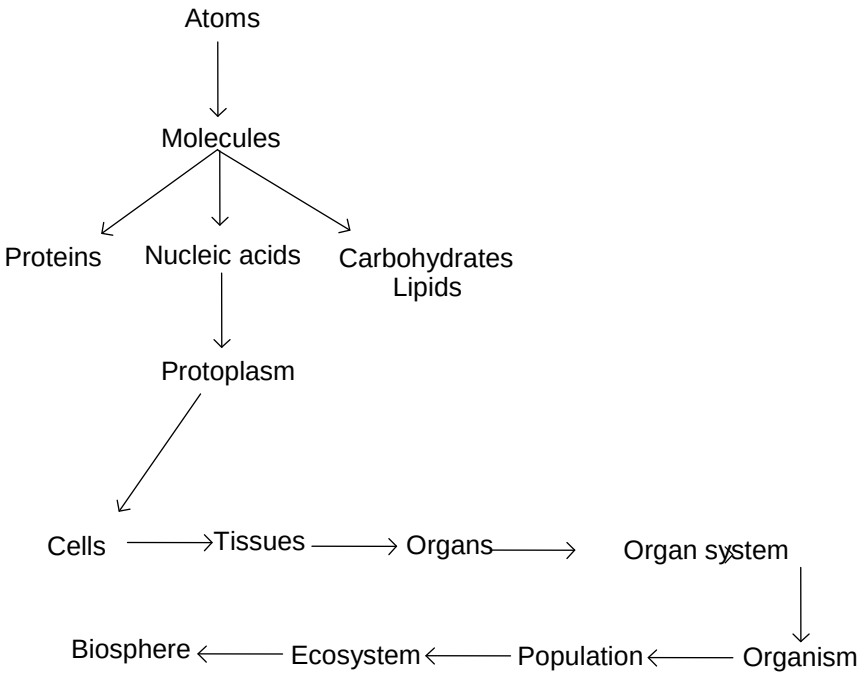
CELL BIOLOGY

INTRODUCTION TO THE CELL

Living organisms show organization:

Living and non-living objects exist together in nature. Studies prove that chemical composition is similar in both types of objects. In both living and non-living forms, the organization starts from the level of **atom**. Atoms of the chemical elements present in the living organisms are also present in the non-living objects. In non-living systems, atoms are organized into **molecules** and molecules in **crystals** or **colloids**. The organization of atoms in living system is shown below.



- **Biology** is the study of life. All the animals and plants are made up of a single unit – the **cell**. Every organism starts its life with a single cell. More complex organisms may have thousands, millions or even billions of cells. An organism's size depends upon the number, and not the size of a cell.
- The term **cytology** is concerned with the ***study of the structure of the cell and its organelles***.
- Whereas the **cell biology** is concerned with the ***physiological & biochemical aspects of the cell and its components.***

Discovery of cell

- Cells were first seen over 300 years ago. In 1665, **Robert Hooke**, an English physicist, designed and put together one of the first working optical **microscopes**. Amongst the many objects he examined were thin sections of cork. Hooke saw that these sections were made up of many tiny, regular compartments which he called "**cells**".
- In 1676 **Anton Van Leeuwenhoek**, a Dutch draper used his lenses to observe a wide variety of living unicellular organisms in drops of water. He called these organisms '**Animalcules'**.
- By the **1840s** it was recognized that cells are the basic units of life, an idea that was first expressed by **Schleiden** and **Schwann** in their '**cell theory'** of 1839.
- **Rudolf Virchow** (1885) gave the concept '***Omnis Cellulae Cellula'*** meaning cells arise from pre existing cells (cell division).

- Nucleus was discovered by **Robert Brown** (1831).
- **Purkinje** (1840) discovered the term '**protoplasm'** for the formative substance of young animal embryos.
- French scientist **Dujardin**, viewed living cells with a microscope and found cell **cytoplasm**.

CELL THEORY

Cell theory was put forth by **Schleiden and Schwann**. The main postulates of the theory are:

1. All living things are made up of cells and their products.

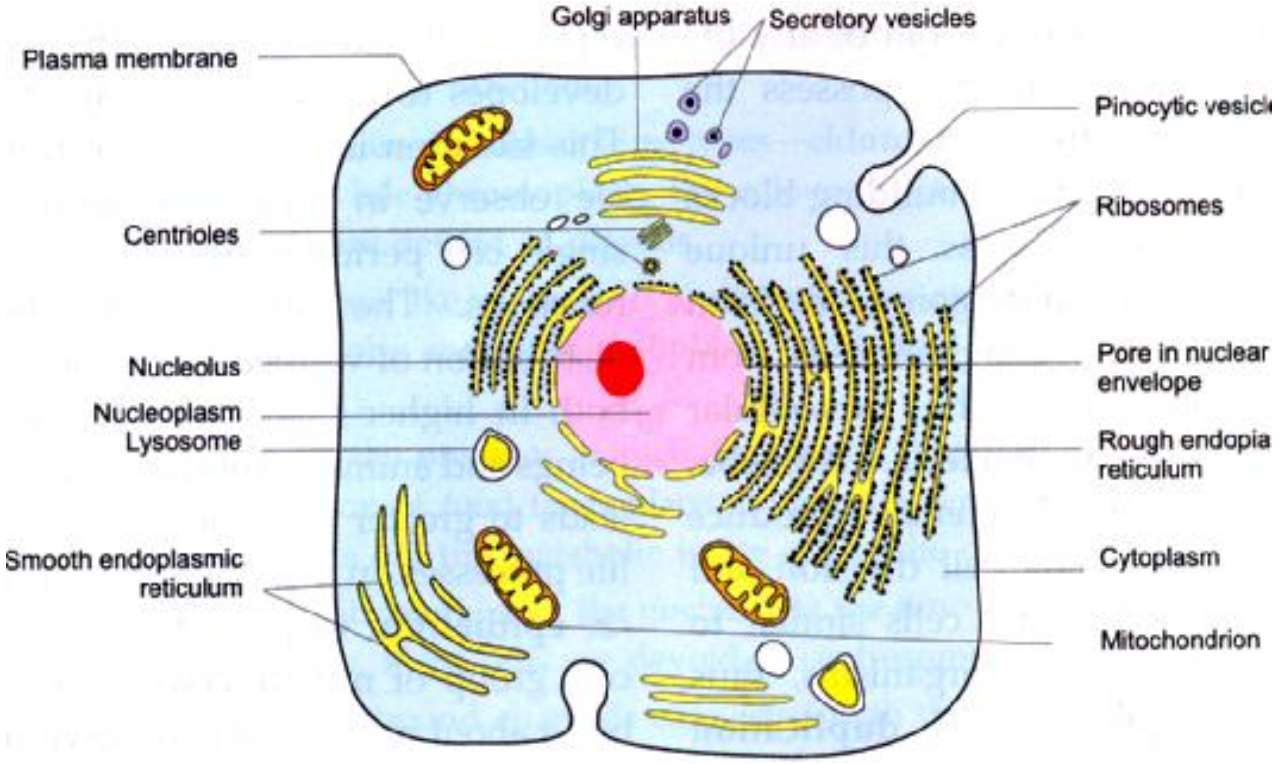
2. All cells arise from pre-existing cells.

