9TH **FUNDAMENTAL UNIT OF LIFE** **BIOLOGY**

CELL:-

Cell is the structural and functional unit of living beings. It consists of an organized mass of protoplasm surrounded by a membrane. Cell is called the basic and the fundamental unit of life.

DISCOVERY OF CELL:

The history of cell began with the classical work and observation of an English scientist in 1665 – Robert Hooke, which was published in Micrographia in London. He used the term cell for the first time to designate the honey – comb like compartments in a thin slice of cork, which was cut by him with the help of sharp pen knife and observed it under his crude microscope. According to him, cell is a dead and empty structure of plant origin.

Antony Von Leeuwenhoek studied the unicellular organisms in pond water, tarter of teeth, protozoan and spermatozoids. Later on, Robert Brown (1831) discovered the presence of small sphere in the cells of Orchid root and termed it as nucleus. During 1824 – 1830, Dutrochet, Turpen and Meyers provided data things are made up of cells. Durjarden used the term 'Sarcode' for the cellular fluid, which was later on, named as "Protoplasm" by Purkinji and Von Mohl.

Thus, the 19th century was an era in which the cell was investigated extensively and in the beginning of the 19th century it was known that all living organisms were composed of cells.

CELL THEORY AND PRINCIPAL:

In 1838, a German Botanist Schleiden announced that all plants are composed of cells and in 1839, German Zoologist Schwann made some statements for animals. These announcements led to the formulation of cell theory, which **"holds that all living matter, form the simplest of unicellular organisms to very complex higher plants and animals are composed of cells, and that each cell can act independently but function as an integral part of the complete organism."** Cell theory could not explain the formation of new cells. In 1855, Rudolf Virchow discovered that cells divide and thus proved that new cells must come from the pre – existing cells. Thus, cell theory was modified by Rudolf Virchow in 1858 with the expression of his opinion that **"Omnis cellula – e - cellula."**

The cell theory in its modified form applies fully and universally to all living objects, and has been given the status of Cell Principal. The cell principal states that:

1. All organisms are made up of cells and their products.
2. The function of an organism as a whole is the outcome of the activities and interactions of the constituent cells.
3. All cells are basically similar in their chemical composition and metabolic activities.
4. All cells arise from pre – existing cells.
5. The cells are structural and functional units of organisms.
6. Growth of an organism occurs by cellular growth (Unicellular) or by cellular multiplication (Multiplication).

DIFFERENCE BETWEEN PROKARYOTIC AND EUKARYOTIC CELLS:

Prokaryotic cell	Eukaryotic cell
1. Generally small in size (1 to 10 µm)	1. Generally large in size (5 to 10 µm)
2. Only single DNA strand is present	2. Several DNA strands are present in nucleus
3. DNA is not associated with histone sugar	3. DNA is associated with histone sugar
4. Nucleolus absent	4. Nucleolus present
5. Membrane bound cell organelles are absent	5. Membrane bound cell organelles are present

DIFFERENCE BETWEEN UNICELLULAR AND MULTICELLULAR ORAGANISMS:

Unicellular Organisms	Multicellular Organisms
1. It is present by a single cell	1. It consists of a large number of cells.
2. All activities of the organism are performed by a single cell	2. A single cell performs one or a few activities of the organism.
3. There is no division of labour as the cell has to perform all activities.	3. Cells are specialized to perform different functions of the body so that there is division of labour.
4. It consumes the single cell.	4. Some cells called germ cells take part in reproduction. Others remain intact.

- **CELL SHAPE:**

Most of the cells have a definite shape. Cells amy be spindle-shaped-muscle cells, elongated-nerve cells, oval-red blood corpuscles, cuboidal-germ cells, branched-osteocytes and chromatophores and so on.

➢ **CELL SIZE:**

The smallest known cell is Mycoplasma or PPLO (Pleuro Pneumonia like organisms). Its size is 0.1 to 0.5 µm (micrometer). The bacterial cell is 0.5 to 5 µm, human red blood corpuscles are 7 to 20 µm, human liver and kidney cell is 20 to 30 µm in size, nerve cell is about 90 to 100 cm.

Acetabularia, a single-celled algae has a length of 10 cm. In plants, fibres are quite long, 4 cm in cotton in 1 metre in hemp.

The largest cells are avian eggs. The egg of an ostrich is 170 X 135 mm, egg of hen is 60 X 45 mm, while human female ovum is about 0.1 mm in diameter.

