CHAPTER 4

CHAPTER 4

THE CELL

LONG QUESTIONS

EMERGENCE AND IMPLICATION OF CELL THEORY

Q.1: Define cell discuss brief discovery of cell theory.
→ Who formulated the cell theory finally?
→ State Cell Theory and discuss its emergence.

Ans. CELL

Definition:

"Cell is the basic structural and functional unit of life. It is the smallest unit that can carry all activities of life. Cells are building blocks of complex multi-cellular organisms"

HISTORY OF DISCOVERY OF CELL:

(i) Robert Hooke:

Study of cell (cell biology) began with the discovery of cell by Robert Hooke (1665), who reported his work in his famous publication '***Micrographia***'.

- He prepared and studied thin sections of cork (consisting dead plant material) under his self-made compound microscope.
- He observed that the cork is composed of minute honeycomb like compartments, which he termed as '**Cells**'.
- According to Hooke, cell is an empty space bounded by thick walls.

Fig. The microscopic structure of a piece of cork

Q: Write the name of Rober hook publication. (LHR-G2)-16)

(ii) Lorenz Oken:

LorensOken (1805) was a German scientist, who believed that **"all living beings originate from or consist of vesicles or cells"**.

(iii) Jean Baptist de-Lamarck:

He in 1809 expressed an idea similar to Lorenz and said **"no body can have life if its constituent parts are not cellular tissues or are not formed by cellular tissues."**

(iv) Robert Brown:

In 1831, Robert Brown reported the presence of **nucleus** in the cell. Due to this discovery Hook's idea about the cell as an empty space was changed. It was later established cell is not an empty space.

(v) Schwann &Schleiden:

A German zoologist Theodor Schwann (1839) and a German botanist Schleiden (1838), working independently, came out with a theory called the **Cell Theory**. They divided cell into three parts i.e. nucleus, cytoplasm (the fluid surrounding the nucleus) and cell / plasma membrane (an outer thin covering or membrane). They differentiated plant cell having cell wall from animal cells in which cell wall is absent. Keeping in view this definition of cell, the cells could be observed in plants as well as animal according to the cell theory, all living things are composed of cells and cell products.

(vi) Rudolph Virchow:

He was a German physician. In 1855, he hypothesized that **new cells were formed only by the division of previously existing cells (To put it in Virchow's words, "Omnis cellulaecellula"** and thus rejected the idea of abiogenesis. (formation of living ones from non living abruptly).

(vii) Louis Pasteur:

Louis Pasteur 1862, one of the greatest scientists of all times, ***experimental proof for Virchow's hypothesis*** by demonstrating that microorganisms (bacteria) could be formed only from existing bacteria.

(viii) August Weismann:

In 1880, he 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.

Cells are basically similar but extraordinary versatile. Cell is not only the structural but also the functional unit of living organisms. So, cell theory is a very important unifying concept.

Q.2: Write importance of Microscopy.

➔ Give role of microscope in biology?

Ans. IMPORTANT OF MICROSCOPE IN BIOLOGY

Observations in biology can be made with naked eye or with use of microscope.

Human Eye:

The human naked eye can differentiate between two points, which are at least 1.0 mm apart. This is known as resolution power of the eye. This resolution can be increased with the aid of lenses.

Compound Microscope:

A compound microscope is a typical laboratory microscope with at least different magnifying powers.

- ★ In a typical compound microscope, the resolution is 2.0 µm, which is about 500X that of the naked eye.
- ★ It consists of two lenses i.e. ocular and objective.
- ★ Typical ocular lenses could be 5X and 10X, but others also exist.
- ★ There are different type of objectives e.g. 20X, 40X and 100X etc.
- ★ The magnifying power of microscope is determined by multiplying X values of ocular lens and X values of objective lens. Therefore a microscope with 10X ocular lens and 40 X objective lens will have (10 X 40 = 400X) 400 X magnifying power.
- ★ Source of illumination in compound microscope is visible light.

Electron Microscope:

- ★ Resolution of electron microscope ranges between 2-4 Angstrom.
- ★ Resolution of electron microscope is 500X more than compound microscope and 250,000X greater than that of naked eye.
- ★ Source of illumination is beam of electrons.

Q. How magnification power of microscope is calculated.
(SGD-G2)-16

Q.3: Write down the salient features of cell theory.

➔ Cell as a unit of structure and function! discuss?

Ans. THE CELL THEORY

Introduction:

The cell theory is of the most fundamental generalizations in biology. It states that all living beings (animals and plants) are composed of cells and cell products.

Presentation:

The cell theory was presented by a botanist named Schleiden (1838) and a zoologist named Schwann (1839).

Salient Features:

The salient features of the cell theory in its present form are:

(1) All organisms are composed of one or more cells.

(2) All cells arise from pre-existing cells.

(3) Cell is the basic structural and functional unit for all organisms.

Q. Write down the silent feature of cell theory. (LHR-G1)-14, (BWP-G1)-16, (RWP-G1)-16

Importance:

- It has wide ranging effect in all fields of biological research.
- It has been established that every cell is formed by the division of another cell
- It shows that function of whole organisms is the result of the activities and interactions of the cell and its components.
- Progress in biochemistry confirmed that there are fundamental similarities in the chemical composition and metabolic activities of all cells.

CELL AS A UNIT OF STRUCTURE AND FUNCTION

Cell:

Q: Define cell theory. (SGD-G2)-16

A cell is defined as structural and functional unit of organism.

DIVISION OF LABOUR:

In multi-cellular organisms, there is a division of labour among cells. The function of the organism as a whole is the result of the sum of activities and interactions of different cells and of different components of the cell. Different cells are specialized for different functions in animals.

(i) **Examples in Animals:**

- **Muscle cells**: contract and relax
- **Nerve cells:** transmit impulses
- **Gland cells:** secrete
- **Red blood cells:** carry oxygen
- **Some gastric cells:** secrete gastric juice.

(ii) **Examples in Plants:**

- **Xylem cells:** conduct water and mineral salts from soil to the aerial parts of plants.
- **Phloem cells:** translocate food
- **Sclarenchymatous cells:** give support to the plant.
- **Chlorenchymatous cells:** carry out photosynthesis.
- **Parenchymatous cells:** store surplus food
- **Meristematic cells:** produce new cells for growth and development of the plant.

As animal and plant cells mentioned above show great variation in shapes and sizes, they have a common plan of organization.

Q.4: What is cell fractionation? Give its steps.

Ans. CELL FRACTIONATION

The modern technology by which we can isolate various components of cell including its organelles is called ell fractionation. After this we can study their structure and function in detail under electron microscope.

OR

During cell fractionation the tissues are homogenized or disrupted with special instruments and the various rts of the cells are separated by density gradient centrifugation.

llowing steps are involved in cell fractionation.

Disruption:

The tissues are homogenized or disrupted with special instruments.

(ii) Spinning:

The homogenized or disrupted cells are made to spin in a special medium in a centrifuge at high speed.

(iii) Density Gradient Centrifugation:

The various cellular parts separate out in different layers depending upon their size, weight and density of the medium.

Some cellular components require very high speeds for separation from other parts of the cells. This is achieved through ultracentrifugation.

STRUCTURE OF A GENERALIZED CELL

Q.5: What is the structure of generalized cell? Give types of cell.

➔ What is a difference between prokaryotic and eukaryotic cell.