3. All cells are similar in chemical composition and metabolic activities.

4. The function (working) of an organism is the outcome of activities and interactions of constituent cells.

STRUCTURE OF ANIMAL AND PLANT CELL

A generalized animal cell is to be understood as a cell which is supposed to contain the sum total of the organ present in different types of specialized animal cells. The animal cell is bounded by a **plasma membrane** or **cell membrane** or **Plasmalemma** and encloses the **cytoplasm** along with a **nucleus** and various other organs. A brief account of the various components is given below.



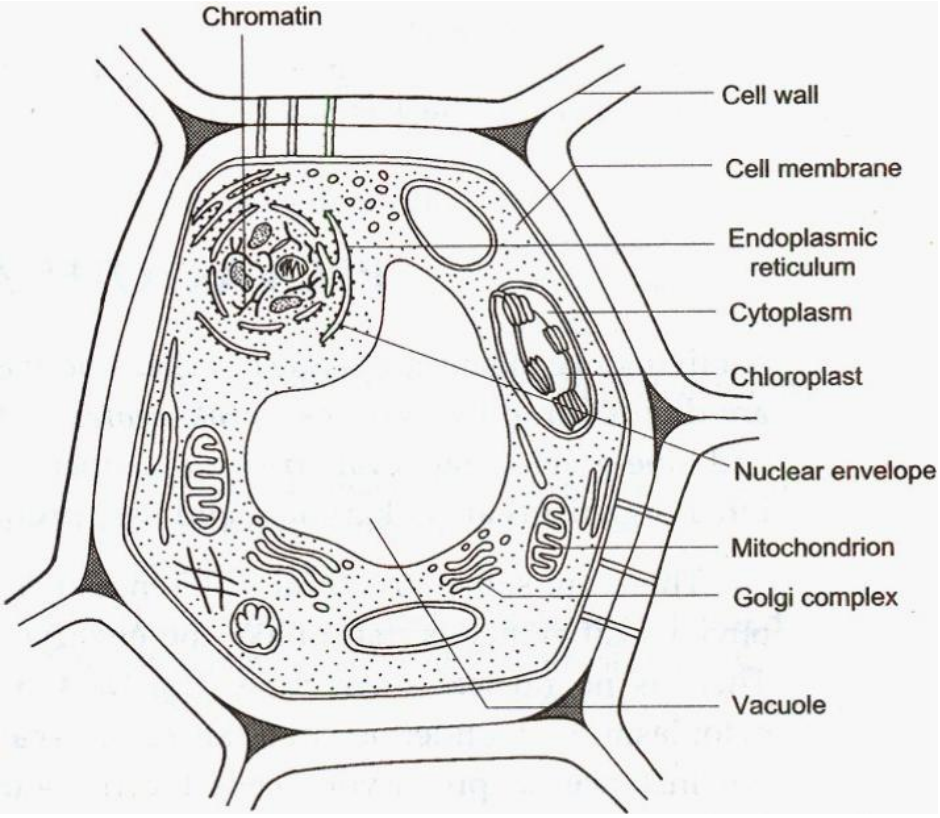
CELL WALL

It is outer rigid protective supportive and semi-transparent covering of **plant cells, fungi and some protists.** Cell wall was first seen in **cork** cells by **Robert Hooke** in **1665**. Cell wall is a **non-living extra cellular secretion** or **matrix** of the cell which is closely appressed to it. Cell wall is ***metabolically active*** and is ***capable of growth***. It is laid down during development of the cell and starts as a thin **organic material**

called **pectin**, beneath which, **cellulose** secreted by the outer part of cytoplasm is laid down (***primary wall***). Further layers of cellulose constitute the ***secondary wall*** (Pectin, **legnin**, **suberin**, **cellulose** and hemi cellulose are the basic units of cell wall).

Functions:

Cell wall protects the protoplasm against **mechanical injury.** It protects the cell from attack of **pathogens.** Counteracts **osmotic pressure**. Cell wall of sieve tubes, tracheids and vessels are specialized for long distance **transport**. **Cutin** and **suberin** of the cell wall **reduce** the loss of water through **transpiration**. Cell wall gives **definite shape** to the plant cells. It provides mechanical strength and **protection** to the cell. Cell wall prevents the cell from **desiccation.**



PLASMA MEMBRANE

The thin membrane bounding the cell is known as **Plasmalemma** or **plasma membrane**. It is a transparent elastic structure, which delimits the interior of the cell from the external environment. The cell membrane of all cells is actually a **two-layered membrane**, each layer being composed of **phospholipids** and **proteins**. It also regulates the entry and exit of various substances into and out of the cell by allowing some substances to enter the cell and some substances (secretory and excretory products) to move out of the cell. Such a membrane is termed **selectively permeable** membrane. It is also capable of ingesting external substances by **phagocytosis** (cell-eating) and by **pinocytosis** (cell-drinking).

