
THE FUNDAMENTAL UNIT OF LIFE

- **Discovery of Cell:**

The history of the cell begins with the publication of the classical work "Micrographia" in London by Robert Hooke in 1665. The credit of discovery of cell goes to Robert Hooke who observed honeycomb pattern in very thin slice of cork. The honeycomb like structure was made of enclosed box-like compartments. He used the Latin term 'cellulae' (cells) for little compartments with hollow space. Cell is a Latin word for little room.

- **Shape of the cells:**

- The shape of cells is determined by the cell environment and cell activities they perform.
- The cell shape could be more or less fixed and peculiar for a particular type of cell.
- Living cell has capacity to perform certain basic functions that are characteristic of all living forms.

- **Organisms can have cells of different kinds.**

- (i) Blood cells (Discoïd shaped)
- (ii) Nerve cells (Elongated shaped)
- (iii) Sperm (Tadpole shaped)
- (iv) Ovum (Spherical shaped)
- (v) Smooth muscles cells (Spindle shaped)



- **Size of the cells**

- The size of the cells is related to the specific functions they perform.
- It may vary from 1 micrometer to 100 micrometer ($1 \mu\text{m} = 10^{-6} \text{m}$)

- **Types of cells**

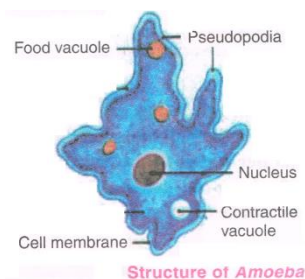
(a) On the basis of number of cells, organisms can be grouped under two major categories.

The organisms made of single cells are called unicellular organisms. e.g., Amoeba, Paramecium

The organisms made of many cells are called multicellular organisms. e.g., Plants and Animals

Unicellular organisms:

- The organisms made of single cell are called unicellular organisms.
- A single cell carries out all life process.
- Numerous extensions of cell membrane of single cell helps to increase the surface area to exchange the information and material through the surface.
- The unicellular organisms have also division of labour.
- They are easily susceptible to damage and lead to death of an organism.
- E.g., Amoeba, Paramecium.

**Multicellular Organisms:**

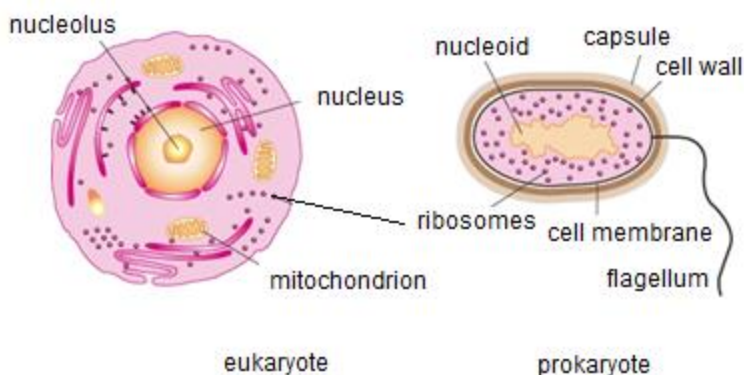
- The organisms made of many cells are called multicellular organisms.
- A multicellular organism is not a simple aggregation of cells.
- Multicellular organisms are more efficient and carry out number of activities.
- These organisms have greater capacity of survival as death of a few cells is not of serious consequence and are replaced continuously.
- There is a division of labour in multicellular organisms such as human beings.
Different parts of human body perform different functions. The human body has a heart to pump blood , a stomach to digest food and so on.
- Examples: Some fungi, plants and animals.

(b) On the basis of nature of nucleus: The cells can also be grouped into two categories:**(i) Prokaryotic cells:**

- A cell does not possess membrane-bound organelles is called Prokaryotic cell.
- Even the chromosome is not enclosed in a membrane.
- The primitive nucleus lies freely in the cytoplasm.
- Examples: Bacteria and cyanobacteria (Blue green algae)

(ii) Eukaryotic cells:

- A cell which possesses organelles, i.e., membrane bound structures like nucleus, mitochondria, chloroplasts is called Eukaryotic cell.
- The intracellular compartmentalisation is well reported.
- The eukaryotic cells further show diversities in plant cells and animal cells.

