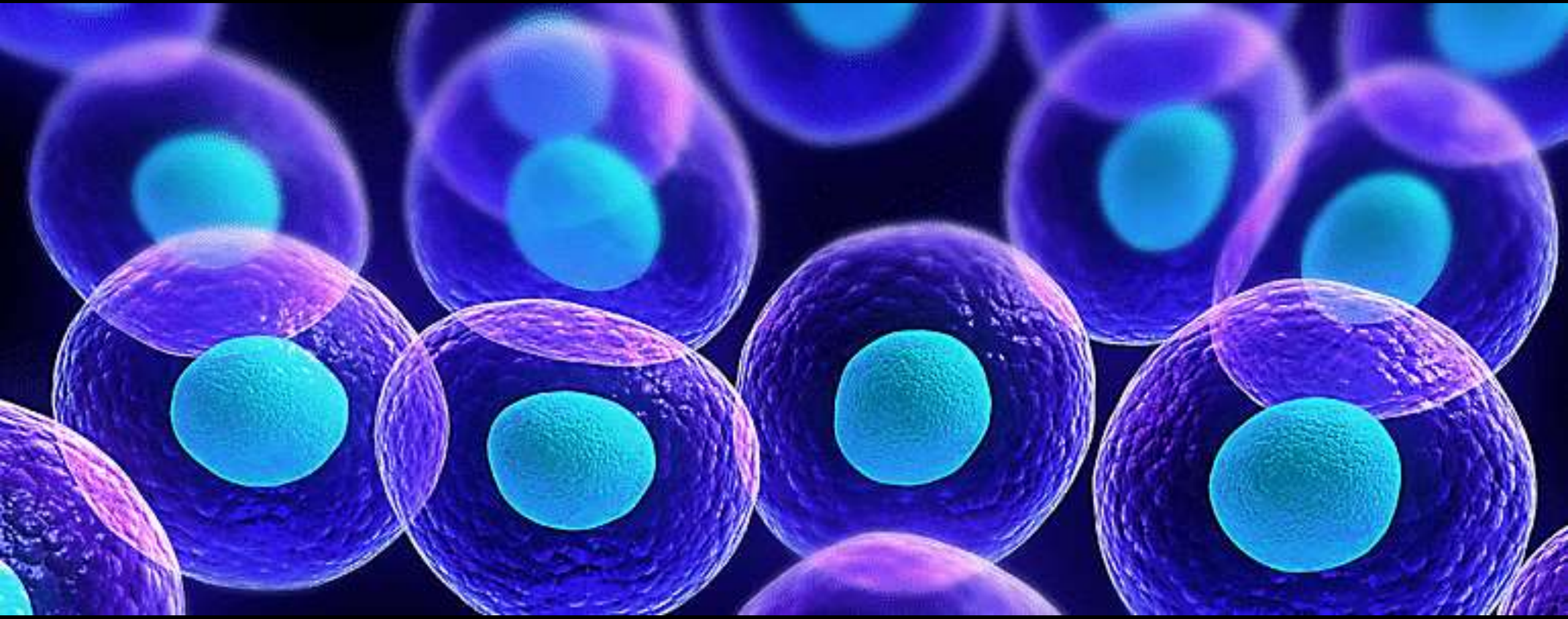
Cell.

The Fundamental Unit Of Life



Introduction

- Cell is the structural and functional unit of life.
- All living organisms in this universe are made up of cells.
- They either exist as a single cell or as a combination of multiple cells.

Robert Hooke and "Cells"

CELLS IN A PIECE OF CORK

Hooke's famous 1665 image of "cells" in cork

ROBERT HOOKE'S MICROSCOPE (1665)

Hooke's compound microscope

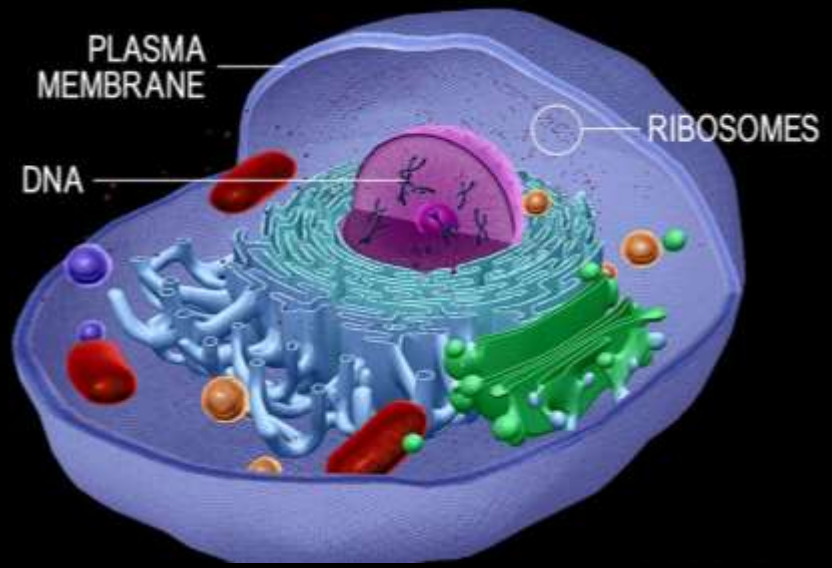
- Hooke and contemporaries did not have any understanding of cells as we now known them
- Cork "cells" are the cellulose walls that remain long after the cells that made them die

Cork

Bark of tree.

What is a Cell?

The bodies of living organisms are made up of microscopic units called Cells.



"basic structural and functional unit of living organisms"

Discoveries about cells : The Fundamental Unit of Life

Discovered By	Period of time	What they discovered?
Robert Hooke	1665	noticed the presence of cells in a cork slice
Leeuwenhoek	1674	found the presence of living cells in the pond water
Robert Brown	1831	recognized the existence of a nucleus in the cell
Purkinje	1839	invented the term 'Protoplasm' which is the liquid present in a cell
Schleiden and Schwann	1838, 1839	presented the cell theory that all organisms are actually made up of cells
Virchow	1855	suggested that all cells come from cells that already exist in nature

The Cell Theory

Originally proposed by Schleiden and Schwann

- All the living organisms (plants and animals) are composed of cells.
- Cell is the basic unit of life.

Extended by Rudolf Virchow

- All the living organisms (plants and animals) are composed of cells.
- Cell is the basic unit of life.
- All the cells arise from preexisting cells.

Types of Organisms

Unicellular Organisms

- Organisms consisting of only one independent cell.
- Examples: Amoeba, Paramecium, Chlamydomonas, bacteria, yeast, etc.

Multicellular Organisms

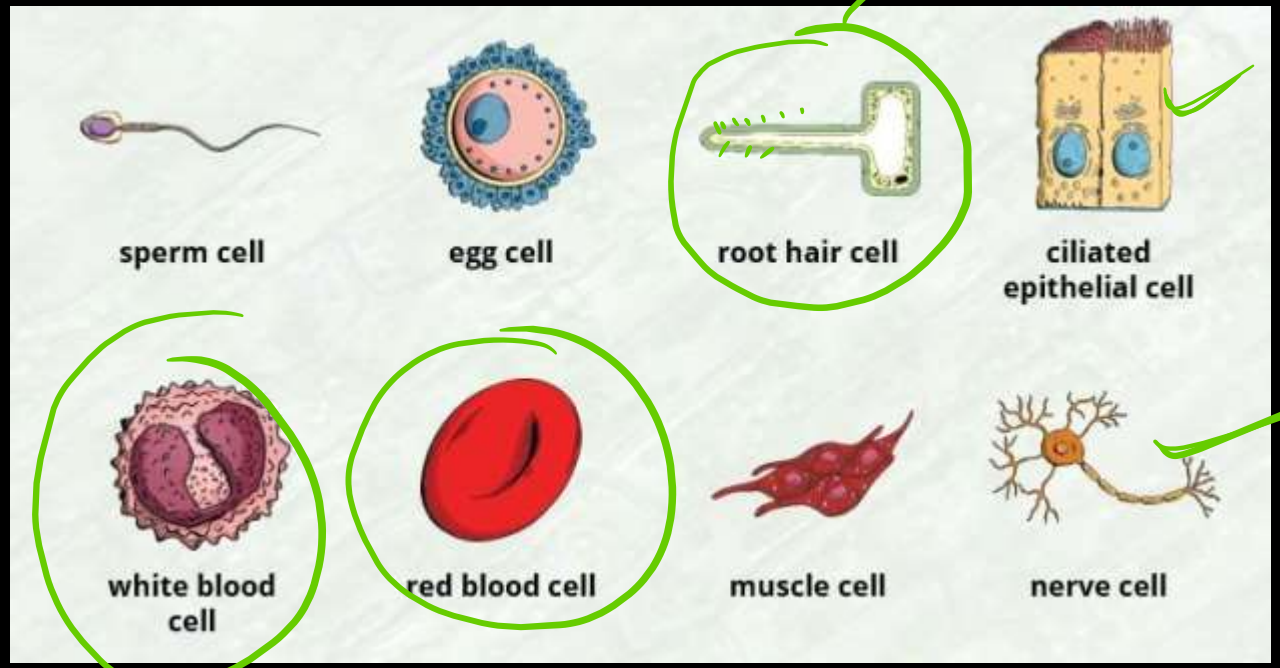
- The organisms which contain various cells that perform different functions in the organism and forms various body parts.
- Examples: Plants, fungi and animals, humans

Different types of Cells from the Human Body

- The shape and size of the cell are different according to the function they perform.
  - There is division of labour in cells.
- Each cell has certain type of cell organelle to perform different type of function like mitochondria for respiration.

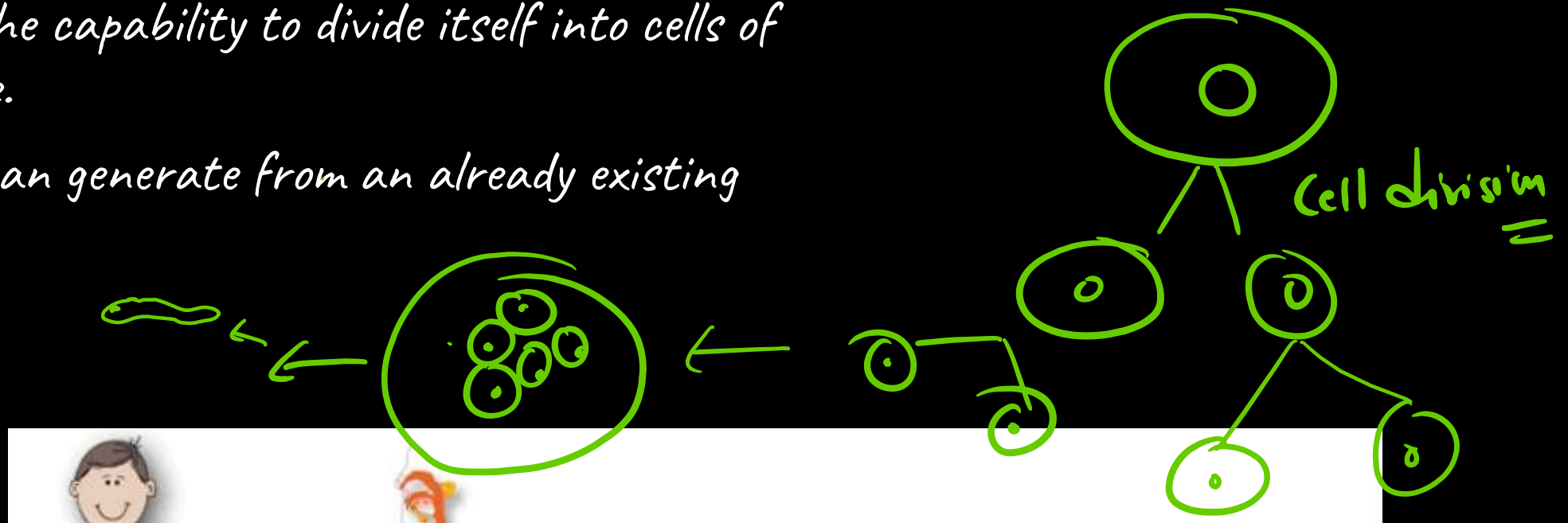
energy

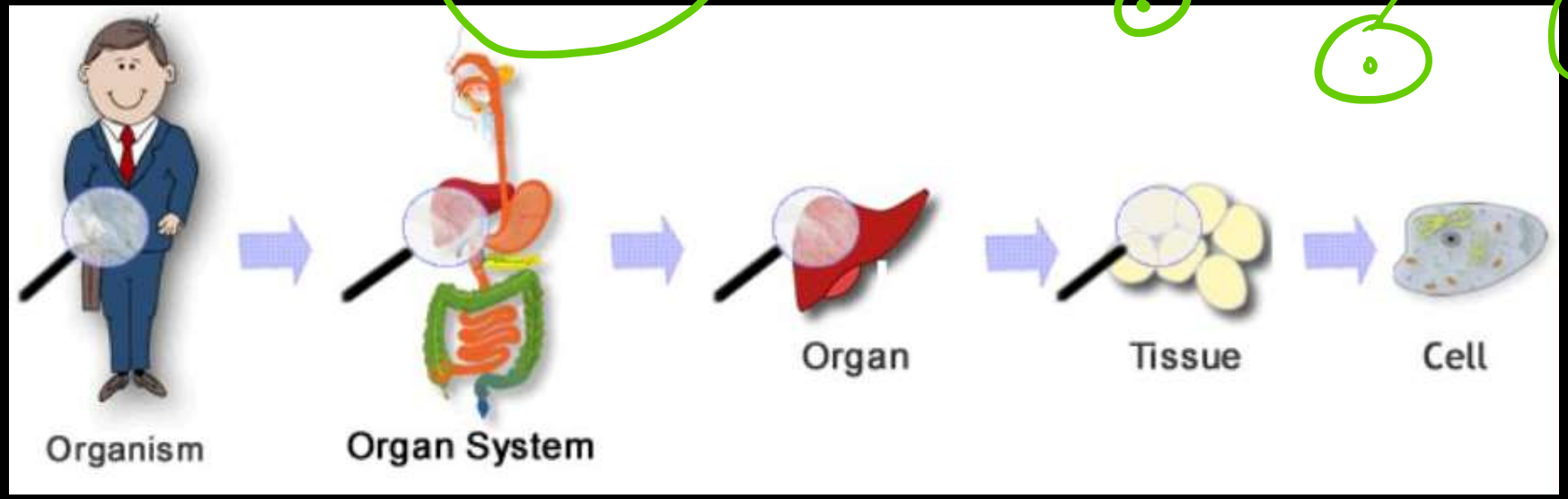
Plant



How can multicellular organism originate from a single cell?