Functions:

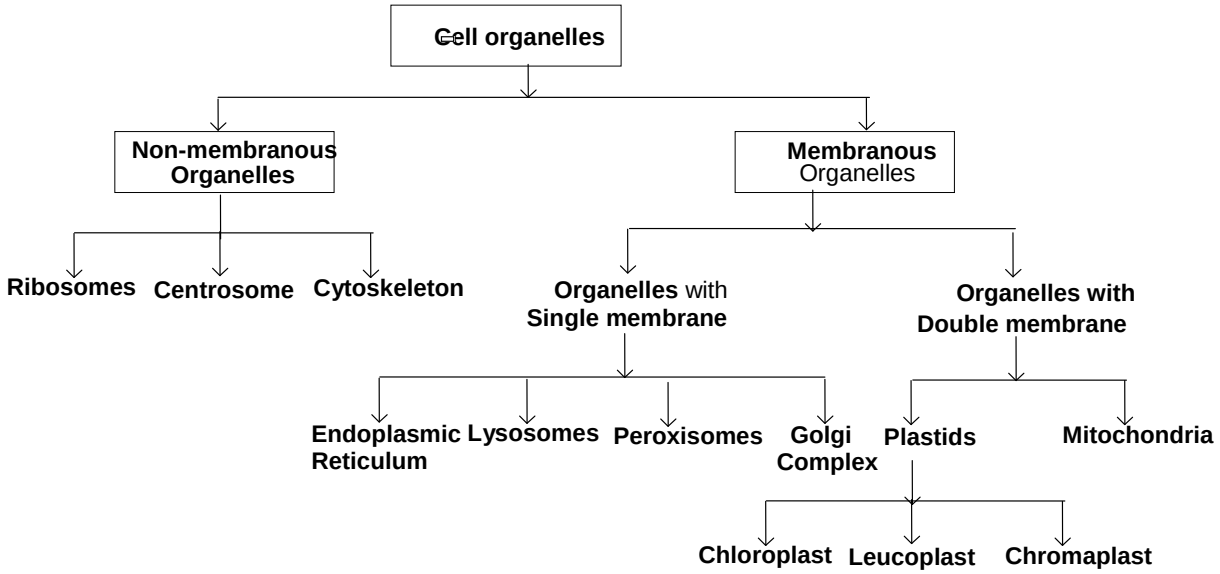
Materials pass into or out of cells through the cell membrane by **diffusion**, **osmosis**, **active transport, exocytosis** and **endocytosis.** Cell membrane maintains a **general shape of the cell**.

CYTOPLASM

The translucent, heterogeneous colloidal substance enclosed by the plasma membrane is called **cytoplasm.** It consists of a fluid matrix called **cytosol** in which various cell organelles are suspended, which perform different functions. The cell organelles are:

1. Endoplasmic reticulum 2. Golgi complex 3. Lysosomes 4. Mitochondria 5. Ribosomes
6. Centrosome 7. Cytoskeleton 8. Plastids 9. Peroxisomes

Types of cell organelles



1. ENDOPLASMIC RETICULUM

It is a network of membranous tubules present in the cytoplasm. It appears **rough** if particles called **ribosomes** are attached to it, and appear **smooth** if ribosomes are not attached to it. It has connections with the cell membrane to the out - side and with the outer membrane of the nuclear envelope to the inside.

The ***rough endoplasmic reticulum is involved in the synthesis of enzymes****, proteins and protein hormones*. The ***smooth endoplasmic reticulum is involved in the synthesis of glycogen, lipids and steroid hormones*****.** The substances so synthesized are released by the ER in the form of minute *transport vesicles* which fuse with the *cisternae* of the Golgi complex. It is an elaborate network of membrane bound tubules highly concentrated in the endoplasm hence called endoplasmic reticulum. In young *meristematic cells* it forms a continuous system extending from the nuclear envelope to the cell membrane and even to the cell wall. It may even extend to the neighbouring cells. It occurs in one of the three shapes **cisternae**, **tubules** and **vesicles**. The **cisternae** are large flattened parallel sac like structures interconnected to each other.

Functions:

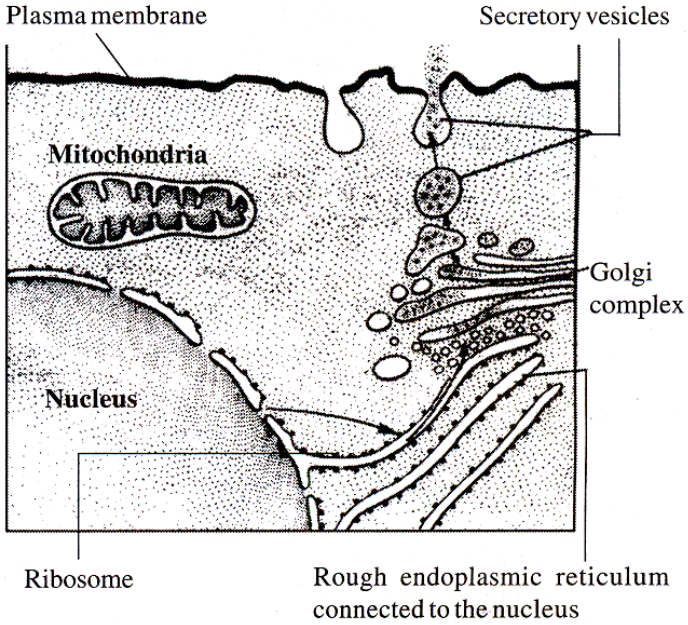
1. It *provides a* ***large surface*** inside the cell for various physiological activities.
2. It functions as ***cytoskeleton or intracellular and ultra structural skeletal framework*** by providing mechanical support.
3. Endoplasmic reticulum *keeps* the various organelles in their ***position***.
4. Endoplasmic reticulum (as desmotubules) controls movement of materials between two adjacent protoplasts through ***plasmodesmata***.
5. Endoplasmic reticulum acts as a ***means of quick intracellular transport***.

6. As ***Sarcoplasmic reticulum*** (S.R.) or endoplasmic reticulum of muscle cells, it ***conducts impulses from the surface to the deeper parts***. In other cells, endoplasmic reticulum ***conducts information from cell exterior to inside and from one part of the cell to another,*** e.g., cytoplasm to nucleus and vice versa.
7. Endoplasmic reticulum *provides precursors* of different secretory substances of Golgi apparatus.
8. It gives membranes to the Golgi apparatus for the envelope formation of vesicles and Lysosomes.

