CHAPTER 10

CELL: THE UNIT OF LIFE

Topics Discussed

1. Introduction

There is a huge diversity in all the organisms on the earth as studied in previous unit. Four million organisms are present on earth including all the phylum and divisions. All these organisms have biological diversity in terms of size, shape, structure and even functions.

Yet there are similarity among them in few of the **basic functions**. All living organisms are made up of a **common basic unit**. After various research and study in this concept, scientist concluded that the basic unit is the cell. The cell is a unit which makes, performs and activates several functions and activities of the organism. Thus, they are termed as the basic functional and structural unit of the cell.

The cell is separated from the surrounding environment through a membrane. The cell has several functions, abilities and organelles in it. This function and ability changes as the position or the organism changes.

Also the cell number changes per organism which is why some organisms are unicellular and some multicellular. In unicellular organisms the cell performs all the functions and work of the organisms while in multicellular one it is well developed and divided among the organisms body.

Objectives of the chapter

At the end of this chapter you will be able to:

- Elaborate a cell and its uniqueness.
- Differentiate a cell as prokaryote or eukaryote.
- Explain different cell organelles.

2. A Cell – What is it all about?

A cell is a structure made up of several small units called organelles, chemicals, molecules and liquids. These all constituents are present in it and work in a way to complete a particular function. The cell shape, size and the constituents vary as per its position and function.

Cell defines an organism's existence and its functions. Hence it is called structural and functional unit of all the living organisms.

Lowey and Sikewitz defined a cell as "the unit of biological activity container and nucleus that has the ability to reproduce or divide in a medium free from other living organisms.

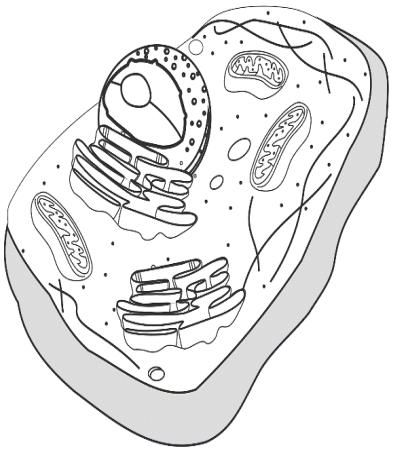

Figure 10.1: Diagram of a cell

Cytology ⇒ The science dedicated to the **Study of Cell Structure.**

Cell biology ⇒ The Study of all the **structures** and **functions** along with the **reproduction of the cell**.

3. History of Cell Study

Various scientist all over the world discovered the cell along with its structure and functions. The major highlights of the work as per the scientist is as follows:

- **Robert Hook** (1665) was an English botanist, first to name the term **"Cell"** in his book "*Micrographia*". He observed thin sections of **cork** (dead cells) under a compound microscope and found **compartment like divisions in a honey comb**. Cells is a Latin word **cellula** which means **a hollow space**. Greek word is cella = Small hollow space or Chamber.
- A. van Leeuwenhoek (1674) called as Animalculist as he was first to study a living cell (bacteria, RBC) and called them as "Animalcule".
- **N. Grew** (1682) proposed a concept for the cell. It explains how **a cell is unit of structure** for several organisms.
- **Robert Brown** (1831) observed and reported the presence of **nucleus** in the **root** cells of orchids.
- **Dujardin** (1836) observed a **semifluid substance** surrounding the **nucleus** in muscle cells and called it as **sarcode**.
- A cell has a nucleus which has living substance around it called as protoplasm. **Purkinje** (1839) found it in animal cell while Von Mohl in plant cell. Huxley called Protoplasm as physical basis of life.
- **Hammerling** called nucleus as the brain of the cell or master or controlling centre of cell.

4. Cell Theory

The scientist who formulated and laid the cell theory are

M. J. Schleiden (1838) - **German Botanist**

T. Schwann (1839) - **British Zoologist**

- **Matthias Schleiden** studied and tested a large number of **plants** and observed that all **plants are composed** of different kinds of **cells** which form the tissues of the plant.
- **Schwann** studied several **animal cells** and marked a conclusion that all cells have a thin outer layer as their limit or boundary which is presently known as the 'plasma membrane'. He also studied plant tissues and concluded that the cell wall is a unique character found in all the plant cells. **Schwann** proposed the hypothesis from all his study that the cell, its products and its constituents form the bodies of animals and plants.
- **Schleiden and Schwann** together formulated the **cell theory**. This theory, however, was incomplete as it failed to explain the process of new cells formation. **Rudolf Virchow** (1855) first explained that the cells are divided so as to form **new cells from pre-existing cells** (Omnis cellula-e cellula). He modified Schleiden and Schwann theory and completed the cell theory.

Conclusions of the theory:

- All **living organisms** are made from cells.

- The cell thus is the **unit of structure and function** of cells.
- All cells have similar basic structure and function.
- Each cell has a membrane which separates it from the surrounding.
- An organism's function are a result of cellular activities and interactions.

Exceptions of cell theory – As all theories have few left outs even this one has:

- **Viruses** are not included in the theory because viruses **lack typical cell properties and organization**.
- Bacteria and cyanobacteria lack an organized nucleus.
- There are cells that lack nucleus like RBC and sieve tubes.
- According to modern scientists, **organisms** that **lack cellular basis** like Monera and Protista, Xanthophytes (*Vaucheria*) Phycomycetes (*Rhizopus*) are the **exceptions of cell theory**.

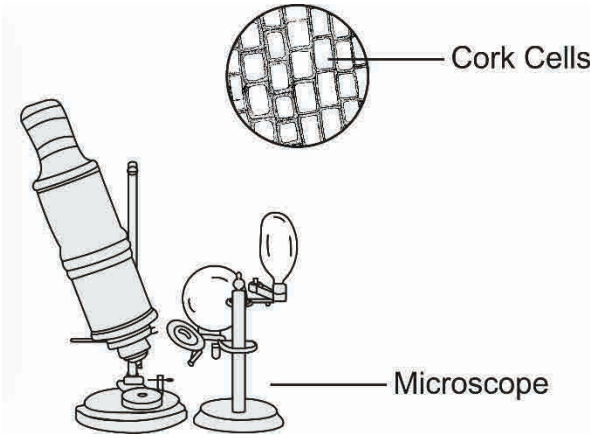

Figure 10.2: Microscope used to view cork cells or any other cells

5. Diversity among the Cells

5.1 Cell Size

A cell has its **limit** for the **size expansion**. It has growing properties which can allow it to grow and increase as much as it can. However there are limits to it. Thus each cell has its prior defined size limits.

The factors which set the limit of cell size or volume are:

- **Nucleocytoplasmic or kemplasma ratio** is the determining property for the area of control of metabolic activities by nucleus.
- Metabolism rate.
- Ratio of surface area to the volume of the cell.

High Metabolic activities in cells give them smaller size as their higher nucleocytoplasmic ratio and higher surface area to volume ratio does not allows to expand much. The nucleus has bigger size which allows better control of metabolic activities. The high surface area to volume ratio allows quicker exchange of materials that occur in the cell and its outside environment. Surface area to volume ratio decreases as the cell size increases.

Cells show diversity in size, shape and their activities.

Following are few examples of cell sizes variations:

Longest cell	:	Nerve cells
Longest plant cell	:	Fibers of Ramie (*Boehmeria nivea*)
Largest isolated single cell	:	Ostrich egg
Smallest cell	:	*Mycoplasma gallicepticum*- 0.3 mm
Human RBC	:	7.0 mm

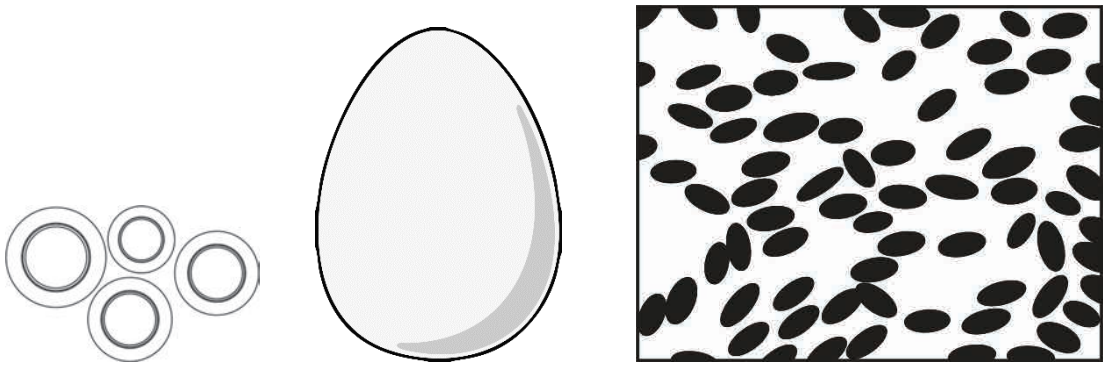

Figure 10.3: Cell sizes differ with types of cells. **A.** WBC, **B.** Egg and **C.** RBC

5.2. Cell Shape

Cells vary greatly in their shape as well. The cell can have shapes that are **disc like, polygonal, columnar cuboid, thread like or even irregular**. The shape of the cell **changes** as per the **function** they are destined to perform.

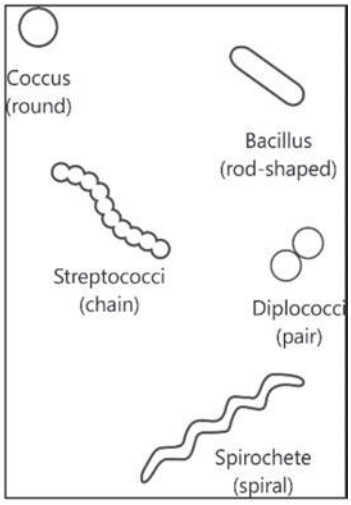

Figure 10.4: Various shapes of bacterial cell

Insight of a cell

Cells are like **compartments**. It is surrounded with a **distinct plasma membrane** or plasma lemma. It forms a **boundary** around the **cell protoplasm** and thus prevent it from getting mixed and lost within the **extracellular material** (surrounding)**.** The cell has an **exhaustive different world** in it which has certain internal compartments called the **organelles** limited by membrane such as **mitochondria, Golgi bodies, plastids, lysosomes, nucleus**, etc. These membrane bound organelles **help** the cell to **maintain the separation** among all the different chemical reactions occurring within the cell all the time. There are **organelles** which **lack membrane** around it like **centrioles** and **ribosomes**. The cells of bacteria and blue green algae (prokaryotes) do not have membrane bound organelles (one envelope system) hence, no compartments. Eukaryotic cells have membrane bound organelles.

Type of Cells

There are differences among the cells as some have organelles while others lack them. They are: **prokaryotic cells** and **eukaryotic cells**. This division is made on basis of the differences among major features: Cell organelles (Compartmentalisation), Cytoskeletal structures and Organisation of nuclear material.

Table 10.1: Difference between Prokaryotic and Eukaryotic Cells

Prokaryotic Cells	Eukaryotic Cells
Cell wall is without cellulose (bacteria) or absent (Mycoplasma).	Cellulosic cell wall is present (Plants) or absent (Animals).
A prokaryotic cell has single membrane system.	A eukaryotic cell has double membrane system.
Cell membrane includes respiratory enzymes.	Cell membrane does not has respiratory enzymes.
Mesosomes are formed by inward folding of the cell membrane.	Lack Mesosomes.

Cytoplasm does not show presence of any membrane bound organelles.	Cytoplasm shows many membrane-bound organelles like endoplasmic reticulum, mitochondria, Golgi apparatus, lysosomes, glyoxysomes, peroxisome, etc.
Ribosomes are often free floating organelles with 70 S.	Ribosomes are 80 S, can be free or bound to E. R. and nuclear envelop. (70 S ribosomes are also present within the mitochondria and chloroplast)
Streaming movements are absent of the cytoplasm.	Cytoplasm has streaming movements (Cyclosis)
Photosynthetic lamellae i.e. thylakoids occur freely in the cytoplasm (cyanobacteria)	Photosynthetic lamellae occur inside the chloroplasts in plants.
Sap vacuoles are absent instead gas vacuoles may be present.	Sap vacuoles are commonly present.
Transcription and translation occur in cytoplasm only.	Transcription occurs in nucleus while translation occur in cytoplasm.
Protein synthesis occur in cytoplasm only.	Protein synthesis are often in the cytoplasm, mitochondria and plastids.
Cytoskeleton is absent.	Cytoskeleton (microtubules, microfilaments and intermediate filaments) is present.
Nuclear material lies directly in the cytoplasm called as nucleoid.	Nuclear material is enclosed in the nuclear envelop which creates nucleus a distinct organelle in the cytoplasm.
There is no nucleolus.	One or more nucleoli can occur within the nucleus.
DNA is circular closed in the cytoplasm and without histone core (Polyamines may be present instead)	Nuclear DNA is in linear arrangement along with histone protein core.
DNA occurs in the cytoplasm and plasmid.	DNA occurs in the nucleus as well as in the mitochondria and chloroplasts.
The ratio of A + T / G + C in DNA is low, < 1	The ratio of A + T / G + C in DNA is high, > 1
Plasmids and pili are common in prokaryotic cells.	The plasmids and pili are not present in eukaryotic cells.
Flagella are singlet fibers made up of a protein flagellin.	Flagella (if present), are complex, have 9 + 2 pattern of microtubules which are made from tubulin protein.
Mitotic spindle fibers are not formed in cell division (Amitotic).	Mitotic spindle fibers are formed during cell division.
Sexual reproduction is absent (recombination is present in bacteria).	Sexual reproduction is common.
E.g., bacteria, blue-green algae and Mycoplasma.	e.g., Algae other than blue-green algae, protists, fungi, plants and animals.

Table 10.2: Difference between Animal and Plant cell

Animal Cell	Plant Cell
Cell wall is absent. Cells are enclosed in a thin flexible living cell membrane.	Cells are covered by thick rigid, cellulosic cell wall in addition to the cell membrane.
Chloroplasts and other plastids are generally absent.	Chloroplasts and other plastids are present.
Golgi complex is present near nucleus and is distinct, and well developed.	Golgi complex is not free and present in the form of unconnected units called as dictyosomes.
Glyoxysomes are absent in all animal cells.	Glyoxysomes may be present in plant seeds.
Nucleus is centrally located in the cytoplasm.	The large sap vacuole is present which pushes the nucleus to the peripheral position.
Some small sized food vacuoles and contractile vacuoles may be present in cytoplasm.	Vacuoles are larger more which has a large central sap vacuole. Lack Food vacuoles and contractile vacuoles.
Animal cell include centroids and centrosome in cytoplasm.	Centrioles and centrosome are absent. Centrosomes and contractile vacuoles are however present in lower plants.
Cell division has amphiastral spindle.	Cell division has anastral spindle.
Cytokinesis occurs through constriction or furrowing.	Cytokinesis occurs through cell plate method.

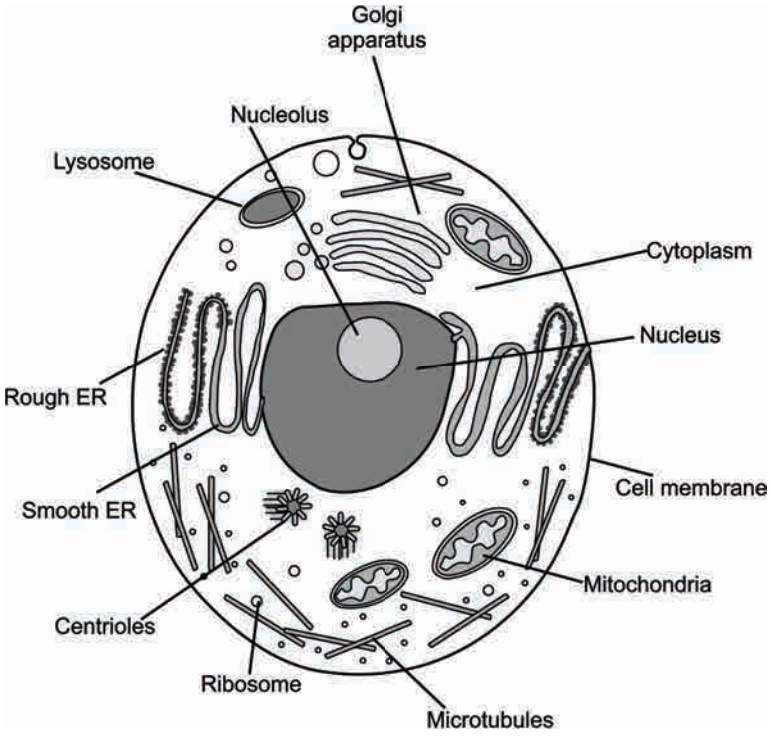

Figure 10.5: Structure of an animal cell

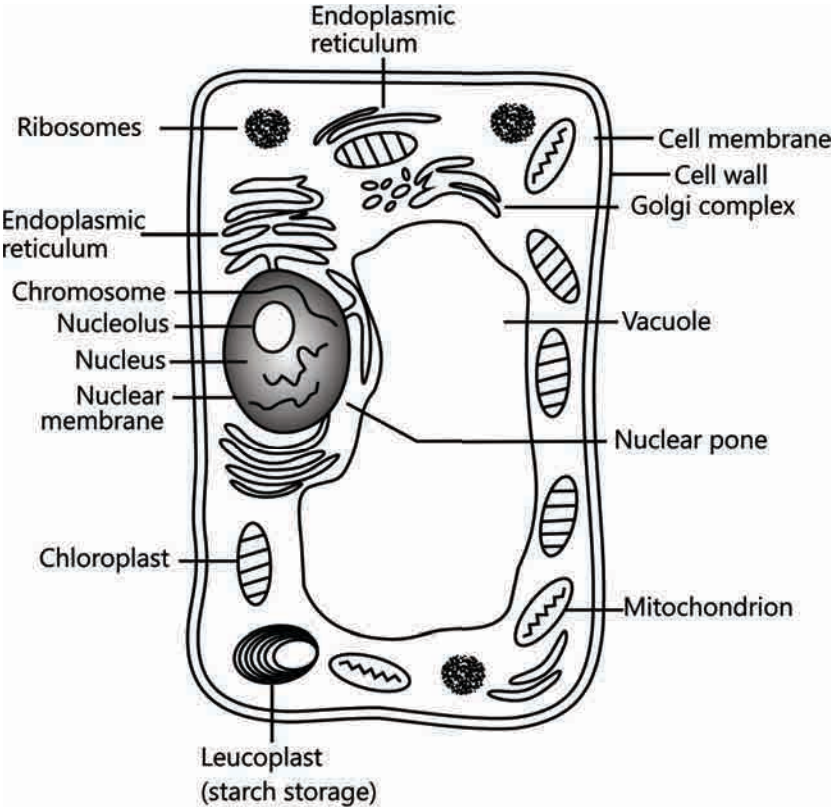

Figure 10.6: Structure of a plant cell

6. Prokaryotic Cells – Bacterium

Antony Von Leeuwenhoek was first to discover bacteria from the **teeth scum** and **stored rain water** which was called as **wild animalcules**. He called them as **Dierkens**. Later, **Ehrenberg** named it as **Bacteria**. **Se'Dillot** called animalcules as **microbes**.

6.1 Occurrence

Prokaryotes are included in **Kingdom Monera** and thus are commonly called as **Monerans.**

The common ones are **bacteria, cyanobacteria** (Blue-green algae), **mycoplasma or PPLO** (Pleuro-pneumonia like organisms), ***Spirochaetes* and *Rickettsiae***.

Bacteria is the **simplest** and **commonest** type of organisms occurring all over in almost all habitats.

The habitat are **diverse and varied**, even found in the **hot springs, beneath the icebergs, in intestine of man, deep in the soil, deep in sea water**, etc.

6.2 Size

- Bacteria have **range** of cell sizes.
- Smallest bacterium is ***Dialister*** **(0.15 to0.3 µm** in diameter).
- Largest bacterium is ***Spirochaetes*** **(about 500 µm**).
- Normally the size of ***Bacillus*** lies from **0.3 µm to 15 µm.**

6.3 Shape

E. J. Cohn studied bacteria and identified the following four basic shapes of bacteria:

- **Coccus:** Spherical shaped bacteria. The cells can be **Monococcus** (single rounded) or **diplococcus** (two rounded) or **Tetracoccus** (four rounded) or **streptococcus** (chain of cocci) or **staphylococcus** (bunch of cocci) or **Sarcina** (eight-celled cubical mass).
- **Bacillus:** Rod shaped bacteria. The bacteria cells may be **Monobacillus** or **Diplobacillus** or **Streptobacillus** or **Palisade** (bacteria lying parallel to each other).
- **Spirillum**: Spirally coiled and flagellated.
- ***Vibrio*****:** Comma shaped and flagellated.

