# CELL: THE UNIT OF LIFE

All organisms are composed of cells. Some are composed of a single cell & are called unicellular organisms while others, composed of many cells, are called multicellular organisms.

Unicellular organisms are capable of

i. Independent existence
ii. Performing the essential functions of life.

Hence, cell is the fundamental structural and functional unit of all living organisms.

- Swanson is known as father of modern cytology.
- Robert Hooke discovered the cell when he observed thin slice of cork and saw compartments which he called cellulae.
- Anton von Leeuwenhoek first observed living cells (bacteria, protozoa, RBC, sperms) under microscope.

## Cell theory:

In 1838, **Malthias Schleiden** observed that all plants are composed of different kinds of cells which form the tissues of the plant. In 1839, **Theodore Schwann,** observed that animal cells had a thin outer layer which is today known as the 'plasma membrane'. He also studied. Plant tissues and suggested that the presence of cell wall is a unique character of the plant cells.

On the basis of this, Schwann proposed the hypothesis that the bodies of animals and plants are composed of cells and products of cells. Schleiden and Schwann together formulated the cell theory. This theory however, did not explain as to how new cells were formed.

Rudolf Virchow (1855) first explained that cells divided and new cells are formed from pre- existing cells (Omnis cellula –e cellula). He modified the hypothesis of Schleiden and Schwann to give the cell theory a final shape.

Cell theory as understood today is:

i. All living organisms are composed of cells and products of cells.
ii. All cells arise from pre- existing cells.

## AN OVERVIEW OF CELL

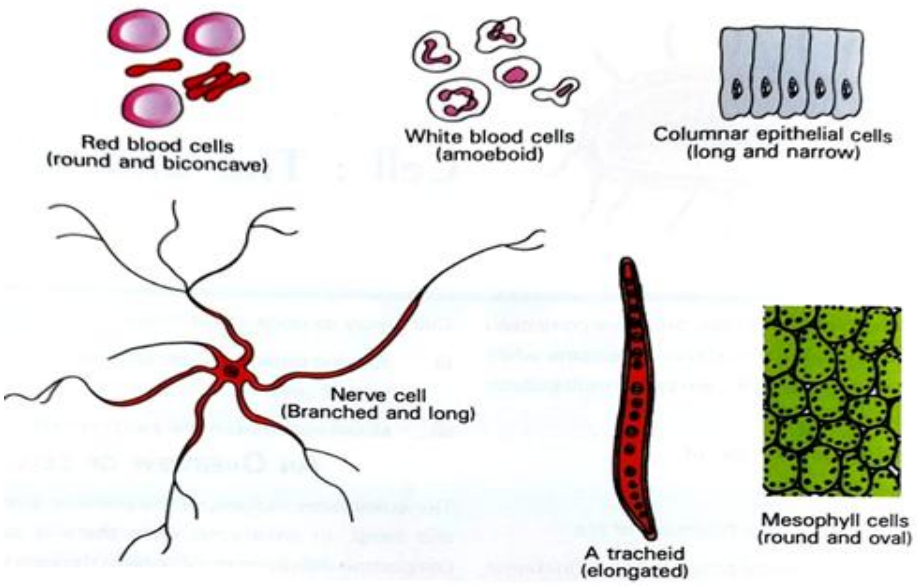
The eukaryotes include all the protists, plants, animals and fungi. In eukaryotic cells there is an extensive compartmentalization of cytoplasm through the presence of membrane bound organelles. Eukaryotic cells possess an organized nucleus with a nuclear envelope. In addition, eukaryotic cell have a variety of complex locomotory and cytoskeletal structures. Their genetic material is organized into chromosomes.

All eukaryotic cells are not identical. Plant and animal cells are different as the former possess cell walls, plastids and a large central vacuole which are absent in animal cells. On the other hand, animal cells have centrioles which are absent in almost all plant cells.

In both prokaryotic and eukaryotic cells, a semi – fluid matrix called cytoplasm occupies the volume of the cell. The cytoplasm is the main arena of cellular activities in both the plant and animal cells.

Various chemical reactions occur in it to keep the cell in the 'living state'.

Mycoplasmas, the smallest cells, are only 0.3 µm in length while bacteria could be 3 to 5 µm. The largest isolated single cells is the egg of an ostrich. Human red blood cells are about 7.0 µm in diameter. Nerve cells are some of the longest cells. Cells differ greatly in size, shape and activates. They may be disc – like, polygonal, columnar, cuboid, thread like, or even irregular. The shape of the cell may very with the function they perform.




## PROKARYOTIC CELLS

The prokaryotic cells are represented by bacteria, blue-green algae, mycoplasma and PPLO (Pleuro Pneumonia Like Organisms). They are generally smaller and multiply more rapidly than the eukaryotic cells . They may vary greatly in shape and size. The four basic shapes of bacteria are bacillus (rod like), coccus (spherical), vibrio (comma shaped) and spirillum (spiral). The organisation of the prokaryotic cell is fundamentally similar even though prokaryotes exhibit a wide variety of shapes and functions. All prokaryotes have a cell wall surrounding the cell membrane except in mycoplasma. The fluid matrix filling the cell is the cytoplasm. There is no well-defined nucleus. The genetic material is basically naked, not enveloped by a nuclear membrane. In addition to the genomic DNA (the single chromosome/circular DNA), many bacteria have small circular DNA outside the genomic DNA. These smaller DNA are called plasmids. The plasmid DNA confers certain unique phenotypic characters to such bacteria. One such character is resistance to antibiotics. In higher classes you will learn that this plasmid DNA is used to monitor bacterial transformation with foreign DNA. Nuclear membrane is found in eukaryotes. No organelles, like the ones in eukaryotes, are found in prokaryotic cells except for ribosomes. Prokaryotes have something unique in the form of inclusions. A specialised differentiated form of cell membrane called mesosome is the characteristic of prokaryotes. They are essentially infoldings of cell membrane.

## EUKARYOTIC CELLS

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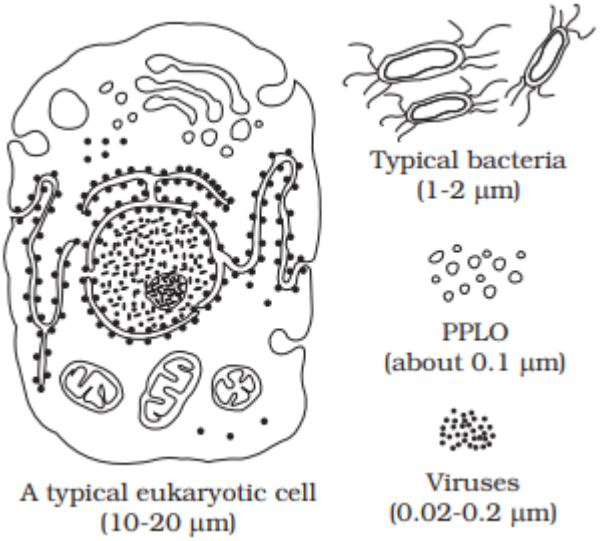
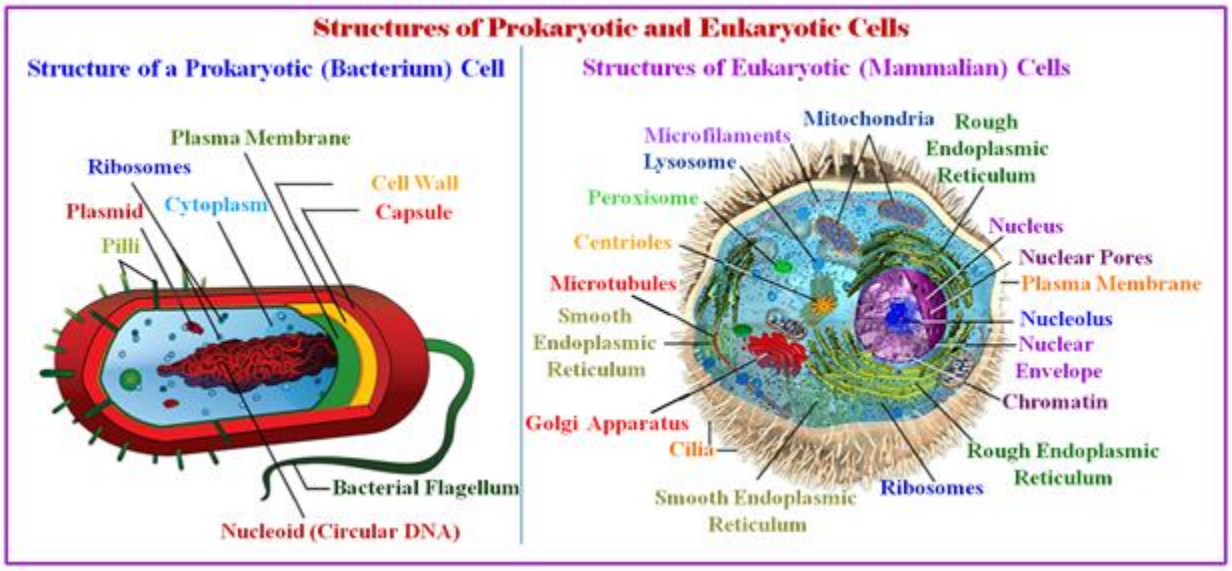
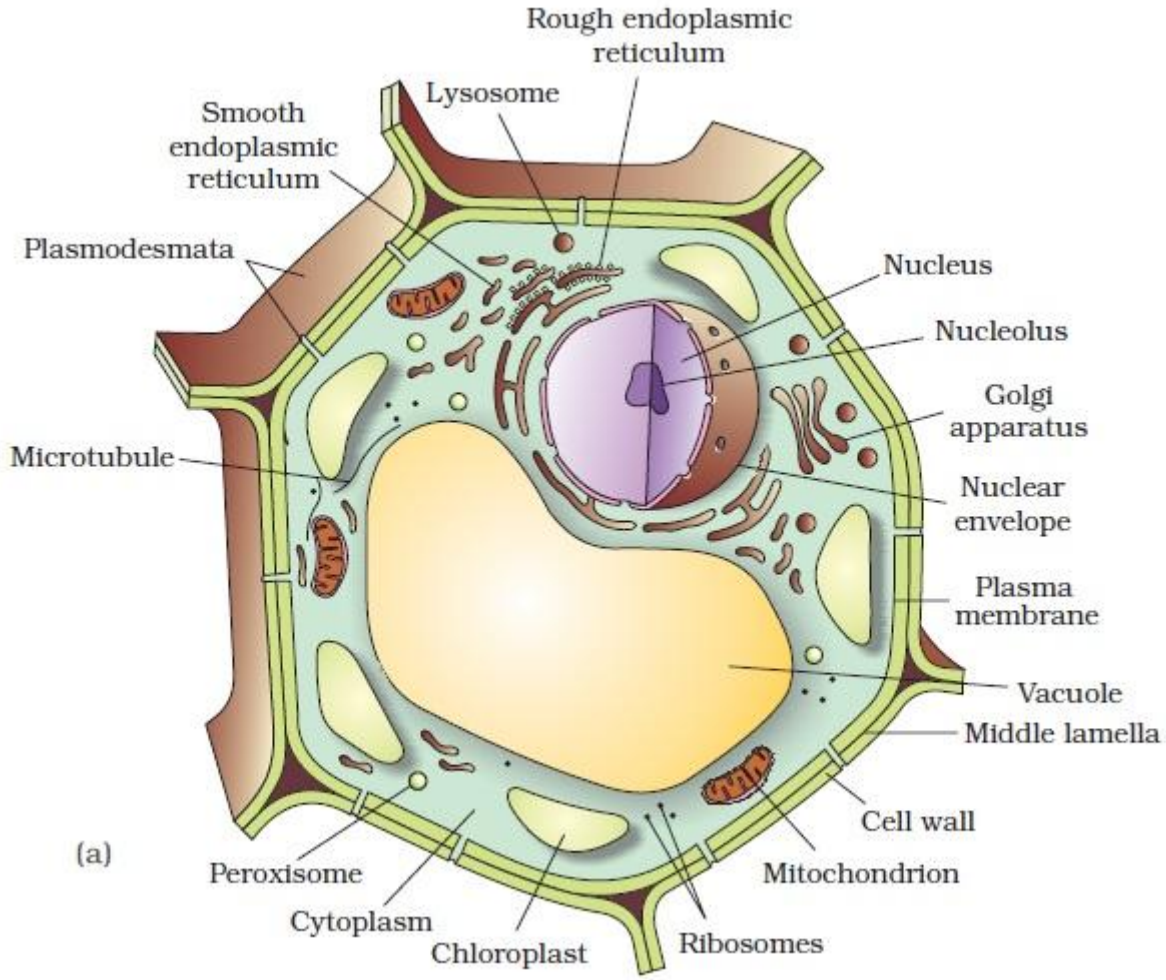
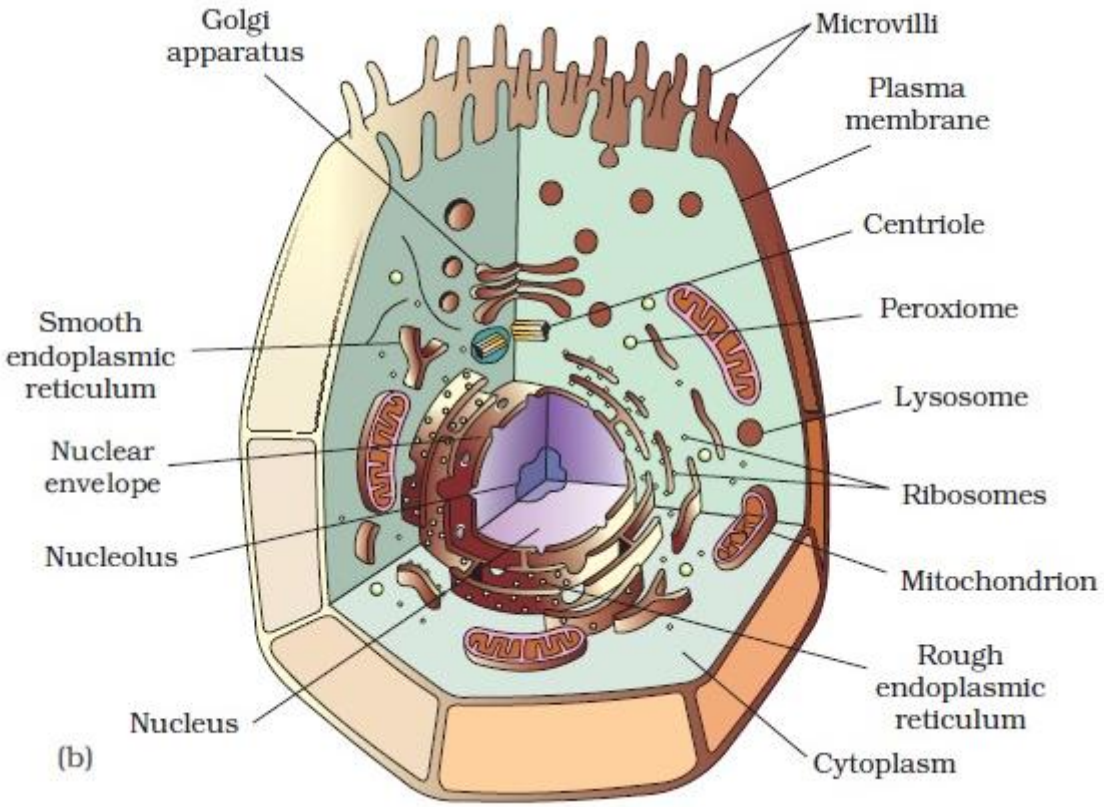



| Differences between Prokaryotic and Eukaryotic Cell | | | |
|---|---|---|---|
| **S.No** | **Prokaryotic Cell** | **S.No** | **Eukaryotic Cell** |
| **1** | The Cell size is small (0.1–5.0 um.) | **1** | The cell size is comparatively larger (5–100 um). |
| **2** | A prokaryotic cell has one envelope organisation. | **2** | A eukaryotic cell has two envelope organisation. |
| **3** | An organized nucleus is absent. Instead a nucleoid is found. | **3** | An organized nucleus is found. It is differentiated into nuclear envelope, chromatin, one or more nucleoli and nucleoplasm. |
| **4** | Cell wall, if present, contains muramic acid. | **4** | Cell wall, if present, muramic acid is absent |
| **5** | DNA is naked, it means histones absent | **5** | DNA is found with histones. |
| **6** | DNA lies freely in the cytoplasm. | **6** | Most of the cell DNA is found in the nucleus. A small quantity is also found in the plastids and mitochondria. |
| **7** | DNA is circular. | **7** | Nuclear DNA is linear whereas Extra nuclear DNA is circular. |
| **8** | Transcription and translation take place in the cytoplasm. | **8** | Transcription occurs in the nucleus while tanslation takes place in the cytoplasm. |
| **9** | Cytoplasm does not show cyclosis. | **9** | Cytoplasm usually shows cyclosis. |
| **10** | Membrane bound organelles like mitochondria, Golgi apparatus, ER, lysosomes and other microbodies are absent. | **10** | Mitochondria, ER, Golgi apparatus & microbodies including lysosomes are present in cell of organisms. |
| **11** | Microtubules and microfilaments are commonly absent. | **11** | Mircrotubules and microfilaments are present. |
| **12** | Gametes are not formed, since sexual reproduction and meiosis are absent. | **12** | Gametes are formed either directly or through meiosis, as sexual reproduction is found in the life cycle. |
| **13** | A spindle apparatus is not formed during division. | **13** | A spindle apparatus is produced during nuclear division. |
| **14** | 70S types of Ribosomes are found. | **14** | Ribosomes are of 80S types. 70S ribosomes are found in mitochondria and plastids. |
| **15** | Centriole is also absent | **15** | Centriole is present in animals & lower plants |
| **16** | Ex- Bacteria, cyanobacteria, Mycoplasma. | **16** | Ex:- Protists, Fungi, Plants and Animals. |




| Differences between Plant and Animal Cells | | | |
|---|---|---|---|
| S.No. | Plant Cell | S.No. | Animal Cell |
| 1 | A plant cell has rigid wall on the outside. | 1 | A cell wall is absent. |
| 2 | Plastids are found in plant cells | 2 | Plastids are usually absent. |
| 3 | A mature cell has a large central vacuole. | 3 | An animal cell may have many small vacuoles. |
| 4 | Nucleus lies on one side in the peripheral cytoplasm due to central vacuole. | 4 | Nucleus usually lies in the centre. |
| 5 | Centrioles are usually absent. | 5 | Centrioles are found in animal cells. |
| 6 | Spindle apparatus formed during nuclear division is anastral. | 6 | Spindle is amphiastral. |
| 7 | Golgi apparatus consists of number of distinct & unconnected units called dictyosomes. | 7 | Golgi apparatus is either localised or diffused & consists of a well connected single complex. |
| 8 | Reserve food is generally starch and fat. | 8 | Reserve food is usually glycogen and fat. |
| 9 | Adjacent cells may be connected through plasmodesmata. | 9 | Adjacent cells are connected through a number of cell junctions. |
| 10 | Cytokinesis occurs by cell plate. | 10 | Cytokinesis takes place by cleavage. |