Smooth Endoplasmic Reticulum	Rough Endoplasmic Reticulum
1. SER or smooth endoplasmic reticulum does not bear ribosomes over the surface of its membranes	1. RER or rough endoplasmic reticulum possesses ribosomes attached to its membranes
2. It is mainly formed of vesicles and tubules	2. It is mainly formed of cisternae and a few tubules
3. It is engaged in the synthesis of glycogen lipids and steroids	3. The reticulum takes part in the synthesis of proteins and enzymes
4. SER gives rise to sphaerosomes	4. It helps in the formation of lysosomes through the agency of Golgi apparatus
5. SER is often peripheral. It may be connected with plasmalemma	5. It is often internal and connected with nuclear envelope

2. GOLGI COMPLEX

This is a membranous organelle and is highly developed in glandular cells with high secretory activity. It is composed of two components namely stacks of flattened sacs called **cisternae**, and **vesicles**. The Golgi complex receives the substances synthesized and released by the E.R, ***condenses, modifies, packs and releases them in the form of secretory vesicles*** which move to the plasma membrane, fuse with it and release their contents to outside the cell. Some of the secretory vesicles released by the Golgi complex remain in the cytoplasm as lysosomes, which are involved in intracellular digestion (see below).



Endoplasmic Reticulum and Golgi body

Golgi bodies were first detected in nerve cells of cat and owl by **Camillo Golgi** (1891). It is found in all cells **except RBC of mammals and muscle cells.**

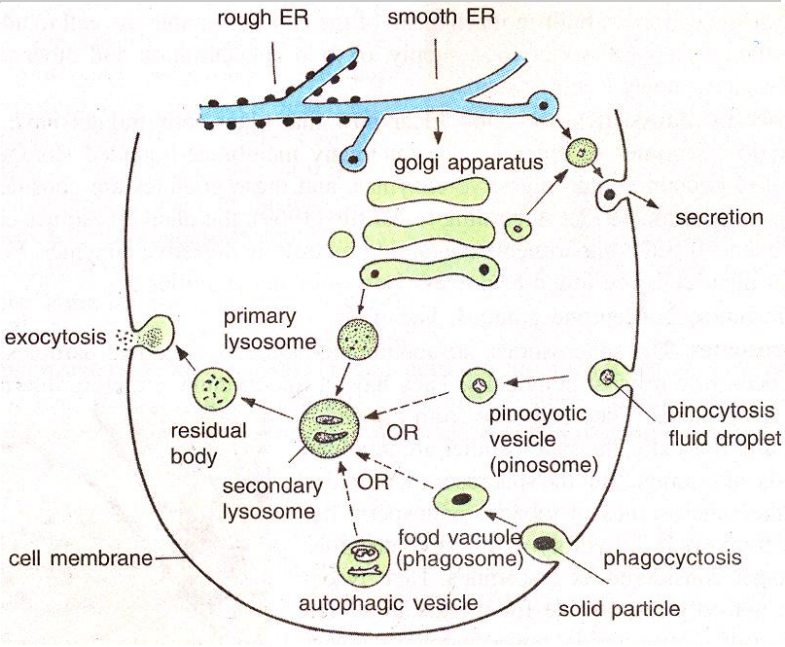
The Golgi bodies of plant cells are called '***dictyosomes'*** (dictyos: net) because of their apparent net like structure. Number - varies from cell to cell, secretory cells have most numerous, while muscle cell has none. In plant cells number increases during cell division in plant cells.

Functions:

Function is synthesis, secretion and packaging of cellular materials and it helps in formation of Acrosome in sperm. **Cellular synthesis** and **cell plate formation** in plant cell. These substances are laid down on the cell plate. It helps in **formation of Lysosomes.**

3. LYSOSOMES

Lysosomes are membrane-bound vesicles released by the golgi complex. They contain different types of enzymes collectively called acid hydrolyses, which are essential for ***intracellular digestion***. If a white blood cell ingests bacteria the Lysosomes lyse or dissolve not only the ingested bacteria but the cell itself. Because of this activity, Lysosomes are commonly called '**suicide bags'**.



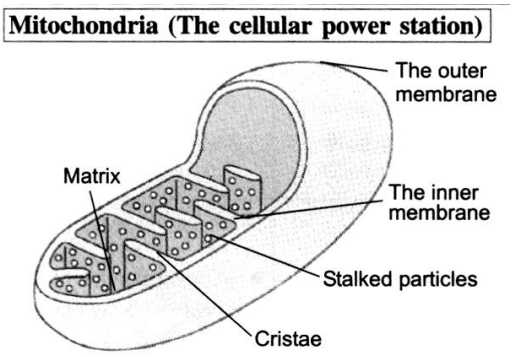
Functions:

Supply the enzymes which destroy old and surplus organelle. Contain about 40 different types of enzymes. Digest material taken into the cell by the process phagocytosis, intracellular digestion. By digesting cartilage, it helps in formation of bone.

4. MITOCHONDRIA

Mitochondria are ***semiautonomous organelles*** of the cell. They occur singly or in groups, may be cylindrical or spherical in shape, and occur in large numbers in metabolically very active cells. They are double-membrane-bound organelles, with an inner and an outer membrane, each of which is similar to the cell membrane. The outer membrane is smooth whereas the inner membrane is folded inward as a number of projections called **cristae**. These cristae project into the central granular ground substance or matrix of the mitochondrion (singular).

The matrix of each mitochondrion contains circular DNA**,** ATP and ribosomes. Oxidative enzymes present in the matrix, play a vital role in **intracellular respiration**. Mitochondria are the ready source of energy required for the various metabolic activities in the cell. Hence, mitochondria are described as power-plants or **powerhouses** of the cell.



Function:

Synthesis of **respiratory enzymes**. Release energy from food in the form of **ATP** (seat of cellular respiration and store energy)

Kolliker (1850) first found it in muscle cell and named *sarcosomes*. **Benda** (1900) coined the term *mitochondria* (*mitos* means thread and *chondrion* means granules). **Sites of cellular respiration** in the cytoplasm ('Powerhouses' of the cell) Found at sites of highest metabolism (e.g. muscle cells) to produce energy-rich molecules of ATP (Adenosine Triphosphate).

