Chapter 4

THE CELL

Q.1 Define: Cell, Cytology, Tissue and histology.

Ans. CELL: *The basic structural and functional unit of the living body is known as cell.*

Cytology: The study of structure and function of cell is known as cytology.

Tissue: A group of physically linked cells and associated intercellular substances for particular function is known as tissue.

Histology: The study of tissue is known as histology.

Q.2 What is Cell?

Ans. ***"Cell is the basic structural and functional unit of the living body"***. Each cell has different cell organelles which perform specific functions. In different parts of the body, different kinds of cells are present.

Cells play their role according to necessity and demand. The activities of a cell depend upon cell organelles, so in different situations and places particular organelle is active. For example, in photosynthetic cells, plastids or chloroplasts play important role. In case of secretory cells, golgi bodies and lysosomes are active. *"A distinct part of a cell which has a particular structure and function is called* ***organelle****".*

Cell is the unit which ***builds up*** the body, and cell is also that unit which is basis of every function. Union of cells forms tissue, assembly of tissue forms organ. Different organs make system when they are arranged in particular arrangement. *Thus body is formed by the specific sequence and combination of systems.*

In other words, the healthy body or organism depends upon normal functions of the systems. The performance of the system depends upon organs. The regulation of

organ depends upon tissue. If tissue will be normal so cells are normal in it. Cell plays its normal role if organelles are normal and active in their duties.

KEEP IN MIND

"The basic structural and functional unit of the cell is Protein". Protein is builder of organelles in the cell, while all enzymes and most hormones are proteins. Immunity, contraction and relaxation, wound healing, and carrying of O_2 etc. depend upon protein.

"Cell is a bag of chemicals. Actually, making and breaking of chemicals occur in it".

Q.3 (a) What is cell theory and also describe its salient features?

(b) Describe the emergence and implication of cell theory?

(OR) Describe the history of cell theory.

Ans. (a) CELL THEORY

Final or concluding description about the cell is known as cell theory". It is described by a German Zoologist Theodar Schwann in 1838 and a German botanist M.J. Schleiden in 1839.

Salient Features:

(i) All organisms (living body) are ***composed of one or more cells.***

(ii) All cell arise ***from pre-existing cells.***

(iii) Cell is the basic ***structural as well as functional unit for all organisms.***

(b) HISTORY OF CELL THEORY

"Is there a fundamental unit of structure shared by all organisms?" This was the scientific question of the history.

Invention of Microscope (1610):

The invention of microscope helped the scientists to find out the answers of this type of question. Crude microscope seen to has been made for the first time in Holland shortly before 1600. By about 1610, the Italian Astronomer and Physicist.

Galilio and Observation of Microorganism:

Galilio had made a microscope and used it to observe very small organisms animals.

Discovery of Microscopic Life:

He was followed by many others among them. *Leeuwenhoek* who discovered microscopic life.

Magnified images revealed a hidden world and answered questions that could not have been answered before.

Robert Hooke and Cork (1665):

Robert Hooke in 1665 was reported first of all his observations, sensational at that time in this book. *"Micrograpahia"*, that the apparently uniform and firm matter of bottle corks (outer bark of the oak) was in reality composed of innumerable ***"tiny boxes"*** *or 'cells'.*

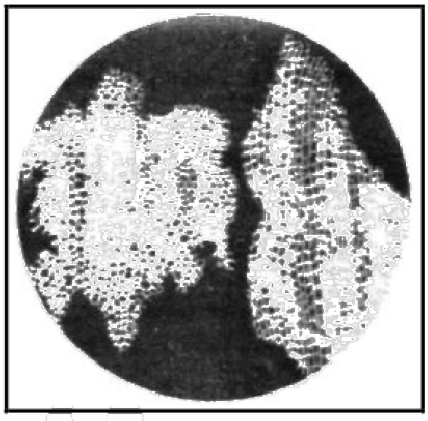


Fig. The microscopic structure of a piece of cork

Conclusion of Hooke:

According to *Hooke* cells were empty space bounded by thick walls or filled with air or water, because he saw only non-living or dead frame work of cell walls.

Oken and Vesicles (1805):

The work was again started in 19th century. In 1805, Lorzen Oken, a German scientist believed that all living beings originated from or consist of vesicles or cells.

Dutrochet and Box Like Structures (1824):

In 1824, French botanist Henri Dutrochet were seen same box like units similar to those as Hooke.

Robert Brown and Nucleus (1831):

In 1831, Robert Brown discard the nucleus in the cell. Due to which the Hooke's idea of empty space changed.

Cell Theory by Schwann and Schleiden (1838 – 39):

In 1838 and 1839, J. Schwann and Schleiden respectively give cell theory. After the cell theory, many details of cell were studied and as a result cell theory was extended.

Rudolph Virchow and Division (1855):

Rudolph Virchow (1855), a German physician made hypothesis that new cells were formed only by division of already existing cells (in Virchow's words) ***"omnis cellula-e-cellula"*** i.e. all cells from cells".) It was contrary to the idea of abiogenesis (living things arise spontaneously from non-living beings).

Prove of Virchow by Louis Pasteur (1862):

Louis Pasteur (1862) supplied experimental proof for Virchow's hypothesis by demonstrating that microorganisms (bacteria) could be formed only from existing bacteria. "Original cell theory and Virchow's hypothesis give us the basis for working definition of living things i.e. *living things are chemical organization, composed of cells which capable of reproducing themselves.*

Weismann and Report of Common Origin (1880):

August Weismann (1880) said that all presently living cells have a common origin because they have basic similarities in structure and molecules etc. It was shown that there are fundamental similarities in the chemical composition metabolic activities and structure, although they differ in many respects. Cell are basically similar but extraordinary versatile. Cell is not only the structural but also a functional unit of living organisms so cell theory is a very important unifying concept.

Q.4 What do you know about division of labour of cells?

OR

Describe cell as a structural and functional unit.

Ans. **CELL AS A STRUCTURAL & FUNCTIONAL UNIT**

A cell is a unit of structure and function but cells also act as sites of growth and development. In multicellular organisms, there is a division of labour.

Division of Labour in Animal Cells:

(i) ***Contraction Relaxation:*** Muscle cells contract and relax.

(ii) ***Transmission of Impulse:*** Nerve cells transmit impulses.

(iii) ***Secretions:*** Gland secretes hormones.

(iv) ***O_2 Carrier:*** *Red blood cells* carry oxygen.

(v) ***Juices:*** Some stomach cells secrete gastric juice.

Division of Labour in Plant Cells:

(i) **Conduction:** Xylem cells conduct water and minerals salts from soil to aerial parts of plants.

(ii) **Food Transport:** Phloem cells transport food.

(iii) **Support:** Sclerenchymatous cells give support to the plants.

(iv) Photosynthesis: Chlorenchymatous cell carry out photosynthesis.

(v) Store: Parenchymatous cells store surplus food.

As these cells perform different functions, they show great variation in shapes and sizes. Despite the structural and functional diversity, the plant cells have a common plan of organization.

Q.5 Describe the techniques to study the cell and parts of cell.

OR

What are fixation staining, cell fraction and centrifugation?

Ans. Cell can be studied under the light microscope as well as electron microscope. To observe the cell under microscope preparation have to do:

(i) Chemical Treatment:

The cells are fixed. This means that they are *treated with chemical agents* that *solidify* the normal jelly like parts. Thus the cells are killed by this fixation process.

(ii) Formation of Thin Slices:

Secondly, if the cell are in thick masses, they have to spread out in this sheath or necessary to make any thin slices of the material.

SPECIAL ATTENTION

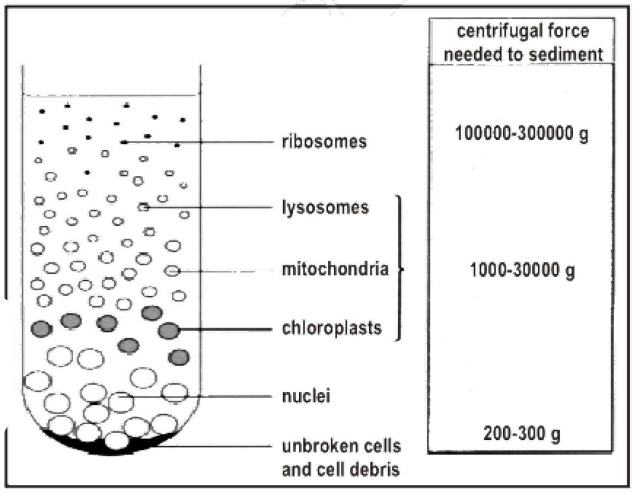


Fig. Fractionation of cell components by centrifugation centrifugal forces are measured in a (number of times gravity)

(iii) Staining.

Thirdly the cells are stained with one or more of a variety of dyes. *Hamatoxylin* dye stain the nucleus.

The modern technology enables us to isolate various components of cell including its organelles by cell fractionation and centrifugation.

Cell Fractionation:

The technique by which the *tissues are homogenized or disrupted* by special instruments is called cell fractionation.

Centrifugation:

Separation of different organelles by density gradient centrifugation. This is due to spinning the homogenized in a special medium in a centrifuge machine at specific speed. Different parts separate out in different layers depending upon their size and weight, related to the density of the medium. High speed for separation achieved by ultra centrifugation.