Rough endoplasmic reticulum
Lysosome
Smooth endoplasmic reticulum
Plasmodesmata
Nucleus
Nucleolus
Golgi apparatus
Microtubule
Nuclear envelope
Plasma membrane
Vacuole
Middle lamella
Cell wall
(a)
Peroxisome
Mitochondrion
Cytoplasm
Chloroplast
Ribosomes




## Cell Envelope and its Modifications

Most prokaryotic cells, particularly the bacterial cells, have a chemically complex cell envelope. The cell envelope consists of a tightly bound three layered structure i.e., the outermost glycocalyx followed by the cell wall and then the plasma membrane. Although each layer of the envelope performs distinct function, they act together as a single protective unit. Bacteria can be classified into two groups on the basis of the differences in the cell envelopes and the manner in which they respond to the staining procedure developed by Gram viz., those that take up the gram stain are Gram positive and the others that do not are called Gram negative bacteria. Glycocalyx differs in composition and thickness among different bacteria. It could be a loose sheath called the slime layer in some, while in others it may be thick and tough, called the capsule. The cell wall determines the shape of the cell and provides a strong structural support to prevent the bacterium from bursting or collapsing. The plasma membrane is selectively permeable in nature and interacts with the outside world. This membrane is similar structurally to that of the eukaryotes.

A special membranous structure is the mesosome which is formed by the extensions of plasma membrane into the cell. These extensions are in the form of vesicles, tubules and lamellae. They help in cell wall formation, DNA replication and distribution to daughter cells. They also help in respiration, secretion processes, to increase the surface area of the plasma membrane and enzymatic content. In some prokaryotes like cyanobacteria, there are other membranous extensions into the cytoplasm called chromatophores which contain pigments. Bacterial cells may be motile or non-motile. If motile, they have thin filamentous extensions from their cell wall called flagella. Bacteria show a range in the number and arrangement of flagella. Bacterial flagellum is composed of three parts – filament, hook and basal body. The filament is the longest portion and extends from the cell surface to the outside. Besides flagella, Pili and Fimbriae are also surface structures of the bacteria but do not play a role in motility. The pili are elongated tubular structures made of a special protein. The fimbriae are small bristle like fibres sprouting out of the cell. In some bacteria, they are known to help attach the bacteria to rocks in streams and also to the host tissues.

## CELL MEMBRANE

### General characteristics

- It is selectively permeable, elastic and repairable.
- It is living, asymmetric, thin.

- It is quasifluid (not completely fluid and not completely solid)
- It is trilaminar, lipoproteinaceous and hydrophilic.
- It separates protoplasm from exterior.
- It regulates entry and exit of molecules and ions.
- It is found in all prokaryotic and eukaryotic cells either as covering of the cell or as covering of cell organelle in the cytoplasm.
- **Nageli**and **Cramer** coined the term cell membrane.
- **Singer** and **Nicholson** preferred to use term biomembrane.

### Molecular organization:

The detailed structure of the membrane was studied only after the advent of the electron microscope in the 1950s. Meanwhile, chemical studies on the cell membrane, especially in human red blood cells (RBCs), enabled the scientists to deduce the possible structure of plasma membrane.

### Fluid mosaic model [Given by singer and Nicolson (1972)]

As per this model cell membranes are protein icebergs in sea of lipids.

Main components of membrane are

**a. Lipids:** A central lipid bilayer is mainly composed of phospholipids (phosphoglycerides). The lipids are arranged with in the outer sides and the hydrophobic tails towards the inner part. This ensures that the nonpolar tail of saturated hydrocarbons is protected from the aqueous environment.
Lipid molecules show lateral movement and flip-flop movement.
The quasi – fluid nature of lipids enables lateral movement of proteins within the overall bilayer. This ability to move within the membrane is measured as its fluidity. The fluid nature of the membrane is also important from the point of view of functions like cell growth, formation of intercellular functions, secretion, endocytosis, cell division etc.
This nature of membrane helps in expansion, contraction and quick repairing.
The quasifluid nature of membrane is decreases if long chain and saturated fatty acid content increases.

**b. Proteins:** Depending on the ease of extraction, membrane proteins are of two types:

### Extrinsic/ peripheral proteins

These proteins are superficially attached and do not cover entire surface. Their present on outer and inner sides of lipid bilayer. They can be easily removed and from 30% of total proteins.

They can act as receptors and recognition centre e.g., ATPase, spectrin (in RBC)

### Intrinsic/integral proteins

Partially or totally buried in the membrane and can be exposed also. They can not be removed and can act as enzymes and carrier proteins, e.g., Cytochrome oxidase, glycophorin.

Some large globular proteins pass throughout lipid bilayer and form **transmembrane proteins** or **Tunnel proteins.** These proteins have channels for passage of water and water dissolving substances.

Proteins make membrane dynamic because they can shift their positions.

On the basis of functions, five types of proteins are present

i. Structural proteins: These provide stability to the membrane e.g., Tunnel protein, glycoprotein.
ii. Permeases proteins: They are involved in facilitated diffusion.
iii. Carrier proteins: They are involved in active transport.
iv. Enzymes: ATPase, cytochrome oxidase etc.

v. Receptor proteins: These are for receiving substances like hormones.

**c. Carbohydrates:**
Oligosaccharides can bind with protein and lipid forming glycoprotein and glycolipids.
Oligosaccharides of glycocalyx act as recognition center and provide antigen specificity to membrane.

**d. Cholesterol:** Provide stability to eukaryotic membrane.

## Chemical composition of Membrane:

| Component of the membrane | Composition |
|---|---|
| Protein | 44-76% |
| Lipids | 20-53% |
| Water | 20% |
| Carbohydrates | 1-8% |

- The ratio of protein and lipid varies considerably in different cell types. In human beings, the membrane of the erythrocyte has approximately 52 per cent protein and 40 per cent lipids.
- They can act as receptors and recognition canter e.g., ATPase, spectrin (in RBC).

## Membrane asymmetry:

- The two surfaces of cell membrane are asymmetric. Oligosaccharides are present only on outer or extrinsic surface.
- Cholesterol is towards exterior & higher numbers of extrinsic proteins are present towards interior.

## Bulk Transport

- This process involve lesser amount of energy as compared to active transport.
- It involves endocytosis and exocytosis.
- Endocytosis may be phagocytosis and pinocytosis.

**Differences between Pinocytosis and Phagocytosis**

| Pinocytosis (cell drinking) | Phagocytosis (cell eating) |
|---|---|
| Intake of fluid materials. | Intake of solid material from outside to the inside of the cell. |
| Vesicles formed are small, 100-200 nm in diameter. | Vesicles formed are large, 1-2μm in diameter. |
| Digestion may or may not occur. A food vacuole may or may not be formed. | A digestive or food vacuole is formed from a phagosome. |
| Lysosomes play no role in utilization of material if digestion is not involved. | Lysosomes are essential because solid substances taken in require digestion. |
| Exocytosis is not always involved. | Undigested parts of solid particle are thrown out by exocytosis. |

## Exocytosis/ Emeiocytosis / Cell vomiting/ Ephagy

Release of secretion by glandular cells, release of neurotransmitter from nerve cells, expulsion of undigested food by residual bodies

## CELL WALL

A non-living rigid structure called the cell wall forms an outer covering for the plasma membrane of fungi and plants. Cell wall not only gives shape to the cell and protects the cell from mechanical damage and infection, it also helps in cell-to-cell interaction and provides barrier to undesirable macromolecules. Algae have cell wall, made of cellulose, galactans, mannans and minerals like calcium carbonate, while in other plants it consists of cellulose, hemicellulose, pectins and proteins. The cell wall of a young plant cell, the primary wall is capable of growth, which gradually diminishes as the cell matures and the secondary wall is formed on the inner (towards membrane) side of the cell. The middle lamella is a layer mainly of calcium pectate which holds or glues the different neighbouring cells together. The cell wall and middle lamellae may be traversed by plasmodesmata which connect the cytoplasm of neighbouring cells

## ENDOMEMBRANE SYSTEM

The endomembrane System include endoplasmic reticulum (ER), golgi complex, lysosomes and vacuoles. While each of membranous organelles is distinct in terms of its structure and function, many of these are considered together as an endomembrane system because their functions are coordinated.

Since the functions of the mitochondria, chloroplast and peroxisomes are not coordinated with the above components, these are not considered as part of the endomembrane system.

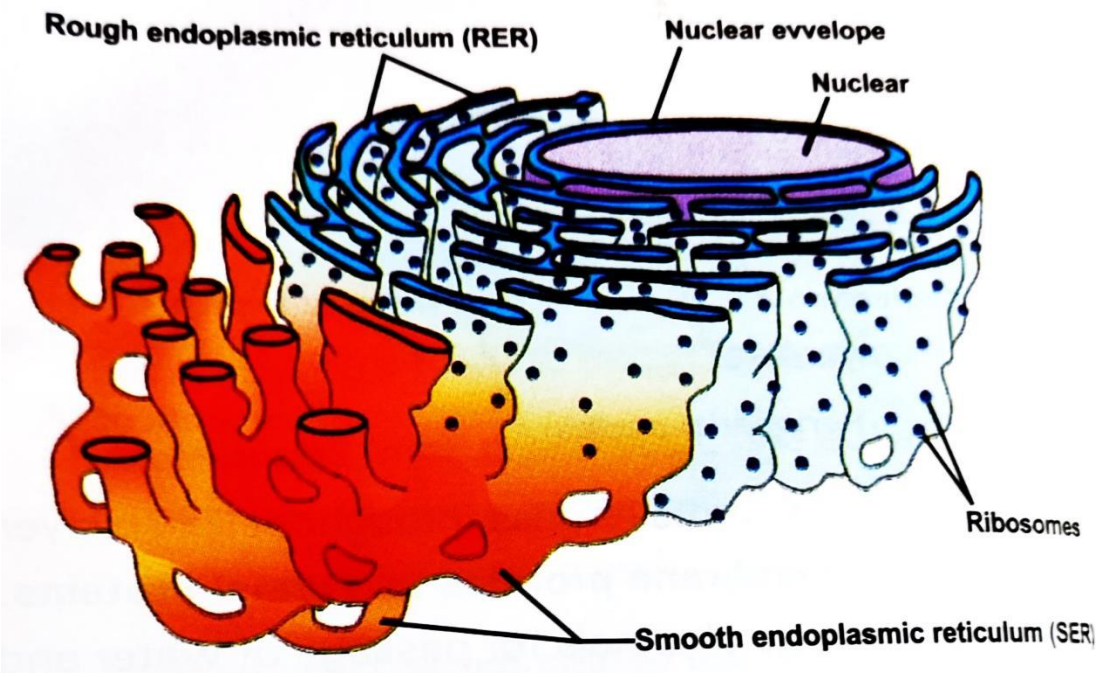
## ENDOPLASMIC RETICULUM

### Introduction

It is a complex network of interconnecting membrane vesicles. It makes membranous network between plasma membrane and nuclear membrane and constitute about 50% of total membrane system.

### Structure

ER is a network or reticulum of tiny tubular structures scattered in the cytoplasm. Hence, ER divides the intracellular space into two distinct compartments, i.e., luminal (inside ER) and extra luminal (cytoplasm),compartments.




ER is made up of three components

i. **Cisternae**

It is also known as flattened sac.
It is parallel in arrangement and it may be interconnected.
It contains macromolecules and granules.

ii. **Tubules**

It is tubes like structure occur at periphery.
It is regular or irregular and branched or unbranched.
In liver cells tubules store glycogen granules.

iii. **Vesicle**

It is oval shaped and devoid of ribosome.
It is prominent in pancreas cells and spermatocytes

**Differences between RER and SER**

| Rough endoplasmic recticulum | Smooth endoplasmic recticulum |
|---|---|
| Granular | Agranular |
| Mainly formed of cisternae and few tubules. | Mainly formed of vesicles and tubules. |
| Possess ribosomes attached to membrane. | Ribosomes absent so appear smooth |
| Ribophorin I and Ribophorin II for providing attachment to ribosomes. | Ribophorin absent. |
| Having narrow pores below its ribosomes for passage of polypeptides into ER. | Pores absent |
| Site of protein processing. | Site of glycogenolysis and gluconeogenesis |
| No $Ca^{++}$ storage | Assists in musceles contraction by $Ca^{++}$. |
| Helps in formation of lysosomes through golgi bodies. | Give rise to sphaerosomes. |
| Develop from outer nuclear membrane. | May develop from RER through loss of ribosomes. |
| Found in cells of pancreas, plasma cells, fiboblasts, goblet cells. Found in the cells actively involved in the protein synthesis and secretions. | Found in glycogen storing liver cells, interstitial cells, adrenal cortax, adipocytes, retinal cells, muscle cells. |

1. Act as cytoskeleton & provide mechanical support.
2. Involved in intra cellular transport.
3. Provides large surface area for many enzyme activities.
4. Act as storage of various membranes.

## Biogenesis

RER is formed from nuclear membrane.

SER is formed from RER.

New tubules develop from pre- existing RER.

# GOLGI BODY

## Introduction

Golgi complex is popularly known as internal reticular apparatus.

It is also known as body, traffic police of cell, export house etc.

**Camillo Golgi (1898)** first observed densely stained reticular structures near the nucleus. These were later named Golgi bodies after him.

## Zone of exclusion

Golgi is surrounded by a zone of cytoplasm in which other cell organelles are absent.

## Structure

It is made up of 4 components.


i. **Cisternae (Saccules)**

They consist of many flat, disc- shaped sacs or cisternae of 0.5 µm 1.0 µm diameter

These are stacked parallel to each other and varied in number. It is curved, flattened with swollen ends.

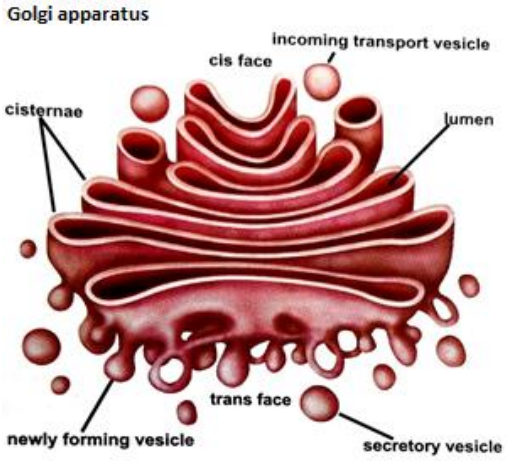
Cisternae are concentrically arranged near the nucleus. Cisternae shows definite polarity i.e. cis/forming/f-face/proximal/convex face – towards nucleus while trans/maturing/ m- face/distal/concave face-towards plasma membrane.

