THE FUNDAMENTAL UNIT OF LIFE

1. INTRODUCTION ::

Study of cell is called **Cytology.**

Cells are the structural and functional units of life.

2. HISTORICAL ACCOUNT ::

- **Robert Hooke** (1665) observing a slice of cork in which he saw honey comb like structure which he called cell.
- **Rudolf Virchow** (1855) stated that all cell arise from the division of pre-existing cells.
- Cell theory was proposed by **Schleiden** and **Schwann (1839)**.

(A) Postulates of Cell Theory :

- Living things made of minute units, the cells, which are the small entities, Thus cells the structural unit of life.
- Cells are normally alike in metabolic activities & structures.
- A cell bounded by a cell membrane & some times cell wall also. It contains protoplasm & nucleus.
- The function of an organism is the result of the activities & interactions of the constituent cell.

(B) Modern Cell Theory :

- It is also referred as cell principle.
- Life exists only in cell.
- Living beings are multinucleate mass of protoplast, containing nuclear material & some cell organelles, limited by a cell membrane.
- Cell have basic similarity in chemical composition & physical structure.
- Cell arise from pre-existing living cells by division.
- Cell working & structure is controlled by DNA.
- Cells have genetic information, stored in their DNA.
- A cell can act (grow, divide & die) Independently.
- A cell is made of living substance called protoplasm. Term '**Protoplasm**' was coined by **Purkinje** (1839).
- Protoplasm with cell organelles comprises cytoplasm.
- Cytoplasm is a part of cell between plasma membrane & nuclear envelope.
- Single celled organisms (unicellular organisms) are **Bacteria**, **Amoeba** and **Chlamydomonas**.
- Many celled organisms (multicellular organisms) are **Fungi**, **Plants** and **Animals**.
- Protoplasm is a aggregate of molecules of organic. (as protein, carbohydrates, fats or lipids), nucleic acid (DNA & RNA) and Inorganic (water, ions, salt etc.) compounds.
- All kinds of true cells share the following three basic characteristic.
- They contain a set of genes.
- They contain a limiting plasma membrane.
- They contain a metabolic machinery.
- Organisms are again divided into following two main types :

(a) Prokaryotes (b) Eukaryotes

➤ Differences between prokaryotic cells and eukaryotic cells are

	Prokaryotic Cells	Eukaryotic Cells
a	Size of cell is generally small (1-10μm)	Large (5-100 μm)
b	**Nucleus Absent**	**Nucleus Present**
c	Contain single chromosome	Contain many chromosome Present
d	Nucleolus is absent	
e	Membrane bound cell organelles are absent (Ribosomes are present)	Present
f	Cell division take place fission or budding (No mitosis)	Cell division occurs by mitosis or meiosis
g	Ex. BGA, PPLO etc.	Ex. *Amoeba*, *Paramecium* etc.

3. DIFFERENCE BETWEEN ANIMAL AND PLANT CELL ::

	Animal Cell	Plant Cell
1	Animal cells are generally small in size	Plants cells are larger
2	Cell wall is absent.	Cell wall is present
3	Except the protozoan *Euglena* no animal cell possesses plastids.	Plastids are present
4	Animals cell have a single highly complex and prominent Golgi apparatus.	Plants cell have many simpler units of Golgi apparatus called dictyosomes
5	Animal cells have centrosome and centrioles	Plant cells lack centrosome and centrioles.

4. STRUCTURE & FUNCTION OF CELL AND CELL ORGANELLES

(A) Structure of Cell :

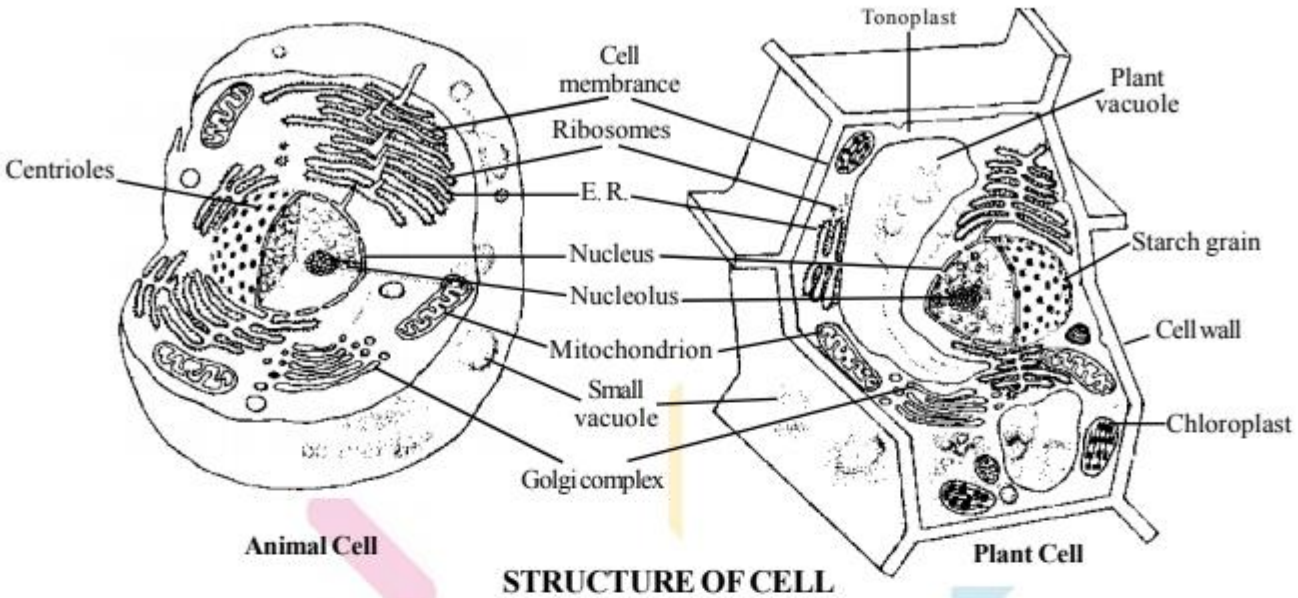
The size, shape number and volume of cell vary greatly among unicellular and multicellular organisms.

❑ **Cell shape :**

➤ The shape of cell may be variable or fixed.

➤ Variable shape occur in *Amoeba*, WBC etc.

➤ Fixed shape occur in most plant and animals.



STRUCTURE OF CELL

- Cells may be diverse shapes such as polyhedral (8, 12 or 14 sides) spherical (e.g. eggs of mainly animals), spindle shaped (Smooth muscle fibres), elongated (e.g. Nerves cells) so on.