➢ **CELL AS BASIC UNIT OF LIFE:**

A cell is called basic unit of life because it performs all life functions like intake of food materials, excretion, metabolism, respiration, irritability, etc. For this a cell usually possesses a number of components or cytoplasmic structures called cell organelles. Each cell organelle performs a different function like clearing waste material, making new materials, protein synthesis, lipid synthesis, RNA synthesis, etc. This results in division of labour inside a cell. A cell is able to live and undertake various life functions because of its cell organelles. Since life functions are the same in all types of cells, the various cells possess same cell organelles despite belonging to different organisms and performing different functions.

STRUCTURE OF EUKARYOTIC CELL:

An eukaryotic cell consists of the following components:-

i) Cell wall ii) Plasma membrane iii) Cytoplasm iv) Nucleus

➢ **CELL WALL:**

It is an outer-rigid protective, supportive and semi-transparent covering of plant cells. The cell wall was first observed in cork cells by Robert Hooke in 1665. Its thickness varies in different types of cells from 1.1 µm to 10 µm. Cell wall is generally considered to be a non-living secretion of the protoplasm but actually it is metabolically active and is capable of growth.

FUNCTIONS OF CELL WALL:

1. It plays a part in helping the aerial portion of the land plants to with stand gravitational forces.
2. It is involved in the transport or movement of materials and metabolites in and out of the cell.
3. It counter acts (by wall pressure) physically the turgor pressures produced by the cell contents due to the entry of water.
4. The cell wall plays an important role in cell expansion, especially in young stage.
5. Some enzymatic activity is also known to occur within the cell wall.
6. The cell wall gives the rigidity to the plant cell.
7. It maintains the shape of the plant cell.
8. It protects the internal organelles from external injuries.

➢ **PLASMA MEMBRANE :-**

It is the outer covering of most of the animal cells, living, ultra thin, elastic, semi – permeable in nature. It provides the mechanical support and external frame to the protoplasm (cytoplasm + nucleus). It also delimits the protoplasm from the exterior, checks the entry or exit of substances and due to semi – permeability, it transmits necessary materials to and from the cell. Plasma membrane consists of outer and inner layers of proteins and a middle layer of lipids. It is found to contain many pores through which exchange of molecules may occur.

FUNCTIONS:

1. It gives shape to the cell.
2. It maintains individuality of the cell.
3. It keeps the cell contents in place and prevents their mixing with the extra cellular materials.
4. It protects the cell from injury.
5. It regulates flow of selected materials into and out of the cell.
6. It helps in compartmentalization.
7. It helps in recognition due to presence of glycolipids and glycoproteins.
8. It helps in flow of materials and information by specific proteins called receptors.

➢ **CYTOPLASM:-**

The space between the plasma-membrane and the nucleus is filled by an amorphous, translucent, homogenous, colloidal liquid called cytoplasmic matrix. It consists of various inorganic molecules, such as water, salts of Na, K, and various organic compounds vic., carbohydrates, lipids, proteins, nucleoproteins, nucleic acids, and a variety of enzymes. In the cytoplasm, various cell organelles are found floating.

FUNCTIONS:

1. It helps in intra-cellular distribution of molecules, enzymes and nutrients within the cell.
2. It helps in exchange of materials between different cell organelles.
3. Biosynthesis of nucleotides, proteins and fatty acids takes place in the cytoplasm
4. Breaking down of glucose (glycolysis) takes place in the cytoplasm.
5. Continuous nucleo-cytoplasmic interaction takes place between the nucleus and the cytoplasm.;

- **NUCLEUS:-**

Nucleus is a dense protoplasmic body that contains hereditary information for controlling cell activities as well as for transfer to next generation. It is the largest cell structure which is oval or spherical in outline. Nucleus lies in median or central position in animal and young plant cells. In mature plant cells, the nucleus lies towards the periphery due to formation of a large central vacuole.

The nucleus has a double layered covering called nuclear membrane. The nuclear membrane has pores which allow the transfer of material from inside the nucleus to its outside, that is, to the cytoplasm.

The nucleus contains chromosomes, which are visible as rod-shaped structures only when the cell is about to divide. Chromosomes contain ifrormation for inheritance of features from parents to next generation in the form of DNA (Deoxyribo Nucleic Acid) molecules. Chromosomes are composed of DNA and protein. DNA molecules contain the information necessary for constructing and organizing cells. Functional segments of DNA are called genes. In a cell which is not dividing, this DNA is present as part of chromatin material. Chromatin material is visible as entangled mass of thread like structures. Whenever the cell is about to divide, the chromatin material gets organized into chromosomes.