The cis and the trans faces of the organelle are entirely different, but interconnected.

The thickness of membrane increases from cis to trans face.

ii. **Tubules:**

They form a complicated network towards the periphery and maturing face of the apparatus and interconnect the different cisternae.




iii. **Vesicles:**

It is a small sac like structure filled by granules of lipoprotein.

iv. **Vacuoles:**

It is large, rounded expanded part of cisternae.

It is filled by amorphous substances and it may function as primary lysosome.

## Biogenesis

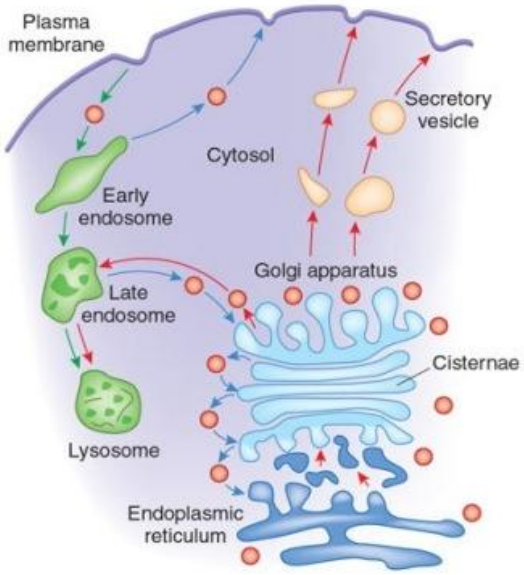
New golgi originate from pre-existing golgi or from SER New cisternae arises by invagination of plasma membrane.

## Functions

1. Principally performs the function of packaging materials, to be delivered either to the intra – cellular targets or secreted outside the cell. Materials to be packaged in the form of vesicles from the ER fuse with the cis face of the golgi apparatus and move towards the maturing face. This explains, why the golgi apparatus remains in close association with the golgi apparatus remains in close association with the endoplasmic reticulum.
2. All sorts of secretions like mucous, enzymes, sweat, tears, antibodies, saliva, mucilage, etc. takes place from golgi, so it is called **factory of cell secretion.**
3. Important site of **glycosylation** (glycoprotein synthesis) and **glycosidation**(glycolipid synthesis).
4. Cell plate which is made up of Ca and Mg pectate is secreted by golgi body.
5. Involved in formation of lysosome.
6. Forms acrosome of sperm.
7. A number of proteins synthesised by ribosomes on the endoplasmic reticulum are modified in the cisternae of the golgi apparatus before they are released from its trans face.

## GERL Complex

RER→ SER→ Golgi→ Lyosome



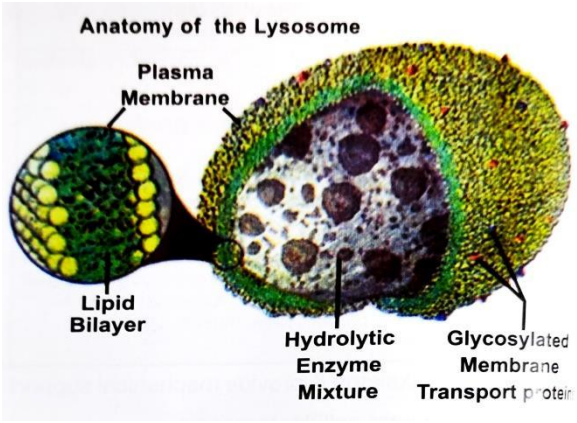

# LYSOSOME

## Introduction

Lysosomes were discovered by De Duve.

It is also called suicidal bag of cell, disposal units, demolition squad, re cycling centre, cellular house keeper, plant lysosome are abundant in WBC and other macrophages.

These are membrane bound vesicular structures formed by the process of packaging in the golgi apparatus. The isolated lysosomal vesicles have been found to be very rich in almost all types of hydrolytic enzymes (hydrolases – lipases, proteases, carbohydrases) optimally active at the acidic pH. These enzymes are capable of digesting carbohydrates, proteins, lipids and nucleic acids.




## Polymorphism in lysosomes

### 1. Primary lysosome

It is also known as **protolysosome.** In this type of lysosome only enzymes are present in inactive stage. It is formed by Golgi body.

### 2. Secondary lysosome

It is also known as Heterophagosome or Digestive vacuole or Phagolysosome. It is made up of primary lysosome + food vacuoles. Digested materials are released in to cytoplasm after enzyme activity.

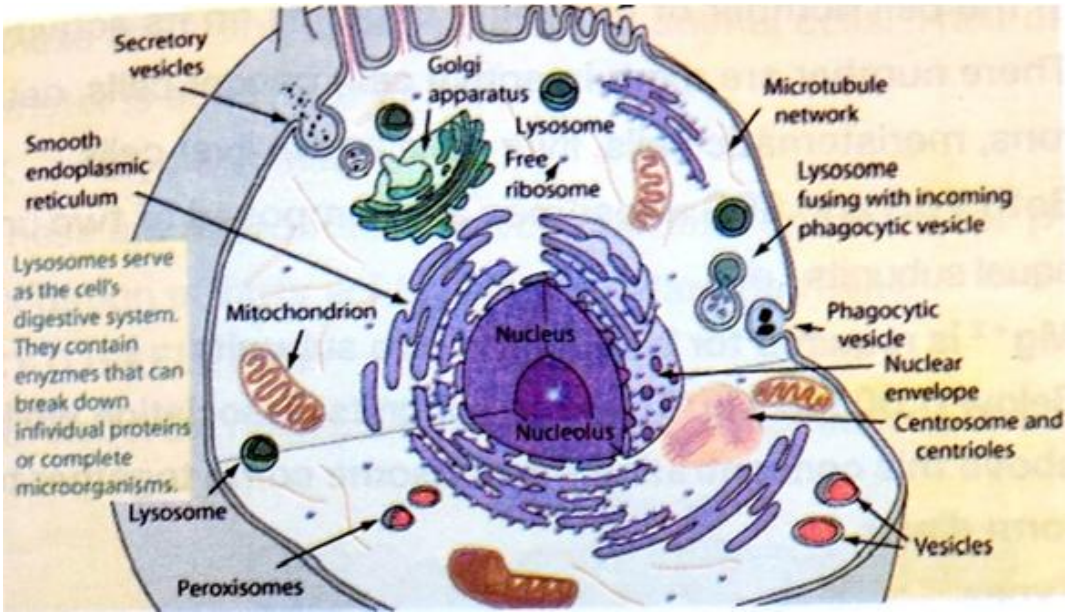
### 3. Tertiary lysosome

It is also known as residual bodies or Telolysosomes. They have undigested food which is passed out by ephagy or exocytosis.

### 4. Autophagic vacuoles

It is also known as Cytolysosomes or Autophagosome.

These are formed by primary lysosome + old dead organelles. Autophagy is required for recycling so these lysosomes are also called recycling site.




In autophagy, digestion of stored food takes place at the time of starvation and energy is liberated, while in autolysis whole cell is digested because enzymes are released in cytoplasm. It takes place at the time of ageing, reabsorption of tail of tadpole (frog) etc.

### Functions

1. It is involve in acrosome activity.
2. It performs phagocytosis.
3. It assists in metamorphosis in frog.
4. It digests microbes and carcinogens.
5. It plays role in intra and extracellular digestion.

- If lysosome membrane get damaged, many cellular components undergo lysis hence called suicidal bags.

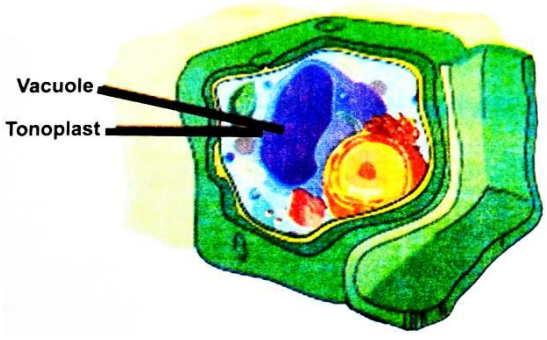
## VACUOLES

### i. Sap vacuoles

The vacuole is the membrane – bound space found in the cytoplasm. It contains water, sap, excretory product and other materials not useful for the cell.

In plant cells the vacuoles can occupy up to 90 percent of the volume of the cell.

Vacuole is bound by a single membrane called tonoplast.



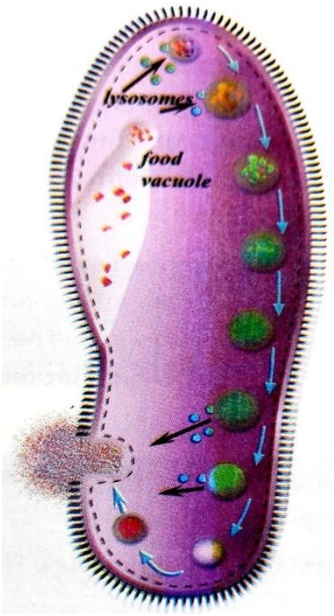

In plants, the tonoplast facilitates the transport of a number of ions and other materials against concentration gradients into the vacuole,hencetheir concentration is significantly higher in the vacuole than in the cytoplasm.

**ii. Food vacuoles**

Food vacuoles are formed by engulfing the food particles.

They constantly move along definite course (cyclosis) within the streaming endoplasm.

Such food vacuoles are seen in paramecium and Amoeba which show intracellular digestion.




**iii. Contractile vacuoles**

In fresh water forms like paramecium, Euglena and other protozoans (Amoeba), the contractile vacuoles help in draining out excess water during its systole. Some contractile vacuoles remove nitrogenous wastes along with water in the form of ammonia as in aquatic protozoans.

**iv. Gas vacuoles**

Gas vacuoles are found in blue green and purple and green photosynthetic bacteria.

## Sphaerosome (oleosome)

**Introduction**

These are spherical structureswhich store and synthesize lipids.

They arises by ER and covered by half unit membrane.

These are abundant in endosperm cell of oil seeds.

It is composed of lipid which makes 98%, proteins 2%. Some proteins are enzymatic and participate in lipid synthesis.

**MITOCHONDRIA** (They are called as chondriosome, sarcosome, plastochondira)

Mitochondria first observed in **striated flight muscles of insect** as granular structure by **Kolliker (1880)**. **Altman (1890)** gave its detailed description and called **bioblasts** .The term mitochondria used by **Benda (1897). Mitochondria is known as power house of the cell**

**Shape & size:**
In terms of shape and size also, considerable degree of variability is observed. Typically it is sausage-shaped or cylindrical having a diameter of 0.2-1.0µm (average0.5µm) and length 1.0-4.1µm.

**Number:** The number of mitochondria per cellis variable depending on the physiological activity of the cells

| S. No. | Name of Organism | Number of Mitochondria |
|---|---|---|
| 1 | Chlorella | 1 (minimum) |
| 2 | Microsterias | 1 |
| 3 | Human sperm | 25 |
| 4 | kidney cells | 300-400 |
| 5 | Liver cells | 500-1000 |
| 6 | Chaos chaos (Giant amoeba) | 50000 |
| 7 | Flight muscles of birds | 500000(maximum) |

**Structure of Mitochondria:**
Mitochondria (sing.: mitochondrion), unless specifically stained, are not easily visible under the microscope.. Each mitochondrion is a double membrane-bound structure with the outer membrane and the inner membrane (diameter of each membrane is **60–75Aº**) dividing its lumen distinctly into two aqueous compartments, i.e., the outer compartment (**80–100Aº)** broad space/ perimitochondrial space) and the inner compartment. The inner compartment is filled with a dense homogeneous substance called the matrix. The outer membrane forms the continuous limiting boundary of the organelle. The inner membrane forms a number of in foldings called the cristae (sing.: crista) towards the matrix. Outer surface of inner membrane is called **C-face** whereas inner surface called **M-face**.The cristae increase the surface area. The two membranes have their own specific enzymes associated with the mitochondrial function

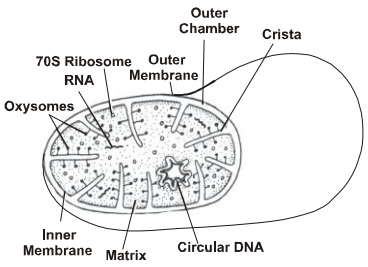


Fig:- Structure of mitochondrion

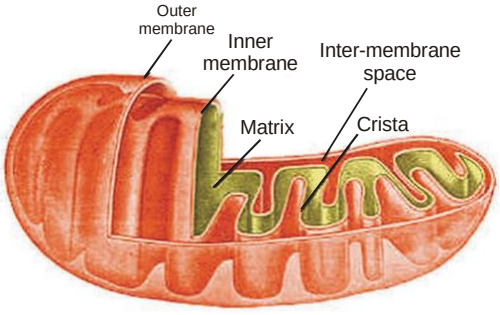


Fig : Structure of mitochondrion (Longitudinal section)

The inner membrane and cristae bear electron transport chain and tennis racket like particles called **Oxysomes or Elementary particles. or $F_0$–$F_1$ particles or ETP (Electron transport particles) or ATPase particles or Fernandez and Moran particles.** The latter are **$10^4$–$10^5$** in number. $F_0$–$F_1$ particles extracted by **Racker (1967)** hence they are also called **Racker's particles**. These are considered as **functional unit of mitochondria** and they are the site of **oxidative phophorylation.** Head part of Oxysomes contains **ATPase ( ATP synthase ) enzymes** for **oxidative phophorylation.**

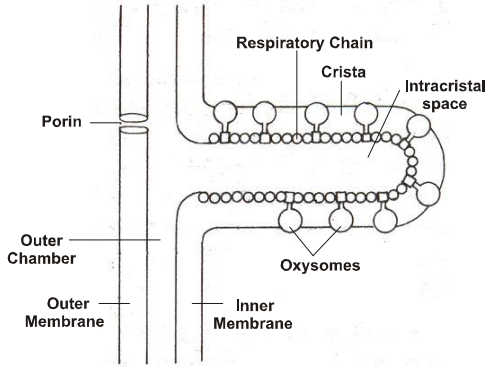



Fig:- Inner membrane with oxysomes

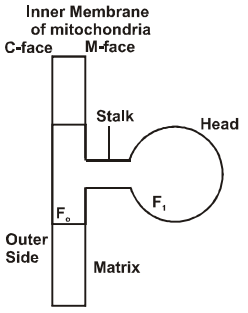



Fig:- Structure of oxysome(Elementary particle)

Mitochondrial matrix is found in inner chamber. The matrix also possesses single circular DNA molecule (naked, circular, **5µ** long prokaryotic DNA, **mt-DNA That is rich in G–C ratio)**, a few RNA molecules (5-7%), ribosomes (70S) and the components required for the synthesis of proteins. Hence mitochondria considered as **semi autonomous cell organelles**. Other components of matrix include protein (60–70%) lipids (25–35%) 70 types of enyzmes.

- **70% of total enzymes of cell are found in mitochondria.**
- The **circular mt DNA** is **1% of total DNA of cell**.
- **Origin:** They have originated from the symbiosis of a prokaryotic organism (aerobic bacteria) with a host cell that was anaerobic and derived its energy only from glycolysis (Endosymbiotic hypothesis).
- The mitochondria divide by fission.

**Functions of mitochondria :**

- Mitochondria are the sites of aerobic respiration. They produce cellular energy in the form of ATP, hence they are called 'power houses' of the cell.
- Enzymes of **krebs cycle, fattly acids synthesis, amino acids synthesis** are found in matrix.
- The **gene for male sterility in maize** plants is found in **mt DNA**. thus it helps in **cytoplasmic inheritance.**
- Mitochondria help in **Vitellogenesis in oocytes**.
- **Heme protein** required for **haemoglobin, cytochrome and myoglobin** is synthesized in mitochondria.

**Key Points**

- All mitochondria of a cell are called **chondriome**.
- Enzymes like **succinic dehydrogenase, ATPase and cytochrome oxidase** are found in inner membrane of mitochondria.
- Mitochondria are rich in **Manganese (Mn).**
- In bacteria the **Mesosomes** bear enzymes of aerobic respiration hence these are called **Chondrioid**. Thus **Mesosome and Mitochondria are analogous organelles.**
- When ATP concentration is low or the respiratory chain is inhibited the mitochondria are in **inactive or orthodox state**. Under this state matrix of the mitochondria occupies a larger area and outer chamber is narrow. In an **active or the condensed state**, mitochondria are actively participated in ATP synthesis/electron transport, the cristae are more randomly distributed and matrix is reduced and outer chamber is quite large.
- If outer membrane of mitochondria is removed then it is called as **mitoplast.**

**PLASTIDS**

These are double membraned, DNA containing largest organelles in plant cells. They disovered by **Haeckel (1865)**. Plastids are found in all plant cells and in euglenoides. These are easily observed under the microscope as they are large. They bear some specific pigments, thus imparting specific colours to the plants. Based on the type of pigments plastids can be classified into

**(i) Leucoplasts** **(ii) Chromoplasts** **(iii) Chloroplasts**

**(i) Leucoplasts :** Colourless, Largest plastids. They classified on the basis of stored material
**(a) Amyloplasts :** They store carbohydrates in the form of starch.
**(b) Aleuroplasts or Proteinoplasts :** They store proteins.
**(c) Elaioplasts :** They store oil or fats.