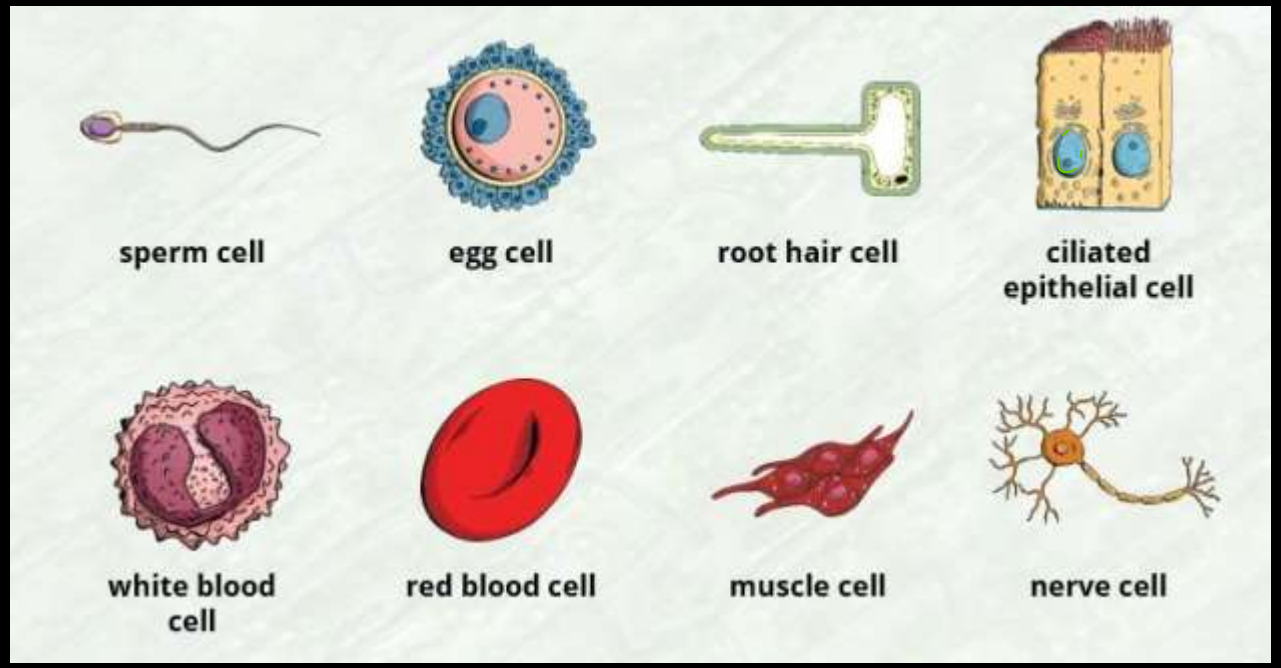
- A cell has the capability to divide itself into cells of its own type.
- More cells can generate from an already existing cell.





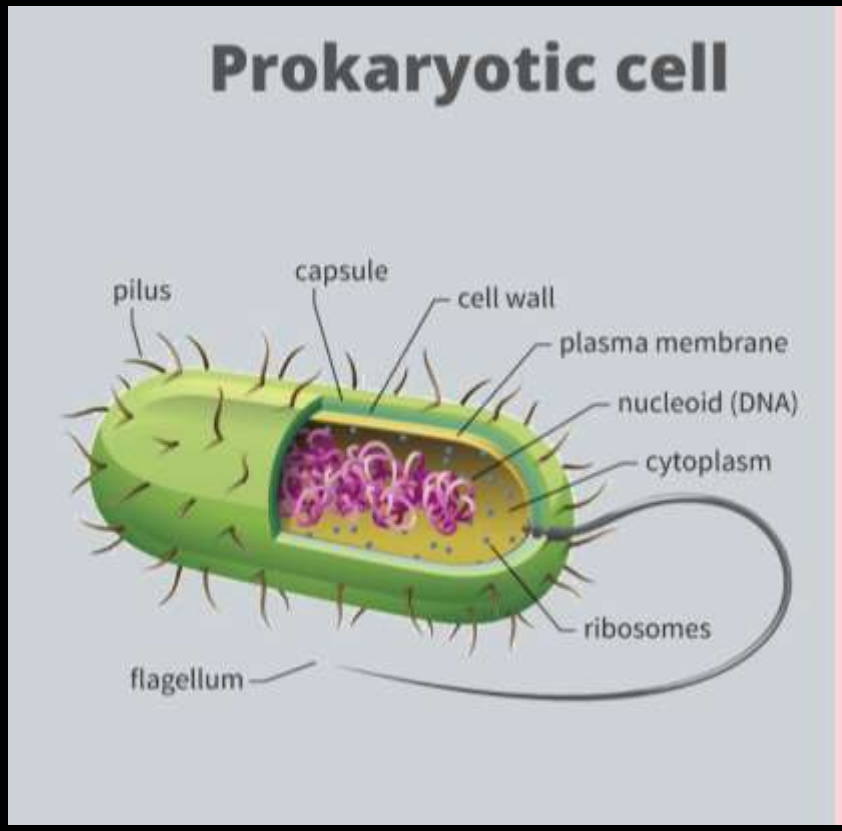
The shape of the cell

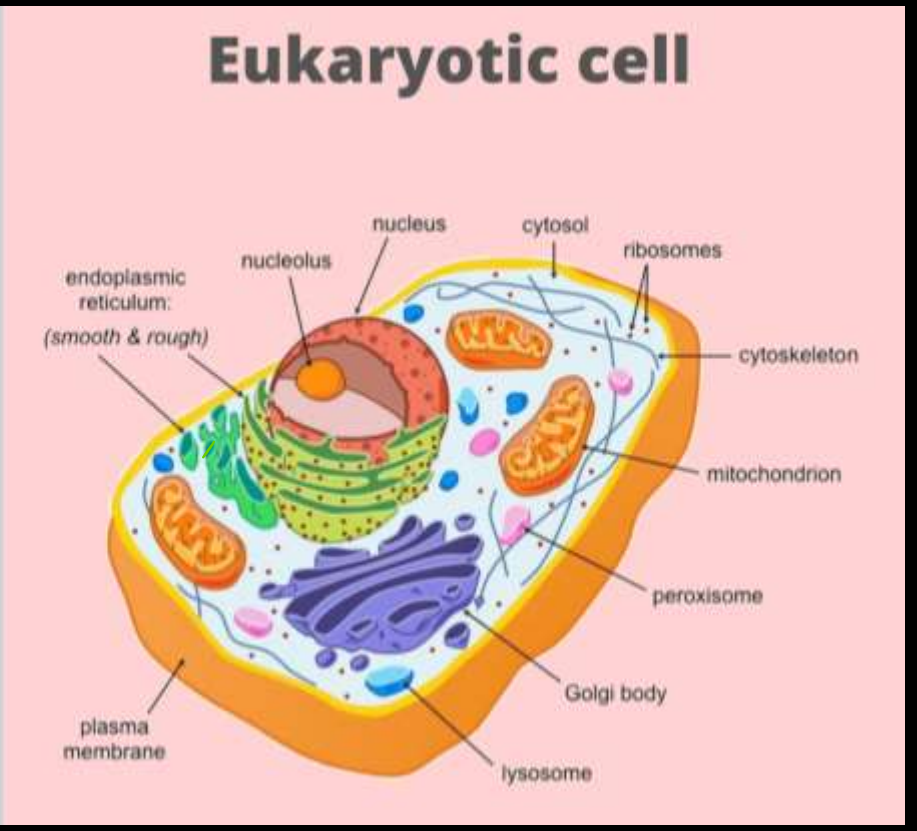
- The shape of the cell may vary depending upon the type of function they perform in an organism.
- Cells are capable of changing their shape. For example, the white blood cells and amoeba can change shapes on their own.



Types of cells

- Prokaryotic Cell (Prokaryotes)
  - Organisms in which genetic material is not bound by nuclear membrane.
- Eukaryotic Cell (Eukaryotes)
  - Organisms in which genetic material is bound by a nuclear membrane





Difference between Prokaryotes and Eukaryotes

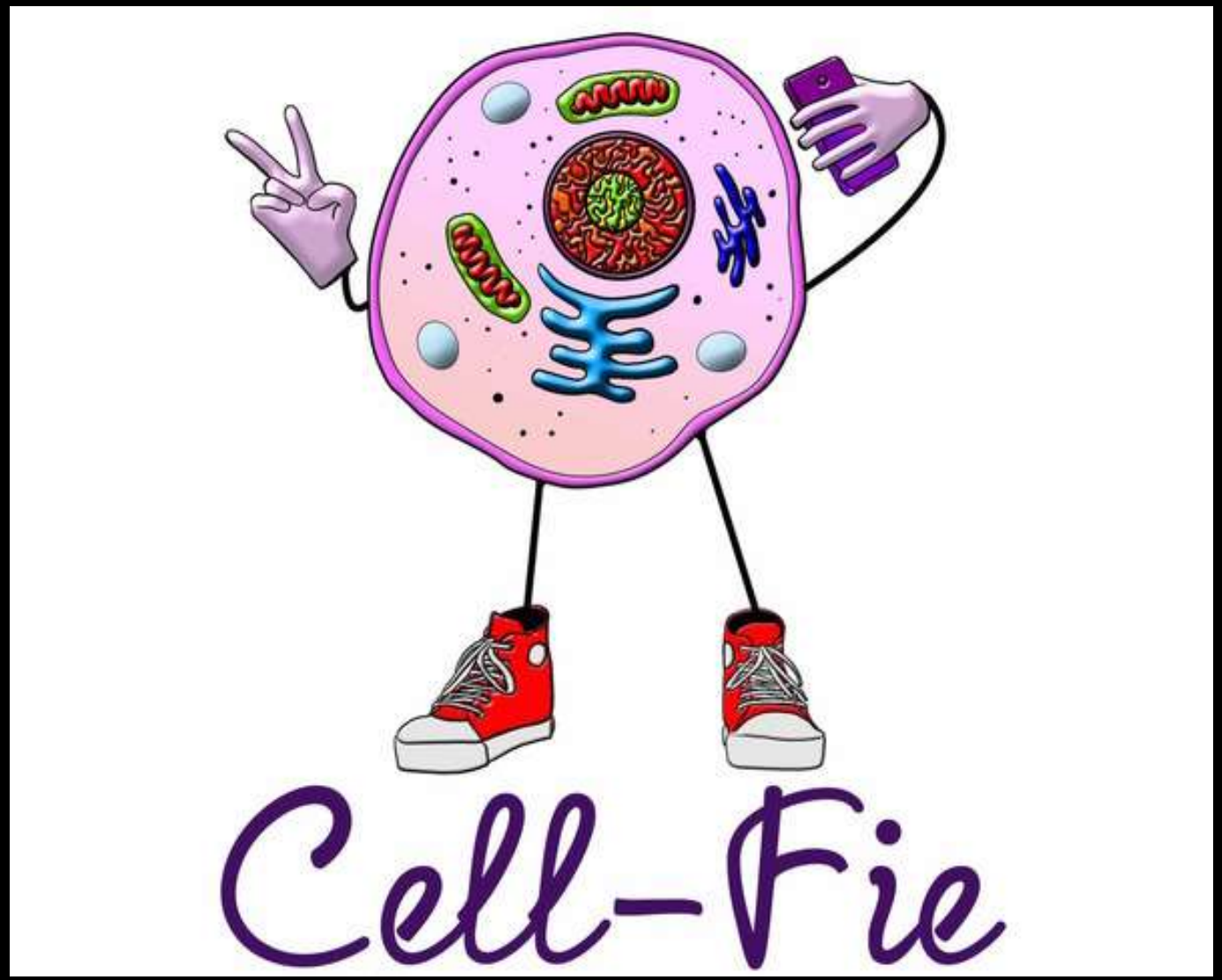
Prokaryotes	Eukaryotes
There is no presence of nucleus	The nucleus exists in the cells
A single chromosome is present	There are multiple chromosomes
They undergo asexual reproduction	They undergo sexual as well as asexual reproduction
They are generally unicellular organisms	They are generally multicellular organisms
There are no membrane bound cell organelles	There are membrane bound cell organelles present inside the cells
Example – Bacteria, Blue green algae (Cyanobacteria)	**Example** – Fungi, Plants and Animals

How can cells perform distinct functions in organisms?