Q.6 What are resolution and magnification power?

Ans. **RESOLUTION (INSTRUMENT'S ABILITY)**

The ability of an observational instrument. Such as human eye or microscope to differentiate between two adjacent points.

Magnification (Size Increasing):

Magnification is the increase in size of a optical image over the size of the object being viewed with the help of lenses.

Explanation:

The unaided human eye or naked human eye under optimal conditions can differentiate between two points which at least apart 1.0 mm apart (Human eye sensitive in 555 mm wavelength of light). This resolution can be increased with the aid of lenses. In typical compound microscope the resolution is 2.0 um. Which 5000 x that of naked eye. The magnification power of a microscope is determined by multiplying x values of ocular lense and x value of objective lenses. Ocular lens may be 5x, 10x or 125x etc. Objective lens may be 5x, 10x, 40x or 100x. The resolution of this microscope remain the same at every magnification power if the same visible light is used as a source of illumination. Resolution increase with decrease in wavelength of light used as illumination source. The resolution in electron microscope become highest (2-4 A°) because here a beam of electron is used as illumination source which is 500 x and 250,000 x greater than compound microscope and naked eye respectively.

Limit of resolution $R = \lambda / n \sin a$

Lamda (λ) = wavelength of light/illumination source

n = Refractive index of the material b/w specimen and the objective lens.

Sina = sin a is sin of angle of the cone of light used to illuminate the specimen which is equal to one. Refractive index of immersion oil is about 1.6.

Q.7 What kind of division of organism are found on the basis of cell numbers and structure?

Ans. Organism are divided into two categories on the basis of number. of cell.

(1) Unicellular (2) Multicellular

(1) Unicellular

The organism who consists of only one cell e.g. Euglena, bacteria, protozoans etc.

(2) Multicellular

If the body of organism consist of two or more than two cells. They are called as multicellular e.g. all higher animals and plants.

Organism are divided in two following categories on the basis of structure of cell e.g.

(i) Plant and animal

(ii) Prokaryotes and Eukaryotes

(1) Plants:

Those organism who have cell wall as an outermost covering and also contain plastids for photosynthesis e.g: chlamydomonas, higher plants.

According to true sense plants also have embryo.
• ***Plastids*** **+** ***cell wall*** **means plants like organism e.g., Algae.** • ***Plastids*** **+** ***cell wall*** **+ embryo means plants i.e., bryophytes, pteridioptytes, gymnosperms and angiosperms.**

(ii) Animal:

Those organisms who have cell membranes as outermost layer and lack cell walls and plastids in cells e.g. amoeba, plasmodium are animal like.

(iii) Prokaryotes (without nuclear membrane)

Primitive type of cells in which chromatin material is not bounded by a membrane e.g. bacterial cell or bacteria and cyanobacteria.

(iv) Eukaryotes:

Those organism in which cells have chromatin material bounded in a definite membrane called nuclear membrane e.g. all higher animals and plants.

KEEP IN MIND

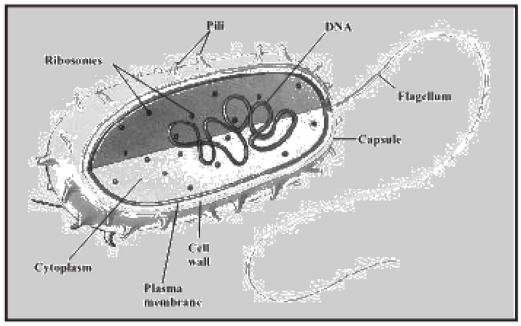
"Plants like" animals and "fungi like" organisms are members of kingdom protista,. These are not member of kingdom animalia and plantae.

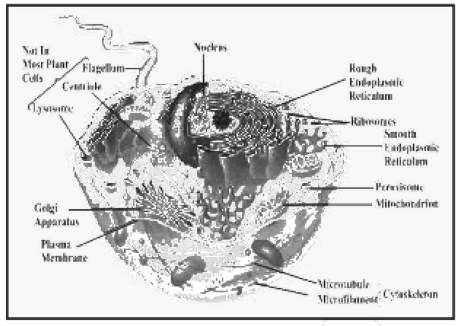
Q.8 Differentiate between prokaryotes and Eukaryotes.

Ans.

	Prokaryotes	Eukaryotes
1.	***Nucleus Absent:*** Organism possessing cells without nucleus are called prokaryotes e.g. *bacteria* and *blue green algae.*	***Nucleus Present:*** Organisms possessing eukaryotic cells are called eukaryotes e.g. cells of plants animals, fungi and protists.
2.	***No Membrane Organelles:*** They lack many of membrane bounded structures e.g. mitochondria, endoplasmic reticulum, golgi bodies and chloroplast etc.	***Membranous Organelles:*** They have membrane bounded structure
3.	***No Nuclear Membrane:*** Nuclear membrane is absent therefore prokaryotic cell has no distinct nucleus. **DNA** molecule is directly suspend in cytoplasm.	***Nuclear Membrane:*** A double nuclear membrane is present. They have a well defined nucleus. Chromosomes or **DNA** are enclosed in double nuclear membrane.
4.	***70s ribosome:*** Prokaryotes have small sized ribosomes i.e. 70s.	***80s ribosome:*** Eukaryotes have 80s ribosomes
5.	***Murein cell wall:*** The cell wall of prokaryotic cell is composed of polysaccharides chains bounded covalently to shorter chains of amino acids forming ***peptidoglycan*** or murein. The entire cell wall is often regarded as single huge molecule or molecular complex called murein.	***Cellulosic cell wall:*** Cell wall (if present) of eukaryotes is composed of **cellulose**.
6.	Mitosis is absent. They are divided by **binary fission**.	Mitosis and mitotic apparatus present.

7.





Q.9 Draw and labeled the diagram of typical cell?

Ans.

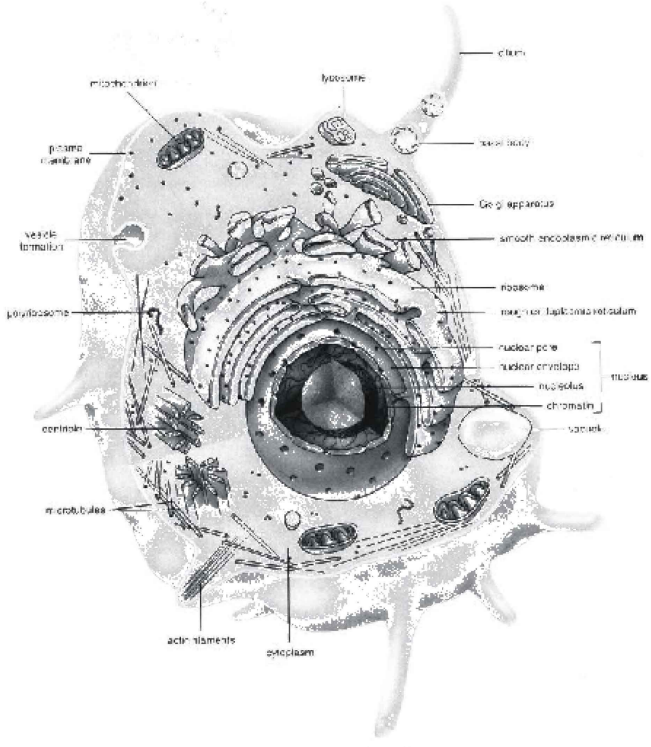


Fig. Animal cell.

EASY TO DRAW

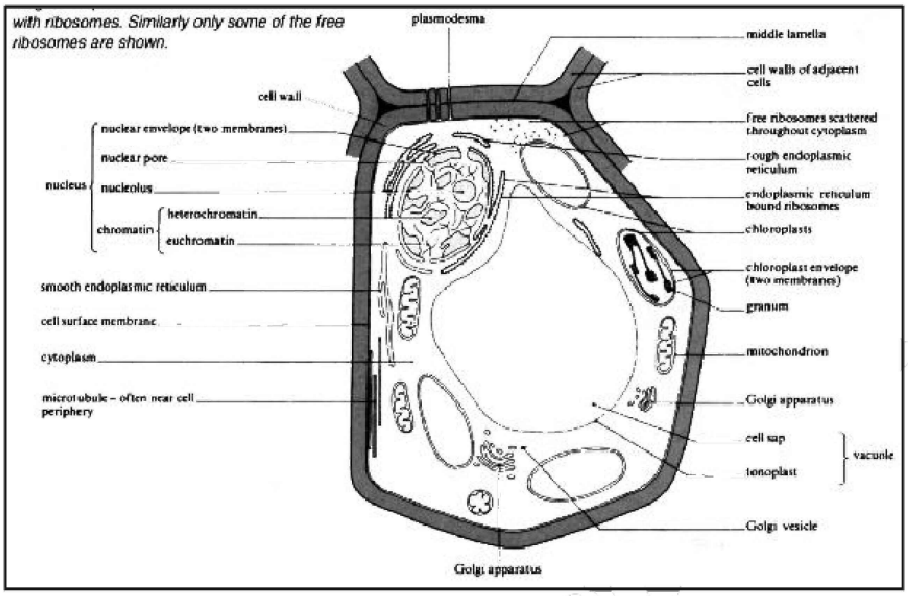


Fig. Ultrastructre of a generalized plant cell as seen with the electron microscope

Q.10 Describe the structure and function of cell membrane or plasma membrane?

