Cell The Unit of Life Class 11 Notes Biology Chapter 8

Topic 1 Cell :An Overview

An organism consist of one or more cells, accordingly there are two types of organisms, i.e., unicellular (composed of single cell) and multi cellular (composed of many cells).

Cell Theory

The cell theory was formulated by two German Scientists, Matthias Schneider and Theodore Schwinn independently. Schneider (1838) examined a large variety of plant tissues and observed that all plants are composed of different kinds of cells. At about the same time, Schwinn (1839), closely studied different types of animal cells and found that the animal cell had a very thin outer layer known as plasma membrane.

He also concluded, from his studies based on plant tissues that animal cells differ from plant cells in lacking cell wall.

Objections to Cell Theory

Cell theory failed to explain how and from where the new cells were formed. All these observations lead to a major expansion of cell theory that was expressed by Rudolf Virchow in 1855 modified the hypothesis of Schneider and Schwinn and explained in his statement that cells divide and new cells are formed from pre-existing cells, i.e., Omnis cellula-e-cellula.

Thus, the cell theory states that

Outer membrane, the boundary of the cell, which provides protection to the cell and controls the exchange of ions, molecules and other components in and out of the cell.

The outer membrane of a cell contains cell wall (only in plant cells) and plasma membrane.

Details of the above mentioned cell components and organelles is given later in the chapter in the second topic.

Microscopes allow us to study the structure of cells, two types are l commonly used, i.e., light microscopes and electron microscopes, Cells are divided into compartments that help segregate functions, leading to more efficient performance; human cells consist of two l major compartments, i.e., the cytoplasmic and nuclear.

Size of a Cell

The cells exhibit an endless variation in size, life span and cellular activities, e.g., Mycoplasma (smallest cell) or PPLOs (Pleuro-Pneumonia Like Organisms) is only 0.3 Jim in length and bacteria are approx. 3-5 Jim in size.

An ostrich egg, which is known to be the largest isolated single cell measures about 170 X 135 mm. Human Red Blood Cells (RBCs) are about 7 Jim in diameter and the nerve cell of human being is the longest cell having length of 90-100 cm.

Shape of a Cell

The cells also vary in their shapes. They may be polygonal, disc-like amoeboid, thread-like, cuboid or irregular. The cell shape is always related and vary with the function they perform.

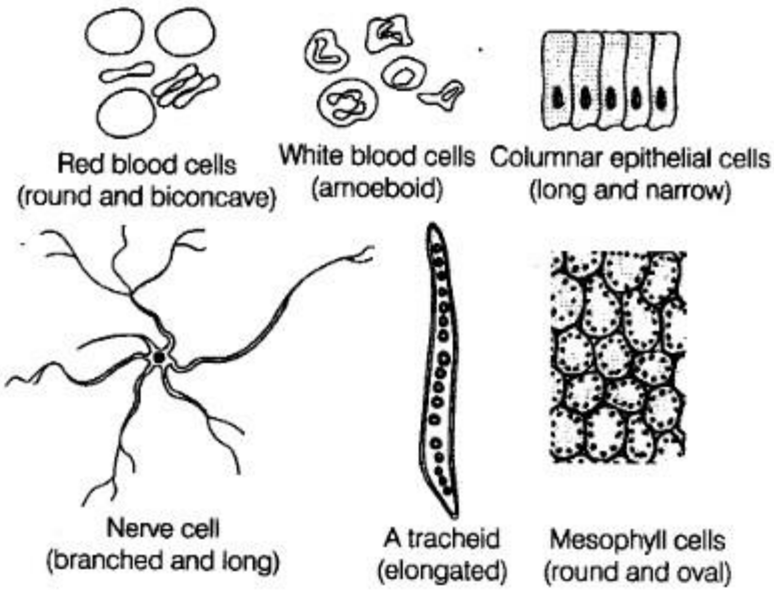


Fig. 8.1 Diagram showing different shapes of the cells

(i) All living organisms are composed of cells and their products.
(ii) All cells arise from pre-existing cells.
(iii) Cells show similarity in chemical composition and metabolic activities.
(iv) Cells are the structural and functional unit of living organism.

Structural Outline of a Cell

The onion cell, which is a typical plant cell has a distinct cell wall as its outer boundary and just within it is the cell membrane. The human and animal cell has an outer membrane, inside which is a dense membrane bound structure called nucleus.
Each cell consists of
(i) Nucleus, the central part of the cell, which is spherical in shape. Its number can be one or more per cell. It is denser than the surrounding cytoplasm.
The nucleus is composed of chromosomes (contains the genetic material, i.e., DNA), nuclear membrane and centrioles (non-membrane bound organelle present in only animal cells, which helps in cell division).
(ii) Cytoplasm, a semi-fluid matrix that occupies the volume of the cell. It is mainly composed of water with free floating molecules.
Inside the cytoplasm all cellular activities like gaseous exchange, elimination of wastes, hereditary mechanisms, etc occur.
Eukaryotic cells also contain other cell membrane bound distinct structures called cell organelles, like mitochondria, vacuoles, Endoplasmic Reticulum (ER), Golgi complex, etc.
The prokaryotic cells lack all these membrane bound organelles. It is to be noted that as ribosomes are not bounded by membrane and are found in all cells.
Ribosomes are also found in chloroplasts (in plants) and mitochondria and on rough ER other than cytoplasm.

Types of Cell

On the basis of the organisation, complexity and variety, all cells can be grouped into two types,i. e., prokaryotic cells and eukaryotic cells.

Prokaryotic Cell

Cell which do not have a nuclear membrane and other membrane bound organelles, is called prokaryotic cell.

Occurrence

Prokaryotic cells are placed in kingdom-Monera. These cells are represented by bacteria, cyanobacteria (blue-green algae), mycoplasma or PPLO. Bacteria are the simplest and common most type of organism amongst prokaryotes. They are generally smaller and multiply more rapidly than the eukaryotic cell.
The bacteria are found in almost every place like deep in the soil, human intestine, deep in seawater, etc.

Size

Bacteria tends to vary greatly in size. It normally ranges from 0.3-1.5p.m with some exceptions.

Shape

The four basic shapes of bacteria are bacillus (rod-like), coccus (spherical), vibrio (comma-shaped) and spirillum (spiral). All prokaryotic cells are similar in their organisation although they exhibit a wide variety of shapes and functions.

Components of a Prokaryotic (Bacterial) Cell

A bacterial cell is composed of various components as genetic material, cell envelope, cytoplasm, nucleoid, inclusion bodies, ribosomes, flagella, pili, fimbriae, etc.

Genetic Material

Nucleoid represents the genetic material incase of prokaryotes that is naked, not enveloped by a nuclear membrane. Many bacteria contain a small circular DNA known as plasmid other than the chromosomal or genomic DNA.
These plasmid confer certain unique characters to the bacteria like antibiotic resistance, sex factor, etc.