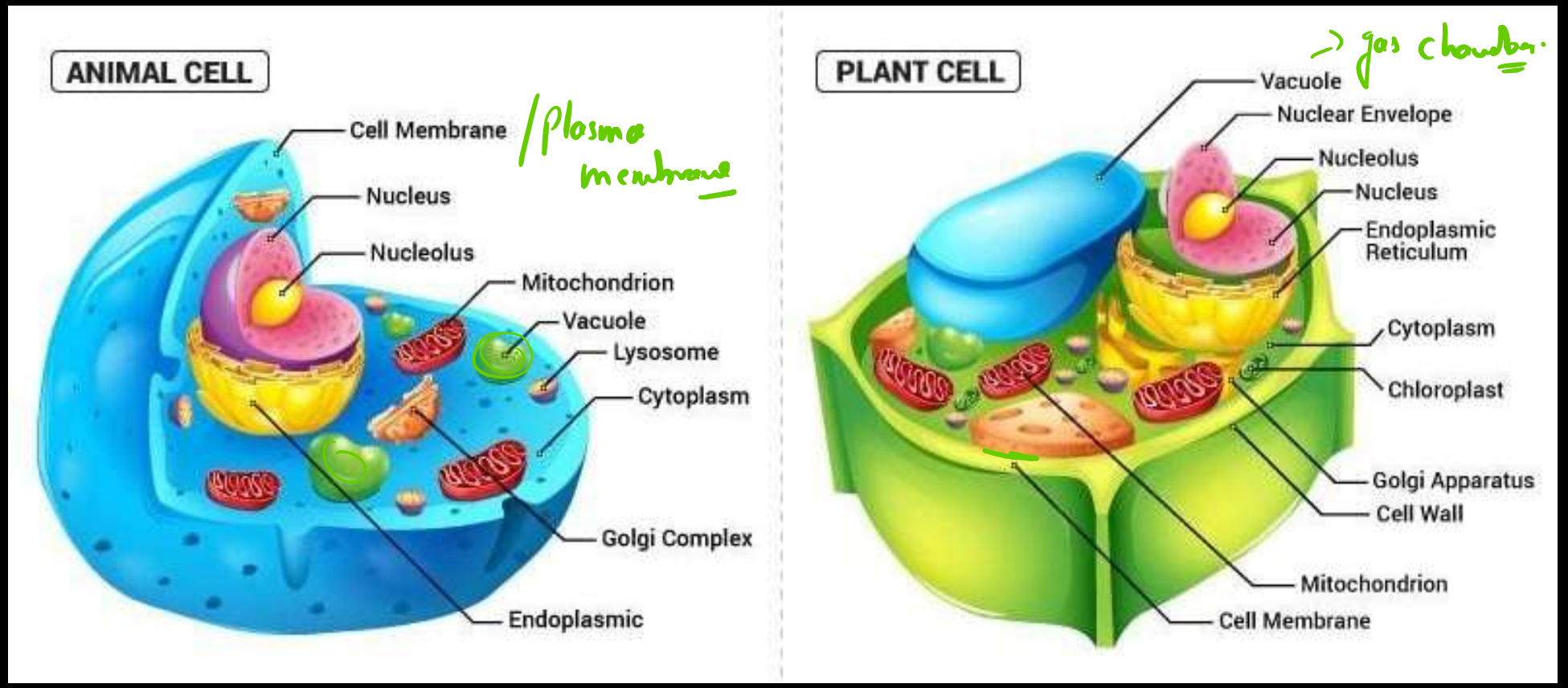
- Cells are capable of performing multiple functions in an organism.
- A cell contains specific components which are called Organelles.
- Each organelle in the cell can perform different functions such as making new cells or clearing the waste of the cell.
- Thus, organelles allow a cell to perform several kinds of activities in an organism.

Organelles

Structure and components of a Cell



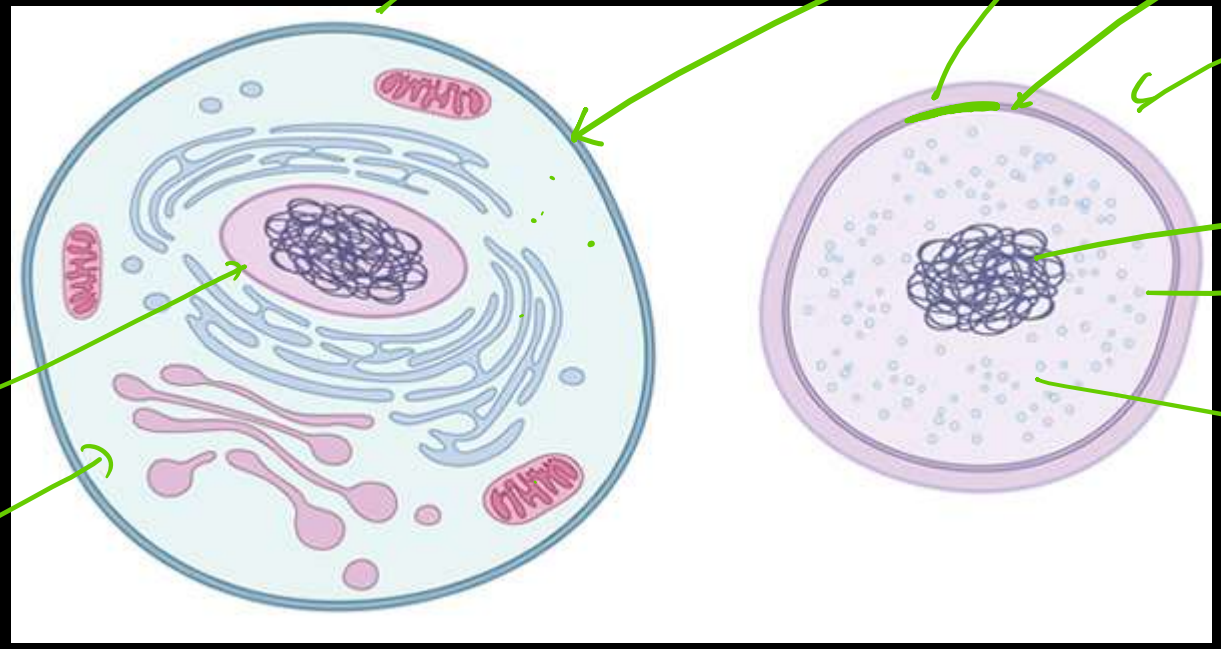
Structure and components of a Cell

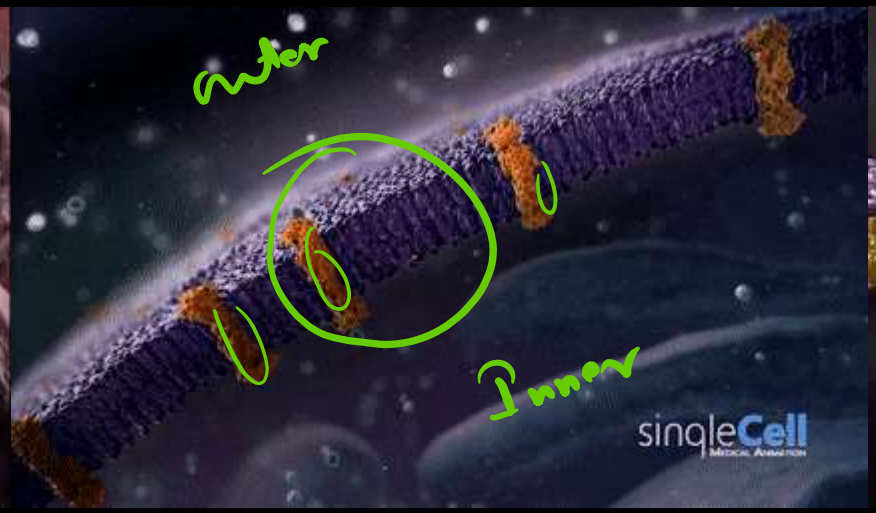


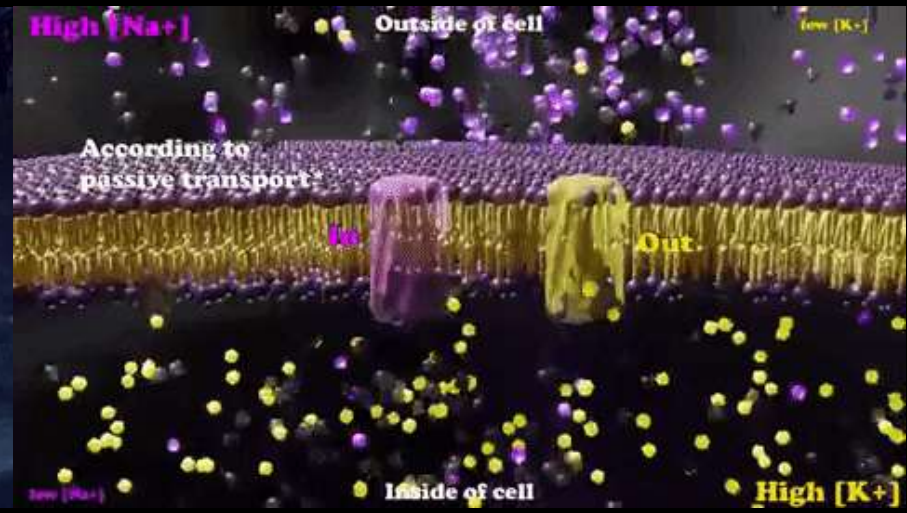
What is a Cell made up of?

What is structural organization of a cell?

- Every Cell has three basic feature:
  1. Plasma membrane or Cell membrane
  2. Nucleus
  3. Cytoplasm