Ans. **CELL MEMBRANE** **(*Plasma Membrane*)**

"The outermost permeable boundary of cell made up of protein and lipid is called cell membrane".

Chemical Composition:

Chemically, it is composed of ***lipids*** and ***proteins.***

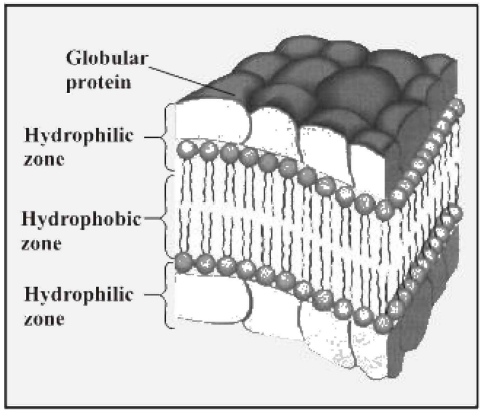
Proteins are 60-80% while Lipids are 20-40%:

In addition there is a small quantity of carbohydrates.

MODEL OF PLASMA MEMBRANE

(a) Three Layers.

In 1935 Danielli and Davson proposed that cell membrane consists of three layers



(b) Unit Membrane:

It was suggested by Harvey and Danielli in 1838 that plasma membrane is composed of lipid bilayer sandwiched between two protein layers. This basic structure is found in all the membrane such as those of mitochondria, chloroplast etc.,

and is called unit membrane.

Fig. Unit membrane

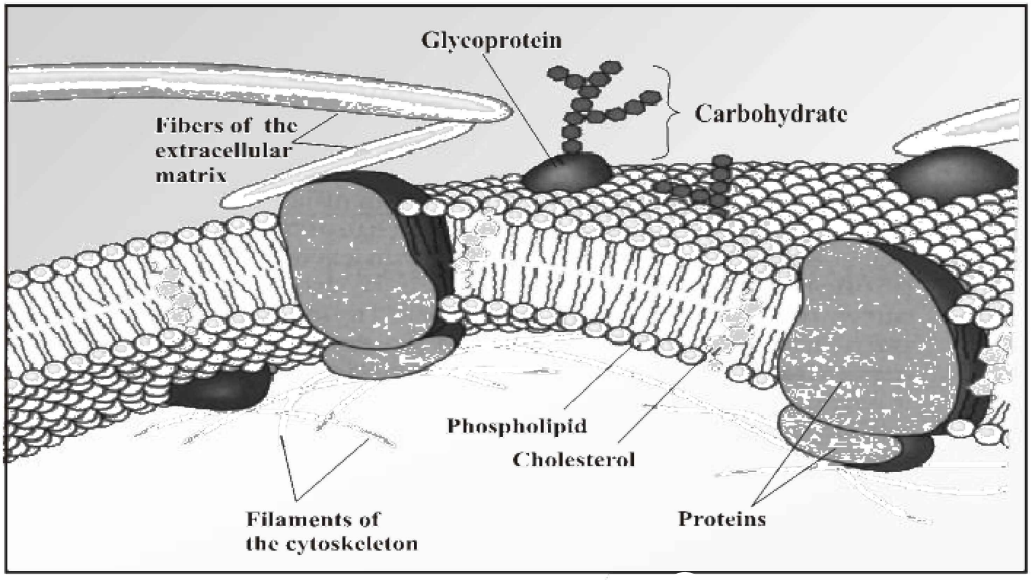


Fig. Fluid Mosaic Model

Fluid Mosaic Model

Singer and Nicolson (1972) reported that lipid bilayer is not sandwiched between two protein layers. Instead proteins are embedded in the lipid bilayer in a mosaic manner. This discovery led to the proposal of "Fluid Mosaic Model". *This model is most acceptable model*. Cell membrane contains *pores* through which movement of materials take place both by active and passive transport.

Intrinsic Proteins or Permeases (*Completely Embedded* in Double Lipid Layer):

Some protein are called intrinsic proteins or permeases. There are completely embedded in the double layer of lipids i.e. they extend from one side of lipid layers to the other.

Extrinsic or Surface Proteins (*Partly Embedded* in Double Layer Lipid):

Some other proteins called extrinsic or surface proteins partly embedded in the lipid bilayer i.e. they may be attached one side of lipid bilayer or the other.

In addition to the proteins and lipids, carbohydrates also participate in the structure building of membrane in the form of glycolipids and glycoproteins.

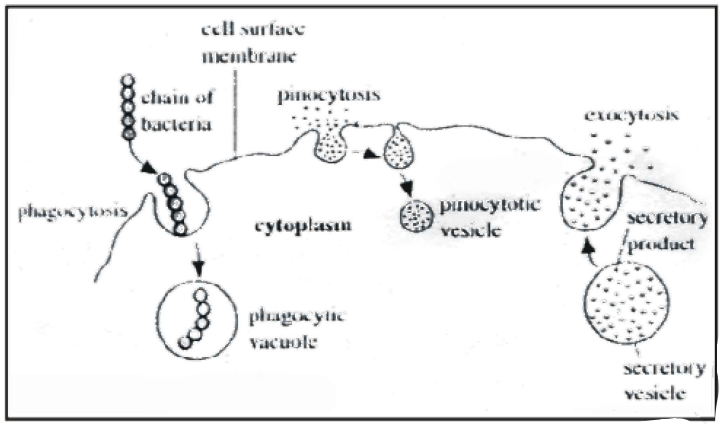


Fig. Endocytosis and exocytosis

FUNCTIONS

(1) Mechanical Support:

Plasma membrane provides mechanical support and external form to protoplasm.

(2) Differentiately Permeable:

Cell membrane is differentiately permeable or selectively permeable membrane because it allows some kind of molecule to pass through it and not others. Lipid bilayer and membrane proteins make the plasma membrane differentiately permeable barrier.

(3) Kinds of Transports:

Cell membrane plays an important role in the movement of materials from and to the cell. These two main processes which are involved in the transport of materials:

(a) Non Facilitated Transport:

Non-polar molecule like ***oil droplets, phospholipids, fatty acids*** *etc*. move across the membrane freely through the lipid bilayer. This is non facilitated transport.

(b) Facilitated Transport:

The movement of ionic materials like *water molecules* ***O_2, CO_2,*** *ions* of radicals is carried out across the cell membrane only ***with the help of proteins***. So it is called facilitated transport. There are two types of facilitated transport:

(i) Active Transport (Transport Against Concentration Gradient):

The transport of molecules across the membrane against concentration gradients (from higher to lower concentration) with the expenditure of energy is called active transport.

(ii) Passive Transport (Transport Along Concentration Gradients):

The transport of molecules across the membrane along concentration gradients (from higher to lower concentration) without utilizing energy is called passive transport. There are two types of passive transport.

(a) Diffusion:

The movement of soluble materials (solutes) from an area of higher concentration to an area of lower concentration across the membrane is called diffusion.

Osmosis:

The movement of water molecule from an area of its higher concentration to an area of lower concentration through differentiately permeable membrane is called osmosis.

(4) Exocytosis:

The process in which transportation occur from cell to the exterior or the other cells is called exocytosis. By exocytosis either the waste products or secretion move across the membrane.

ENDOCYTOSIS:

The process of inward movement of materials by infolding of cell membrane in the form of vacuole or vesicle is known as endocytosis. There are two types of endocytosis.

(i) ***Phagocytosis:*** The intake of *solid particles* into the cell is called phagocytosis.

(ii) ***Pinocytosis:*** The ingestion or intake of *liquid material* into the cell is termed as pinocytosis.

(5) Homeostatsis:

The maintain of balance of chemical and water etc. is called homeostatsis.

EXAMINE YOURSELF

Q.11 Define: Cell, Nerve Cell, Parenchyma, Sclerenchyma.

Q. Write 3 points of cell theory.

Q. What are the roles of Robert Brown and Robert Hooke in Cell discoveries?

Q. Define prokaryote and Eukaryote.

Q. How much proteins and lipids are found in plasma membrane?

Q. Differentiate between unit membrane and fluid mosaic model.

Q. Differentiate between the following:

(i) Intrinsic proteins and extrinsic proteins.

(ii) Non facilitated and facilitated transport.

(iii) Active and passive transports.

(iv) Osmosis and diffusion.

(v) Phagocytosis and pinocytosis.

Q.11 Describe the structure and function of cell wall.

Ans. **CELL WALL**

The non living outermost boundary of plant cells which contain three layers and provides shape and protection is called cell wall.

- Cell wall is the **outermost boundary of the plant cell**.
- It is not found in animal cell.
- Cell wall of plant is different from that of prokaryotes both in structure and chemical composition.
- It is **secreted by the protoplasm** of the cell.
- Cell wall can be separated from the cell without killing it.
- When the cell dies, the cell wall persists which shows that cell wall is **nonliving**.
- Cell wall of woody plants is very thick.

Structure and Chemical Composition:

Thickness of cell wall varies in different cells of plants. It is composed of three main layers:

(i) Primary wall (ii) Secondary wall (iii) Middle lamella.

Middle Lamella:

The middle lamella is first to be formed in between primary walls of neighbouring cells.