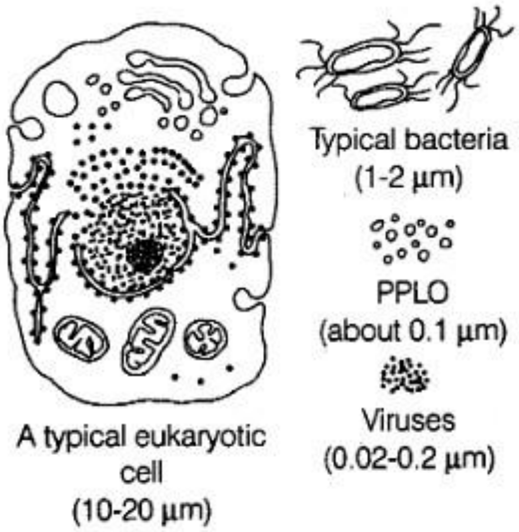


Fig. 8.2 Diagram showing comparison of eukaryotic cell with other organisms

Cell Envelope and Its Modifications

Cell envelope is the outermost covering of protoplasm of the bacterial cell. It is known to protect the cell from mechanical shocks and injuries.
It is composed of following three layers, which perform specialisedfunction

i- Glycocalyx (Mucilage Sheath)

It is the outermost layer, made up of macromolecules that gives sticky character to the cell. Glycocalyx differs in composition and thickness among different bacteria. It could be in the form of loose mucilaginous sheath called slime layer or thick and tough covering called capsule.
Function help in resisting phagocytosis.

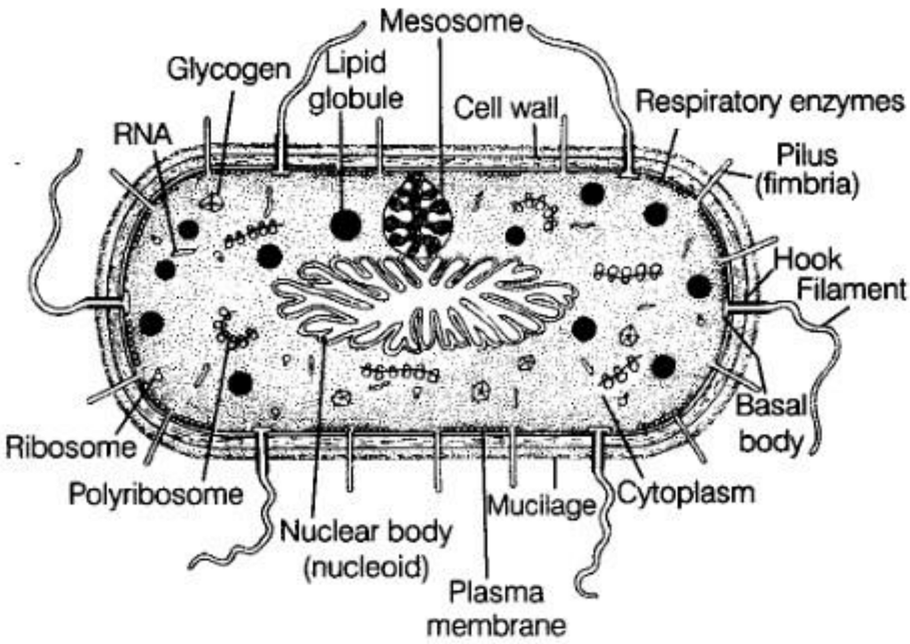


Fig. 8.3 Diagrammatic representation of a typical bactèrial cell

Cell Wall

It is present just below the glycocalyx made up of peptidoglycan or murein in all eubacteria and cyanobacteria. It is a rigid and solid covering that gives shape and strong structural support to the cell.

Cell wall performs the following functions

(a) It helps in preventing cell from bursting or collapsing.
(b) It allows the material to pass in and out of the cell.
(c) It wards off the attack of pathogens like viruses, bacteria, fungi, protozoans.
(d) Provides mechanical support to the cell against gravity.

Gram Positive and Gram Negative Bacteria

According to Christian Gram (1884) various types of reactions are shown by the cell walls of different bacteria. Thus, on the basis of the differences in the cell wall and the |
response to the staining procedure developed by Gram, bacteria are classified into following two types

(i) Gram positive (+ve) bacteria are those that take up the Gram stain and retain blue or purple colour, e.g., Bacillus subtilis, Clostridium, etc.
(ii) Gram negative (-ve) bacteria are those that do not take up Gram stain and loose the blue or purple icolour, e.g., Escherichia coli, (E.coli), Acetobacter, etc.

Plasma Membrane

It is the innermost layer of the cell envelope. It is semi-permeable in nature and is responsible for the interaction of the cell with the outside environment.

It performs a number of functions as follows

(a) It helps in the regulation of the exchange of specific materials between the cytoplasm and extracellular medium.
(b) Selectively permits particular molecules to pass and prevents others.
(c) Prevents loss of components from the cells through leakage.

Note:

* The plasma membrane is vital to cellular homeostasis and therefore, the health and welfare of all living organisms.

* Molecules move through membranes either passively, flowing down concentration gradients or actively, being pumped in or out of cells.
* Membrane in prokaryotes is . structurally similar to eukaryotes.

Membranous Structures

Prokaryotic cells lack the complex membrane bound organelles (such as chloroplast, mitochondria, etc). However, some other special membranous structures are found in them (i.e., mesosomes and chromatophores).

Mesosomes

These are formed by the extensions of the plasma membrane into the cell in the form of vesicles, tubules and lamellae.

Mesosomes are equal to mitochondria in eukaryotes, as these structures participate in aerobic cellular respiration in prokaryotes.

Mesosomes perform the following junctions in bacterium

(a) Helps in respiration, cellular secretion, etc.
(b) Helps in increasing the enzymatic content and surface area of the plasma membrane.
(c) Helps in the formation of a cell wall.
(d) Helps in the replication of DNA and distribution of genetic material to daughter cells during fission.

Chromatophores

They are another membranous structures present in some prokaryotes like cyanobacteria, etc.

They are internal membrane systems of photosynthetic forms, which possess photosynthetic pigments. These pigments are light reflecting.

Flagella

Bacteria can be motile or non-motile. Thus, motile bacteria possess one or more thread-like appendages extending from their cell wall called flagella (sing, flagellum). Bacteria are also classified according to the number and arrangement of flagellum in them.

Each flagellum is about 1-7 nm long covered by a protein coat.

The bacterial flagellum is differentiated into the following three parts

(i) Filament, the longest portion, extending from the cell surface to the-outside. It is made up of protein called flagellin.
(ii) Hook, a curved and tubular structure made up of protein subunits.

Pili Fimbriae

They occur only in Gram negative bacteria. They occur in both Gram positive and Gram negative bacteria.

They are longer and broder. They are shorter and narrower.

They are responsible for sex duction (conjugation) in bacteria. They are specialised for attachment of bacteria to its host (e.g., Bacteria, Salmonella typhimurium, Neisseria gonorrhoea, etc).

They are tubular structures. They are bristle-like solid structures.

(iii) Basal body, the most complex part of flagellum.