Ans. A cell consists of the following basic components:

(a) Plasma membrane, also a cell wall in plant cells.

(b) Cytoplasm, containing cell organelles.

(c) Nucleus, with nuclear or chromatin material.

Q. Give a comparison of prokaryotic and eukaryotic cells. (SWL-GI-2014)

TYPES OF CELLS:

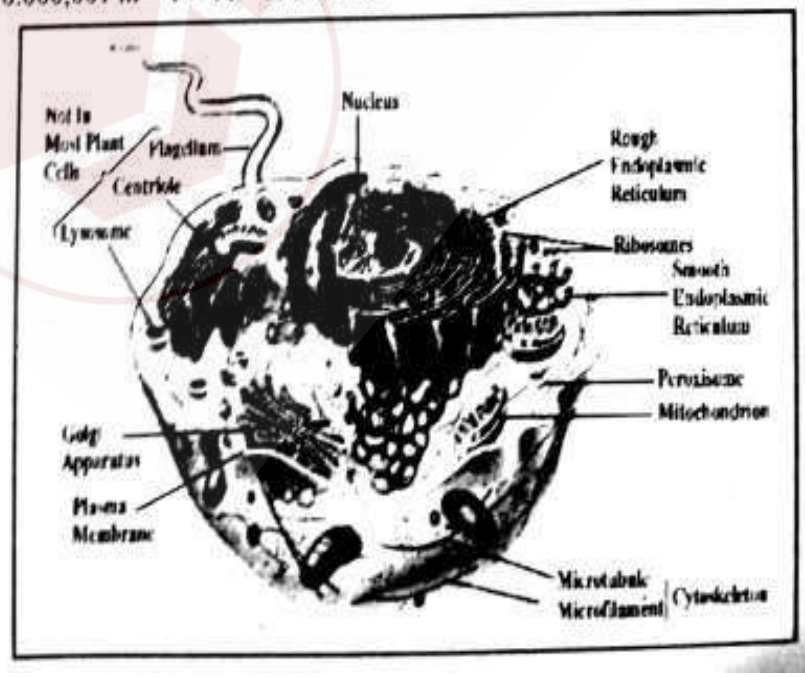
There are two main types of cells i.e. prokaryotic and eukaryotic cells.

(i) Prokaryotic Cell:

- ★ A prokaryotic cell is a primitive type of cell lacks a definite nucleus and their nuclear material is directly submerged in the cytoplasm which is not separated from it by membranes.
- ★ These cells are present in prokaryotes.
- ★ Example is bacteria.

(ii) Eukaryotic Cell:

- ★ A eukaryotic cell has a distinct nucleus (chromatin material is bounded by a membrane).
- ★ These are present in eukaryotes i.e. plants and animals.
- ★ These cells are complex and vary greatly in size.
- ★ They could be as big as an Ostrich's egg.
- ★ Most of the cells are microscopic and are not visible to the naked eye. Their size is measured in micrometer (μm).
- ★ 1 μm = 0.000,001 m = 1×10^{-6} of a meter.



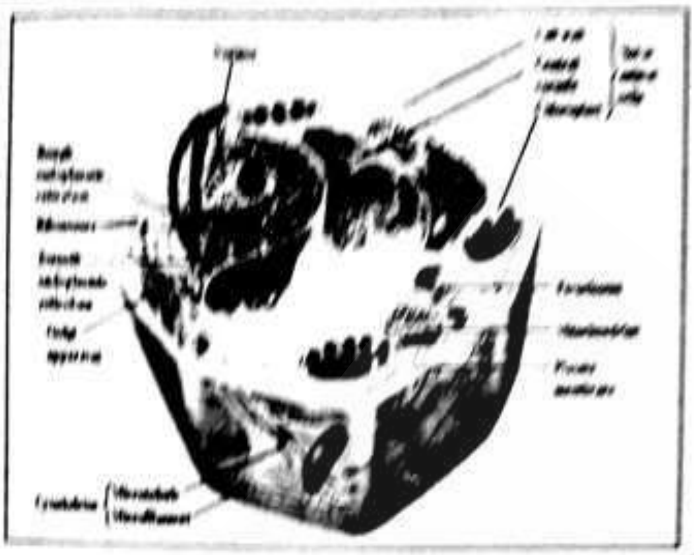


Fig. Electron micrograph structure of an animal cell

Q.6: Discuss plasma membrane in detail.

→ Write note on differentially permeable membrane.

Ans. PLASMA MEMBRANE

Introduction:

It is also known as cell membrane. It is the outermost layer in the animal cell but lies beneath the cell wall in plant cell.

It is thin, delicate, elastic and capable of limited self-repair.

Chemical Composition:

Cell membrane is chemically composed of lipids and proteins.

- 60 – 80% are protein
- 20 – 40% are lipids
- very small quantity of carbohydrate

Q. Describe Fluid Mosaic Model and functions of plasma membrane.
(BWP-G1)-16, (LHR-G1)-14,(LHR-G2)-17

Q. Describe the structure and function of plasma membrane.
(AJK, SWL-GI-2016; RWP-14)

Q. Write a detailed note on Plasma Membrane and give its composition.
(MTN-G2)-10,(RWP-G1)-15

Physical Structure:

Many biologists contributed in describing the arrangement of lipids and proteins in cell membrane.

There are two important models about it i.e.

(1) Unit membrane model

(2) Fluid mosaic model

These are described here briefly:

(1) Unit Membrane Model:

Generally it was believed that plasma membrane is composed of lipid bilayer sandwiched between two protein layers. This is called unit membrane model by Robertson.

This basic structure is found in all the cellular organelles such as those of mitochondria, chloroplasts etc.

(2) Fluid Mosaic Model:

The modern technology has revealed that lipid bilayer is not sandwiched between two protein layers. The protein layers are not continuous and are not confined to the surface of the membrane but are embedded in lipid layers in a mosaic manner. Instead proteins are embedded in the lipid bilayer in a mosaic manner.

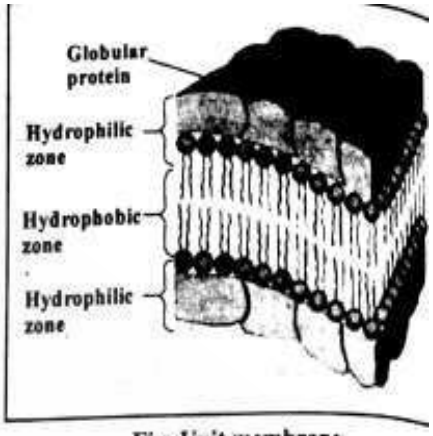


Fig. Unit membrane

This model is called fluid mosaic model and is most accepted now.

According to this cell membrane also contains charged pores through which movement of material takes pla both by active and passive transport.

FUNCTIONS OF CELL MEMBRANE:

(i) Mechanical Support:

It provides mechanical support to the protoplasm.

(ii) External From:

It provides external form to cell.

Q. Cell membrane is selectively permeable member justify it. **(MTN-G1)-16**

(iii) Transportation:

Transport of materials, which is vital for cell, occurs through cell membrane. It offers a barrier between t cell contents and their environment allowing only selective substances to pass through it. Thus it is also known differentially permeable or selectively permeable membrane.

(iv) Regulation of Materials:

It regulates the flow of materials and ions to maintain definite gradient across it.