❑ Cell Size :

- The size of different cells ranges between broad limits.
- Some plants and animals cells are visible to the naked eye.
- Most cells are visible only with microscope.
- The prokaryotic cells usually range between 1 to 10 μm.
- The eukaryotic cells usually range between 10 to 100 μm.
- *Amoeba proteus* may reach a diameter of 0.5 mm.
- The smallest cells are those of *Mycoplasma laidlawiil (0.1μ in diameter)* or PPLO (pleura pneumonia like organism).
- The largest cell is egg of an Ostrich.

❑ Cell Number :

- The number of cell in living organisms also varies greatly.
- In unicellular organisms, a single cell occur its body eg. *Chlamydomonas*, *Chlorella*, *Amoeba*.
- In human body, the estimated number of cell is 100 trillion (10^{14})

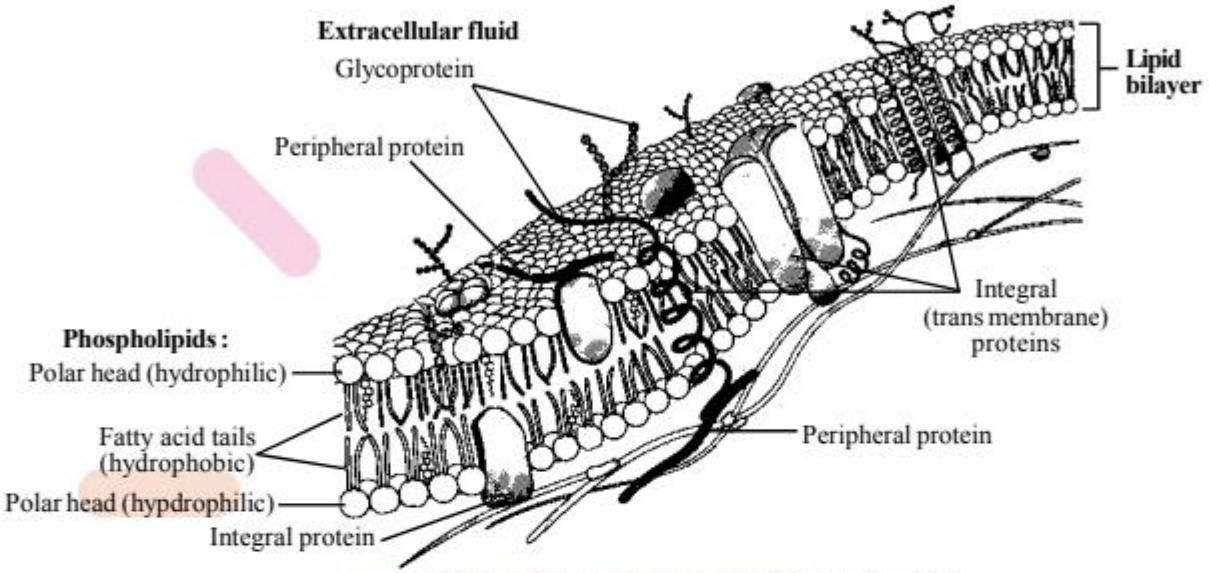
(B) Component of cell :

- Major components are -

A living part of cell	**Non living part of cell**
a. Plasma membrane	a. Cell wall
b. Cytoplasm (i) E.R. (ii) Mitochondria (iii) Golgi apparatus (iv) Ribosomes (v) Lysosomes	b. Vacuoles c. Cell inclusions

(vi) Centrioles (animals only) (vii) Plastids (plants only)	

4.1 Plasma Membrane and Cell Wall :



FLUID MOSAIC MODEL OF PLASMA MEMRANE

(A) Plasma Membrane :

Introduction :

- Cell surface in all the cells is enclosed by a living membrane which is called cell membrane by **C. Nageli** and **C. Kramer** (1855).

Historical Account :

- **J.Q. Plower** (1931) coined the term **Plasmalemma** for cell membrane.

Ultrastructure :

- *Plasma membrane* forms outer covering of each cell.
- It is present in both plant and animal cells.
- Plasma membrane is a living, thin, delicate elastic, selectively permeable membrane.
- It separates contents of a cell from the surrounding medium.

❑ **Fluid Mosaic Model :**

- In 1972**, Singer Nicolson** proposed this model. According to this, cell membrane consists-two layers of phospholipid molecules, phospholipid & protein molecules are arranged as a mosaic.
- Phospholipid molecules have their polar heads directed outward non polar tail pointing inward.
- The proteins are of **two types** –
- Peripheral or integral. Peripheral proteins are located superficially while integral proteins are embeded in the phospholipid matrix. The protein monolayers have elasticity & mechanical support to the lipid matrix.

❑ **Functions of Plasma Membrane :**

➢ The main function of plasma membrane is to regulate the movement of molecules inside and outside the cell.

❑ **Definition of Diffusion :**

➢ The tendency of molecules or ions of liquids, gases and solids to move from regions of higher concentrations to lower concentration due to their random-motion, until they are evenly distributed throughout the available space is called **diffusion**.

❑ **Definition of Osmosis :**

➢ It may be defined as a special type of diffusion that occurs in a liquid medium through a semipermeable membrane. In this process the movement of molecules of a solvent (or water), from the region of higher concentration of water (i.e. dilute solution) to the region of lower concentration of water (i.e. stronger solution) takes place till the concentration on both the sides are equalised, when both are separated by a '**semipermeable membrane**'.

➢ Semipermeable memberane allows only solvent molecules to pass through it but not the solute molecules.

➢ In plants, the cell contains a solution called **cell sap** which is more concentrated (containing some solute particles) than that of water. When the cell is immersed in water, the diffusion of water molecules from the outside into the cell takes place resulting in **endosmosis** (i.e. inward flow) and the reverse process is known as **exosmosis** (i.e. outward flow). Due to endosmosis, gradually the cell sap becomes diluted and enlarged with more water. This process will continue till an equilibrium is reached i.e. the concentration of both the solutions is equalised.

➢ Plasma membrane helps in maintaining distinct composition of cell.

(B) Cell Wall :

➢ In plants cell, there occurs a rigid cell wall which lies outside the plasma membrane.

➢ It is made up of a fibrous polysaccharide (carbohydrates) called cellulose.

➢ Cellulose is responsible for providing structural strength to the plants.

4.2 Nucleus :

Introduction :

➢ The nucleus is the most important component of the cell and controls all functional activities of the cell.

Historical Account :

➢ **Robert Brown** (1831) discovered a dense, spherical body in the cells of an 'orchid' and named it as 'Nucleus'.

Ultrastructure :

➢ It is a prominent, spherical or oval structure, usually located near the centre of cell.

➢ It is the controlling centre of all cell activities.

➢ It is enclosed by a double layered membrane called nuclear membrane.