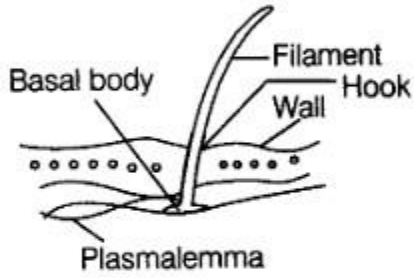


Fig. 8.4 Bacterial flagellum showing different parts

They help in locomotion i.e., movement from one place to another.

Pili and Fimbriae

These are also surface structures, but does not play any role in locomotion of bacteria. The pili are the elongated, tubular structues made of a special protein called pilin and fimbriae are the small bristle-like fibres coming out of the cell.

The pili helps in forming conjugation tube during transfer of genetic material between donor and recipient cell. While, the fimbaiae help the bacteria to attach to solid surfaces.

Differences between Pili and Fimbriae

Pili	Fimbriae
They occur only in Gram negative bacteria.	They occur in both Gram positive and Gram negative bacteria.
They are longer and broder.	They are shorter and narrower.
They are responsible for sex duction (conjugation) in bacteria.	They are specialised for attachment of bacteria to its host (*e.g.*, Bacteria, *Salmonella typhimurium*, *Neisseria gonorrhoea*, etc).
They are tubular structures.	They are bristle-like solid structures.

Ribosomes and Inclusion Bodies

Cytoplasm in prokaryotes appear granular, due to the presence of following structures:

i. Ribosomes

Like eukaryotes, ribosomes are also found in prokaryotes and serves a common function, i.e., acts as a site of protein synthesis. Ribosomes are small, but are complex both in structure and chemical composition. They are about 15-20 nm in size.

In prokaryotes, ribosomes are found in association with the plasma membrane of the cell (as it lack endoplasmic reticulum) in the cytoplasmic matrix. The prokaryotic ribosomes are of 70S type.

It has following two sub-units

(a) Smaller subunit (30S)

(b) Larger subunit (50S)

Ribosomes generally occur in helical groups called polysome or polyribosomes. In each polysome 4-8 ribosomes are attached to a single strand of wRNA. The ribosomes of a polysome helps in the translation (mechanisms to synthesise several copies of the same protein) of wzRNA into protein.

ii. Inclusion Bodies

They are non-living structures present in the cytoplasm and not bounded by any membrane system. They may either lie free in the cytoplasm (e.g., Cyanophycean granules, glycogen granules) or may be covered by 2-4 nm thick, non-protein membrane (e.g., Gas vacuoles, sulphur granules, etc).

Note:

* Gas vacuoles are gas storing vacuoles that do not have any covering of their own. They are found in cyanobacteria (blue-green algae), purple and green photosynthetic bacteria.
* These are named so, because they are permeable to atmospheric gases but not to water.

Topic 2 Eukaryotic Cell

A cell which has a well organised nucleus with a nuclear envelope and several membrane bound organelles is called eukaryotic cell.

Internal organisation of eukaryotic cells is more advanced and elaborate, than the prokaryotic cells. All eukaryotic cells are not identical. Except monerans, eukaryotic organisation is seen in all the protists, plants, fungi and animals. Eukaryotic cell is larger than the prokaryotic cell (i.e., around 10-100 cm in size).

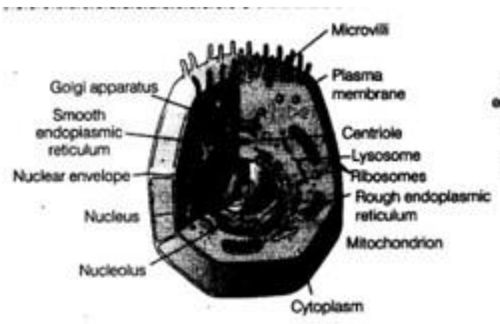
Generalised Structure

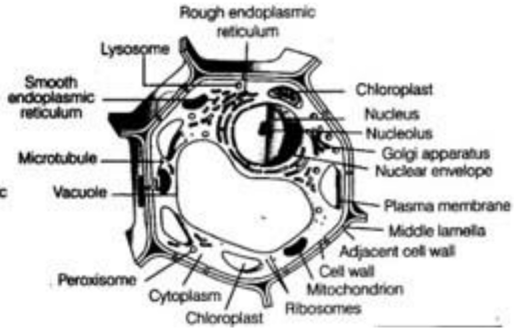
An extensive compartmentalisation of cytoplasm is seen through the presence of membrane bound organelles. Eukaryotic cells also possess a variety of locomotory and cytoskeletal structures.

All eukaryotic cell are not-identical, instead they differ from each other on the basis of structure and function. Cell wall is a special membrane, being present in plants, fungi and some protists. Plants cells also contains a large vacuole and plastids, which are absent in animal cells, while animal cells possess centrioles, which are absent in plant cells.

Differences between Plant and Animal Cell

Characters	Animal Cells	Plant Cells
Cell wall	Absent	Present (formed of cellulose)
Shape	Round (irregular shape)	Rectangular (fixed shape)
Centrioles	Present in all animal cells.	Only present in lower plant forms.
Vacuole	One or more small vacuoles (much smaller than plant cells).	One, large central vacuole taking up 90% of cell volume.
Cytoplasm	Present	Present
Ribosomes	Present	Present
Plastids	Absent	Present
Plasma membrane	Only cell membrane	Cell wall and a cell membrane.
Golgi apparatus	Present	Present
Mitochondria	Present	Present
Endoplasmic reticulum (smooth and rough)	Present	Present
Chloroplast	Animal cells don't have chloroplasts because they don't have the ability to prepare their food.	Plant cells have chloroplasts because they make their own food (autotrophs).
Flagella	May be found in some cells	May be found in some cells.
Microtubules	Present	Present
Microfilaments	Present	present
Cilia	Present	It is very rare
Lysosomes	Lysosomes occur in cytoplasm.	Lysosomes usually not evident.
Nucleus	Present	Present
Cytokinesis	Result in the formation of a furrow in the centre of a cell.	Occurs due to the formation of a cell plate.





Components of a Eukaryotic Cell

An eukaryotic cell is composed of various cell components as cell membrane, cell wall (only in plants), mitochondria, chloroplast, Golgi bodies, ribosomes, centrioles (only in animals), etc.

All these are described here under in detail.

Cell Membrane

Every living cell is covered by a thin, elastic, transparent, semi-permeable and regenerative membrane called cell membrane also called plasma membrane or plasmalemma. The plasma membrane separates the internal environment of the cell from external environment. As this membrane helps in regulating the entrance and exit of molecules into and out of the cell.

In 1950s with the advancement of electron microscope the detailed structure of the membrane was studied. Most of the initial studies on cell membrane structure, i.e., especially on the human Red Blood cells (RBCs), which enabled the scientists to deduce the possible structure of plasma membrane.

Human RBCs are considered to be the best material for the : study of biochemical composition of the cell membrane because they lack nucleus as well as cytoplasmic organelles.

Structure

Studies on human RBCs concluded that the cell membrane is composed of lipid which forms a bilayer with protein molecules embedded in it at places. Later it was revealed that cell membranes also possess protein and carbohydrates.

Lipid

The lipid molecules are amphipathic in nature and are arranged within the membrane by the help of two types of ends. These are as follows

(i) Polar Hydrophilic End This region is in the form of (water loving) head, which faces towards the outer sides of the cell membrane to interact with the aqueous environments on both sides.