Do you know…..?
It is thought that mitochondria in eukaryotic cells may have evolved from ancient symbiotic prokaryotic bacteria that lived inside other larger prokaryotic cells. They have their own DNA and ribosomes, and can reproduce on their own. So, they are known as semi autonomous cell organelle.

5. RIBOSOMES

Ribosomes are the ultramicroscopic structures. They are of two types: **80 S ribosomes**, which occur either freely in the cytoplasm or attached to the endoplasmic reticulum; **70S ribosomes,** which occur in mitochondria. Ribosomes of both types are the sites of protein synthesis and are, therefore, called **"Work benches"** of the cell. Ribosomes are not covered by any membrane.

Function: Ribosomes are involved in protein synthesis**.** They assemble amino acids in the right order to produce new proteins.

Do you know…?
Based on sedimentation co-efficient (unit of measure i.e., Svedberg unit) during ultracentrifugation process, basically two types of ribosomes are recognized. They are 80S and 70S – "S" stands for Svedberg Sedimentation coefficient (measured in Svedberg units).

6. CENTROSOME

Centrosome is a small ***non-membrane- bound spherical zone of cytoplasm*** close to the nucleus and includes a pair of cylindrical structures called centrioles, which are perpendicular to each other. The centrioles play an important role in **cell division** by forming the microtubules that constitute the mitotic spindle. Hence centrioles are also called ***microtubule organizing centers*** (**MTOC**).

Function: Spindle (cradle of thread) present in the centriole guides the chromosome during cell division. Centriole acts as microtubule organizing centre.

7. CYTOSKELETON

Cytoskeleton is ***a network of different kinds of protein filaments*** present through out the cytosol. It forms the structural frame work of the cell; maintain the shape of the cell and aids in the movement of the organelles (including chromosomes) within the cell. The three types of protein filaments, which constitute the cytoskeleton, are described below.

1. The **microfilaments** are the thinnest filaments of cytoskeleton and are composed of a protein called **Actin**. They occur on the periphery of the cell **providing support** and generate the **movement** of the cell.
2. **Intermediate filaments** are thicker than the microfilaments, which are composed of different kinds of proteins. They help in maintaining the position of the organelles such as nucleus.
3. **Microtubules** are the largest components of the cytoskeleton. They are long unbranched hollow tubes composed of a protein called **Tubulin**. They are responsible for intracellular movements like cyclosis, and transport of substances within the cell. They constitute the **spindle fibres** of the mitotic spindle.

8. PLASTIDS

Plastids occur in plant cells only. Chloroplasts contain a green pigment called **chlorophyll**. Present in green **algae** and a **higher plant**, each **chloroplast** is bounded by a double–membrane. Inside the membrane is the matrix or **stroma**. **Grana** which are disc–shaped plates arranged in layers. Leucoplasts are colourless plastids without any pigment. Chromoplasts are coloured plastids, usually orange, yellow or red. Chromoplast imparts colour. Leucoplast stores starch. Chloroplast helps in the process of photosynthesis with the help of solar energy. Plastids occur in most plant cells and are absent in animal cells. Cells of lower non–flowering plants like bacteria, blue–green algae and fungi contain chromatophores instead of plastids. Plastids are self replicating, i.e. they have the power to divide.

They are grouped in two classes:

Pigmented (chloroplast, chromoplast) and **non-pigmented** (leucoplast).

- **Chloroplast**: Present in green algae and higher plants, each chloroplast is bounded by a double membrane. The green pigment chlorophyll traps solar energy and utilizes it to manufacture food for the plant.

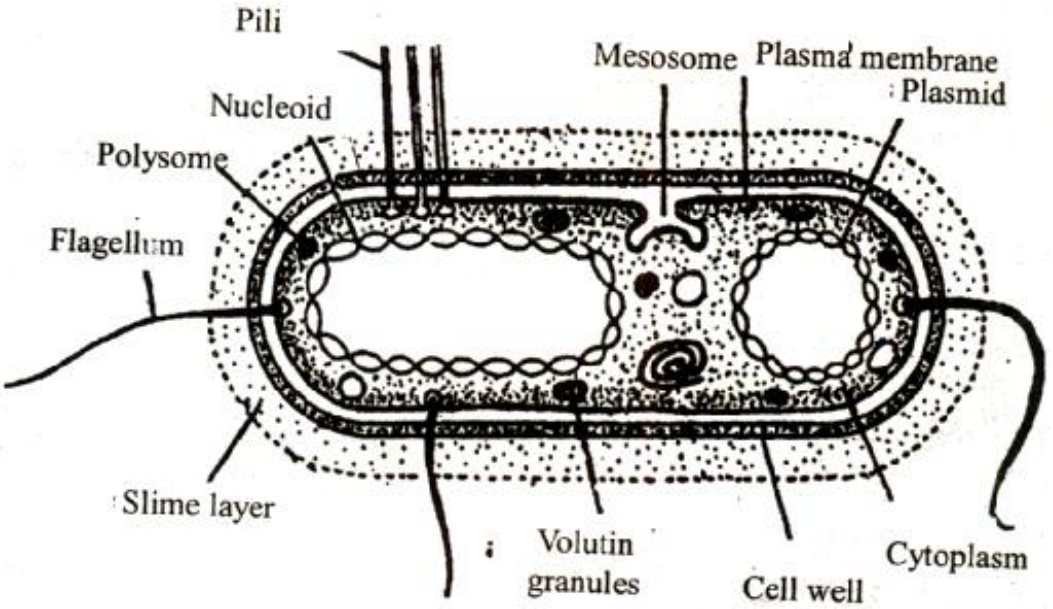
- **Chromoplast**: The variously pigmented plastids by imparting colour to flowers attract insects for pollination. For example
  (i) **Carotenoids** (insoluble in water): Imparts yellow and orange colours. It is contained in carrots.
  (ii) **Anthocyanins** (soluble): Imparts red and blue colours. It is contained in beetroot.
- **Leucoplast**: These are colourless, rod–shaped or spheroid pigments which store food in the form of carbohydrates (starch), lipids and proteins. They are found in seeds, meristematic cells, sex–cells, ground tissue of certain roots and stems.

