE#2

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A.	A	B	D	A	C	A	B	C	C	B	C	A	A	D

4.NUTRITION

EXERCISE#1

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A.	A	B	C	A	C	A	B	B	B	C	B	A	D	A	B
Q.	16	17	18	19	20	21	22	23	24						
A.	A	A	B	A	A	C	C	A	D						

EXERCISE#2

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A.	C	C	A	B	D	D	C	B	C	A	C	C	D	A	A
Q.	16	17	18	19	20	21	22	23	24	25	26	27			
A.	B	D	C	A	A	C	A	D	B	B	C	A			

5.RESPIRATION

EXERCISE#1

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A.	A	A	A	C	B	C	B	D	A	C	B	D	A	B	B
Q.	16	17	18	19	20										
A.	B	B	D	C	C										

EXERCISE#2

Q.	1	2	3	4	5	6	7	8	9
A.	B	A	A	C	C	D	D	D	B

6.TRANSPORTATION

EXERCISE#1

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A.	A	D	A	D	D	C	C	D	B	A	A	D	D	D

EXERCISE#2

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A.	A	D	A	B	D	C	A	C	B	D	C	C	A	A	C	B
Q.	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	
A.	C	A	B	D	A	B	B	A	D	A	B	C	A	D	D	

34. (i) F T T, (i) Chloroplast,(ii) photosynthesis,(iii) decreases,(iv) endosmosis,(v) Higher,(vi) Lower, (vii) increases, (iii) c (iv)-a (v)-c (vi)-a

7.EXCRETION

EXERCISE#1

Q.	1	2	3	4	5	6	7	8	9	10	11	12
A.	A	C	C	A	B	A	C	A	C	C	A	C

EXERCISE#2

Q.	1	2	3	4	5
A.	A	C	A	C	C,D

8.CONTROL & CO-ORDINATION

EXERCISE#1

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A.	B	B	D	B	B	B	D	A	D	A	B	B	D	B	B	D	B	D	A	C

EXERCISE#2

Q.	1	2	3	4	5	6	7	8
A.	C	B	C	A	D	C	C	A

9.REPRODUCTION

EXERCISE#1

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A.	C	D	A	C	D	C	C	B	C	D	A	B	B	D	C	D

EXERCISE#2

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A.	C	C	D		C	C	A	C	A	C	B	C	B	A	D	C	B	B	C	D

21. **A.** (i) - c (ii) - a (iii) - a (iv) - b **21.** **B** (i) - c (ii) - F T T F F

10.HEREDITY AND EVOLUTION

EXERCISE#1

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A.	A	C	C	B	A	A	B	A	B	B	B	D	C	A	C	B	B	A	D	B	B	B

EXERCISE#2

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A.	**C**	**C**	**A**	**C**	**C**	**D**	**C**	**D**	**B**	**A**	**A**	**B**	**C**	**D**	**A**	**D**	**A**	**C**

19. (i) c (ii) b (iii) c (iv) a
(v) Red round eyes **:** b. yes c. 9 : 3 : 3 : 1

11.ECOLOGY

EXERCISE#1

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A.	C	A	A	A	B	C	B	B	B	C	D	B	B	A	A	A	D	B	C	A	A	B

EXERCISE#2

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	20	21	22	23	24	25
A.	B	D	B	A	A	B	B	D	C	A	A	A	C	A	B	A	D	A	C	C	A	C	A	A

12.DIVERSITY OF LIVING ORGANISMS

EXERCISE#1

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A.	B	B	C	D	C	D	C	D	B	D	A	D	A	B	B
Q.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A.	C	B	A	D	B	C	B	D	B	A	B	D	D	D	A
Q.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
A.	A	A	C	D	B	B	C	C	B	C	B	C	D	D	B
Q.	46	47	48	49	50	51									
A.	A	D	D	B	D	C									

EXERCISE#2

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A.	B	C	A	B	C	B	B	D	A	C	D	A	A	C	A

13.WHY DO WE FALL ILL

EXERCISE#1

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A.	D	C	A	D	C	B	D	B	D	B	A	C	D	C	D
Q.	16	17	18	19	20	21	22								
A.	A	D	C	D	B	C	C								

EXERCISE#2

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A.	A	A	D	B	C	C	A	D	A	B	B	B	C	A	D