➢ The chief components of the nucleus are

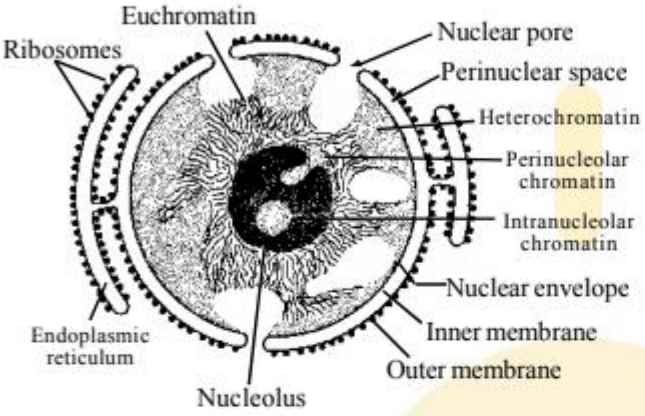
(a) Chromatin material

(b) Nucleolus

➢ **Chromatin material** - Which is in the form of an intertwined mass of thread like structure.

- Chromatin material mainly consist of DNA.
- DNA responsible for hereditary information from one generation to another.
- Double Helical structure of DNA was proposed by Watson & Crick.
- Chromosomes - DNA condenses into compact rod like bodies called chromosomes. Their number in humans is 46 (23 pairs,)

❑ Functions of Nucleus :



ELECTRON MICROSCOPIC STRUCTURE OF NUCLEUS

- The nucleus control all metabolic activities of the cell.
- It regulates the cell cycle.
- It is concerned with the transmission of hereditary traits from the parents to offspring.

4.3 Endoplasmic Reticulum (E. R.) :

Introduction :

- In the cytoplasm some closed or open, branched cavities are present which are bounded by membranes to form a network of membranous system called **Endoplasmic Reticulum.**

Historical Account :

- **K.R.Porter** (1948) reported this net-like system under electron microscope.

Ultrastructrure :

- A system of membranes attached to the nucleus and present in the cytoplasm is called E.R.
- The Endoplasmic Reticulum (ER) is divided into two parts

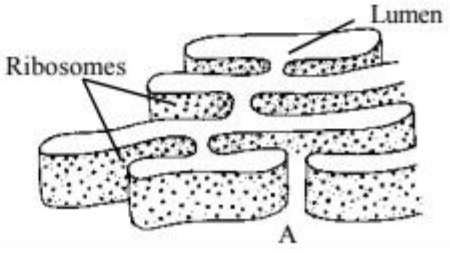
(a) Rough Endoplasmic Reticulum (RER)

(b) Smooth Endoplasmic Reticulum (SER)

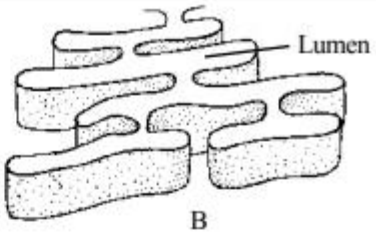
- RER possesses rough wall because ribosomes remain attached on the surface. **RER** is present in cells which are involved in protein synthesis.
- **SER** mainly present in cells which are involved in lipoproteins and glycogen synthesis. It perfoms **detoxification**.

❑ Functions of Endoplasmic Reticulum :

- It forms supporting skeleton framework of the cell.
- Certain enzymes present in smooth E.R. synthesis fats (lipids), steroids and cholesterol.
- Rough E.R. is concerned with protein synthesis.



➤ Smooth E.R. is involved in the process of detoxification.



A. ROUGH ENDOPLASMIC RETICULUM
B. SMOOTH ENDOPLASMIC RETICULUM

4.4 Ribosomes :

Introduction :

➤ Ribosomes are found in both prokaryotic and eukaryotic cells. In prokaryotes, they are found in the cytoplasm in free form, called **monosomes.** Ribosomes are the smallest organelles in the cell.

Historical Account :

➤ In plant cells ribosomes were first of all observed by **Robinson** and **Brown** (1953). In animal cells these are called **Palade particles,** observed by **Palade** (1955).

Ultrastructure :

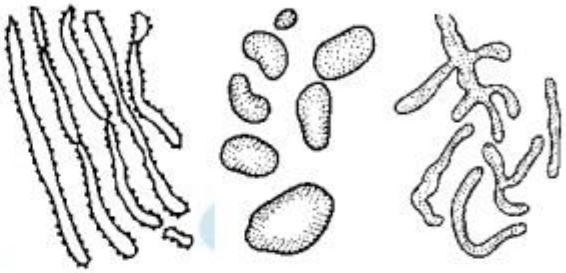
➤ Ribosomes are dense, spherical and granular particles. These are also known as **RNP particles** (Ribonucleoprotein particles.)

➤ Ribosomes occur freely in the matrix or remain attached to the endoplasmic reticulum. Also with in chloroplast, mitochondria and nuclei. Thus called organelle with a **organelle**.

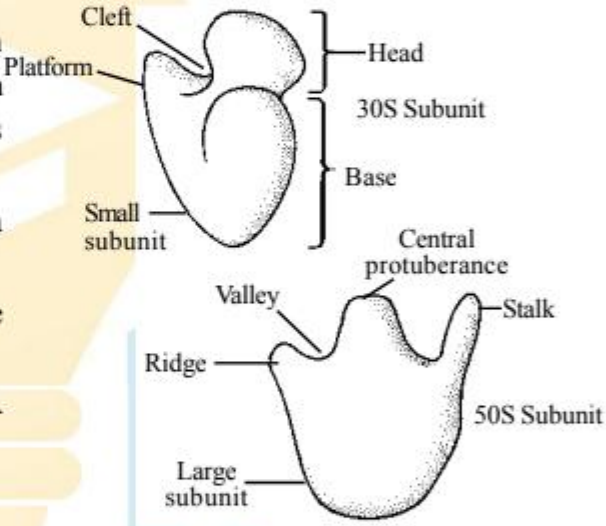
➤ Each **ribosome** is made up of two subunits, a smaller subunit and larger subunit.

➤ Two subunits of ribosomes are attached with the help of Mg^{2+} ions.

➤ Many ribosomes may be associated with mRNA to form **polyribosomes.**



ENDOPLASMIC RETICULUM



PARTS OF RIBOSOME

❑ Functions of Ribosomes :

➤ Ribosomes play an important part in the protein synthesis. Ribosomes are the **'protein factories'** of the cell.