9. PEROXISOMES

Peroxisomes are mainly found in the mesophyll cells of the leaf. They are the small spherical single bounded cell organelles which store oxidizing enzyme like catalase. It is mainly responsible for photo respiration.

PROKARYOTIC CELL (BACTERIA)

The bacteria are most simple and smallest of all cellular organisms (0.5 to 50). All **monerans**, or all bacteria, are **prokaryotes**. The prokaryotic cell has a definite **cell wall**, a **cell membrane** and a granular **cytoplasm** filled with **ribosomes** and a few clumps of **genetic material**. Many common cell structures, such as the membrane-bound organelles are absent. For instance, no membrane encloses the genetic material to form a distinct nucleus. Instead, the single strand of DNA, called the **bacterial chromosome** is present in the cytoplasm. No golgi bodies and no endoplasmic reticulum are found. The mitochondria are also absent, and their function is done by enzymes found along the cell membrane. The layers around the bacterial cell, i.e., (i) the **Cell membrane** and (ii) the **cell wall** are protective in nature. Without the cell wall, water pressure inside the cell would burst the cell membrane. The strength of the wall is not provided by cellulose but by another **organic complex** substance called **peptidoglycan**. This substance is found only in prokaryotes. This substance has not been found in any **eukaryote** or in **archaebacteria.**



A bacterial cell. Internal structure of a typical rod shaped (bacillus), flagellate bacterium as revealed by electron microscope.

Just beneath the cell wall there is cell membrane, which regulates the passage of materials in and out of the cytoplasm. Only dissolved materials are absorbed and given out. Digestion occurs outside the cell. There is no phagocytosis and no food vacuoles are formed.

Other cell structures:
Many forms of bacteria bear thin, elongated thread like flagella (singular flagellum) which help in their locomotion.

Mesosomes:
The mesosomes arise as invagination of plasmalemma and may become quite a complex whorl of convoluted membranes. The function of mesosomes is controversial. It is believed that the mesosomes are active in cell wall synthesis and in the secretion of extracellular substance. There is considerable evidence that the bacterial nuclear body is attached to a mesosome.

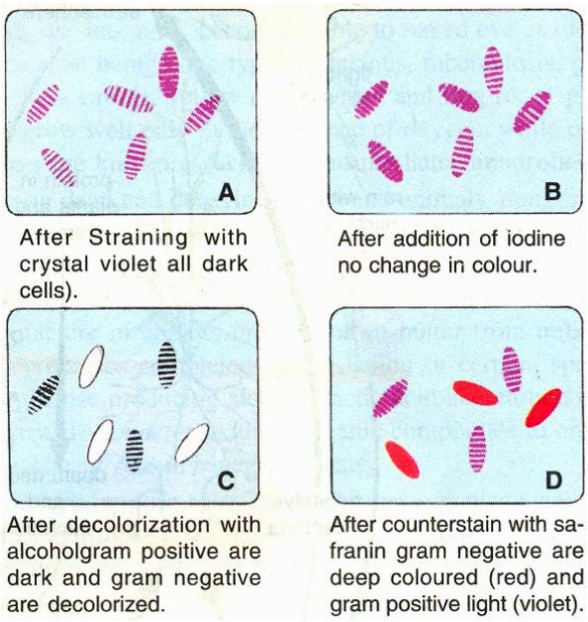
Nucleoid:

Biologists generally agree that bacteria do not have nuclei of the type found in cells of higher plants and animals. Most of the bacteriologists now believe that the nucleus in the bacteria is present in the cell as a discrete body. It does not have nuclear membrane and it divides amitotically. In electron microscope the prokaryotic nuclear region appears as an electron translucent area and can be shown to contain very fine fibrils. These fibrils are molecular strands of DNA and make the **bacterial chromosome**. It is known that DNA comprises the genetic material of living cells. **Histone** proteins are absent. The region of the bacterial protoplasm containing the genetic material is termed as **Nucleoid**. Shortly before a bacterium divides, these DNA bodies divide and are equally distributed to the daughter cells. In this way the DNA bodies resemble chromosomes replicating in a dividing cell.

Plasmids: Some bacteria may also posses a self replicating; circular, naked double stranded DNA which is known as ***Plasmid***. They can exist independently in the cytoplasm or may be integrated with the chromosome. The plasmids can render bacteria drug resistance, give them new metabolic pathways and make them pathogenic.

GRAM-POSITIVE AND GRAM-NEGATIVE

- **BACTERIA:** The cell wall of certain bacteria shows a characteristic reaction to the stain devised by **C. Gram**. Those bacteria which retain the stain are known as **Gram-positive** and those which do not retain the stain are termed **Gram-negative**. The procedure involves staining the cells with the **dye crystal violet** and all bacteria will be stained blue.
- The bacteria are then treated with an iodine solution and then decolorized with alcohol. Gram positive bacteria retain the stain crystal violet, Gram negative are decolorized. This is a fundamental difference between Gram-positive and Gram-negative bacteria.

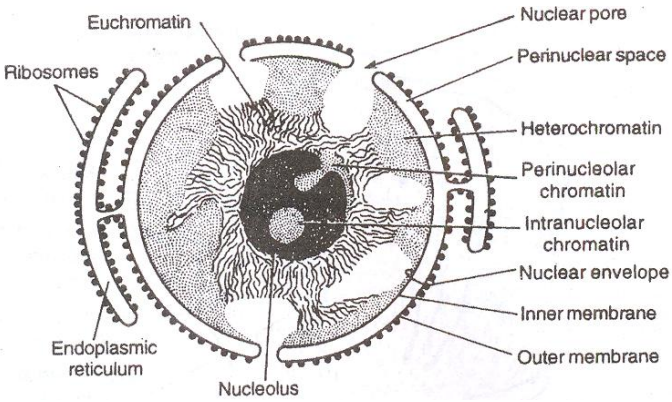


Bacteria –(gram positive and gram negative)

Do you know….?
Gram-positive bacteria cell wall thicker contains only traces of lipids, where as Gram-negative bacteria cell wall is thinner may contain 20 percent lipids. Teichoic acid is present in gram positive bacteria and absent in gram negative bacteria. All this information helped us to prepare many antibiotics to kill some pathogenic bacteria.