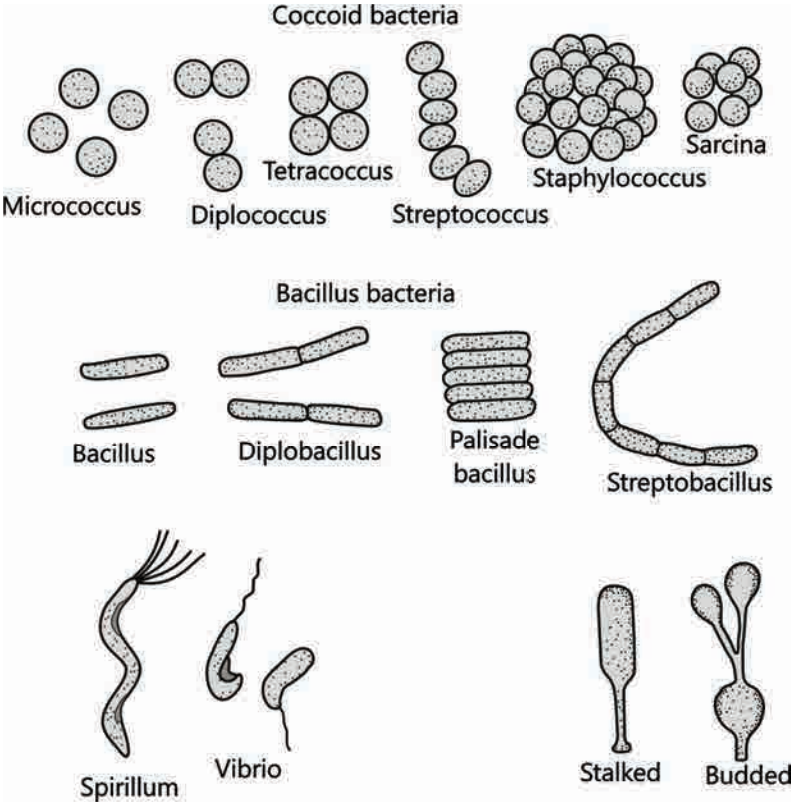

Figure 10.7: Various cell shapes in bacteria

6.4 Basic Structure of a Bacterial Cell wall

6.4.1 Cell Envelop

The outermost covering of the cell which provides shape and rigidity.

It also **protects** the cell from major mechanical injuries and bursting or collapsing completely. Electron microscope studies revealed that the cell envelop has three basic layers. Each layer has its own composition and is specialized to carry out **specific functions**.

(i) Glycocalyx: It is the **outermost layer.** It has its **chemical composition** and **thickness** differing in different bacteria. In most of bacteria e.g., *Escherichia coli*, the layer is in the form of a **loose mucilaginous covering** called as the **slimy layer**. It protects the bacterium against desiccation, action of phagocytes and helps in adhesion. However some bacteria have hard and tough covering which is called as **capsule**. It resists **phagocytosis** and also incorporates **virulence** to them.

(ii) Cell wall: Middle layer below **Glycocalyx** is **rigid**, **protective** and **supportive** in function. *E. coli* and other **Gram negative bacteria** have two layered cell wall: **inner layer** made up of murein or peptidoglycan which consists of polysaccharides (like acetyl glucosamine - NAG and acetyl muramic acid - NAM) and a **tetra peptide**. The **outer layer** consists of glycolipids. **Gram positive bacteria** have **single layered** cell wall which is made up of mainly murein. The difference of cell wall composition divides bacteria into two categories Gram positive and Gram negative bacteria.

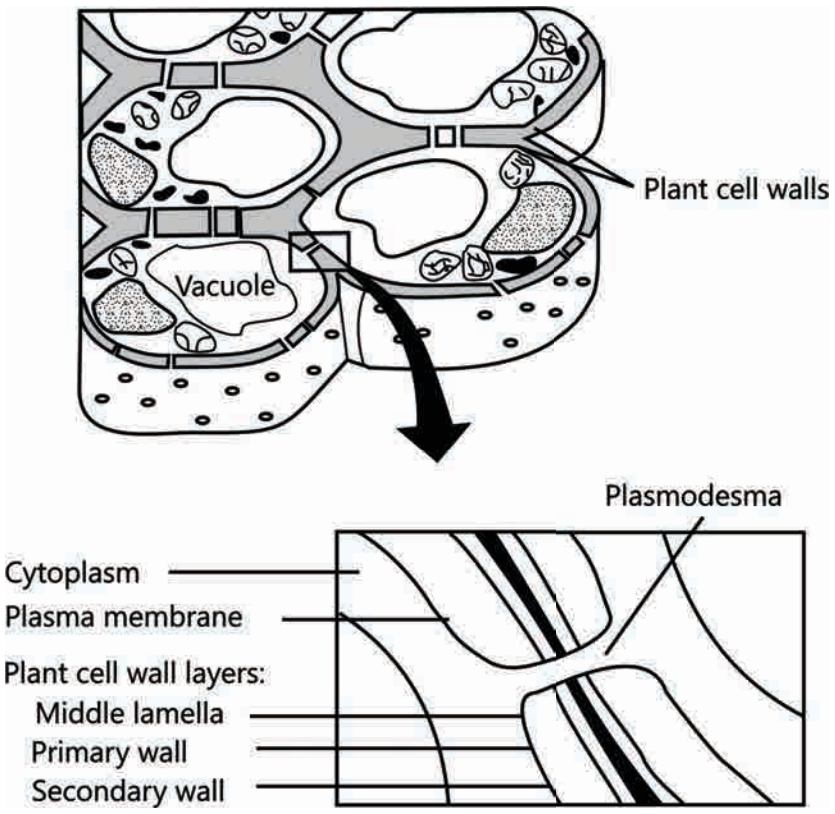

Figure 10.8: Cell wall arrangement in plants

Table 10.3: Difference between Gram Positive and Gram Negative bacteria

Characters	Gram Positive	Gram Negative
Staining ability	Absorb Gram stain and appear purple colored.	Do not absorb Gram stain.
Cell wall	Monolayer (mainly of murein)	Two layered - Outer of glycolipids and inner of murein.
Thickness of cell wall	100–200 Å so is thicker.	70–120 Å so is thinner.
Murein percentage	70%–80%	10%–20% only.
Lipids quantity	Less.	More
Mesosomes	Present	Absent.
Pili	Absent.	Present.
Examples	*Diplococcus pneumoniae*.	*E coli*.

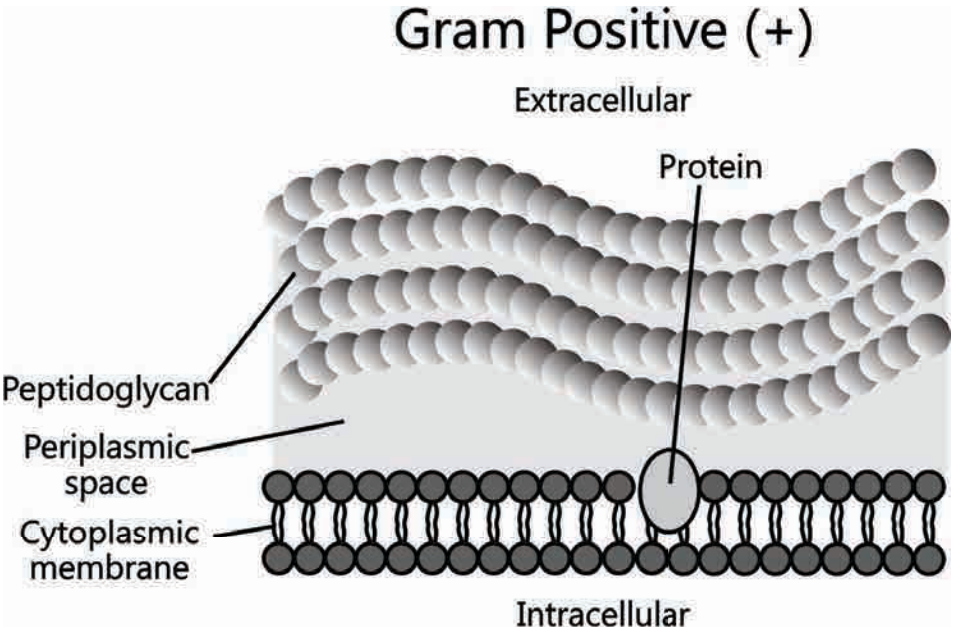

Figure 10.9 (A): Structure of cell membrane in Gram positive bacteria

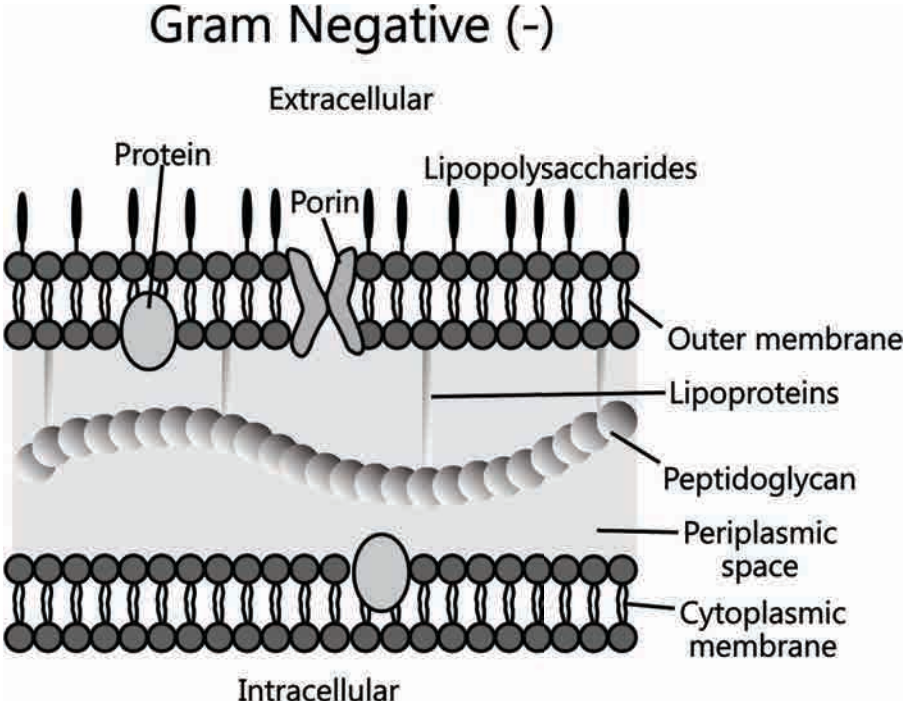

Figure 10.9 (B): Structure of cell membrane in Gram negative bacteria

(iii) Plasma membrane: The **innermost layer** is made up of **cell envelop**. It is thin, transparent layer which is a **semipermeable membrane**. It has lipoproteins and trilaminar layer (3-layers) similar to eukaryotes. It has components and enzymes that are involved in respiration and thus the layer is called as respiratory membrane. It regulates the movement through the membrane of specific materials between the **cytoplasm** and **extracellular medium**. The membrane has certain receptor molecules that detect and respond to the chemicals helping the bacteria to survive.

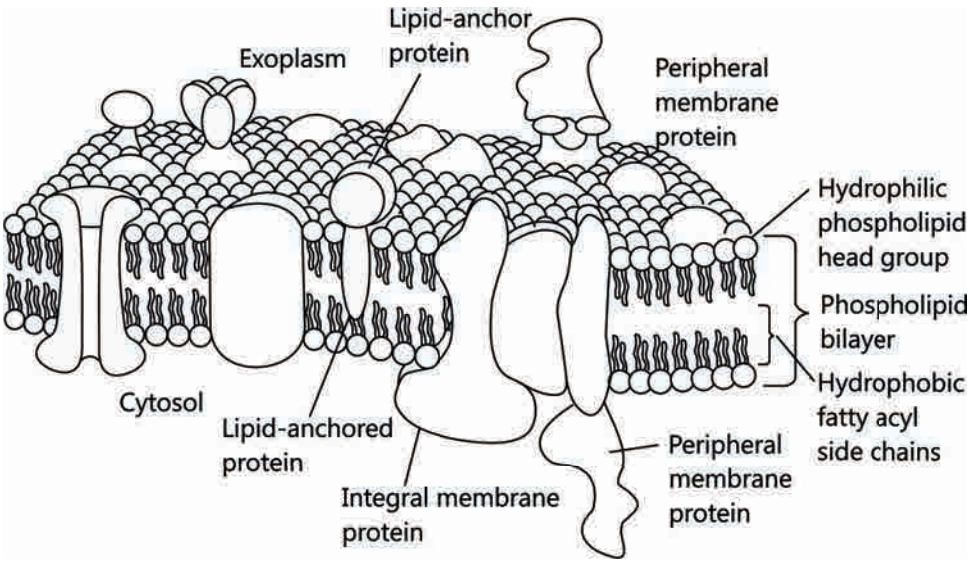

Figure 10.10: Structure of cell membrane

Mesosomes and Chromatophores

Mesosomes: Characteristic features of prokaryotes. The plasma membrane infolds itself in only **Gram positive** and may be in the form of vesicles or tubules or lamellae. The membrane is helpful to bacteria in. In **DNA replication** and its **separation** during cell division into daughter cells; **increase** the surface area for **respiration**; in **cellular secretion** which perform like the **Golgi body** in eukaryotes and in **cell wall construction**.

Chromatophores: Internal membrane systems that help in **increasing** the surface area for **efficient enzymatic activity** and **metabolic rate**. In cyanobacterial cells, the chromatophores have pigments for **photosynthesis**.

6.4.2 Flagellation

The bacterial cell **surface** show one or more **thread-like structures** extending **outwards** from the cell membrane which are called as **flagella**. Each flagellum is made up of **single strand** i.e. **monofibrillar**. The strand consists of **flagellin protein**. Flagella has a shaft or **basal body, hook** and longest part a **filament**. The major function is **locomotion** of the bacteria.

Flagella number changes in each bacteria and thus the bacteria are of following types:

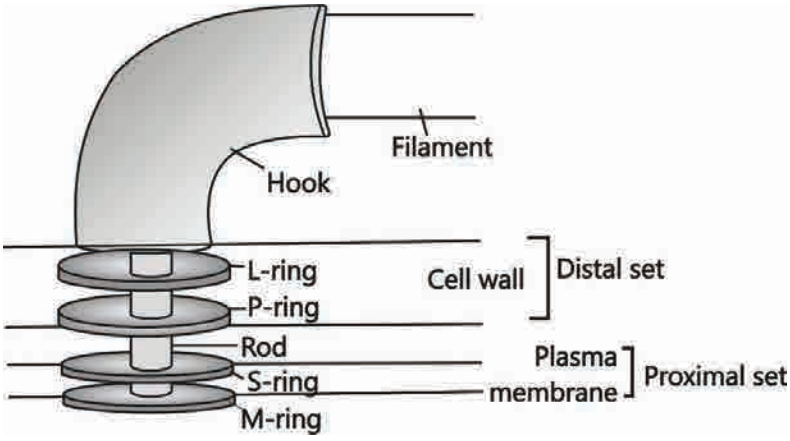

Figure 10.11: Structure of a flagella

i. **Atrichous:** Flagellum is absent.

ii. **Monotrichous**: Presence of single flagellum at one end.

iii. **Amphitrichous**: Presence of two flagella, one at each end.

iv. **Cephalotrichous**: Two groups of flagella, one at each end.

v. **Peritrichous:** Several flagella distributed throughout the membrane of the bacterium.

6.4.3 Pili / Fimbriae

Certain bacteria e.g., *Escherichia coli*, also have minute **hair-like, small** and **thin structures** called as **fimbriae** or **long tubular** structures called as **pili**. Pili is made from **pilin protein**. In male *E. coli* these pili are called as sex pili as the pili **helps** in the **attachment** with the **female bacterium** during sexual reproduction (conjugation). Fimbriae help in **adhesion** of the bacteria to the **rocky substratum** or to the **host's tissues.**

Table 10.4: Difference between Fimbriae and Pili

Characters	Fimbriae	Pili
Occurrence	Both Gram negative and Gram positive bacteria	Only in Gram negative bacteria
Number	More, 300-400 per cell	Less, 1-4 per cell
Size	Shorter and narrow	Longer and broader
Function	In adhesion	In conjugation

6.5 Cytoplasm

Colourless, translucent and viscous (jelly) ground substance which is present **inside** the **cell envelop** all over. There are **reserve food** materials (glycogen and lipids) along with **70 S ribosomes**. The ribosomes can be **free flowing** or arranged as **helical series on the signal mRNA** (active) strand majorly during **protein synthesis**, which is called as **polyribosomes** or polysome. There are **membrane bounded cell organelles** like the mitochondria, E R, Golgi apparatus, plastids, lysosomes, etc. are altogether **absent** in prokaryotes completely. Cytoplasm has few **non-living** structures which are called as **inclusion bodies** e.g., reserve food, phosphate granules, etc. The **inclusion bodies** of cyanobacteria have **cyanophycean granules, glycogen granules and gas vacuoles.**

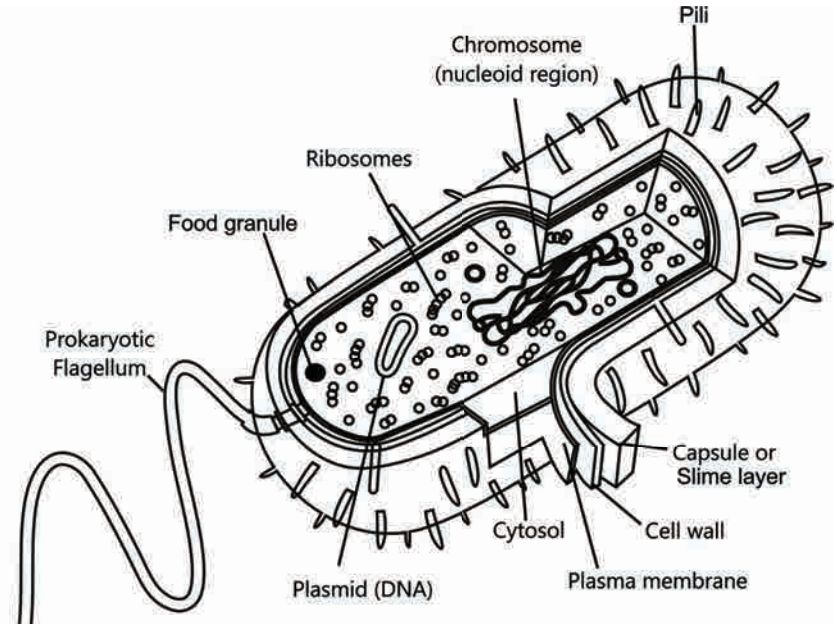

Figure 10.12: Bacterial cell structure

6.5.1 Nucleoid

Representative of the incipient nucleus in the prokaryotes. The single and circular chromosome that have no free ends and is a double-stranded DNA without histone proteins. Also termed as genophore or prokaryon. This circular DNA is super looped and coiled in presence of nucleoid proteins. However, it does not have nucleoplasm, nucleolus and nuclear membrane.

Some bacteria e.g., *Escherichia coli*, there are **extra chromosomal circular DNA** molecules, called as **plasmids**. Each plasmid is made up of few thousand genes, which are **not required** for the cells **basic functions** and thus act as **extra-nuclear genetic material**. The plasmid DNA incorporates **peculiar phenotypic characters** e.g., Fertility or sexuality factor, antibiotic resistance, virulence, etc.

Did You Know

- There are prokaryotes which lack cell wall e.g., Mycoplasma.
- **Gas vacuoles:** The gas-filled structures in the cytoplasm of cyanobacteria, purple and green photosynthetic bacteria. These structures provide buoyancy and help the bacteria for floating on water surface.
- Plasmid of male bacterium e.g. *E. coli* has fertility factor gene which is called as F-positive bacteria. This cell acts as donor cell during sexual reproduction (conjugation) with the F factor.
- **Episome:** When plasmid associates with the nucleoid of bacterium.
- Gram stain is crystal violet which gives it violet colour. Iodine treatment acts as mordant on Gram negative turning it pink.
- Tetrapeptide of murein is composed of four amino acids: D-Alanine, L-Alanine, D-Glutamic acid and L-Lysine.

7. Eukaryotic Cells

7.1 Occurrence

The cells make up the **protists, plants, animals** and **fungi**. The structure have eukaryotic cellular organisation different from the **prokaryotic cellular organisation** with respect to several factors.

7.2 Protoplasm

The cell has cell wall or **membrane** which **encloses living substance** inside it. The protoplasm makes it possible for **life to exist**. All living cell has **protoplasm** which performs all **vital functions** of the cell.

J. Huxley defined it as **'physical basis of life'**.

Max Schultz (1861) established a **protoplasmic theory** which explains the **protoplasm** present in all the cells which play **crucial role** in **cell's functioning and existence**.

7.3 Cell Wall

- **Robert Hook** discovered Cell wall.
- Plant cell has outer **most layer dead** and **permeable boundary** called as **cell wall**.
- Plant cell wall consists of **cellulose, hemicelluloses, pectins** and **proteins**.
- Algae cell wall is made up of cellulose, galactans, mannans and minerals like calcium carbonate.