* *It **holds** adjacent cells together.*

Primary Wall (Outer):

The primary wall is composed of many layers formed of ***cellulose*** with some deposition of ***pectin and lignin***. * (PC-L).

- In each layer the cellulose fibers run parallel to one another but at same angle to those in the first layer.
- Thus cellulose molecule show a crisscross (zigzag) arrangement.

- The primary wall is a true wall and developed in newly growing cells.

Secondary Cell Wall (Inner):

The secondary cell wall is formed on its inner surface and is comparatively *thick and rigid.*

* Chemically, it is composed of ***inorganic salts***, ***silica***, ***waxes*** and **cutin** etc.

FUNCTION

(1) **Protection:** Cell wall provides protection from drying environment.

(2) **Stiffness:** It gives stiffness to the cell.

(3) **Definite Shape:** It gives a definite shape.

(4) **Prevent from Swelling:** It prevents plant cell from swelling and bursting as a result of osmosis when it is in a medium of higher potential.

(5) **Not a Barrier (Freely Permeable):** It does not act as a barrier to the materials passing through it. Water various ions and small molecules can pass freely through ***tiny pores*** in cell wall.

(6) **Antigenic Properties:** The cell wall (in bacteria) also has a antigenic properties caused by both proteins and polysaccharides.

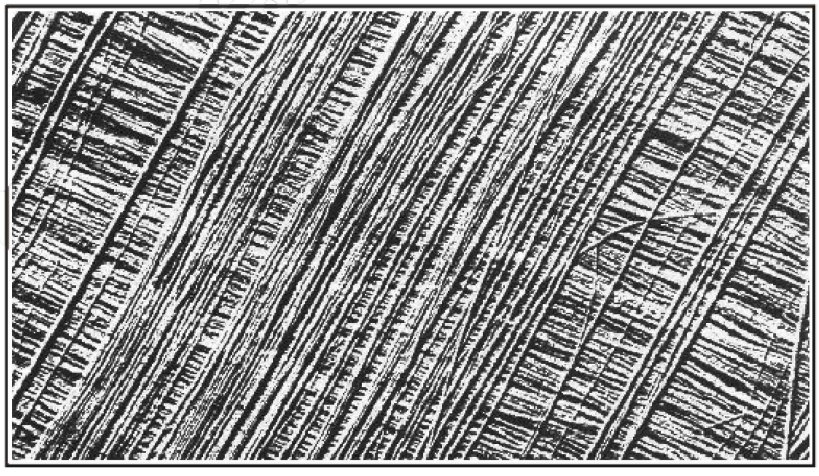


Fig. Secret of the strength of plant structure is revealed by electron microscope photographs of the cell walls. The cellulose fibers are arranged in layers, with the fibres of each layer at right angle to those of other layers.

Q.12 Describe the structure and function of cytoplasm.

Ans. **CYTOPLASM**

The word *cytoplasm literally means living gel (plasm)* "of the cell" (cyto). *It is a fluid portion of the cell lying outside the nucleus and inside the cell membrane.*

The living contents of eukaryotic cells are divided into nucleus and cytoplasm, the two collectively form protoplasm.

MAJOR COMPONENTS:

The **major components** of ***cytoplasm are:***

(i) **A gel like fluid**

(ii) **Storage substances**

(iii) **A network** of interconnected filaments (microfilamets and microtubules) and fibers (intermediate fibers), collectively called *cytoskeleton.*

(iv) **Cell organelles** e.g., mitochondria. plastids golgi bodies, lysosomes, vacuoles etc.

(v) The free floating cell organelles like mitochondria move about in cytoplasm due to cytoplasmic ***streaming movements***. This is an active mass movement of cytoplasm.

CYTOSOL

Cytoplasm has an aqueous ground substance called cytosol. Chemically it is about 90% of water and *forms a solution* having all the fundamental molecules of life. In the ***cytosol***, small molecules and ions form *true solutions* and larger molecules from *colloidal solutions*. Colloidal solutions may be in the form of a ***sol (non viscous)*** or ***a gel (viscous)***.

Peripheral parts of the cells are often like a gel.

FUNCTION OF CYTOPLASM:

(i) ***Store house.*** Cytoplasm serves as store house of vital materials/chemicals e.g. glycogen in the liver cell.

(ii) ***Metabolic Pathway:*** It is a site of certain metabolic pathways (e.g. glycolysis). [Glycolysis means breakdown of glucose into pyruvic acid]

(iii) ***Maintains the Shape:*** The cytoskeleton present in the cytoplasm not only *maintains the shape* of the cell but also helps in the *movement of cell organelles.*

Q.13 Describe the structure and function of endoplasmic reticulum.

Ans. **ENDOPLASMIC RETICULUM**

"The network of channels or tubules extending between nuclear membrane and cell membrane which performs the functions like detoxification, transport and protein synthesis".

The channels seems to be in contact with plasma membrane as well as nuclear membrane. The entire system or channels is the endoplasmic reticulum. These membranes vary widely in appearance from cell to cell. The materials present in these channels is separated from cytoplasmic materials by the spherical or tubular membranes, called cisternae.

Types of Endoplasmic Reticulum:

There are two types of endoplasmic reticulum on the basis of their appearance:

(i) Rough endoplasmic reticulum (**RER**) having ribosome at its surface.

(ii) Smooth endoplasmic reticulum (**SER**) *without ribosomes.*

FUNCTIONS:

(1) **Mechanical Support:** Due to flexible nature of plasma membrane and ability to extend into the cytoplasm, it has connections with nuclear envelope, golgi apparatus etc. which helps to provides mechanical support to the cell.

(2) **Transportation of Materials:** *Smooth endoplasmic reticulum* also plays an important role in the transport of materials from one part of the cell to the other.

(3) **Synthesis and Transportation of Proteins:** The *rough E.R.* is involved in the synthesis and transportation of cellular proteins.

(4) **Detoxification:** *Smooth endoplasmic reticulum* due to its own enzyme system metabolizes or destroys the toxic substances like steroids, carcinogenic etc.

(5) **Synthesis of Lipids:** The *smooth endoplasmic reticulum* synthesizes different types of lipids which are used for the formation of plasma membrane and steroid hormones like testosterone and estrogens. Glycogen and glycolipids are also synthesized here

(6) **Site of New Membrane:** Endoplasmic reticulum being the site for synthesis of proteins and lipids are also considered to be primary site of new membranes.

(7) **Transmission of Nerve Impulse:** The *smooth endoplasmic reticulum* of the muscle cells is developed and is involved in the transmission nerve impulse which initiates muscle contraction.

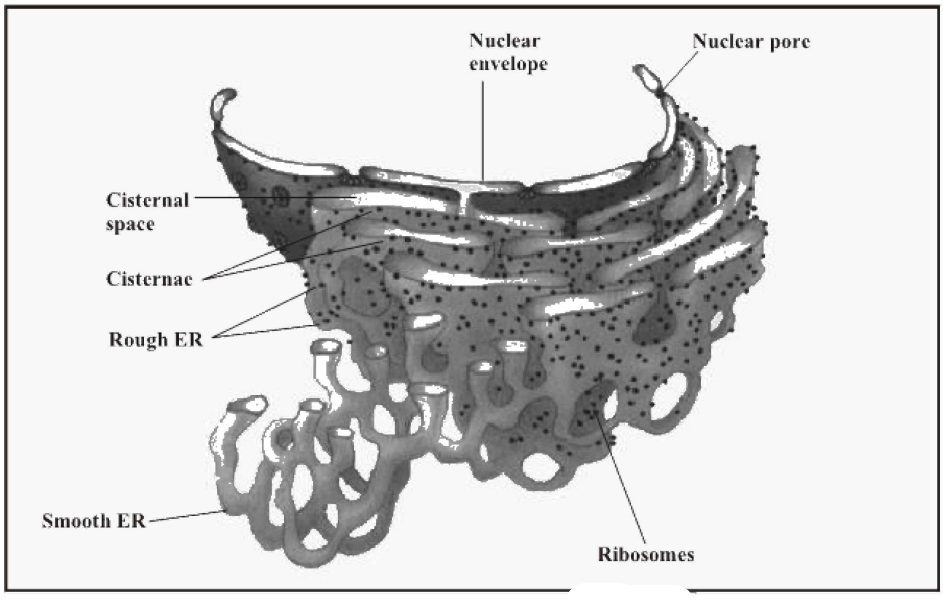


Fig. Rough endoplasmic reticulum is marked by he presence of ribosomes attached to the membranes of endoplasmic reticulum. Proteins synthesized on ribosomes are pushed into channels of endoplasmic reticulum, from where they are transported to Golgi Apparatus, on their way out of the cell

Q.14 Describe the structure and function of Ribosomes.

Ans. **RIBOSOMES**

"The non membraneous cell organelles with two sub units and involve in proteins synthesis are called ribosomes".

Composition:

These are tiny granules first studied by Palade in 1955. They are composed of about 60% RNA and 40% protein (i.e. ribonucleoprotein). This RNA is of ribosomal type.

Location:

The ribosomes exist in two forms:

(i) Freely scattered in cytoplasm (ii) Attached with rough endoplasmic reticulum.

New ribosomes are assembled in the nucleolous of the nucleus from where they are transported to the cytoplasm via the pores in nuclear membrane:

The factory of ribosome is the nucleolous.

While the factory of protein synthesis is the ribosome.