1. Plasma Membrane

aka Cell Membrane

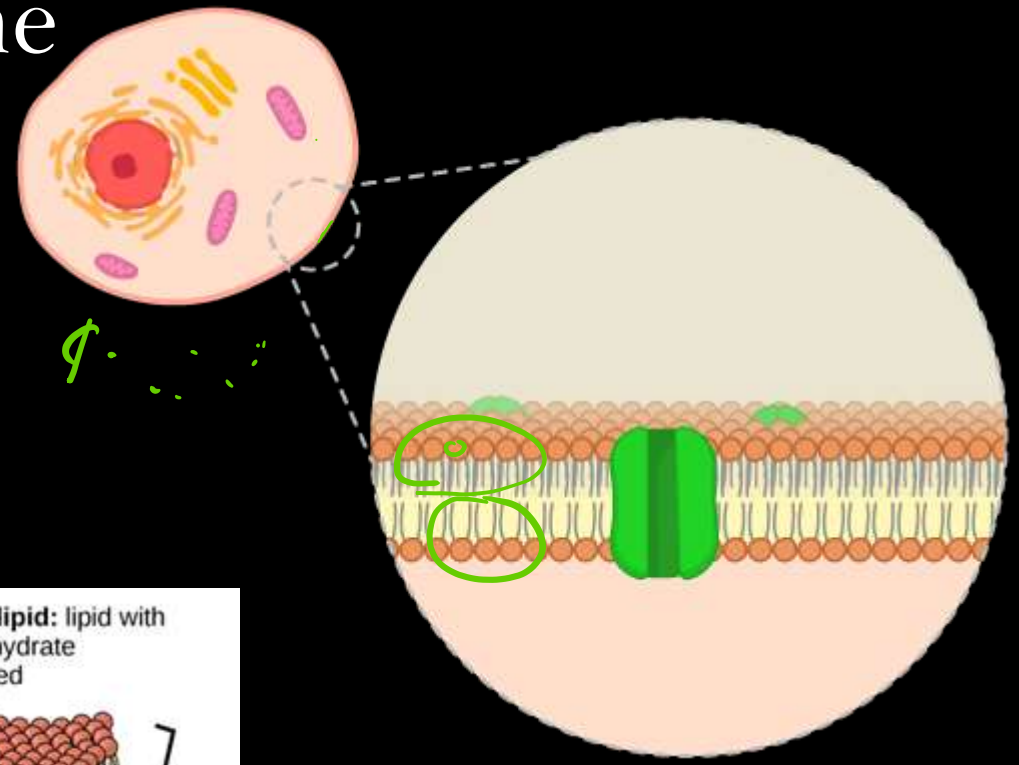
Plasma Membrane or Cell Membrane

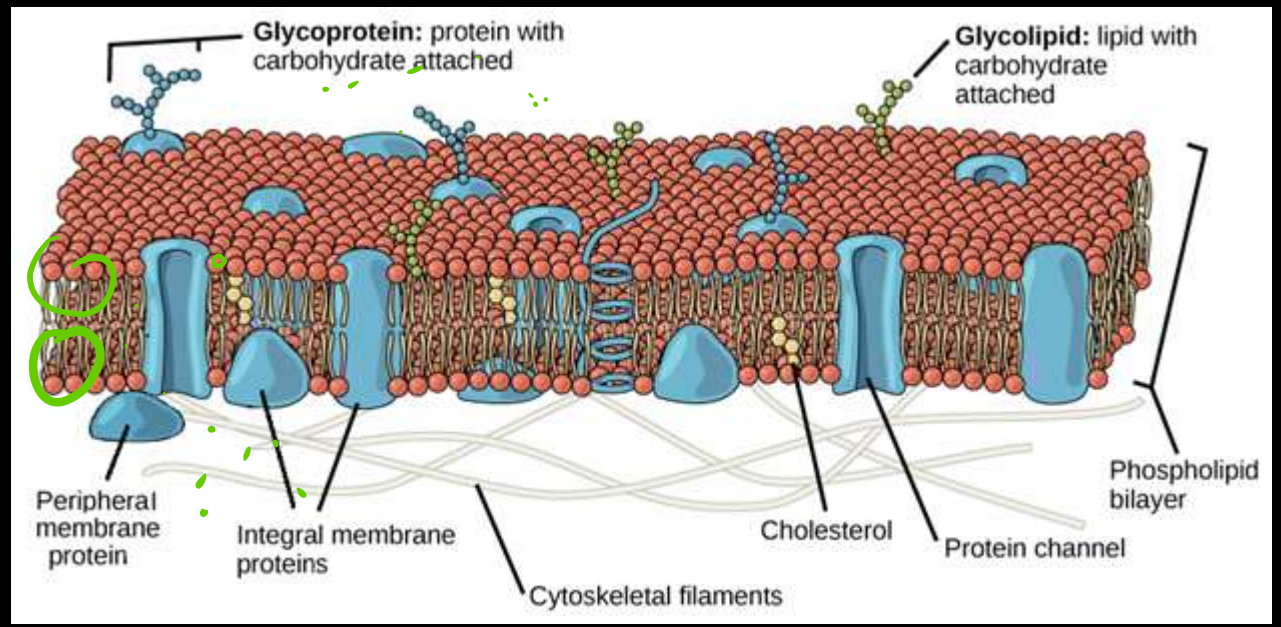
- It is outermost covering of the cell (just like envelope).
- It separates content of the cell from external environment.
- The plasma membrane has the capability to decide which material should enter or leave the cell and which should not.
  - Therefore, it is also called as "Selectively Permeable Membrane"

Semi-Permeable membrane

Components of Plasma membrane

- It is made up of 3 components:
  - Lipids (fats)
  - Proteins
    - Carbohydrates





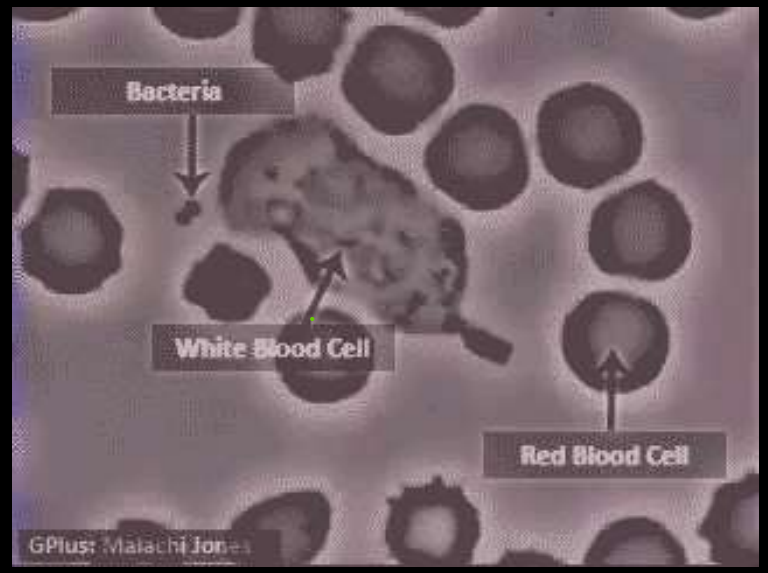
Properties of Plasma Membrane

- It is very flexible and fluid like (because it is made up of organic molecules lipids and proteins).
- Flexibility enables cell to engulf food and other particles from the external environment.
  - This process is called Endocytosis.
  - Amoeba acquire food through this process.
  - Immune cells in our body engulf germs through this process.

Properties of Plasma Membrane

Endocytosis Example:

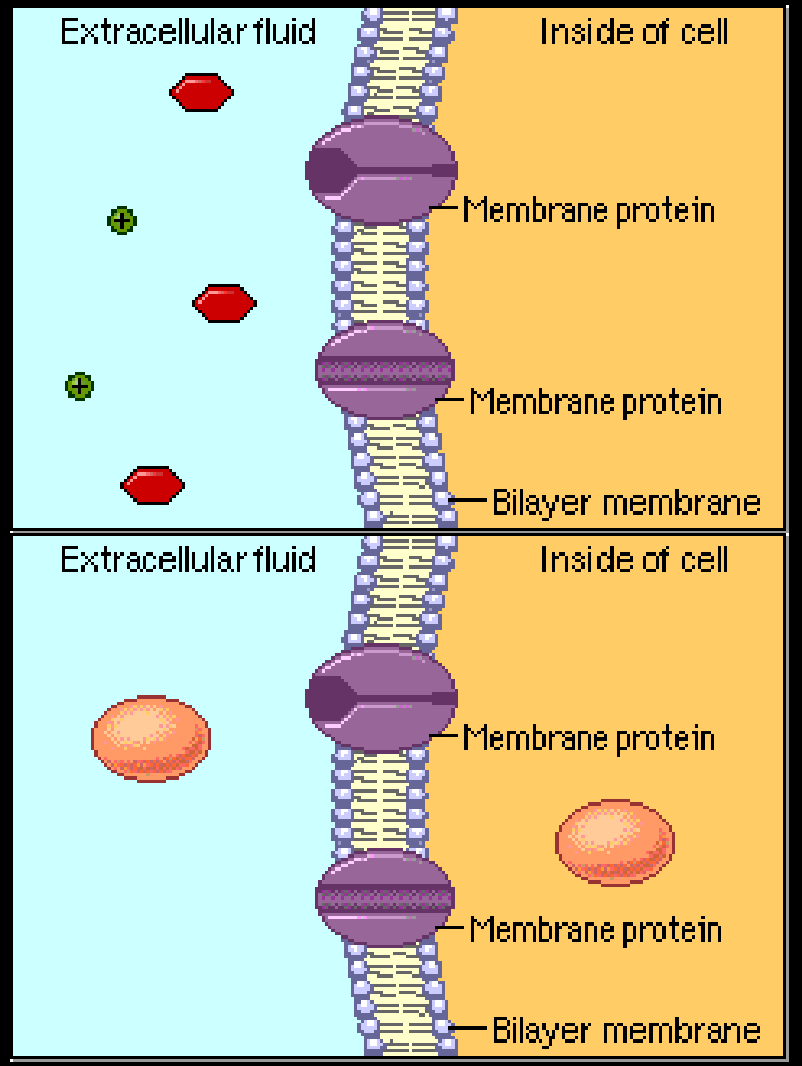
Amoeba eating paramecium



WBC Chasing and killing bacteria

Functions of Plasma Membrane

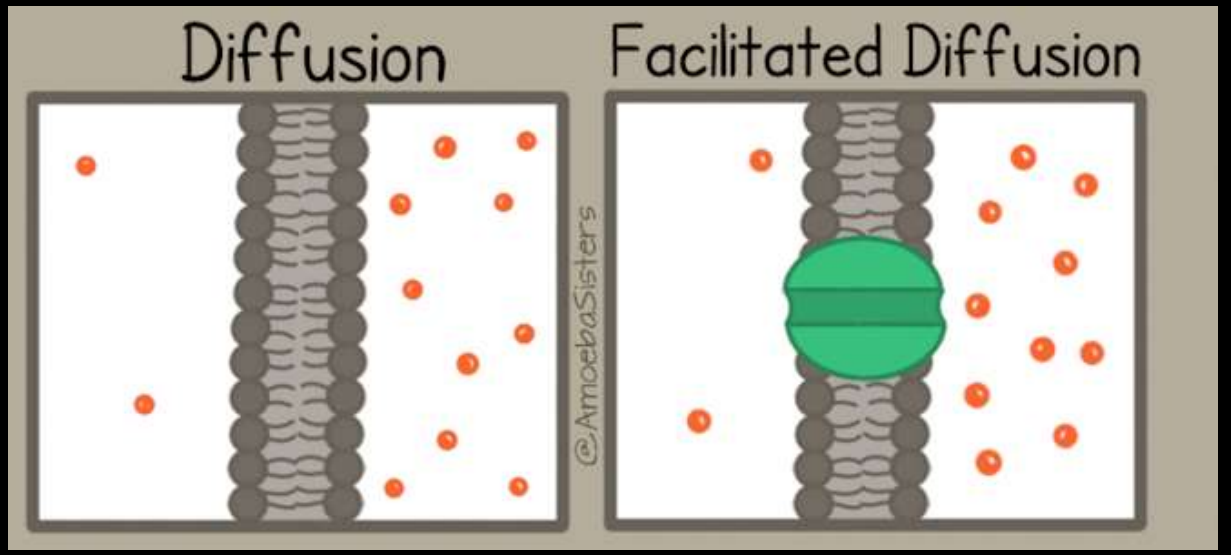
- *It permits entry and exit of some materials in and out of the cell.*
- *It prevents movement of other material (not required by the cell).*



How can substance move in and out of a cell?

1. Gaseous Exchange between the Cell and its External Environment (Diffusion)

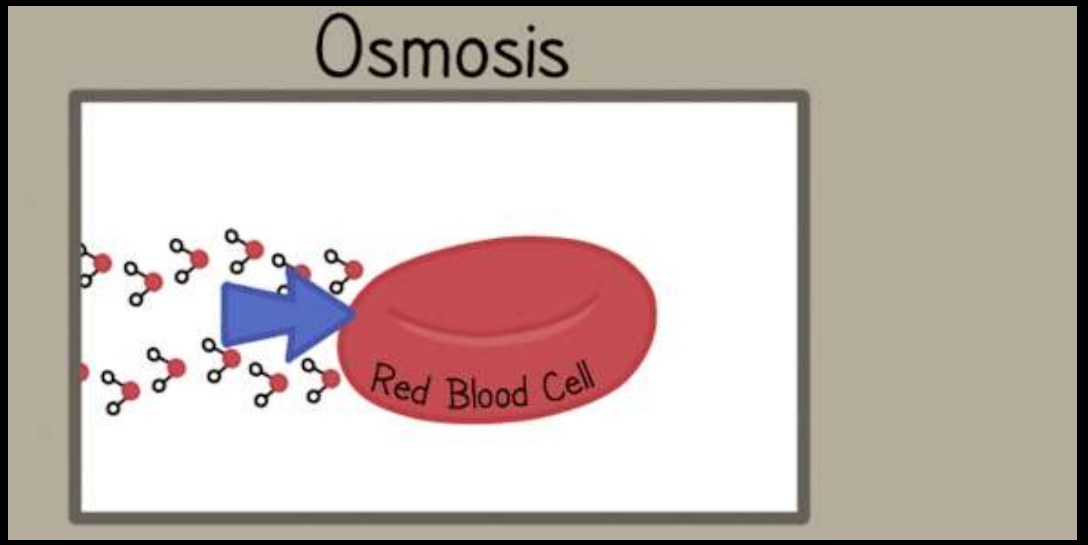
- Movement of Oxygen and Carbon dioxide to and from the cell is carried out by means of diffusion (energy not required).
- Gaseous substances tend to move to areas where their concentration is less from the areas where there is higher.
  - This movement is defined as the process of diffusion.
- Diffusion can take place of solids, liquid, gases.

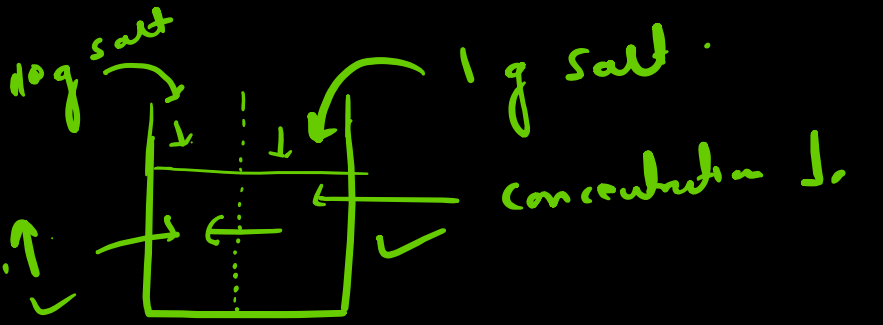


How can substance move in and out of a cell?

2. Movement of Water between the Cell and its External Environment (Osmosis)

- It is carried out by the means of osmosis.
- **Osmosis** is a process in which water moves from the region of low concentration to one where its concentration is high through a semi permeable membrane.
- Therefore we can say that Osmosis is just a special case of the process of diffusion.
- Plant Cell obtain water through osmosis.