- The substances, which are lipid soluble, cross it more easily.
- Many small gas molecules, water, glucose etc being neutral can easily cross.
- Ions, beings charged particles have some difficulty in crossing.

(v) Active Transport:

Many substances, which are not needed, enter the cell by passive transport other are taken up against t concentration gradient (they move from the area of low concentration to the area of high concentration). This uph movement of materials requires energy and is termed as active transport. The energy for this transport is provided ATP.

(vi) Endocytosis:

In many animal cells, the cell membrane helps to take in materials by infolding in the form of vacuoles. Th type of intake is termed as endocytosis. It may be:

- ★ Phagocytosis – ingestion of solid material
- ★ Pinocytosis – ingestion of liquid material

(vii) Exocytosis:

The outward transportation of materials from the cell then such process is called exocytosis e.g. transport waste material or secretions across the membrane.

(viii) Conduction:

In neuron (nerve cells), the cell membrane transmits nerve impulse from one part of the body to the other keep coordination.

Q.7: Write a note on cell wall.

→ Discuss characteristics, structure and functions of cell wall.

Ans. CELL WALL

Characteristics:

(1) It is the outermost boundary in plant cells.

(2) It is absent in animal cells.

(3) It is secreted by protoplasm of the cell.

(4) Its thickness varies in different cells of the plant.

(5) Cell wall of plant cell is different from that of prokaryotes both in structure and chemical composition.

Q. Write a note on Cell Wall. **(MTN-GII-2014)**

Q. Write major component of cell wall of Fungi. **(FBD-G1)-14**

Structure:

Cell wall is composed of:

(i) Primary wall (ii) Middle lamella

(iii) Secondary wall

(i) Primary Wall:

The primary wall is composed of:

Cellulose and some deposition of pectin and hemicelluloses.

Cellulose whose molecules are arranged in a criss-cross arrangement

Some amount of **pectin** is also present.

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

(ii) Middle Lamella:

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

(iii) Secondary Wall:

The secondary wall is formed on inner surface of primary wall. It is comparatively thick and rigid as compared to primary wall.

Chemically it is composed of:

- Inorganic salts
- Silica
- Waxes
- Lignin
- Cutin etc.

Prokaryotic cell wall lacks cellulose; its strengthening material is peptidoglycan or muerin. Fungal cell contain chitin.

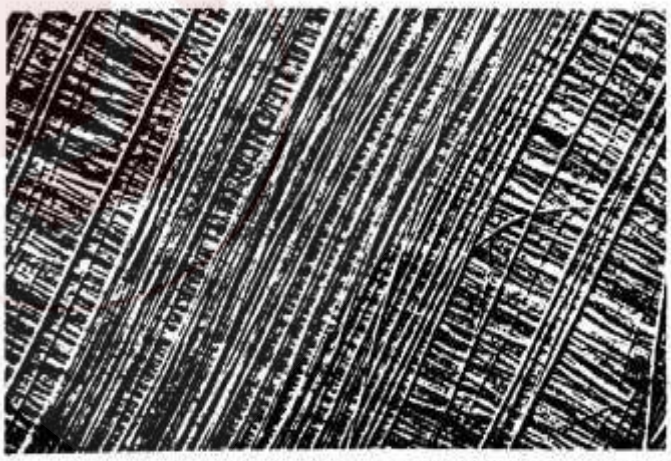


Fig. Secret of the strength of plant structure is revealed by electron microscope photographs of the cell walls. The cellulose fibers are arranged in layers, with the fibres of each layer at right angle to those of other layers.

Functions of Cell Wall:

Cell wall is very important. It performs following important functions:

(1) It provides a definite shape to the cell.

(2) It makes cells rigid.

(3) It provides protection to inner parts of cell.

(4) It does not act as a barrier to the materials passing through it.

Q.8: Write a note on cytoplasm.

→ What are functions of cytoplasm.

Ans. CYTOPLASM

Inner to the cell membrane lies cytoplasm, which contains many organelles. The living contents of the eukaryotic cells are divided into nucleus and cytoplasm, the two collectively form protoplasm. Cytoplasm consists of an aqueous ground substance containing a variety of cell organelles and other inclusions such as insoluble wastes and storage products.

Composition:

Cytoplasm contains:

(i) Cytosol

(ii) Fundamental molecules of life

(iii) Cell organelles

Q. What is Cytosol. (FBD-G1)-14

(i) Cytosol:

It is the soluble part of cytoplasm. Chemically, it is about 90% water and forms a solution containing all the fundamental molecules of life.

(ii) Fundamental Molecules of Life:

- Some of them are in ionic form.
- Small molecules and ions may form true solutions.
- Some large molecules form colloidal solutions. Colloidal solution may be sol (non-viscous) or gel (viscous). Peripheral region is mainly gel.

(iii) Cell Organelles:

In living cells, the cytoplasm contains several cell organelles such as endoplasmic reticulum, mitochondria, Golgi complex, nucleus, plastids, ribosomes, lysosomes and centrioles.the free floating cell organelles e.g. mitochondria move about in cytoplasm due to cytoplasmic streaming movements. This is an active mass movement of cytoplasm.

Function of Cytoplasm:

Q. Write function of cytolasm. (LHR-G1)-15, (AJK-G1)-16

The most important functions of cytoplasm are:

(1) It acts as a store house of vital chemicals.

(2) It is a site of certain metabolic pathways e.g. Glycolysis.

Q.9: Write a note on endoplasmic reticulum.

→ Explain types of endoplasmic reticulum.

Ans. ENDOPLASMIC RETICULUM

Introduction:

Endoplasmic reticulum is a network or channels, which is continuous with plasma membrane at one end and also appears to be in contact with the nuclear envelope.

Structure:

- Endoplasmic reticulum is visible with electron microscope as a network of channels extending throughout the cytoplasm.
- They vary widely in appearance from cell to cell.
- These channels are filled with material, which is separated from the cytoplasmic material by the spherical or tubular membranes, called cisternae.

Q. Write a detailed note on Endoplasmic Reticulum.
(FBD-GI-14: DGK, LHR-GII-15: SGD-GI-16)
Q. Discuss the structure and functions of endoplasmic reticulum.
(LHR-GI-2014)

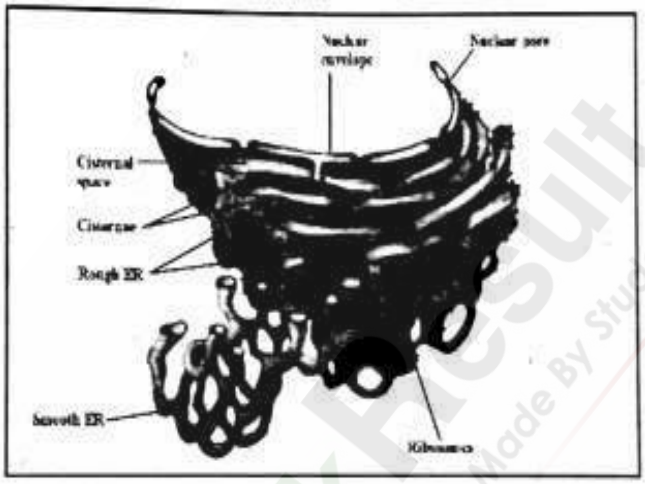


Fig: Rough endoplasmic reticulum is marked by the presence of ribosomes attached to the membranes of endoplasmic reticulum. Proteins synthesized on ribosomes are pushed into channels of endoplasmic reticulum, from where they are transported to Golgi apparatus, on their way out of the cell.