(ii) Non-polar Hydrophobic End This region is in the form of (water repelling) tail, both ends of which faces each other that occur towards the centre of the cell membrane.

The proportion of lipid molecules varies in plasma membrane of different cell types. These are formed of cholesterol (25-32%) and mainly of phospho- glycerides or phospholipids (55-75%).

Outside of cell Phosphatidylcholine

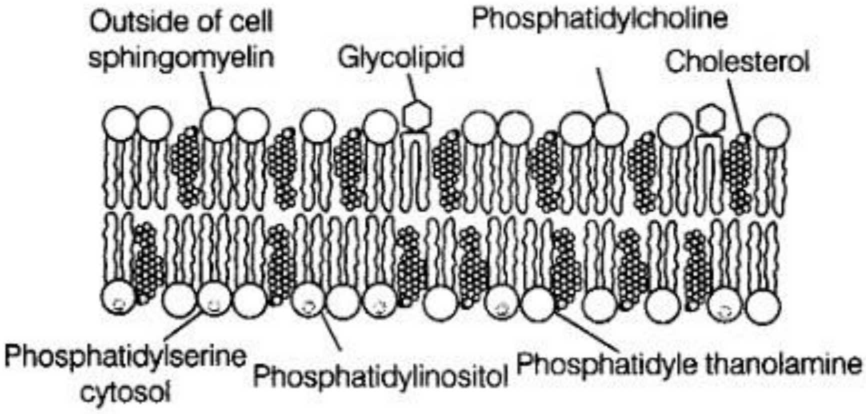


Fig. 8.5 Generalised view of plasma membrane

Proteins

Depending upon the ease of extraction, the ratio of protein and lipid varies considerably in different cell types. In human beings, the membrane of the erythrocytes (RBCs) has approximately 52% protein and 40% lipid.

The membrane proteins can be classified as

(i) Integral Proteins (intrinsic protein) They have stronger association and bound firmly to the membrane. These proteins are buried partially or totally in the phospholipid bilayer.

(ii) Peripheral Proteins (extrinsic protein) They have weaker association and are bound to lipids of membrane by electrostatic interactions.

Carbohydrates

These constitute about 1-5% of chemical composition of plasma membrane. These are associated with the phospholipids or with the peripheral proteins to form glycolipids and glycoproteins respectively.

To understand the structure of plasma membrane various models are given out of which the most accepted model is Fluid Mosaic Model.

Fluid Mosaic Model

This model was given by Singer and Nicholson (1972). According to this model, the lipid bilayer and integral proteins appear like a mosaic arrangement and the quasi-fluid nature of lipid enables the lateral movement of the proteins within the overall bilayer.

This ability of proteins to move within the membrane indicate the fluidity of the lipid part.

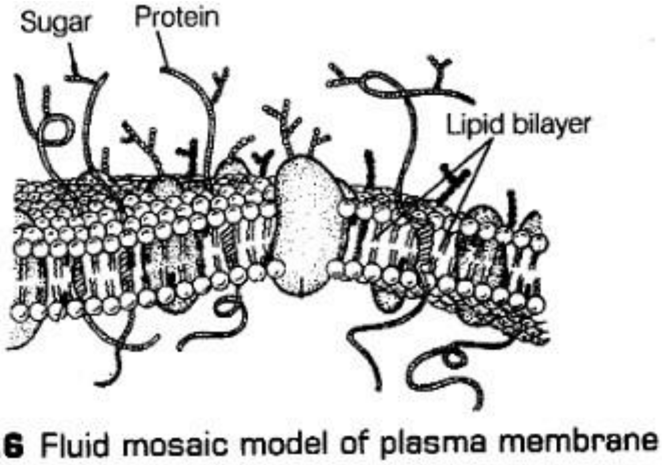


Fig.8.6 Fluid mosaic model of plasma membrane

Fluidity of Membrane

The fluid nature of the membrane is important from the point of view of interactions of molecules within the membrane as well as other functions like formation of inter cellular junctions, cell growth, secretion,
endocytosis, cell division, etc.
Passage of substances across the membrane occurs mainly by two methods
i- Active Transport
Active transport is the movement of the molecules across the membrane against their concentration gradient, i.e., from lower to the Tighter concentration. It is an energy dependent process, in which ATP is utilised. It occurs in few ions and molecules,
e.g., Na+ / K+ pump.
Polar molecules requires a carrier protein of the membrane to facilitate their transport across the membrane because they cannot pass through the non-polar lipid bi-layer.
ii- Passive Transport
Passive transport is the mode of movement of molecules or substances across the membrane without any requirement of energy.
It can be further of following three types
(a) Osmosis It is the process by which water molecules pass through a membrane from a region of higher concentration to a lower concentration.
(b) Simple Diffusion In this process, neutral molecules move across the membrane along the concentration gradient (from higher to lower concentration), e.g., Gases and small molecules.
(c) Facilitated Diffusion In this process, the molecules are transported along concentration gradient by the help of ion channels and permeases. Energy is not required in this process.
Differences between Active and Passive Transport

Active Transport	Passive Transport
In this process, energy is required.	Energy is not required.
It is a rapid process.	It is comparatively slower process.
It occurs usually against the concentration gradient.	It occurs along the concentration gradient.
It is highly selective.	It is non-selective.
It requires carrier proteins.	It occurs without carrier proteins.

Functions
Cell membrane possess the folbwing functions
(i) It is a selectively permeable or semi-permeable membrane, allows only selected substances to pass inwardly.
(ii) It protects the cell from injury.
(iii) Membranes have carrier proteins for active transport.
(iv) Cell membrane contain enzymes which perform certain reaction on their surface, e.g., ATPase, phosphatase, etc.
Cell Wall
It was first discovered by Robert Hooke (1665). It is a rigid and a non-living structure which forms an outer covering of the plasma membrane in plants and fungi. It is absent in animal cells.

Cell wall is metabolically active in nature and is capable of growth. Its thickness varies from 0.1-10 pm.
Cell wall not only gives shape to cell and protects the cell from mechanical damage and infection, it also helps in cell to cell infraction and provides barrier to undesirable macromolecules.

Chemical Composition

The cell wall of algae is made up of cellulose, galactans, mannans and minerals like calcium carbonate, etc., while cell wall of plant is composed of cellulose, hemicellulose, pectins and proteins.

i.Structure of Cell Wall

On the basis of the structure, cell wall is differentiated into the following three parts

Middle Lamella

It is the layer mainly made up of calcium and magnesium pectates. It cements the cell walls of two adjoining cells together. It is absent on the outer side of surface cells middle lamella along with a cell wall transversed by plasmodesmata which connects cytoplasm of ^ neighbouring cells.

ii. Primary Cell Wall

It is produced inner to the middle lamella in a young and growing cell. It is capable of growth and extension. It tends to diminish gradually as the cell attain maturity.

iii. Secondary Cell Wall

The thick secondary wall is formed inner towards membrane to the primary wall. As the cell gets fully matured. Its composition is similar to the primary wall.