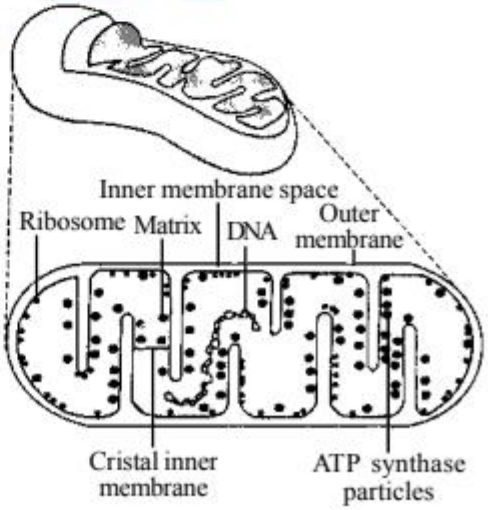
4.5 Mitochondria :

Introduction :

➤ A single mitochondrion is present in unicellular green alga, Micrasterias. Number of mitochondria varies from **50–50,000** per cell. Mitochondria of a cell are collectively known as **chondriome.**

Historical Account :

➤ **C. Benda** (1897) gave the name Mitochondria (Mitos, thread + Chondrion, granules).



INTERNAL STRUCTURE OF A MITOCHONDRION

- Term 'Bioplast' for mitochondria was used by **Altman.**

Ultrastructure :

- Mitochondria are rod shaped organelles, bounded by a double membrane envelope.
- The outer membrane is smooth, the inner membrane surrounds a central cavity of **matrix.** Central cavity is filled with gel like substances
- Inner membranes folds are called cristae, these folding are tubular and called **microvilli**.
- Mitochondria contain electron transport systems aggregated into compact structure. **F_1 particles or oxysome**, tennis racket like bodies on inner membrane involved in oxidation & phosphorylation.
- Kreb's cycle occurs in mitochondria.
- Each particle is made up of base, stalk and head.

❑ **Functions of Mitochondria :**

- Mitochodria are called **power plants** or **power houses** or **cellular furnaces**.
- Synthesis of ATP (**Adenosine Tri-phosphate**) in mitochondria is called **oxidative phosphorylation.**
- Mitochondria as place of cellular respiration was first observed by **Hogeboom.**

4.6 Plastids :

Introduction :

- Plastids are organelles enclosed by a double membrane found in all plants.

Historical Account :

- **E.Heckel** (1865) gave the term plastid. Plastids are largest cell organelles.

Ultrastructure :

- Plastids occur in most plant cells and are absent in animal cells.
- Plastids are self replicating organelles like mitochondria i.e. they have the power to divide.
- **Schimper** divided plastids into three types :

(a) **Chromoplast** - Coloured plastids (except green colour)

(b) **Chloroplast** - Green coloured plastids

(c) **Leucoplast** - Colourless plastid.

- Plastids also have double membrane but no cristae.

❑ **Functions of Plastids :**

- Chloroplasts trap solar energy and utilized it to manufacture food for the plant.
- Chromoplast impart various colour of flower to attract insect for pollination.

4.7 Golgi Complex :

Introduction :

- Golgi bodies are absent in prokaryotic cells. Golgi complex is found in all eukaryotic cells except RBCs.

Historical Account :

- **Camillo Golgi** (1898), a zoologist, observed Golgi bodies in the form of a network in nerve cells of barn owl.

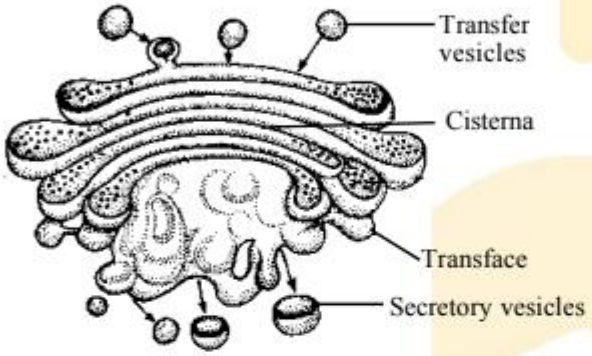
Ultrastructure :

- It is also called **Golgi complex** or **Golgi apparatus** or **Dictyosome** (in plants cell).
- It is made up of cisternae.
- Golgi bodies are interconnected with the tubules.

Functions of Golgi Apparatus :

- The main function of Golgi apparatus is secretory.
- It produces vacuoles or secretory vesicles which contain cellular secretions like enzymes, proteins, cellulose etc.
- Golgi apparatus is also involved in the synthesis of cell wall, plasma membrane and lysosomes.

4.8 Vacuoles, Lysosomes, Peroxisomes and Centrosome :



DETAILED STRUCTURE OF GOLGI COMPLEX

Introduction :

- Vacuoles serve as temporary storehouse for many of the cell's solutes and macromolecules,

Ultrastructure :

- **Vacuoles** - The Vacuoles are liquid filled spaces in the cell.
- Each vacuole remains surrounded by a membrane called tonoplast.

Functions of Vacuoles :

- Vacuoles help to maintain the osmotic pressure in a cell (osmoregulation).

(a) Lysosomes :

Introduction :

- Lysosomes are generally found in the cytoplasm of animal cells. Lysosomes exhibit polymorphism.

Historical Account :

- The term **lysosome** was introduced by **de Duve** in 1955.

Ultrastructure :

- It is also called **demolition squads, scavengers, cellular house keepers and suicide bags.**
- Lysosome are simple tiny spherical sac like structures evenly distributed in the cytoplasm.
- Lysosome is small vesicle surrounded by a **single membrane** and contains powerful enzymes.

Functions of Lysosomes :

- Lysosomes serve as interacellular digestive system, hence called **digestive bags**.
- Lysosomes also remove the worn out and poorly working cellular organelles by digesting them to make way for their new replacement.

(b) Peroxisomes :

Introduction :

- Peroxisomes are round to oval bodies, limited by a single membrane.

Historical Account :

- Peroxisomes were observed by **Tolbert** and **Yamazaki.**

Ultrastructure :

- Peroxisomes are small and spherical organelles containing powerful oxidative enzymes.
- They are bounded by single membrane.
- They are mostly found in kidney and liver cells.
- These are specialized for carrying out of some oxidative reactions.

❑ **Functions of Peroxisomes :**

Peroxisomes are specialized for carrying out some oxidative reactions.

(c) Centrosome :

Introduction :

- Outside the nuclei of animal cells is an area called the centrosome.

Historical Account :

- **T. Boweri** (1888) coined the term centrosome. Each centrosome consists of **two sets of centrioles.**

Ultrastructure :

- Centrosome is found only in animal cells.
- It is not bounded by any membranes.
- Consists of cylindrical, rod, like structures called centrioles.
- Centrioles are made up of microtubules.

❑ **Functions of Centrosome :**

- Centrosome helps in cell division in animals cells.
- In plants cells, cell division involves polar caps for the spindle formation.