**(ii) Chromoplasts :** They are coloured plastids those have fat soluble carotenoids. eg- carotene in carrot, red pigments in tomato & chillies (lycopene), attractive colour to flowers, fruits, seeds.

**(iii) Chloroplasts (Schimper) :**

The chloroplasts contain chlorophyll and carotenoid pigments which are responsible for trapping light energy essential for photosynthesis. In the chromoplasts fat soluble carotenoid pigments like carotene, xanthophylls and others are present. This gives the part of the plant a yellow, orange or red colour.

Chloroplast is a double membraned, self replicating, DNA containing, oxidative, energy transducing, semiau tonomous largest organelle of cell. It is also called **autoplasts or photosynthetic apparatus or Kitchen of cell.**

- Majority of the chloroplasts of the green plants are found in the mesophyll cells of the leaves.
- These are lens-shaped, oval, spherical, discoid or even ribbon-like organelles having variable length
- Size: (5-10μm) and width (2-4μm).
- Number: varies from 1 per cell of the *Chlamydomonas*, a green alga to 20-40 per cell in the mesophyll

**Shape :**

| Plant | Shape of chloroplasts |
|---|---|
| Chlamydomonas | Cup shaped |
| Ulothrix | Girdle shaped |
| Spirogyra | Spiral (Ribbon like) |
| Zygnaema | Stellate |
| Oedogonium | Reticulate |
| higher plants | Discodial or oval |

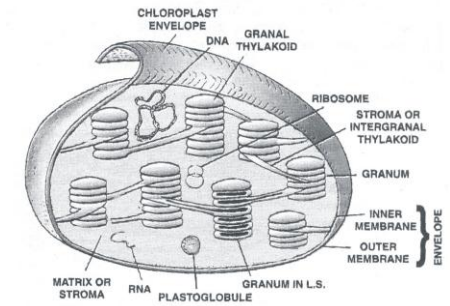



**Fig:- Structure of chloroplast**

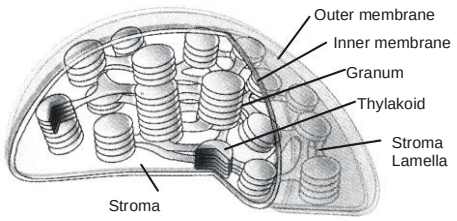



Fig : Chloroplast (TB)

**Structure of Chloroplast :**

Each chloroplast contains three parts

**(i) Envelope** **(ii) Stroma** **(iii) Lamellar system**

**(i) Envelope :**

It contains two lipoprotein unit membranes. The diameter of each membrane is 90–100Å. 100–200Å broad space lies between these two membranes. It is called periplastidial space.Outer membranes freely permeable and whereas inner membrane is selective permeable.

**(ii) Stroma (Matrix) :**

It is a space limited by inner membrane of the chloroplast.

It is highly proteinaceous. It has double stranded circular DNA (0.5% that is rich in **G - C ratio** called **cp-DNA or plastidome.** Other components are RNA (2–3%), plastoglobules (fat globules), 70s ribosomes, proteins (50–60%), lipids (25–30%), chlorophyll (5–10%), carotenoids (1–2%), minerals (Fe, Cu, Mg, Mn, Zn, Co) and enzymes of dark reaction of photosynthesis. **Rubisco** is the most abundant enzyme on the earth. It forms 16**%** protein of the chloroplast.

**(iii) Lamellar system :**

It is composed of number of organized flattered double membrane sac called **thylakoids or baggy trousers** (term coined by **Menke (1962)**.Thylakoids are structural units of chloroplast. These (2–100) thylakoids are stacked like the piles of coins to form granum or the intergranal thylakoids. Each chloroplast has 40–60 grana. The latter is absent in the chloroplasts of algae and bundle sheath chloroplasts of $C_4$ plants. These chloroplasts are called **Agranal chloroplasts**. In addition, there are flat membranous tubules called the stroma lamellae connecting the thylakoids of the different grana. The membrane of the thylakoids enclose a space called a lumen. The stroma of the chloroplast contains

enzymes required for the synthesis of carbohydrates and proteins. It also contains small, doublestranded circular DNA molecules and ribosomes. Chlorophyll pigments are present in the thylakoids. The ribosomes of the chloroplasts are smaller (70S) than the cytoplasmic ribosomes (80S).
Inner membrane of thylakoid contains **Quantasomes (Discovered by Park and Biggins) or photosynthetic functional units**. Each of them consists of **230 chlorophyll molecules (160 chl a + 70 chl b) and about 50 carotenoid molecules.**
**Chloroplast** is considered as **semi autonomous cell organelle** due to **presence of DNA , RNA, 70s ribosomes and proteins synthesis systems.**

**Origin :** All types of plastids have common origin from **proplastids** (sac like non:lamellar structures).

- **All the three types of plastids are interchangeable but chromoplasts do not change to other plastids.**
- **Etioplasts :** In the absence of light these plastids occur.

## RIBOSOMES (PALADE PARTICLES)

### Introduction

Ribosomes are granular smallest, naked, submicroscopic, ribonucleo protoplasmic (RNP) particles, first observed under electron microscope as dense particle by George Palade (1953).

Ribosomes are composed of RNA and proteins and are not surrounded by any membrane.

In prokaryotes ribosomes are associated with the plasma membrane of the cell. They are about 15 nm by 20 nm in size and are made of two subunits – 50S and 30S units which when present together form 70S prokaryotic ribosomes.

Ribosomes are the site of protein synthesis. Several ribosomes may attach to a single mRNA and form a chain called **polyribosomes or polysome.** The ribosomes of a polysome translate the mRNA into proteins.

### Occurrence

These are universal organelle i.e. found in both prokaryotic and eukaryotic cells.

These are secondarily lost in mature RBC and mature sperm.

These occur in 2 forms.

**A. Cytoplasmic ribosomes**

These are 70S type in prokaryotic cell while 80S type eukaryotic cells.

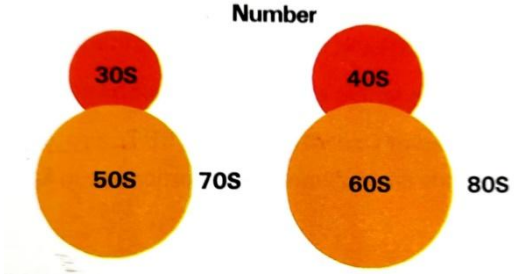
These are found in cytoplasm either in free form or attached to ER and nuclear membrane.

These are attached to ER by special ribophorin in proteins.

**B. Organelle ribosome**

These are found in mitochondria as mitoribosome, in plastids plastidosome and in nucleus as nucleoribosome.

Organelle ribosomes are absent in prokaryotic cells.



In the cell number of ribosome depends on its activity. There number are more in active cell, cancer cells, neurons, meristematic cells, liver cells and in liver cells. Both 70S and 80S ribosomes are composed of two unequal subunits i.e.

**$Mg^{+2}$ is required for binding the two subunits**

**Below 0.001 M $Mg^{+2}$the two subunits dissociation while above this concentration the ribosome come together to form dimer.**

## Types

Svedberg's unit indirectly measure of density and size.On the basis of sedimentation co – efficient or svedburg units ($S + 1 \times 10^{-13}$ sec.), ribosomes are of 2 types

| 80S | 70S |
|---|---|
| It Occur only in eukaryotic cells. | It is found in both prokaryotic and eukaryotic cells. |
| It occur in the cytoplasm either freely or attached to membranes | It is found freely inside cytoplasm of prokaryotes and matrix of plastids and mitochondria. |
| It is larger in size | It is smaller in size |

### Polysomes

It is also known as ergosome. It occurs in rosette or helical groups in which nearly 10-20 ribosomes form chain.These are involve in formation of copies of one protein formed during period of active protein synthesis.

### Biosynthesis

In prokaryotes its synthesis takes place in cytoplasm, in eukaryotes synthesis takes in nucleolus, r synthesis occurs in cytoplasm. However, 5S rRNAsynthesised outside nuecleolus in the nucleus.

### Functions

1. It is involve in protein synthesis.
2. It is involve in attachment of t-RNA during translation.
3. It provides protection to newly synthesis m-RNA

## MICROBODIES

Many membrane bound minute vesicles called microbodies that contain various enzymes, are present in both plant and animal cells. These are of two types

### A. Peroxisome

These are microbodies which contain enzymes for peroxide biosynthesis and breakdown.
These are found in both plant and animal cells. Their diameter is about 0.5 to 1.0μ.

### B. Glyoxysomes

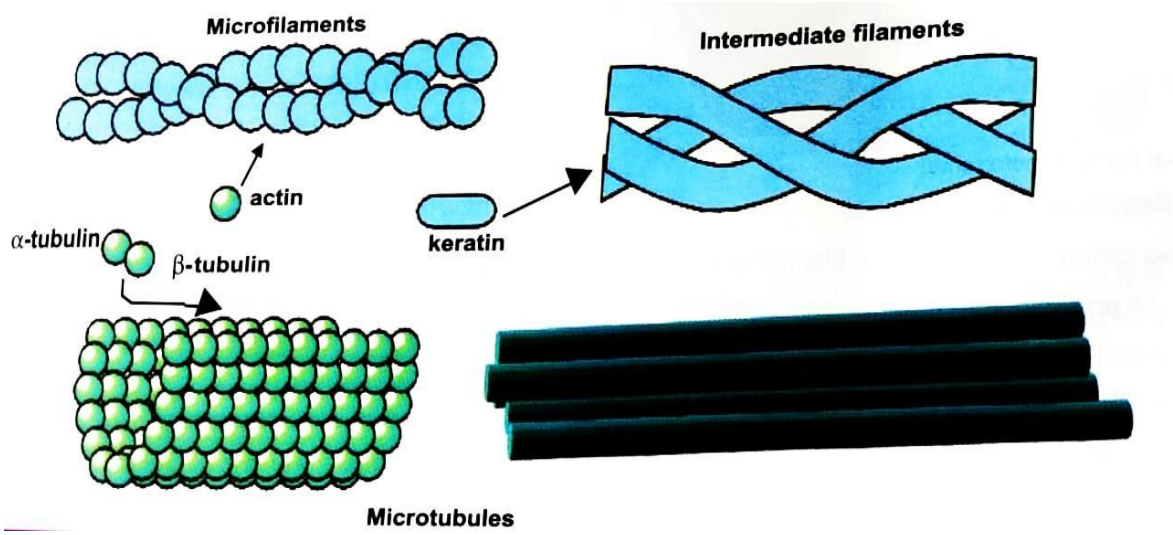
These are microbodies which contains enzymes for β- oxidation of fatty acids and Glyoxylate pathway.

## CYTOSKELETON

An elaborate network of filamentous proteinaceous structures present in the cytoplasm is collectively referred to as the **cytoskeleton.**

The cytoskeletons in a cell are involved in many functions such as mechanical support, motility, maintenance of the shape of the cell.

It is formed of microtubules, microfilaments and intermediate filaments.



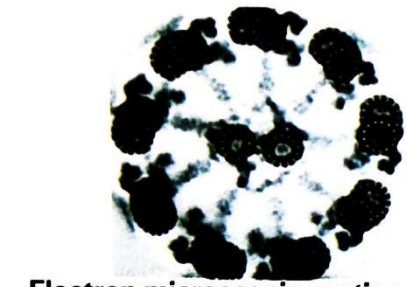

| Microfilaments | Microtubules | Intermediate filaments |
|---|---|---|
| Contractile | Non-contractile. | Non-contractile. |
| Do not possess longitudinal sub units. | Contains 13 proto filaments helically arranged with cross bridges arms on surface. | Rope like and unbranched |
| Solid cylindrical structures | Hollow tubules. | Solid tubules. |
| Mainly made up of action & myosin protein. | Formed of α and β tubulin proteins rich in sulphur. | Formed of keratin, desmin, vimentin. |
| Diameter is 5-6 nm. | Diameter is 25 nm with 15 nm core. | Diameter filament is 8-10 nm. |
| Responsible for cytoplasmic streaming, undulatroy movement &pseudopodia formation. Help in endocytosis and exocytosis, muscle contraction. | Basic structure of spindle, centriole, basal body cilia & flagella, provide shape &rigidity to cell and involve in intracellular transport. | Provide stability to cells and cytoplasm. Present in skin Neurons z-line in muscles, glial cells |

## FLAGELLA AND CILIA

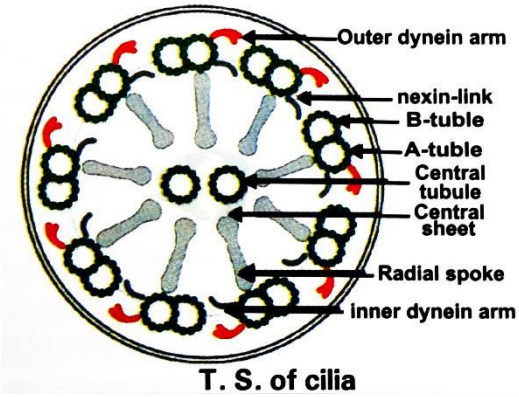
These are fine hair like movable outgrowth of cell membrane causing the movement of either cell or surrounding fluid.

| Cilia | Flagella |
|---|---|
| Number per cell is usually very large(300-14000) | Number per cell is usually 1-4. |
| Cilia are small structures which work like oars, causing the movement of either the cell or the surrounding fluid. | Flagella are comparatively longer and responsible for cell movement. |
| Occur throughout or major part of the surface of a cell. | Commonly found at one end of the cell. |

| | |
|---|---|
| Beat in a co-ordinated rhythm either simultaneously (isochronic or synchronous rhythm) or one after theother (metachronic rhythm) | Flagella beat independently. (Undulatory motion) |
| Surface is smooth. | Surface may be smooth or possess flimmers. |

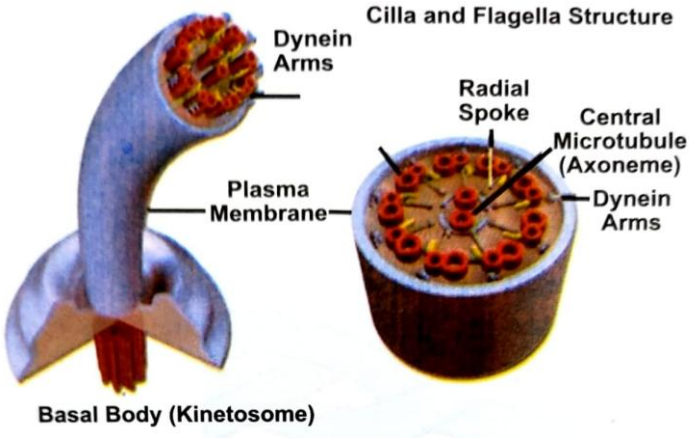


Electron microscopic section of cilia




T. S. of cilia

Prokaryotic bacteria also possess flagella but these are structurally different from that of eukaryotic flagella.

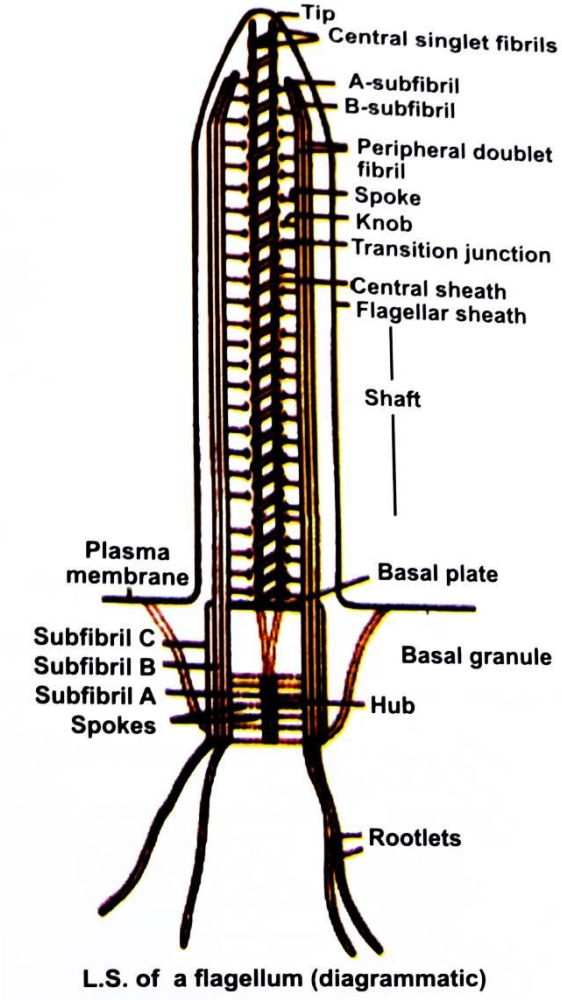



## A. Basal body or kinetosome

It is also called basal granule or blepharoplast.