The nucleus plays a central role in cellular reproduction, the process by which a single cell divides and forms two new cells. It also plays a crucial part, along with the environment, in determining the way the cell will develop and what form it will exhibit at maturity, by directing the chemical activities of the cell.

FUNCTIONS:

1. It helps in the maintenance of cell, without a nucleus the cell does very quickly.
2. It helps in cell division.
3. The nucleus contains genetic material DNA, so it is needed for the inheritance of characters from one generation to another.
4. It controls various cytoplasmic activities of the cell by controlling the synthesis of a specific type of protein.
5. The nucleoli present in the nucleus helps in the formation of ribosomes.

ENDOPLASMIC RETICULUM (E.R):

It was discovered and named so by Porter. Endoplasmic reticulum is an interconnected system of membrane-lined channels that runs through the cytoplasm. At places it is connected with the plasmalemma as well as with the nuclear envelope.

Endoplasmic reticulum is quite extensive in metabolically active cells, e.g., pancreas and liver, simple in storage cell, e.g., adipose cells, reduced in spermatocytes and absent in eggs, mature erythrocytes, embryonic cells, resting cells, and prokaryotic cells.Endoplasmic reticulum is of two main types- smooth and rough.

TYPES OF E.R:

There are two main types of E.R – Rough E.R and Smooth E.R

Rough E.R:- This type has ribosomes on the surface. It is well developed in cells actively engaged in protein synthesis. The basophilic staining of RER is due to the ribosomes. The RER is more stable than the SER. In pancreatic exocrine cells only granular E.R is found. In liver cells, the RER is distributed through the cytoplasm in the form of groups, each group probably represents one functional unit.

Smooth E.R:- The SER membranes are not covered with ribosomes. It is characteristic of cells in which synthesis of non – protein substances like phospholipids, glycolipids and steroid hormone takes place e,g, Adipose tissue cells, Adrenocortical cells and interstitial cells of testis. SER is usually tubular and cisternae are rare. In the liver cells it is made up of tubular elements that apparently originate at the edge of cisternae of the E.R.

A modified form of the SER is sarcoplasmic reticulum found in striated muscles. This is delicate plexus surrounding myofibrils.

DIFFERENCE BETWEEN SER AND RER:

SER	RER
1. *Ribosomes.* They are absent.	1. Ribosomes occur over the surface of RER.
2. *Synthesis.* It is specialized to synthesize lipids and steroids.	2. It is specialised to synthesize proteins.
3. *Lumen.* The products do not pass into lumen	3. The products pass into lumen of E.R. for transport to other places.

FUNCTIONS OF E.R.:-

1. Mechanical support: - E.R contributes to the mechanical support of the cytoplasm.
2. Transport: - The E.R acts as an intracellular transport system of various substances. Watson (1959) has suggested that exchange between the nucleus and the cytoplasm takes through nuclear opening which communicate with the E.R.
3. Detoxification:- E.R helps in detoxification of many endogenous and exogenous compounds.
4. Storage:- E.R helps in temporary storage of materials e,g, lipids.
5. Glycogenolysis:- Synthesis of glycogen occurs in the cytoplasmic matrix but the SER is involved in glycogenolysis.
6. Protein synthesis:- The E.R is the site of secretion of secretory proteins. proteins are synthesized on the ribosomes and enter the E.R cisternae through channels in the membrane. The proteins leave E.R and enter the Golgi complex for reprocessing.
7. Lipid synthesis:- The SER is concerned with synthesis of lipid e,g, triglyceride. The membranes of SER also appear to be involved in the formation of lipo – protein complexes. The SER is also involved in the initial stages of the break down of fatty acids.

8. Synthesis of cholesterol and steroid hormones:- Cholesterol is an important precursor of steroid hormones. The major site cholesterol synthesis is the SER. In the testis, ovary and the adrenal cortex, the SER has a role in the synthesis of steroid hormones. In the interstitial cells of testis, the enzymes catalysing biosynthesis of androgens have been located in the SER.
9. Formation of microbodies:- Microbodies are formed as dilations of the E.R and frequently show connections with the E.R . cisternae. They are rich in enzymes peroxidase, catalase etc. The chief microbodies are peroxisomes , spherosomes and glyoxysomes.
10. Membrane flow:- Transport of ions, molecules and particles into and out of membrane flow. Thus, substances like RNA and nuclear proteins may pass out from the nucleus outside the cell by the following route – nuclear membrane ----- pores ----- E.R ----Golgi body ----- cell membrane ------ outside.
11. Synthesis of nuclear membrane:- E.R is the source of nuclear membrane at the time of cell division.