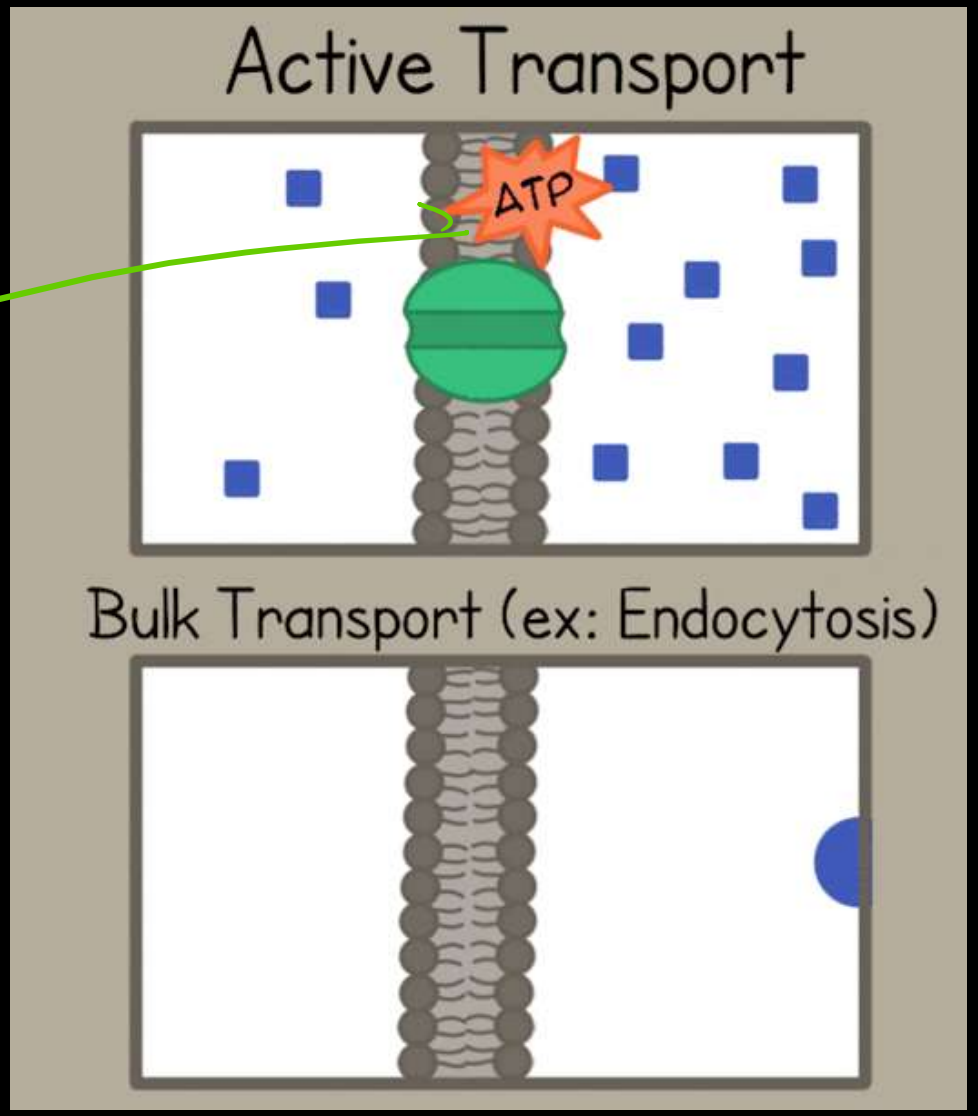


How can substance move in and out of a cell?

3. Some substance (nutrients) move in and out of cell using energy

- This type of transport system of cell is called **Active Transport.**

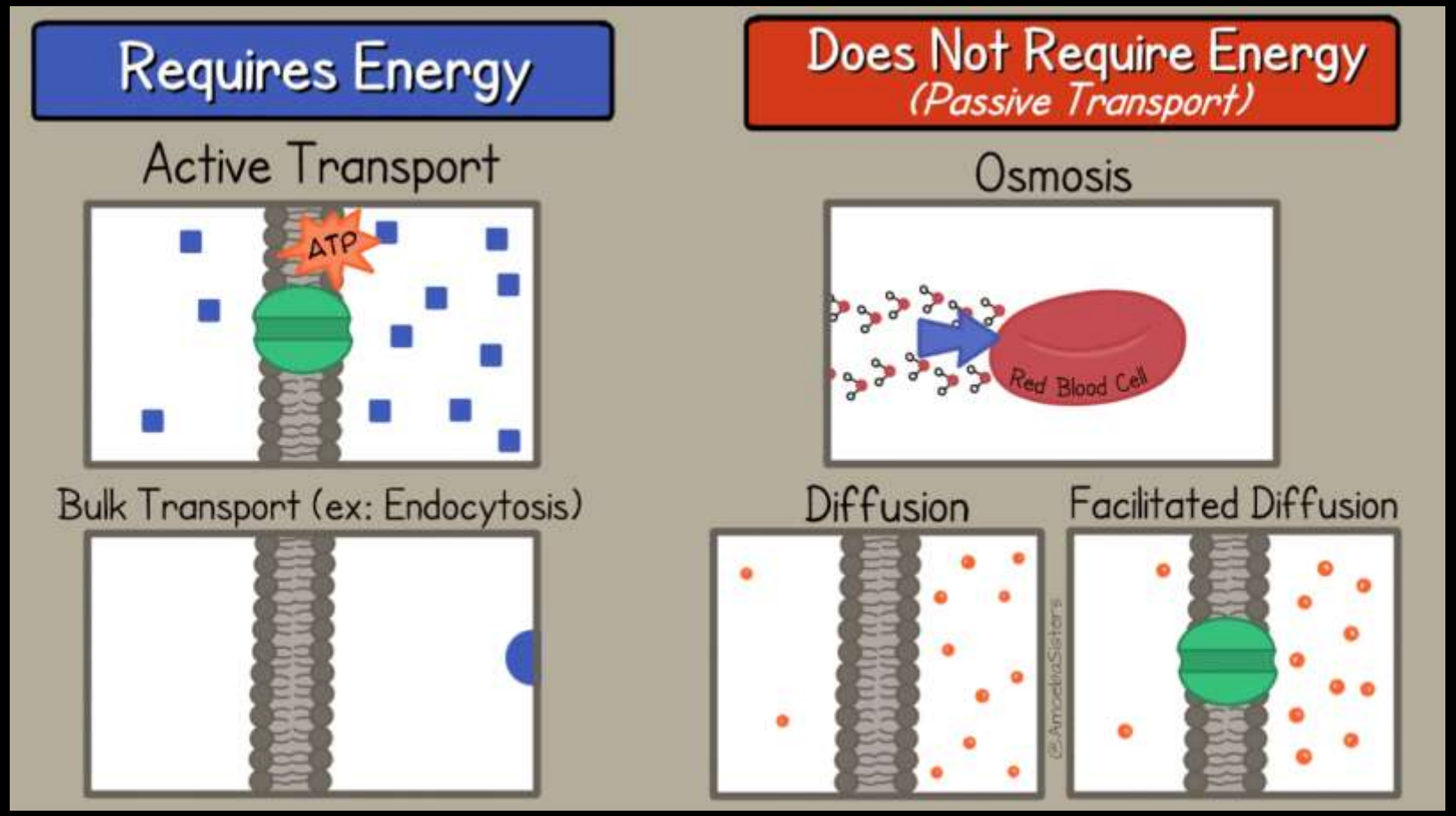
Energy



How can substance move in and out of a cell?

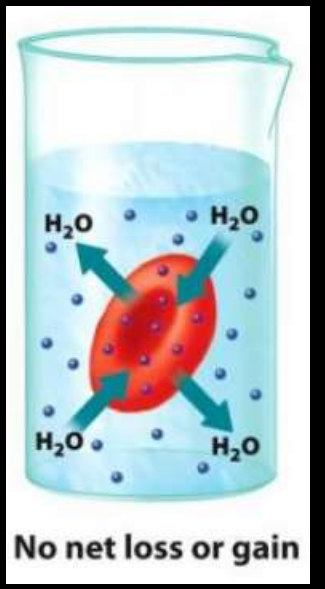
Examples of Osmosis:

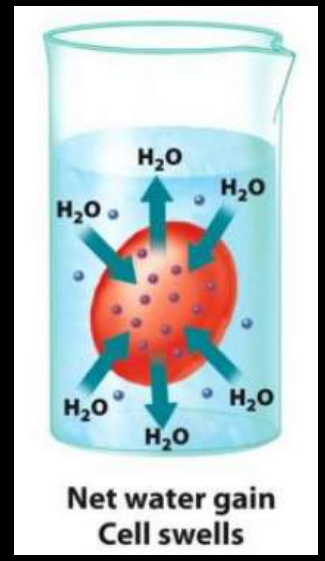
- *Unicellular freshwater organisms and most plant cells takes up water through osmosis.*
- *Absorption of water by plant roots is also an example of osmosis.*

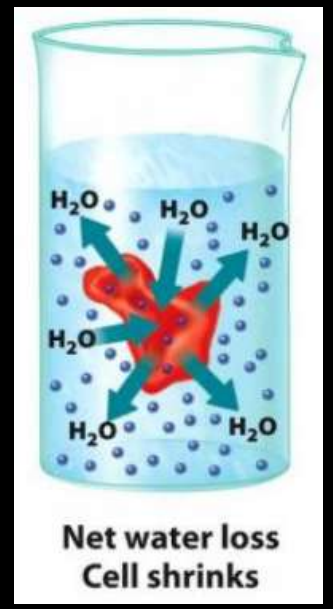


Hypotonic, Isotonic and Hypertonic Solution

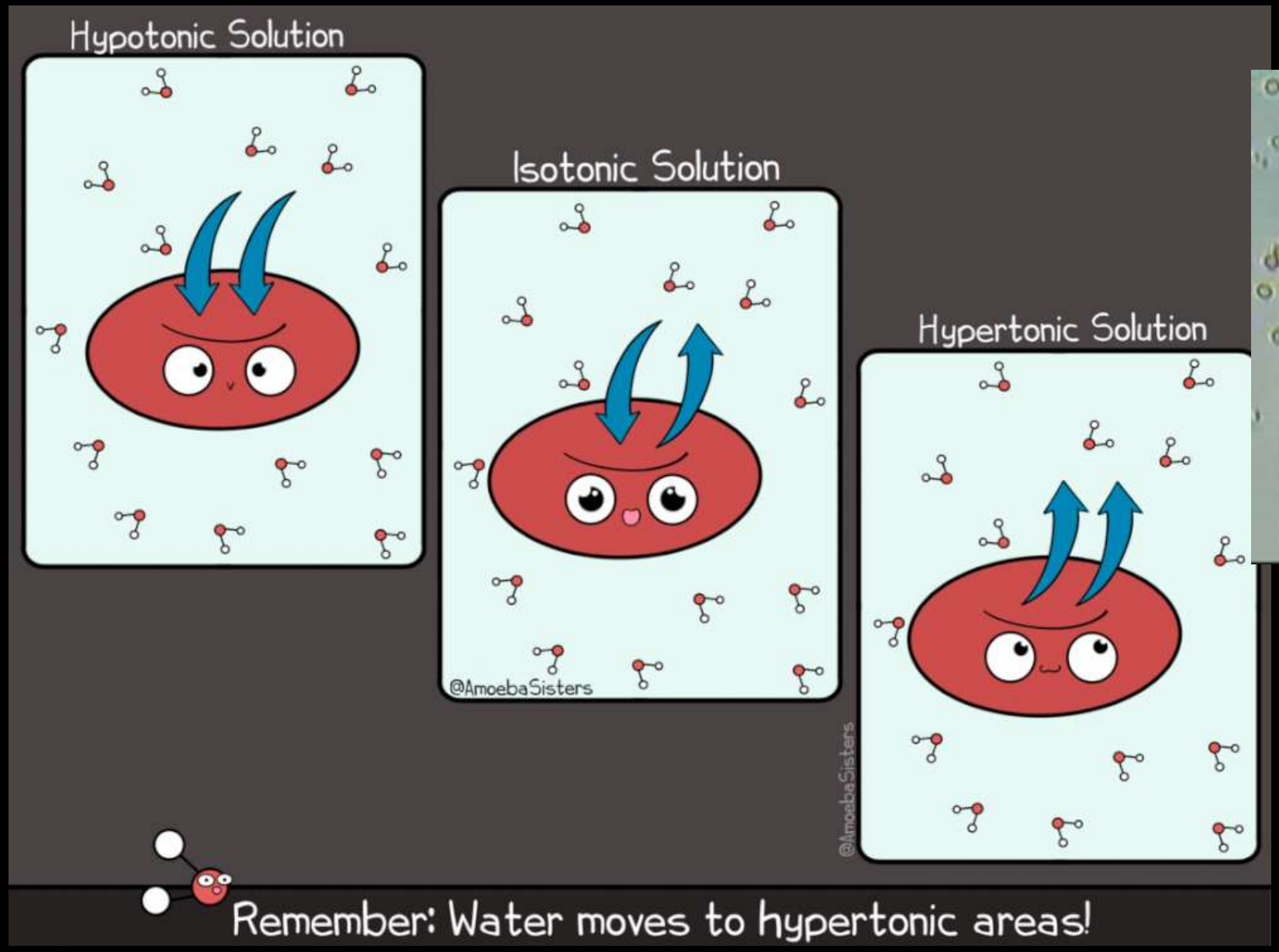
Name of Solution	Condition	Result
Hypotonic Solution	Medium surrounding cell has higher water concentration than cell.	Cell will gain water by osmosis and likely to swell up.
Isotonic Solution	Medium surrounding cell has exactly same water concentration as the cell.	Water crosses the cell membrane in both directions. Cell will stay at the same size.
Hypertonic Solution	Medium has lower water concentration than the cell.	Water crosses the cell in both the direction, but more water leaves the cell than enters it.