NUCLEUS

It is a double-membrane-bound organelle**,** with an inner and an outer membrane, which are together called **nuclear envelope**. Each of the membranes is equal to the cell membrane. The nucleus has a number of openings called nuclear **pores**. The space between the two membranes is called perinuclear space**.** The outer membrane has connections with the endoplasmic reticulum. The nucleus plays a central regulatory role in the activities of the cell. It is usually spherical, generally located in the centre of a cell. It contains a liquid matrix called **karyolymph** or **nuclear sap**.



Electron microscopic view of Nucleus

Chromatin and a nucleolus are suspended in the nuclear sap. Chromosomes contain a complex molecule called deoxyribonucleic acid, which controls the synthesis of various substances, particularly enzymes, and also determines the characters that are transmitted by the parent to its offspring. Therefore, chromosomes are considered as the bearers of hereditary characters. The diffused thread like structures present in nucleus is known as chromatin fibres. These chromatin fibres during cell division condensed to ribbon like structures known as chromosomes. They are made up of DNA and nuclear proteins.

Function:

Controls and regulates all functions. It contains the instructions to make new cells. It maintains hereditary characters through chromosome. Nucleolus participates in protein synthesis. Chromosomes carry hereditary information.

Nucleolus: One or more round–shaped structures inside the nucleus. Dictates ribosome's to synthesize proteins and protein synthesis by manufacturing and storing RNA.

VACUOLE

Vacuoles are the fluid-filled spaces, enclosed by membrane. They are well developed in plant cells, but absent from most animal cells, except the protozoans. Vacuoles are not permanent features in animal cells. These membrane bound vesicles of cell sap are formed and lost as required. In plant cells vacuoles are large and permanent.

Functions:

In plant cells helps in absorption of water, they can maintain **turgidity** of the cell. Vacuolar sap contains food substances such as sugars and minerals salts. They store pigments that give colour to plant structures such as petals. Vacuoles are covered by a membrane known as **tonoplast**.

PROKARYOTIC CELL	EUKARYOTIC CELL
Size of the cell is generally **small** (1-10 μm)	Size of cell is generally **large** (5–100 μm)
Nucleus is absent (Nuclear region '**nucleoid'** is not surrounded by a nuclear membrane)	Nucleus is present (Nuclear material is surrounded by a **nuclear membrane**)
It contains **single chromosome**	It contains more than one chromosome
Nucleolus is absent	**Nucleolus is present**
Membrane bound cell organelles are **absent**	Cell organelles such as mitochondria, plastids, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, etc., are present
Cell wall surrounds the plasma membrane in most cases. It is composed of **peptidoglycans** comprising **polysaccharides** linked to amino acids. Strengthening material is murein.	Cell wall surrounds the plasma membrane in some protists, most fungi and all plants. It is composed of **polysaccharides**. Main strengthening material is **chitin** in most fungi and **cellulose** in others. Animal cells lack cell wall.
Cell membrane bears **respiratory enzymes**.	Cell membrane **lacks** respiratory enzymes
Cell membrane may infold to form **mesosomes** or **photosynthetic lamellae** (**thylakoids**). The latter occur free in the cytoplasm.	Cell membrane **does not form mesosomes** or photosynthetic lamellae. Thylakoids, if present, occur within the chloroplasts.
Cytoplasm lacks organelles (endoplasmic reticulum, mitochondria, golgi apparatus, centrosome, microfilaments, microtubules, intermediate fibres, micro bodies), except ribosomes.	Cytoplasm contains organelles, viz. endoplasmic reticulum, mitochondria, Golgi apparatus, lysosomes, centrosome, microfilaments, intermediate fibres, microtubules and micro bodies, besides ribosomes.
E.g., **Bacteria**	E.g., **Plant** and **Animal** cells

DIFFERENCES BETWEEN PLANT CELL AND ANIMAL CELL	
Plant cell	**Animal cell**
1. Plant cell is surrounded by a rigid, protective **cell wall** Formed of cellulose.	1. There is **no cell wall** in animal cells.
2. Cytoplasm not so dense.	2. Cytoplasm denser and more granular.
3. Only a **thin lining of cytoplasm** mostly pushed to the periphery.	3. Cytoplasm fills almost the entire cell.
4. **Plastids** are of three kinds — chloroplast, chromoplast and leucoplast.	4. Plastids absent.
5. **Vacuoles** occupy large space.	5. Vacuoles are rare and if present are small.
6. **Centrioles** are absent.	6. Centrioles and centrosomes present near the nucleus.

7. **Lysosomes** are absent.	7. Lysosomes present.

Here are some misconceptions and facts based on cell biology.

Common misconception	Facts
1. Cell wall is a living membrane.	1. Cell wall is made of cellulose and other compounds. It is non-living allowed water and dissolved substances to pass through.
2. Vacuole is a cell organelle.	2. Vacuole is fluid filled space which contains cell sap.
3. The protoplasm of the cell decides what the cell will be.	3. The function of the nucleus is to regulate the chemical changes which take place in the cell. As a result, the nucleus determines what the cell will be, e.g., a blood cell, a liver cell, a muscle cell etc.
4. Mitochondria originate from the cytoplasm of the cell.	4. Mitochondria originate from other non-mitochondrial membranes such as infolding of the plasma membrane or nuclear membrane.
5. Viruses are prokaryotes.	5. Viruses being a cellular do not fall into prokaryotic or eukaryotic group.
6. Nucleolus is a single membrane structure.	6. Nucleolus is present inside the nucleus and lacks a membrane.
7. Plant cells lack lysosomes.	7. Some plant cells yeast and fungi do possess lysosomes.

ASSIGNMENT

I. Name the following

1. The scientists who postulated the cell theory ……
2. Collective term for cytoplasm and nucleus ……
3. The site of protein synthesis in a cell …….
4. The powerhouse of the cell ……
5. The brain of the cell ……..
6. The suicidal bags of the cell ……
7. It provides a large surface inside the cell for various physiological activities …….
8. The plastids containing green pigment ……
9. The structures which initiate cell division in animal cells ……..
10. The scientist who coined the term cell ……..
11. A cell organelle found only in animal cell ……..
12. A part of chromosome having hereditary unit …….
13. The structure which initiates cell division in animal cells ……
14. The region of the bacterial protoplasm containing the genetic material …….
15. The process by which living organisms obtain energy for their life activities ……..
16. The parts which act as bearers of hereditary units ……
17. The cell organelles which are responsible for intercellular transport ……
18. The cell organelles which are responsible for intracellular transport …….
19. The cell organelles known as prokaryotic cell present in eukaryotic cell …….
20. The cell organelles provide precursors of different secretory substances of golgi apparatus.