4.9 Cytoskeleton (Cilia and flagella) :

- In many eukaryotic as well as prokaryotic cells of both plants and animals a cytoskeleton has been reported in recent years.
- The elements of this cytoskeleton are proteins.
- The cytoskeleton consists of following two elements within a cell.
  (a) Microtubules
  (b) Microfilaments
- Cilia and flagella of eukaryotic cells are microscopic, contractile & filamentous process of cytoplasm.
- Cilia is shorter than flagella and are numerous.

4.10 Microtubules & Microfilaments :

(A) Microtubules :

Introduction :

➤ These are cylindrical structures formed by the polymerization of two-part subunits of globular protein tubulin into helical stacks.

Historical Account :

The term **'microtubule'** was coined by **Slautterback** in 1963.

Ultrastructure :

➤ Microtubules radiate from each end of the cell. Which helps in the movement of chromosomes.

➤ These are found in many plant and animal cells.

❑ **Function :**

➤ Microtubules help in the structure and movement of cillia and flagella.

➤ It also play a role in cell division.

(B) Microfilaments :

Ultrastructure :

➤ These are long and helically intertwined polymers. Microfilaments are made up of protein **actin.**

❑ **Function :**

➤ These filaments help in cell movement and in formation of cell furrow and cell plate.

5. CELL DIVISION ::

➤ Cell multiplication is needed for the growth, development and repair of the body. Cell multiplies by dividing itself again and again this process called **cell division**.

➤ Cell divisions are two types
(a) Mitosis (b) Meiosis

5.1 Mitosis :

Stages of Mitosis :

Interphase, prophase, metaphase, anaphase and telophase are roughly the five stages or phases of mitosis.

(a) Interphase :

➤ The period between one cell division and the next is called **interphase** in which the cell is said to be in the resting stage.

➤ Interphase, however, includes three phases, i.e. G1-phase, S-phase and G2-phase. G1-phase is a resting phase or pre-DNA synthesis phase.

➤ During S-phase, DNA synthesis takes place. G2-phase is again a resting phase and it may be described as a post-DNA synthesis phase.

➤ The main mitosis division takes place during M-phase which involves prophase, metaphase, anaphase and telophase.

(b) Prophase :

➤ Prophase is actually the first and the longest phase in the mitosis cell division.

➤ Chromosomes become visible in the nucleus as short, thick and helically-coiled threads.

➤ Each chromosome splits into two chromatids joined at the centromere.

➤ Nuclear membrane dissolves away.

- Nucleolus also dissolves away and finally disappears.

(c) Metaphase :

- It is the second stage in the mitotic cell division.
- Nuclear membrane and nucleolus disintegrate and they are lost completely.
- Spindle tubules start appearing, and these tubules get attached to chromosomes at the centromeres.
- Chromosomes move actively, become shorter and thicker and arrange themselves in the centre or on the equator of the spindle.
- Separation of the two chromatids from each chromosomes also begins at the end of metaphase.

(d) Anaphase :

- It is the third stage of mitosis.
- Chromatids separate from each other at centromeres.
- Separated sister chromatids, each with a centromere, are called daughter chromosomes. They move to the ends of opposite poles of the spindle.
- Daughter chromosomes appear in V, U or J-shaped during their movement towards the poles.
- During the late anaphase stage, the cell starts constricting in the middle region.

(e) Telophase :

- Telophase is the last stage of mitotic cell division.
- Chromatids or daughter chromosomes are now at the end of the spindle.
- Nuclear membranes and nucleoli reform around each group of chromosomes and thus two new nuclei are reorganized at each pole.
- Chromosomes begin to lose their compact structure.
- Spindle apparatus disappears gradually.

5.2 Karyokinesis :

Division of nucleus is called **karyokinesis** and, the process of the division of cytoplasm is called cytokinesis.

- In animal cells, a circular constriction appears at the equator, the constriction deepens and eventually divides the cell into two.
- In plant, there is no constriction. A cell plate or new cell wall forms across the cell resulting in the separation of two daughter cells.

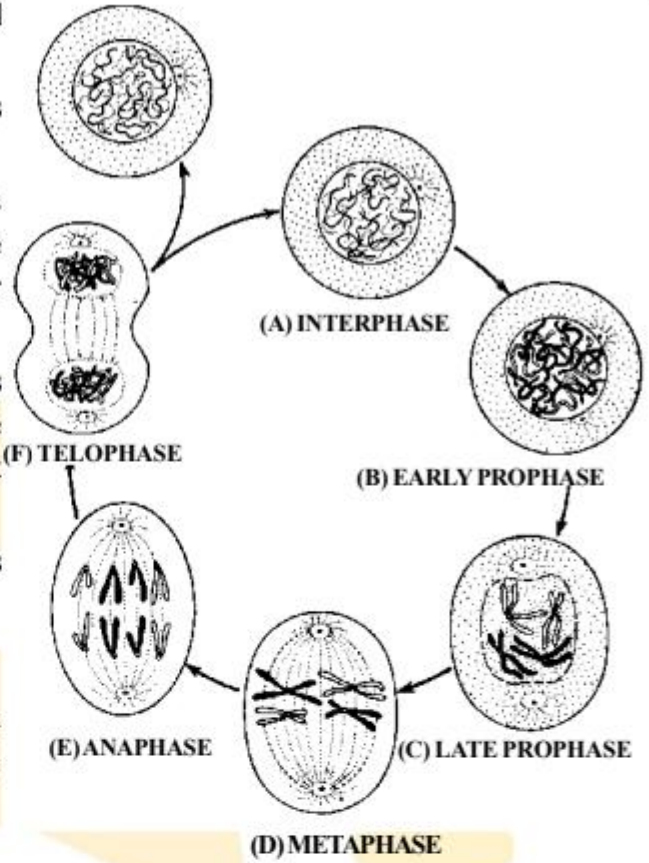
Significance of Mitosis :

- Mitosis occurs during the growth and development of multicellular plants and animals.
- Mitosis ensures that the two daughter cells inherit the same number of chromosomes.
- It helps the cell in maintaining proper size.
- In unicellular organisms mitosis helps in asexual reproduction during which two or more individuals arise from the mother cell.
- If mitosis becomes uncontrolled it may cause tumour or cancerous growth.

5.3 Meiosis

- **Meiosis is also called reduction division** because the chromosomes in this division are reduced from the diploid to the haploid number.
- Meiosis occurs in all organisms which reproduce sexually.

- Meiosis produces haploid sex cells from diploid cells.
- Meiosis involves two cell division, viz., meiosis I and meiosis II.
- In meiosis I, the replicated homologous chromosomes pair with each other on the spindle, cross over and then separate to either end of the spindle.
- On the other hand, in meiosis II, the chromatids of each chromosome move towards the centromere, and these chromatids separate at each end of the second spindle.
- As a result of this process, a diploid cell divides to form four haploid cells.