Table 10.5: Various Layers in a Cell wall

Cell wall			
Primary wall	**Secondary wall**	**Tertiary wall**	**Middle lamella**
Outermost layer is thin and elastic Disintegrates as cell matures and is capable of growth Permanent in parenchyma and meristem	Rigid and thick (absent in meristematic cells) Formation is called as accretion or apposition Matrix is present Suberin and lignin are deposited	Thin and elastic Present only in trachieds of Gymnosperms Hemi cellulose and xylan is present in cell wall	Common layer between two cells Cementing layer formed during cytokinesis Composed of Ca and Mg pectates

- Cellulose, microfibril and macrofibrils are arranged in layers so that they form skeleton of cell wall. There are pectin and hemicellulose in between these layers that form matrix of the cell wall.
    - 35-100 cellulose chain = 1 micelle/elementary fibril
    - 20 micelle= 1 Microfibril
    - 250 micro fibril = 1 Microfibril in cell wall (rarely form)
- **Cell wall substances** (cellulose, hemicellulose, pectin, and lignin) are **synthesized** in the cell of plant **Golgi bodies** or **dictyosomes**.
- **Lipids** (cutin and suberin) are synthesized in the **sphaerosome**.
- **Martinez** and **Paloma** (1970) discovered the **cell coat** in animal cells, which is now called as **Glycocalyx.** [Made by sialic acid, mucin and hyaluronic acid (animal cement)].

Knowledge Builder

Ultrastructure of cell wall

Cell wall has three main parts:

- Matrix
- Microfibrils and
- Depositions

Matrix: Matrix consists of:

- **Water:** forms the dispersion or fluid medium.
- **Pectin:** forms the colloidal complex and determines the cell wall hydration.
- **Hemicellulose:** binds microfibrils to the matrix.
- **Glycoproteins:** control the orientation or location of microfibrils.
- **Lipid and Protein:** are also present in the matrix.

Microfibrils: These are structural or skeleton elements of cell wall made of cellulose (plants) or chitin (fungi).

- **Deposition on cell wall:**
  - **Lignin:** special hydrophobic substance which gets deposited mainly in xylem cells and sclerenchyma, and makes them hard. However, the lignified wall allows the water exchange.
  - **Suberin:** complicated mixture of fatty acids that are deposited on cork cells and endodermis cells in plants (casparian strips)
  - **Cutin:** wax-like fatty substance in the form of cuticle gets deposited on the epidermal cells and reduces the loss of water. Cuticle amount changes with environment as: is very thick in xerophytes, thin in mesophytes and absent in hydrophytes.
  - **Silica:** In some cases of plants, sand or silica particles gets deposited on the cell wall and gives it a rough touch e.g., *Equisetum* and grasses.
  - **Non-siliceous minerals:** Iron and calcium found in *Chara*.

Intracellular spaces: Young cells are closely or compactly packed with no intracellular spaces. However, mature cells have certain spaces (cavities) produced among them, which are of 3 types:

- **Schizogenous cavities:** the cell walls separate from each other in mature adjacent cells, and form a cavity in the tissue, E.g., resin canal in *Pinus*.
- **Lysigenous cavities:** formed from the breakdown (dissolution) of the cell walls, E.g., oil cavities in Citrus fruit rind.
- **Schizo-lysigenous cavities:** Both the above types are compiled here together, E.g., protoxylem water canals of maize stem.

- **Cell wall formation takes place by two methods:**
  - **Intussusceptions** – The deposition of **cell wall material** in the form of **fine grains**.
  - **Apposition** – Deposition of **layers** and not grains.
  - **Primary wall** is formed with **intussusceptions**. The **secondary wall** is formed from **both** the methods. Cell wall which is already constructed **grows** only **by intussusceptions**.
  - A Special protein called as **expansin** helps in growth of **cell wall**. Growth occurs by losing the cellulose microfibril and addition of the **new cell wall material**. Thus, expansin is also called as "**cell wall loosening factor**".
- **Plasmodesmata** – **Strasburger** proposed the name (1901). The **cytoplasmic connections** between **the two adjacent** plant cells. Plasmodesmata are characteristic feature of **multi-cellular plants** and also **maintain the continuity** of **cytoplasm** among the adjacent cells. **E.R. tubules** (Desmotubules) helps in the formation of continuity.

Specializations of cell wall –

- **Lignification** – Lignin is a cellulose derivative **carbohydrate** which **deposits on walls** of **sclerenchyma, vessels** and **tracheids**. Lignin is impermeable to water which is the reason for **cell death** during lignification.
- **Pits –** The **lignified cell wall** has pits. There are **deposition of lignin** which is throughout the cell wall. There are **areas left** without pits that are **small thin walled** called as the **pits**. **Pits** form in **pairs** on the **adjacent cell walls**. The two pits in a pair have a **thin membrane** for **separation** called as pit **membrane** (completely permeable) (initially composed of middle lamella and primary wall). However, after a while the **primary wall may dissolve**. There are two types of pit pairs –
  - **Simple pits** – When the pit cavity **diameter is uniform** throughout its **length** the pits are called as **simple pits**.
  - **Bordered pits** – When the pit cavity diameter increases from **inside** to **outside** then such pits are called as **Bordered pits**. The pit membrane has a thickening, which is made of suberin called as **Torus**.

- **Suberisation** – Suberin is **strictly impermeable** to water and air. Thus Suberisation leads to death of the cell. Suberisation is common in middle lamella. e.g. Cork
- **Cutinisation** – Cutin is also **hydrophobic** and is a **waxy substance**. Cutinisation is the process of **deposition** of **cutin** on cell walls. It **reduces** the **transpiration rate** in plants as it occurs on **leaf epidermis**.

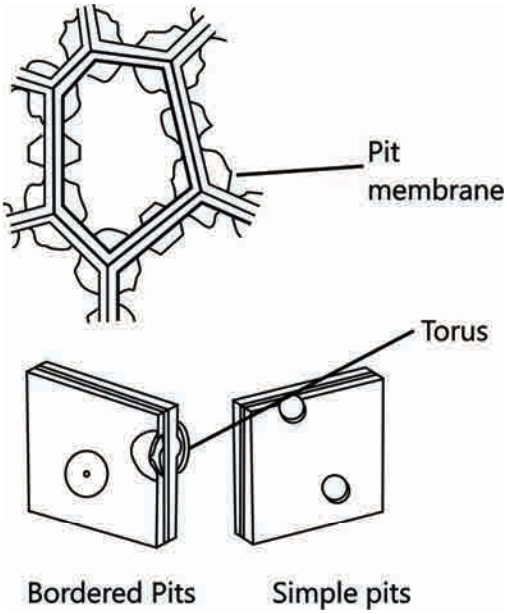

Figure 10.13: Structure of Pits

Table 10.6: Difference between Primary and Secondary wall of pits

Primary wall	Secondary wall
Cellulose microfibrils are arranged in a dispersed manner	Microfibrils are well arranged (Compact)
Hemicelluloses are more	Hemicelluloses are less
Primary wall have lipids and proteins	Proteins and lipids either absent or present in less amounts
Forms by intussusceptions only	By both the methods
Primary cell wall is the universal layer	Absent in meristem cells

- **Functions of cell wall**
  - Cell wall gives the cell its shape
  - Protective against mechanical damage and infection
  - Allows cell-to-cell interaction
  - Provides barrier to undesirable macromolecules

7.4 Biomembranes or Cell Membranes

- Living cells have thin, delicate, elastic, selectively permeable and living boundary or cover called as the cell membrane (by Nageli and Cramer) or plasma lemma (By J. Q. Plower) or bio membrane or plasma membrane.

7.4.1 Structure of Biomembranes

Sandwich or Trilamellar model – proposed by Davson and Danielli (1935).

- The **plasma membrane** includes three layers: a bimolecular layer of lipid is sandwiched between two layers of proteins.
- Each protein layer is 20 Å while phospholipid bilayer is 35 Å. Thus the total thickness of the membrane is 75Å (PLLP- structure, 75-100 Å average)
- **Phospholipid molecule** is also called as **amphipathic** molecule as it has two different parts: **hydrophilic** (polar head) and **hydrophobic** (nonpolar tail).
- **Hydrophilic head** binds with the protein layer through hydrogen and ionic bonds.
- **Hydrophobic tail** are attached with the **Vander wall forces**.

Unit membrane model – proposed by Robertson -1959

- All the **cellular** and **organelle membranes** have similar structure and function (difference in chemical and size). All the above models fail to explain the cell wall **Fluidity** and **selective permeability** which is why they are not accepted all over.

Fluid mosaic model: Singer and Nicolson (1972)

- Chemical studies in human red blood cell membrane (**RBCs**), revealed the possible structure of the plasma membrane.
- The most widely accepted model as the structure of plasmalemma is well explained.
- Proteins are present in the phospholipid layer in the mosaic pattern.
- Thus, membrane is termed as **protein iceberg** in a sea of **phospholipid**.

(i) Phospholipids

- **Phospholipid** is the main component as it gives **continuous structural frame** to the cell membrane.
- **Phospholipid** layer allows plasma membrane to be **flexible** or **elastic** because **phospholipids** have high **unsaturated fatty acid** content which are liquid in nature.
- The **lipids** have **polar heads** facing outer sides and the **hydrophobic** tails facing inner parts. The **aqueous environment** does not affect the cell membrane.

- **Cholesterol** (type of lipid) is found in **plasma membrane**. Cholesterol are **more rigid** in nature than **phospholipids** which helps in the membrane **stability** (quasifluid nature)
- The **fluid nature** of the membrane is important as it helps in **various functions** like cell growth, formation of intercellular junctions, secretion, endocytosis, cell division etc.
- Hopanoids instead of cholesterol provide stability to prokaryotic cell membrane.

(ii) Proteins

- The proteins are of two types depending on the process of extraction.

a. Integral or intrinsic protein:

- Tightly binds with phospholipid and are not released easily from the membrane.
- Intrinsic proteins are completely embedded, partially embedded
- Completely embedded intrinsic proteins are also termed as **transmembrane proteins** that act like **porins**, **tunnel** or **channel proteins** and pump proteins.

b. Peripheral or extrinsic protein:

- **Superficially** arranged on the surface thus leave the membrane easily.
- **Spectrin** are **helical extrinsic** protein found on membrane **cytosolic face** and attached to intrinsic protein. **Spectrins** are part of **cytoskeleton**.

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Chemical composition of plasma membrane: The plasma membrane chiefly consists of proteins and lipids. The percentage such components varies in different cells (E.g., human erythrocyte has approximately 52% protein and 40% lipids.), yet an average value is:

- Proteins: 20% −70%
- Lipids: 20% −78%
- Carbohydrates: 1% −5%
- Enzymes: About 30 enzymes are present
- Water: 20% of its total weight

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- **Proteins:** 20%–70%, these can be classified on extraction processes as integral and peripheral. Peripheral proteins are present on the outer surface, while integral proteins are partially or totally buried in the membrane from inner membrane to outside. On the basis of functions the proteins can be of three types:
  - **Structural proteins:** Form the cell membrane back bone.
  - **Carrier proteins:** Help in exchange of substances across the membrane.
  - **Enzymes:** Are catalytic proteins.
- **Lipids:** 20%–79%, the common types of lipids are lecithin and cephalin (phospholipid), cholesterol and galactolipids in the membrane. Lipids have the flip-flop movements.
- **Carbohydrates:** 1%–5%, the most ones are the hexose, hexosamine and fructose. The sialic acid are like glycolipids.

(iii) Transport through **plasma membrane**

- Most important functions are the transport of the molecules across it. The membrane is **selectively permeable** to molecules which the cell requires and are present on inner as well as outer sides of the membrane. Thus, it is called as **semipermeable membrane**.
- There are molecules that can move across the membrane without any requirement of energy by the process called as the **passive transport**.
- **Neutral solutes** travel across the membrane through simple **diffusion** dependent on the **concentration gradient**, i.e., from higher concentration to the lower. The process called as **diffusion**.
- **Water** moves with same process across this membrane (from higher to lower concentration). Movement of water is called as **osmosis**.
- Apart from these **non-polar molecules,** there are **polar molecules** as well which, **fail to pass** through the **non-polar lipid bilayer**, there are **carrier proteins** in the membrane to facilitate the transport across the membrane.
- A few molecules move across the membrane against concentration gradient, i.e., from lower to the higher concentration. The transport is facilitated with an energy dependent process, where **ATP** is utilized. The process is called as **active transport**, e.g., Na^+/K^+ Pump.

(iv) Endocytosis

- **Pinocytosis or Cell Drinking:** Plasma membrane **intakes liquid** material in the form of **vesicles** or alike **bag structures** i.e. **Pinosome** is called as **pinocytosis**.
- **Phagocytosis or Cell eating:** Plasma membrane ingests **solid complex materials** in the **form** of **vesicles** i.e. Phagosome is called as **Phagocytosis**.

(v) Exocytosis / Emeiocytosis / Cell vomiting / Reverse pinocytosis

- Plasma membrane **excretes** waste materials from the cell to outside.

7.5 Cytoplasm

- Strasburger termed "**Cytoplasm**", for the cell portion which includes the **nucleus** and cell organelles. Cytoplasm has two parts:
  - **Ground plasm / Hyaloplasm / Cytosol:** Only the Liquid matrix of cytoplasm
  - **Trophoplasm:** All the **organelles** along with the non-living **inclusions** (Deutoplasm).

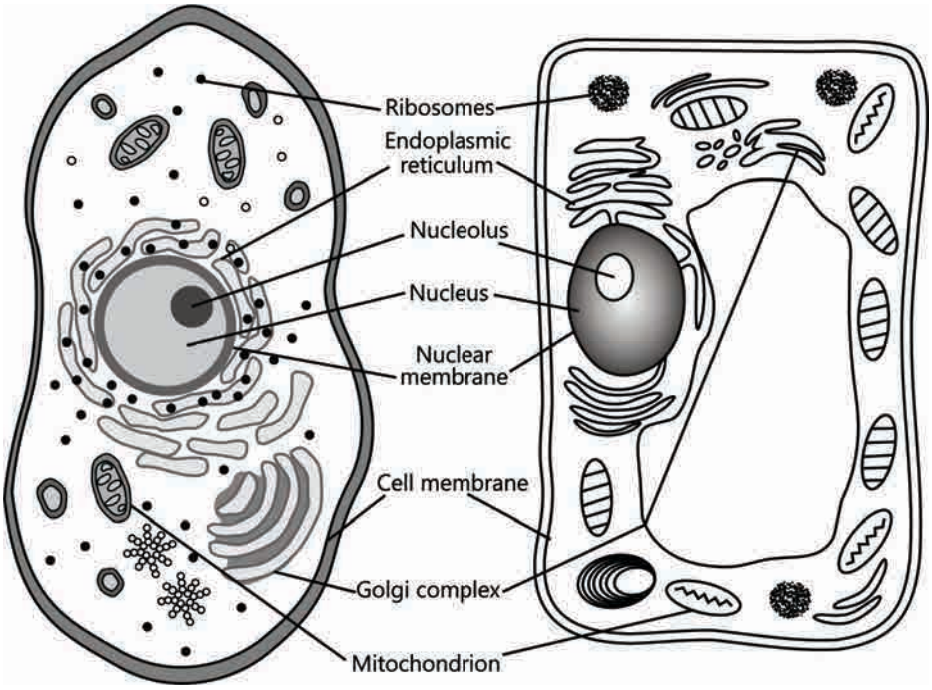


Figure 10.14: Comparison of **A.** Animal cell and **B.** Plant cell

7.6 Cell Organelles

- The Metabolically active permanent and the living structures present in the **cytoplasm** are called as **organelles**.

Endomembrane System

- The membranous organelles in a cell are different in its **structure** and **function**. Yet they are considered similar called as an endomembrane system as their **functions** are inter related and coordinated.
- The endomembrane system in a cell have **endoplasmic reticulum** (ER), **Golgi complex**, **lysosomes** and **vacuoles**. However, the functions of **mitochondria**, **chloroplast** and **peroxisomes** are not in relation with the above components, they are not part of the endomembrane system.

7.6.1 Endoplasmic Reticulum

- Grainer discovered ER, however, the details were described by Porter, Claude and Fullam. It is absent in prokaryotes while present in eukaryotes.
- **It includes followin`g parts:**
  - **Cisternae** – Narrow, long, flattened, double layered and unbranched units which are arranged in stacks. They lie close to nucleus, interconnected, have 40−50 μm.
  - **Vesicles** – Oval, scattered in cytoplasm, are membrane bound structures with 25−500 μm.
  - **Tubules** – Irregular, tubular, membrane bounded, present near the cell membrane. Tubules may be free or in association with cisternae.
- ER is termed as "**System of Membranes**" and attached with nuclear membrane and plasma membrane.
- ER **divides** the intracellular space into the two distinct compartments namely **luminal** (inside ER) and **extra luminal** (outside ER in the Cytoplasm) compartments. This division is essential for cellular life which ensures proper functioning of it.

Table 10.7: Difference between Rough and Smooth Endoplasmic reticulum

Rough ER (Granular)	Smooth ER (Agranular)
80s ribosomes are present on the surface.	Ribosomes are completely absent.
Mainly made up of cisternae.	Mainly made up of tubules.
Abundantly in actively growing cells that are engaged in protein synthesis and secretion.	Abundantly present in cells with lipid synthesis in animal cell steroid hormones are synthesized in SER.

- **Microsomes** – Fragmentation and high speed centrifugation of the cell yields E.R. part that are **associated ribosomal particles**. **Living cell** otherwise does **not** has this parts. Scientists use microsome for the study of in vitro protein synthesis.
- **Functions of ER are as follows:**
  - Protein and lipid synthesis.
  - **Mechanical support** ER along with microfilaments, microtubules are the endoskeleton of a cell.
  - **Intracellular exchange** ER makes a conducting system inside the cell. Also transports materials from one place to another.
  - ER is attached at some places to plasma membrane thus ER can secrete materials outside the cell.
  - Smooth ER plays a role in the glycogen synthesis.
  - **Detoxification** smooth ER concerned with detoxification of drugs and steroids.
  - Cytochrome P_{450} present in ER function like an enzyme in **detoxification** of cell.
  - Cellular metabolism ER membranes in a cytoplasm provide an increased surface for metabolic activities.

- Nuclear membrane development in telophase while the cell is dividing.
- Golgi-body and micro-bodies formation.

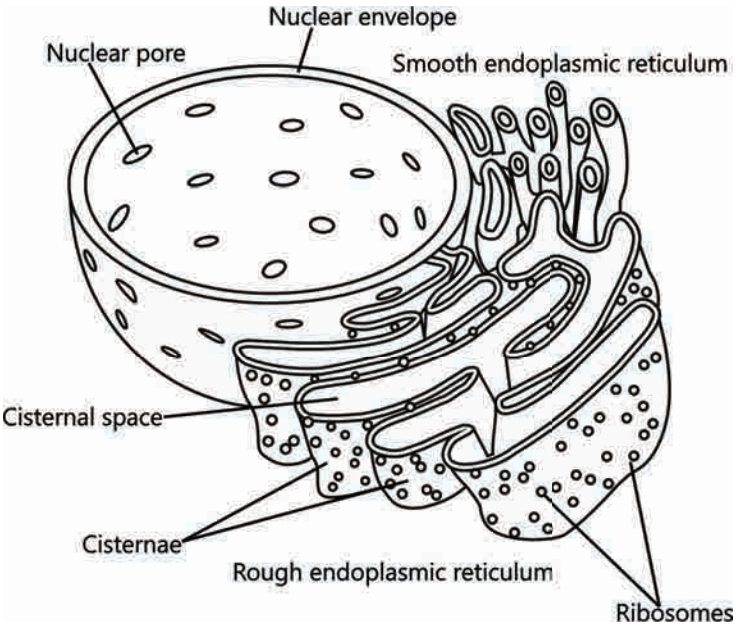


Figure 10.15: Structure of endoplasmic reticulum and nuclear envelope

7.6.2 Golgi Apparatus

- **Camilla Golgi** observed **Golgi** (1898) in the nerve cells of barn owl. He called it as "**internal reticular apparatus**".
- Golgi apparatus is also named as Golgi body / Golgi complex, Lipochondria (rich in lipids) and Idiosome (plant Golgi body)
- Number of Golgi body - absent in prokaryotes; several in eukaryotes, located near the **nucleus**.
- The **cytoplasm** around the Golgi body lacks any other **organelles**. It is called as **Golgi ground substance** or **Zone of Exclusion**.
- Golgi bodies are **pleomorphic organelles** as the components of Golgi body change in structure and shape in different cells.

Structure of Golgi Body is:

- **Cisternae** – Unbranched, flat disc like saccules. 4–8 saccules arranged in a stack like structure that are elongated two layered flat and curved in middle with swollen ends. The diameter is 0.5 µm to 1.0 µm. the dense opaque material inside the cisternae is called as Nodes.
  - Cisternae has a convex surface facing towards the nucleus called as cis face or forming face.
  - Cisternae has a concave surface facing towards the cell membrane called as trans face or maturing face.
  - Cis and trans faces are entirely different, but interconnected.

- **Tubules** – Branched and irregular tubules that are associated with the cisternae.
- **Vesicles** – Spherical structures from the tubules that have originated through budding. Vesicles have secretory materials.

Functions of Golgi bodies:

- **Packaging** and **Secretion** of materials – Major function is secretion (export) of macromolecules post packaging. It involves:
    - ER transports materials to Golgi body through the cis face (Golgi apparatus is in close association with the ER).
    - Chemically modified as glycoproteins and glycolipids.
    - Materials are packed in the vesicles. Then the vesicles from the Trans face are pinched off, and then delivered either in the cell or secreted outside the cell.
    - All the macromolecules that is secreted outside the cell, have to move through the Golgi body. So Golgi body is termed as "**principal director of macromolecular traffic in cel**l" or **middle men of cell**.
- Formation of **Lysosome** – Collective function of Golgi body and ER
- Cell wall material synthesis (polysaccharide synthesis).
- Cell **plate formation** (Phragmoplast) in the new cell formation.
- Formation of **acrosome** during spermiogenesis in male gametes.
- Formation of **Vitelline membrane** of egg
- Endocrine glands that secrete hormones is mediated through the Golgi bodies.

