RAMA UNIVERSITY

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FACULTY OF AGRICULTURAL SCIENCES

AND ALLIED INDUSTRIES

CELL

A Cell may be defined as the structural and functional unit of a living being. It is the minimal biological unit capable of maintaining and propagating itself.

A study of the structural and functional organization of different structures within a cell is known as '**Cytology**'.

Cytogenesis concerns with the study of various aspects of chromosomes and their effects on the development of characters of organisms. It is universally accepted that genes are located in chromosome. Cytogenetics originated as a result of bringing two different branches of biology namely cytology and genetics together.

HISTORY- the word '**Cell**' has been derived from the Latin word Cellula meaning a small compartment. The term was first used by Robert Hook (1665). Robert Hook who constructed the first compound microscope observed the sections of Cork and opined that they contain honeycomb like compartments. German biologists M.J. Schleiden and T.S. Schewann (1838) established the 'Cell theory' that all organisms are made up of cells.

One of the significant discoveries of the cell came from 'Robert Brown' (1830). He discovered the presence of a spherical body in the centre of every cell, which he named 'Nucleus'.

In 1835-37, Purkinje and Mohi independently discovered that protoplasm is an important constituent of every cell and it plays an important role in every cell activity including division.

Golgi (1838) discovered the golgi apparatus, Balbiam (181) discovered chromosomes in the salivary glands of chironomus. At amount the same time, Flemming (1882) studied cell division in detail and gave the name ' Mitosis'.

Endoplasmic reticulum was discovered by proter in 1945, while Benda gave the name mitochondria to organells originally discovered by Hemming. Lyzosomes were discovered in 1955 by de Duve.

The shape of cell may be variable like spherical, rectangular, flattened, oval, polygonal triangular come like column etc.,

There is a great rang eof variation among cells in size also. This small cell size can be encountered in coccus bacteria (0.2 to 0.5 m) while the largest size of the cell is seen in Ostrich egg (Mearly 15 cm).

Morphology of the cell

A generalized plant cell has an outer most envelope called the 'Cell wall'. This is absent in animal cells. Internal to this in the plasma membrane. This encloses the

nucleus and other cytoplasmic inclusions suspended in cytoplasm. The inclusions are Ribosomes, Lysosomes, Mitochondria, Plastids, Golgi complex, Endoplasmic reticulum, Vacuole.

The primitive organisms like certain bacteria blue green algae, the nucleus is not properly organized hence such cells are called Prokaryotic, while in evolved organisms, the nucleus is organized. Such cells are called Eukaryotic. The following are some of the fundamental differences between eukaryotic and prokaryotic cells.

S. No.	Character	Prokaryotic	Eukaryotic cells
1	Nuclear membrane	Absent	Present
2	DNA	Naked ad circular	Combined with proteins
3	Chromosome	Single	Multiple
4	Nucleolus	Absent	Present
5	Coty regenells	Absent	Present
6	Chromplast	Absent	Present
7	Cell wall	Non-Cellulosic	Cellulosic
8	Flagella	No definite arrangement of firbrills.	9+2 fibrillar arrangement

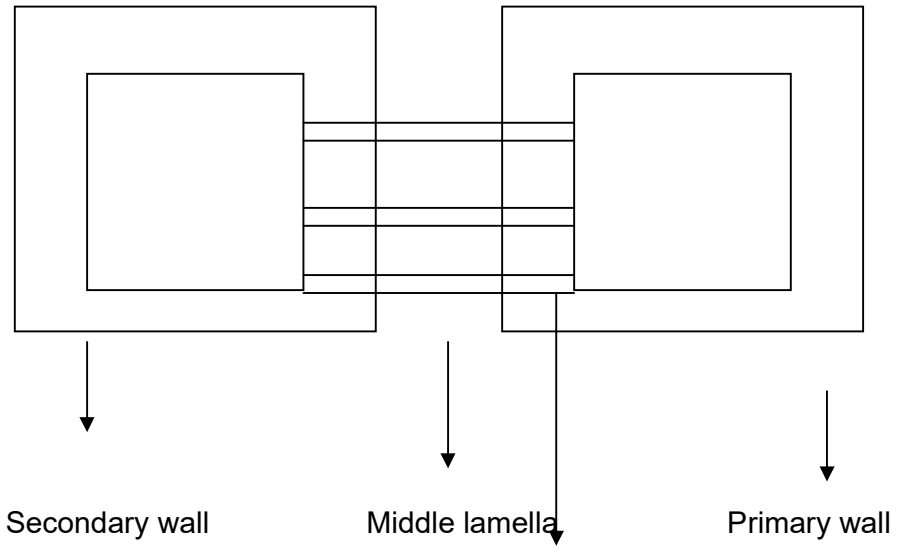
Studies with electron microscope have revealed various structures seen in an eukaryotic cell.