VARIOUS STAGES OF MITOSIS

First Meiosis Division :

First meiosis division is actually the reduction division. It consists of prophase I, metaphase I, anaphase I and telophase I.

(a) Prophase I :

- Prophase I is the longest phase of meiosis and includes five sub-phases.

(i) Leptotene :

- This is the first stage in the first meiosis prophase.
- In this stage, the chromosomes appear as separate thin and fine thread-like structures.

(ii) Zygotene :

- Homologous chromosomes come together, or arrange themselves side by side in pairs to form bivalents.
- This **pairing of homologous chromosomes** during zygotene in the first meiosis prophase is called **synapsis**.

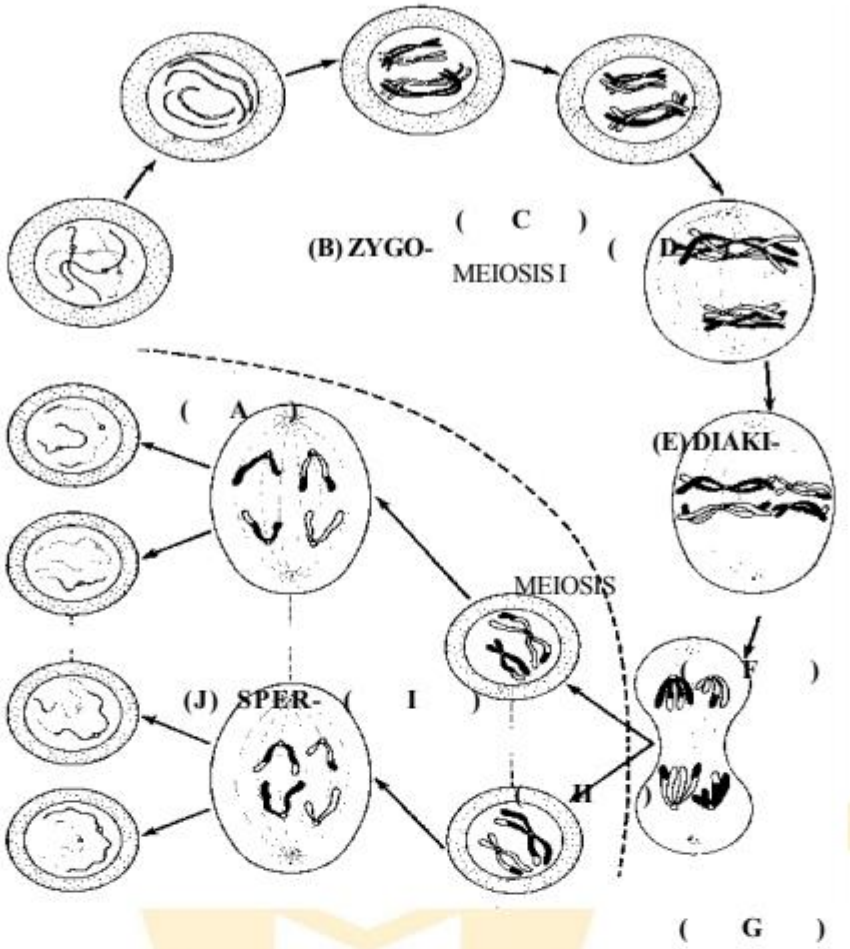
(iii) Pachytene :

- The bivalents or chromosomes become shorter and thicker.
- They replicate or split into chromatids but remain linked at the centromeres.
- Each bivalent thus now consists of four chromatids.
- **Crossing over** between non-sister chromatids of homologous pair takes place.

(iv) Diplotene :

- The centromeres of paired chromosomes or bivalents move away from each other and crossing over can also be seen.
- The points in a bivalent where the two chromosomes appear to be joined and crossed over are called **chiasmata**.
- Chiasmata formation and crossing over are the distinguishing features of diplotene.

(v) Diakinesis :



DIFFERENT STAGES OF

- This is the last stage of first meiosis prophase.
- The chromosomes become shortest and thickest.
- **Terminalisation of chiasmata**.
- Nuclear membrane starts disintegrating. Nucleolus also disintegrates. Diakinesis followed by metaphase I.

(b) Metaphase I :

- Nuclear membrane disappears completely at the beginning of metaphase I.
- Pairs of homologous chromosomes are lined up at the centre.
- Spindle apparatus starts appearing. Few spindle fibres get attached with the centromeres of chromosomes.
- Metaphase I change into anaphase I.

(c) Anaphase I :

- Partners of homologous chromosomes separate completely and move to opposites poles of spindle during anaphase I, which in turn changes into telophase I.

(d) Telophase I :

- The separated partners of homologous chromosomes collect at the poles of the spindle and nuclear membranes form around them. Two daughter haploid nuclei are thus formed. The chromosomes lengthen as they uncoil. Nucleoli start reappearing.

Second Meiosis Division :

Like mitosis, the second meiosis divisions also consists of four phases, i.e. prophase II, metaphase II, anaphase II and telophase II.

❑ **Prophase II :**

➤ In both the haploid nuclei, each chromosome splits up into two chromatids with a single functional centromere. The nuclear membrane and nucleolus disintegrate partially or completely.

❑ **Metaphase II :**

➤ The chromatids arrange themselves at metaphase plate or spindle.

❑ **Anaphase II :**

➤ During anaphase II, the centromere splits. The two chromatids belonging to each chromosomes may now be called chromosomes and pass to the two opposite poles of spindle.

❑ **Telophase II :**

➤ The haploid set of chromosomes at two different poles of spindle uncoil and form chromatin material. Nuclear membrane forms around each haploid set of chromosomes. Nucleolus also reappears.

Significance of Meiosis :

➤ Meiosis results in the formation of haploid gametes (sperm and ovum)

➤ The phenomenon of crossing over provides new combinations of chromosomes and, hence new combinations of genes and also of characters in offspring.

➤ **The four chromatids of a homologous pair of chromosomes are passed on to four different daughter cells. This is called the segregation of chromosomes.** This causes genetic variations in daughter cells.

➤ Failure of meiosis leads to the formation of diploid gametes which on fusion form polyploids.

6. DIFFERENCE BETWEEN MITOSIS AND MEIOSIS CELL DIVISION ::

Special Note :

Besides mitosis and meiosis, there is also a third type of division. It is called **amitosis**. It is a direct division of the nucleus by constriction.