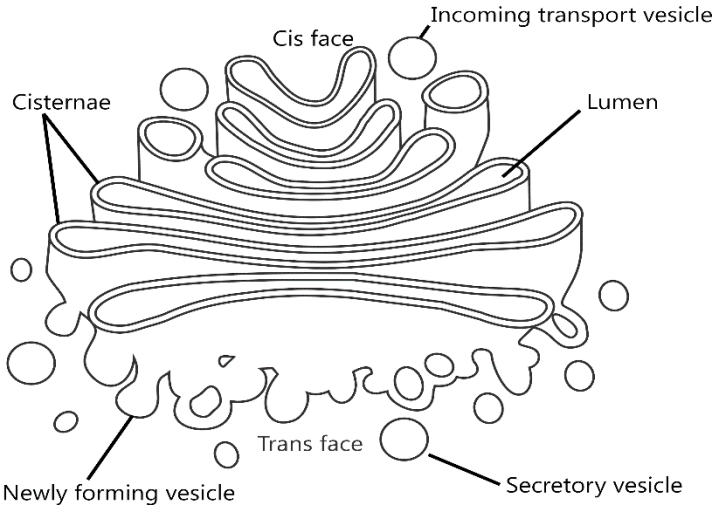


Figure 10.16: Structure of Golgi body

7.6.3 Lysosome

- **Spherical bag** like structures that has a single unit membrane.
- Lysosomes have different type of digestive **hydrolytic enzymes** are termed as **acid hydrolases**. (lipases, proteases, carbohydrases, nucleases)
- This acid hydrolyses its function in **acidic medium** (pH 5). Lysosome membrane has an active H^+ pump mechanism. This mechanism produces acidic pH in lumen or stomach of lysosome.
- Lysosomes have polymorphic structures.

Different forms of Lysosomes:

- **Primary lysosomes** or **storage granules** – lysosomes store inactive Acid Hydrolases. These are the new lysosomes.
- **Digestive vacuoles** or **heterophagosomes** – The fusion of primary lysosomes and phagosomes produces secondary Lysosomes called as digestive vacuoles.
- **Residual bodies** – Lysosomes with the undigested material are called as residual bodies. These bodies are eliminated through exocytosis and are called as Telo lysosomes. (Tertiary lysosomes)
- **Autophagic lysosomes** or Cyto lysosomes or auto phagosomes – Lysosomes with the dead cell organelles that are to be digested in the cell are called as Auto phagosomes.

Functions:

- Intracellular digestion
    - **Heterophagy** – Foreign materials that enter the cell are digested through a process called as **phagocytosis** and **pinocytosis**
    - **Autophagy** – Old or dead cell organelles are digested in the cell. Autophagy also takes place during starvation of cell.
- Extracellular digestion
    - Lysosomes of osteoclast called as bone eating cells, dissolve the unwanted part of bones.
- **Autolysis** – The cell has its life like all living organisms which are destined to death. All lysosomes of a cell sometimes burst such that the cell is dissolved completely. Old cells, unwanted organs of embryo in the body die through autolysis. Cathepsin of lysosome dissolves the tadpole tail of frog during its metamorphosis. Thus, lysosomes are called as suicidal bags of cell.
    - **Stabilizers** are chemicals, which stabilize the membrane of the lysosome to stop its rupture. This process prevents Autolysis and cell death. E.g. cholesterol, chloroquine etc.
    - **Labilizers** are chemicals which increase the fragile nature of lysosome membrane and increase the **autolysis** possibility, E.g. Progesterone, testosterone, Vitamin A, D, E, K, U, V. radiations, bile salts etc.

- **Biogenesis** of **lysosome** – Lysosomes originates from **GERL** – (Golgi associated Endoplasmic Reticulum: the area for Lysosomes to arise).

ER ⟶ Golgi body ⟶ Lysosome

- Vacuoles are the single membrane bound organelles called as tonoplast.
- Vacuoles are absent in animal cells and in plants the **meristematic cells** lack it while permanent tissue have well developed vacuoles. The vacuoles can increase in size of upto 90 percent volume of the cell in plants.
- The vacuole has a non-living fluid called as the **Cell Sap**. It can have few water soluble pigments like **Anthocyanin** (blue or violet), **Anthoclor** (yellow) etc. Best known is β **cyanin** in **beet root** cells.
- **Water** and excretory material storage are major functions.
- Amoeba has the **contractile vacuole** which is important for excretion. In many cells, as in protists, food vacuoles engulf the food particles which initiates their formation.

7.6.4 Mitochondria (Singular: Mitochondrion)

- **Mitochondria: Kolliker** discovered it in the **voluntary muscles**.
- These are **present** in all **eukaryotes** and **absent** in mammalian **RBC** and **prokaryotes**.
- The shape is not constant and is variable, can be granular, fibrillary, spherical, cylindrical as sausage or discoidal.
- The size is dependent on the **metabolic activeness** of the cell. Diameter ranges from 0.2–1.0 μm (average 0.5 μm) and Length 1.0–4.1 μm.
- The **number** ranges from 1000–1600 per cell which is variable and dependent on the **physiological activity** of the cells.

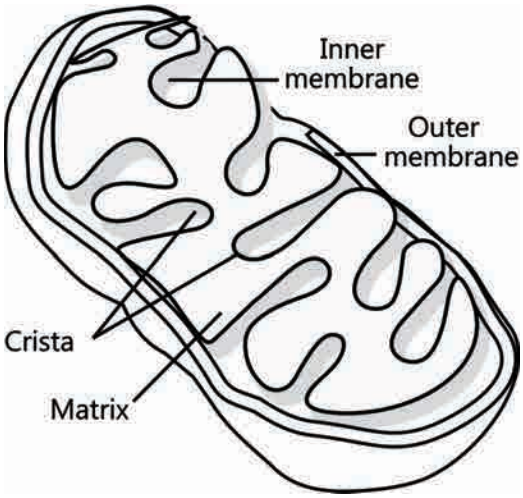


Figure 10.17: Structure of mitochondria

Did You Know

Mitochondria is also called as

- **Power house** of cell or **ATP-mill** in a cell
- Cell furnaces or storage batteries
- Cell within a cell
- Most busy and active organelle in a cell

- **Double membranous** covering. The **phospholipids** and **cholesterol** are high in outer membrane and **low** in **inner** membrane. Protein content is high in the inner membrane and porins are present in outer membrane for the exchange.
- The membranes have **60–75 Å** thickness and are separated with **80−100 Å** space called as the peri mitochondrial space (outer compartment). The space has good amount of **enzymes** that are required for the **oxidation of fats**.
- The **outer membrane** of mitochondria when removed, then the structure left is called as **mitoplast**.
- **Inner membrane** shows several **folded finger like** structures facing inwards called as **cristae**. This cristae increases the surface area. Fungal cristae are plate like while Euglenal cristae are vesicle shaped. There is **intra-cistral** space which is continuous outer membrane.
- Inner membrane has **studded pin head** particles which are called as **oxysomes** or elementary particles or $F_1 - F_0$ particles or ATPase or ATP synthase. The main function is Oxidative phosphorylation in respiration which produces **ATP**. (10^4 to 10^6 in number per mitochondria). These particles were first described by **Fernandez Moran** (1962).
- Space enclosed by inner membrane is called as **Matrix**. **Mitochondrial** matrix are energy produces as they have all the **enzymes essential** for **Krebs cycle** (Aerobic respiration). Also the matrix have its own complete **protein synthesis apparatus** (70s Ribosome, DNA and RNA). Thus mitochondria are called as semi-autonomous cell organelles. Some proteins required by the mitochondria are **self-synthesized**, while others are synthesized from nuclear DNA.

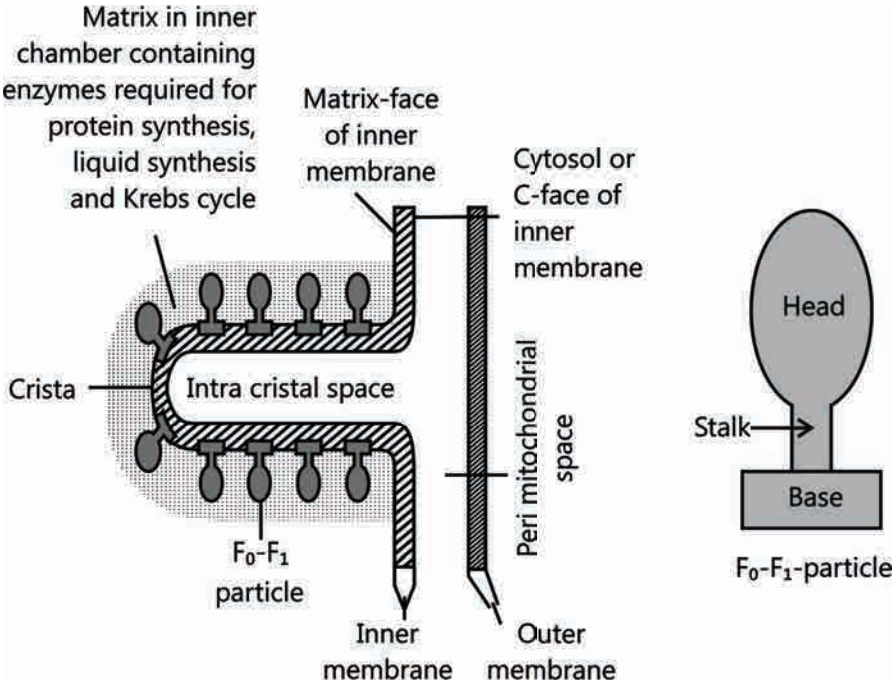


Figure 10.18: Structure of inner membrane of Mitochondria and F particle on it

- DNA is **double stranded circular** and **naked** in mitochondrial matrix.

Function of mitochondria: ATP production in Aerobic respiration and in Krebs cycle. Thus produce heat required by the cell for its survival (thermogenesis).

- **Biogenesis** of **mitochondria** – New cells arise from existing ones.
- **Endosymbiosis origin** from Purple Sulphur bacteria or any **prokaryotic cells**, as the **eukaryotic mitochondria** are **similar** to prokaryotic cell in ways-
    - Structure of DNA and DNA sequences.
    - Type of ribosome (70s).
    - Divide by amitosis or fission.

Did You Know

- The number of mitochondria is variable in the cell depending on the physiological activity.
  - A single mitochondria is present in the primitive eukaryotes (e.g., *Chlorella*, *Microasterias*).
  - 25 in sperms
  - 300–400 in kidneys cells
  - 500–1000 in liver cells
  - 50,000 in giant Amoeba *Chaos chaos*.
  - 140,000–150,000 in eggs of Sea urchin
  - 5,00,000 in fight muscles cells.
- Green plant cells having chloroplasts often contain lesser number of mitochondria as compared to non-green plant cells and animals cells. Dormant and inactive cells possess fewer mitochondria. All mitochondria of a cell are collectively called chondriome.

7.6.5 Plastids

- **Plastids** are called by this name by **Haeckel**.
- They are present in all the plant cells and **Euglenoids**.

Types of Plastids

The major basis are its presence and types of pigments in it.

- **Chromoplasts:** They contain different **fat soluble pigment** types (carotenes, Xanthophylls etc.). **Chlorophylls** are either absent or few present.
  - **Chromoplasts** are mainly present in the **pericarp** and **petals** of flowers, fruits. E.g. **Red colour** of **chillies** and **red tomatoes** have **red pigment** "**Lycopene**" of chromoplasts. **Lycopene** is a pigment included in **carotene**. **Yellowish orange** colour of fruits are incorporated as they have **α-carotene, β-carotene** and **γ-carotene**. Richest source of β-carotene are carrot which is a precursor of vitamin-A.
- **Chloroplasts:** Green coloured plastids that have chlorophyll and carotenoid pigments.
- **Leucoplasts (Colourless plastids)**: Food storing organelles in different forms. E.g. starch (Amyloplasts), fat and oil (Elaioplasts) and protein (Aleuroplasts). Pigments and lamellar structure is absent. Non green plant cells contain it.

- Different types of plastids can interchange their forms from one form to another as the genetic material in all the leucoplasts are similar. However, chromoplasts are never transformed to chloroplasts. E.g. Tomato, Chilly etc.

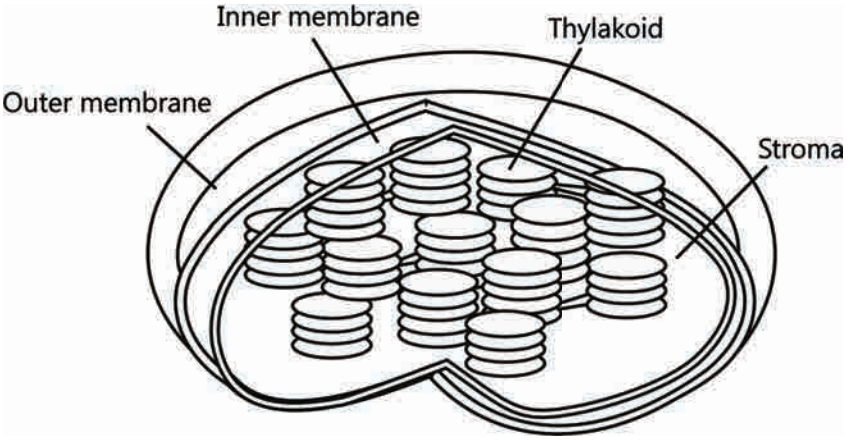


Figure 10.19: Structure of chloroplasts

Structure of Chloroplast

- Double membranous cell organelle.
- 20–40 **chloroplast** in **mesophyll cell** of higher plants. ***Chlamydomonas*** have one Chloroplast per cell.
- **Outer membrane** is more permeable than inner membrane as it has porins.
- It contains stroma and grana (thylakoids or lamellae). **Stroma** is similar to cytoplasm part and it contains circular DNA, RNA, 70-s Ribosomes, and starch grains, enzymes of Calvin cycle or dark reaction of photosynthesis. Stroma also has enzymes to synthesize proteins and carbohydrates.
- **Thylakoids** are membranous flattened sacs placed one above the other like stacks called as **granum** (Plural grana). 40–60 granum is present in a chloroplasts.
- Fret channel or stromal thylakoids or stroma lamellae is the linking of the two granum. The photosynthetic functional unit, with 230 to 400 various pigment molecules is called as Quantasomes.
- **Quantasomes** or photosystem are present in the thylakoid membranes that bear **Photosynthetic pigments** (**chlorophylls**).
- Thylakoid membrane encloses a space called as **Lumen**.
- Chloroplasts have their own genetic system along with the complete protein synthetic set (ds-DNA, RNA, Ribosomes, enzymes, Amino Acids). The chloroplasts are called as semiautonomous organelle of the cell as Photosynthetic enzymes are synthesized on both the genes of the chloroplast and the nucleus.

Biogenesis or new plastid formation is from proplastid and division by amitosis.

Origin – From endosymbiotic origin by a cyanobacterium.

7.6.6 Cytoskeleton

- The minute, fibrous tubules that form an elaborate network made of filamentous proteinaceous structures collectively called as the cytoskeleton. Its main functions are mechanical support, motility, maintenance of the cell shape.
- **Microtubules**
    - Made up of contractile unbranched hollow protein, Tubulin.
    - Microtubules during cell division form spindle fibres. Also, it develops centrioles, Cilia and Flagella.
    - It is present in eukaryotes, and not in slime moulds and amoeba.
- **Microfilaments**
    - Made up of contractile protein, Actin.
    - They are concerned with muscle contraction,
    - **Microtubules** and **microfilament** provides **cytoskeleton**-base of cell.

7.6.7 Centrosome and Centrioles

- Centrosome have a pair of centrioles that lie at right angle (90^0) outside the nucleus to each other. **Centrioles** are surrounded by **amorphous, protoplasmic plaques called sa peri centriolar** materials or **massules**.
- **Centrioles** are **elongated membranous** structure that show cart wheel like structure in transverse section.
- There are 9 microtubules on periphery which is composed of three tubules namely A-tubule, B-tubule and C-tubule. Central part of the centriole is proteinaceous called as "**Central Hub**". The arrangement is 9+0 as centre does not have a tubule.
- Protein fibres called as primary fibres or spokes connect microtubules to the central hub. Secondary fibres connect microtubules with each other.
- Primary fibre are thick with layers called as **X-thickening**. **Y-thickenings**, lie between X-thickenings and both of them are inter connected.
- Centrioles are self-duplicating units without the DNA and covering.
- Centrioles **replicate** in **S phase** when the cilia and flagella basal bodies are formed.

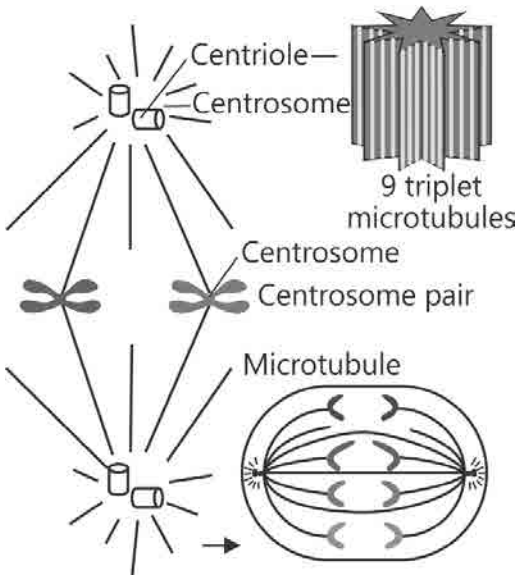


Figure 10.20: Structure of centriole

Function

- Centrioles play an important role in cell division as they form spindle fibres that separate two poles in a nucleus. Centrioles are also termed as "**cell centres**".
- Transformation is possible which give rise to the basal body of cilia and flagella.
- In a spermatozoan the two centrioles gives rise to axial filament or tail.

7.6.8 Cilia and Flagella

- **Cilia** (Sing – Cilium) and **Flagella** (Sing- Flagellum) are **microscopic hair** or **thread** like outgrowths which are **locomotory structures**. These extend from inner cell membrane layer to outside the cell.
- **Cilia** are present in all **protozoans**,
- Flagellum or Cilium is covered with protective sheath which is connected with the plasma membrane. The central part or core which is contractile is composed of 11 microtubules (9 doublet + 2 singlet) called as **Axoneme**.
- Peripherally nine microtubules are present, composed of pair of small tubules: A-tubule and B-tubule.
- Arms of A tubules have an enzymatic protein **dynein** (like myosin of muscle cells). Dynein hydrolyses ATP such that energy is liberated for movement.
- The central tubules are bundled together which are enclosed in a central sheath. This sheath is connected to one of the tubules present in each peripheral doublets with the radial spoke. Nine radial spokes in all are present. The peripheral doublets are further interconnected by linkers.
- Both the cilium and flagellum in the cell membrane emerge from centriole like structure which is called as the basal bodies.

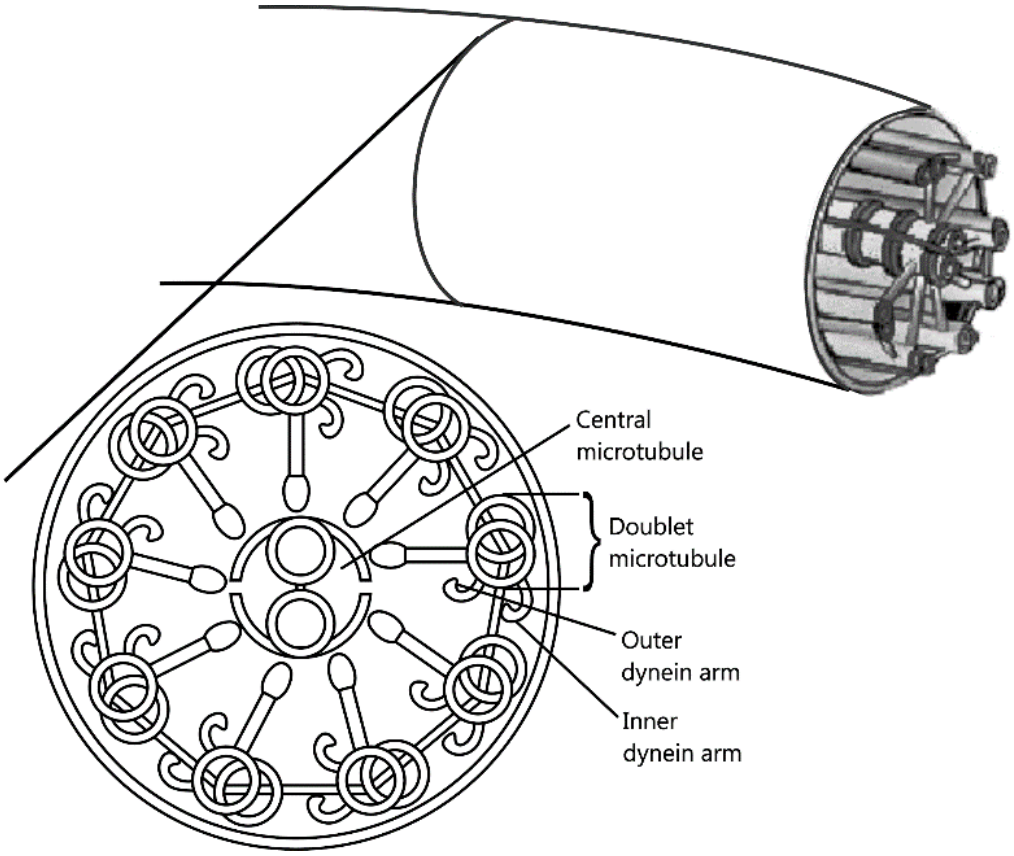


Figure 10.21: Structure of cilia T.S.