Functions

Cell wall possess the following Junctions

(i) It helps in providing a definite shape to the cell and also protects protoplasm against any mechanical injury, i.e., damage and infection.
(ii) It also helps in cell-to-cell interaction.
(iii) It provides barrier to undesirable macromolecules and attack of pathogens.

Endomembrane System

The endomembrane system consists of nuclear envelope, Endoplasmic Reticulum (ER), Golgi complex, lysosomes and vacuoles suspended in the cytoplasm.
These are considered together as an endomembrane system because their functions are coordinated with each other, inspite of this that each membranous organelles is distinct in terms of its structure and functioning.

Endoplasmic Reticulum (ER)

The endoplasmic reticulum is a complicated system of membranous channels and flattened vesicles. It is physically continuous with the outer membrane of the nuclear envelope. It is revealed from the electron microscopic studies of eukaryotic cells that there is a presence of a network or reticulum of tiny tubular structures that are being scattered in the cytoplasm.
ER is known to be absent in prokaryotes but is present in all eukaryotic cells except germinal cells and mature human RBCs.
Endoplasmic reticulum divides the intracellular space into two main compartments
(i) Luminal (inside ER) compartment
(ii) Extra-luminal (cytoplasm) compartment,

Types of Endoplasmic Reticulum

Endoplasmic reticulum are mainly of two types, depending upon the nature of its membranes
(i) Smooth Endoplasmic Reticulum (SER) These are smooth because they do not bear ribosomes in the form of granules on their surfaces. It is present in cells where

they acts as a major site for the synthesis of lipid and also helps in synthesis of steroidal hormone in animal cells.

(ii) Rough Endoplasmic Reticulum (RER) They are found extensive and continuous with the outer membrane of nucleus. These have rough membrane because they bear ribosomes being attached to their surfaces.

They are actively being seen in the cells which have their involvement in the synthesis and secretion of proteins.

Functions

Endoplasmic reticulum possess the following functions

(i) It provides support to the colloidal cytoplasmic matrix.

(ii) Helps in the rapid intracellular transport of the material.

(iii) ER membranes contains a variety of enzymes for various metabolic processes, e.g., ATPase,
phosphatases, etc.

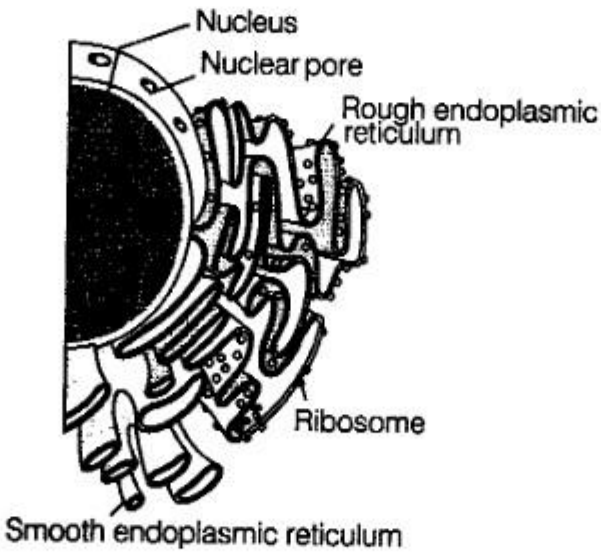


Fig.8.7 Structure of an endoplasmic reticulum

Differences between SER and RER

SER	RER
It is not associated with ribosomes but generally associated with plasma membrane.	It is associated with ribosomes and nuclear membrane.
Its main function is synthesis of proteins.	Its main function is synthesis of lipids.
Formed of vesicles and tubules.	Formed of cisternae and few tubules.
It is usually found in periphery.	It is found deep inside the cytoplasm.

2. Golgi Apparatus

It was first discovered by Camillo Golgi (1898), when he was observing the densly stained reticular structures being present near the nucleus of the cell. These structures were named Golgi bodies after his discovery.

Golgi complex or Golgi apparatus is a major complex protoplasmic structure being made up of many flat, disc-shaped sacs or cisternae (0.5-1.0 nm) in diameter.

Occurrence

Golgi complex, occurs in all cells except prokaryotes (i.e., PPLO, bacteria, cyanobacteria) and some eukaryotes such as human RBCs, sieve tubes of plants, etc.

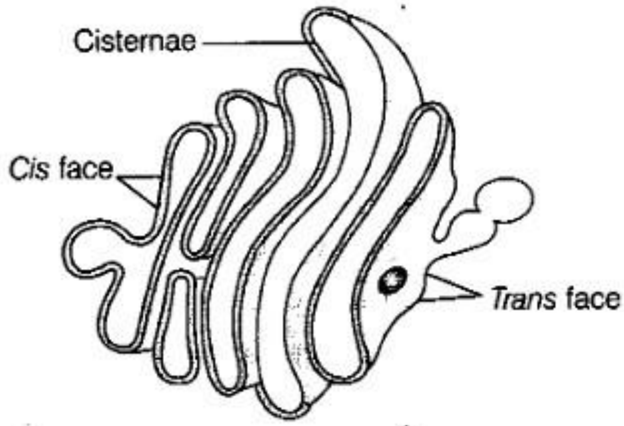


Fig.8.8 Golgi apparatus

Cisternae of Golgi apparatus are found stacked parallel to each other. They vary in number in a Cell. They are often curved-like a shallow bowls to give Golgi complex a definite polarity.
They are concentrically arranged near the nucleus with two distinct faces
(i) Cis face {forming face) This is convex in shape that lies towards the cell membrane and is responsible for receiving secretory materials through the transitional vesicles, which are pinched off from the SER.
(ii) Trans face (maturing face) This is concave in shape that lies towards the nucleus and is responsible for releasing the material, which is being secreted by cis face and modified in the cisternae.
Note:
* Although, the cis and the trans faces of the organelle are entirely different in origin, but they inter connect each other.
* Proteins that are synthesised by ribosomes on ER are first modified in cisternae before they released from its trans face.
The Golgi apparatus acts as a site where the material to be released is being packaged in the form of vesicles delivered either to the intracellular targets or secreted outside the cell.
Functions
Golgi apparatus possess the following functions
(i) The Golgi apparatus is involved in the formation of lysosomes, vesicles that contain proteins and remains within the cell.
(ii) It performs the function of packaging material.
(iii) It acts as an important site for the formation of glycoproteins and glycolipids.
(iv) It helps in the production of complex carbohydrates other than glycogen and starch.
(d) It helps in the formation of cell wall.
3. Lysosomes
These are membrane bounded vesicles that are produced by the Golgi apparatus. They are rich in several hydrolytic digestive enzymes (hydrolases-lipases, proteases, carbohy- drases, etc). As these are optimally active at the acidic pH (less than 7). Therefore, are also called acid hydrolases and are capable of digesting macromolecules from various sources like carbohydrates, lipids and nucleic acids.
Functions
Lysosomes possess the following junctions

(i) They digest the food contents (intra cellular digestion).
(ii) They also perform extracellular digestion.
(iii) They also digest the old and useless organelles of the cells.
(iv) They also have functioning in cell division.
These are called suicidal bags due to the presence of hydrolytic enzymes.
De Duve observed the rounded bodies in liver cells and called them pericanalicular dense bodies (1949).