Both cilia and flagellum emerge from centriole like basal body. Basal occurs embedded in the outer part of the cytoplasm below plasma membrane.

It is like a microcylinder with triplet fibrils present on the periphery without a central fibril. But a hub of protein is present in this structure.




L.S. of a flagellum (diagrammatic)

## B. Rootlets

They are fibrillar outgrowths of bundles of microfilaments which develop from the outer lower part of the basal body and are meant for providing support to the basal body.

## C. Basal plate

It is an area of high density which lies above the basal body, one sub- fiber of each peripheral fibril disappears. The central fibrils develop in the area.

## D. Shaft

It is the hair- like projecting part which internally, it contains a semifluid matrix having a core called axoneme of 9 peripheral doublet fibrils of radially arranged peripheral microtubules and 2 central singlet fibrils. This arrangement is called 9 + 2 fibrilar arrangement (11 stranded in composition).

The two central singlet fibres are covered by a proteinaceous central sheath. They are connected by a double bridge.

Central sheath is connected to one of the tubules of each peripheral doublets by a radial spoke. Thus there are nine radial spokes.

Each peripheral fibril consists of two microtubules or sub – fibres B and A. the subfibre A is slightly narrower. It bears two bent arms, the outer one having a hook. These are mode up of protein dynein with ATPase activity.

ATP ase activity is also present in central fibrils.

The peripheral doublet fibrils as well as central singlet fibrils are made up of tubulin.

Each sub- fibre or central singlet fibril contains 13 protofilaments. The peripheral double fibrils are inter connected by A-B linkers of protein nexin.

The cilia and flagella move by sliding of the doublet fibrils against one another. Energy is provided by ATP.

### Function of cilia and flagelia

1. They help in locomotion in flagellate and ciliated organisms.
2. In aquatic organisms cilia create currents in water for renewal of oxygen supply and quick diffusion of carbon dioxide.
3. In land animals the cilia of respiratory tract help in eliminating dust particles in the incoming air.
4. Internal transport of several organs is performed by cilia, e.g., passage of eggs in oviduct, passage of excretory substances in the kidneys, etc.
5. Cilia and flagella show sensitivity to changes in light, temperature and contact, can function as sensory structure.

## CENTROSOME & CENTRIOLES

**Centrosome** is an organelle usually containing two cylindrical structures called centrioles. They are surrounded by amorphous pericentriolar materials. Both the centrioles in a centrosome lie perpendicular to each other in which each has an organization like the cartwheel.

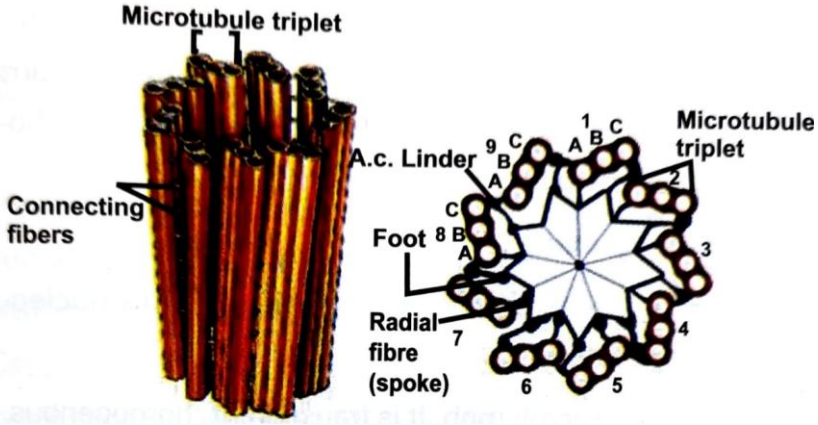
Centrioles are minute submicroscopic microtubular structure with a configuration of 9 triplet fibrils and ability to form their own duplicates, astral poles and basal bodies.

These are without DNA and a membranous covering. They are visible under light microscope, but the details of centriole structure were revealed only under electron microscope.

Two centrioles are found associated together but at perpendicular to each other. The pair of centrioles often called diplosome. Diplosome lies in a common specialized part of cytoplasm called centrosphere or kinoplasm (cytocentrum). Centrosphere is devoid of any other cells organelle and is amorphous percentriolar material.

Centrioles are found in almost all eukaryotic animal cells, protozoan protists, some fungi and the cells of all those eukaryotic plants where flagellate structures are present in the life cycle. They are absent in angiosperms, higher gymnosperms, some algae and fungi.

Centrioles are capable are capable of replication.




A centriole possesses a whorl of nine peripheral fibrils of tubulin protein. Each of the fibril is a triplet. Central fibrils are absent. The arrangement is called 9 + 0. Fibrils run parallel to one another.

Each fibrils made up of three subfibres. Therefore, it is called triplet fibril. From outside to inside the three subfibres of a triplet fibril are named as C, B and A.

Adjacent triplet fibril are connected C –A linkers

The central part of the proximal region of the centriole is also proteinaceous and called the hub, which is connected with tubules of the peripheral triplets by radial **spokes** made of protein.

Each spoke has a thickening called X before uniting with A sub- fibre. Another thickening known as Y is present nearby. It is attached both to X thickening as well as C-A linkers by connectives.

The centriole gives a cart wheel appearance in T.S.

On the outside of centriole are present dense, amorphous, protoplasmic plaques in one or more series. They are called massules or pericentriolarstatellites.

### Function

1. Centriole help in cell division and form spindle fibre that gives rise to spindle apparatus.
2. Distal centriole in sperm gives rise to axial filament of tale.
3. Centriole can be transformed into basal bodies which gives rise to cilia and flagella.

## NUCLEUS

### Introduction

The nucleus also called director of the cell. It is the most important part of the cell which directs and controls all the cellular function. The nucleus as a cell organelle was first observed by **Robert Brown** in orchid root cells (1831). Later, the material of the nucleus was stained by the basic dyes and given the name **chromatin** by Flemming.

### Occurrence

A true nucleus with definite nuclear membrane and linear chromosome, is present in all the eukaryotes except mature mammalian RBCs, sieve tube cell of phloem, tracheids and vessels of xylem. The prokaryotes have an incipient nucleus, called nucleoid or prokaryotes or genophore or false nucleus.

### Number:

Usually there is a single nucleus per cell i.e., monoucleate condition. Variation in the number of nucleus are frequently observed.

### i. Anucleate (without nucleus)

This condition is reported in mature RBCs of mammals, sieve tube cells of vascular plants.

### ii. Binucleate

This condition is reported in ciliate, protozoans like Paramecium.

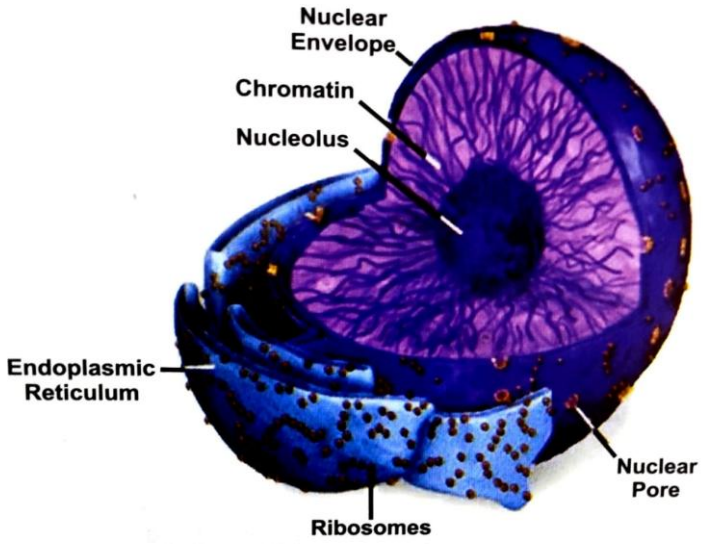
### iii. Polynucleate

This condition is reported fungal hyphae of Rhizopus, vaucheria. Polynucleate condition may be because of fusion of a number of cells. i.e., syncytium in coconut endosperm or by free nuclear divisions without cytokinesis i.e., coenocyte.

### Ultrastructure:

The interphase nucleus (nucleus of a cell when it is not dividing) has highly extended and elaborate nucleoprotein fibres called chromatin, nuclear matrix and one or more spherical bodies called **nucleoli.**

The nucleus is composed of following structure:




## A. Nuclear membrane

Electron microscopy has revealed that the nuclear envelope, which consists of two parallel membranes with a space between (10 to 50nm) called the **perinuclear space, forms** a barrier between the materials present inside the nucleus and that of the cytoplasm.

The outer membrane usually remains continuous with the endoplasmic reticulum and also bears ribosomes on it.

At a number of places the nuclear envelope is interrupted by minute pores, which are formed by the fusion of its two membranes.

These nuclear pores are the passages through which movement of RNA and protein molecules takes place in both directions between the nucleus and the cytoplasm.

### Functions of nuclear membrane

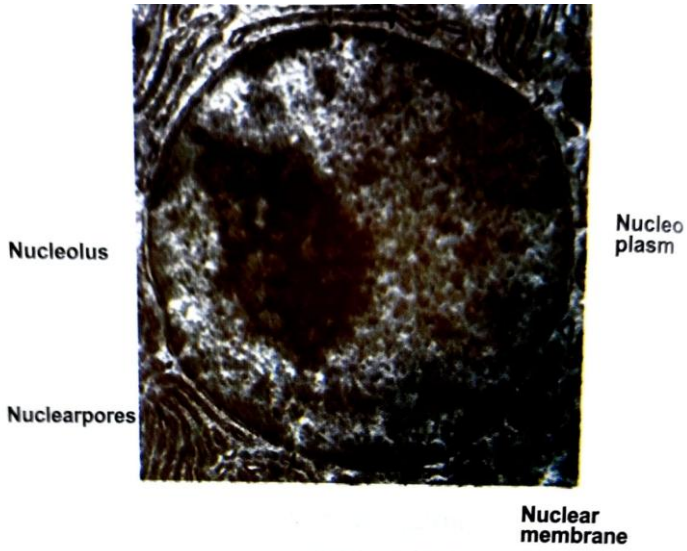
1. It regulates the nucleo – cytoplasmic interactions.
2. It allows the passage of inorganic ions, small organic molecules, ribosomal subunits, RNAs and proteins in both directions between the nucleus and cytoplasm.
3. It maintains the shape of the nucleus.
4. It forms a barrier between the materials present inside the nucleus and that of the cytoplasm.

## B. The nucleolus (little nucleus plasmosome)

The nucleoli are spherical structure present in the nucleoplasm. The content of nucleolus is continuous with the rest of the nucleoplasm as it is not a membrane bound structure.

Larger and more numerous nucleoli are present in cell actively carrying out protein synthesis.

Nucleolus is mainly formed of RNA and non histone acidic proteins. It is a store house of rRNA.




Electron microscopic section of nucleus

### Functions of nucleolus

1. It is seat of biogenesis of rRNA and also stores rRNA.
2. It plays important role in spindle formation during cell division.
3. It receives the ribosomal proteins from the cytoplasm, combines the rRNA and ribosomal proteins to form ribosomal subunits. So it is also called ribosome producing machine or factory.

## C. Nucleoplasm

The nuclear matrix or the nucleoplasm contains nucleolus and chromatin.

It is also called karyolymph. It is transparent, homogenous, semifluid, colloidal ground substance present inside the nuclear membrane. It contains nucleic acids basic and acidic proteins, enzymes minerals like K, Na, Ca, Mg etc. and ribonucleoproteins.

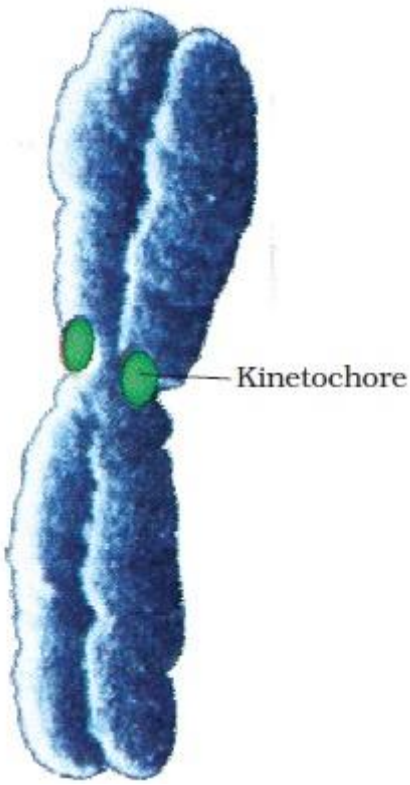
## D. Chromatin fibres

It is also called nuclear chromatin.

The nucleoplasm contains many thread like, coiled and much elongated structures which take readily the basic stains such as 'basic fuchsine'. These thread like structures are known as chromatin fibre. They are uniformly distributed in the nucleoplasm. They are observed only in the 'interphase stage'.

## CHROMOSOMES

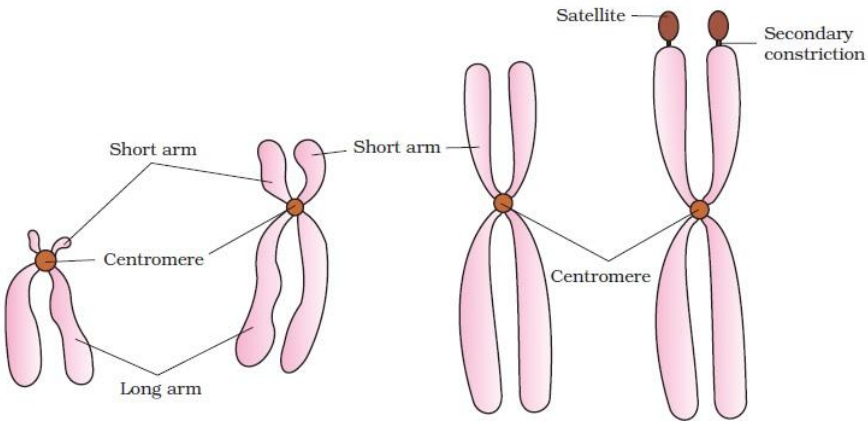
Interphase nucleus has a loose and indistinct network of nucleoprotein fibres called chromatin. But during different stages of cell division, cells show structured chromosomes in place of the nucleus. Chromatin contains DNA and some basic proteins called histones, some non-histone proteins and also RNA. A single human cell has approximately two metre long thread of DNA distributed among its forty six (twenty three pairs) chromosomes.




Chromosome with kinetochore

Every chromosome (visible only in dividing cells) essentially has a primary constriction or the centromere on the sides of which disc shaped structures called kinetochores are present. Centromere holds two chromatids of a chromosome. Based on the position of the centromere, the chromosomes can be classified into four types. The metacentric chromosome has middle centromere forming two equal arms of the chromosome. The sub-metacentric chromosome has centromere slightly away from the middle of the chromosome resulting into one shorter arm and one longer arm. In case of acrocentric chromosome the centromere is situated close to its end forming one extremely short and one very long arm, whereas the telocentric chromosome has a terminal centromere.

Sometimes a few chromosomes have non-staining secondary constrictions at a constant location. This gives the appearance of a small fragment called the satellite.