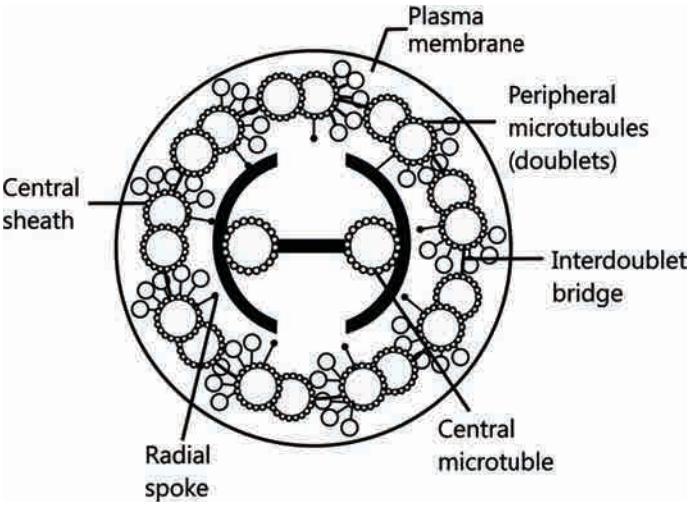


Figure 10.22: Structure of Flagella T.S.

Table 10.8: Differences between Cilia and Flagella

Cilia	Flagella
The cilia are small in size	Flagella are long
Number of cilia per cell is very high	Few in number
Cilia beat in a coordinated maner like oars (sweeping or pendular movement)	Flagella beats independently (Non-coordinated manners) undulating movement
They take part in locomotion, attachment, feeding and sensation.	Flagella involved only in locomotion

7.6.9 Ribosomes (Engine of Cell)

- Observed by **George Palade** (1953).
- All living cells have ribosomes both prokaryotes and eukaryotes however not in RBC.
- **Smallest** cell **organelles without** outer **membranes**.
- Also called as "**organelle with in an organelle**" and "**Protein factory of cell**".
- Ribosomes are different in eukaryotes and prokaryotes:

  Eukaryotic ribosomes – 80S = freely floating in cytoplasm or are attached to ER in eukaryotic cells.

  Prokaryotic ribosomes – 70S (15nm x 20 nm) = free floating in cytoplasm or remain associated with the plasma membrane in prokaryotes. Also found in mitochondria and Chloroplast of eukaryotes.

  - S is Svedberg unit or Sedimentation rate: The measure of density and size of ribosomes.
  - Each ribosome has two subunits: Larger and smaller subunits.
  - 80S = 60S (larger) + 40S (smaller)
  - 70S = 50S (larger) + 30S (smaller)
  - Ribosomal subunits are bound together by Magnesium ion. 0.001 M Mg^{+2} concentration is essential for ribosomes to be formed and remain active. Mg^{+2} concentration increases by 10 times and ribosome dimers are formed.
  - 80S+80S =120S (Dimer)
  - 70S+70S=100S (Dimer)
  - In prokaryotes, several ribosomes get attached to m-RNA during the protein synthesis called as polyribosome or polysome or Ergosome
  - There are fixed and free ribosomes with different protein synthesis: Secretory and lytic proteins - fixed ribosomes; non-secretory proteins - free ribosome.

- **Chemical composition of ribosomes**
  - 70S – 60% R-RNA + 40% proteins
  - 80S – 40% R-RNA +60% proteins
  - 60S – R-RNA 28S, 5.8S, 5S
  - 40S – R- RNA 18S
  - 50S – R-RNA 23S, 5S
  - 30S – R-RNA 16S

TRY IT YOURSELF

1. Matrix of mitochondria occupies a larger area in _____ state.

2. Colourless plastids in endosperm cells of castor seeds are _____.

3. Select correct match

	Column I		Column II
a.	Conversion of fats into carbohydrates	(i)	Thylakoid
b.	23 S, 5 S rRNA and 34 proteins	(ii)	40 S ribosomal unit
c.	18 S rRNA and 33 proteins	(iii)	50 S ribosomal unit
d.	Quatasomes	(iv)	Glyoxysomes

7.6.10 Microbodies

- Small, **Spherical**, Single **membrane bound** cell organelles that have **enzymes** in it are called as "**Microbodies"**. These are present in both plants and animals.
- Microbodies are divided on the basis of their enzyme content and function as:

Sphaerosome

- Found in plant cells. The major function is lipid storage and synthesis. High amounts in fatty seeds like groundnut, castor etc.
- Sphaerosome have additional ability similar to lysosome, hence they are also called as plant lysosomes.

Peroxisomes

Present in both the plants and animals and its functions are as follows:

- Photorespiration or Glycolate cycle (along with chloroplast in plants and mitochondria in animals)
- β-oxidation of fatty acids.
- Breakdown of H_2O_2 with catalase enzyme.

Glyoxysomes

- Found only in plants, mainly in fatty seeds.
- **Glyoxylate cycle** is the Conversion of fat into carbohydrates.

7.6.11 Nucleus

- **Robert Brown** studied in detail the **orchid root cells** and named the nucleus in 1831
- Nucleus is called as **controller** or **director** of cell. It controls heredity, growth and metabolism in a cell as experimentally proved by **Hammerling**. (Experiment was on Acetabularia a single cell largest alga).
- **Eukaryotic cell** has at least one nucleus. However it is **absent** in prokaryotes, mature **phloem** sieve tube elements and mature **RBCs** or erythrocytes of mammals.

Structure of nucleus shows presence of:

- Nuclear membrane or nuclear envelope or karyotheca.
- Nucleoplasm / Karyoplasm / Karyolymph
- Chromatin net
- Nucleolus / Little nucleus / Ribosome factory

i. **Nuclear membrane:** Two unit membranes cover the nucleus, thus it is **double membranous component** of cell. Space between two membranes of nucleus is known as **perinuclear space** (10 to 50nm). Outer membrane of nucleus is connected with **ER** at several places and ribosomes also found on it. Nuclear membrane has **minute nuclear pores** which are result of the two membrane fusion. The nuclear pores have octagonal discoid structure as **guard** for them which is made of **nucleoplasmin protein.** This pore with protein structure is called as **annulus** or Bleb (Annulus + Pore = **Nuclear Pore complex**). **Pore complex** is connection for nucleoplasm and cytoplasm, and **nucleoplasmin** is responsible for nucleocytoplasmic traffic (movement of RNA and proteins). Nuclear membrane is continuous with ER in the telophase of the cell division.

ii. **Nucleoplasm or Karyolymph:** Nucleoplasm (Nuclear sap) is a ground substance or matrix of the nucleus which includes complex colloidal form of many chemicals like nucleotides, RNA and DNA polymerase, endonucleases, minerals (Ca++, Mg++) etc. Chromatin net and nucleolus are a part of nucleoplasm.

iii. **Chromatin net (Term given by Flemming):** These are intranuclear, long, thread like thin fibres, embedded in the nucleoplasm. Chromatin net is made up of DNA, histone protein, non-histone protein and RNA. Chromatin fibres condense in cell division to collect all the genetic information and form fixed number of chromosomes. Chemically chromatin has DNA (31%), RNA (2%–5%), Histone protein (36%) and non-histone (28%). 20% to 30% histone includes arginine and lysine amino acids. Relative amount of arginine and lysine change in histones which is basis for its classification into five types of Histone protein. (H_2A, H_2B, H_3, H_4, H_1). Acetocarmine (basic dye) staining reveals two type of regions in chromatin net-

a. **Euchromatin –** Lightly stained and diffused part which is transcriptionally or genetically more active.
b. **Heterochromatin –** Dark stained, thick and condensed part of chromatin, having more histone and less acidic protein. This part is genetically less active.

Table 10.9: Difference between Euchromatin and Heterochromatin

Euchromatin	Heterochromatin
Consist of thin, extended, light stained part of chromatin.	Consist of thick, coiled, dark stained condensed part of chromatin
Genetically more active part in chromatin	Less active or inert part in chromatin
Less histone protein	More histone protein

iv. **Nucleolus**: Nucleolus is one per nucleus. Human cell has five nucleoli. Nucleolus is naked or without any membrane, round or slightly irregular part present in nucleus. It is attached to chromatin (or chromosomes) at specific site called as nucleolar organizer region (NOR). **Nucleolus**, is called as **ribosome factory of cell**, as it has the proteins for ribosomes synthesis. r-RNA (synthesized by nucleolus) and ribosomal proteins are assembled in nucleolus to form ribosomes. Active cells for protein synthesis have larger and more numerous nucleoli. r-RNA and protein are synthesized in the cytoplasm for all prokaryotes.

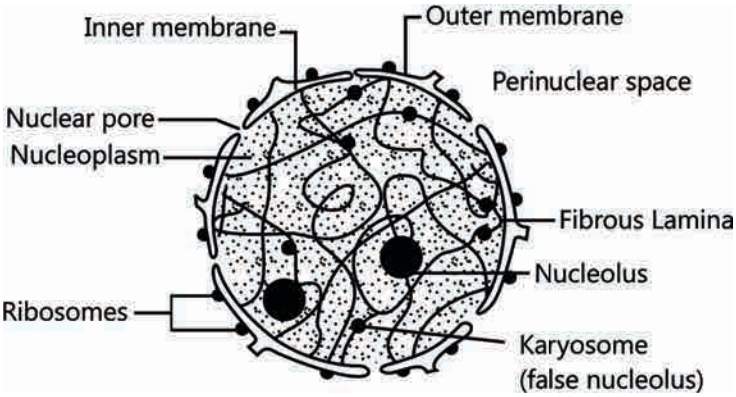


Figure 10.23: Structure of a nucleus in eukaryotes

KNOWLEDGE BUILDER

Nucleolus includes these parts:

- **Granular region:** Made of ribonucleoprotein granules.
- **Fibrillary region:** Consists of long proteinaceous fibrils, called as nucleolonema.
- **Amorphous matrix:** Less dense region.
- **Nucleolus associated chromatin:** Two types of fibrils i.e. perinucleolar chromatin fibres which are along the periphery of nucleolus and intranucleolar chromatin fibers which are able to penetrate into Nucleolar matrix. The DNA in chromatin is called as rDNA (ribosomal DNA) and helps in the rRNA and ribosomal unit synthesis.

7.6.12 Chromosomes

General introduction

- The chromatin material gets condensed into chromosomes during a cell division, thus chromosome is a highly condensed form of the chromatin fibers.
- Chromosome number are different in different organisms.

Structure of chromosome

- **Pellicle** is outermost, thin proteinaceous sheath as a cover of the chromosome.
- **Matrix** is ground substance in the chromosome which has different type of enzymes, minerals, water, and Proteins. It is liquid that has no genetic or chromatic substance.
- **Chromatid**: Each chromosome consist of two cylindrical structures during metaphase called as chromatids. Both sister chromatids or longitudinal hands of chromosome are attached to a common centromere. A chromosome, is a single chromatid in Anaphase and two chromatids in prophase and metaphase. Each chromatid has a single long DNA associated with histones.

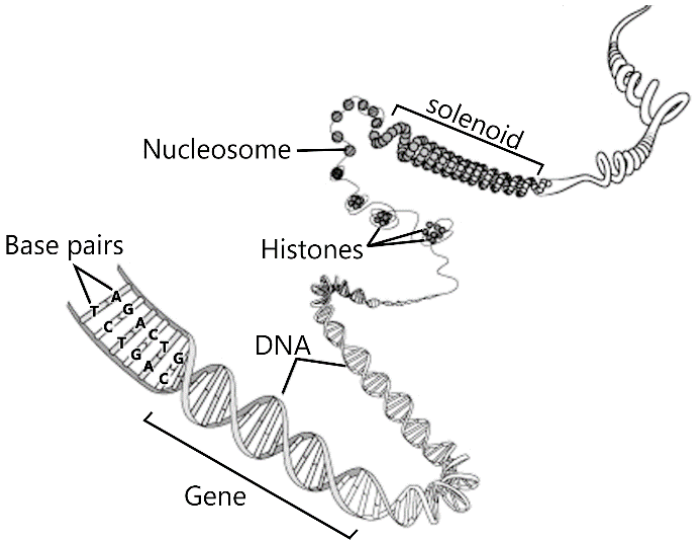


Figure 10.24: Structure of a DNA with its details

- **Centromere / Kinetochore**: Each chromosome during metaphase has two half chromosome or two chromatids. Both the chromatids of a chromosome are joined or connected by a structure called as Centromere. At this junction or the centromere there are two protein discs which are called as Kinetochore. Kinetochores are the actual site of attachment of spindles to chromosomes during cell division. At the region of centromere there is less chromosome comparatively than the remaining part of chromosome, thus it is termed as Primary constriction.

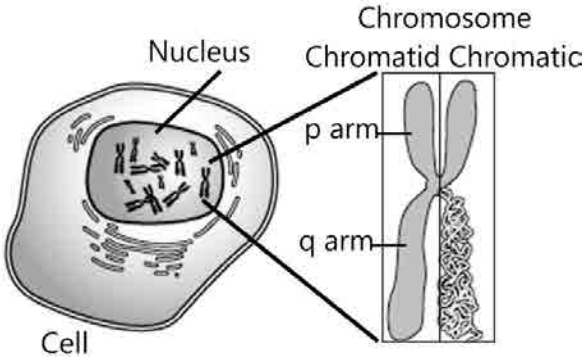


Figure 10.25: Structure of nucleus and chromosome

- **Secondary constriction**: Along with primary constriction, one or two other constrictions are also occurs possible on some chromosomes, called as secondary constriction. Secondary constriction I is also known as NOR (Nucleolar organizer region). Secondary constriction I: found on chromosome number 13, 14, 15, 21, 22 of Human. Secondary constriction II: found on chromosome number 1,10,13,16 and Y-chromosome of Human.

- **Satellite:** The left out part of chromosome that remains after the NOR is called as chromosome satellite/ Trabent. Chromosomes with satellite part are called as SAT chromosome (SAT= Sine Acid Thymidine)
- **Telomere:** Chromosomes are polar with polar ends known as Telomere. Telomere prevents fusion of two chromosomes. Human Telomeres are rich in Guanine bases (5'-TTAGGG-3'). According to Richard Kathan (2003) chromosome telomeres are getting shorter with the ageing process.

KNOWLEDGE BUILDER

Number of Chromosomes: Chromosomes number changes from species to species. Yet it is fixed for a particular species.

- Least chromosome number is in plants which is 2n = 4 (n = 2) in *Haplopappus gracillis* (Compositae) and highest one is 2n = 1260 in *Ophioglossum* (a pteridophyte called Adder's tongue).
- In a protozoan (radiolarian) *Aulacentha*, the diploid number is 2n = 1600
- 'n' represents the gametic or haploid chromosome number.
- '2n' is the diploid or somatic number.

Packaging of DNA (Nucleosome Model)

- A single human cell is 2.2 meters long DNA thread distributed in the 46 (23 pairs) chromosomes.
- This model shows the DNA packaging.
- Nucleosome is a unit measure of chromatin (chromosome). It is composed of about 200 DNA base pairs and an Octamer (Core particle) of four histone protein types (H_2A, H_2B, H_3, H_4,).
- 6 Nucleosome units together (or super coiling) forms Solenoid structure.
- H_1 histone protein (the sealing histone) attaches the turns of the binding DNA in a nucleosome.
- In nucleosome unit, the Binding DNA have 1.75 or 1¾ turns on the octamer part.

Types of Chromosomes on the Basis of Position of Centromere

- **Telocentric –** When centromere is terminal or located at the tip of chromosome.
- **Acrocentric –** When the centromere is sub-terminal or located near the tip.
- **Metacentric –** When the centromere is located at mid of the chromosome.
- **Sub metacentric –** When the centromere located near centre or midpoint of chromosome.

Function of Nucleus

- Controls the synthesis of structural proteins.
- Controls the enzymes and proteins synthesis and thus controls cellular functions.

- Has the genetic material intact and protects it.
- Translation of DNA into ribosomes occur.
- Genetic variation essential for the evolution is initiated.
- Cellular differentiation as per its destined function is a result of nucleus.

TRY IT YOURSELF

1. Fill in the blanks:

a. _____ maintain continuity between nucleo-cytoplasmic regions.

b. _____ region gets dark stain interphase and has condensed region with _____ packed DNA.

c. Acrocentric chromosomes appear_____.

d. Disc-shaped protein structure attached to the centromeric portion is called _____.

Summary

- All organisms are made of cell or its aggregates. Cells have different shape, size and activities / functions depending upon the location.
- The presence or absence of membrane bound nucleus and organelles, the cells and even the organisms are divided as eukaryotic and prokaryotic.
- A typical eukaryotic cell is a cell that has a cell membrane, nucleus and cytoplasm with membrane bound organelles.
- Plants have cells that have a cell wall outside the usual cell membrane.
- The plasma membrane is selectively permeable to several important molecules and facilitates their transport in and out of the cell.
- The endomembrane system is the assembly of membrane bound organelles that are interconnected in terms of their functions. It includes ER, golgi complex, lysosome and vacuoles.
- All the cell organelles in a cell perform different and specific assigned functions. Centrosome and centriole are able to form the basal body of cilia and flagella which are used in locomotion of the cell of prokaryotes.
- In animal cell, centrioles also initiate the spindle apparatus formation during the cell division.
- Nucleus contains nucleoli and chromatin network. It controls the activity of all the cellular organelles and also plays a major role in heredity of genetic information.

- ER has tubules or cisternae. The ER is of two types: rough and smooth. ER helps in the transport of substances, synthesis of proteins, lipoproteins and glycogen.
- Golgi body is a membranous organelle which is composed of flattened sacs. The secretions of cells are packed inside and transported from the cell to outside.
- Lysosomes are single membranous structures consisting of enzymes for the macromolecules digestion of all types.
- Ribosomes carry out protein synthesis. They occur freely in the cytoplasm or are on the surface of ER.
- Mitochondria perform oxidative phosphorylation and generation of adenosine triphosphate during respiration. They are double membranous structures where the outer membrane is smooth while the inner one folds into several inward folding called as cristae.
- Plastids are organelles that have pigment found in plant cells only.
- Chloroplasts a plastid, help in photosynthesis by trapping light energy essential for it. The grana, is the site of light reactions while the stroma is for the dark reactions. The green coloured plastids, called as chloroplasts contain chlorophyll, whereas the other coloured plastids are called as chromoplasts which contain pigments like carotene and xanthophyll.
- The nucleus is a double membranous organelle called as nuclear envelop that has enclosed DNA and RNA. The inner membrane enclosed the nucleoplasm and the chromatin material.
- Thus, cell is called as the structural and functional unit of life.