4. Vacuoles

Vacuole are a large membranous sac found in the cytoplasm. These store substances that are not essentially useful for the cell (like water, sap, excretory product and other materials). Plant vacuoles contain not only water, sugars and salts but also contain pigments and toxic molecules and also occupy up to 90% of the volume of the cell.
The vacuole is bounded by a single membrane structure known as tonoplast which in plant cells, facilitates the transport of materials and some ions against the concentration gradient inside the vacuole. Thus, the concentration of material is tend to be the higher in vacuole, than to be in the cytoplasm
Animal cells also have vacuole, but they are much more prominent in case of plant cells. Thus, plant cells have typically large central vacuole filled with a watery fluid that gives added support to the cell.

Following types of vacuoles are being found in different organisms

(i) Contractile Vacuole They play an important part in osmoregulation and excretion in Amoeba, etc. It occurs mosdy in protistan and algal cells that are found mainly in water.
(ii) Food Vacuole They occur in the cells of mainly protozoan protists. These are formed by engulfing the food particles, i.e., by the fusion of lysosome and phagosome. The digested material thus, passes out into the surrounding cytoplasm.
Air vacuoles and sap vacuoles are the another types of vacuoles being formed by the cells.
Mitochondria
Mitochondria are membrane bound cell organelles, essential for aerobic respiration of eukaryotic cells. These are also known as power house of the cell. Thus, they produces cellular energy in the form of ATP.

Occurrence

Mitochondria are present in all living cell except, prokaryotic cell and certain specialised eukaryotic cell such as anaerobic cells and mature RBCs.
It is revealed from the studies that mitochondria is not easily visible, unless it is specifically stained.

Shape and Size

Mitochondria vary considerably according to the shape and size. They have varying shape such as granular fibrillar, spherical, oval, discodial, etc. Average size of mitochondria is 2-6 |im in length and 0.5 pm in diameter (typical cylindrical or sausage-shaped mitochondria has diameter of 0.2-1.0 Jim).

Ultrastructure

A mitochondrion contains two membranes, i.e., outer and inner. Out of which outer membrane is smooth and forms the continuous boundary of the organelle. The inner membrane is semipermeable to some metabolities. It is infolded into the matrix as incomplete partitions called cristae.
The cristae are responsible for increasing the physiological active area or surface area. The density of cristae determines the intensity of respiration.

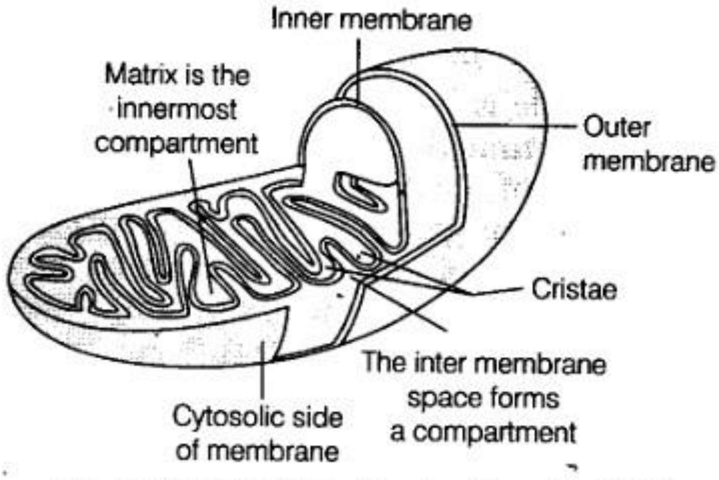


Fig. 8.9 Structure of mitochondria (LS)

The outer and the inner membranes divides its lumen into two aqueous compartments separately, i.e., the outer and the inner compartment.
Inner compartment is also called matrix, which forms the inner core of the mitochondrion. The matrix also possesses single circular DNA molecule, a few RNA molecules, ribosomes (70S) and the components required for the synthesis of proteins. The mitochondria divide by fission.
The two membranes of mitochondria have their own specific enzymes associated with mitochondrial function.

Functions

Mitochondria possess the following functions

(i) Mitochondria provide important intermediates for the synthesis of several biochemicals like pyrimidines, alkaloids, etc.
(ii) The inner chamber matrix of the mitochondria has enzyme for the synthesises of fatty acids.
(iii) Helps in regulation of cellular metabolism.
(iv) Helps in apoptosis (programmed cell death).
(v) Each of membrane potential.
Mitochondrion is the second largest cell organelle and are more in animal cells than in plant cells.

Plastids

These are semi-autonomous organelles that have double membrane envelope.
Plastids have their own genetic material (i.e., DNA). Due to their large size, they are easily seen under the microscope.

Occurrence

Plastids are found in all plant cells and euglenoides except in some protistans (e.g., Euglena, Dinophyceae, etc).

Types

Plastids are differentiated into three different types on the basis of the colour, i.e., type of pigments found in them.

Leucoplasts

These are the colourless plastids of varied shapes and sizes with stored nutrients in the form of carbohydrates lipids and proteins.

These are of following three types

(a) Amyloplasts are the carbohydrates (starch) containing leucoplast, e.g., Rice, wheat, potato, etc.
Amyloplasts are larger than the normal/original size of leucoplast.

(b) Elaioplasts are the leucoplast which stores oils and fats, e.g, Tuberose endosperm of castor seeds, etc.
(c) Aleuroplasts are the protein storing leucoplast.
e.g., Maize (aleurone cells).

ii. Chromoplasts

These are the leucoplast, whioh are yellow or reddish in appearance because of the presence of fat soluble carotenoid pigment carotene.
Xanthophyll and some other pigments are also present as the fat soluble carotenoid pigment other than carotene, e.g., Orange colour of carrot, etc.

iii. Chloroplasts

These are the plastids which are greenish in colour containing photosynthetic pigments chlorophyll and carotenoids. These pigments are responsible for trapping the light energy, essential for the photosynthesis, i.e., the synthesis of organic food from an inorganic raw materials in the presence of sunlight.

Occurrence

Chloroplasts occur in major number in the photosynthetic mesophyll cells of leaves and green stem.

Shape and Size

• They may be lens-shaped, oval, spherical, discoid or even ribbon-like organelles. They also have variable length (5-10 mm) and width (2-4 mm).

Number

Their number also varies from one per cell of the Chlamydomonas (a green alga) to 2-40 per cell in mesophyll.

infrastructure

Chloroplasts are also bounded by double membrane envelope like mitochondria, the two membranes are smooth and are thick of about 90-100 A. The inner membrane of chloroplast is less permeable than the other one.
The inner membrane is grounded by a space known as stroma or matrix, a dense, colourless and a granular substance mainly formed of soluble proteins. It also contains enzymes which are essential for the synthesis of carbohydrates, lipids and proteins.