Size:

Their size is always about the same; from 150 to 2000 A° in diameter.

PARTICLES OF RIBOSOMES:

Eukaryotic Ribosomes:

Each eukaryotic ribosomes is composed of two sub units. The larger sub unit sediments at 60S (S=swedbarg unit which specifies sedimentation rate of specific particles or molecule in medium during ultracentrifugation) with smaller sub unit sediments at 40S. Two sub units on attachment with each other form ***80S*** particles. This attachment is controlled by the presence of Mg++ ions.

Prokaryotic Ribosomes:

Bacterial ribosomes exist in the cell as 70S particles, but they can be broken down to smaller 50S and 30S.

"If several ribosomes are to the same stretch of mRNA the resulting structure is called ***polysome***"

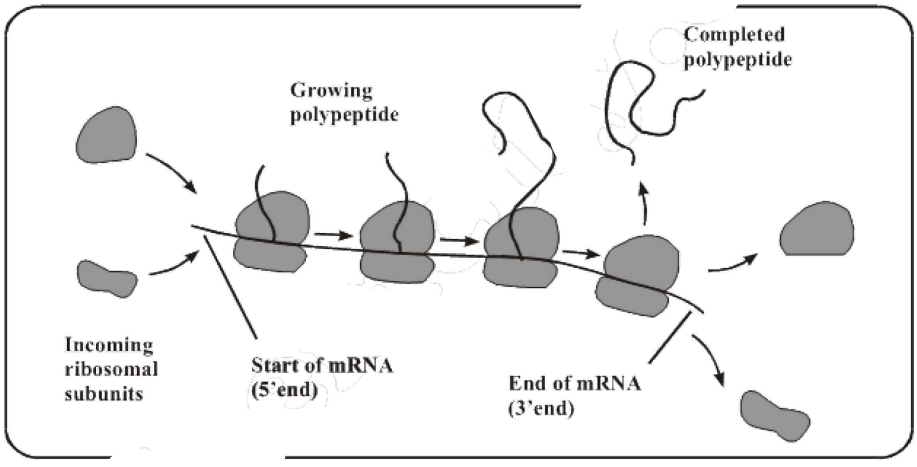


Fig. mRNA attached to ribosomes forming polysomes

Function:

The ribosomes are concerned with the synthesis of protein.

Q.15 Describe the structure and function of Golgi Apparatus.

Ans. **GOLGI APPARATUS**

Structure:

They were discovered by **Camillo Golgi** in 1898, so called golgi complex or apparatus.

The term golgi apparatus refers to a set of smooth membranes that are stacked into flattend, fluid filled sacs called cisternae, **containing proteins, carbohydrates, glycoprotein and specific enzymes.**

In plant they are also known as dictyosomes.

Most of the Golgi apparatus is formed of *flattened sac or cisternae* but some tubules and vesicles may also participate in the formation of Golgi complex. The number of fluid filled flattened sacs may range from 3-7 in most of the animals but the lower organisms may have up to 30 flattened sacs.

These flattened sacs are arranged in a concentric fashion, the convex sac lie closer to the nuclear membrane and are termed as *cis-golgi or forming face.* The farthest concave sacs are named as *trans-golgi or maturing face.*

Functions:

(1) Secretion:

The main function of the golgi complex is cell secretion. Secretions are produced within the cell on ribosomes and then passed to the outside through endoplasmic reticulum and golgi apparatus. The *secretions are converted in to* ***finished products*** and are packed inside membrane, before export.

(2) Storage of Proteins:

The exportable proteins synthesized by the ribosomes are passed to endoplasmic reticulum and stored in the golgi apparatus.

(3) Formation of Glycolipid and Glycoprotein:

The carbohydrates, lipids and proteins synthesized by the endoplasmic reticulum are modified as glycolipid and glycoprotein within golgi complex.

(4) Cell Wall Formation.

Golgi bodies are involved in the formation of new cell wall.

(5) Formation of Digestive Granules:

In mammals the golgi bodies have a role of in the formation of ***certain granules secreted by pancreas****. These granules have enzymes that help in digestion.*

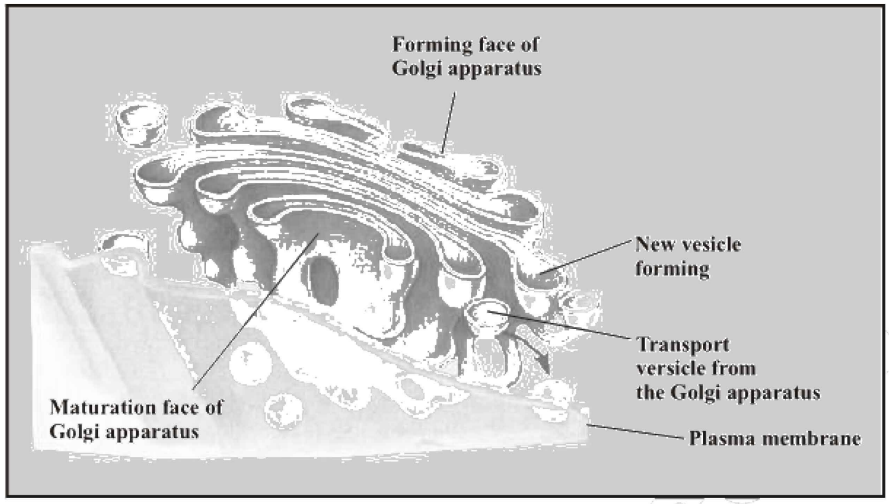


Fig. This figure shows relationship of endoplasmic reticulum with Golgi Apparatus, lysosome and plasma membrane, golgi Apparatus has two ends, forming face and Maturation Face. Blebs from tips of SER fuse with Golgi Apparatus cisternae at Forming Face, whereas secretory granules (transport vesicles) are pinchedoff at the Maturation Face of Golgi Apparatus. The arrows show the direction of flow of protein product synthesized on ribosomes. These proteins are converted into glycoproteins in the Golgi apparatus.

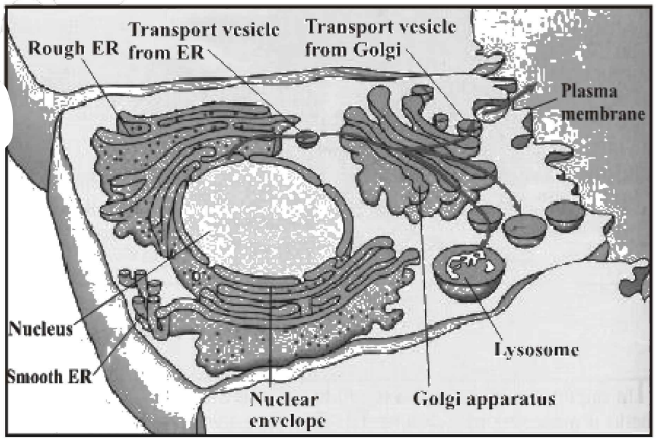
Q.16 Describe the structure and function of Lysosomes.

Ans. **LYSOSOMES**

A. STRUCTURE: ***"The cytoplasmic organelles bounded by single membrane and are simple sacs".*** Lysosomes (***lyso=splitting, so...=body***) were first discovered by De Duve in 1949. They are found in most of eukaryotic cells. They are rich in acid phosphatases and hydrolytic enzymes such as *proteases, nucleases and lipases.*

Size:

In animal cell lysosomes are commonly 0.1-0.5 um in diameter. Their no. varies from 15 to 20 per cell.



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Origin From Vesicles of Golgi Complex:

(1) *Lysosomes are often derived from vesicles of golgi apparatus.*

(2) Acid phosphatases and other hydrolytic enzymes are taken to golgi apparatus where they are further processed and budded off as golgi vesicles. These vesicles are called *Primary lysosomes.*

(3) When primary lysosomes fuse with food vacuole, they digest the food particles and become residual body secondary lysosomes (autophagosome).

B. FUNCTIONS

(1) Phagocytosis:

Any foreign object that gains entry into the cell, immediately engulfed by the lysosomes and is completely broken into simple digestable pieces. This process is called phagocytosis.

(2) Intra-Cellular Digestion:

They are involved in intracellular digestion since they have enzymes to digest the phagocytosed food particles present in food vacuoles.

(3) Extra-Cellular Digestion:

They also help in extra cellular digestion by releasing enzymes.

(4) Exocytosis: (Cell Egestion / Excretion)

Sometimes enzymes or primary lysosomes are released from the cell. *This occurs during the replacement of cartilage by bone during development.* Similarly the matrix of bone may be broken down during the remodeling of bone that can occur in response to injury, new stresses and so on.

(5) Autophagy: (Self Eating)

It is a process by which unwanted structures e.g. damaged mitochondria etc. within the cell are removed. Unwanted structures are first enclosed by a single membrane, usually derived from smooth endoplasmic reticulum. Then this structure fuses the unwanted materials and digests.