EXERCISE

Objective Questions

Q.1 Which cell wall component present in all three cell wall

(A) Pectin (B) Cellulose (C) Hemicellulose (D) Lignin

Q.2 Growth of cell wall during cell elongation takes place by

(A) Apposition (B) Intussusception

(C) Both A and B (D) Super position

Q.3 Plasmodesmata are

(A) Pores in cell wall (B) Pores in cell membrane

(C) Protoplasmic connection (D) A and B both

Q.4 Which element mainly occurs in middle lamella

(A) Ca (B) Mg (C) Na (D) K

Q.5 Lignified cell wall is characteristic feature of

(A) Vessels (B) Sieve cells

(C) Sieve tubes (D) All of the above

Q.6 Cell membrane have how many enzymes

(A) 20 (B) 30 (C) 40 (D) More than 50

Q.7 Cell membrane is composed of

(A) Proteins and cellulose (B) Proteins and phospholipids

(C) Proteins and carbohydrates (D) Proteins, phospholipids and some carbohydrates

Q.8 Which of the following is main enzyme of plasma membrane

(A) TPPase (B) ATPase (C) Peptidyl transferase (D) Catalases

Q.9 Cell wall is

(A) Dead and impermeable (B) Dead and permeable

(C) Living and impermeable (D) Living and selective

Q.10 Carbohydrates are present in the plasmalemma in the form of

(A) Hemicellulose (B) Cellulose

(C) Starch (D) Glycoprotein

Q.11 Synthesis of cell wall material takes place in

(A) Dictyosome (B) Mitochondria (C) Lysosome (D) E.R

Q.12 Tondifibrils are characteristic of which junction

(A) Desmosomes (B) Plasmodesmata

(C) Gap junction (D) Tight junction

Q.13 According to fluid mosaic model (proposed by Singer and Nicholson) plasm membrane is composed of

(A) Cellulose, hemicellulose

(B) Phospholipid and integrated protein

(C) Phospholipid, extrinsic protein, intrinsic protein

(D) Phospholipid and hemicellulose

Q.14 Torus is composed of

(A) Suberin (B) Chitin (C) Cutin (D) Lignin

Q.15 Carbohydrates which present in the cell membrane take part in

(A) Transport of substance (B) Cell recognition

(C) Attachment to microfilament (D) Attachment to microtubules

Q.16 Plasma membrane is fluid structure due to presence of

(A) Carbohydrate (B) Lipid

(C) Glycoprotein (D) Poly saccharide

Q.17 The most abundant lipid in cell membrane is

(A) Cutin (B) Cholesterol (C) Steroid (D) Phospolipids

Q.18 Cell wall of lignified cell is

(A) Semipermeable and dead (B) Permeable and living

(C) Impermeable and dead (D) Impermeable and living

Q.19 Which type of cell surface junction abundantly occur in epithelial tissues

(A) Nexus (B) Desmosomes

(C) Zona occludense (D) Plasmodesmata

Q.20 Cell wall is present in

(A) Plant cell (B) Prokaryotic cell

(C) Algal cell (D) All of the above

Q.21 Plasma membrane is

(A) Selectively permeable (B) Permeable

(C) Impermeable (D) Semipermeable

Q.22 Amphipathic molecule in plasma membrane is

(A) Protein (B) Carbohydrates

(C) Phspholipids (D) All of the above

Q.23 Primary cell wall formed by

(A) Intussusception (B) Apposition

(C) Intussusception and lignification (D) Minearalization

Q.24 The singer's Model of Plasma membrane differs from the Robertson's model in the

(A) Number of lipid layers (B) Arrangement of proteins

(C) Arrangement of lipid layers (D) Absence of protein layers

Q.25 Ingestion of solid food by plasma membranes is called

(A) Endoosmosis (B) Pinocytosis (C) Cytokinesis (D) Phagocytosis

Q.26 Ingestion of large molecules by animal cell is called

(A) Diffusion (B) Osmosis (C) Exocytosis (D) Endocytosis

Q.27 Endocytosis Includes

(A) Phagocytosis (B) Pinocytosis (C) Both (A) and (B) (D) None of these

Q.28 Rough ER mainly responsible for

(A) Protein synthesis (B) Cell wall formation

(C) Lipid synthesis (D) Cholesterol synthesis

Q.29 Besides producing secretory vesicles, the function of golgibody is

(A) Lysosome formation (B) Formation of spindle fibers

(C) Formation of ER (D) All of the above

Q.30 Mitochondrial DNA is

(A) Naked (B) Circular

(C) Double stranded (D) All of the above

Q.31 Golgibody orginates from

(A) ER (B) Mitochondria

(C) Nucleus (D) Proplastid

Q.32 Lysosomes are not help-full in

(A) Osteogenesis (B) Cellular digestion

(C) Metamorphosis in frog (D) Lipogenesis

Q.33 Acrosome of sperm is derived from

(A) Golgi vesicle (B) Lysosome

(C) Golgi tubule (D) Cisternae

Q.34 Which of the cell organelle synthesizes steroids

(A) ER (B) Golgi body (C) Peroxisomes (D) Lysosomes

Q.35 In mammals, the mitochondrial ribosomes are

(A) 55s (B) 70s (C) 80s (D) 100s

Q.36 True statement for golgibody is all except

(A) Convex surface of cisterne is towards nucleus

(B) Concave surface of cisternae is towards plasma membrane

(C) Golgi body are filled with digestive enzyme

(D) Carbohydrate form in golgi body

Q.37 Power house of cell is

(A) Nucleus (B) DNA (C) Mitochondria (D) ATP

Q.38 Mitochondria are site of respiration first reported by Kingsbury and supported by Hogeboom. Mitochondria are related with the oxidation of

(A) Carbohydrates (B) Fats (C) Proteins (D) All of the above

Q.39 Elementary particle of mitochondria are

(A) F_1 particles (B) Ribosomes (C) DNA (D) Lysosomes

Q.40 Hydrolytic enzymes are abundantly found in which cell organelles

(A) Ribosome (B) Lysosome

(C) Oxysome (D) Endoplasmic reticulum

Q.41 Which of the following sets of cell organelles contain DNA

(A) Mitochondria, peroxysome (B) Plasma membrane, ribosome

(C) Mitochondria, chloroplast (D) Chloroplast, dictyosome

Q.42 Semiautonomous cell organelle is

(A) Mitochondria (B) Ribosome

(C) Plasma membrane (D) Peroxysome

Q.43 Golgi body is absent in

(A) Prokaryotes (B) Mature mammalian RBC

(C) Alkaryotes (D) All of the above

Q.44 In which types of cell lysosomes are abundantly found

(A) Storage cell (B) Glandular cell

(C) Phagocytic cell (D) Vascular cell

Q.45 One of the following is present outside the plasma membrane but inside the cell-wall

(A) Spherosome (B) Peroxisome

(C) Lomasome (D) Golgi body

Q.46 Chemical modification of substance like glycosidation of protein and lipid occur in

(A) Endoplasmic reticulum (B) Golgi body

(C) Lysosome (D) Ribosome

Q.47 At which pH lysosomal enzymes remain active

(A) pH-5 (B) pH-7 (C) pH-8 (D) pH-10

Q.48 Synthesis of cellulose and hemicelluloses take place in

(A) Micro bodies (B) Smooth ER (C) Golgi complex (D) Lysosome

Q.49 The cell organelles having abundance of oxidizing enzymes is

(A) Golgi body (B) Endoplasmic reticulum

(C) Centrioles (D) Mitochondria

Q.50 Main function of golgi-compelx is

(A) Fermentation (B) Phosphorylation

(C) Respiration (D) Packaging of materials for secretion

Q.51 Polymorphic cell organelles is

(A) Ribosome (B) Lysosome (C) Chloroplast (D) Nucleus

Q.52 Due to presence of cristae in mitochondria

(A) Surface area increase of outer membrane

(B) Surface area increase of inner membrane

(C) Surface area decrease of outer membrane

(D) Surface area decrease of inner membrane

Q.53 ATP ase activity occur in

(A) Head of F_1- particle (B) Stalk of F_1- particle

(C) Base of F_1- particle (D) All of the above

Q.54 Mark the lysosomal stabilizer

(A) Vitamin–K (B) Vitamin–A

(C) Cortisone (D) Progesterone

Q.55 RER is well developed in cell engaged in the synthesis of

(A) Steroids (B) Fats (C) Vitamin (D) Proteins

Q.56 Which of the following prevents the rupturing of lysosomal membrane

(A) Cholesterol (B) Vit. A

(C) Testosterone (D) UV-rays

Q.57 Aerobic respiration is performed by

(A) Mitochondria (B) Chloroplast (C) Ribosome (D) Golgi body

Q.58 Mitochondria originated from

(A) Purple sulphur bacteria (B) Cyanobacteria

(C) Mycoplasma (D) Virus

Q.59 GERL concerned with the biogenesis of

(A) Golgi body (B) ER

(C) Mitochondria (D) Lysosomes

Q.60 Occurrence of DNA in chloroplast and mitochondria support the hypothesis that

(A) Glycolysis takes place in both chloroplast and mitochondria

(B) Both the organelles produce ATP

(C) Both of them can produce Amino acid

(D) They were independent organism which become symbiotic of eukaryotic cells

Q.61 Suicide bags of cells are

(A) Endoplasmic reticulum (B) Lysosome

(C) Golgi bodies (D) Vacuoles

Q.62 Three morphological forms of golgi complex are

(A) Lamellae, tubules, and vesicles (B) Cisternae, tubules, and vesicles

(C) Cisternae, tubules and lamellae (D) Granum, thalykoids and vesicles

Q.63 The stored food and secretory substances found in the cytoplasm makes

(A) Cytoplasm (B) Hyaloplasm (C) Protoplasm (D) Deutoplasm

Q.64 Labilisers found on membrane of lysosome are

(A) Cortisone and cortisol (B) Cholesterol and heparin

(C) Testosterone and progesterone (D) Cholesterol and progesterone

Q.65 Autodissolution and osteogenesis are function of

(A) Golgi bodies (B) Ribosome (C) Lysosomes (D) Mitochondria

Q.66 A single unit membrane organelle is

(A) Ribosomes (B) Mitochondria (C) Chloroplast (D) Lysosomes

Q.67 Double layered organelle are

(A) Ribosomes (B) Mitochondria (C) Lysosomes (D) Centriole

Q.68 Cistern is found in

(A) Only mitochondria (B) Only endoplasmic Reticulum

(C) Endoplasmic Reticulum and Golgi body (D) Only Golgi body

Q.69 Which enzyme performs detoxification of hydrogen peroxide in peroxisome

(A) Urate acid oxidase (B) Peroxidase

(C) Catalase (D) Ascorbic acid synthetase

Q.70 Cilia and flagella have

(A) Dissimilar internal structure and are of unequal size

(B) Similar internal structure and are of equal size

(C) Similar internal structure and are of dissimilar size

(D) Dissimilar internal structure and are of similar size

Q.71 DNA is not found in

(A) Nucleus (B) Mitochondria (C) Chloroplast (D) Ribosome

Q.72 Mitochondria and chloroplast are considered to be endosymbionts of cell because they

(A) Possess their own nucleic acid (B) Have capacity of ATP synthesis

(C) Do not reproduce (D) All of the above

Q.73 Spherosome are involved in

(A) Synthesis and storage of lipid (B) Synthesis of protein

(C) β-oxidation of fatty acids (D) Synthesis and storage of carbohydrate

Q.74 Factory of ribosome in a cell is

(A) Endoplasmic reticulum (B) Nucleolus

(C) Mitochondria (D) Golgi body

Q.75 What is the angle between two centriole of a centrosome

(A) 30^0 (B) 45^0 (C) 60^0 (D) 90^0

Q.76 Self duplication does not occur in

(A) Mitochondria (B) Centrioles

(C) Chloroplast (D) Ribosome

Q.77 In which tubulin protein is not present

(A) Plasma membrane (B) Cilia

(C) Flagella (D) Microtubules

Q.78 Sphaerosomes are formed from

(A) Lipidochondria (B) Endoplasmic reticulum

(C) Ribosome (D) Mitochondria

Q.79 The peroxisomes are associated with the phenomenon of

(A) Oxidative anabolism (B) Degradation of H_2O

(C) Anaerobic respiration (D) Photorespiration and degradation of H_2O_2

Q.80 Factory for synthesis of sugars in autotrophic eukaryotes is

(A) Mitochondria (B) Ribosome

(C) Chloroplast (D) Endoplasmic reticulum

Q.81 Plastids which store fats and oils are called

(A) Aleuroplast (B) Amyloplast

(C) Etioplast (D) Elaioplast

Q.82 Cell organelle associated with conversion of light energy to chemical energy is

(A) Chloroplast (B) Mitochondria

(C) Ribosome (D) Endoplasmic reticulam

Q.83 Biogenesis of eukaryotic Ribosomes takes place in

(A) Mitochondria (B) Chloroplast

(C) Both A and B (D) Nucleolus

Q.84 “Palade particles” are

(A) Ribosomes (B) Golgivesicles

(C) Lysosomes (D) Sphaerosomes

Q.85 Ribosomes are center of

(A) Lipid synthesis (B) Carbohydrate synthesis

(C) Protein synthesis (D) All of the above

Q.86 Red colour of tomato and chilly is due to

(A) Lycopene in chloroplast (B) Xanthophylls in chromoplast

(C) Lycopene in chromoplast (D) Anthocyanin in leucoplast

Q.87 Animal cell differ from plant cell in possessing

(A) Glogi body (B) Centrosome (C) Vacuole (D) Plastid

Q.88 Which of the cilia protein is analogous to myosin of muscles

(A) Tubulin (B) Dynien (C) Flagellin (D) None of these

Q.89 Function of centrosome is

(A) Initiation of cell div (B) Inhibition of cell div

(C) Termination of cell div (D) Cytokinesis

Q.90 Blepheroplast is a type of

(A) Centriole (B) Plastid (C) Cilia (D) Mitochondria

Q.91 Which of the following lacks unit membrane

(A) Cilia (B) Flagella (C) Basal granule (D) Sphaerosome

Q.92 Prokaryotic Ribosomes are 70 s, s refers to

(A) Svedberg unit (B) Smallest unit (C) Smooth (D) Speed

Q.93 Glyoxylate pathway takes place in

(A) Peroxisomes (B) Sphaerosomes (C) Lysosomes (D) Glyoxysomes

Q.94 Pericarp and petals contain

(A) Chloroplast (B) Chromoplast (C) Leucoplast (D) Etioplast

Q.95 Arrangement of microtubules in centriole is

(A) 9+2 (B) 2+9 (C) 11+0 (D) 9+0

Q.96 Non pigmented part of chloroplast is called

(A) Thalakoids (B) Grana (C) Stroma (D) Lamella

Q.97 Which of the following plastids are helpful in starch formation and storage

(A) Chromoplast (B) Leucoplasts (C) Chloroplast (D) Lycopen

Q.98 Lamellae of chloroplast are known as

(A) Granum (B) Frets (C) Thylakoids (D) Stroma lamellae

Q.99 70s type of ribosomes found in

(A) Prokaryotic cells
(B) Prokaryotic cells, chloroplasts and mitochondria
(C) Mitochondria
(D) Nucleus, mitochondria

Q.100 Mitoplast is

(A) Outer membrane less chloroplast
(B) Outer membrane less mitochondria
(C) Granum less chloroplast
(D) Well developed nucleus

Q.101 Which of the following substances are sotred in Aleuroplast

(A) Starch (B) Oil and Lipids (C) Proteins (D) Water and oil

Q.102 Smallest cell organelle which called cell engine is

(A) Ribosome
(B) Lysosome
(C) Vacuoles
(D) Endoplasmic reticulum

Q.103 The ribosomes are made up of

(A) DNA + Protein
(B) RNA + Protein
(C) DNA + RNA
(D) None of these

Q.104 Functional unit of Chloroplast is

(A) Stroma (B) Quantasoma

(C) Oxysomes (D) Peroxysomes

Q.105 Which of the following pair lack the unit membrane

(A) Nucleus and ER (B) Mitochondria and chloroplast

(C) Ribosome and nucleolus (D) Golgi body and lysosome

Q.106 Three of the following statements regarding cell organelles are correct while one is wrong. Which one is wrong?

(A) Lysomes are double membrane vesicles budded off form golgi apparatus and contain digestive enzymes

(B) Endoplasmic reticulum consists of a network of membranous tubules and helps in transport, synthesis and secretion.

(C) Leucoplasts are bound by two membranes lack pigment but contain their own DNA and protein synthesizing machinery

(D) Spharosomes are single membrane bound and are associated with synthesis and storage of lipids.

Q.107 Nuclear organizer is a

(A) Primary constriction (B) Secondary constriction

(C) Tertiary constriction (D) Centriole

Q.108 True chromosomes absent in prokaryotes due to the absence of

(A) Nucleus (B) Nucleolus (C) Histone (D) All of the above

Q.109 Chromosomes composed of

(A) DNA, RNA, Histones, Non histones (B) DNA and Histones

(C) DNA and RNA (D) DNA, RNA and Histones

Q.110 Which of the following character is not taken into consideration while preparing a kayotype

(A) Chromosomal length (B) Arm ratio

(C) Position of sec. constriction (D) Length of DNA

Q.111 The non-sticky chromosomal ends are known as

(A) Chromatids (B) Centromere (C) Chromomere (D) Telomere

Q.112 Highest arm ratio occur in which chromosome

(A) Telocentric (B) Metacentric (C) Submetacentric (D) Acrocentric

Q.113 The nucleolar chromatin contains gene for

(A) B-DNA (B) Z-DNA (C) r-RNA (D) Satellite-DNA

Q.114 One solenoid composed of

(A) 8-nucleosome (B) 6-nucleosome

(C) 10-nucleosome (D) 16-nucleosome

Q.115 Histone which links the nucleosomes together is called

(A) H_1 (B) H_2A (C) H_2B (D) H_4

Q.116 The protein nucleoplasmin occurs in

(A) Nuclear pore complex (B) Sieve cells

(C) Nucleolus (D) Hetero chromatin

Q.117 Function of centrosome is

(A) Secretion (B) Respiration

(C) Water regulation (D) Arrangement of spindle fibres

Q.118 The chromatin material which takes darker stain in interphase is called

(A) Euchromatin (B) Heterochromatin

(C) Primary constriction (D) Satellite body

Q.119 Nucleus is

(A) Single layered structure (B) Three layered structure

(C) Four layered structure (D) Two layered structure

Q.120 Nucleolus are rich in

(A) Deoxy Ribonucleoprotein
(B) Lipoprotein
(C) Ribonucleoprotein
(D) m-RNA and r-RNA

Q.121 Part of chromosome after secondary constriction is called

(A) Chromomere
(B) Telomere
(C) Satellite
(D) Nucleolar organizer

Q.122 Nucleosome is made up of

(A) Nonhistone protein +RNA
(B) Histone protein and DNA
(C) Non-histone and histone protein
(D) Phospholipid and protein

Q.123 Linker DNA present in between

(A) Two nucleosome
(B) Two chromatid
(C) Two solenoid
(D) Chromomere

Q.124 Who is the controller of cell

(A) Mitochondria
(B) Nucleus
(C) Golgi bodies
(D) Endoplasmic reticulum

Q.125 If the centromere is sub-median the two arms are unequal then the chromosome is called as

(A) Metacentric
(B) Submetacentric
(C) Acrocentric
(D) Telocentric

Q.126 Structure which provide shape to chromosome is called

(A) Telomere (B) Satellite (C) Centromere (D) Chromomere

Q.127 Nucleolus is formed by

(A) Mitochondria
(B) Nucleus and Ribosome
(C) Primary constriction
(D) Secondary constriction

Q.128 Chromosome with centromere at one End

(A) Metacentric (B) Submetacentric

(C) Telocentric (D) Acrocentric

Q.129 Part of Chromosome which joins with spindle fibres is

(A) Chromatid (B) Chromonema

(C) Chromomere (D) Centromere

Q.130 If a karyotype having fewer metacentric chromosomes is called

(A) Symmetric karyotype (B) Asymmetric karyotype

(C) Ideogram (D) Cryptogram

Q.131 Who among the following scientist is credited with the discovery of cell was published in 'Micrographia'

(A) Robert Brown (B) Robert Hooke

(C) Schleiden (D) Schwann

Q.132 Who was first to observe living substance in the cells?

(A) Anton van Leeuwenhoek (B) Alfonso Corti

(C) Robert Brown (D) Johannes Purkinje

Q.133 Nucleus was first observed in the cells of orchid roots in 1837 by

(A) Robert Brown (B) Hugo Von Mohl

(C) Fontana (D) Malpighi

Q.134 Protoplasm is physical basis of life was stated by

(A) Purkinje (B) Huxley (C) Rudolf Vichow (D) Schwann

Q.135 Which of the following does not show a circular DNA?

(A) Bacterial cell (B) Nucleus (C) Mitochondria (D) Chloroplast

Q.136 The saccules and utricles were names used for the cells by one of the following

(A) Robert Brown (B) Malpighi (C) Purkinje (D) Swanson

Q.137 Which of the following structures form a basket around the nucleus?

(A) Microfibril (B) Microfilament

(C) Microtubule (D) Intermediate filament

Q.138 Most of the water found in the cell occurs in

(A) Cell wall (B) Nucleus (C) Cytoplasm (D) Nucleolus

Q.139 Which of the following is described as “energy currency of the cell”?

(A) DNA (B) RNA (C) ATP (D) Vitamins

Q.140 Cell theory was put forward by

(A) Schleiden and Schwann in 1838–1839

(B) Sutton and Boveri

(C) Watson and Crick

(D) Darwin and Wallace

Q.141 The cell envelop in gram positive bacteria consists of tightly bond

(A) One-layered structure (B) Three-layered structure

(C) Two-layered structure (D) Four-layered structure

Q.142 Who was the first to explain that the cells divide and new cells are formed from the pre-existing cells (Omnis cellula-e-cellula) in 1855?

(A) Louis Pasteur (B) Rudolf Virchow

(C) Nagali (D) Robert Brown

Q.143 The longest cell in the human body is

(A) Liver cell (B) Muscle cell

(C) Neruoglia cell (D) Nerve cell

Q.144 What is absent in mammalian erythrocytes?

(A) Aerobic respiration (B) Nucleus

(C) DNA (D) All of these

Q.145 A specialised differentiated form of cell membrane in some prokaryotes is

(A) Sphaerosome (B) Lomasome

(C) Plasmid (D) Mesosome

Q.146 The membrane covering the vacuole is known as

(A) Desmosomes (B) Tonoplast

(C) Plasmodesmata (D) Tyloses

Q.147 Which is non-membranous (not covered by membrane) organelle?

(A) Ribosome (B) Lysosome

(C) Mitochondria (D) Chloroplast

Q.148 One of the following is absent in plant cell

(A) Vacuole (B) Cell wall (C) Centrosome (D) Plastids

Q.149 Find the cell type which do not have ability to divide

(A) Nerve cells (B) Liver cells

(C) Muscle cells (D) Bone marrow cells

Q.150 The prokaryotic cells are characterised by

(A) Distinct chromosome (B) Absence of chromatin material

(C) Absence of nuclear membrane (D) Distinct nuclear membrane

Q.151 Cell originate

(A) From pre-existing cells (B) Absence of chromatin material

(C) Absence of nuclear membrane (D) Distinct nuclear membrane

Q.152 Which of the following is present in both plant and animal cells?