Functions:

(i) It provides mechanical support to the various cellular organelles in cytoplasm so that its shape is maintained.
(ii) It plays an important role in transport of materials from one part of the cell to other.

Forms:

There are two morphological forms of endoplasmic reticulum i.e.
(i) Rough form with attached ribosomes.
(ii) Smooth form without ribosomes.

Q. How many type of endoplasmic reticulum are present?
(BWP-G1)-15

(i) **Rough Endoplasmic Reticulum (PER)**

On this form, ribosomes are attached, so it is called as rough endoplasmic reticulum.

Functions:

It is involved in the synthesis of proteins. After synthesis, the proteins are either stored in the cytoplasm or exported out of the cell through these channels.

(ii) **Smooth Endoplasmic Reticulum (SER):**

This form of endoplasmic reticulum is without ribosomes, so called as smooth endosplasmic reticulum.

Functions:

(i) It helps in metabolism of a number of different types of molecules particularly lipids.
(ii) It also helps to detoxify the harmful drugs.
(iii) In some cells, it is responsible for transmission of impulses e.g. muscle cells, and nerve cells.
(iv) It also plays an important role in transport of materials from one part of the cell to the other.

Q.10: Write a note on ribosomes.

Ans. RIBOSOMES

> **Q. Write a note on Ribosomes.** (LHR-G2)-15,(GUJ-G1)-12
> **Q. Where are ribosome assembled.** (DGK-G1)-16
> **Q. What is meant by submits of ribosomes.** (MTN-G)-15

Introduction:

These are tiny granular structures present in cytoplasm.

Discovery:

Palade (1955) was the person, who first time discovered and studied them.

Production:

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

Chemical Composition:

Eukaryotic ribosomes are composed of almost an equal amount of

- ★ rRNA
- ★ Proteins

Due to presence of rRNA and proteins, these are also called as ribonucleoprotein particles.

Forms:

Ribosomes exist in two forms:

- ★ Freely dispersed in cytoplasm
- ★ Attached with the endoplasmic reticulum as tiny granules.

Structure:

Each eukaryotic ribosome consists of two sub units.

- ★ Larger subunits sediment of 60S.
- ★ Smaller subunits sediment at 40S.

Two subunits on attachments, with each other form 80S particles. This attachment is controlled by Mg^{2+} ions.

S = Svedberg unit which specifies sedimentation rate used in ultracentrifugation. The ribosmoes are attached to messenger RNA through small ribosomal subunit. A group of ribosomes attached to mRNA and form a structure called Polysome.

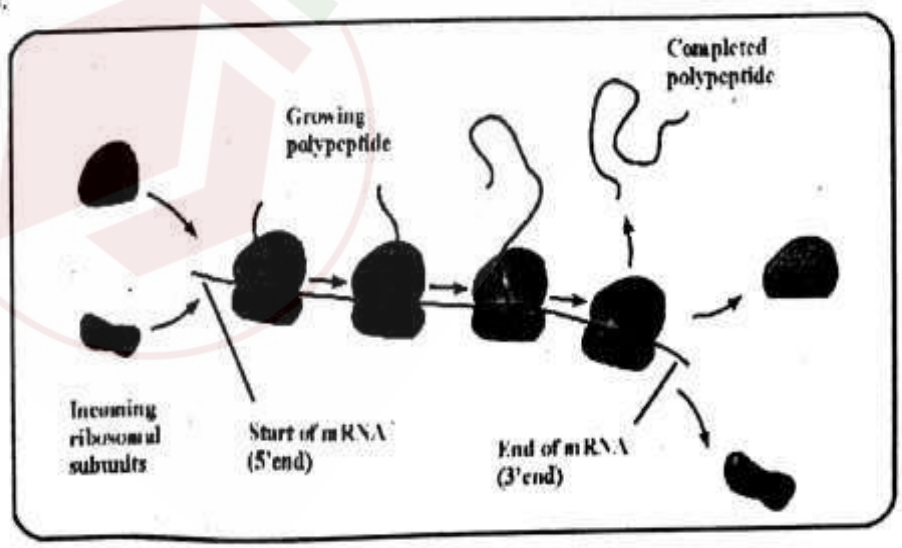


Fig: mRNA attached to ribosomes forming polysomes.

Function:

Ribosomes are involved in the synthesis of proteins.

Q.11: Write a note on Golgi Apparatus.

Ans. GOLGI APPARATUS

Introduction:

Golgi apparatus is also known as Golgi bodies or Golgi complex. In plants, these are also called as Dictyosomes. This apparatus was found virtually in all eukaryotic cells.

Discovery:

Golgi apparatus was discovered by Golgi in 1898.

> **Q. Describe structure and function of Golgi Apparatus in a Cell.**
> **(MTN-GI-2015)**
> **Q. Write a note on Golgi apparatus.**
> **(MTN-GI-2016: FBD-13)**

Structure:

- Golgi complex is formed by cisternae alongwith associated vesicles.
- Cisternae are stacks of flattened, membrane-bounded sacs.
- Associated vesicles are complex system of interconnected tubules the central stacks.
- These are produced by budding of SER and are gathered around cisternae.
- The whole stack consists of a number of cisternae though to be moving outer to the inner face.
- Their outer convex surface is the forming face, while the inner concave surface is the maturing face. Vesicles are separated from cisternae from maturing face.

Functions:

(i) Cell Secretions:

Golgi complex is concerned with cell secretions. Mechanism of formation of these products is as:

- Formation of products within the cell on ribosomes
- Transport to Golgi Apparatus
- Conversion into finished products
- Packing of finished products inside membrane
- Export to outside through Golgi bodies or Endoplasmic reticulum.
- For example in mammals, the pancreas secretes granules containing enzymes that help in digestion. The Golgi complex has a role in formation of these granules.

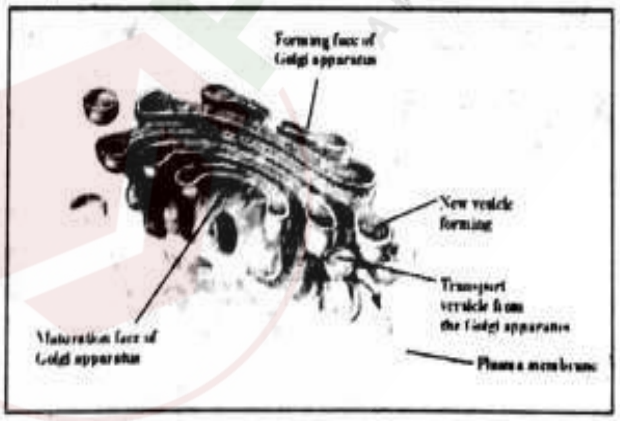


Fig: Golgi Complex

(ii) Transport Outside the Cell:

The proteins or enzymes, which have to be transported out of the cell, pass through the Golgi Apparatus.

(iii) Modification in Molecules:

The most important function is to modify the proteins and lipids by adding carbohydrates and converting them into glycoproteins and glycolipids.