II. Complete the following statements by choosing the correct alternative out of those given in Brackets.

(i) Membrane-bound non-living structures in a cell are …….
(Organelle les / Ergastic substances / Vacuoles)

(ii) All living cells contain ……
(Protoplasm / Plastids / Centriole)

(iii) RBCs do not have ……..……..
(Nucleus / Cytoplasm / Hemoglobin)

(iv) The largest cell in the living world …….
(Egg of ostrich / PPLO / Sieve tube)

(v) The master of cell or key performer in cell is ……..
(Nucleus / Ribosome / Cell wall).

(vi) The part of cell associated with heredity is …….
(Centrosome / chromosome / nucleolus)

III. Mention if the following statements are **true/false**. If false, rewrite the sentence by changing only the words printed in bold face.

(i) **Lamarck** propounded the Cell Theory ……
(ii) **Robert Hooke** discovered the wonder world of microbes ……
(iii) **A. Van Leeuwen Hook** discovered cell. ……
(iv) **Endoplasmic reticulum** is concerned with protein synthesis ……..

IV. Match the cell organelles with the special functions they perform.

I		II
	Cell organelle	**Special function**
1.	Nucleus	a. Packaging secretions
2.	Ribosome	b. Initiation of cell division
3.	Golgi complex	c. Photosynthesis
4.	Mitochondria	d. Protein synthesis
5.	Chloroplasts	e. Regulates cell functions and is concerned with the transmission of hereditary characters
6.	Centrosome	f. Cellular respiration

V. Tick the most appropriate answer

(i) The cell wall —
(a) Helps in protein synthesis (b) traps solar energy
(c) Provides rigidity to plant cells (d) is selectively permeable.

(ii) **Genes are —**
(a) finger-like processes found in mitochondria
(b) Coloured plastids found in flowers and fruits
(c) Tiny sacs containing destructive (hydrolytic) enzymes
(d) Hereditary units present on chromosomes.

(iii) **The site of protein synthesis in a cell is**
(a) Lysosome (b) ribosome
(c) Mitochondria (d) Golgi apparatus.

(iv) **Respiration is**
(a) An anabolic process
(b) A process by which living organisms respond to stimuli
(c) A catabolic process
(d) Exhibited by animals only.

(v) **Chloroplast, leucoplast and chromoplast are different kinds of**
(a) Plastids (b) vacuoles
(c) Golgi bodies (d) granules.

VI. **Define** the following terms:
(i) Leucoplast (ii) Genes (iii) Protoplasm

VII. **Differentiate** between
(i) Cytoplasm and Protoplasm (ii) Cell organelles and Ergastic substances
(iii) Nucleus and Nucleolus (IV) Anabolism and Catabolism
(v) Cell membrane and Cell wall

VIII. Differentiate between a **plant cell** and an **animal cell.**

IX. Find the **odd one** in each of the following and give the **reason** for your answer.
(i) Cell wall, centrosome, plastid, large vacuole.
(ii) Chromatin, chromosome, cristae, genes.
(iii) Cell membrane, chloroplast, nucleus, cell wall.
(iv) Ribosome, Golgi apparatus, chromatin, nucleus.
(v) Nutrition, protoplasm, respiration, excretion.
(vi) Fat droplet, glycogen, cell membrane, starch.

X. State **one main function** of the following

(i) Nucleus	(ii) Ribosome	(iii) Mitochondria	(iv) Golgi apparatus
(v) Chromosomes	(vi) Cell wall	(vii) Chloroplast	(viii) Lysosome
(ix) Cell membrane	(x) Centrosome		

XI. Do you think the cells of an elephant would be larger than the cells of a rat? Explain briefly.

XII. (a) Give three main functions of nucleus.
(b) What is the name of the chemical substance of which genes are made?

XIII. Write any six structures found in both plant and animal cells.

XIV. Describe any five activities which are the outcome of cell activities.

XV. Given below is an example of a certain structure and its special functional activities, e.g., **centriole** and **spindle formation**. On a similar pattern, fill in the blanks

(i)	Ribosome	and _____
(ii)	Chloroplast	and _____
(iii)	Mitochondria	and _____
(iv)	Cell wall	and _____

CPP

1. Give some examples of specialised cells, mentioning their functions.

2. Complete the right column of the table by matching the cells with the correct number from the list of functions.

Name of the cell	Function
Muscle cell	(i) Absorbs salts and water from the soil.
Palisade cell	(ii) kills bacteria
Root hair cell	(iii) makes food by photosynthesis
Sensory neuron	(iv) carries electrical impulses
White blood cell	(v) Shorten to bring about movements.

3. List any five activities of an organism which are the outcome of the cell activities.

4. The diagram below represents a cell.

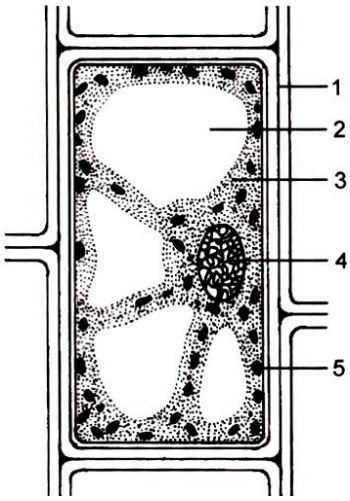
a. Name the parts numbered 1 to 5.

b. Is it a plant cell or an animal cell? Give one reason in support of your answer.

c. Name one important chemical substance found in part 1.

d. Name one organelle which is clearly shown in the diagram but has not been indicated by a guideline.

e. According to the diagram how many cells would be surrounding this single cell?



6. Study the figure given below and answer the questions which follow.

(i) Is this a plant or an animal cell? Give three reasons in support of your answer.

(ii) Name the parts (1 to 6) indicated by guidelines.

(iii) State one main function of each of the following