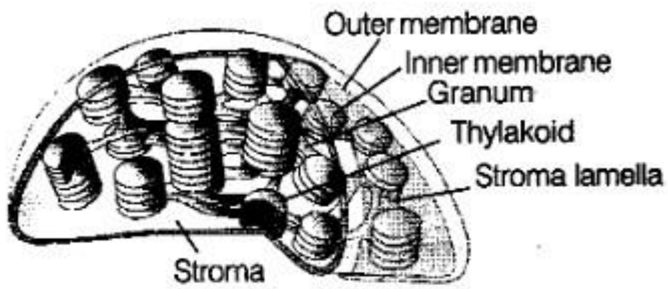


Fig 8.10 Sectional view of chloroplast

Thylakoids are number of membranous like flattened structures that run throughout the matrix or stroma. When several thylakoids are arranged or organised in the stack (like the piles of coins), called grana or the intergranal thylakoids. Many flat membranous tubules interconnect the thylakoids of different grana known as stroma lamellae.

Functions

Chloroplasts possess the following functions

(i) Helps in photosynthesis, i.e., formation of organic compounds.
(ii) In consumption of C02 and release of 02 in photosynthesis.
(iii) May also change into chromoplast in order to provide colour to many flowers and

fruits.
(iv) Helps in storing fat and lipids.
(v) Functions in transduction of energy.
Note:
* The sum total of all plastids in a cell is called plastidome.
* The chloroplast with nitrogen fixing genes are called nitroplast.
* The space between the two membrane is called intermembrane space, which separates the two membrane. This space contains a narrow fluid. Stroma also contains small, double-stranded circular DNA, molecules and ribosomes.
* Ribosomes of chloroplasts are smaller (70S) than the ribosomes of cytoplasm (80S).Ribosomes
These are the small sub-spherical granular organelles, not bounded by any membrane. Ribosomes were first observed by George Palade (1953), as the dense particles under the electron microscope. Hence, are also called Palade particles. Ribosomes are mainly composed of ribonucleoproteins (i. e., RNA-t- proteins) and are also known as protein factories,
as they are primarily involved in the synthesis of proteins or polypeptides.
As studied earlier, the prokaryotic ribosomes are 70S type, while the eukaryotic ribosomes are 80S type. Here, 'S' (Svedberg's unit) stands for sedimentation coefficient (measure of density and size).
Both 70S and 80S ribosomes contains two sub-units, i.e., the smaller and the larger sub-unit .
Differences between 70S and 80S Ribosomes

70S Ribosomes	80S Ribosomes
They are found in prokaryotes (bacteria, cyanobacteria and viruses).	They are found in eukaryotes (algae, fungi, higher plants and animals).
Larger sub-unit (50S)	Larger sub-unit (60S)
Small sub-unit (30S)	Smaller sub-unit-(40S)
Comparatively smaller	Larger than 70S
Synthesised in cytoplasm	Synthesised inside the nucleolus
RNA: protein = 60:40	RNA: protein = 50:50

Cytoskeleton
The network of interconnected proteinaceous filaments and tubules, which extends from the nucleus to the plasma membrane in eukaryotic cells.
Functions
Cytoskeleton possess the following functions
(i) The cytoskeletal structures maintain the shape of the cell and its extensions.
(ii) It is also involved in many functions in a cell as mechanical support, motility, etc.
Cilia and Flagella
These are hair-like projections of cell membrane. Both cilia and flagella are almost identical in structure but differ somewhat in length. As cilia are small structures, working as oars (causing the movement of either the cell or the surrounding fluid), while flagella are comparatively longer in size than cilia and are responsible for the movement of cell.

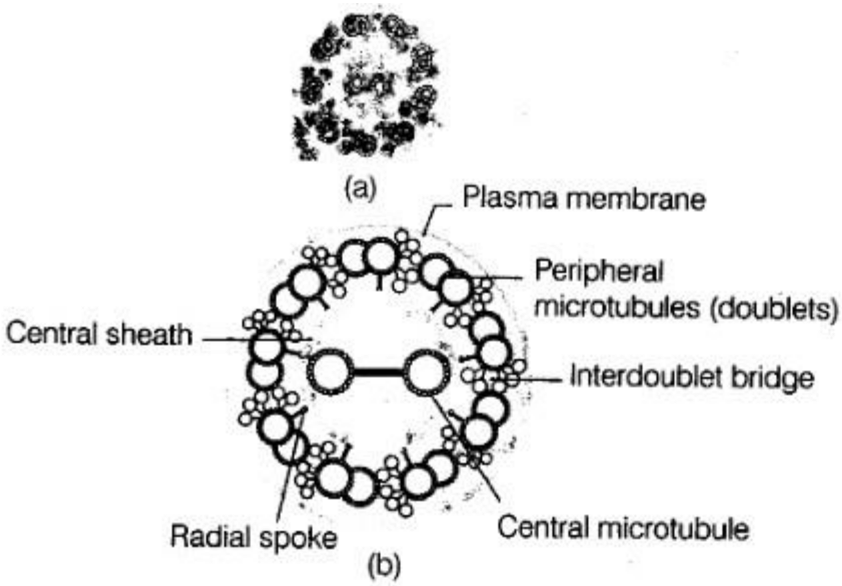


Fig 8.11 Section of cilia /flagella showing different parts (a) Electron micrograph (b) Diagram representation of internal structure

According to the electron microscopic studies it is predicted that the cilium or the flagellum are covered with plasma membrane. Their core called the axoneme, contains a number of microtubules, running parallel to the long axis.
Usually, the axoneme has nine pairs of doublets of peripheral microtubules that are radially arranged and a pair of centrally located microtubules. This arrangement of axonemal microtubules is referred to as the (9 + 2) array.
The central tubules are connected by bridges and is also enclosed by a central sheath, which is connected to one of the tubules of each peripheral doublets by a radial spoke.
Thus, it has been estimated that there are nine radial spokes. The peripheral doublets are also interconnected by linkers. Both the cilium and flagellum emerge from centriole like structure called the basal bodies.

Differences between Cilia and. jrgella

Cilia	Flagella
Cilia are short, hair-like organelles, 2-20 µm in length.	Flagella are long, whip-like organelles that may be 10-200 µm long.
They occur relatively in large numbers per cell.	They are usually fewer per cell.
They often cover the entire cell or the entire exposed surface of a cell.	They are often at one end of a cell.
They show sweeping or rowing motion.	They show undulatory motion.

Flagella are also present in prokaryotic bacteria but these are ’ structurally different from that of eukaryotic flagella.