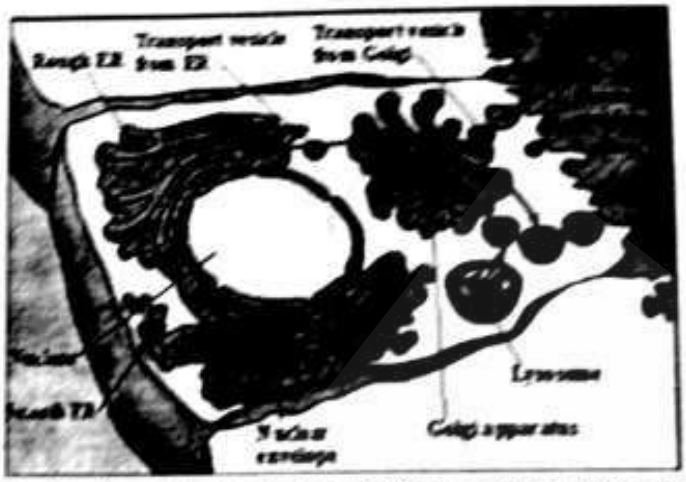


Fig: This figure shows relationship of endoplasmic reticulum with Golgi Apparatus, lysosome and plasma membrane. Golgi Apparatus has two ends, Forming Face and Maturation Face. Blebs from tips of SER fuse with Golgi Apparatus cisternae at Forming Face, whereas secretary granules (transport vesicles)are pinched off 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 glycoprotein in the Golgi Apparatus

Q.12: Write a note on lysosomes.

→ Give functions and diseases related to lysosomes.

→ What happen if some lysosomal enzymes are absent? Explain with example.

Ans. LYSOSOMES

Introduction

The word 'Lysosomes' has been derived from two words i.e. '**Lyso**' means splitting and '**soma**' means body

These were isolated as separate components from the first time by De Duve (1949). These are mostly found in eukaryotic cells and are most abundant in these animal cells which exhibit phagocytosis.

Structure

They are bound by a single membrane and simple sacs rich in acid phosphates and several other hydrolytic enzymes. These enzymes are synthesized on R.E.R and are further processed in the Golgi apparatus. The processed enzymes are budded off as Golgi vesicles and are called as primary lysosomes.

Functions:

(i) Pagocytosis

Any foreign object that gains entry into the cell is completely broken into simple digestible pieces. This process is known as phagocytosis (eating process of cell). They also contain enzymes, which can digest the phagocytosed food particles.

Q. Give three functions of smooth endoplasmic reticulum.
(GUJ-G1)-14,(MTN-G1)-15

Q. Give functions of lysosomes.
(LHR-G1)-14

(ii) Autophagy

They are also involved in autophagy (self eating). During this process, some old, worn out parts of cell, such as old mitochondria are digested. In this way, materials of cell may be recycled and cell may be renewed.

(iii) Degeneration

Their enzymes can also result in degeneration of cell, as may occur during some developmental processes.

Q. Define Endocytosic.
(LHR-G1)-14, (LHR-G1), (LHR-G2)-16

(iv) Extracellular Digestions

They also release enzymes for extra cellular digestion.

Q. Define congenital disease.
(RWP-G1)-15

DISEASES RELATED TO LYSOSOMES

Several congenital diseases have been found results from accumulation within the cell of substance such as glycogen or various glycolipids. These are also called storage diseases and are produced by a mutation that affects one of the lysosomal enzymes involved in the catabolism of a certain substance. For example:

- **About twenty** such diseases are known these days, which are because of absence of particular enzymes.

Q. Define storage disease.
(SWL-G1)-14, (LHR-G1)-15

- In **glycogenosis type II disease**, the liver and muscles appear filled with glycogen within membrane bounded organelles. In this disease, an enzyme that degrades glycogen into glucose is absent.
- **Tay-Sach's** disease is because of absence of an enzyme that is involved in the catabolism of lipids. Accumulation of lipids in brain cells lead to mental retardation and even death.

Q. Define TaySach's disease.
(MTN-G1)-16

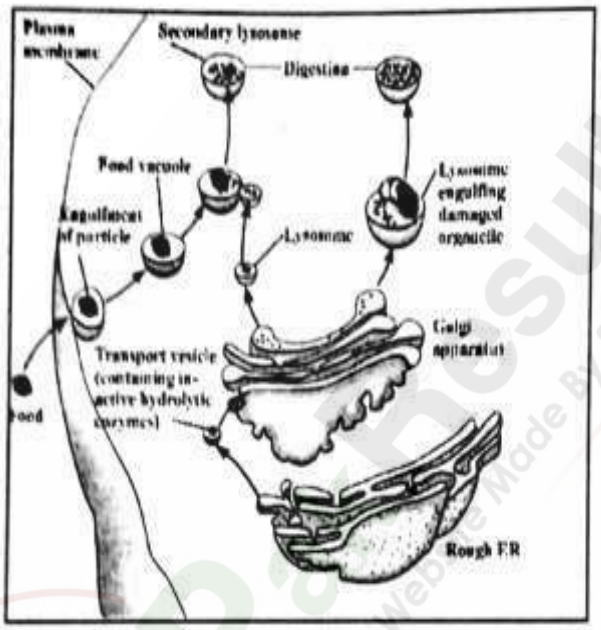


Fig. Lysosomes protect the cells from invading organisms or any other foreign object, (food) which are engulfed in the cell as phagocytic vacuoles. These fuse with primary lysosomes to form digestive vacuole (secondary lysosome) in which various lysosomal enzymes digest various components of the vacuole. Some time, under abnormal circumstances, e.g. starvation, or as a 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.13: Write a note on peroxisomes, glyoxysomes and vacuole.

Ans. PEROXISOMES

The name peroxisome (peroxi-peroxide & soma-body) has been given because this organelle is specifically involved in the formation and decomposition of hydrogen peroxide in the cell.

Q. What is peroxisomes.
(FBD-G1)-14, (LHR-G1)-15

Discovery:

These were isolated by **De-Duve** and his coworkers in 1965 from liver cells and other tissues, which were enriched with some oxidative enzymes, such as peroxidase, catalase, glycolic acid oxidase and some other enzymes.

Q. What is of peroxisomes.
(LHR-G1)-15, 16

Characteristics:

- ★ These are **single membrane** enclosed cytoplasmic organelle found both in animal and plant cells.
- ★ They are characterized by **containing H_2O_2-producing oxidases and catalases.**
- ★ They are approximately **0.5 μm in diameter**.
- ★ They have also been found in protozoa, yeast and many cell types of higher plants.

Functions:

The name peroxisome was applied because these are involved in the **formation and decomposition of hydrogen peroxide** in the cell, which is used in various metabolic reactions.

GLYOXISOME

Introduction:

- ★ These are found ***only in plant cells*** and absent in animals cells.
- ★ These are most abundant in plant seedlings.
- ★ They appear for only short period of time during germination of the lipid-rich seed such as castor oil, bean and soyabean and are absent in lipid-poor seed such as the pea.

Q. Write a note on Glyoxysomes.
(LHR-GI-2015)

Q. What are Glyoxysomes? Give their structure and functions.
(MTN-GI-2013)

Composition:

These are single cell organelle, which is addition to glycolic and oxidase and catalase, also possess a number of enzymes that are not found in animal cells.

Function:

- ★ In plants, they play important role in both catabolic and anabolic activities.
- ★ In germinating seedlings, enzymes of glyoxisome are important in conversion of stored fatty acids to carbohydrates especially succinate through a cycle called glyoxylate cycle.