RIBOSOMES:-

Ribosomes are sub - microscopical dense granules about 150 to 250^0A in diameter and have been seen by Plade in 1955 under electron microscope. They are the sites of protein synthesis. Chemically, the ribosome is composed of RNA and proteins, almost in equal proportion.

Location:- Ribosomes are present –

a) attached to RER.
b) In the cytoplasm, either singly (monosomes) or in groups called polysomes or polyribosomes.
c) In the mitochondria.
d) In the chloroplasts.

FUNCTIONS:-

Ribosomes help in protein synthesis inside the cell. Hence, they are called protein factories of the cell. At the time of protein synthesis, ribosomes are attached to RNA and form a structure called polyribosome, which is the site of protein synthesis.

MITOCHONDRIA:

Mitochondria are rod-shaped or sausage-shaped cell organelles of aerobic eukaryotes which take part in part of aerobic respiration called Krebs cycle. Mammalian RBCs are devoid of them. Mitochondria are commonly knowm as 'power house of the cell' because they contain enzymes necessary for the total oxidation of food and for release of high amount of energy in the form of ATP (Adenosine triphosphate molecules). The body uses energy stored in ATP for synthesis of new chemical compounds and for mechanical work. ATP is also known as energy currency of the cell.

Each mitochondrion is bounded by two membranes. The outer membrane is smooth and porous whereas the inner membrane is folded inwards to form cristae. Cristae increase the surface area for ATP generating chemical reactions. Mitochondria enclose a matrix having DNA, ribosomes and enzymes. Enzymes take part in respiration. DNA and ribosomes make the mitochondria semi-autonomous as they are able to manufacture some of their own proteins and enzymes.

FUNCTIONS OF MITOCHONDRIA:

1. Mitochondria are described as the power house of the cell, and therefore, most interest is directed to the process that evolve energy, mainly TCA, ETS, oxidative phosphorylation. All these three processes occur in mitochondria and result in the formation of energy compound called ATP.
2. Some of the enzymes have been located in mitochondria, which helps in the synthesis of lipids like Lecithin from fatty acids and glycerol.
3. Mitochondria help in the transport of ATP. They collect at sites where energy requirement is high.
4. Due to the presence of RNA,DNA and ribosomes, proteins can be manufactured in mitochondria.
5. Mitochondria possess some of the enzymes of glyoxylate cycle. This cycle is modification of Kreb's cycle in which fatty acids are converted into the carbohydrates.

PLASTIDS:

Plastids are small bodies found free in the cytoplasm of most plant cells. They are absent in bacteria, fungi, cynobacteria. There are three types of plastids –

1. **Chloroplasts:-** The green plastids are called chloroplasts. They are meant for photosynthesis as they contain chlorophyll. They are generally elliptical bounded by a double membrane. Inside is matrix called stroma concerned with dark reaction of photosynthesis. The stroma possesses lamellar system meant for light reaction. The lamellae may occur in the form of thylakoids while stacks of thylakoids form grana.
2. **Chromoplasts:-** These contain carotenoid pigments. They are red to yellow in colour and much more variable in shape. They impart specific colours (other than green) to various plant tissues, fruits and flowers. They are more abundant in the petals of flower and attract the insects for cross – pollination. Chromoplasts may develop from leucoplasts that contain starch. As the caroteins increase in concentration, the starch disappears. In fruits, the chloroplasts are later on replaced by chromoplasts to attract the dispersing agents.
3. **Leucoplasts**:- Plastids without pigments are called leucoplasts. They are found in embryonic and sexual cells, and in the region of the plant not receiving light. Leucoplasts which function in storage of starch are called Amyloplasts. They are found cotyledons, endosperm and storage tubers. Leucoplasts which store oil are called Elaioplasts and those storing proteins are Aleuroplasts e,g, Maize grain.

CHLOROPLASTS:-

The green plastids were called chloroplasts by Shimper inn 1883, where as plastids were named as such by Haekil in 1866.