1. Cell wall
2. Plasma lemma
3. Endoplasmic reticular (E.R)
4. Ribosomes
5. Golgi bodies
6. Lysosomes
7. Spherosomes
8. Chlroplasts
9. Mitochondria
10. Nucleus (Animal cell lack cell wall, chloroplast while centrioles are not found in plant cell)

CELL WALL - Plant cells are surrounded by a non-living and rigid coat called a 'cell wall'. The main functions of a cell wall are to provide plant cells a definite shape and mechanical support and strength to tissue and organs. Cell wall has 3 distinct parts ;

1. Middle lamella
2. Primary cell wall
3. Secondary cell wall

Middle lamella - In plants, the wall of contiguous (immediate neighbour) cells are joined by middle lamella, which is composed mainly of pectin.



The pectin of middle lamella is most likely in the form of calcium (Ca^{++}) and Magnesium (Mg^{++}) salts. Adhesian of the walls of cotinguos cells in primarily dependant on the presence of Ca^{++} and Mg^{++} ions in themiddle lamella a removal of these ions results in the separation of cells from each other. Pectin is readily hydrolysed by the enzyme pectinase as well as by strong acids.

PRIMARY CELL WALL - is deposited after the formation of middle lamella and lies between midlle lamella and plasma lemma. It is main constituent are hemi cellulose (53%) and cellulose (30%). In addition it contains pectin (5%). Protein (5%) and lipid (7%).

SECONDARY CELL WALL - Is the last to be deposited and lies between cell wall and plasma lemma in a cell, it is the inner most laayer of wall. It is compsed of mainly of cellulose. The cellulose microfibrils are relatively more closely packed and they are arranged more or less parallel to each other. Several microfibrils associate to form a macrofibril, which is the structural unit of secondary cell wall.

PLASMA LEMMA (PLASMA MEMBRANE)

The membrane enclosing cytoplasm of a cell is known as plasma lemma or plasma membrane. It is composed of lipids and preoteins, the ratio between the two being quite variable among different cell types. Three distinct layers are seen under electron microscope, two or three are relatively dense and osmiphilic in nature; each of them is about 20^{o}A thich. The two osmaphilic layers are separated by a relatively light osmiphobic layer of about 35^{o}A thickness. The three layers together are known as 'Unit membrane"' this term coined by Robertson.

The chief function of plasma lemma in to regulate the movements of various molecules into and out of the cytoplasm. In addition to the passive movement of molecules, some ions are transported across plasma lemma by means of active transport.

CYTOPLASM

The substance, except nucelar, surrounded by the plasm lemma is known as 'Cytoplasm". Electron microscope reveal a member of membraneous and other structures in the cytoplasm; the portion of cytoplasm other than therse structure is known as 'hyaloplasm. Of the various structures preseent in the cytoplasm, mitochondria and plastids contain DNA; as a result they are autonomous to a limited degree. However, the remaining cytoplasmic structures do not contain DNA and they are specified exclusively by nuclear genes.

The cytoplasm may contain the following structues -endoplasmic reticulum (ER), ribosomes, Golgi bodies, Lysosomes, Sphersomes, Vacoles, certioles (in animals only), microtubrils, Mitochondira and plastids (in green plants only).

ENDOPLASMIC RETICULUM (E.R)

The cytoplasm contains an extensive network of membrane-enclosed space; these space along with the membranes enclosing them are known as E.R. It consists of 3 types of membrane-enclosed elements.

1. Vesicles of 25-500 in μ diameter
2. Tubules of 50-100 m μ diameter
3. 40-50 m μ thick cisterns of variable length and width.

The tubulus may or may not be extensivley branched, and the cisterns may or mmay not be connected with each other.