Types of chromosome based on position of centromere

# EXERCISE - 1

1. Which of the following is not correct?
   (a) Robert Brown discovered the cell
   (b) Schleiden and Schwann formulation the cell theory
   (c) Virchow explained that cells are formed from pre – existing cells
   (d) A unicellular organism carries out its life activites within a single cell
2. New cells originate form
   (a) Bacterial fermentation
   (b) Regeneration of old cells
   (c) Pre – existing cells
   (d) Abiotic materials
3. The branch which deals with the study of cell structure and function is known as
   (a) Histology
   (b) Ecology
   (c) Morphology
   (d) Cytology
4. The main difference between plant and animal cell is
   (a) Animal cells lack cell wall
   (b) Plant cell has no cell wall
   (c) Animal cell has rigid cell wall
   (d) Plant cell lack cell membrane
5. A live cell was first seen & described by
   (a) Robert Brown
   (b) Robert Hooke
   (c) Leeuwenhoek
   (d) Schleiden
6. Which among the following is the correct statement regarding Theodore Schwann?
   (a) He was a British zoologist
   (b) He studied different types of animal
   (c) He reported that cells had a outer layer which is today known as plasma membrane
   (d) All the above
7. "Omnis cellula – e cellula" means
   (a) Cells have abiotic origin
   (b) All cells are alike
   (c) New cells are formed from pre – existing cells
   (d) All living organisms are composed of cells
8. Find the correct match among the following
   (a) Robert Brown – Protoplasm
   (b) Schleiden – German Botanist
   (c) Schwann – British botanist
   (d) Rudolf Virchow – Plasma membrane
9. Mycoplasmas are
   (a) Smallest cells with 0.3 µ m length
   (b) Largest cells with 7.0 µ m diameter
   (c) Smallest cells with 0.1 µ m length
   (d) Longest cell with 8.5 µ m length
10. Find correct match among the following
    (a) Bacteria – 0.1 – 0.2 µ m length
    (b) RBCs – 7.0 µ m diameter
    (c) Nerve cell – largest cell
    (d) All the above
11. Match the name of the scientist to his contribution to cell biology

| | |
|---|---|
| a. Leeuwenhoek | i. Cell theory |
| b. Robert Brown | ii. Discovered nucleus |
| c. Robert Hooke | iii. Discovered cell |
| d. Schwann | iv. Saw live cell |

    (a) a – I, b – ii, c – iii, d – I
    (b) a – iv, b – iii, c – ii, d – I
    (c) a – I, b – iii, c – ii, d – iv
    (d) a – iv, b – ii, c – iii, d – I
12. Schwann and Schleiden formulated cell theory. Which of the following feature of cell theory was contributed by Rudolf – Virchow to give it its present form?
    (a) All living organisms are composed of cells
    (b) All cells arise from pre – existing cells
    (c) Cells can perform activities which are not present in the organisms
    (d) All of these
13. Find the correct match
    a. Smallest cell – mycoplasma
    b. Largest isolated single cell – ostrich egg cell
    c. Longest cell – nerve cell
    (a) a, b, c (b) b and c only
    (c) a and c only (d) a and b only
14. Which of the following is absent in prokaryotes?
    (a) Nuclear membrane
    (b) Golgi bodies
    (c) Endoplasmic reticulum
    (d) All of these
15. Intracellular compartments are not formed in cells of
    (a) Lower plants
    (b) Higher plants

(c) Prokaryotes
(d) Eukaryotes

16. In the structure of cell membrane lipids are arranged in the form of
(a) Monolayer
(b) Bilayer
(c) Trilayer
(d) None of these

17. In human beings the membrane of erythrocytes has approximately _____% of lipids respectively
(a) 40,52
(b) 52,40
(c) 40,40
(d) 60,40

18. The plasma membrane consist mainly of
(a) Proteins embedded in carbohydrate bilayer
(b) Phospholipids embedded in protein bilayer
(c) Proteins embedded in polymer of glucose molecules
(d) Proteins embedded in polymer of glucose molecules

19. Keeping in view the fluid mosaic model for the structure of cell membrane, which of the following statement is correct w.r.t. movement of lipids and proteins from one lipid monolayer to other (described as flip flop movement)
(a) Proteins can flip flop, lipids can not
(b) Neither lipids nor proteins can flip flop
(c) Both lipids and proteins can flip flop
(d) Lipids can rarely flip flop, proteins cannot

20. The type of cell junction which facilitates cell to cell communication is
(a) Tight junction
(b) Adhering junction
(c) Gap junction
(d) Desmosomes

21. According to fluid mosaic model, plasma membrane is made up of
(a) Cellulose and hemicellulose
(b) Phospholipid and integrate protein
(c) Phospholipid, extrinsic and intrinsic protein
(d) Phospholipid and hemicellulose

22. Who proposed fluid mosaic model for cell membrane?
(a) Cramer and Nageli
(b) Singer and Nicholson
(c) Robertson
(d) Denielli and Davson

23. Which among the following enables lateral movements of proteins within the overall bilayer?
(a) Static nature of lipids
(b) Lateral movements of lipids
(c) Up and down movement of lipids
(d) Quasi – fluid nature of lipids

24. Find correct statement regarding cell membrane
(a) It is composed of lipids arranged in a monolayer
(b) The lipid content of membrane consists of mainly phosphoglycerides
(c) The ratio of protein and lipid is constant in different cell types
(d) Non polar tails of saturated hydrocarbons is not protected from aqueous environment

25. Chemical studies on the cell membranes of which among the following cells enabled the scientists to deduce possible structure of plasma membrane
(a) Human WBCs
(b) Human RBCs
(c) Plasma cells
(d) Nerve cells

26. Besides phospholipid layer, cell membrane also possess
(a) Proteins
(b) Carbohydrates
(c) Nucleic acids
(d) Both (a) & (b)

27. Membrane proteins can be classified as integral or peripheral depending on
(a) Stability
(b) Configuration
(c) Ease of extraction
(d) All the above

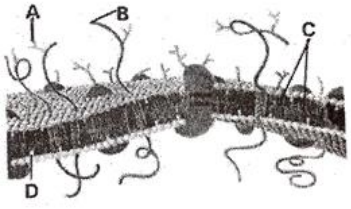
28. Fluid nature of membrane of responsible for
(a) Cell growth
(b) Inter cellular junctions
(c) Endocytosis, cell division
(d) All the above

29. The lipids ar arranged within the memberane with polar heads towards
(a) Inner sides
(b) Outer sides
(c) Lateral sides
(d) Some towards outer & some towards inner side

30. Integral proteins

(a) Are partially buried in the membrane
(b) Lie on the surface of membrane
(c) Are totally buried in the membrane
(d) Both (a) & (c)

31. Identify A, B, C and D from the given figure of plasma membrane




Endomembrane system includes
(a) ER, golgi complex, lysosomes, vacuoles
(b) ER, lysosomes, golgi complex
(c) Lysosomes, golgi complex, nucleus, mitochondira
(d) Nucleus, mitochondira, plastids, ER

32. Cisternae are concentrically arranged near the nucleus with cis & trans faces. The correct statement regarding these faces is
(a) both are similar and interconnected
(b) Both are entirely different and interconnected
(c) Cis is concave or maturing face
(d) Trans is convex or forming face

33. Materials to be packaged in the form of vesicles for ER fuse with
(a) Trans face of golgi
(b) Cis face of golgi
(c) Both faces of golgi
(d) Do not fuse with any face of golgi

34. ER divides the intracellular spaces into two distinct compartments, out of which luminal space is
(a) In the cytoplasm
(b) In the cytoplasmic compartments
(c) Inside ER
(d) Inside ER and cytoplasmic compartments

35. Golgi apparatus is important site of formation of
(a) Glycoproteins & nucleoproteins
(b) Glycolipids & Nucleoproteins
(c) Glycoproteins & glycolipids
(d) Glycolipids only

36. "Lipids and steroids are synthesized in _____and proteins are synthesized on _____."
(a) SER and RER
(b) RER and SER
(c) RER and SER
(d) Golgibody and Ribosomes

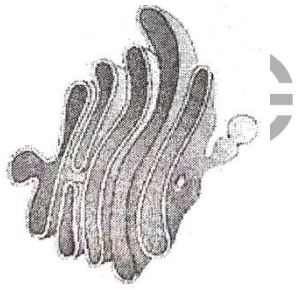
37. What is not applicable to RER?
(a) Observed in cells actively involved in protein synthesis
(b) Continuous with the outer membrane of nucleus
(c) Ribosomes are attached to the surface
(d) Lipid – like steroidal hormones are synthesised in it

38. Golgi apparatus performs the function of packaging materials to be
(a) Delivered to intra – cellular targets
(b) Secreted outside the cell
(c) Delivered to SER
(d) Both (a) & (b)

39. Protein synthesis and detoxification of drugs are main functions of
(a) ER
(b) Ribosomes
(c) Peroxisomes
(d) Dictyosomes

40. Golgi body originates from
(a) Lysosomes
(b) Endoplasmic reticulum
(c) Mitochondria
(d) Cell membrane

41. The given structure is of



(a) Tubules of ER
(b) Tubules of golgi appartus
(c) Cisternae of golgi apparatus
(d) Cisternae of mitochondria

42. In the structure of golgi apparatus there are present many flat 0.5 $\mu$m to 1.0 $\mu$m diameter structures. Which among the following is correct regarding these structures?
(a) These are tubular and called tubules
(b) There are disc shaped
(c) These are called cisternae

(d) Both (b) & (c)

43. Golgi cisternae are arranged near the nucleus
    (a) Eccentrically
    (b) Concentrically
    (c) Diagonally
    (d) Parallely
44. Which among the following organelle is concerned with packaging of materials?
    (a) Endoplasmic reticulum
    (b) Golgi apparatus
    (c) Lysosomes
    (d) Mitochondria
45. Endoplasmic reticulum studded by ribosomes on outer surface of the cisternae, is called
    (a) Sarcoplasmic reticulum
    (b) Smooth endoplasmic reticulum
    (c) Granular endoplasmic reticulum
    (d) None of these
46. 'S' – Svedberg's unit is indirectly a measure of
    (a) Size & volume
    (b) Volume & density
    (c) Size & density
    (d) Density & shape
47. Lysosomal vesicles are very rich in all types of hydrolytic enzymes, which are optimally active at
    (a) Alkaline pH
    (b) Acidic pH
    (c) Neutral pH
    (d) At and pH
48. Membrane bound space found in the cytoplasm which contains water, sap, excretory product and secretory materials of for the cell is
    (a) Inclusion bodies
    (b) Lysosomes
    (c) Vacuole
    (d) All the above
49. Ribosomes are
    (a) Granular structures
    (b) Composed fo ribonucleic acid only
    (c) Bounded by single unit membrane
    (d) All the above
50. Category of enzymes in lysosomal vesicles is
    (a) Transferases & belong to class II
    (b) Hydrolases & belong to class III
    (c) Hydrolases & belong to class II
    (d) Transferases & belong to class III
51. Which of the following rRNA is similar in 70s and 80 ribosomes
    (a) 5 S rNA
    (b) 16 S RNA & 10 S rRNA
    (c) 5.8 S rRNA
    (d) None of these
52. Ribosomes are
    (a) Membrane bound organelles found in all cells both prokaryotic as well as eukaryotic
    (b) Non membrane bound organelles found in the cells both prokaryotic & eukaryotic
    (c) Membrane bound organelles found only in some cells
    (d) Non – membrane bound organelles found only in some cells
53. Which among the following are correct w.r.t. ribosomes?
    a. Non membrane bound organelles
    b. Found in both prokaryotic & eukaryotic cells
    c. Found only in the cytoplasm
    d. Are also found within chloroplast, mitochondria, and on rough ER
    (a) a, b, c
    (b) b, c
    (c) a, b, d
    (d) a, b, c, d
54. The membrane bound vesicular structures formed by the process of packaging in the golgi apparatus are
    (a) Vacuoles (b) Lysosomes
    (c) Peroxisomes (d) Glyoxisomes
55. Lysosomes are known as suicidal bags because of
    (a) Anabolic enzymes
    (b) Hydrolytic enzymes
    (c) Parasitic on nucleus
    (d) Proteolytic enzymes
56. Which of the following organelle is called as protein factory of the cell?
    (a) Chloroplast
    (b) Mitochondria
    (c) Ribosomes
    (d) Golgi body
57. Which of the following cell organelles lacks unit membrane?
    (a) Mitochondria
    (b) Lysosomes

(c) ER
(d) Ribosomes

58. Ribosomes of bacteria, mitochondira, prokaryotes and chloroplast are generally of
(a) 50 S type
(b) 80 S type
(c) 70 S type
(d) 30 S type

59. What is true about ribosomes?
(a) Prokaryotic ribosomes are 80 S where S stands for sedimentation coefficient
(b) These are composed of ribonucleic acids and proteins
(c) They are found only in eukaryotic cells
(d) These are self splicing introns of some RNAs

60. Which of the following is not considered as a part of endomembrane system?
(a) Vacuole
(b) Lyosome
(c) Golgi complex
(d) Peroxisomes

61. Tonoplast is a
(a) Covering layer of golgi complex
(b) Covering layer of vacuoles
(c) Covering layer of microbodies
(d) Non – Living cytoplasmic content

62. The number of protofilaments in a microtubule is
(a) 10
(b) 13
(c) 9
(d) 12

63. Filamentous proteinaceous structures present in cytoplasm is referred to as
(a) ER
(b) Endomembrane system
(c) Golgi body
(d) Cytoskeleton

64. Centriole is
(a) Non membranous bound organelle
(b) Membrane bounded organelle
(c) Helps in cell division
(d) Both (a) & (c)

65. A centrosome has
(a) One centriole & pericentriolar bodies
(b) Two centriole perpendicular to each other
(c) Two centriole parallel to each other
(d) Two basal bodies & one centriole

66. Microbodies include
(a) Oleosomes & sphaerosomes
(b) Peroxisomes & Glyoxysomes
(c) Peroxisomes & Oleosomes
(d) Glyoxysomes & Oleosomes

67. What is common to centriole and ribosome?
(a) Presence of nucleic acids
(b) Site of protein synthesis
(c) Occur in subunits
(d) Lack a limiting membrane

68. Solid, Unbranched, contractile, non – membranous cytoskeletal elements are
(a) Microtubule and microfilaments
(b) Microtubule and intermediate filament
(c) Intermediate filaments
(d) Microfilaments

69. Centrioles are
(a) Membrane bound organelles found in animal cells
(b) Membrane bound organelles found in plant cells
(c) Non – membrane bound organelles found in animal cells
(d) Non membrane bound organelle found in plant cells

70. The function of an elaborate network of filamentous proteinaceous structures present in the cytoplasm is
(a) Mechanical support
(b) Motility
(c) Maintainance of shape of cell
(d) All the above

71. Which among the following is incorrect statement regarding centrioles?
(a) Centriole is an organelle usually containing two cylindrical structures called centrosomes
(b) Centrioles are surrounded by amorphous pericentriolar material
(c) Centrosome is an organelle usually containing two cylindrical structure called centrioles
(d) Bothe the centrioles lie perpendicular to each other

72. Radial spokes in the structure of centriole are made up of
(a) Carbohydrate
(b) Protein

(c) Lipid
(d) Glycoprotein

73. The spindle fibres which give rise to spindle appartus during cell division in animal cells is formed from
(a) Basal body
(b) Centrioles
(c) Nucleolus
(d) Nucleolar organisar region

74. The central pat of ____region of centriole is made up of ___and is called _____
(a) Distal, protein, core
(b) Proximal, carbohydrate
(c) Distal, glycoprotein, hub
(d) Proximal, protein, hub

75. Triplet peripheral microtubules are seen in the structure of
(a) Cilia (b) Flagella
(c) Centriole (d) All the above

76. Microbodies are
(a) Membrane bound vesicles
(b) Rich in various enzymes
(c) Present in both plant & animal cells
(d) Are the above

77. A centrosome is
(a) Cytoplasmic organelle present in plant cells
(b) Cytoplasmic organelle present in animal cells
(c) Cytoplasmic organelle present in both plant and animal cells
(d) A Nuclear structure present in animal cells

78. Main structure of centriole is
(a) 9 + 3 fibrils
(b) 9 + 2 array
(c) 9 triplets
(d) 13 globular units

79. Find correct difference between cilia and flagella given below

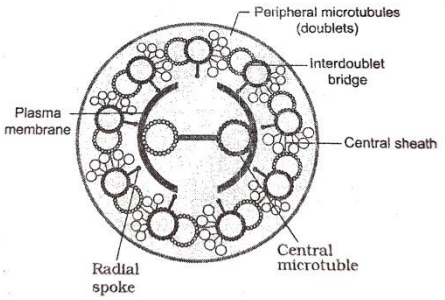
| | **Cilia** | **Flagella** |
|---|---|---|
| (a) | Longer | Smaller |
| (b) | Undulatory movement | Work line oars |
| (c) | 9 + 2 array | 9 + 2 array |
| (d) | Few in number | numerous |

80. Number of radial spokes in cilia and flagella are
(a) 2 (b) 7
(c) 9 (d) Variable

81. What is applicable to cilia & flagella?
a. Core is called axoneme
b. Central tubules are connected by bridges
c. Emerge from centriole – like structure
(a) a & b only (b) b & c only
(c) a & c only (d) a, b & c

82. The filaments associated with cilia and flagella are constituted by
(a) Microfilaments (b) Microtubules
(c) Microfibrils (d) Microvilli

83. In the given internal structure of cilia/flagella, if there are two correctly labelled parts, these are




(a) Doublets & interdoublet bridge
(b) Central sheath & interdoublet bridge
(c) Plasma membrane & peripheral microtubules
(d) Radial spoke & central microtubules

84. The core of cilia of flagella is called
(a) Central sheath
(b) Interdoublet bridge
(c) Axoneme
(d) Basal body

85. Which among the following are correct w.r.t. prokaryotic & eukaryotic flagella?
(a) Both are similar structurally
(b) Prokaryotic flagella are structurally different from eukaryotic flagella
(c) Prokaryotic flagella are functionally different from eukaryotic flagella
(d) Both are different structurally as well as functionally