VACUOLE

Introduction:

Vacuole are present both in animal and plant cells.

- ★ **In plant cells**, vacuole are large and few in number, often occupying a major portion of cell and pushing intracellular structures into a thin peripheral layer.
- ★ **In animal cells**, these are small but numerous in numbers.

Formation:

The vacuoles are bounded by a single membrane and are formed by the coalescence of smaller vacuoles during the plants growth and development. In plants, smaller vacuoles combine to form a larger vacuole.

Function:

- ★ They serve to expand the plant cell without diluting its cytoplasm.
- ★ They function as sites for the storage of water and cell products or metabolic intermediates.
- ★ The plant vacuole is major contributor to the turgor that provides support for the individual plant cell and contributes to the rigidity of the leaves and younger parts of the plants.

Q.14: Write a note on cytoskeleton and centrioles.

Ans. ## CYTOSKELETON

Cytosole contains cytoskeletal fabrics formed of microtubules, microfilaments and intermediate filaments all constituting cytoskeleton.

Composition:

Cytoskeleton is made by different proteins. The main proteins that are present in cytoskeleton are tubulin (in microtubules), actin, myosin, tropomyosin and others, which are also found in muscles.

Q. Write a note on cytoskeleton.
(LHR-GI-2011, 13)

TYPES OF CYTOSKELETAL FIBRES:

(i) **Microtubules:**

- These are long, unbranched and slender tubulin protein structures.
- Their important role is in assembly and disassembly of the spindle structure during mitosis.
- Several cell organelles are derived from special assemblies of microtubules.
- They are also involved in formation of cilia, flagella and basal bodies.

(ii) **Microfilaments:**

- These are more slender cylindres made up of contractile action protein, linked to inner face of the plasma membrane.
- They are involved in internal cell motion e.g. movement of cyclosis and amoeboid movement.

(iii) **Intermediate Filaments:**

- They have diameter in between those of microtubules and microfilaments.
- They play role in maintenance of cell shape and integration of cellular compartment.

CENTRIOLE

Introduction:

Animal cell and the cells of some microorganisms and lower plants contain two centrioles located near the exterior surface of the nucleus and absent in higher plant. They are usually placed at right angle to each other (triplets).

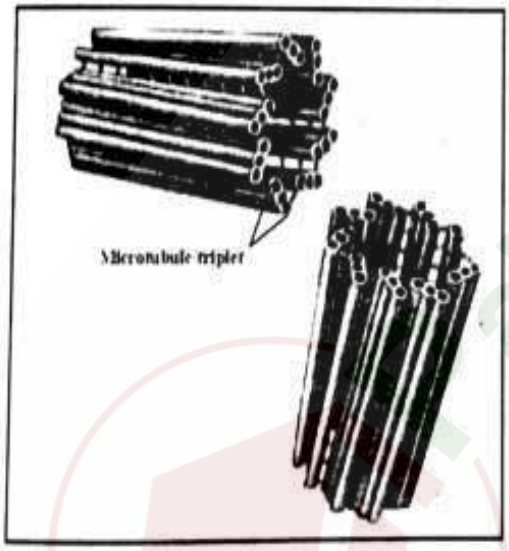


Fig: Centrioles are made up of nine microtubule triplets

Q. Give any two important function of centriols. (GUJ-G2)-15
Q. What is location of centriols. (GUJ-G1)-15

Structure:

In cross-section, each centriole consists of a cylindrical array of 9 microtubles. Each of the 9 microtubules is further composed of three tubules. The centrioles are usually placed at right angle to each to other.

Function:

Centrioles are involved in *cell division.* Just before cell divides, its centrioles ***duplicate and one pair migrate*** *to the opposite side of the nucleus.* The spindle then forms between them. Centrioles play important role in location of furrowing during cell division, and in formation of cilia.

Q.15: Write a note on mitochondria. Give its functions.

Ans. MITOCHONDRIA

Introduction:

Mitochondria are very important organelle of the eukaryotic cell because they are involved in the manufactu and supply of energy to the cell. They are also known as **powerhouses** of the cell.

Mitochondria are self-replicating organelles.

Q. Describe the structure and function of Mitochondria.
(SGD-GII, FBD-GI-2015: LHR-GI-16: SWL-GII-14)

Q. Show the Similarities and differences in structure and functions of Mitochondria and Chloroplasts.
(DGK-GI-2015)

Q. Write a note on Mitochondria.
(MTN-GI-2016)

Q. Write a note on Mitochondria.
(BWP-2013)

Q. Write a note on mitochondria.
(FBD-GI-2014)

Structure:

- ★ Under compound microscope they appear to be vesicles, rods or filaments.
- ★ Under electron microscope, they show a complex morphology.
- ★ Their number and size varies and depends on the physiological activity of the cell.
- ★ It is bounded by the membranes. Outer membrane is smooth. Inner membrane forms infoldings into the inner chamber or mitochondrial matrix. These infoldings are called cristae.
- ★ The inner surface of cristae has small knob like structures known as F_1 particles.
- ★ Mitochondrial membranes are similar in structure to other membranes.
- ★ Mitochondria also contain some DNA and ribosomes and are called self replicating organelle. So, due to DNA and ribosomes itself replicate, to increase its number to meet energy requirement of a cell.

Q. Why mitochondria is self replicating Organelles?.
(SWK-G1)-16

Function:

(i) Presence of ribosomes and DNA indicates that some proteins are also synthesized in it.

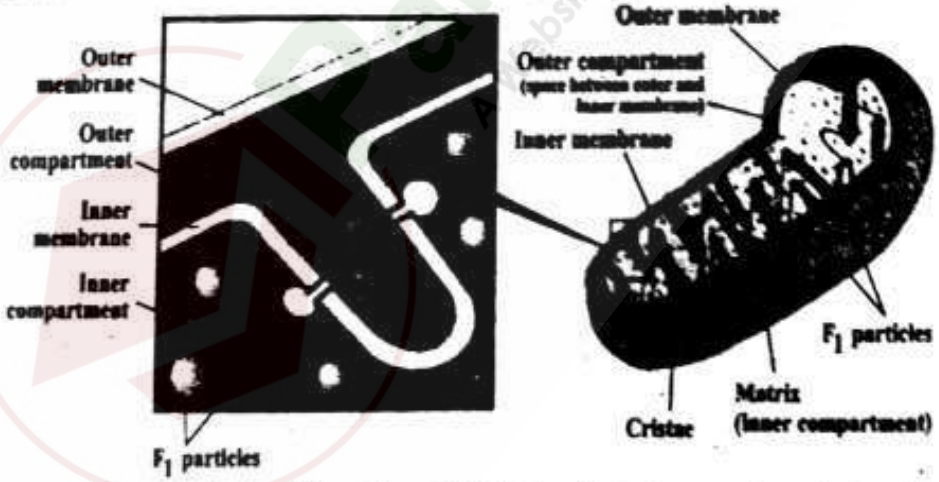


Fig: diagrammatic representation of a mitochondrioncut longtudinally.the main features are shown.A crista is made of lipoprotein membrane containing different enzymes as well as F1 particles embedded in it.After aspecial processing the inner mitochondrial membrane is ruptured and the F1particles come out on the surface.