The ultastructure of E.R membrane in the same as that of a unit membrane, that is, it has two osmiophilic layers separated by an osmiopholic layers. E.R is grouped into two categories,

1. Smooth E.R.
2. Rough E.R.

In smooth E.R elements, both outer and inner surfaces are regular and smooth. In those cells where little or no protein synthesis takes place, only smooth ER is found. The rough ER elements, ther outer surfaces of membranes have a rough appearance due to the attachment of ribiosomes on the outer surface. Rough ER is mainly composed of cisterns (membrane-enclosed plate like elements) and is found in cells actively involved in protein synthesis. Smooth and rough E.R change into each other as per the needs of cells.

Functions of ER

i. it provides the structural base for protein (rough ER), lipid, phopholipid synthesis.
ii. it proivides channel for the transport of materials synthesized in association with ER to the various parts of cells and even outside the cells.
iii. it provides a controlled passage for the export of m.RNA moelecules from nucleus to rought ER.
iv. Several enzyme molecules are embedded in the membranes of E.R.

RIBOSOMES

These are dense granular nucleo protein strcutures occurring in cytoplasm, matrix of mitochondria and chlorplasts. In many instances ribosomes are attached to the ER. Observed first in plants cells in 1953 by Robinson and Brown, while studying bean roots. Ranging in diameter from 150 to 200A^{o}, they have RNA and protein in equal quantities.

Ribisomes are isolated by differential centrifugation depending on sedimentation co-efficient. The sedimentation coefficient is expressed in terms of Sved berg units. The 'S' units are related with the size and weight of the ribosome molecules.

TYPES

Two types of ribosomes have been identified based on the sedimentation co-efficient. If the organella is heavier, its sedimentation co-efficient is more. The two types are 70s ribosomes and 80s ribosomes.

Ribosomes may occur singly as isolated units when they are called 'monosomes'. When they occur in clusters or groups, they are called 'polyribosomes'. The poly ribosomes may have a sedimentation coefficient of 100s-600s. The number of ribosomes per cell varies, it may be 10,000 (bacterial cell) or up to 10 million (eukaryotic cell).

Ribosomes of chlorplasts and mitochondria have their own protein synthesis. They have a sedimentation co-efficient of 55s with two sub units 40s and 30s.

ULTRA STRUCTURE

Ribosomes are oblate or spheroidal structures having two sub units (a large and a small). The larger sub unit in dome like and the smaller subunit is placed above like a cap. The 70 s ribosome has two units 50 s and 30s.

FUNCTIONS

Ribosomes are the sites of protein synthesis. The polyribosomes serve as a plat form in the assembly of amino acids brought together by specific to RNA from cytoplasm.

GOLGI COMPLEX

Described first by Camilo Golgi in 1890. Golgi complex found in plant cell are often referred to as 'Dictyosomes". Each golgi body consists of following parts ;

1. Eisternae
2. Tubulus
3. Vesicles
4. Golgian vacuoler.

Functions

i. Absorbtion of compounds
ii. Sites of enzyme production
iii. Sites of hormonal produciton
iv. Sits of protein storage
v. Formation of plant cell wall-by synthezing pectin, hemicellulose and cellulose microfibrils. They also help in the formation of cell plate during mitosis.

PLASTIDS

These are living cytoplasmic inclusions found inmost of the plants. The plastids are of three categoties viz., chromoplasts, leucoplasts and chlroplasts.

Chromoplasts

They are pigmented plastids. The pigments are non-chlorophyllous like carotenes, xeithophyll fucoxalthin, phycoerythrin etc.,

Leucoplasts

They are colourless plastids. They lack pigments and are usually present in cells which do not receives direct light. Leucoplats may be seen in the storage leaves of onion. Leucoplats that store starch are called amyloplast, those that store oil are called elaioplasts and the ones storing proteins are called alemone plasts.