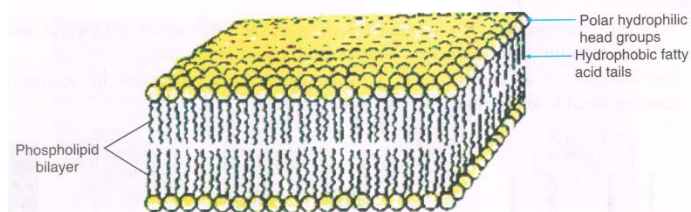


▪ **Structure of the cell:**

If we study under the microscope, we would come across under three features in almost every cell.

- (a) Plasma membrane
- (b) Nucleus
- (c) Cytoplasm

(a) Plasma membrane:



- Plasma membrane is thin, flexible, selectively permeable membrane, covering the cell.
- It is composed of lipid and protein.
- It separates the contents of the cell from its external environment.
- It is a selectively permeable membrane.
- **Diffusion:** A spontaneous movement of any substance from a region of high concentration to the region of lower concentration is called diffusion.

Note:

- In cellular respiration, oxygen diffuses into the cell from extracellular fluid because its pressure is higher in the extracellular fluid than in the cell.
- CO₂ diffuses out from the cell because its pressure is higher than in the extracellular fluid.

- **Osmosis:** It is the passage of water from a region of higher water concentration to a region of lower water concentration through a semi-permeable membrane.

On the basis of given definition what will happen:

If the plant cell or animal cell is put into sugar solution or salt solution, then any one of the following processes may take place.

- (i) If the concentration of water around the cell is more than that in the cell (**hypotonic condition**), then water enters into the cell through osmosis.
The cell will swell.
- (ii) If the concentration of water is the same inside and outside the cell (**Isotonic condition**) then there will not be movement of water on the either side.
- (iii) If the concentration of water outside the cell is less than inside the cell (**hypertonic condition**) then water moves out of the cell. The cell shrinks.

When a plant cell is placed in a hypertonic solution then a plant cell loses water through osmosis and there is a shrinkage or contraction of the contents of the cell away from the cell wall, this phenomenon is called **plasmolysis**

Endocytosis is a process by which cell takes in food from the outside by engulfing and fusing them with its plasma membrane.

Cell wall

- It is non-living and freely permits the entry of substances.
- Apart from cell membrane, the cells of all plants and fungi have a rigid, protective covering outside the plasma membrane called cell wall.
- Cell wall is absent in animal cells.
- The plant cell wall is composed of cellulose.

Function of cell wall:

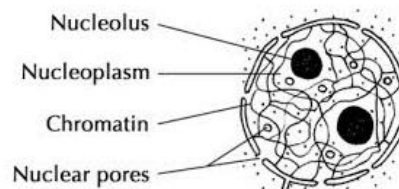
- It gives definite shape and rigidity to the cell.
- It protects the internal protoplasm against injury.
- It transports various substances in and out of the cells.

Remembering facts about cell wall:

- Cell wall permits cells of plants, fungi and bacteria to withstand hypotonic conditions by taking in water. By this the cell swells, building up pressure against the cell wall. The wall exerts an equal pressure against the swollen cell.

Nucleus:

- Nucleus was first observed by Robert Brown in 1831.
- Nucleus has double layered covering called nuclear membrane.
- Nuclear membrane has pores which allow the transfer of materials from inside and outside the nucleus into the cytoplasm.
- Nucleus contains rod shaped structures called chromosomes (in dividing cells).
- Chromosomes contain information for inheritance of characters or traits from parents to next generation in the form of DNA (Deoxyribo nucleic acid).
- Genes: Genes are the functional segments of DNA.
- In non-dividing cells DNA is present as chromatin material which is visible as an entangled mass of thread like structures.
- Whenever the cell is about to divide, the chromatin material gets organized into chromosomes.

**Function of nucleus**

- Nucleus plays important role in cellular reproduction, the process in which a single cell divides and forms two new cells.
- It also helps in determining the way the cell will develop and directing the chemical activities of the cell.

Remembering facts about nucleus:

- Nuclear membrane is absent in bacterial cells (Prokaryotic Cells)
- An undefined nuclear region in prokaryotic cell containing only nucleic acids is called **nucleoid**.