86. Central tubules in the structure of cilia or flagella are
(a) Two in number
(b) Connected by bridges
(c) Enclosed by central sheath
(d) All the above

87. Find correct statements among the following
a. Cilia work like oars and cause movement of either the cell or the surrounding fluid
b. Flagella are responsible for cell movement
c. The arrangement of axonemal microtubules in cilia is 9 + 0

d. Central tubules are connected to one of the tubules are connected to one of the tubules are connected to one of the tubules of each peripheral doublet by interdoublet bridge

Both cilia and flagella emerge from centriole like structure called basal bodies

(a) a, b, c, d
(b) a, b, c, d, e
(c) b, c, d
(d) a, b, e

88. Number of microtubules in a flagellum including those sharing free protofilaments with each other is

(a) 11 (b) 20
(c) 22 (d) 10

89. Microtubules are absent in

(a) Mitochondria (b) Flagella
(c) Spindle fibres (d) Centriole

90. Controlling center/master mind of the cell is

(a) Nucleus
(b) Mitochondria
(c) Nucleolus
(d) Ribosome

91. Which among the following is correct w.r.t. nucleolus?

(a) It is not a membrane bound structure
(b) It is a site for active ribosomal RNA synthesis
(c) Larger and more numerous nucleoli are present in cells active carrying out protein synthesis
(d) All the above

92. Nuclear pores are formed by

(a) Dissolution of two membranes
(b) Fusion of two membranes
(c) Separation of two membranes
(d) Rupturing of two membranes

93. Which of the following is incorrect?

(a) The interphase nucleus has highly extended and elaborate nucleoprotein fibres called chromatin
(b) The outer nuclear membrane usually remains continuous with ER and bear ribosomes on it
(c) RNA and proteins show bidirectional movement through nuclear pores
(d) Nucleolus bounded by single unit membrane

94. The nucleus is separated from surrounding cytoplasm by a nuclear membrane, which is

(a) single layered with pores
(b) Single layered without pores
(c) Double layered with pores
(d) Double layered without pores

95. Structure of nuclear membrane help in

(a) Organisation of the spindle
(b) Synapsis of homologous chromosome
(c) Nucleo – cytoplasmic exchange of material
(d) Anaphasic separation of daughter chromosome

96. The space between two parallel membranes of nuclear envelop is

(a) 100 – 500 nm
(b) 10 – 50 nm
(c) 1 – 5 nm
(d) 15 – 25 nm

97. Which among the following is correct regarding nucleoplasm?

(a) It is also called nuclear matrix
(b) It contains nucleolus and chromatin
(c) It is a site of active tRNA synthesis
(d) Both (a) & (b)

98. Nuclear envelope is a derivative of

(a) Microtubules
(b) Rough endoplasmic reticulum
(c) Smooth endoplasmic reticulum
(d) Membrane of Golgi complex

99. The function of nucleolus is synthesis of

(a) DNA
(b) mRNA
(c) rRNA
(d) tRNA

100. Nuclear material without nuclear membrane is observed in

(a) Bacteria and green algae
(b) Cyano bacteria and red algae
(c) Bacteria and Cyano bacteria
(d) Mycoplasma and green algae

101. The nucleus has

(a) One membranes with pores
(b) Two membranes with pores
(c) Two membranes with pores through which substances cannot pass
(d) Two membranes with pores through which macromolecule may pass

102. In nucleoplasm, a conspicuous body of spherical shape attached to a particular chromosome on a definite position is called

(a) Plasmid
(b) Karyolymph
(c) Nucleolus
(d) Nuclear reticulum

103. Nucleus as a cell organelle was first described by
(a) Robert Hooke
(b) Robert Brown
(c) Schwann
(d) Flemming

104. The material of nucleus stained by _____was given the name chromatin by _____
(a) Acidic dyes, Flemming
(b) Basic dyes, Robert Brown
(c) Basic dyes, Flemming
(d) Acidic dyes, Robert Brown

# EXERCISE – 2

1. Identify the correct statements
   a. Diameter of RBC is 7 – 8 $\mu$m
   b. Largest isolated cell is verve cell
   c. Egg of ostrich is longest cell
   d. Mycoplasmas is smallest cell
   (a) a and b (b) b and d
   (c) a and d (d) a, b and c
2. _____ proposed the hypothesis that bodies of animals and plants are composed of cells and products of cells
   (a) Theodore Schwann, a British zoologist
   (b) Malthias Schleiden, a German botanist
   (c) Anton von Leeuwenhoek
   (d) Rudolf Virchow
3. Which of the following is correct
   (a) Cell of all living organisms have a nucleus
   (b) Both animal and plant cells have a well defined cell wall
   (c) In prokaryotes, there are no membrane bound organelles
   (d) Cells are formed do novo from abiotic material
4. Which of the following is not correct?
   (a) Robert Brown discovered the cell
   (b) Schleiden and Schwann formulated cell theory
   (c) Virchow explained that cells are formed from pre – existing cells
   (d) A unicellular organism carries out its life activites within a single cell
5. "Omnis cellula e cellule" is generalization given by
   (a) Leeuwenhoek (b) Dutrochet
   (c) Lamarck (d) Virchow
6. Which one of the following cell organelle is enclosed by a single membrane?
   (a) Chloroplasts (b) Lysosomes
   (c) Nuclei (d) Mitochondria
7. According to fluid mosaic model
   (a) Spectrins are intrinsic protein
   (b) Glycophorin are extrinsic protein
   (c) Tunnel proteins help in transport of water soluble substances
   (d) All are true
8. In Singer and Nicolson's model of cell membrane
   (a) Upper layer is non polar and hydrophilic
   (b) Proteins forms a continuous middle layer
   (c) Glycocalyx forms a continuous middle layer
   (d) Phospholipids form a bimolecular layer in middle part
9. Glycocalyx contain
   (a) Lipids only
   (b) Phospholipid and proteins
   (c) Glycolipid and glycoproteins
   (d) Glycolipid and phospholipids
10. Choose the correct match
   (a) Lipid model – Singer and Nicolson
   (b) Fluid mosaic model – Danielli and Davson
   (c) Unit membrane concept – Robertson
   (d) All matches are correct
11. Mosaic and dynamic nature of membrane is due to
   (a) Cholesterol
   (b) Lipids
   (c) Oligosaccharides
   (d) None of these
12. Choose the incorrect statement
   (a) Lipids show flip flop movement
   (b) Carrier molecules of membrane are protein
   (c) Cholesterol provides stability to prokaryotic membrane
   (d) Oligosaccharides help in recognition and form glycocalyx
13. Membrane asymmetry can be accounted for by

(a) Different types of lipids on two sides of bilayer
(b) Occurrence of oligosaccharides on only external surface of the membrane
(c) Mole number of extrinsic proteins on inner surface of the membrane
(d) All of these

14. Membrane is asymmetrical because
(a) Two lipid layers have different lipids
(b) Two faces of membrane have different proteins
(c) The exposed surface bears glycoproteins and glycolipids
(d) All the statements are correct

15. Correct statement with reference to membrane is
(a) Detailed structure of membrane can be studied under light microscope
(b) Membrane of erythrocyte has approximately 52% proteins and 40% lipids
(c) Integral proteins lie on the surface of membrane on inner sides
(d) Unit membrane model is most acceptable model

16. Extrinsic proteins are
(a) 30%, easily separable, glycophorin
(b) 70%, easily separable, glycophorin
(c) 30% , easily separable, spectrin
(d) 70%, not easily separable, glycophorin

17. Cell recognition and adhesion occur due to biochemical of cell membranes named
(a) Protein
(b) Lipids
(c) Proteins and lipids
(d) Glycoproteins and glycolipids

18. Which of the following set is included in endomembrane system
(a) ER, golgi complex, lysosome
(b) ER, golgi complex, mitochondria
(c) ER, golgi complex, lysosome, vacuoles
(d) ER, golgi complex, mitochondria, plastids

19. E.R. will be abundant in
(a) Adipose tissue
(b) Acinar cells of pancreas
(c) Plasma cells
(d) All of the above

20. Abundant Ca ions are stored in the following
(a) Sarcoplasmic reticulum
(b) Golgi complex
(c) Lysosomes
(d) None of these

21. Testosterone and progesterone hormones are synthesized by
(a) Golgi complex
(b) Smooth ER
(c) Rough ER
(d) All above

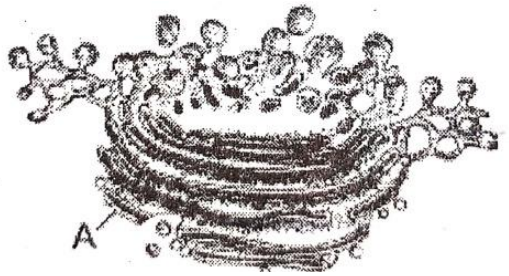
22. Endoplasmic reticulum can be attached to
(a) Plasma membrane
(b) Peroxisome
(c) Nuclear envelope
(d) Both (a) and (c)

23. Choose the incorrect statement regarding SER
(a) Composed of tubules and vesicles
(b) Involved in detoxification
(c) Involved in protein, cellulose synthesis
(d) Synthesis of steroids

24. The characteristic function performed by ER is
(a) Mechanical support
(b) Lipid synthesis
(c) Protein synthesis
(d) All of these

25. What is true for Golgi bodies?
a. Cisternae are disc shaped
b. Cisternae are concentrically arranged near nucleus parallel to each other
c. Helps in transformation of membrane
d. Their membrane is half unit membrane
(a) a, b and d
(b) b, c and d
(c) a, c and d
(d) a, b and c

26. In the following figure surface marked 'A' is




(a) Proximal/convex face
(b) Proximal/concave face
(c) Distal/concave face
(d) Distal/convex face

27. Which is incorrect in relation to lysosome?

(a) These contain acid hydrolases, bounded by two unit membranes
(b) These are Autophagic
(c) These can digest proteins, nucleic acids, lipids and polysaccharides
(d) These are polymorphic

28. Lysosomes alongwith food content is known as
(a) Primary lysosomes
(b) Secondary lysosomes
(c) Phagosomes
(d) Both (b) and (c)

29. Which of the following is associated with autolytic activity by lysosomes?
(a) Digestion of organelle
(b) Phagocytosis
(c) Mobilisation of food
(d) Metamorphosis of frog

30. Which is incorrect in relation to lysosome?
(a) These contain acid hydrolases
(b) These are Autophagic
(c) These can digest proteins, nucleic acids, lipids and polysaccharides
(d) These are monomorphic

31. Identify the correctly matched cell organelle to its common name
(a) Ribosome – suicide bag
(b) Lysosome – protein factory
(c) Golgi body – internal reticular apparatus
(d) All are incorrectly matched

32. Which of the following vacuole considered as waste deposit bin?
(a) Sap vacuoles
(b) Contractile vacuoles
(c) Gas vacuoles
(d) Food vacuoles

33. Which of the following can be termed as organelle within organelle?
(a) Chloroplast
(b) Golgi complex
(c) Ribosome
(d) ER

34. Ribosomes can come together to form dimers at $Mg^{+r}$ concentration
(a) 0.001 M
(b) less than 0.001 M
(c) Above 0.001 M
(d) 0.0001 M

35. Ribosomes are composed of
(a) DNA and protein
(b) rRNA and protein
(c) Nucleoproteins, $Mg^{++}$, tRNA
(d) DNA, rRNA proteins

36. Identify the cell organelles arranged according to their size (smallest to largest)
(a) Ribosome – golgi complex – lysosome
(b) Ribosome – lysosome – golgi complex
(c) Microbodies – lysosome – ribosome
(d) Lysosome – ribosome – microbodies

37. Hollow, unbranched, non contractile, non – membranous cytoskeletal elements are
(a) Microtubule and microfilaments
(b) Microtubule and Intermediate filament
(c) Intermediate filaments
(d) Microtubules

38. The supporting framework of a cell consists of
(a) Microtubules
(b) Microfilaments
(c) Microbodies
(d) Both (a) & (b)

39. Microtubules are polymerised structure of
(a) Actin protein
(b) Tubulin protein
(c) Myosin protein
(d) None of the above

40. The _____are surrounded by dense, amorphous, protoplasmic spheres in one or more series called massules
(a) Histogram
(b) C → A linker
(c) Centrioles
(d) Cilia

41. The pattern of microtubule Organisation in a centriole is
(a) 9 doublet + 2 central singlet
(b) 9 doublet + no central singlet
(c) 9 doublet + no central singlet
(d) 9 triplet + 2 central singlet

42. Choose the correct match
(a) 9 + 1 arrangement – basal body
(b) 9 + 0 arrangement – shaft of cilia
(c) 9 + 2 arrangement – shaft of flagella
(d) 9 + 0 arrangement – rootlets

43. A definite unit membrane is present in
(a) Microtubules
(b) Centriole

(c) Nucleolus
(d) Flagellum

44. Dynein protein found in
(a) Arms of A microtubules
(b) Arms of B microtubules
(c) Peripheral singlet
(d) Knob of spoke

45. Site of formation of ribosomal precursor/ribosomal subunits in cell is
(a) Nucleus
(b) Nucleolus
(c) Golgi body
(d) Stroma

46. A: SER is better developed in the lipid forming cells.
R: SER is with more lipid syntehtase than protein syntehtase.

47. A: Acrosome is synthesized by golgi apparatus.
R: Acrosome release hydrolytic enzymes which digest away the covering sheath of ovum.

48. A: Lysosomes are called "suicide bags" of the cell.
R: Lysosomes carry on autolysis in the cell.

49. Which of the following is not correct?
(a) Robert Brown discovered the cell
(b) Schledein and Schwann formulated cell theory
(c) Leeuwenhoek first saw & described a live cell
(d) A unicellular organism carries out its life activities within a single cell

50. Cell is fundamental structural and functional unit of living
(a) Unicellular organisms are capable of independent existence
(b) A single cell can perform essential functions of life
(c) Cell organize to form tissues
(d) Both (a) and (b)

51. Select the correct matching in the following pairs
(a) Rough ER – synthesis of glycogen
(b) Rough ER – oxidation of fatty acids
(c) Smooth ER – oxidation of phospholipids
(d) Smooth ER – synthesis of lipids

52. Find the correct match
(a) Smallest cell – mycoplasma
(b) Largest isolated single cell – ostrich egg cell
(c) Longest cell – nerve cell
(d) All of these

53. Which of the following is correct?
(a) Cells of all living organisms have a nucleus
(b) Both animal and plant cell have a well defined cell wall
(c) In prokaryotes, there are no membrane bound organelles
(d) Cells are formed do novo form abiotic material

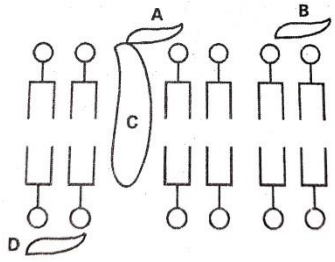
54. Which is correct about plasma membranes?
(a) Membrane glycoproteins usually have their carbohydrate groups facing the cytoplasm
(b) Hydrophilic portion of phospholipids is oriented towards the inside of the phospholipid bilayer
(c) Phospholipid composition of the inner & outer layer of phospholipid bilayer is usually same
(d) None of these

55. Choose the incorrect statement w.r.t. transport across membrane
(a) Polar molecules can not pass through the lipid bilayer
(b) Polar molecules require a carrier protein to facilitate their transport
(c) Energy dependent process is called active transport
(d) Neutral solutes may move by the process of simple diffusion e.g. $Na^+/K^+$

56. A cell organelle containing hydrolytic enzymes is
(a) Mesosome
(b) Lysosome
(c) Microsome
(d) Ribosome

57. Fluid nature of membrane is important for
(a) cell growth, formation of intracellular junctions
(b) Secretion, endocytosis, protein synthesis
(c) Secretion, endocytosis, cell division
(d) All of these

58. In the diagram given below, extrinsic proteins are



(a) A & B
(b) A, B & C
(c) A, B & D
(d) A, B, C & D

59. New cells generate from
(a) Bacterial fermentation
(b) Regeneration of old cells
(c) Pre – existing cells
(d) Abiotic materials

60. Endomembrane system does not include
(a) Golgi complex
(b) Lysosomes
(c) Endoplasmic reticulum
(d) Cell membrane

61. Endomembrane system include
a. ER
b. Golgi complex
c. Lysosome
d. Vacuoles
e. Microbodies
(a) a, b, c, d, e (b) a, b, c, d
(c) a, b, c (d) a, b, c, e

62. ER helps in
(a) Transport of substances
(b) Synthesised of protein, glycogen
(c) Synthesis of lipoprotein
(d) All of these

63. ER divides the intracellular spaces into two distinct compartment i.e.
(a) Luminal (cytoplasm) and extraluminal (inside ER)
(b) Luminal (inside ER) and extraluminal (cytoplasm)
(c) Intracisternal and intertubular
(d) Intracisternal and intravacuolar