Centrosomes and Centrioles

Centrosome is an organelle that generally have two cylindrical structures known as centrioles. They are basically surrounded by an amorphous pericentriolar materials. Both the centrioles in a centrosome lie perpendicular to each other in which each has an organisation like the cartwheel.
They are usually made up of nine evenly spaced peripheral fibrils (triplet in nature) of tubulin protein. With which adjacent triplets are also being linked.
The centre part of the proximal region of the centriole possess rod-shaped proteinaceous mass known as hub, which is connected with tubules of the peripheral triplets fibrils known as radial spokes (made up of protein).
From the basal body of cilia or flagella the centrioles and spindle fibres give rise to spindle apparatus during cell division in animal cells.
Functions
Centrosomes and centrioles possess the following functions
(i) These forms spindle fibres and move to the poles, at the time of cell divisidn, which thus, help in the movement of chromatids in daughter cells.
(ii) Help in the formation of cilia and flagella of the cells.
Nucleus
It is a specialised and principle cell organelle of the cell, which contains all the genetic information for controlling all essential processes related to metabolism and transmission.
Nucleus was first described by Robert Brown as early as 1831.
Later the name chromatin was given by Flemming when the material of the nucleus was stained by the basic dyes.
Nucleus is known to be the largest cell organelle also known as brain of the cell.
Occurrence
A nucleus is known to be present in all eukaryotic cells except a few cell types such as RBCs of humans, sieve cells of vascular plants, etc.
Prokaryotic cell lack a well organised nucleus, instead they have a nucleoid.
Ultrastructure
The interphase nucleus (nucleus of a cell when it is not dividing) has highly extended and elaborate nucleoprotein fibres called chromatin, nuclear matrix and one or more spherical bodies called nucleoli.

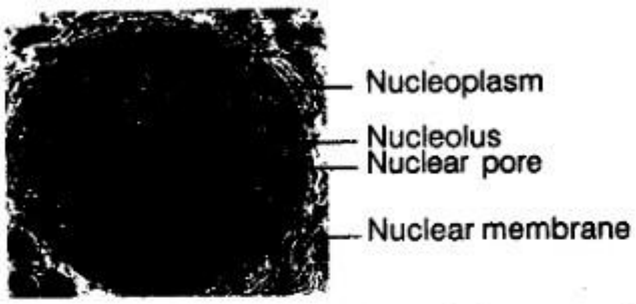


Fig 8.12 Ultrastructure of interphase nucleus

Microscopic Structure
It has been revealed from the studies of electron microscopy that the nuclear envelope, consists of two parallel membranes with a space between 10-50 nm called the perinuclear space, which forms a barrier between the materials present inside the nucleus and that of the cytoplasm.
The outer membrane usually bears ribosomes on it andremains continuous with the endoplasmic reticulum. The nuclear envelope is interrupted by minute nuclear pores, at a number nuclear of places, which are produced by the fusion of its two

membranes. These nuclear pores are the passages through which movement of RNA and protein molecules takes place in I both directions between the nucleus and the cytoplasm.
Normally, there is only one nucleus per cell, but variations in the number of nuclei can also be seen in various organisms.

Nucleus is differentiated into following four parts

i. Nuclear Envelope

It is a double membrane bound envelope that surround the nucleus and separates the latter from the cytoplasm.

ii. Nucleoplasm

It is a clear, non-staining, fluid material present in the nucleus, which contains raw materials (nucleotides), enzymes (DNA/RNA polymerases) and metal ions for the synthesis of RNAs and DNA. The nuclear matrix or the nucleoplasm is composed of nucleolus and chromatin (spherical structures present in the nucleoplasm).

iii. Nucleolus

It is a naked, round and slightly irregular structure, which is attached to the chromatin at a specific region. The content of nucleolus is continuous with the rest of the nucleoplasm as it is not a membrane bound structure.
It is a site for active ribosomal RNA synthesis. Larger and more numerous nucleoli are present in cells actively carrying out protein synthesis.

Chromatin

It is named so, because it has the ability to get stained with certain basic dyes. It is known to be the hereditary DNA protein fibrillar complex. The chromatin fibres are distributed throughout the nucleoplasm.
It has two distinct regions
(a) Euchromatin (lightly stained)
(b) Heterochromatin (darkly stained)

Functions

Nucleus possess the following functions

(i) It stores information that control cellular functions.
(ii) It controls the synthesis of structural proteins.
(iii) It also stores the genetic information for development reproduction and behaviour.
(iv) It also induces genetic variations.

Chromosomes

It has been already studied in the chapter that the nucleus in the interphase has a loose and indistinct network of nucleoprotein fibres called chromatin. But during different stages of*cell division cells show structured chromosomes in place of the nucleus. The chromosomes are meant for the equal distribution of genetic material. Their number is fixed and is same in all individuals of a species.
Chromatin is composed DNA and some basic proteins called histones. Some non-histone proteins and RNA are also present in the chromatin.
A single human cell has approximately two metre long thread of DNA distributed among its 46 (23 pairs) chromosomes.
Each and every chromosome is composed of a primary constriction or the centromere. On the sides of which the disc-shaped structures are present known as kinetochores.

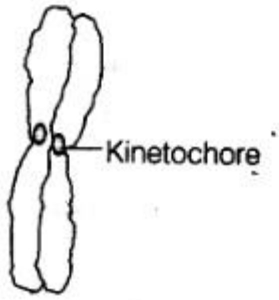


Fig 8.13 Chromosome with kinetochore

On the basis of the position of the centromere, the chromosomes can be classified into four following types

i. Metacentric Chromosome

It has chromosome with equal arms and centromere lies in the centre.

ii. Sub-metacentric Chromosome

It has one shorter arm and one longer arm with centromere slighdy away from the middle of the chromosome.

iii. Acrocentric

It forms one extremely short and one very long arm and centromere is located near the end of the chromosome.

iv. Telocentric

It has the terminal centromere, i.e., centromere is placed at an extreme end. Telocentric chromosomes are not present in humans.

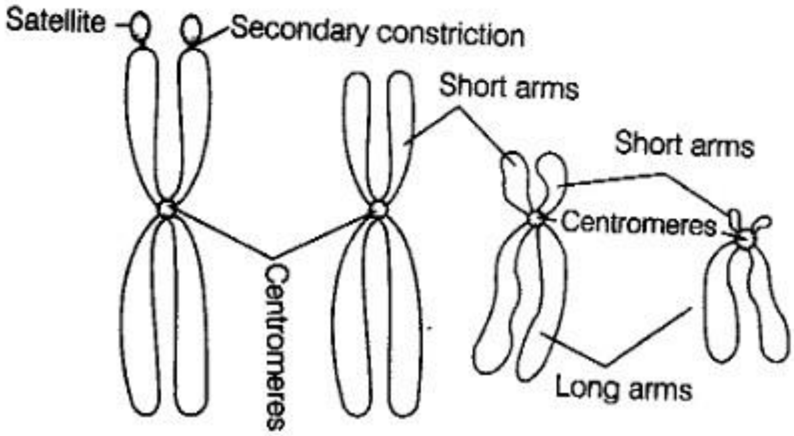


Fig. 8.14 Types of chromosomes based on the position of centromere

Few chromosomes have a non-staining secondary constrictions being present at a constant location at some or the other time which gives the appearance of a small fragment known a satellite.

Functions

Chromosomes possess the following functions

(i) Control cellular differentiation.
(ii) Contains all hereditary information located in the genes.
(iii) Forms a link between the offspring and the parents.
(iv) Introduce variations, through the process of crossing over.
(v) Control cell metabolism.

Microbodies

These are the membrane bound cytoplasmic elements that are composed of

enzymes and other substances. These are minute vesicles found in both plant cells and animal cells, e.g., In the liver, kidney, Protozoa, yeast and many other types of cells. Their shape can be ovoid, spherical, granular, etc.
Peroxisomes and glyoxysomes are the types of microbodies being found in plant cell and animal cell respectively.