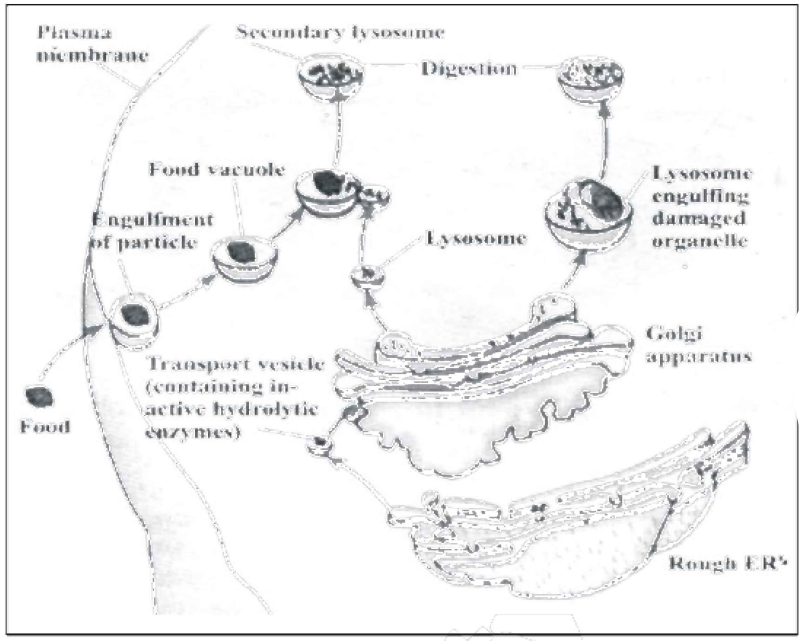

Fig. Lysosomes protect the cells from invading organisms or any other foreign object, (food) which are engulfed in the cell as phagocytic vacuoles. These fuse with primary lysosomes to form digestive vacuole (secondary lysosome in which various lysosomal enzymes digest various componenets of the vacuole. Some time under abnormal circumstances, e.g. starvation, or as normal physiological process the parts of the cell are engulfed by primary lysosomes and digested to generate energy. The lysosomes which eat parts of its own cell are known as autophagosomes. The digestive vacuoles and autophagosomes are also known as secondary lysosomes.

Q.17 Write a note on storage disease or congenital diseases produced by a mutation that effect of the lysosomal enzymes.

Ans. **AS STORAGE DISEASES OR CONGENITAL DISEASES**

Several congenital diseases, have been found to be *due to accumulation within the cell* of substances such as *glycogen* or various *glycolipids*. These are also called ***storage diseases,*** and are produced by a mutation that affect one of the lysosomal enzymes involved in the catabolism of a certain substances. About twenty such diseases are known these days. Which are because of absence of a particular enzyme.

(ii) Glycogenosis Type-II Disease (*Due to absence of D- Glucosidase*):

In this disease liver and muscle appear filled with glycogen with in membrane bound organelles. *D-glucosidase* the enzyme that *degrades glycogen to glucose is absent.*

(iii) Tay-Sach's Disease (*Lipid storage in brain cells*)

Tay-Sach's disease is due to ***absence of hexaseamidase*** *that* is involved in the *catabolism of lipids*. Accumulation of lipids in brain cells lead to mental retardation, and even death.

Q.18 Write a note on Peroxisomes.

Ans. **PEROXISOMES**

"Single membraned cell organelle in which large amount of oxidative enzymes are found".

De-Duve and co-workers isolated in 1965 *particles from liver cells* and other tissues which were enriched with some oxidative enzyme, such as *peroxidase, catalase D-amino acid oxidase, glycolic acid oxidase* and *orate oxidase.* They have also been found in protozoa, yeast and many cells of higher plants. These are single membrane enclosed cytoplasmic organelles found *both in animal and plant cells.*

Diameter and Number:

They are approximately 0.5 um in diameter. The average diameter of peroxisome in liver is 0.6-0.7 um. There number varies between 70-100 per cell.

FUNCTION (Formation and Decomposition of H_2O_2):

(i) The name peroxisome was applied because this organelle is specifically involved in the formation and decomposition of hydrogen peroxide (H_2O_2) in the cell.

(ii) Catabolic and Anabolic Pathway:

In plants, peroxisomes play important role in both catabolic and anabolic paths.

(iii) Producing Oxidases and Catalase.

These are characterized by containing H_2O_2-producing oxidases and catalases.

(iv) Contain β oxidation:

Liver peroxisomes also contain *β oxidation system for oxidizing long chain fatty acid.*

The short chain fatty acids are oxidized in mitochondria.

Q.19 Write a short note on glyoxisomes.

Ans. **GLYOXISOME**

"Plant cell organelle which contain enzymes like glycolic acid oxidase and catalase etc. are called glyoxisome".

Abundant in Plant Seedling:

This organelle is present in plants, which in addition to glycolic acid oxidase, and catalase, also posses a number of enzymes that are not found in animal cells.

This organelles, called glyoxisome is most abundant in plant seedling which rely upon stored fatty acids to provide them with the energy and materials to begin the formation of a new plant.

Primary Activities:

One of the primary activities in these germinating seeding is the conversion of stored fatty acids to carbohydrates. This is achieved through a cycle, glyoxylate cycle, the enzymes of which are located in the glyoxisome.

Fatty Acids ⟶ Carbohydrates

In Seed:

In seed, rich in lipids such as *castor bean* and *soybean*, glyoxisomes are the site for *break down of fatty acid to succinate.*

Fatty Acids ⟶ Succinate

Short Period in the Germination:

This organelle is present only during short period in the germination of the ***lipid rich seed***, Glyoxisomes are ***absent in lipid poor seed*** such as ***pea***.

Q.20 Describe the structure and function of vacuoles.

Ans. **VACUOLES**

"The single membranous nonliving cell organelles involve in storage to rigidity and support etc. are called vacuoles".

In Animal and Plant Cell:

Vacuoles are present both in animal and plant cells, but they are particularly large and abundant to plant cells often occupying a major portion of the cell volume and forcing the remaining interacellular structures into a thick peripheral layer.

Single Membrane:

These vacuoles are bounded by a single membrane and are formed by coalescence of small vacuole during the plants growth and development.

FUNCTIONS

To Expand: Vacuoles serve to expand the plant cell without diluting its cytoplasm.

Site for Storage: Vacuole performs function as sties of storage of water and cell products or metabolic intermediates.

Provides Support: The plant vacuole is the major contributor to the turgor pressure that provides support for the individual plant cell and also contributes the rigidity to leaves and younger parts of the plants.

Q.21 Write a short note on cytoskeleton.

Ans. **CYTOSKELETON**

Unbranched cylindrical structures which are made by protein and involves in internal structures and movement contraction and relaxation etc.

Cytosol is made up cytoskeletal fabric formed of microtubules, microfilaments and intermediate filaments. The main proteins that are present in cytoskeleton are *tubulin actin, myosin, tropomyosin* and others which are also found in muscles.

(i) Microtubules: Microtubules are long unbranched cylindrical structures.

It has an average ***diameter of about 0.25 nm***.

The structures are made primarily by the self assembling of tubulin protein.

Constituents of Cilia, Flagella, Basal Bodies and Centrioles:

Several cell organelles are derived from special assembled of microtubules, for example cilia, flagella, basal bodies and centrioles. One very important function of microtubules is their role in the assembly and disassembly of the spindle structures during mitosis. They also provide internal structures.

(ii) Microfilaments:

Microfilaments are considerably more *slender cylinders* made up of *contractile protein* ***actin*** and linked to the inner face of the plasma membrane (***they are narrower than microtubules***). They are involved in internal cell motion e.g. movement of ***cyclosis*** and amoeboid movements are because of microfilaments

(iii) Intermediates Filaments:

They are ***8-10 nm in diameter***. Intermediate filaments are involved in determination of cell shape and integration of cellular compartments.

Q.22 Describe structure and function of centriole.

Ans. **CENTRIOLE**

Location: Animal cells and cells of some microorganisms are lower plants contain two centrioles located near the exterior surface of the nucleus. *They are absent in higher plants.*

Structure: In cross section each centriole consists of a cylindrical *array of nine microtubules*. However, each of the nine microtubules is future composed of three tubules. The two centrioles are usually placed at right angle to each other.

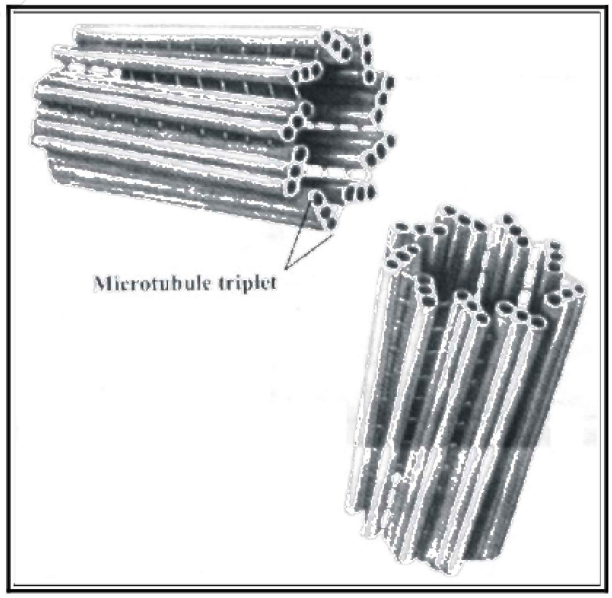

Fig. Centrioles are made up of nine microtubule triplets

Functions:

Help in Cell Division: Just before a cell divides, its centrioles duplicate is

one pair migrates to the opposite side of the nucleus. The spindles then form then centioles play important role in the location of furrowing during cell division is in the formation of cilia.