(A) Primary wall (B) Secondary wall

(C) Plasma membrane (D) Plastids

Q.153 Which of the following has one-envelope system?

(A) Pseudomonas (B) Chlamydomonas

(C) Acetabularia (D) Saccharomyces

Q.154 Small cells are metabolically active as they have

(A) Higher surface area to volume ratio

(B) Higher nucleocytoplasmic ratio

(C) Lower nucleocytoplasmic ratio

(D) Both (A) and (B)

Q.155 Which of the following cells do not show DNA duplication or RNA synthesis?

(A) Liver cells (B) Muscle cells

(C) Meristem (D) Mature RBCs

Q.156 The function of polysome in bacterial cell is to

(A) Translate the mRNA into protein

(B) Store reserve food materials

(C) Synthesize pigments

(D) Help in buoyancy

Q.157 Select the organelle which divides the intracellular space into two distinct compartments, i.e., luminal and extra-luminal cytoplasm

(A) GBs (B) ER (C) Vacuole (D) Cytoskeletons

Q.158 Eukaryotic cell differs from a prokaryotic cell in having

(A) No cytoskeleton (B) Circular DNA

(C) Mesosomes (D) Sap vacuoles

Q.159 Trilamellar model of membrane structure was proposed by

(A) J.D. Robertson (B) Danieli and Davson

(C) Gorter and Grendel (D) Singer and Nicolson

Q.160 Animals cells differs from plant cells in not having

(A) Plastids (B) Cell wall (C) Glyoxisome (D) All of these

Q.161 The first structure formed from cell plate between newly daughter cell is called.

(A) Primary wall (B) Secondary wall (C) Tertiary wall (D) Middle lamella

Q.162 Which of the following is present in the prokaryotes

(A) Nuclear envelop (B) Golgi apparatus

(C) Mitochondria (D) Ribosomes

Q.163 Gram negative bacteria differ from gram positive bacteria in having

(A) Thick cell wall and is primarily made up of peptidoglycan

(B) Complex cell envelope made up of three layers

(C) The cell wall is 20–80 nm in thickness and also contains tightly bound techoic acids

(D) Absence of cell wall lipids

Q.164 The organelle which is concerned with O_2 evolution, is

(A) Peroxisome (B) Mitochondria (C) Glyoxysome (D) Chloroplast

Q.165 Pigment responsible for colour of petals is found in

(A) Gas vacuoles (B) Sap vacuoles

(C) Contractile vacuoles (D) Food vacuoles

Q.166 Glycocalyx or cell coat which functions as cell recognition is made up of

(A) Proteins (B) Lipids

(C) Proteins and lipids (D) Glycoproteins and glycolipids

Q.167 Plasma membrane is asymmetric because

(A) Lipids present in the outer and inner side of the bilayer are different

(B) Extrinsic proteins are more abundant on the inner surface than on the outer surface

(C) Oligosaccharides are attached only to the external surface of lipids and proteins of a biomembrane

(D) All of these

Q.168 The membrane of the erythrocyte has approximately

(A) 40% carbohydrates (B) 80% protein

(C) 52% protein (D) 48% lipids

Q.169 Unit membrane concept was proposed by

(A) Danielli (B) Davson (C) Robertson (D) Singer

Q.170 The universally accepted model of plasma membrane is

(A) Lamellar model (B) Unit membrane model

(C) Fluid mosaic model (D) Overton model

Q.171 According to Fluid Mosaic Model of plasma membrane, extrinsic proteins are

(A) Superficially arranged and cannot be separated easily

(B) Peripheral proteins and are loosely connected to membranes and therefore, can be easily removed in aqueous medium

(C) Integral proteins which object beyond the lipid layer on both sides of the membrane and are considered as channel proteins

(D) Tightly attached to lipids and cannot be separated

Q.172 According to widely accepted “fluid mosaic model” cell membranes are semi-fluid, where lipids and integral proteins can diffuse randomly. In recent years, this model has been modified in several respects. In this regard, which of the following statements is incorrect?

(A) Proteins in cell membranes can travel within the lipid bilayer

(B) Proteins can also undergo flip-flop movements in the lipid bilayer

(C) Proteins can remain confined within certain domains of the membranes

(D) Many proteins remain completely embedded within the lipid bilayer.

Q.173 Fluid mosaic model of cell membrane proposes that

(A) A lipid bilayer with embedded proteins only

(B) A lipid bilayer with proteins on the outer surface only

(C) A lipid bilayer coated with proteins on both the surfaces.

(D) A lipid bilayer with proteins of two types, embedded (intrinsic) and superficial (extrinsic).

Q.174 Out of proteins lipids and carbohydrates present in a cell membrane, what is true?

(A) Carbohydrates are minimum (B) Carbohydrates are maximum

(C) Lipid is minimum (D) All the three are in equal proportion.

Q.175 Carrier molecules facilitating transport across cell membrane are

(A) Proteinaceous (B) fatty acids (C) Starch (D) Alkaloids

Q.176 "Protein icebergs in a sea of lipid" means

(A) Unit membrane concept (B) Sandwich model

(C) Fluid mosaic model (D) None of these

Q.177 Extrinsic and intrinsic proteins found in plasma membrane are in the following ratio

(A) 70 : 30 (B) 30 : 70 (C) 40 : 60 (D) 60 : 40

Q.178 The main function of plasma membrane is to

(A) Store cell material

(B) Control of all cellular activity

(C) Maintain the cell shape and size

(D) Regulate the flow of material into and outside the cell

Q.179 The plasma membrane is more permeable to

(A) Polysaccharides (B) Proteins (C) Glycoproteins (D) Phospholipids

Q.180 Plasma membrane particularly in animal cells is elastic due to

(A) Lipids (B) Proteins (C) Carbohydrates (D) None of these

Q.181 Which of the following cytoskeletal element plays an important role in movement of chromosomes?

(A) Microfilaments (B) Microtubules

(C) Intermediate filaments (D) All of these

Q.182 Bacterial genome or nucleoid is made up of

(A) A single double stranded chromosome with histone

(B) RNA and histone

(C) A single double strands DNA, not complexed with histone proteins, nor is it packed in the chromosome.

(D) A single strands circular DNA

Q.183 A bacterial cell DNA is extensively looped and coiled with the help of

(A) Acid proteins

(B) Histones

(C) Basic nucleoid protein called as polyamines

(D) Actin

Q.184 The Golgi cistemae are concentrically arranged near the

(A) Plasma membrane (B) ER (C) Nucleus (D) Vacuole

Q.185 Type of growth shown by primary cell wall is

(A) Accretionary (B) Istussuceptionary

(C) Protoplasmic (D) None, as it can't expand or grow

Q.186 Plasmodesmata often has ER (endoplasmic reticulum) tubule called as

(A) Symplasm (B) Desmotubule

(C) Apoplasm (D) Intermediate filaments

Q.187 Which of the following is associate with detoxification of drugs and muscle contraction by the release and uptake of CA^{2+} ions?

(A) Golgi complex (B) RER

(C) SER (D) Free ribosomes

Q.188 The main organelle involved in modification and routing of newly synthesized proteins to their destination is

(A) Chloroplast (B) Mitochondria

(C) Lysosome (D) Endoplasmic reticulum

Q.189 The term endoplasmic reticulum was used by

(A) Keith Poter (B) Thompson

(C) Robertson (D) Keith Poter and Thompson

Q.190 Ribosomes when associated with ER, are attached with their

(A) Small subunit (B) Large subunit (60 S)

(C) 80 S subunit (D) Either by smaller subunits or by the larger subunits

Q.191 Ribosomes are attached to the endoplasmic reticulum through

(A) Ribophorins (B) r-RNA

(C) t-RNA (D) Hydrophobic interaction

Q.192 RER is well developed in cells engaged in the synthesis of

(A) Nucleotides (B) Proteins (C) Lipids (D) Secretory products

Q.193 SER is mainly found in cells actively engaged in/SER is site of

(A) Secretion activity (B) Protein metabolism

(C) Lipid metabolism (D) Catabolic activity

Q.194 Golgi apparatus / apparato reticulare is specialised for all except

(A) Glycosidation and glycosylation of lipids and proteins

(B) Recycling of the plasma membrane pinched off by pinocytosis and phagocytosis

(C) Secretion

(D) Intracellular digestion

Q.195 Which of the following statements is incorrect about the Golgi apparatus?

(A) The sacs on the forming face (cis-faces) are associated with ER

(B) Golgi apparatus was studied by Camillo Golgi in the nerve cells of owl metallic impregnation technique

(C) Golgi apparatus in plants is called as dictyosome and secrets mucilage in root cap cells

(D) Golgi apparatus has no role in modification of Proinsulin

Q.196 Lysosomes are formed by budding off vesicles from golgi apparatus and contain

(A) Oxidising enzymes (B) 40 different acid hydrolases

(C) Respiratory enzymes (D) Basic hydrolases

Q.197 Which of the following is likely to show the absence of lysosomes?

(A) Cyanophyceae (B) Protozoa

(C) Anther tapetum (D) Mammalian leucocytes

Q.198 Lysosomes were first discovered by

(A) Rohdin (B) Pemer

(C) Christian de Duve (D) None of these

Q.199 Which of the following organelles show polymorphism?

(A) Golgi apparatus (B) Lysosome

(C) Mitochondria (D) Chloroplast

Q.200 Autolysis is associated with

(A) Ribosome (B) Kinetosome

(C) Lysosome (D) Golgi apparatus

Q.201 Which of the following organelle possess oxidases and are associated with oxidation reaction other than those of respiration?

(A) Sphaerosomes (B) Peroxisomes

(C) Lysosomes (D) Golgi

Q.202 Which of the following organelle takes part in photorespiration?

(A) Glyoxisome (B) Peroxisome (C) Dictyosome (D) ER

Q.203 Peroxisomes contain peroxide producing enzymes. These are found in

(A) Plant cells (B) Animal cells

(C) Both (A) and (B) (D) Bacteria and blue green algae

Q.204 Which of the following is peroxide destroying enzyme present in Peroxisome?

(A) Urate oxidase (B) Catalase

(C) Amino acid oxidase (D) Peroxidase

Q.205 Non-secretory proteins are synthesized by

(A) ER-bound ribosomes (B) Free ribosomes

(C) Polysomes (D) Endosomes

Q.206 Find out the incorrect statement w.r.t. Glyoxysomes

(A) It is reported from endosperm of germinating seeds

(B) Usually occurs in fat rich plant cells

(C) Associated with glyoxylate cycle

(D) It is formed from mitochondria

Q.207 The proper folding of proteins following synthesis is assisted by

(A) Polyribosomes (B) Specific proteins called chaperons

(C) Polysomes (D) Free ribosomes

Q.208 Protein synthesis in an animals cell occurs

(A) Only on the ribosomes present in the cytosol

(B) Only on ribosomes attached to the nuclear enveloped and ER

(C) On ribosomes present in the cytoplasm as well as in mitochondria

(D) On ribosomes present in the nucleolus as well as in cytoplasm

Q.209 Select the correct match

	Column I		Column II
a.	Centre of hydrolytic enzymes	(i)	Mitochondria
b.	Oxidative phosphorylation	(ii)	Elaioplast
c.	Glycolate oxidation	(iii)	Lysosome
d.	Oils and fats storage	(iv)	Peroxisome

(A) a(i), b(iii), c(iv), d(ii) (B) a(iv), b(i), c(iii), d(ii)

(C) a(ii), b(i), c(iv), d(ii) (D) a(iii), b(i), c(ii), d(iv)

Q.210 Mitochondria and chloroplast are semi-autonomous as they possess

(A) DNA (B) DNA + RNA

(C) DNA + RNA + ribosomes (D) Proteins

Q.211 Which of the following organelle is concerned with generation of ATP through electron transport and oxidative phosphorylation?

(A) Chloroplast (B) Mitochondria (C) Glyoxysome (D) Both (A) and (B)

Q.212 $F_0 - F_1$ particles are also called as

(A) Quantasomes (B) Glyoxysome (C) Palade particles (D) Oxysomes

Q.213 Organelle lacking DNA, but is capable of duplication is

(A) Ribosomes (B) Centriole (C) Chloroplast (D) Nucleus

Q.214 The presence of DNA in mitochondria and chloroplast supports the hypothesis that

(A) Glycolysis occurs in both mitochondria and chloroplast

(B) Mitochondria and chloroplast both originated as independent free living organisms

(C) ATP is produced in mitochondria as well as in chloroplast

(D) Mitochondria and chloroplast undergo meiosis and mitosis independent of nucleus

Q.215 Synthesis of ATP in mitochondria takes place

(A) In the matrix (B) In the intracristal space

(C) At the cristae (D) At the outer membrane

Q.216 Oxysomes are submicroscopic particles present on the

(A) Surface of the inner membrane of mitochondria

(B) Thylakoid membrane of chloroplast

(C) Outer membrane of mitochondrion

(D) Rough endoplasmic reticulum

Q.217 Find odd one out w.r.t. endomembrane system

(A) ER (B) Peroxisome (C) Golgi complex (D) Vacuole

Q.218 The mitochondria DNA differs from the nuclear DNA in

(A) Lacking association with histone (B) Being circular in nature

(C) Having higher C-G ratio (D) All of these

Q.219 Genes for cytoplasmic male sterility in plants are generally located in

(A) Mitochondrial genome (B) Chloroplast genome

(C) Nuclear genome (D) Cytosol

Q.220 Chlorophyll in chloroplasts is located in

(A) Grana (B) Pyrenoid

(C) Stroma (D) Both grana and stroma

Q.221 Which of the following organelle stores proteins?

(A) Amyloplasts (B) Aleuroplasts

(C) Plastids (D) Elaioplasts (oleosomes)

Q.222 Grana in chloroplast is formed by the pilling of

(A) Cristae (B) Thylakoids (C) Oxysomes (D) Dictyosomes

Q.223 The symbiont hypothesis suggests that there are similarities between prokaryotes, mitochondria and chloroplasts like

(A) Presence of circular DNA associated with histone and 70 S ribosomes

(B) Presence of circular DNA not associated with histone and 70 S ribosomes present

(C) 50 S ribosomes and DNA

(D) 30 S ribosomes and DNA

Q.224 Quantasomes are found in

(A) Mitochondria (B) Chloroplast (C) Nucleus (D) Lysosome

Q.225 Each quantasome contains

(A) 100 chlorophyll molecules (B) 200 chlorophyll molecules

(C) 300 chlorophyll molecules (D) 230 chlorophyll molecules

Q.226 Hammerling's experiment on Acetabularia proved the role of

(A) Chromosomes in heredity (B) Nucleus in heredity

(C) Nucleo-cytoplasmic ratio (D) Cytoplasm in controlling differentiation

Q.227 At certain places, the nuclear envelope is interrupted by presence of nuclear pores which are enclosed by circular structures called as

(A) Perinuclear (B) Annuli (C) Pore complex (D) Nucleolus

Q.228 The main site for ribosomal RNA synthesis is

(A) Nucleus (B) Nucleolus (C) Endoplasmic reticulum (D) Golgi apparatus

Q.229 Telomeres

(A) Initiate RNA synthesis (B) Seal ends of chromosomes

(C) Have guanine rich repeats (D) Both (B) and (C)

Q.230 The term nucleolus was coined by

(A) Browman (B) Fontana (C) Flemming (D) Leeuwenhoek

Q.231 Telomerase is

(A) Simple protein
(B) dsRNA
(C) Ribonucleoprotein
(D) Repetitive DNA

Q.232 Nucleolus is produced from

(A) Primary constriction
(B) Nuclear organizing region of certain chromosomes
(C) Nuclear envelope
(D) ER

Q.233 A cystolith is a deposit of

(A) Calcium citrate
(B) Calcium carbonate
(C) Silica
(D) Calcium oxalate

Q.234 The membrane-bound space found in the cytoplasm

(A) Is food vacuole in bacteria
(B) Is contractile vacuole in plants
(C) Is sap vacuole in cyanobacteria
(D) Can occupy 90 percent volume in plant cell

Q.235 Tolbert is associated with which one of the following cell structures?

(A) Peroxisomes
(B) Sphaerosomes
(C) Quantasomes
(D) Glyoxysomes

Q.236 A single mitochondria is found in

(A) Flight muscles of insects
(B) Human sperm
(C) Microsterias
(D) Chaos chaos

Q.237 The smallest cell structure is

(A) Peroxisome
(B) Sphaerosome
(C) Ribosome
(D) laysosome

Q.238 The complex formed of centriole and kinoplasm is called as

(A) Diplosome (B) Centrosphere

(C) Centrosome (D) Kinetosome

Q.239 The site for active ribosomal RNA synthesis is

(A) Primary constriction (B) Telomere

(C) Satellite (D) Nucleolus

Q.240 Adenosine triphosphate (ATP) powers the movement of cilia and flagella, adenosine triphosphate activity is present in

(A) Nexin protein (B) Dynein protein

(C) Massule (D) Both (A) and (B)

Q.241 The r-RNAs of 80 S ribosomes of larger sub-unit are

(A) 18 S (B) 23 S + 5 S (C) 18 S + 5.8 S + 5 S (D) 16 S

Q.242 A component of cytoskeleton is

(A) Microtubules (B) Bone (C) Chitin (D) Cartilage

Q.243 Kinetochore is

(A) Fibrous granular structure on the surface of centromere

(B) Surface of centromere

(C) Constriction near chromosome end

(D) End of chromosome

Q.244 Cell wall of algae is made of

(A) Cellulose (B) Galactans and mannans

(C) Minerals like $CaCO_3$ (D) All of these

Q.245 In plants, the tonoplast facilitates the transport of a number of ions and other materials

(A) Against concentration gradient into vacuole

(B) Along concentration gradient into vacuole

(C) Along concentration gradient into gas vacuole

(D) Against concentration gradient in contractile vacuole

Q.246 Select the correct combination of the statements regarding the characteristic of middle lamella

a. It holds the different neighboring cells together.

b. It is composed of Mg pectate only.

c. It gets dissolved during ripening of fruits.

Correct statements is/are

(A) a and c (B) b and c (C) Only a (D) a, b and c

Q.247 Triglyceride metabolism to convert fats into carbohydrate is helped by glyoxylate cycle. The organelle responsible for this is found in

(A) Rice seeds (B) Castor seeds

(C) Wheat seeds (D) More than one option is correct

Q.248 Cathepsin is an enzyme that helps to digest the tail of tadpole is secreted by the organelle.

(A) Called apparato reticolare

(B) Surrounded by half unit membrane and showing polarity of structure

(C) Having polymorphic nature

(D) Having P_{450} activity

Q.249 Each centriole has a cart wheel organisation having a whorl tubulin fibrils at periphery. These peripheral fibrils are composed of how many microtubules?

(A) 11 (B) 18 (C) 9 (D) 27

Q.250 Catalase and urate oxidase enzymes are associated to the organelle which is also involved in

(A) Gluconeogenesis (B) Photorespiration

(C) Glycolate oxidation (D) More than option is correct

Q.251 Find out all the proteins that make eukaryotic flagellum.

(A) Nexin, tubulin and flagellin

(B) Tubulin, nexin, dynein, and flagellin

(C) Actin, myosin, dynein and tubulin

(D) Dynein, tubulin and nexin

Q.252 How many organelles of an eukaryotic cell are considered to have an independent existence during early events of evolution?

(A) 1 (B) 2 (C) 3 (D) 4

Q.253 Identify the correct statements w.r.t. the given cell

i. Connected with lipid and steroidal hormone synthesis

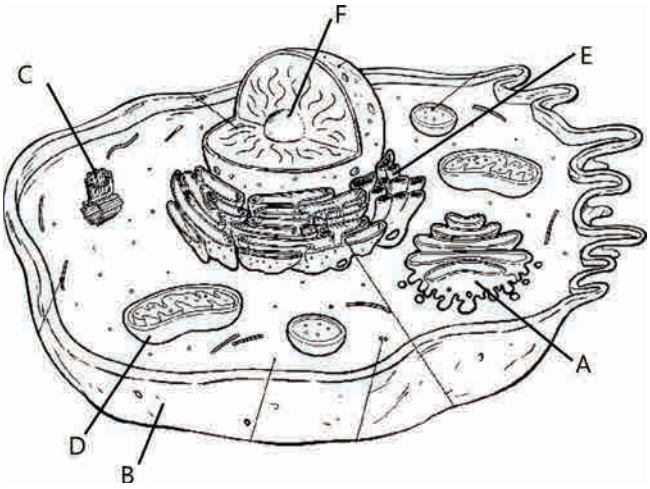
ii. Outer non-living rigid structure which gives shape to the cell and protects from mechanical damage and infection.

iii. Both lie perpendicular to each other and each has an organisation like the cart wheet.

iv. Responsible for trapping light for the synthesis of sugar.

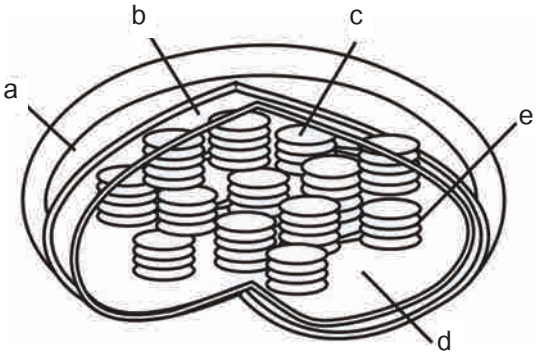
v. Present in cells actively involved in protein synthesis and secretion.

vi. Spherical structures, rich in hydrolytic enzymes.