Cytoplasm:

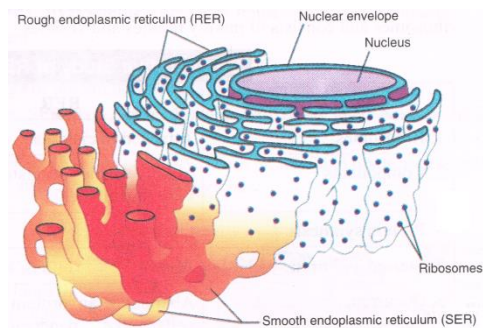
- The term 'cytoplasm' is used for the fluid content inside the plasma membrane.
- The cytoplasm is jelly-like fluid covered by plasma membrane and contains the organelles.

Functions of cytoplasm:

- It is the active site of several metabolic processes like sugar, protein and fatty acid synthesis.
- It contains many specialised cell organelles.
- It helps in exchange of materials between cell organelles.

Cell Organelles:

- Every cell has a membrane around it to keep its own contents separate from the external environment.
- To perform various functions, the cell has organelles.
- In these organelles nucleus, mitochondria, chloroplast, Golgi body, Endoplasmic reticulum, plastids, vacuoles and ribosomes are included.
- These organelles do protein synthesis, photosynthesis and energy (ATP) synthesis.

Endoplasmic Reticulum:

- The term ER was given by K. Porter.
- Endoplasmic Reticulum is a large network or reticulum of membrane bound tiny tubular structures in the cytoplasm.
- The ER network connects the nucleus with the cell membrane.
- ER are of two types:

Rough Endoplasmic Reticulum (RER)

When ribosomes are attached to the outer surface of ER, the endoplasmic reticulum is rough ER.

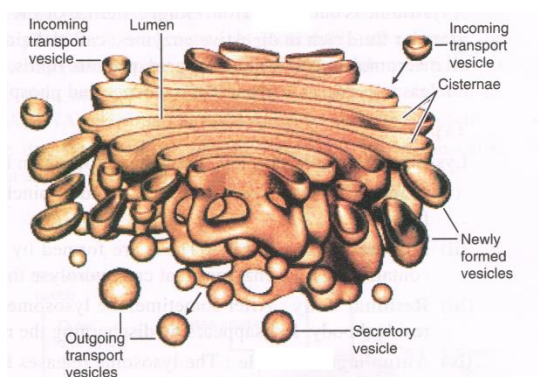
Function: Ribosomes are the site of protein synthesis. So, it manufactures protein.

Smooth Endoplasmic Reticulum (SER)

In the absence of ribosomes or when no ribosomes are attached to the surface of ER they appear smooth and are called smooth endoplasmic reticulum.

Function: No ribosomes are present. So, SER manufacture lipid or fat molecules important for cell functioning.

- The manufactured proteins are delivered to various places in the cell depending on need using the ER and lipid important for cell function.
- **Note:** The manufactured proteins and lipids help in building the cell membrane. This process is known as membrane biogenesis.
- **Function of ER:**
 - ◆ ER serves as channels for transport of proteins between different regions of the cytoplasm or between the cytoplasm and the vacuoles.
 - ◆ It also functions as cytoplasmic framework and provides a platform for some of the biochemical activities of the cell.

Golgi Body:

- Golgi apparatus was first observed by Camillo Golgi.
- These consist of membrane bound vesicles arranged parallel to each other in stacks called **cisterns**.
- These cisterns often have connections with the membranes of ER and therefore constitute another portion of a complex cellular membrane system.

Functions of Golgi Apparatus:

- Secretion is the main function of the Golgi complex.
- The material synthesized near the ER is packaged to various targets inside and outside the cell through Golgi apparatus.
- Its main functions include the storage, modification and packaging of products in vesicles.
- It also participates in the formation of lysosomes.