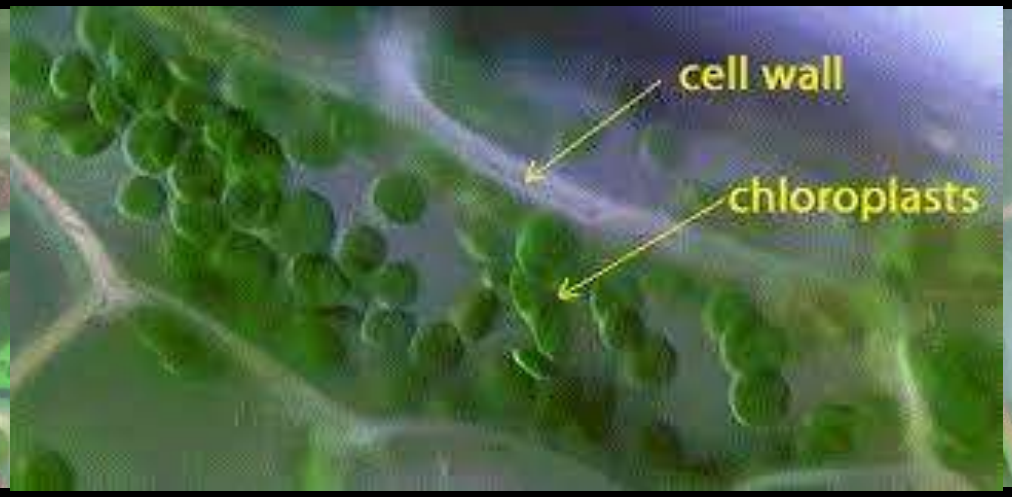






Hypotonic, Isotonic and Hypertonic Solution



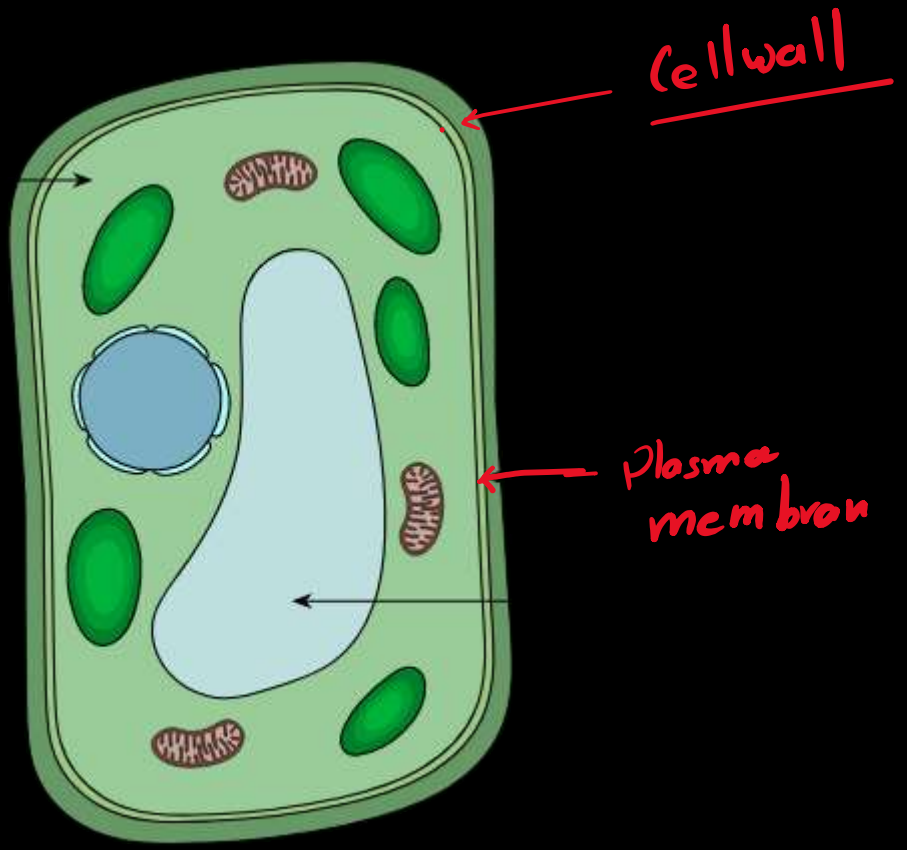


Cell Wall

Absent in animal cells. Present in plant cell, fungal cell and bacterial cell.

Cell Wall

- Cell wall is rigid/hard outer covering in addition to plasma membrane.
- It is found in Plants, Fungi and Bacteria.
- The cell wall lies outside the plasma membrane.
- Plant cell wall is mainly composed of cellulose.
- Cellulose is a complex chemical substance which provides structural strength to plants.

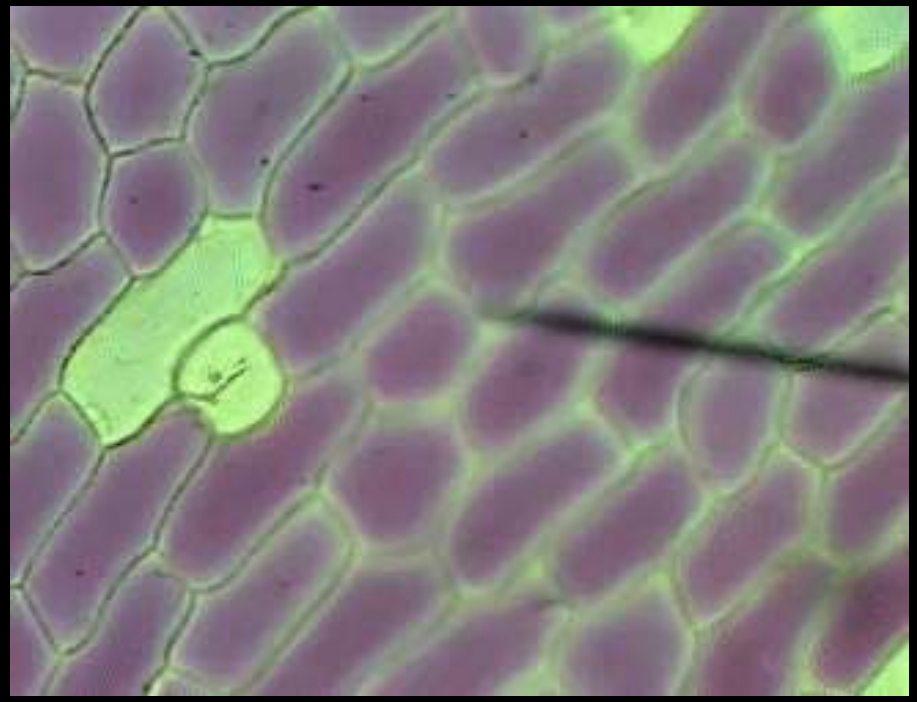


Function of Cell Wall

- Cell wall permit the cells of plants, fungi and bacteria to withstand very dilute (hypotonic) external media without bursting.
  - Cell takes up water by osmosis.
  - Cell swells and builds pressure against Cell Wall.
  - Cell wall exerts an equal pressure against swollen cell.
- Because of cell wall, plant cells can withstand much greater chance in the surrounding medium than animal cells.
- Dead cells cannot absorb water through osmosis.
- Plants, fungi, and bacteria exist in hypotonic conditions because of their rigid cell membranes. Even if the cells swell up the cell membrane can prevent them from bursting out.

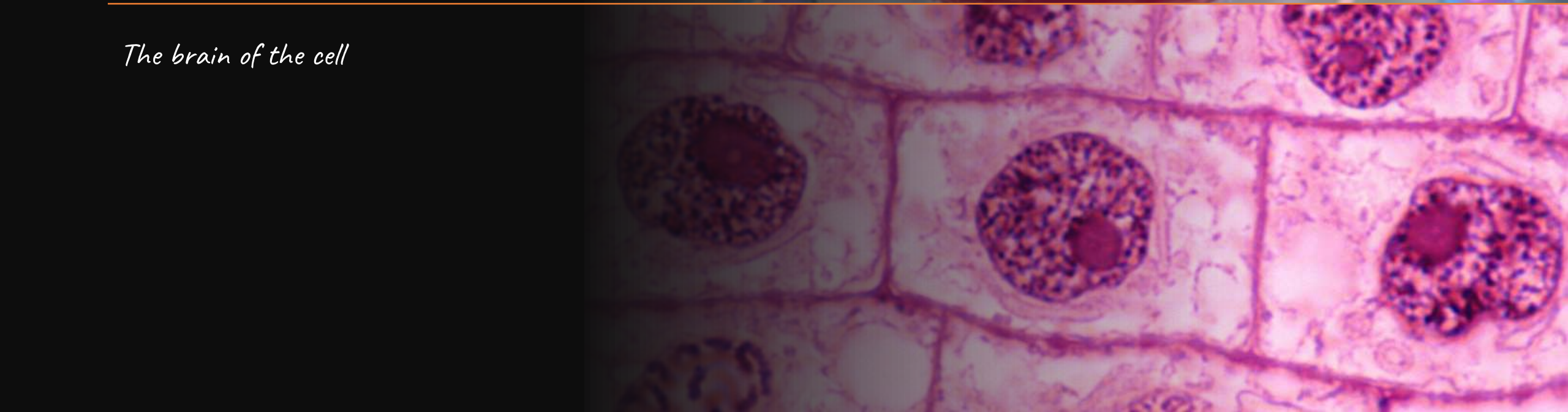
Plasmolysis

- When living plant cell loses water through osmosis (in hypertonic medium), there is shrinkage or contraction of contents of the cell away from the cell wall.
  - This process is known as Plasmolysis