S.No.	Mitosis	Meiosis
1	It occurs in all somatic cells.	It occurs in reproductive cells (germ cells or sex cells)
2	In the resultant daughter cells, the number of chromosomes remains the same (i.e. diploid) hence called equational division.	In resultant daughter cells the number of chromosomes reduces to half (i.e. haploid) hence, called reductional division.
3	By mitosis two daughter cells are produced.	By meiosis, four daughter cells are produced.
4	During mitosis no crossing over takes place.	During meiosis crossing over take place.
5	Daughter cells have identical chromosomes which are also identical to that of parent cell (i.e., remains constant)	Chromosomes of the daughter cells are with combined components (genes) of both parents (i.e. genetic variability occurs)

EXERCISE - 1

A. VERY SHORT ANSWER TYPES QUESTIONS

Q.1 What is full form of ATP ?

Q.2 What is the main functions of mitochondria ?

Q.3 Name the cell organelle present in animal cell & absent in plant cell ?

Q.4 What are two types of cell division ?

Q.5 Give two main differences between equational and reductional divisions ?

Q.6 Write three differences between plants cell and animal cell ?

Q.7 What is the structural and functional unit of life ?

Q.8 Which type of cell division is responsible for the formation of pollen grains or gametes?

Q.9 Name the largest cell ?

Q.10 Who formulated cell theory ?

B. SHORT ANSWER TYPES QUESTIONS
(About 30–40 word)

Q.11 Write down four main differences between prokaryotic and eukaryotic cell.

Q.12 Distinguish between ribosome and centrosome.

Q.13 What is Interphase in cell cycle.

Q.14 Distinguish between mitosis and meiosis.

Q.15 What is its significance of mitosis and meiosis.

Q.16 Differentiate between nucleus, nucleolus and nucleoplasm.

Q.17 Differentiate between cilia and flagella ?

Q.18 Which cell organelle is called digestive bag ? Why is it called so.

Q.19 What is a gene ? What is its significance ?

Q.20 Which organelle is called power house of a cell ? Describe its function in brief.

C. LONG ANSWER TYPES QUESTIONS
(More than 60–70 word)

Q.21 Represent the various stages of mitosis with the help of labelled diagrams ?

Q.22 Discuss prophase - I of meiosis ?

D. FILL IN THE BLANKS

Q.23 'Protoplasm' term was coined by .....

Q.24 Number of chromosomes in human body cell is .....

Q.25 The division of nucleus is called .....

Q.26 Cell is the basic ..... and ..... unit of all living organisms.

Q.27 Ribosomes are concerned with the synthesis of .....

E. TRUE OR FALSE

Q.28 The oxysomes are called F_1 particles.

Q.29 Two daughter cells are produced in meiosis.

Q.30 Second meiosis division resembles very much with the mitosis.

Q.31 Prophase-I of meiosis is of longer duration than prophase of mitosis.

Q.32 Flagella are smaller than cilia.

Q.33 Colourless plastids are called leucoplasts.

Q.34 Ribosomes are called power house of cell.

Q.35 Number of chromosome in human sperm or ovum is 23.

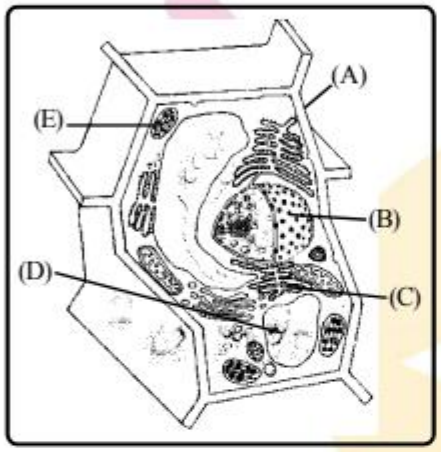
Q.36 All eukaryotic cells bear a definite nucleus.

Q.37 Plasma membrane is the outermost protective layer in cells of all plants and animals.

F. DIAGRAMMATIC QUESTIONS

Q.38 Draw a labelled diagram of animal cell showing nucleus and major organelles ?

Q.39 Label the figure for (A – E) .



G. SINGLE CHOICE QUESTIONS

Q.40 Who proposed the Structure of DNA -
(A) Schleiden and Schwann
(B) Watson and Crick
(C) Darwin and Wallace
(D) Mendel and morgan

Q.41 Centrosome is found in -
(A) Cytoplasm (B) Nucleus
(C) Chromosomes (D) Nucleolus

Q.42 Site of oxidative phosphorylation is -
(A) Ribosomes (B) Golgi apparatus
(C) Mitochondria (D) Endoplasmic reticulum

Q.43 Which one is called the "digestive bags" -
(A) Centrosome (B) Lysosome
(C) Mesosome (D) Chromosome

Q.44 Ribosomes are the centre for -

(A) Respiration (B) Photosynthesis

(C) Protein synthesis (D) Fat synthesis

Q.45 Detoxification is performed by -

(A) Plasma membrane (B) Cell membrane

(C) SER (D) RER

Q.46 The network of endoplasmic reticulum is present in the -

(A) Nucleus (B) Nucleolus

(C) Cytoplasm (D) Chromosomes

Q.47 The membrane surrounding the vacuole of a plant cell is called -

(A) Tonoplast (B) Plasma membrane

(C) Nuclear membrane (D) Cell wall

Q.48 Centriole is associated with -

(A) DNA synthesis (B) Reproduction

(C) Spindle formation (D) Respiration

Q.49 Polymorphic cell organelle is -

(A) Lysosome (B) Ribosome

(C) Centrosome (D) Chromosome

H. MATCH THE COLUMNS

Q.50

Column - I	**Column - II**
1. Tonoplast	a. Protoplasm
2. Schleiden and Schwann	b. Sun light
3. Suicide bags	c. Inheritance
4. Purkinje	d. Lipid synthesis
5. Cellulose	e. Cell theory
6. ATP	f. Vacuoles
7. Mitochondria	g. Lysosomes
8. Chromosomes	h. F1 particle
9. Chloroplast	i. Glucose polymer
10. SER	j. Energy currency
	k. Protein synthesis
	l. Excretory

I. ASSERTION-REASON TYPE QUESTIONS

The following questions consist of two statement each : assertion (A) and reason (R). To answer these questions, mark the correct alternative as described below :

(a) If both **A** and **R** are true and **R** is the correct explanation of **A**.

(b) If both **A** and **R** are true but **R** is not correct explanation of **A**.

(c) If **A** is false but **R** is true.

(d) If both **A** and **R** are false.

Q.51 **A :** Lysosomes are called "Suicidal bags".
R : A large number of hydrolytic enzymes are present in lysosomes.

Q.52 **A :** Meiosis associated with somatic cells.
R : Chromosome number is reduced to half by meiotic division.

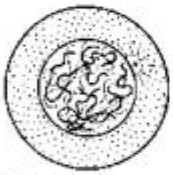
Q.52 **A :** Meiosis-I called heterotypic (reduction) divisions.
R : It halves the chromosome number in the daughter cells.

Q.54 **A :** Meiosis produces gametes in all organisms.
R : Mitosis and meiosis have nothing in common.