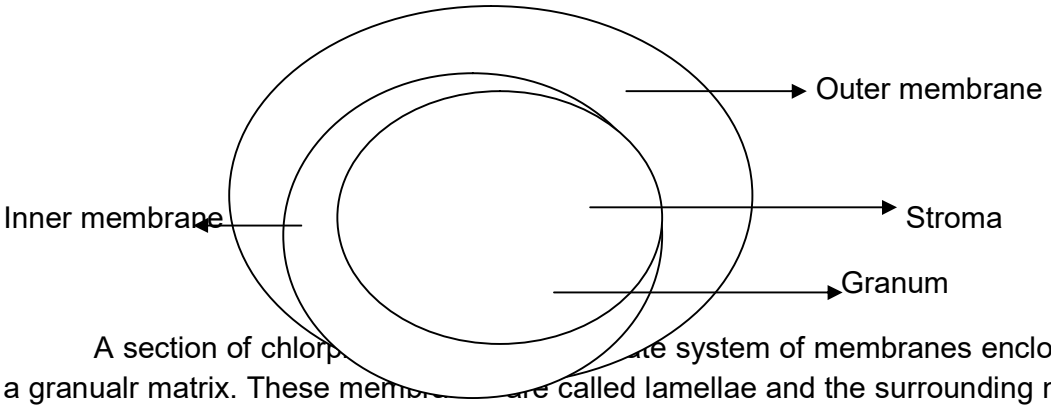
Chloroplast

These are by far, the commonest and the most plastids. As the primary sties for trapping and converting solar energy they are very vital for the existence of not only the green plants, bu for the whole living world.

Chloroplasts have varied shape and variied size. Chlorplast of polyploid cells are generally larger than in the diploid cells. They are uniformly distributed all over the cytoplasm, but in some instances they cluster towards the nucleus. The concentration of chlorplasts will also depend on light intensity.

Structure

It has a covering of two membrances with an inner membrane space. These membranes are smooth and there are no perforations or particles. The membrances are differentially permeable.



A section of chlorp[illegible]te system of membranes enclosed in a granualr matrix. These memb[illegible]are called lamellae and the surrounding matrix-the stroma. In a sectional view, the lamellae can be seen packed and there stacks are called thylakoids. In higher plants, the thylakoids themselves form highly compact bundles called grana. Some thylakoids of granum extend into the stroma and maintain contact with other grama. These are called stroma thylakoid or stroma lamellae or inter grama.

Ribosomes and RNA have also been isolated from the chloroplasts indicating a mechinery for protein synthesis. Some of the important pigments present in chloroplast are chlorophylls, carotenoids, cytochromes etc.

NUCLEUS

It is the most important organelle of the cell which regulates all its activities. It was discovered by Robert Brown (1831). Most of the cells are uninucleate. It has the following parts;

1. Nuclear membrane
2. Karyolymph (Nuclear sap)
3. Chromonemata
4. Nucleolous

5. Endosperms

NUCLEAR MEMBRANE

It helps in effective communication between nucleus and cytoplasm. The elements of E.R. contribute to the nuclear envleope during cell division. The nuclear membrane is a double membrane with a number of pores called 'Nucleopores'. The space between these two membranes is called 'perinucelar space' or cisterna.

KARYOLYMPH (NUCLEAR SAP)

It is proteinaceous, but also has nucleic acids, enzymes and minerals. It is quite probable that in plants the nuclear sap contributes to the spindle.

CHROMONEMATA

Enclosed in the karylymph and visible in the interphase nucleus are found a number of fibrillar structures constituting a network called chromonemata or chromatrin fibrils. Some coarsegranules are deposited on the chromatin net work. These are called chromocentres and constitute the points of condensation of chromosomes. During cell division the chromatin network brakes up into specific number of chromosomes. Two regions can be identified in the chromatin material. These are heterochromatic region and enchromatic region.

The heterochromatic region stains darkly and shows numerous bead like structure called 'Chromomeres'. The heterochromatic region has less DNA. This region is believed io the genetically and metabolically inert. The light staining region of the chromatin is called the 'enchromatin region" This region contains more of DNA an is supposed to be genetically active.

NUCLEOLOUS

Nucleolous was first discovered by Fortana (1874). A speroidal body, situated either in the central or pheripheral position, the necleolous is supported to regulate the synthetic activity of the nucleus. Usually 2 or more chromosomes are associated with the nucleus (this can be seed during late prophase) and these are called nucleolar organisms as they play a role in re-appearance of the nucleolus after cell division. The number of neucleoli per nucleus varies from one to 2 or 3. Chemically the nucleolar is rich in RNA.

Functions

i. It is the active site of RNA synthesis
ii. It is the source of ribosomal RNA
iii. It produces precursors of ribosomes

ENDOSPERMS

These are granular structues present in the karyolymph and are smaller insize than the nucleolus.

Important Questions

1. Describe the functions of different cell organells.
2. Explain functions of chloroplast and mitochondria.
3. Briefly explain the differences between prokaryotic and eukaryotic cells.
4. Describe the role of centriole in cell division.
5. Explain the functions of cell wall.
6. Briefly explain different types of ribosome and its importance.
7. Differentiate between plant cell and animal cell.
8. What are different types of plastids? Explain with example.