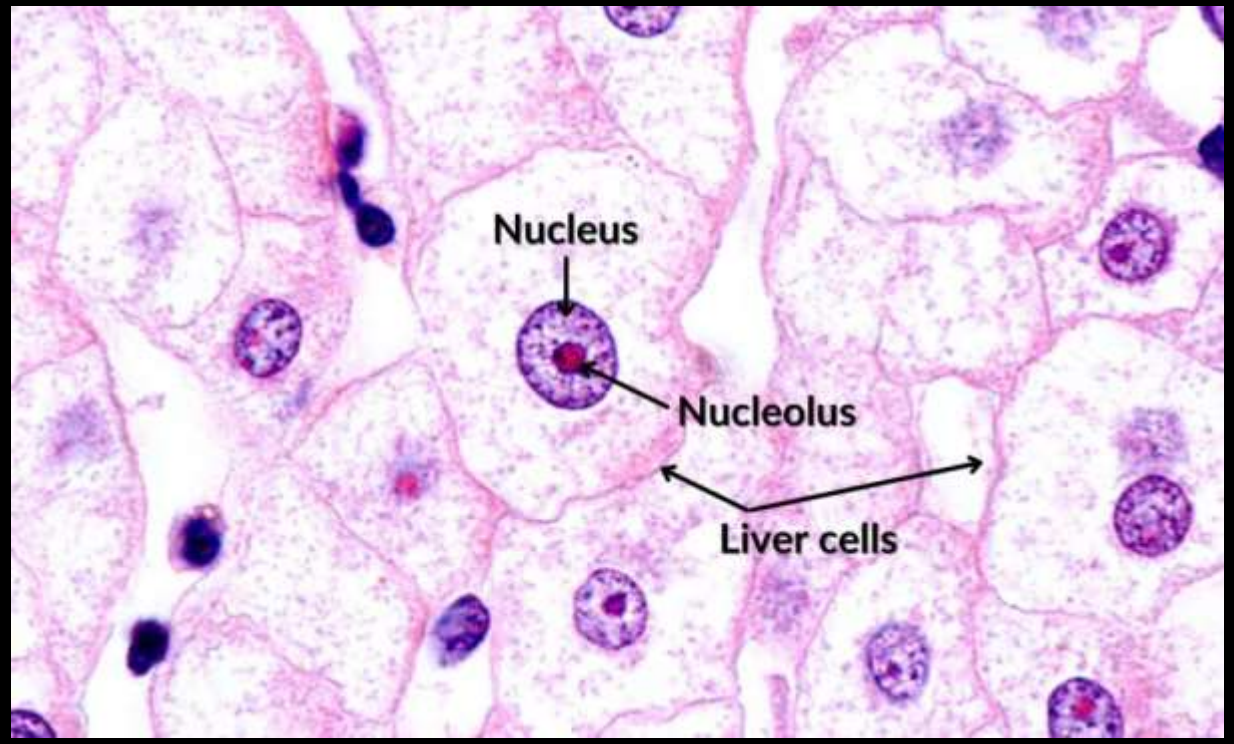
2. The Nucleus

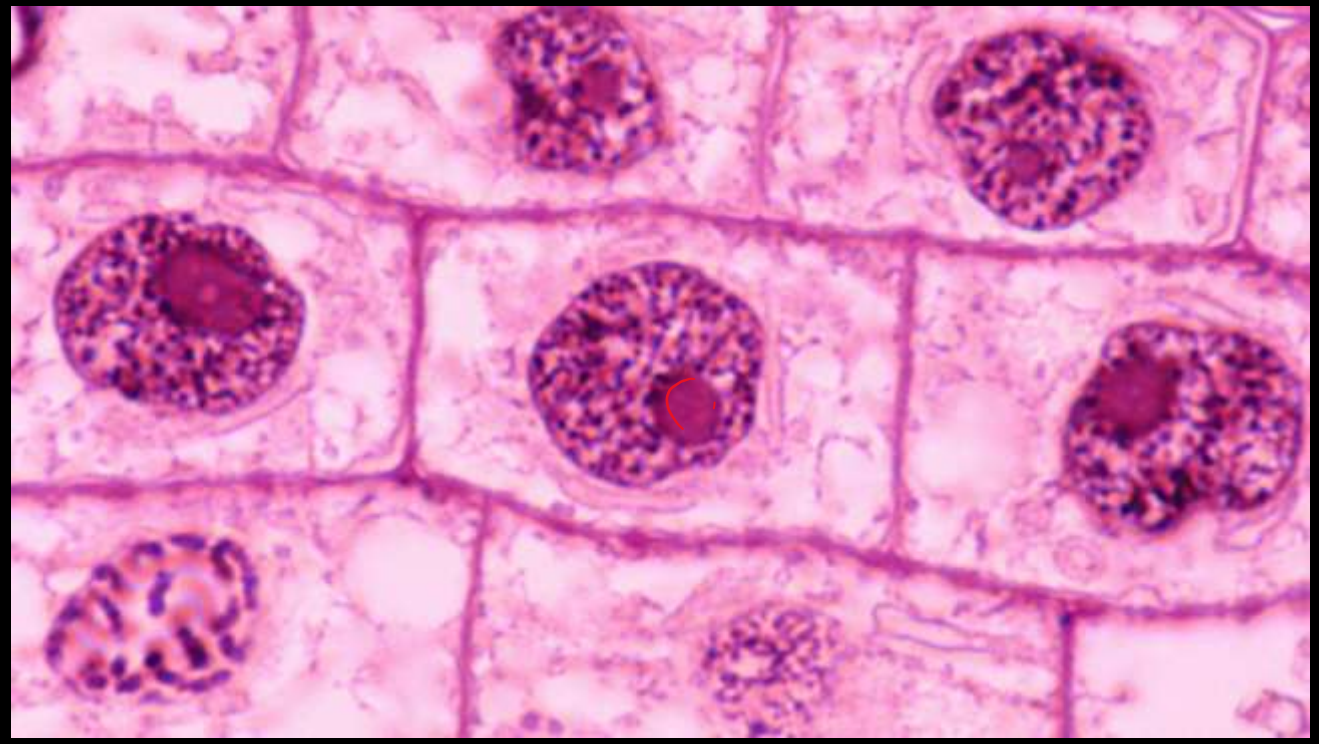
The brain of the cell



The Nucleus

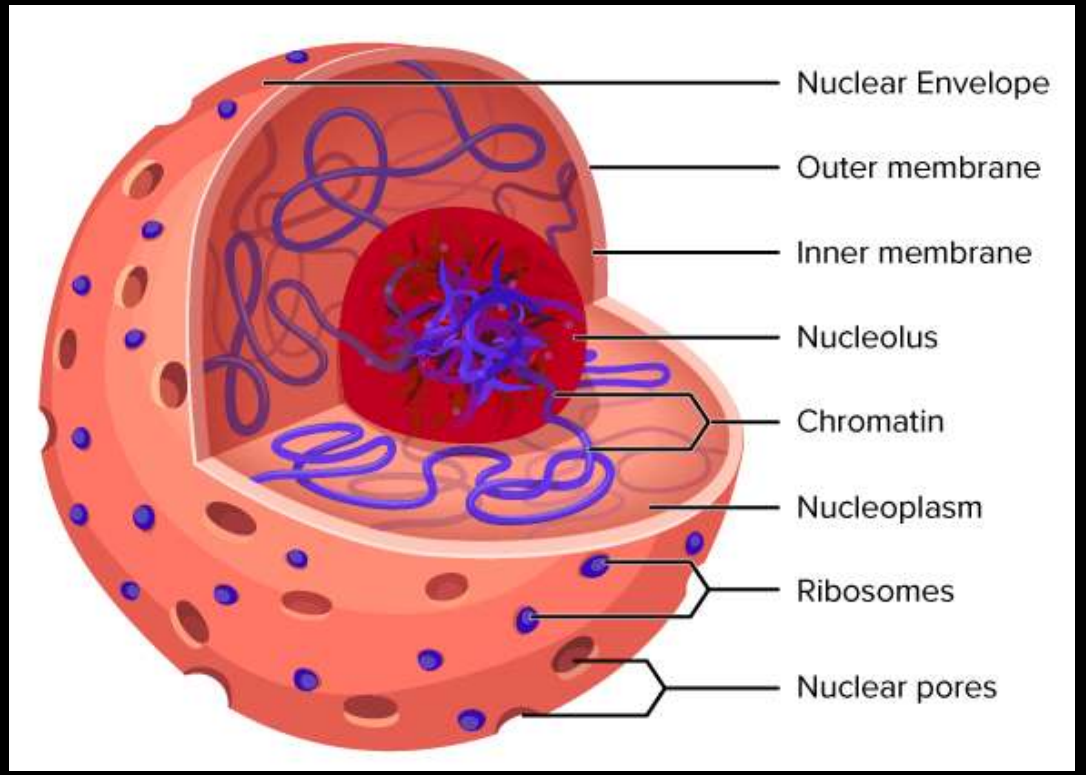
- It is most prominent component of cell.
- Nucleus is controlling center of all activities of cell.
  - Hence it is aka brain of the cell.





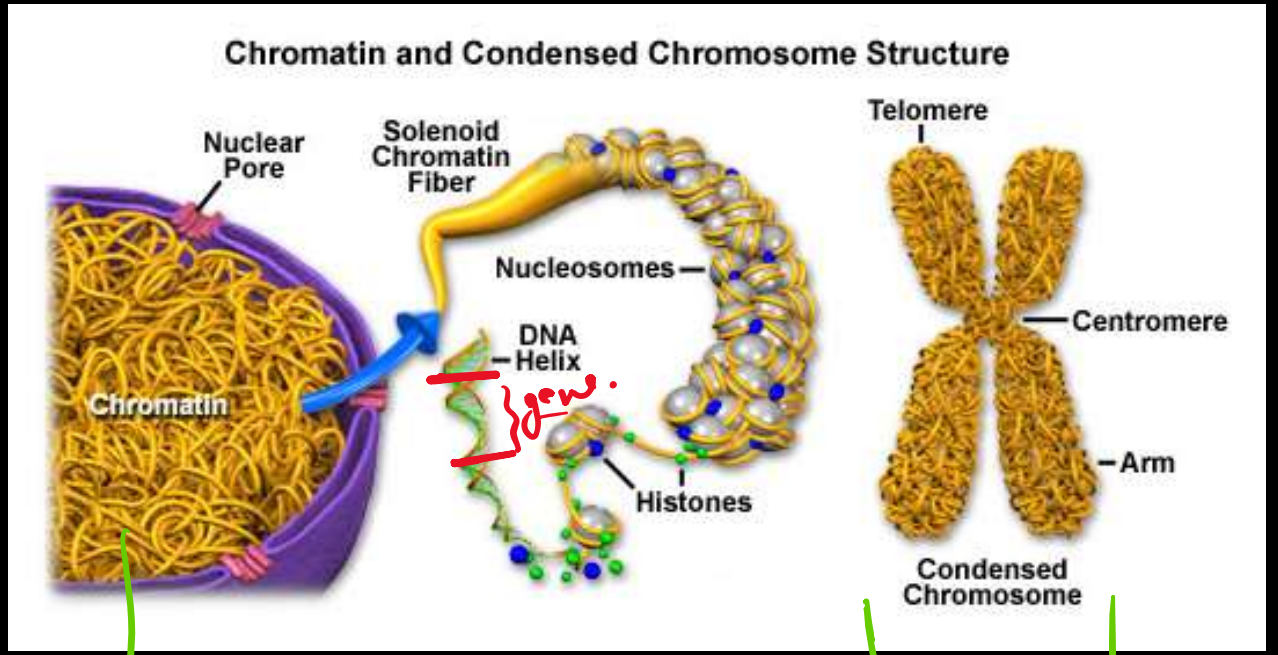
Structure of the Nucleus

- Nucleus has a double layer covering called **nuclear membrane**.
- There are **pores** present on the nuclear membrane that allow movement of substances in and out of the nucleus.
- When cell is not dividing, nucleus contains **chromatin** thread which contains genetic information.
- When cell is dividing, chromatin condenses to form **chromosomes**, rod-shaped structures which contain genetic information.
- It also contains **nucleolus** (site of ribosome synthesis). aka **brain of nucleus**.



Chromosomes Structure and Function

- Composed of two things:
  - DNA (Deoxyribo Nucleic Acid) : contains information necessary for constructing and organizing new cells.
  - Proteins : helps in packaging and condensation of DNA.
- Functional segment of DNA are called Genes.
- DNA contains information for inheritance of features from parent to next generation.
- When cell is not dividing supercoiled chromosomes opens up to form thread like material called chromatin threads