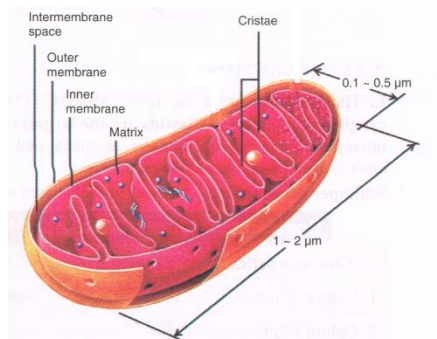
Lysosomes:

- Lysosomes were discovered by Christain de Duve.
- Lysosomes are membrane bound structures formed by the process of packaging in the golgi apparatus.
- Lysosomes contain powerful digestive enzymes which help to keep cell clean by digesting any foreign material such as bacteria or food, as well as old organelle, which break them up into small pieces.
- During the disturbance in cellular metabolism, when the cell gets damaged, lysosomes may burst and the enzymes digest their own cells. Therefore, lysosomes are called 'suicidal bags' of a cell.
- These enzymes are made by RER.

Functions of Lysosomes:

- (i) Lysosomes act as waste disposal system of the cell.
- (ii) These help to keep the cell clean by digesting any foreign material and worn out cell organelles.
- (iii) Lysosomes contain powerful digestive enzymes that can breakdown organic matter.
- (iv) Lysosomes are defensive organelles.

Mitochondria



- Mitochondria were first discovered by Kolliker and then Benda coined the term mitochondria.
- Mitochondria are essential for aerobic respiration of eukaryotic cells.
- They are also known as powerhouse of the cell.

Note: The energy required for various chemical activities needed for life is released by mitochondria in the form of ATP (Adenosine Triphosphate) molecules. ATP is known as energy currency of the cell. The body uses stored energy in the form of ATP for making new chemical compounds and for mechanical work.

Structure of Mitochondria:

- Mitochondria are sausage shaped or cylindrical.
- Each mitochondrion is a double membrane structure.
- The outer membrane is very porous and forms continuous lining boundary of the organelles.
- The inner membrane is deeply folded.
- The inner membrane of mitochondria has many infoldings which create a large surface area for ATP generating chemical reactions.
- Mitochondria contains its own DNA and ribosomes. Therefore mitochondria are able to make some of their own proteins. So mitochondria are called semi-autonomous organelles.

Function of Mitochondria:

- Mitochondria are the sites of aerobic respiration. They produce cellular energy in the form of ATP. Hence they are called "Powerhouse of the cell".
- DNA present in the mitochondria helps self-duplication. So, mitochondria are called semi-autonomous organelles.

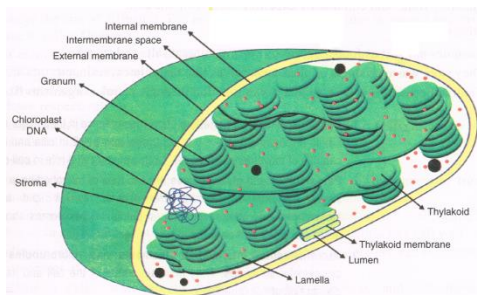
Plastids

- E. Haeckel introduced the term "plastids".
- Plastids are the plant cell organelle.
- Plastids bear some specific pigments thus, imparting specific colours to the plants.

Types of plastids based on its Pigments:

- (i) Chloroplasts (green) (ii) leucoplasts (colourless) (iii) chromoplasts (coloured)

Chloroplasts: Chloroplasts contain chlorophyll pigments which impart green colour to the plants and are important for photosynthesis.



Leucoplasts: These are colourless pigments. They do not impart any colour but are important for storage of starch, oil, and proteins.

Chromoplasts: Impart other than green colour. Present in petals and fruits.

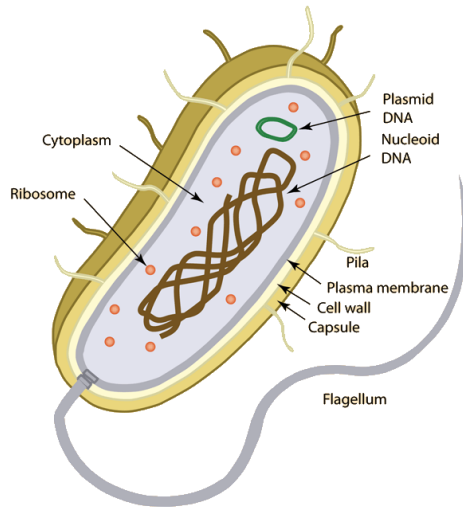
- Plastids consist of numerous membrane bound layers embedded in a material called the stroma.
- Plastids have their own DNA and ribosomes.