Q.23 Describe structure and function of mitochondria.

Ans. **MITOCHONDRIA** **(Power House)**

Double membranous cell organelle which acts as power house due to metabolic processes is called mitochondria.

They are involved in the *manufacture and supply of energy to cells*

Location: Mitochondria are found in the cytoplasm of all the eukarvotic ceus. Except in mature RBC of multicultural organisms.

Shape: Mitochondria may be spiral or spherical , elongate , cup-shaped and even branched . They are usually larger in active cells than in less active ones.

Size: Their length ranges from 1.5- lum and width 0.25-1.00 um, but their diameter does not exceed 1um.

Number: The no of mitochondria per cell varies considerably and depends on they type of organism and nature of the cell.

Structure:

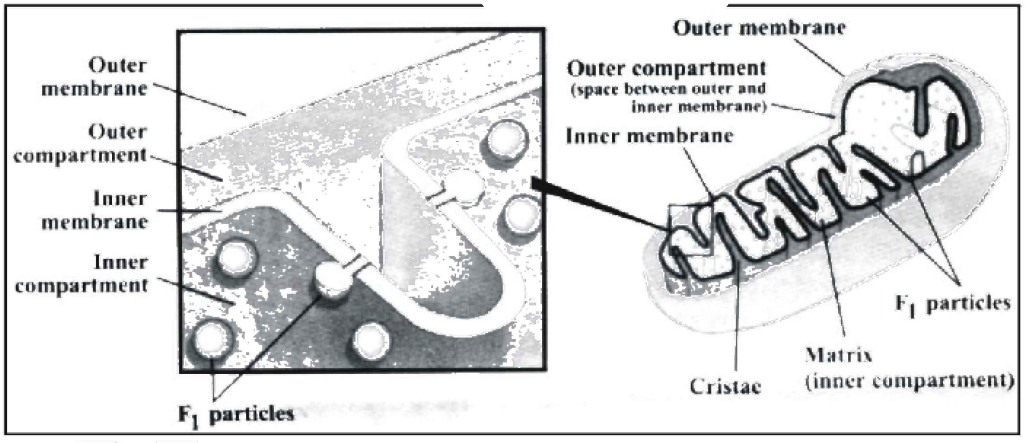

Fig. Diagrammatic representation of a mitochondrion cut longitudinally. The main features are shown. A cristae is made of lipoprotein membrane containing different enzymes as well as F1 Particles embedded in it. After a special processing the inner mitochondrial membrane is ruptured and the F1 particles come out on the surface.

mitochondria	Mitochondria (sing. mitochondrion) phosphate granule ribosome matrix cristae envelope (two membranes) circular DNA	Surrounded by an envelope of two membranes, the inner being folded to form cristae. Contains a matrix with a few ribosomes, a circular DNA molecule and phosphate granules.	In aerobic respiration cristae are the sites of oxidative phosphorylation and electron transport, and the matrix is the site of Krebs cycle enzymes.

Double Membranous: A mitochondrion is bound by two membranes the outer membrane is smooth while the inner membrane form infolding into the inner chamber called ***Cristae***.

The mitochondrial membranes are similar in structure to other cell membranes.

DNA: Detailed studies have shown that mitochondria also contains DNA indicate that some proteins are synthesized in them. It is a self replicating organelle.

F1 Particle: The inner surface of cristae in the mitochondrial matrix has small ***knob like*** structures known as F1 particles . Mitochondrial matrix contain in it a large number of enzyme. Coenzyme and organic and inorganic salts which help in several vital metabolic processes like *Kreb's cycle, aerobic respiration, fatty aid metabolism etc.*

FUNCTIONS

As Power House: As a result of metabolic processes occurring in mitochondria . The energy extracted from the organic food is transformed into energy rich compound ATP(adenosine triphosphate) and the ATP then provides energy to the cell on demand. This energy is used for various cellular activities . *The spent energy, which is in the form of ADP is regenerated by mitochondria into ATP.* Mitochondria is therefore described as power house of the cell.

Q.24 What are Plastids? Describe different types of Plastids or explain the structure and function of different types of plastids.

Ans. **PLASTIDS**

Double membranous pigment containing organelle which involves in photosynthesis is called plastids.

Plastids are present *only in plant cell.* There are three main types of plastids

(1) **CHLOROPLAST**

The *green pigment containing plastid* in plant cell is called chloroplast . The green pigment is an organic compound called chlorophyll, which helps the cell to absorb light energy and utilized it to manufacture food. Chloroplast are ***self replicating organelles***.

Chlorophyll:

Chlorophyll molecule resembles the haem group of haemoglobin, a protein used in the transport of oxygen. The main difference between these two molecules is that chlorophyll has Mg++ while haem has Fe++ as a central atom.

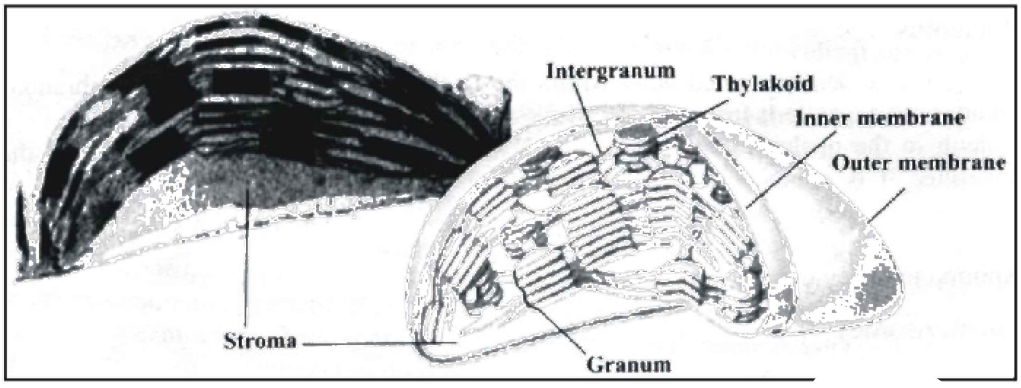

Fig. Diagram of chloroplast showing the main structural components

Shape and Size: Chloroplast vary in their shape and size with a decimeter or out 4-6 um.

Grana: In the mature chloroplast heterogeneous structures with small granules known as grana. Chloroplast shows three

(i) The envelope (ii) Stroma (iii) Thylakoid

(i) **Envelope:** The envelope is formed by *double membrane* while stroma covers most of the colume of the chloroplast.

(ii) **Stroma:** *The fluid which surrounds the thylakoid in the chloroplast is called stroma.* It contains proteins some ribosome and small circular DNA. It is in this part of the chloroplast where CO_2 is fixed to manufacture sugar. Some proteins are also synthesized in this part.

(iii) **Thylakoids:** The flattened vesicles which arrange themselves to form grana ***and intergrana*** in the chloroplast. A granum appears to be a pile of thylakoid stacked on each other like coins. On the average, there are 50 or more thylakoids piled to form one ***granum***. On the layers of thylakoids chlorophyll molecules are arranged is that is why granum appears to be green .Each granum is interconnected with other by the non green part called *intergranum.*

Membranes of grana are the sites where sunlight energy is trapped and ATP is formed.

(2) CHROMOPLAST

The colourful kind of plastids in the coloured parts of plants is called chromoplast. They colours to the plants other than green. They are present in the **petals** of flower and in the **ripened fruit**. They help in pollination and dispersal of seeds.

(3) LEUCOPLASTS

The *colourless* kind of plastids is known as leucoplast. They are **triangular tubular** or of some other shape. They are found in the **underground parts** of the plants and store food.

THINKING ROOM

Table Eukaryotic Cell Components

Category	Name	Composition	Function
Nucleus	Nucleus	Nuclear envelope surrounding the nucleoplasm, chromosomes, and nucleoli	Cellular reproduction and control of protein synthesis
	Nucleolus	Concentrated area of chromatin, rRNA, and proteins	Ribosome formation
Granule-like particle	Ribosome	Protein and rNA in two subnits	Protein synthesis
Membranous canals and vacuoles	Endoplasmic reticulum (ER)	Membranous flattened channels and and tubular canals	Synthesis of macromolecules and transport by vesicle formation
	Rough	Studded with ribosomes	Protein synthesis
	Smooth	No ribosomes	Various, lipid synthesis in some cells
	Golgi apparatus	Stack of membranous saccules	Processing, packaging, and secretion of proteins
	Vacuole and vesicle	Membranous sacs	Storage of substances
	Lysosome	Membranous vesicle containing digestive enzymes	Intracellular digestion
Energy-related organelles	Mitochondrion	Inner membrane (cristae) within outer membrane	Aerobic cellular respiration
	Chloroplast*	Grana within inner and outer membranes	Photosynthesis
Cytoskeleton	Microtubule Intermediate filament Actin filament	Network of protein tubules and filaments	Cell shape and movement
Centrioles and related structures	Centriole**	9 + 0 pattern of microtubules	Microtubule organization, forms basal bodies
	Cilium and flagellum	9 + 2 pattern of microtubules	Movement of the cell

Q.25 Describe the structure and function of nucleus.

Ans.