Q.55 **A :** Crossing over occurs the pachytene stage of meiosis-I
R : Crossing over introduces genetic variation in the cells.

J. VISUAL TYPE QUESTIONS

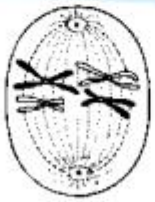
Q.56 Identify following stages of cell division.



(a) Stage name [?]

(b) Stage name [?]

(c) Stage name [?]



(d) Stage name [?]

(e) Stage name [?]

(f) Stage name [?]

Q.57 Identify and label the following figure (1-3).

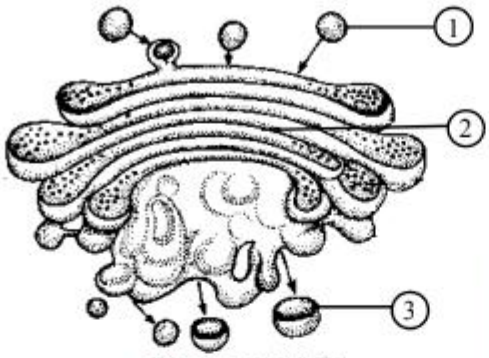


Figure name [?]

Q.58 Identify and label (1-5) the following given figure.

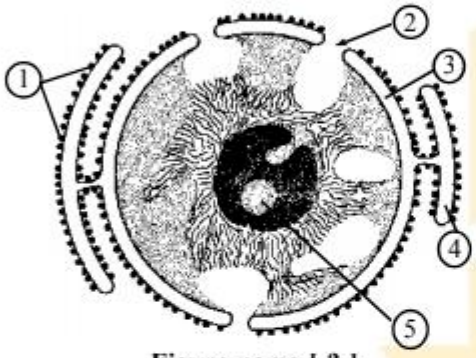


Figure name [?]

EXERCISE - 2

A. SINGLE CHOICE QUESTIONS

Q.1 'Fluid mosaic model' of plasma membrane was given by –

(A) Robertson
(B) Gorter and Grendel
(C) Singer and Nicolson
(D) Danielli and Davson

Q.2 Cell membrane is –

(A) Semipermeable
(B) Permeable
(C) Selectively permeable
(D) Impermeable

Q.3 Mitochondria are the seat of :

(A) Electron transport
(B) Cellular respiration
(C) ATP formation
(D) All of these

Q.4 Grana and stroma lamella occur in –

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

Q.5 Rough endoplasmic reticulum differs from smooth walled endoplasmic reticulum due to the presence of –

(A) DNA (B) Nucleus
(C) Riobosomes (D) Ergastic substance

Q.6 Golgi bodies take part in –

(A) Lipid synthesis
(B) Protein synthesis
(C) Carbohydrate synthesis
(D) Oxidative phosphorylation

Q.7 Protein synthesis occurs on -

(A) Ribosome (B) Nucleus
(C) lysosome (D) Centrosome

Q.8 Microfilaments are composed mainly of a protein called –

(A) Actin (B) Myosin

(C) Tubulin (D) Keratin

Q.9 Basis component of cell membrane :

(A) protein

(B) Carbohydrates

(C) Proteins and lipids

(D) Carbohydrates and lipids

B. MULTIPLE CHOICE QUESTIONS

Q.10 Lysosomes are called 'suicidal bags' because they contain -

(A) Catabolic enzyme

(B) Hydrolytic enzymes

(C) Food vacuoles

(D) Acidic enzyme

Q.11 Organelle within a organelle is -

(A) Ribosome (B) Lysosome

(C) Chloroplast (D) DNA

Q.12 Which is a function of ER -

(A) Nucleus (B) Mechanical support

(C) Raphide (D) Exchange of molecules

Q.13 Kreb's cycle occurs in -

(A) Matrix of mitochondria

(B) Nucleoplasm

(C) Cytoplasm

(D) Protoplasm

Q.14 Which one of the following has a single membrane -

(A) Nucleus (B) Ribosomes

(C) Sphaerosome (D) Mitochondrion

C. PASSAGE BASED QUESTIONS

PASSAGE 1 (Q.15 TO Q. 17)

A cell with 46 chromosome divides twice to form 4 cells with 23 chromosomes each.

Q.15 Name the type of division & cell involved ?

Q.16 Name the two divisions in above case ?

Q.17 What is the significance of such division ?

PASSAGE 2 (Q.18 TO Q. 19)

During a observation in cell division pairing of homologous chromosome, crossing over & chiasmata formation was observed.

Q.18 Which stage of the division is observed ?

Q.19 List the stages in their sequence and assign the observations to them ?

EXERCISE -1

A. VERY SHORT ANSWER TYPES QUESTIONS

1. Adenosine triphosphate
2. The energy stored in ATP is used by the cell.
3. Centriole
4. Mitosis and Meiosis cell division.
5. In equational division the chromosome number is soma whereas in redutional division will be chromosome number is half.
6.

	Plant cell	Animal cell
(i)	Cell wall is present	Absent
(ii)	Large in size	Small in size
(iii)	Plant cells lack centrioles and centrosome	Present

7. Cell
8. Meiosis
9. Egg of Ostrich
10. Schleiden and schwann.

D. FILL IN THE BLANKS

23. Purkinje
24. 46
25. Karyokinesis
26. Structural and functional
27. Proteins

E. TRUE OR FALSE

28. True
29. False
30. True
31. True
32. False
33. True
34. False
35. True
36. True
37. False

G. SINGLE CHOICE QUESTIONS

40. B
41. A
42. C
43. B
44. C
45. C
46. C
47. A
48. C
49. A

H. MATCH THE COLUMNS

51. 1-f ; 2-e ; 3-g ; 4-a ; 5-i
6-j ; 7-h ; 8-c ; 9-b ; 10-d

H. ASSERTION-REASON TYPE QUESTIONS

51. a **52.** c **53.** a **54.** d
55. b

EXERCISE -2

A. SINGLE CHOICE QUESTIONS

1. C **2.** C **3.** D **4.** B
5. C **6.**C **7.** A **8.** A
9. C

B. MULTIPLE CHOICE QUESTIONS

10. B, D **11.** A **12.** B **13.** A **14.** B, C

C. PASSAGE BASED QUESTIONS

PASSAGE 1 (Q.15 TO Q. 20)

15. Meiosis and sex cell.
16. Meiosis I or reductional division.
Meiosi II or equational division.
17. After fertilization original number of chromosome is restored.

PASSAGE 2 (Q.18 TO Q. 19)

18. Prophase - I of Meiosis -I.
19. a) Leptotene
b) Zygotene - Pairing of chromosome
c) Pachytene - Crossing over
d) Diplotene - Chiasmata formation
e) Diakinesis