Vacuoles:

- The vacuole is single membrane-bound space found in the cytoplasm.
- Vacuoles are small sized.
- In plants cells, the vacuoles occupy upto 90% volume of a cell.
- In plant cells, vacuoles are full of cell sap and provide turgidity and rigidity to the cell.
- Its membrane is called tonoplast and it facilitates the transport of a number of ions and other materials (amino acids, sugars, various acids and proteins).
- It also contains water, sap, excretory product and other materials which are not useful for the cell.
- In single-celled organisms like Amoeba, the food vacuoles contain the food items.
- In some unicellular organisms, specialised vacuoles also play important roles in expelling water and some wastes from the cell.

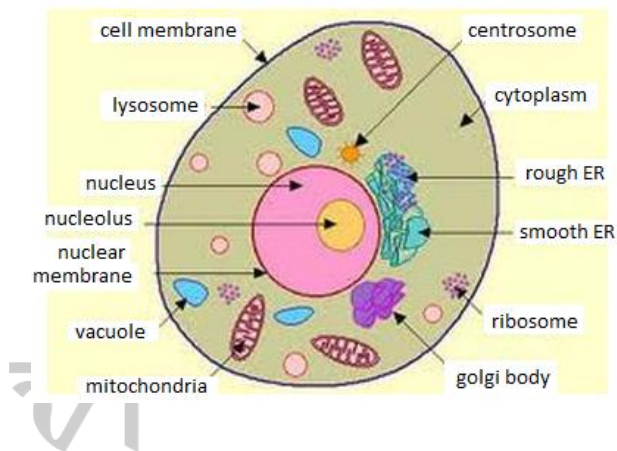
Prokaryotic cell

- Single membrane system
- Very minute in size
- Nuclear region (nucleoid) not surrounded by a nuclear membrane
- Membrane bound cell organelle are absent
- Example-Bacterial cell



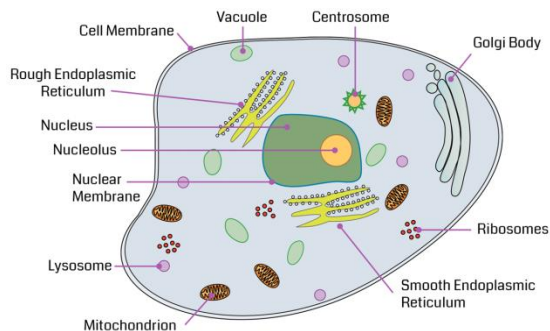
Eukaryotic cell

- Double membrane system
- Large in size
- Nuclear region surrounded by a nuclear membrane
- Membrane bound cell organelle are present
- Example-Plant and animal cell



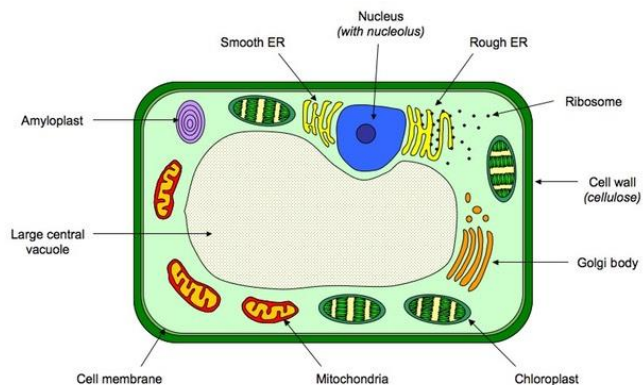
Animal cell

- Animal cell is small in size
- Plasma membrane is the outermost covering. Cell wall is absent
- The shape of animal cell is not definite due to absence of cell wall
- Vacuoles are either absent or very small



Plant cell

- Plant cell is larger in size
- Outside plasma membrane, plant has rigid cell wall. The rigid cell wall gives definite shape to the cell
- Vacuoles are present



RER

- Attached to cistern
- Protein synthesis occurs
- Lipid synthesis does not occur