(ii) Mitochondrial matrix contains a large number of enzymes, coenzymes and organic and inorganic salts which help in several metabolic processes like Krebs cycle, aerobic respiration, fatty acid metabolism etc. As a result of these metabolic processes, the energy present in the food stuff is transformed into energy rich compound known as adenosine triphosphate abbreviated as ATP and ATP then provides energy to cell on demand.

Q.16: Write a note on plastids.

→ Discuss in detail the types of plastids.

Ans. PLASTIDS

Membrane bounded, mostly pigment containing bodies present in the cells are called plastids. These are present in plant cells only.

Q. What is to stoma? Give its function? (MTN-G1)-14, (FSD-G1)-16
Q. Described the structure and functions of Chloroplast. (SWL-GI-2013, 14: GUJ-GI-15: LHR-GII-16)
Q. Write a note on plastids. (MTN-12GII, 14GI: DGK-GII, GUJ-GI, FBD-GI-16)
Q. What are plastids? Explain the structure and functions of Chloroplast. (GUJ-G1)-14, 15G2 (LHR-G1)-12, (SWL-G1)-14, (SGD-G1)-16
Q. What are plastids? Give its type and their role. (BWP-GI-2015)
Q. Write a note on Chloroplasts. (SGD-GII-2016)
Q. Describe different types of plastids. (GUJ-GI-2013)
Q. What are Plastids? Discuss their structure and role. (MTN-GI-2011)
Q. Write a note on Plastids. Explain with diagram. (MTN-GI-2010)

TYPES:

There are three main types of plastids.

(1) Chloroplast
(2) Chromoplast
(3) Leucoplast

(1) Chloroplast:

Green coloured plastids are called as chloroplasts. These are self-replicating organelle.

Structure:

- Their green colour is due to presence of a pigment, which is organic compound called chlorophyll, which helps the cell to absorbs light energy and utilize it to manufacture food.
- Chlorophyll resembles haem group of haemoglobin. The main difference between these two molecules is that chlorophyll has Mg^{++} while haem has Fe^{++} as the central atom.
- Chloroplasts vary in their shape and size with a diameter of about 4-6μm.
- Under light microscope, they appear to be heterogeneous structures with small granules known as **grana** embedded in the matrix.
- Under electron microscope, it shows three components i.e. envelope, stroma and thylakoid

Q. What are that thylakoid and granna. (DGK-G2)-16

(i) **Envelop** is formed by double memberane.

(ii) **Stroma**covers most of the volume of the chloroplast. It is a fluid, which surrounds the thylakoids. It contains proteins, some ribosomes and a small circular DNA. In it CO_2 is fixed to manufacture carbohydrates during photosynthesis. Some proteins are also synthesized in this part.

(iii) **Thylakoids** are the flattened vesicles, which arrange themselves to from grana and intergrana. On the layers of thylakoid, chlorophyll molecules are arranged.

(iv) A **grannum** appears to be a pile of thylakoids, in which on an average 50 or more thylakoids may be present.

- Grana look green due to presence of chlorophyll on thylakoids layers.
- Each granum is interconnected with others by the non-green part called intergranum
- These are the sites where sunlight is trapped and ATP is formed.

Function

Process of **photosynthesis** by which plants manufacture their **food takes places** in chloroplast.

(2) Chromoplast:

They are present in the petals of the flowers and **in the ripened fruit.**

Function:

- They impart colours to the plants other than green.
- They help in pollination and dispersal of seeds.

(3) Leucoplast:

- They are colourless.
- They are triangular, tubular or of some other shape.
- They are found in underground parts of the plant and stored food.

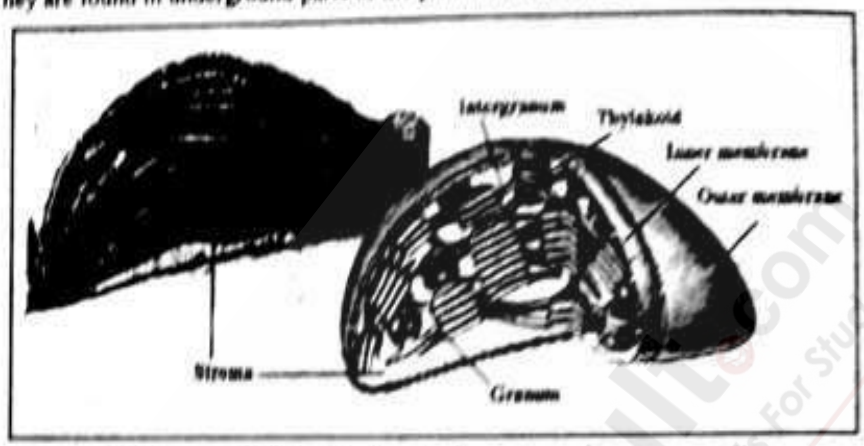


Fig: Diagram of chloroplast showing the main structural components.

NUCLEUS

Q.17: Write a note on Nucleus.

➔ Discuss in detail the structure of Nucleus.

Ans. NUCLEUS

Introduction:

Nucleus is the most important organelle of cell, which controls all the activities of cell.

Discovery:

Robert Brown discovered nucleus first time in 1831 its early discovery was undoubtedly due to its prominence in many cells, where it standout as slightly darker than surrounding cytoplasm.

General Features:

(i) In animal cells, it generally occupies the central space, while in the case of plant cells it is pushed towards periphery due to the presence of a large vacuole.

(ii) Nucleus may be irregular or spherical in shape. Generally the cells have one nucleus and are called mononucleate. On the other hand, the cells with two nuclei are binucleated and with more than two as multinucleated.

(iii) Nucleus is only visible when the cell is in non-dividing stage. It contains chromation network and soluble sap called nucleoplasm. In dividing cells, the nucleus disappears and chromosomes replace the chromation material in it.

(iv) DNA, RNA and proteins including enzymes form the chemical composition of the nucleus.

Structure:

Nucleus consists of three important components i.e. nuclear membrane, nucleoli, nucleoplasm and chromosomes.

(I) Nuclear Membrane:

Nucleus is surrounded by nuclear membrane, which separates the nuclear material from the cytoplasm.

- Nuclear membrane acts as nuclear envelope, which is composed of two membranes.
- Outer membrane is at places continuous with the endoplasmic reticulum.
- Inner membrane encloses the nuclear contents.

- ★ Outer and inner membranes are continuous at several points, giving rise to nuclear pores.
- ★ They allow exchange of materials between the nucleus and cytoplasm.
- ★ Their number is highly variable. The undifferentiated cells e.g. eggs have numerous pores (about 30,000 per nucleus), whereas differentiated cells e.g. erythrocytes have only 3 or 4 pores per nucleus.
- ★ Each pore has a specific structure, which controls the traffic of substances passing through them.

Q. What are nucleus pores and their function. (DGK-G1)-15

(ii) Nucleolus:

It is a darkly stained within the nucleus, and is without any membranous boundary to separate it from the rest of the nuclear material.

- ★ There may be one or more nucleoli in the nucleus.
- ★ It is involved in the synthesis and storage of ribosomal RNA. It is the site where ribosomes are assembled and exported to the cytoplasm via nuclear pores.
- ★ It is composed of two regions, the peripheral granular area composed of precursors of ribosomal subunits and the central fibrill area consisting of large molecular weight RNA and rDNA.