The process of photosynthesis occurs from start to completion in the chloroplasts, a cytoplasmic particle with highly complicated structure.

Size:- Chloroplasts are the largest organelles of the plant cell in the cytoplasm. They are about 5 to 10μm in diameter and have a thickness of 2 to 3μm.

Shape:- The shape of most chloroplasts in higher plants is spheroid, ovoid, or discoid. Other irregular shapes sometimes occur but are more common in lower plants e,g, In algae, the chloroplast may be cup – shaped, ribbon - shaped , star – shaped, collar shaped etc.

Number:- In some algal cells there is only a single chloroplast but highest number can be found in some palisade cells of leaves of Angiosperms (200 to 300). However, this number varies from 5 to 50 per cells in majority of the cases.

FUNCTIONS OF CHLOROPLASTS:

1. Decomposition of water and liberation of oxygen to purify atmosphere.
2. Chloroplast stroma contains enzymes for conversion of carbondioxide into carbohydrate.
3. The lamella are represented as the sites of enzyme activities associated with the conversion of light energy into chemical energy.
4. Some lipids and proteins are also synthesized by them.

GOLGI COMPLEX:

The Golgi apparatus, first described by Camillo Golgi, consists of a system of membrane-bound vesicles arranged approximately parallel to each other in stacks called cisterns. These membranes often have connections with the membranes of ER and therefore constitute another portion of a complex cellular membrane system. The material synthesized near the ER is packaged and dispatched to various targets inside and outside the cell through the Golgi apparatus. Its functions include the storage, modification and packaging of products in vesicles. In some cases, complex sugars may be made from simple sugars in the Golgi apparatus. The Golgi apparatus is also involved in the formation of lysosomes.

FUNCTIONS OF GOLGI BODIES OR COMPLEX:

The chief function of the Golgi body is secretion. Five examples are given below:-

1. Cell plate formation:- In plants cells during the division, the Golgi bodies secrete materials (cellulose, pectin) for the cell plate formation which is then transformed in the cell wall.
2. Cell membrane proliferation:- For the growth of plasma membrane, the proteins are secreted by Golgi body in membrane bound by vesicles.
3. Pigment synthesis:- Golgi complex has also been described as the site of synthesis of melanin in several melanocytes, retinal pigment in retinal epithelium.
4. Lysosome formation:- The primary lysosomes are formed from Golgi cisternae. It is believed that the enzymes are carried from E.R to Golgi cisternae and then pinched off as primary lysosome.
5. Acrosome formation:- The acrosome is found in the sperm cells of most animals. It assists in the fertilization of ovum. The acrosome is formed by a single large Golgi body present in the sperm cell.

LYSOSOME:

Lysosomes are small spherical vesicles covered by a single membrane which contains digestive enzymes for intracellular digestion and waste disposal. Because of their function in intracellular digestion, lysosomes are called digestive bags. The digestive (=hydrolytic) enzymes contained in lysosomes are synthesized by R.E.R. The enzymes are seldom released except when the cell has been damaged. Old organelles, germs, food, etc. enter the lysosomes for disposal by digestion. In damaged cell, lysosomes burst to release enzymes for digestion of cellular compounds. Because of their ability to kill and digest cellular components, lysosomes are called suicide bags.

FUNCTIONS OF LYSOSOMES:

1. Defence:- They help in the destruction of foreign particles (bacteria and viruses). So they provide protection to the body.
2. Digestion:- They help in intracellular digestion of food particles.
3. Cleansing:- They help in removing dead and worn out cellular organelles (cell debris) by digesting them.

Difference between Plant Cell and Animal Cell:

Plant cell	Animal cell
Cell wall is found in kingdom monera, fungi and plantae.	Animal cells do not possess cell wall.
Plant cell's especially green have colouring pigment chlorophyll.	Chlorophyll is absent in animals.
Centrioles and centromeres are absent	Well defined in animsla cells to help in cell division
Plant cells have lare central vacuole.	They have small vacuoles.
Plastids are present in cells.	Plastids are absent.
Lysosomes are absent.	Lysosomes are present mostly help in digestion
They show secondary growth.	Secondary growth is absent.
Growth occurs even after death.	Growth stopsw well before death.