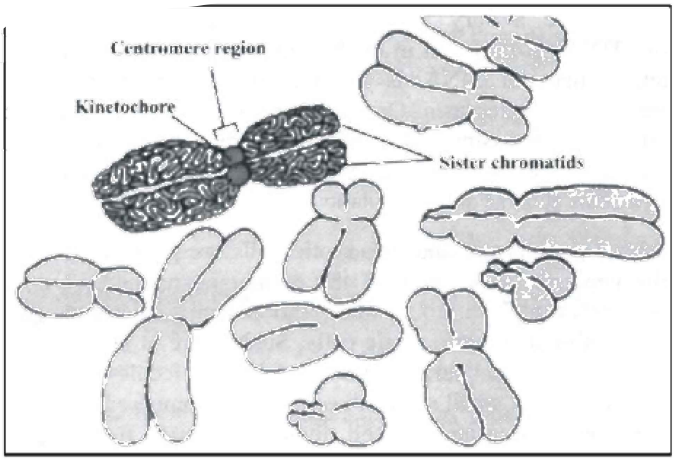

Fig. Structure of chromosome and its shape

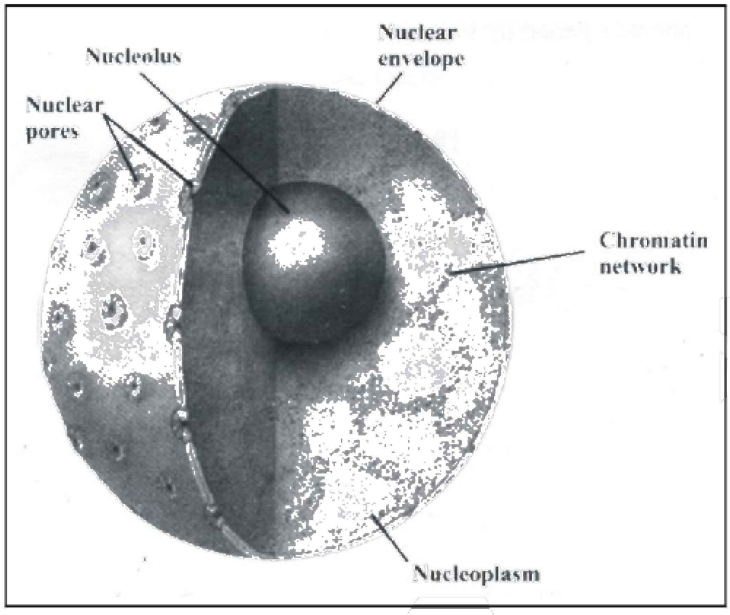

Fig. Structure of nucleus

Ans. **NUCLEUS** ***"The organelle which controls the activities of life and genetics etc. is called nucleus."***

Nucleus was discovered in **1831** by ***Robert Brown***.

- It controls the life activities of cell in cell, It is generally **occupies the central space**
- In case of plant cells it is pushed towards periphery due to the presence of a large vacuole.
- Nucleus may be **irregular or spherical** in **shape**.
- Generally the cells with one nucleus are called uninucleate.
- The *cell with two nuclei are* ***binucleatie***.
- The cell with more than two as ***multinucleated***.
- Nucleus is only visible when the cell is in non dividing stage.
- In dividing cells the nucleus disappears and the chromatin material is replaced by chromosomes
- Nucleus consists of ***nuclear membrane, nucleoli, nucleoplasm*** and ***chromosomes***.

Nuclear Membrane:

- Nucleus is surrounded by a nuclear membrane which *separates the nuclear materials* from the cytoplasm.
- The nuclear membrane is actually *a nuclear envelope composed of two membranes.*
- The outer membrane is at places continuous with the endoplasmic reticulum, while the inner membrane is at places continuous with the endoplasmic reticulum while inner membrane encloses the nuclear content.
- The outer and the inner membranes are continuous at certaing points resulting in the formation of pore the *nucleus and the cytoplasm.*
- The no of nuclear pores is highly variable. The undifferentiated cells (such as eggs) have numerous pores (about 30,000 per nucleus),whereas differentiated cell such as erythrocytes have only 3 or 4 pores/***nuclears***. Each pore has a definite structure which controls the traffic of substances passing through them.

Nucleoplasm:

The *soluble sap and chromatin network in the nucleus,* and is without any membraneous boundary to separate it form the rest of nuclear material. There may be one or more nucleoli in nucleus.

Synthesis of rRNA:

The ribosomal RNA (rRNA) is synthesized and stored in the nucleolous. It is composed of two regions, the peripheral granular area composed of precursors of ribosomal sub-unit and the central fibril consisting of large molecular weight RNA and rDNA . It is the nucleolus where ribosome are assembled and are then exported to cytoplasm via nuclear pores.

Chromosomes ***"The thread like structures which contain DNA and histone protein, act as hereditary bodies are known as chromosomes."***

Nucleus is often deeply stained with basic dyes because of chromatin material is converted into darkly stained thread like structures.

Chromosomes appear to be made of chromatids (arms) and centromeres.

2, Chromatids + 1, centromere = 1 chromosomes

Centromere:

Centromere is the place on the chromosomes where spindle fibers are attached during cell division. Each chromosome attacks with spindle fibre by centromere. Each chromosome consists of two identical chromatids at the begning of cell division (*chromatid is exact replica of the chromosomes*) Which are held together at contromere.

Composition and Function

A chromosome is composed of DNA and proteins.All the information necessary to control the activities of the cell is located on the chromosomes in the form of genes which are transferred from one generation to the other.

Number of Chromosomes:

All the organism of same species have same or equal no of chromosomes and remain constant generation after generation. The no of chromosomes in the normal body cells are diploid (2n), where in germ cells chromosomes are haploid.

Organism	In Somatic cells	In sex cells
	(2n)	(n)
Man	46	23
Frog	26	13
Chimpanzee	48	24
Fruitfly	8	4
Onion	16	8
Potato	48	24
Garden Pea	14	7

Q.26 Describe the differences similarities between Prokaryotic and Eukaryotic cells.

Ans. **PROKARYOTIC AND EUKARYOTIC CELL**

Biologists have divided cells into two types:

Prokaryotic and eukaryotic.

The differences between these two types of cells are mainly based upon the structure of their nuclei.

DNA of Eukaryotic and Prokaryotic:

Eukaryotes have a very well defined nucleus, in which nuclear material (chromosomes or DNA) is enclosed in double nuclear membrane. In prokaryotic cells, however the genetic material (DNA) is without any nuclear membrane covering and is directly submerged in the cytoplasm.

Prokaryote and Eukaryotes:

Organisms possessing prokaryotic cells are called Prokaryotes and those possessing eukaryotic cells are called Eukaryotes.

Examples: Prokaryotes include bacteria and blue green algae. Eukaryotes include all other unicellular or multicellular organisms such as animals, plants, fungi and protista.

Organelles:

Prokaryotic cells generally lack many of the membrane bounded structures found in eukaryotic cells. For example, mitochondria, endoplasmic reticulum, chloroplasts and Glogi apparatus are absent in prokaryotic cells. Since there is no nuclear membrane, a prokaryotic cell has no distinct nucleus and its DNA molecule is directly suspend in cytoplasm.

Sizes of Ribosomes:

Prokaryotes have small sized ribosomes 70S while eukaryotes has 80S.

Cell Division:

In prokaryotes mitosis is missing and the cell divides by binary fission. Because of their simpler structure, it was widely accepted for a long time that prokaryotic cells represent a more primitive stage of evolution than eukaryotic cells.

Cell Wall:

The most distinctive feature of the prokaryotic cell is its cell wall, composed of polysaccharide chains bound covalently to shorter chains of amino acids forming peptidogly can or murein. The entire cell wall is often regarded as a single huge molecular complex called **sacculus**. The cell wall of plants is generally made up of cellulose and is differently structured than that of a bacterium.

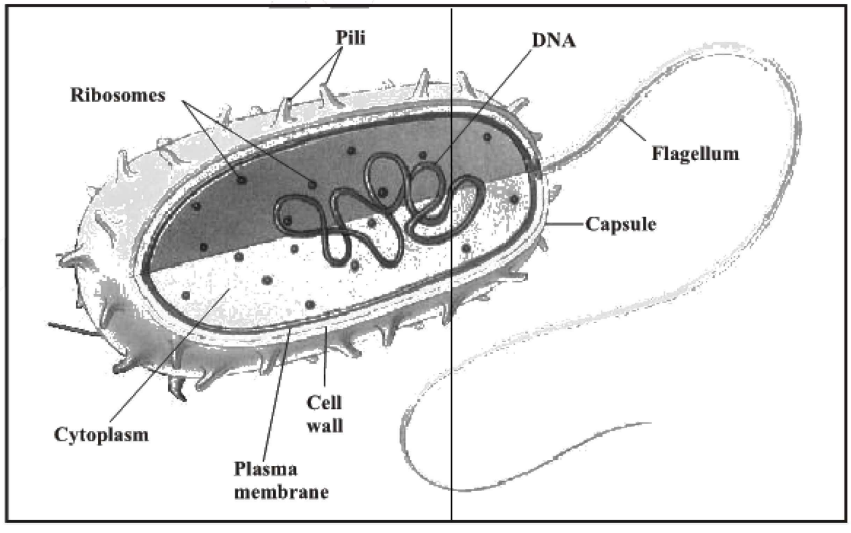

Fig. Generalized Prokaryotic cell