(A) i, iv and v (B) ii, iii and iv (C) i, iii and vi (D) i, ii, iii and vi

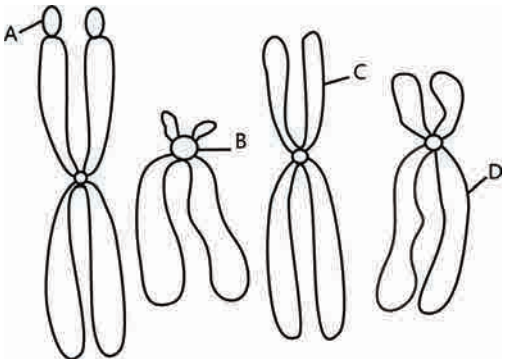
Q.254 Consider the following five statements (A to E) w.r.t. chloroplast shown below. Select the correct option stating which ones are true (T) and which ones are False (F).



1. It is impermeable and lack porins.
2. It is selectively permeable, having carrier proteins for transport.
3. Staked thylkaoids one over other which is the site of production of assimilatory power.
4. Present between two grana and contains enzymes of dark reaction
5. It contains enzymes for the synthesis of sugar and proteins.

	a	b	c	d	e
(A)	F	T	T	T	T
(B)	F	T	T	F	T
(C)	T	F	T	T	T
(D)	T	F	F	T	T

Q.255 Find out the correct option on the basis of following diagrams



(A) A- Satellite, B-Secondary constriction C-Short arm, D-Long arm

(B) A-Satellite, B-centromere C-Short arm, D-Long arm

(C) A-Secondary constriction, B-Satellite C-Long arm, D-Short arm

(D) A-NOR, B-Secondary constriction C-Short arm, D-Long arm

Previous Years' Questions

Q.1 In fluid mosaic model of plasma membrane ***[AIPMT 2002]***

(A) Upper layer is non-polar and hydrophilic

(B) Polar layer is hydrophobic

(C) Phospholipids form a bimolecular layer in middle part

(D) Proteins form a middle layer

Q.2 Which one of the following is not a constituent of cell membrane ***[AIPMT 2007]***

(A) Cholesterol (B) Glycolipids

(C) Proline (D) Phospholipids

Q.3 Keeping in view the ''Fluid mosaic model'' for the structure of cell membrane, which one of the following statements is correct with respect to the movement of lipids and proteins from one lipid monolayer to the other (described as flipflop movement ***[AIPMT 2008]***

(A) While proteins can flip-flop, lipids can not

(B) Neither lipids, nor proteins can flip-flop

(C) Both lipids and proteins can flip-flop

(D) While lipids can rarely flip-flop proteins can not

Q.4 Plasmodesmata are ***[AIPMT 2009]***

(A) Connections between adjacent cells

(B) Lignefied cemented layers between cells

(C) Locomotary structures

(D) Membranes connecting the nucleus with plasmalemma.

Q.5 Middle lamella is composed mainly of ***[AIPMT 2009]***

(A) Phosphoglycerides (B) Hemicellulose

(C) Muramic acid (D) Calcium pectate

Q.6 The plasma membrane consists mainly of ***[AIPMT Pre. 2010]***

(A) proteins embedded in a carbohydrate bilayer

(B) Phospholipids embedded in a protein bilayer

(C) Proteins embedded in a phospholipid bilayer

(D) proteins embedded in a polymer of glucose molecules

Q.7 Which one of the following structures between two adjacent cell is an effective transport parhway ***[AIPMT Pre. 2010]***

(A) Plasmalemma (B) Plasmodesmata

(C) Plastoquinones (D) Endoplasmeic refleculum

Q.8 In eubacteria, a cellular component that resembles eukaryotic cell is ***[AIPMT Pre. 2011]***

(A) Plasma membrane (B) Nucleus

(C) Ribosomes (D) Cell wall

Q.9 Select the correct statement from the following regarding cell membrane ***[AIPMT Pre. 2012]***

(A) Lipids are arranged in a bilayer with polar heads towards the inner part

(B) Fluid mosaic model of cell membrane was proposed by Singer and Nicolson

(C) Na+ and K+ ions move across cell membrane by passive transport

(D) Proteins make up 60 to 70% of the cell membrane

Q.10 Which one of the following does not differ in E.coli and Chlamydononas? ***[AIPMT Pre. 2012]***

(A) Cell wall (B) Cell membrane

(C) Ribosomes (D) Chromosomal organization

Q.11 Which of the following is the site of lipid synthesis ***[RPMT 2002]***

(A) Rough ER (B) Smooth ER (C) Golgi bodies (D) Ribosome

Q.12 Which of the following statements regarding mitochondrial membrane is not correct? ***[RPMT 2006]***

(A) The outer membrane is permeable to all kinds of molecules

(B) The enzymes of the electron transfer chain are embedded in the outer membrane

(C) The inner membrane is highly convoluted forming a series of infoldings

(D) The outer membrane resembles a sieve

Q.13 The main arena of various types of activities of a cell is ***[RPMT 2010]***

(A) Nucleus (B) Plasma membrane

(C) Mitochondrian (D) Cytoplasm

Q.14 Important site for formation fo glycoproteins and glycolipids is ***[AIPMT Pre. 2011]***

(A) Vacuole (B) Golgi apparatus

(C) Plastid (D) Lysosome

Q.15 Which one of the following is not considered as a part of the endomembrane system? ***[AIPMT Mains 2011]***

(A) Lysosome (B) Golgi complex

(C) Peroxisome (D) Vacuole

Q.16 A major site for synthesis of lipids is ***[NEET 2013]***

(A) Symplast (B) Nucleoplasm

(C) RER (D) SER

Q.17 Golgibody is concerned with ***[RPMT 2004]***

(A) Respiration (B) Secretion

(C) Excretion (D) Degradation

Q.18 In which one of the following would you except to find glyxysomes ? ***[AIIMS 2005]***

(A) Endosperm of wheat (B) Endosperm of castor

(C) Palisade cells in leaf (D) Root hairs

Q.19 Which of the following statements regarding cilia is not correct ***[AIPMT 2006]***

(A) The organized beating of cilia is controlled by fluxes of Ca^{2+} across the membrane

(B) Cilia are hair-like cellular appendages

(C) Microtubules of cilia are composed of tubulin

(D) Cilia contain an outer ring of nine doublet microtubules surrounding two single microtubules

Q.20 Select the wrong statement from the following ***[AIPMT 2007]***

(A) Both chloroplasts and mitochondria have an inner and outer membrane

(B) Both chloroplasts and mitochondria have an internal compartment, the thylakoid space bounded by the thylakoid membrane

(C) Both chloroplasts and mitochondria contain DNA.

(D) The chloroplasts are generally much larger than mitochondria

Q.21 The two sub-units of ribosome remain united at a critical ion level of ***[AIPMT 2008]***

(A) Magnesium (B) Calcium (C) Copper (D) Manganese

Q.22 Polysome is formed by ***[AIPMT 2008]***

(A) A ribosome with several subunits

(B) Ribosomes attached to each other in a linear arrangement

(C) Several ribosomes attached to a single mRNA

(D) Many ribosomes attached to a strand of endoplasmic reticulum

Q.23 Vacuole in a plant cell ***[AIPMT 2008]***

(A) Lacks membrane and contain air

(B) Lacks membrane and contains water and excretory substances

(C) Is membrane-bound and contains storage proteins and lipids

(D) Is membrane-bound and contains water and excretory substances

Q.24 Cytoskeleton is made up of ***[AIPMT 2009]***

(A) Proteinaceous filaments

(B) Calcium carbonate granules

(C) Callose deposits

(D) Cellulosic microfibrils

Q.25 An elaborate network of filamentous proteinaceous structures present in the cytoplasm which helps in the maintenance of cell shape is called ***[AIPMT Mains 2010]***

(A) Endosplasmic Reticulum (B) Plasmalemma

(C) Cytoskeleton (D) Thylakoid

Q.26 Peptide synthesis inside a cell takes place in ***[AIPMT Pre. 2011]***

(A) Chloroplast (B) Mitochondria (C) Chromoplast (D) Ribosomes

Q.27 The correct sequence of cell organelles during photorespirations is ***[AIPMT Pre 2012]***

(A) Chloroplast-mitochondria-peroxisome

(B) Chloroplast-vacuole-peroxisome

(C) Chloroplast-Golgibodies-mitochondria

(D) Chloroplast-Rough endoplasmic reticulum-Dictyosomes

Q.28 Which one of the following structures is in organelle within an organelle? ***[AIPMT Mains 2012]***

(A) ER (B) Mesosome (C) Ribosome (D) Peroxisome

Q.29 Which one of the following cellular parts is correctly described? ***[AIPMT Mains 2012]***

(A) Ribosomes: those on chloroplasts are larger (80s) while those in the cytoplasm are smaller (70s)

(B) Lysosomes: optimally active at a pH of about 8.5

(C) Thylakoids: flattened membranous sacs forming the grana of chloroplasts

(D) Centrioles: sites for active RNA synthesis

Q.30 Which of the following occurs more than one and less than five in a chromosome ***[CPMT-2002]***

(A) Chromatid (B) Nuclesome (C) Centromere (D) Telomere

Q.31 The cells without nuclei are present in **[RPMT-2002]**

(A) Vascular hair (B) Root hair (C) Companion cell (D) Members of sieve tube

Q.32 Which protein regulate the nucleocytoplasmic traffic

(A) Desmin (B) Vimentin (C) Nucleoplasmin (D) Synemin

Q.33 If you are provided with root-tips of onion in your class and are asked to count the chromosomes which of the following stages can you most conveniently look into ***[AIPMT-2004]***

(A) Telophase (B) Anaphase (C) Prophase (D) Metaphase

Q.34 Plant with minimum number of chromosomes is ***[RPMT-2004]***

(A) Haplopoppus gracilis (B) Solix tetrasperma

(C) Poa (D) Cynodon

Q.35 Protein synthesis in an animal cell occurs ***[AIPMT-2005]***

(A) On ribosomes present in cytoplasm as well as in mitochondria

(B) On ribosomes present in the nucleolus as well as in cytoplasm

(C) Ony on ribosomes attached to the nuclear envelope ad endoplasmic reticulum

(D) Only on the ribosomes present in cytosol

Q.36 The length of DNA molecule greatly exceeds the dimensions of the nucleus in eukaryotic cells. How is the DNA accommodated ? ***[AIPMT-2007]***

(A) Deletion of non-esential genes

(B) Supper-coiling in nucleosomes.

(C) DNase digestion

(D) Through elimination of reptetitive DNA

Q.37 Nuclear membrane is absent in ***[AIPMT Pre-2012]***

(A) Volvox (B) Nostoc (C) Penicillium (D) Agaricus

Q.38 Ribosomal RNA is actively synthesised in ***[AIPMT Pre-2012]***

(A) Nucleoplasm (B) Ribosomes (C) Lysosomes (D) Nucleolus

Q.39 Which of the following statements regarding mitochondria' membrane is not correct? ***[CBSE 2006]***

(A) The inner membrane is highly convoluted forming a series of infoldings

(B) The outer membrane resembles a sieve

(C) The outer membrane is permeable to all kinds of molecules

(D) The enzymes of the electron transfer chain are embedded in the outer membrane.

Q.40 Which of the following organelles is common between plants and animal? ***[Orissa 2007]***

(A) Chloroplast (B) Centriole (C) Cell wall (D) Mitochondria

Q.41 Which one of the following is not a part of cell membrane? ***[CBSE 2007]***

(A) Proline (B) Phospholipids (C) Cholesterol (D) Glycolipids

Q.42 Stroma in the chloroplasts of higher plant contains ***[CBSE Prelims 2009]***

(A) Ribosomes (B) Chlorophyll

(C) Light-independent reaction enzymes (D) Light-dependent reaction enzymes

Q.43 There is no DNA in ***[CBSE Prelims 2009]***

(A) A mature spermatozoan (B) Hair root

(C) An enucleated ovum (D) Mature RBCs

Q.44 Which one of the following has its own DNA? ***[CBSE Prelims 2010]***

(A) Peroxisome (B) Mitochondria (C) Dictyosome (D) Lysosome

Q.45 The main arena of various types of activities of a cell is ***[CBSE Prelims 2010]***

(A) Nucleus (B) Plasma membrane

(C) Mitochondrian (D) Cytoplasm

Q.46 Recent researches suggest that peroxi-somes have origin. ***[Chandigarh CET 2010]***

(A) Cyanobacterial (B) Fusobacterial (C) Actinobacterial (D) Proteobacterial

Q.47 Who first saw and described-a live cell? ***[HP PMT 2010]***

(A) Anton von Leeuwenhoek (B) Matthias Schleiden

(C) Theodore Schwan (D) Rudolf Virchow

Q.48 In animal cells, lipid-like steroidal hormones are synthesized in ***[HP PMT 2010]***

(A) Rough Endoplasmic Reticulum (RER) (B) Smooth Endoplasmic Reticulum (SER)

(C) Golgi apparatus (D) Lysosomes

Q.49 New cells generate from ***[HP PMT 2010]***

(A) Bacterial fermentation (B) Regeneration of old cells

(C) Pre-existing cells (D) Abiotic materials

Q.50 Which of the following is not a true organelle? **[AMU Medical 2011]**

(A) Lysosome (B) Ribosome (C) Chloroplast (D) Mitochondrion

Q.51 Plant cell differs from animal cell by ***Chandigarh CET 2012]***

(A) Presence of vacuoles (B) Presence of cell wall and chloroplast

(C) Absence of cell wall (D) Absence of chloroplast

Q.52 Chromosomes are concerned with ***[Chandigarh CET 2012]***

(A) Respiration (B) Growth

(C) Transmission of heredity characters (D) Assimilation

Q.53 Which of the following structures is not bounded by cell membrane? ***[Chandigarh CET 2012]***

(A) Spherosomes (B) Mitochondria (C) Ribosomes (D) Lysosomes

Q.54 The colour of flower petals is due to ***[Chandigarh CET 2012]***

(A) Xanthophyll (B) Carotenes (C) Anthocyanin (D) Phycoerythrin

Q.55 Site of protein synthesis is ***[Chandigarh CET 2012]***

(A) Ribosomes (B) Mitochondria (C) Nucleus (D) DNA

Q.56 Which of the following structures is not found in a prokaryotic cell? ***[HP PMT 2012]***

(A) Plasma membrane (B) Nuclear membrane

(C) Cell wall (D) Ribosomes

Q.57 Smooth endoplasmic reticulum (ER) is mostly concerned with ***[HP PMT 2012]***

(A) Protein synthesis (B) Carbohydrate synthesis

(C) Peptide bond formation (D) Lipid synthesis

Q.58 The membrane around the vacuoles of the plant cell is known as ***[HP PMT 2012]***

(A) Cell envelope (B) Plasma membrane

(C) Nuclear membrane (D) Tonoplast

Q.59 The prokaryotic ribosomes are ***[HP PMT 2012]***

(A) 50S (B) 60S (C) 70S (D) 80S

ANSWER KEY

Objective Questions

Q.1 C	**Q.2** B	**Q.3** C	**Q.4** A	**Q.5** A	**Q.6** B
Q.7 D	**Q.8** B	**Q.9** B	**Q.10** D	**Q.11** A	**Q.12** A
Q.13 C	**Q.14** A	**Q.15** B	**Q.16** B	**Q.17** D	**Q.18** C
Q.19 B	**Q.20** D	**Q.21** A	**Q.22** C	**Q.23** A	**Q.24** B
Q.25 D	**Q.26** D	**Q.27** C	**Q.28** A	**Q.29** A	**Q.30** D
Q.31 A	**Q.32** D	**Q.33** A	**Q.34** A	**Q.35** A	**Q.36** C
Q.37 C	**Q.38** D	**Q.39** A	**Q.40** B	**Q.41** C	**Q.42** A
Q.43 D	**Q.44** C	**Q.45** C	**Q.46** B	**Q.47** A	**Q.48** C
Q.49 D	**Q.50** D	**Q.51** B	**Q.52** B	**Q.53** A	**Q.54** C
Q.55 D	**Q.56** A	**Q.57** A	**Q.58** A	**Q.59** D	**Q.60** D
Q.61 B	**Q.62** B	**Q.63** D	**Q.64** C	**Q.65** C	**Q.66** D
Q.67 B	**Q.68** C	**Q.69** C	**Q.70** C	**Q.71** D	**Q.72** A
Q.73 A	**Q.74** B	**Q.75** D	**Q.76** D	**Q.77** A	**Q.78** B
Q.79 D	**Q.80** C	**Q.81** D	**Q.82** A	**Q.83** D	**Q.84** A
Q.85 C	**Q.86** C	**Q.87** B	**Q.88** B	**Q.89** A	**Q.90** A
Q.91 C	**Q.92** A	**Q.93** D	**Q.94** B	**Q.95** D	**Q.96** C
Q.97 B	**Q.98** C	**Q.99** B	**Q.100** B	**Q.101** C	**Q.102** A
Q.103 B	**Q.104** B	**Q.105** C	**Q.106** A	**Q.107** B	**Q.108** C
Q.109 A	**Q.110** D	**Q.111** D	**Q.112** D	**Q.113** C	**Q.114** B
Q.115 A	**Q.116** A	**Q.117** D	**Q.118** B	**Q.119** D	**Q.120** C
Q.121 C	**Q.122** B	**Q.123** A	**Q.124** B	**Q.125** B	**Q.126** C
Q.127 D	**Q.128** C	**Q.129** D	**Q.130** B	**Q.131** B	**Q.132** B

Q.133 A	**Q.134** B	**Q.135** B	**Q.136** B	**Q.137** D	**Q.138** C
Q.139 C	**Q.140** A	**Q.141** D	**Q.142** B	**Q.143** D	**Q.144** D
Q.145 D	**Q.146** B	**Q.147** A	**Q.148** C	**Q.149** A	**Q.150** C
Q.151 A	**Q.152** C	**Q.153** A	**Q.154** D	**Q.155** D	**Q.156** A
Q.157 B	**Q.158** D	**Q.159** B	**Q.160** D	**Q.161** D	**Q.162** D
Q.163 B	**Q.164** D	**Q.165** B	**Q.166** D	**Q.167** D	**Q.168** C
Q.169 C	**Q.170** C	**Q.171** B	**Q.172** B	**Q.173** D	**Q.174** A
Q.175 A	**Q.176** C	**Q.177** B	**Q.178** D	**Q.179** D	**Q.180** A
Q.181 B	**Q.182** C	**Q.183** C	**Q.184** C	**Q.185** B	**Q.186** B
Q.187 C	**Q.188** D	**Q.189** A	**Q.190** B	**Q.191** A	**Q.192** B
Q.193 C	**Q.194** D	**Q.195** D	**Q.196** B	**Q.197** A	**Q.198** C
Q.199 B	**Q.200** C	**Q.201** B	**Q.202** B	**Q.203** C	**Q.204** B
Q.205 B	**Q.206** D	**Q.207** B	**Q.208** C	**Q.209** C	**Q.210** C
Q.211 B	**Q.212** D	**Q.213** B	**Q.214** B	**Q.215** C	**Q.216** A
Q.217 B	**Q.218** D	**Q.219** A	**Q.220** A	**Q.221** B	**Q.222** B
Q.223 B	**Q.224** B	**Q.225** D	**Q.226** B	**Q.227** B	**Q.228** B
Q.229 D	**Q.230** A	**Q.231** C	**Q.232** B	**Q.233** B	**Q.234** D
Q.235 A	**Q.236** C	**Q.237** C	**Q.238** C	**Q.239** D	**Q.240** B
Q.241 C	**Q.242** A	**Q.243** A	**Q.244** D	**Q.245** A	**Q.246** A
Q.247 B	**Q.248** C	**Q.249** D	**Q.250** D	**Q.251** D	**Q.252** B
Q.253 C	**Q.254** B	**Q.255** B			

Previous Years' Questions

Q.1 C	**Q.2** C	**Q.3** D	**Q.4** A	**Q.5** D	**Q.6** C
Q.7 B	**Q.8** A	**Q.9** B	**Q.10** B	**Q.11** B	**Q.12** B
Q.13 D	**Q.14** D	**Q.15** B	**Q.16** D	**Q.17** B	**Q.18** B
Q.19 A	**Q.20** B	**Q.21** A	**Q.22** C	**Q.23** D	**Q.24** A
Q.25 C	**Q.26** D	**Q.27** A	**Q.28** C	**Q.29** C	**Q.30** D
Q.31 D	**Q.32** C	**Q.33** D	**Q.34** A	**Q.35** A	**Q.36** B
Q.37 B	**Q.38** D	**Q.39** D	**Q.40** D	**Q.41** A	**Q.42** C
Q.43 D	**Q.44** B	**Q.45** D	**Q.46** C	**Q.47** A	**Q.48** B
Q.49 C	**Q.50** B	**Q.51** B	**Q.52** C	**Q.53** C	**Q.54** C
Q.55 A	**Q.56** B	**Q.57** D	**Q.58** D	**Q.59** C	