SER

- absent
- protein synthesis does not occur
- lipid synthesis occurs

assignment

- 1) Who discovered cells and how?
- 2) Why is cell called structural and functional unit of life?
- 3) How is prokaryotic cell different from eukaryotic cell?
- 4) Write the general characteristics of cell.
- 5) How unicellular organism differ from multicellular organism?
- 6) Who proposed cell theory? Write the postulates of the theory.
- 7) State the Virchow's cell theory.
- 8) How unicellular organisms like amoeba, paramecium survive yet they contain single cell?
- 9) Write two points of difference between nuclear region of a bacterial cell and nuclear region of an animal cell.
- 10) Name the special case of diffusion through a selectively permeable membrane.
- 11) How do substance like carbon dioxide and water move in and out of the cell? Explain.
- 12) Why plasma membrane is called a selectively permeable membrane?
- 13) When a living plant cell loses water through of osmosis, there is contraction of the contents of the cell away from the cell wall. What is this phenomenon called?
- 14) List the constituents of plasma membrane.
- 15) How does an amoeba obtain its food?
- 16) List two main functions of plasma membrane.
- 17) What will happen when a plant cell is placed in
 - (i) hypotonic solution?
 - (ii) sugar solution?
- 18) Why the nucleus is called director of the cell?
- 19) What is osmosis?
- 20) Write differences between osmosis and diffusion.
- 21) Name the two organelles we have studied that contain their own genetic material?
- 22) If the organization of a cell is destroyed due to some physical or chemical influence, what will happen?
- 23) Why are lysosomes known as suicidal bags?
- 24) Where are proteins synthesized inside the cell?
- 25) What would happen to the life of cell if there was no Golgi apparatus?

- 26) Which organelle is known as the power house of the cell and why?
- 27) Where do lipids and proteins constituting the cell membrane get synthesized?
- 28) What are the different types of endoplasmic reticulum? Write the functions of each.
- 29) What is the function of Golgi body?
- 30) In which form mitochondria release energy?
- 31) Inner membrane of mitochondria is deeply folded. What is the advantage of these folds?
- 32) Explain the term ATP.
- 33) Give one word answer of the following:
- (i) Organelle containing chlorophyll
 - (ii) An organelle with cristae
 - (iii) An organelle with ribosome attached to its surface.
 - (iv) Plastids that help in photosynthesis
 - (v) Organelle called factory of ribosomes
 - (vi) Organelle called suicidal bags
 - (vii) Organelle called power house of the cell
 - (viii) Cell organelle, which is able to destroy the damage cell
 - (ix) Component of which cell wall is made of.
 - (x) Organelle which serve as channel for transport of material between cytoplasm and nucleus.
- 34) Give reason:
- (i) Ribosomes called protein factories.
 - (ii) Nucleus is called brain of the cell.
 - (iii) Mitochondria and plastids are able to synthesize some of their proteins.
 - (iv) The Golgi apparatus are called secretory organelle of the cell.
 - (v) A cell is a building block of an organism.
- 35) In which cell organelle, the complete breakdown of glucose (in presence of oxygen) takes place?
- 36) Which molecules in a cell are known as the energy currency of the cell?
- 37) What is role of ribosomes in cell?
- 38) What is the functional segment of DNA?
- 39) What does the nucleus contain?
- 40) What does chromosome contain?
- 41) What is the function of cellulose in plant cells?
- 42) What are genes? Where are they located?
- 43) What are chromosome made up of?
- 44) Name the cell organelle present only in plants which have their own genome and ribosomes.
- 45) What is endocytosis?

- 46) Where does ATP synthesis occur in mitochondria?
- 47) Name two structures that are found in animal cell but not in plant cell.
- 48) Name the organelle of the cell, which has membrane bound sac filled with powerful digestive enzymes. Write its functions in the cells.
- 49) Define membrane biogenesis.
- 50) What happens to an animal cell when it is placed in a very dilute external medium? Why?
- 51) Write functions of Golgi apparatus and lysosomes.
- 52) Why does skin of your fingers shrink when you wash clothes for a long time?
- 53) Why is endocytosis found in animals only?
- 54) A person takes concentrated solution of salt. After sometime he starts vomiting. What is the phenomenon responsible for such situation?
- 55) How are chromatin, chromatid and chromosome related to each other?
- 56) Define following terms:
- (i) Protoplasm
 - (ii) Cytoplasm
 - (iii) Nucleoplasm
- 57) Write difference between plant cell and animal cell
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Forgiveness is the best form of love.

It takes a strong person to say a sorry

and

an even stronger person to forgive.