Growth is unlimited.	Growth is limited.
Growth is confined to certain regions like shoot tip, root tip etc.	Growth is diffused in animals.
Plants have two main tissues i.e, permenant and meristems.	Animals possess 10 or more types of tissues.
Plant cell can snthesize food	Animals cells can not synthesize food except Vitamin D synthesis.
Cell divides amitiotically, mitiotically and meiotically.	Cell divides mostly mitiotically and meiotically.

BIOMEMBRANE TRANSPORT:

These are different processes used by molecules and ions to move into and out of cells through membranes. These are:

1. Diffusion
2. Osmosis

a) Diffusion:- The process of movement of a substance (solid, liquid or gas) from a region of higher concentration to a region of lower concentration, to spread uniformly in the given space is called diffusion

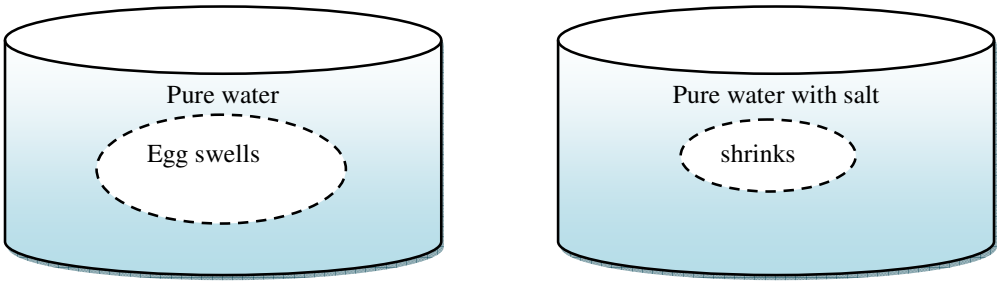
Diffusion across cell membrane:- Metabolic gases (CO_2 and O_2) move out and into the cells through diffusion. Respiration of the cell produces carbon dioxide. As the concentration of CO_2 increases inside the cell as compared to the outside, CO_2 diffuses out of the cell into the external medium. Similarly, concentration of oxygen is always higher in the external medium as compared to the cell where it is being consumed in respiration. Therefore, oxygen diffuses from outside to the inside of cell.

b) Osmosis: - It is a special passive diffusion which involves the transfer of solvent through differentially permeable membrane. Osmosis may be defined as movement of water (solvent) from dilute solutions (higher potentiality of water) through differentially permeable membrane.

Osmosis with an Egg:-Remove the shell of an egg by dissolving it in dilute HCl. The shell is mostly $CaCO_3$. A thin outer skin now encloses the egg. Put the egg in pure water and observe after 5 minutes. The egg sells because water passes into it by osmosis.

Place a similar de-shelled egg in a concentrated salt solution and observe for 5 minutes. The egg shrinks. Water passes out of the egg solution into the salt solution because the salt solution is more concentrated.

Same experiment can be done with raisins or apricots.



DIFFERENCE BETWEEN DIFFUSION AND OSMOSIS:

Diffusion	Osmosis
1. It is the movement of a substance from the area of its higher concentration to the area of its lower concentration.	It is the movement of water from the area of its higher concentration to the area of its lower concentration through a semipermeable membrane.
2. It can take place in solid, liquid and gases.	It takes place only in liquid.
3. It does not involve any semipermeable membrane.	It requires a semipermeable membrane.
4. It equalizes the concentration of substance throughout the available space.	It does not equalize the concentration of solvent on the two sides of the membrane.

CELL IN:

Hypertonic solution: - When a cell is place in a hypertonic solution i.e in a solution having higher concentration than that present within the cell sap. The ex-osmosis begins. The water from the cell sap moves out into the hypertonic solution till concentration in and out reaches equilibrium. This movement of solvent is controlled by cell membrane which is differentially permeable. The ex-osmosis can result in the plasmolysis of the cell in which protoplasm detaches from the cell wall and collects in the centre.(1.25% salt solution and 10% of glucose solution – RBCs)

Hypotonic solution: - If plant cell is placed in hypotonic solution i.e in a solution having lower concentration than the cell sap, the water begins to enter the cell by end-osmosis. Thus results in turgidity of the cell. Plasmolysed cell can get deplasmolysed when put in such solution. E,g. 0.66% salt solution and 0.2% glucose solution are hypotonic for RBCs.

Isotonic solution: - under such a solution the water neither enters the cell nor it leaves the cell or there exists a dynamic equilibrium. This is due to the fact that concentration inside and outside of the cell is same. E,g. 0.9% salt solution and 5% of glucose solution are isotonic for RBCs.