64. Golgi apparatus consists of many
(a) Flat, disc shaped cisternae of 0.5 mm to 1.0 $\mu$ m diameter
(b) rounded, cube shaped cisternae of 0.5 mm to 1.0 mm diameter
(c) Elongated, pillar shaped cisternae of 0.5 mm to 1.0 mm diameter
(d) Flat, disc shaped cisternae of 5 mm to 10 mm diameter

65. The cis and the trans faces of golgi apparatus are
(a) similar but interconnected
(b) Similar but not connected
(c) Entirely different but interconnected
(d) Entirely different but not connected

66. Golgi apparatus remains in close association with ER because
(a) Materials in the form of vesicles from ER fuse with trans face of golgi apparatus
(b) Materials in the form of vesicles from ER fuse with cis face of golgi apparatus
(c) Materials in the form of Microsomes from ER fuse with trans face of golgi apparatus
(d) Materials in the form of Microsomes form ER fuse with cis face of golgi apparatus

67. Membrane bound vesicular structures formed by packaging in golgi apparatus are
(a) Contractile vacuoles (b) Food vacuoles
(c) Lysosomes (d) All of these

68. Golgi apparatus performs the function of packaging materials, to be delivered
(a) Outside only
(b) Either to intra cellular targets or secreted outside
(c) In the extra cellular space only
(d) to ER

69. Many membrane bound minute vesicles called microbodies that contain various enzymes are present
(a) Animal cells
(b) Plant cells
(c) Both animal cells and plant cells
(d) Both eukaryotes and prokaryotes

70. What is true for lysosomes?
(a) Formed by packaging in golgi apparatus
(b) Rich in acid hydrolases
(c) Contain lipases, proteases, carbohydrases
(d) All of these

71. Non membrane organelle which help in cell division is
(a) Centriole (b) Ribosome
(c) Nucleus (d) Both (a) & (b)

72. Which of the following statements are true?
(a) Eukaryotes includes fungi, protists, plants and animals
(b) In eukaryotic cells there is an extensive compartmentalization
(c) Plant cells have centrioles which are absent in almost all animal cells
(d) Both (a) and (b)

73. Elaborate network of filamentous proteinaceous structure presents in the cytoplasm is collectively referred to as
    (a) ER
    (b) Cytoskeleton
    (c) Microtubules, microbodies
    (d) Both (a) and (b)
74. Cytoskeleton of cell is
    (a) An elaborate net work of globular proteins
    (b) An elaborate net work of filamentous proteins
    (c) A compact system of extrinsic proteins
    (d) A comact system of globular proteins
75. Basal body resemble & in structure with
    (a) Centrosome with 9 + 2 organization
    (b) Centriole with 9 + 2 organization
    (c) Centriole with 9 + 0 organization
    (d) None of these
76. Find the incorrect statement
    (a) Structural organization of basal body is 9 + 0
    (b) Structural organization of cilia is 9 + 2
    (c) Main protein present in cilia, centriole is sulphur containing tubulin
    (d) Detailed structure of centriole is visible under light microscope
77. Centrioles are absent in
    (a) All animal cells
    (b) Almost all plant cells
    (c) Prokaryotes
    (d) Both (b) & (c)
78. Which of these provide motility, support and shape to the cells?
    (a) centrosomes & centrioles
    (b) Centrosomes & cilia
    (c) Flagella & cilia
    (d) Cytoskeleton
79. The function of centrosome is
    (a) To increase protein synthesis
    (b) Helps cell division
    (c) Inhibition of cell division
    (d) all of these
80. Both cilium & flagellum emerge from
    (a) Centriole like structure called basal plate
    (b) Centriole like structure called basal bodies
    (c) Axoneme like structure called basal bodies
    (d) Centrosphere like structure called basal bodies
81. Electron microscopic study of cilia show that they are covered with plasma membrane. Their core is called
    (a) Axoneme which possesses number of microtubules running perpendicular to each other
    (b) Axoneme, which have microtubules running parallel to horizontal axis
    (c) Axoneme, which have microtubules running parallel to long axis
    (d) Axoneme running parallel to each other
82. Which of the following is concerned with synthesis and transport of lipids and steroids within a cell?
    (a) Pinocytic vesicle
    (b) Nuclear membrane
    (c) Smooth endoplasmic reticulum
    (d) Rough endoplasmic reticulum
83. Centrioles
    (a) Hold sister chromatids together during metaphase
    (b) Are duplicated before cell division
    (c) Are only present during cell division
    (d) Consists of DNA and histones
84. Ribosomes were first observed under EM as
    (a) Dense particles by Claude (1953)
    (b) Dense particles by George Palade (1953)
    (c) Discrete particles by George Palade (1935)
    (d) Discrete particles by Flemming (1935)
85. Ribosomes were first observed under EM as
    (a) The same size and composition as in bacteria
    (b) Larger than in bacteria, but of similar composition
    (c) Smaller than in bacteria and different in composition
    (d) The same size but completely different in composition
86. Prokaryotic ribosome dissociates into ____subunit's
    (a) 50S and 30S
    (b) 40S and 30S
    (c) 60S and 20S
    (d) 60S and 30S
87. Microtubules are the constituents of
    (a) Spindle fibres, centrioles and cilia
    (b) Centrioles, spindle fibres and chromati
    (c) Centrosome, nucleosome and centriole
    (d) Cilia, flagella and peroxisomes

88. Which of the following are correct statements?
    i. prokaryotes lack nuclear membrane while entire genetic material of eukaryotes is enclosed in nucleus
    ii. 70S ribosomes are present in prokaryotes while they are absent in eukaryotes
    iii. Prokaryotes are unicellular while eukaryotes are multicellular
    iv. Chromosomes of eukaryotes contain histones while that of prokaryotes lack histone
    (a) I, ii, & iv
    (b) ii & iii
    (c) iv only
    (d) I & iv
89. Active synthesis of ribosomal RNA synthesis occurs
    (a) In cytoplasm
    (b) In RER
    (c) In SER
    (d) In nucleolus
90. Plant & animal cells are different as former posess
    (a) cell walls, mitochondria and large central vacuole
    (b) Cell walls, plastids and large central vacuole
    (c) cell membrane, plastids and large central vacuole
    (d) Cell membrane, plastids and cell wall
91. Nuclear envelope consists of
    (a) Two parallel membrane with a 10 – 50 nm perinuclear space
    (b) Two perpendicular membrane with 1 10 – 50
    (c) Two perpendicular membrane with a 50 – 70 nm perinuclear space
    (d) Two parallel membrane with a 50 – 90 nm perinuclear space
92. Material of nucleus is stained by
    (a) Acidic dyes and named chromatin by Flemming
    (b) Basic dyes and named chromatin by Flemming
    (c) Basic dyes & named chromatin by Robert Brown
    (d) Acidic dyes & Name chromatin by Robert Brown
93. A complex of ribosomes attached to a single strand of RNA is known as
    (a) Polymer
    (b) Polypeptide
    (c) Okazaki fragment
    (d) Polysome
94. A: Ribosomes are involved in protein synthesis.
    R: they occur freely in cytoplasm or associated with ER.
95. A: Membranes of cisternae of golgi complex show a transition from the cis to the trans face.
    R: Membranes at the forming face must be more like the plasma membrane for their easy fusion with it than at maturing face.
96. A: Concentration of a number of ions & other materials is significantly higher in vacuoles than in cytoplasm.
    R: Tonoplast facilitates transport of ions & other materials against concentration gradient into the vacuole.
97. A: Content of nucleolus is continuous with rest of nucleoplasm.
    R: Nucleolus is not a membrane bound strucutre.
98. A common characteristic feature of plant sieve tube cells and most of mammalian erythrocytes is
    (a) Absence of mitochondria
    (b) Presence of cell wall
    (c) Presence of haemoglobin
    (d) Absence of nucleus
99. Select one which is not true for ribosome
    (a) Made of two sub units
    (b) Form polysome
    (c) May attach to m RNA
    (d) Have no role in protein synthesis
100. Which one of these is not a eukaryote?
    (a) Euglena
    (b) Anabena
    (c) Spirogyra
    (d) Agaricus
101. Which one of the above organelle in the figure correctly matches with its functions?
    (a) Golgi apparatus, formation of glycolipids
    (b) Rough endoplasmic reticulum, protein synthesis
    (c) Rough endoplasmic reticulum, formation of glycoproteins
    (d) Golgi apparatus, protein synthesis
102. Arrange the following cells in an ascending order of their size.
    i. mycoplasma
    ii. ostrich eggs

iii. human RBC
iv. Bacteria
(a) I, iv, iii & ii (b) I, ii, iii & iv
(c) ii, I, iii & iv (d) iii, ii, I & iv

103. Which of the following features is common to prokaryotes and many eukaryotes?
(a) chromatin material
(b) Cell wall present
(c) Nuclear membrane present
(d) Membrane bound cellular organelles

104. Who proposed the fluid mosaic model of plasma membrane?
(a) Camillo golgi
(b) Schleiden & Schwann
(c) Singer and Nicolson
(d) Robert Brown

105. Which statement is true for a secretory cell?
(a) Golgi apparatus is absent
(b) Rough Endoplasmic Reticulum (RER) is easily observed in the cell
(c) Only Smooth Endoplasmic Reticulum (SER) is present
(d) Secretory granules are formed in nucleus.

106. What is a tonoplast?
(a) Outer membrane of mitochondria
(b) Inner membrane of chloroplast
(c) Membrane boundary of the vacuole of plant cells
(d) Cell membrane of a plant cell

107. Which is not true of a eukaryotic cell?
(a) It has 80S type of ribosome present in the mitochondria
(b) It has 80S type of ribosome present in the cytoplasm
(c) Mitochondria contain circular DNA
(d) Membrane bound organelles are present

108. Which statement is not true for plasma membrane?
(a) It is present in both plant and animal cell
(b) Lipid is present as a bilayer in it
(c) Proteins are present integrated as well as loosely associated with the lipid bilayer
(d) Carbohydrate is never found in it

109. Which is not a function of cytoskeleton in a cell?
(a) Intracellular transport
(b) Maintenance of cell shape and structure
(c) Support of the organelle
(d) Cell motility

110. What is the significance of vacuole in a plant cell?
(a) Storage of useful substances
(b) Dumping of wastes
(c) Maintenance of turgidity
(d) All of these

111. What does 'S' refer in a 70S & an 80S ribosome?
(a) Svedberg unit
(b) Sedimentation coefficient
(c) Satellite unit
(d) Both (a) & (b)

112. A single membrane bound organelle which is rich in hydrolytic enzymes is
(a) Mitochondria (b) Lysosomes
(c) Ribosomes (d) Microtubules

113. Which of the following are functions of gas Vacuoles?
a. Stores gases
b. Buoyancy regulation
c. Protection against radiation
(a) a only (b) a & b only
(c) c only (d) a, b & c

114. What is the function of a polysome?
(a) Synthesis of multiple copies of same polypeptide
(b) Attachment of different m – RNA
(c) Synthesis of different types of proteins
(d) Attachment of 70 s and 80 s ribosomes

115. The role of nucleolus in the cells actively involved in protein synthesis is
(a) Ribosomes synthesis
(b) Lysosomes synthesis
(c) Mitochondira synthesis
(d) Nucleus synthesis

116. Branched and unbranched small carbohydrates form glycolipids and glycoproteins and are exposed towards the outer surface of cell membrane. Which of the following are their significance.
a. Components of receptors
b. Recognition centre
c. Helps in cell attachment

d. Provide in cell attachment
(a) a and b only
(b) a, b and c
(c) a and c only
(d) a, b, c and d

117. Chose the incorrect option
(a) Rudolf Virchow (1855) first explained Omnis cellula e cellula
(b) Schleiden and Schwann proposed that bodies of animal and plants are composed of cell and products of cells
(c) Plasmid is extra genomic DNA present in prokaryotes
(d) Plasmid is extra genomic DNA present in both prokaryotes an eukaryotes

118. The genomic content of the nucleus is constant for a given species where as the extra chromosomal DNA is found to be variable among the members of a population. It may be due to presence of
(a) DNA in mitochondria
(b) DNA in plastids
(c) Plasmids
(d) Any of these

119. Which of the following stains is not used for staning chromosomes?
(a) Basic fuchsin
(b) Safranin
(c) Methylene blue
(d) Carmine

120. Different cells have different sizes. Arrange the following cells is anascending order of their size. Choose the correct option among the followings
i. mycoplasma
ii. ostrich eggs
iii. human RBC
iv. Bacteria
(a) I, iv, iii, & ii
(b) I, iii, iv, ii
(c) ii, I, iii & iv
(d) iii, ii, I & iv

121. Select the mismatch
(a) Methanogens – Prokaryotes
(b) Gas vacuoles – Green bacteria
(c) Large central vacuoles – Animal cells
(d) Protists – Eukaryotes

# ANSWER KEY

## EXERCISE – 1

| Ques. | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. |
|---|---|---|---|---|---|---|---|---|---|---|
| Ans. | a | c | d | a | c | d | c | b | a | b |
| Ques. | 11. | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. | 20. |
| Ans. | d | b | a | d | c | b | b | c | d | c |
| Ques. | 21. | 22. | 23. | 24. | 25. | 26. | 27. | 28. | 29. | 30. |
| Ans. | c | b | d | b | b | d | c | d | b | d |
| Ques. | 31. | 32. | 33. | 34. | 35. | 36. | 37. | 38. | 39. | 40. |
| Ans. | a | b | b | c | c | a | d | d | a | b |
| Ques. | 41. | 42. | 43. | 44. | 45. | 46. | 47. | 48. | 49. | 50. |
| Ans. | c | d | b | b | c | c | b | c | a | b |
| Ques. | 51. | 52. | 53. | 54. | 55. | 56. | 57. | 58. | 59. | 60. |
| Ans. | a | b | c | b | b | c | d | c | b | d |
| Ques. | 61. | 62. | 63. | 64. | 65. | 66. | 67. | 68. | 69. | 70. |
| Ans. | b | b | d | d | b | b | d | d | c | d |
| Ques. | 71. | 72. | 73. | 74. | 75. | 76. | 77. | 78. | 79. | 80. |
| Ans. | a | b | b | d | c | d | b | c | c | c |
| Ques. | 81. | 82. | 83. | 84. | 85. | 86. | 87. | 88. | 89. | 90. |
| Ans. | d | b | d | c | b | d | d | b | a | a |
| Ques. | 91. | 92. | 93. | 94. | 95. | 96. | 97. | 98. | 99. | 100. |
| Ans. | d | b | d | c | c | b | d | b | c | c |
| Ques. | 101. | 102. | 103. | 104. | | | | | | |
| Ans. | d | c | b | c | | | | | | |

# EXERCISE – 2

| Ques. | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. |
|---|---|---|---|---|---|---|---|---|---|---|
| Ans. | c | a | c | a | d | b | c | d | c | c |
| Ques. | 11. | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. | 20. |
| Ans. | d | c | d | d | b | c | d | c | d | a |
| Ques. | 21. | 22. | 23. | 24. | 25. | 26. | 27. | 28. | 29. | 30. |
| Ans. | b | d | c | d | d | a | a | b | d | d |
| Ques. | 31. | 32. | 33. | 34. | 35. | 36. | 37. | 38. | 39. | 40. |
| Ans. | c | a | c | c | b | b | d | d | b | c |
| Ques. | 41. | 42. | 43. | 44. | 45. | 46. | 47. | 48. | 49. | 50. |
| Ans. | c | c | d | a | b | a | b | a | a | d |
| Ques. | 51. | 52. | 53. | 54. | 55. | 56. | 57. | 58. | 59. | 60. |
| Ans. | d | d | c | d | d | b | c | c | c | d |
| Ques. | 61. | 62. | 63. | 64. | 65. | 66. | 67. | 68. | 69. | 70. |
| Ans. | b | d | b | a | c | b | c | b | c | d |
| Ques. | 71. | 72. | 73. | 74. | 75. | 76. | 77. | 78. | 79. | 80. |
| Ans. | a | d | b | b | c | d | d | d | b | b |
| Ques. | 81. | 82. | 83. | 84. | 85. | 86. | 87. | 88. | 89. | 90. |
| Ans. | c | c | b | b | a | a | a | d | d | b |
| Ques. | 91. | 92. | 93. | 94. | 95. | 96. | 97. | 98. | 99. | 100. |
| Ans. | a | b | d | b | c | a | a | d | d | b |
| Ques. | 101. | 102. | 103. | 104. | 105. | 106. | 107. | 108. | 109. | 110. |
| Ans. | b | a | b | c | b | c | a | d | a | d |
| Ques. | 111. | 112. | 113. | 114. | 115. | 116. | 117. | 118. | 119. | 120. |
| Ans. | d | b | d | a | a | d | d | d | b | a |
| Ques. | 121. | | | | | | | | | |
| Ans. | c | | | | | | | | | |