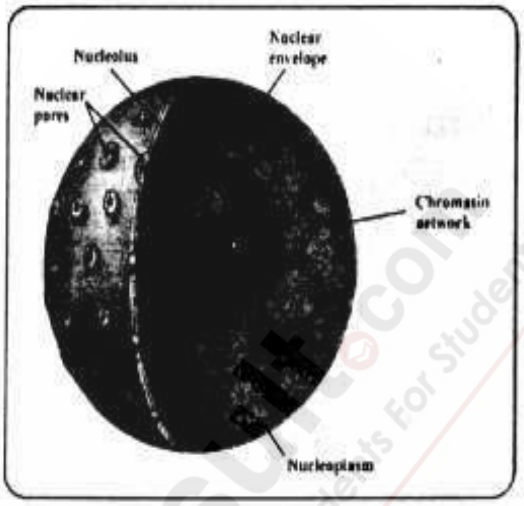


Fig: Structure of nucleus

(iii) Chromosomes:

Nucleus is deeply stained with basic dyes because of the chromatin material. During cell division chromatin material is converted into darkly stained thread like structures known as chromosomes.

Physical Structure:

Under compound microscope appear to be made of arms and centromere. Each chromosome consists of:

- ★ Two identical chromatids at the beginning of cell division (chromatid is exact replica of the chromosome), which are held together at centromere.
- ★ Centromere is the place on the chromosome where spindle fibers are attached during cell division.

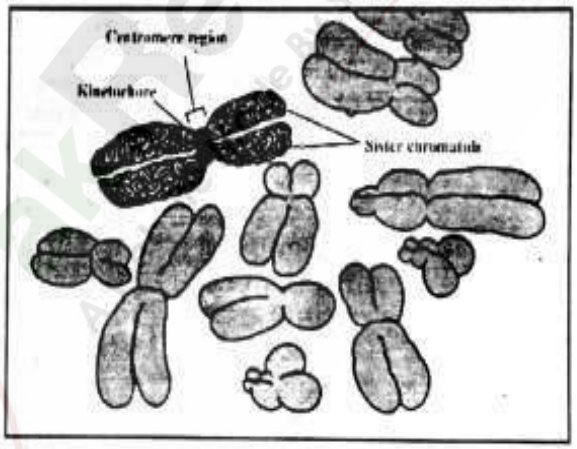


Fig: Structure of chromosome and its shape.

Chemical Structure:

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

The number of chromosomes in all individuals of the same species remains **constant generation after generation.**

For example

- ★ In man, each cell contains 46 chromosomes.
- ★ Frog cell has 26.
- ★ Chimpanzee has 48.

- ★ Fruitfly, *Drosophila melanogaster*, has 8.
- ★ Onion cell has 16.
- ★ Potato cell has 48.
- ★ Garden pea has 14.

The number of chromosomes in normal body cells is **diploid (2n)** whereas **haploid number (n)** is present in germ cells e.g. human sperm and eggs have 23 , while those of Drosophila have 4 chromosomes.

PROKARYOTIC AND EUKARYOTIC CELL

Q.18: Write down the characteristics ofProkaryotic and Eukaryotic Cell.

CHARACTERS OF PROKARYOTIC AND EUKARYOTIC CELL

DIFFERENCE	PROKARYOTE	EUKARYOTE
(1) Cell Type	They are composed of prokaryotic cells.	They are composed of eukaryotic cells
(2) Nucleus	Nucleus is absent in them.	They have well defined nucleus.
(3) DNA(genetic material)	DNA is without any nuclear membrane covering and is directly submerged in cytoplasm.	DNA is enclosed inside the nucleus.
(4) Membrane-Bounded Structures	Membrane-bounded structures are absent. e.g.mitochondria, endoplasmic reticulum, chloroplast, Golgi Apparatus are absent.	Membrane-bounded structures are present
(5) Ribosomes	They have small sized 70S ribosomes.	They have large sized 80S ribosomes.
(6) Cell Wall	Their cell wall is composed of polysaccharide chain covalently bonded with shorter chains of amino acids forming peptidoglycan or murein.the entire cell wall is often regarded as a single huge molecule or molecular complex called sacculus.	Cell wall of plants is generally composed of cellulose and is differently structured than that of a bacterium.
(7) Cell Division	They reproduce by binary fission.	They reproduce by mitosis and meiosis.
(8) Example	Bacteria and blue green algae	Examples are unicellular, multicellular animals, plants, fungi and protista are

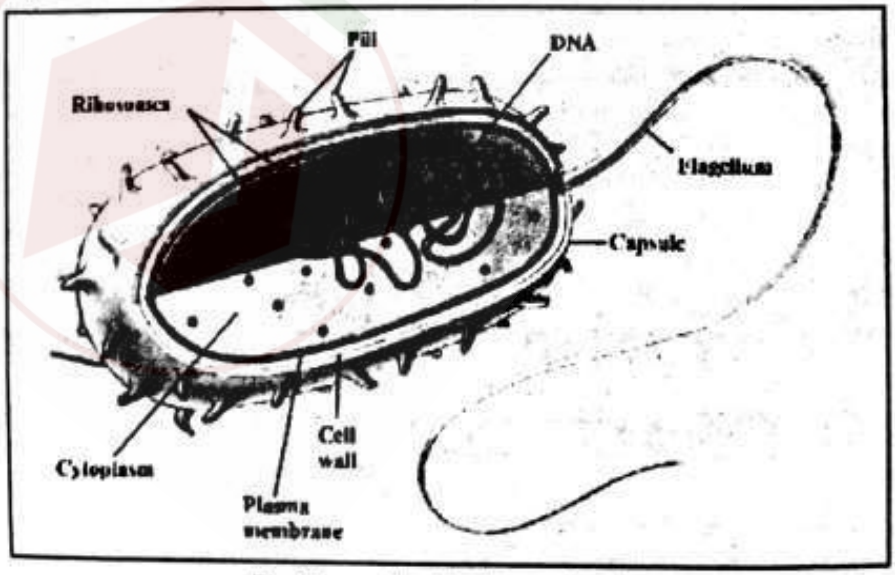


Fig. Generalized Prokaryotic cell.

Q.19: Compare structure and function of chloroplasts and mitochondria.

Ans.

COMPARISON	CHLOROPLAST	MITOCHONDRIA
Introduction	They are found only in plant cells.	They are found both in plant and animals cells.
Structure	Their outer and inner membranes are smooth.	Their inner membrane forms infoldings called cristae.
Matrixe	Their matrix is called stroma.	Their matrix is called mitochondrial matrix.
Inner structures	Grana are present in swtroma.	Cristae are present in mitochondrial matrix.
Enzymes	Enzymes present in stroma are concerned with photosynthesis.	Enzymes present in mitochondrial matrix are concerned with respiration.
Function	These are involved in process of photosynthesis.	These are involved in processes of respiration.

Q.20: What might happen if some lysosomal enzymes are absent? Explain with examples.

Ans. As lysosomal enzymes are involved in various processes. So absence of lysosomal enzymes will result in loss of these processes.

- Lysosomes are involved in intracellular digestion through their enzymes. Absence of these enzymes will result in loss of digestion.
- Lysomosol enzymes are involved in degeneration of various structures e.g. frog trail during metamorphosis. Absence of these enzymes will result in loss of this process.
- Lysosomal enzymes of WBCs are involved in killing of microorganisms. Absence of these enzymes will result in loss of immunity and killing of these microorganisms.