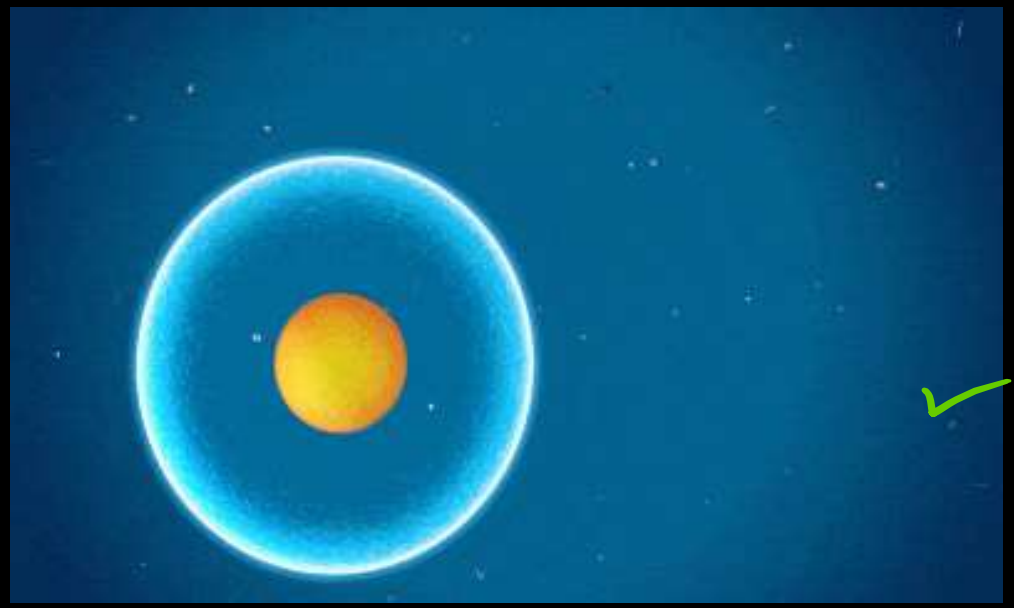


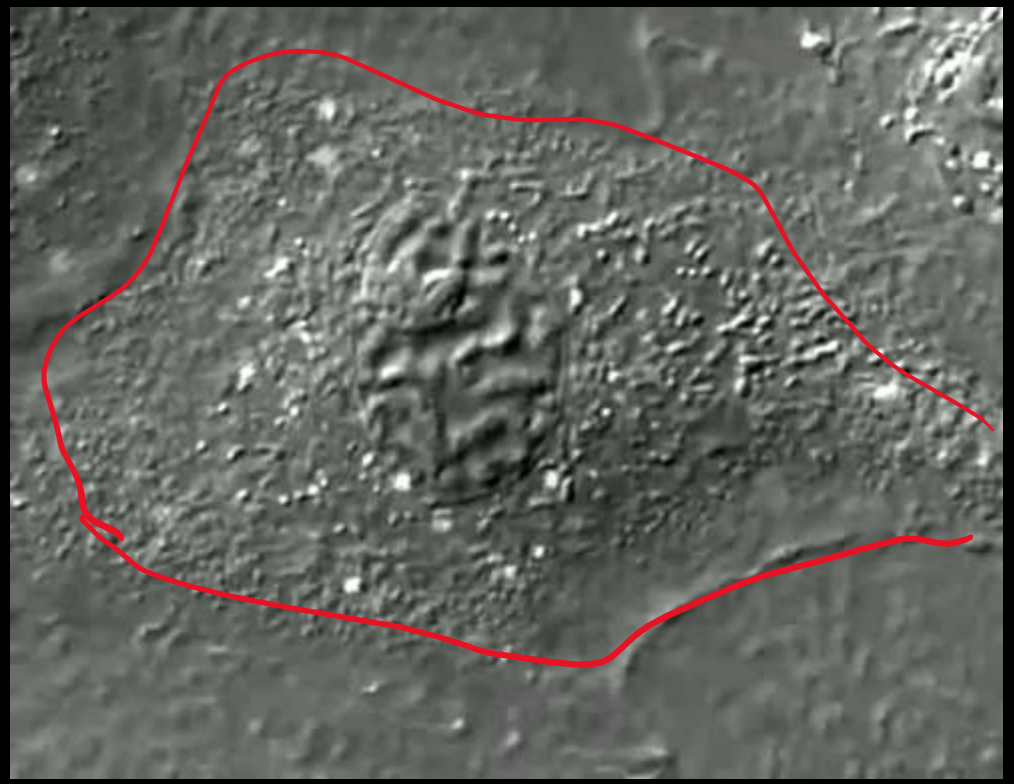
when cell is not dividing

during cell division

Function of Nucleus

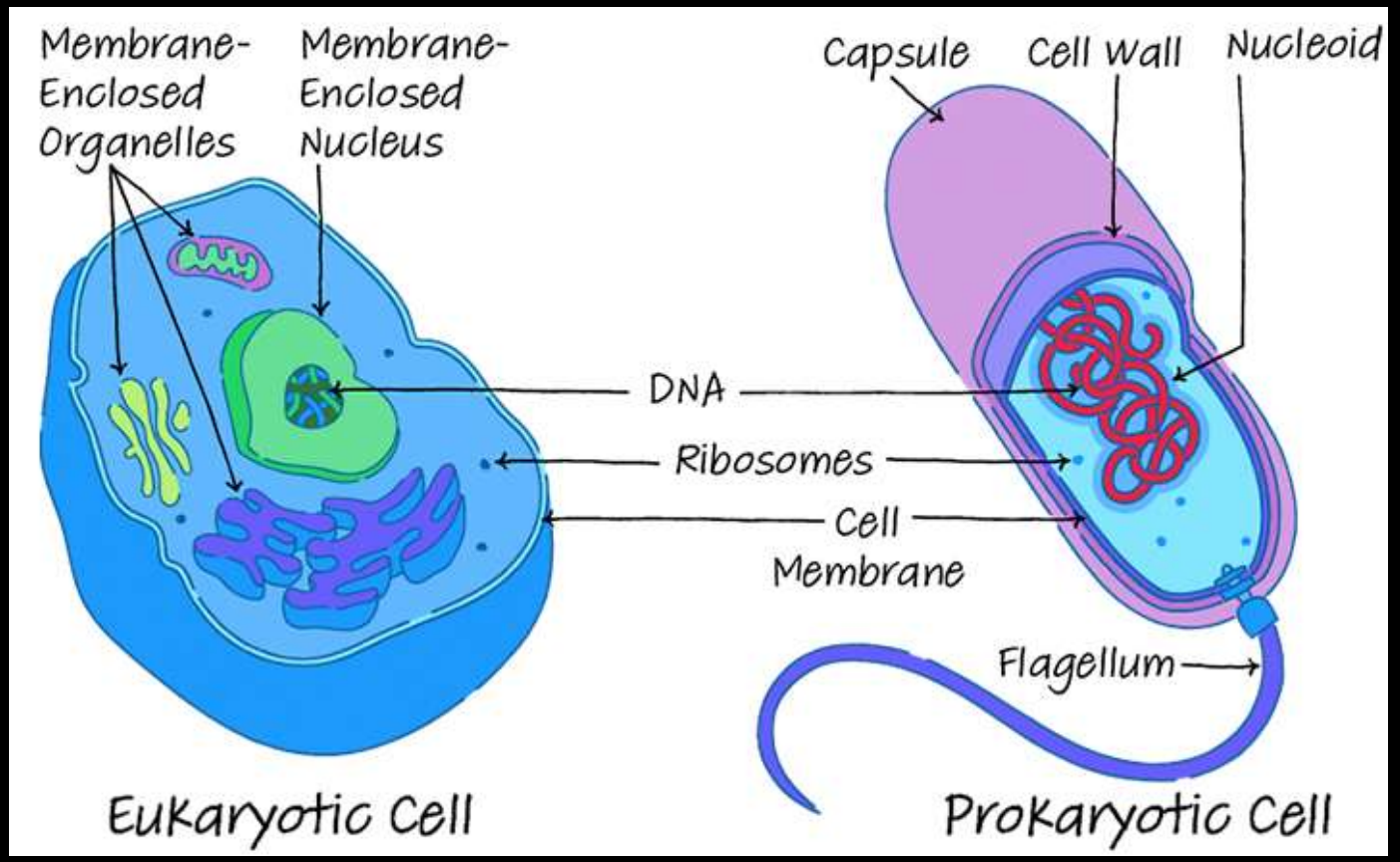
- It plays central role in cellular reproduction.
  - Cellular reproduction is the process by which single cell divides to form two new cells.
- It plays crucial part, along with environment, in determining the way the cell will develop and what form it will exhibit at maturity, by directing the chemical activities of the cell.





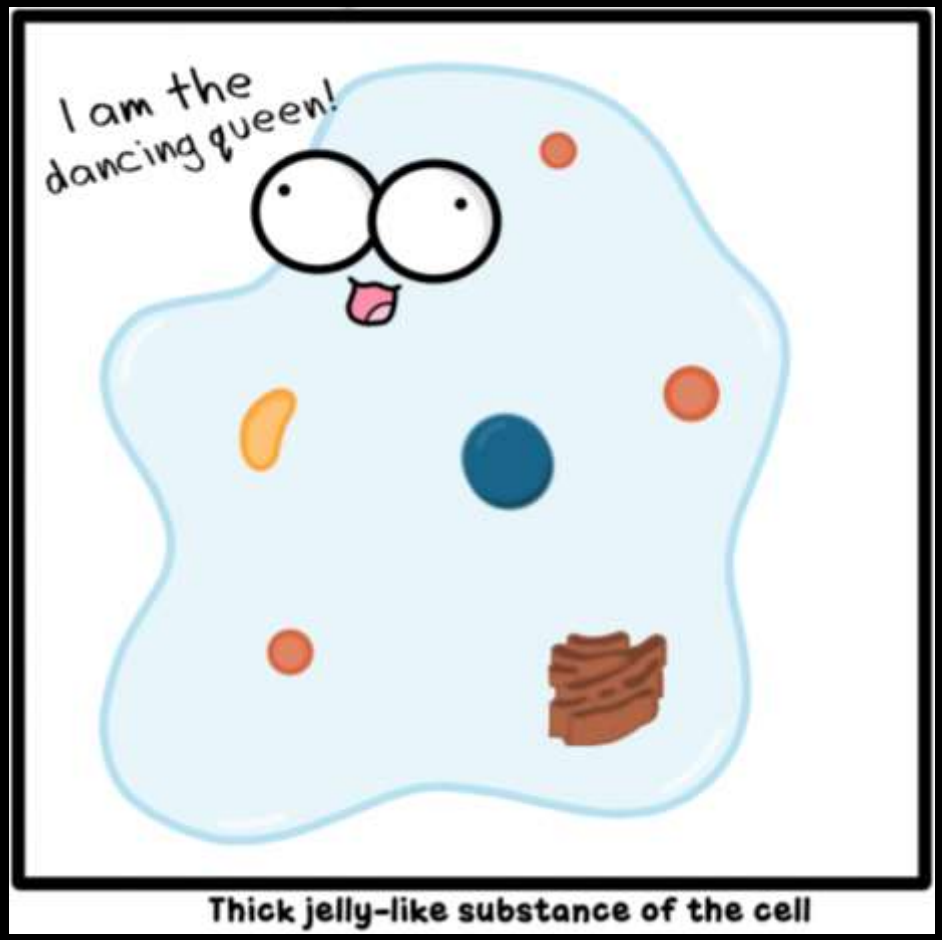
Nucleoid

- In some organisms, like bacteria, nuclear region is not well defined due to absence of nuclear membrane.
- Such an undefined nuclear region containing only nucleic acid (DNA) is called a nucleoid.



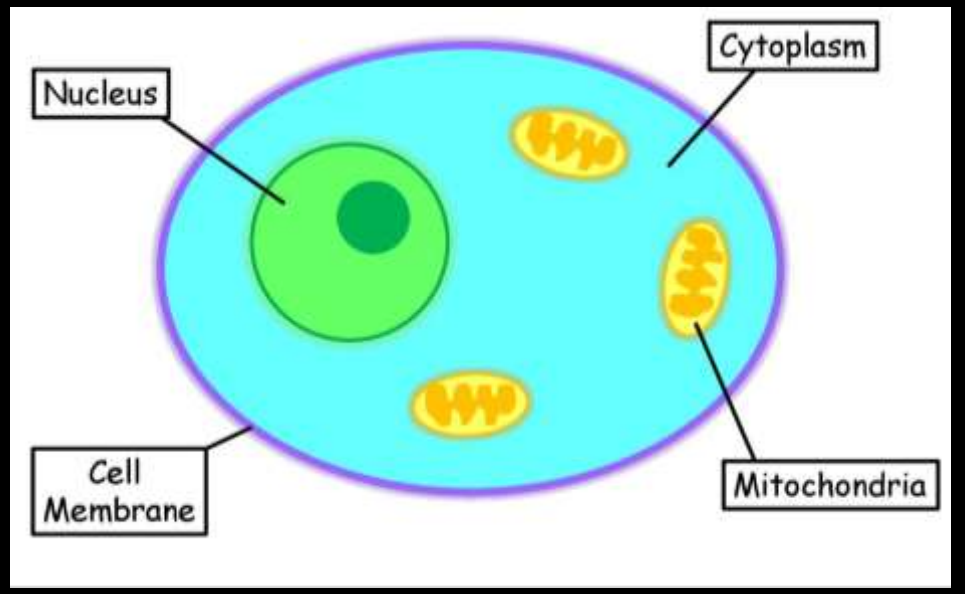
Overview of CELL STRUCTURE

3. Cytoplasm



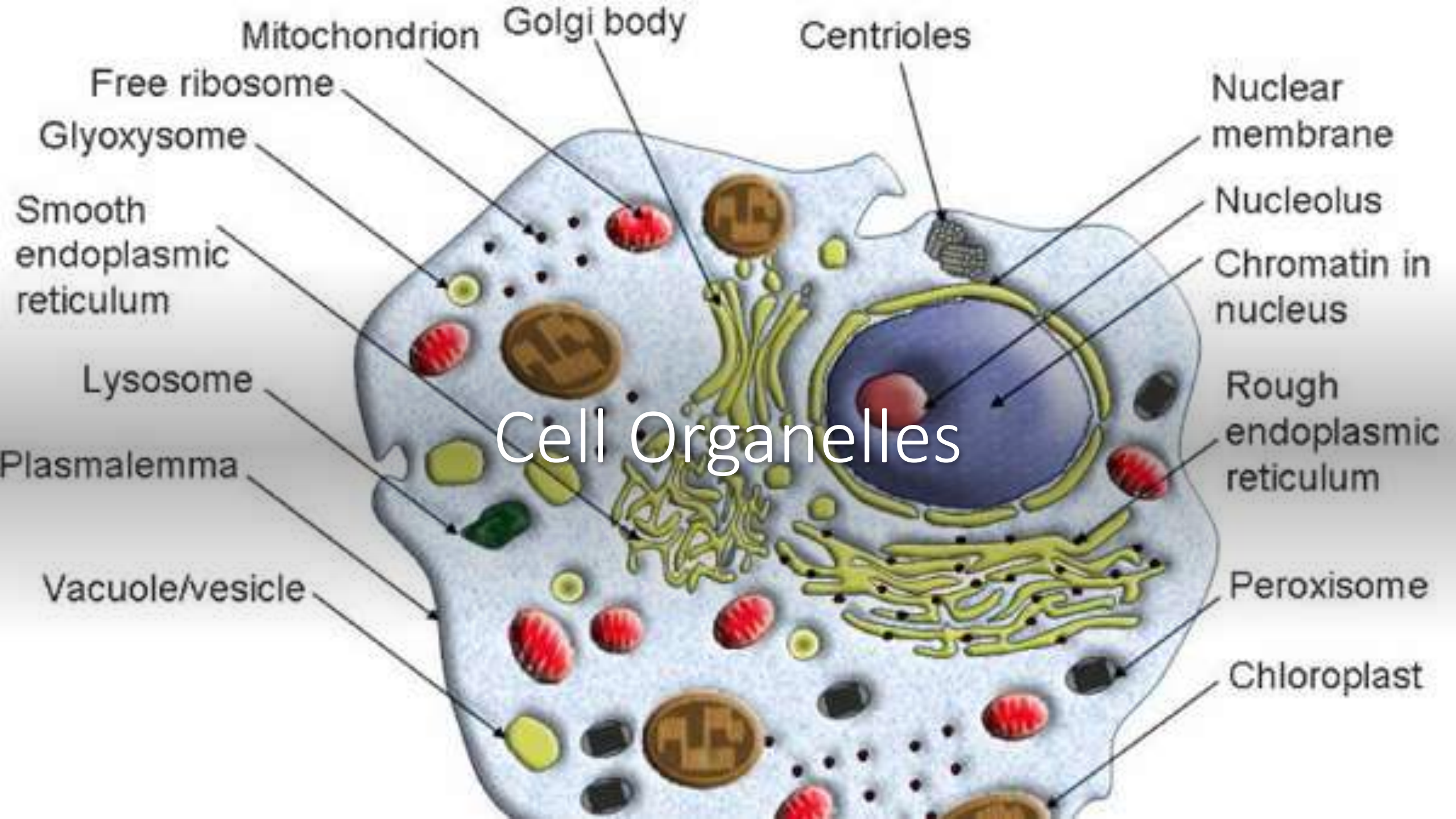
Cytoplasm

- Cytoplasm is the fluid content inside the cell/plasma membrane.
- It also contains specialized cell organelles.
- Cell organelles performs a specific function for the cell.



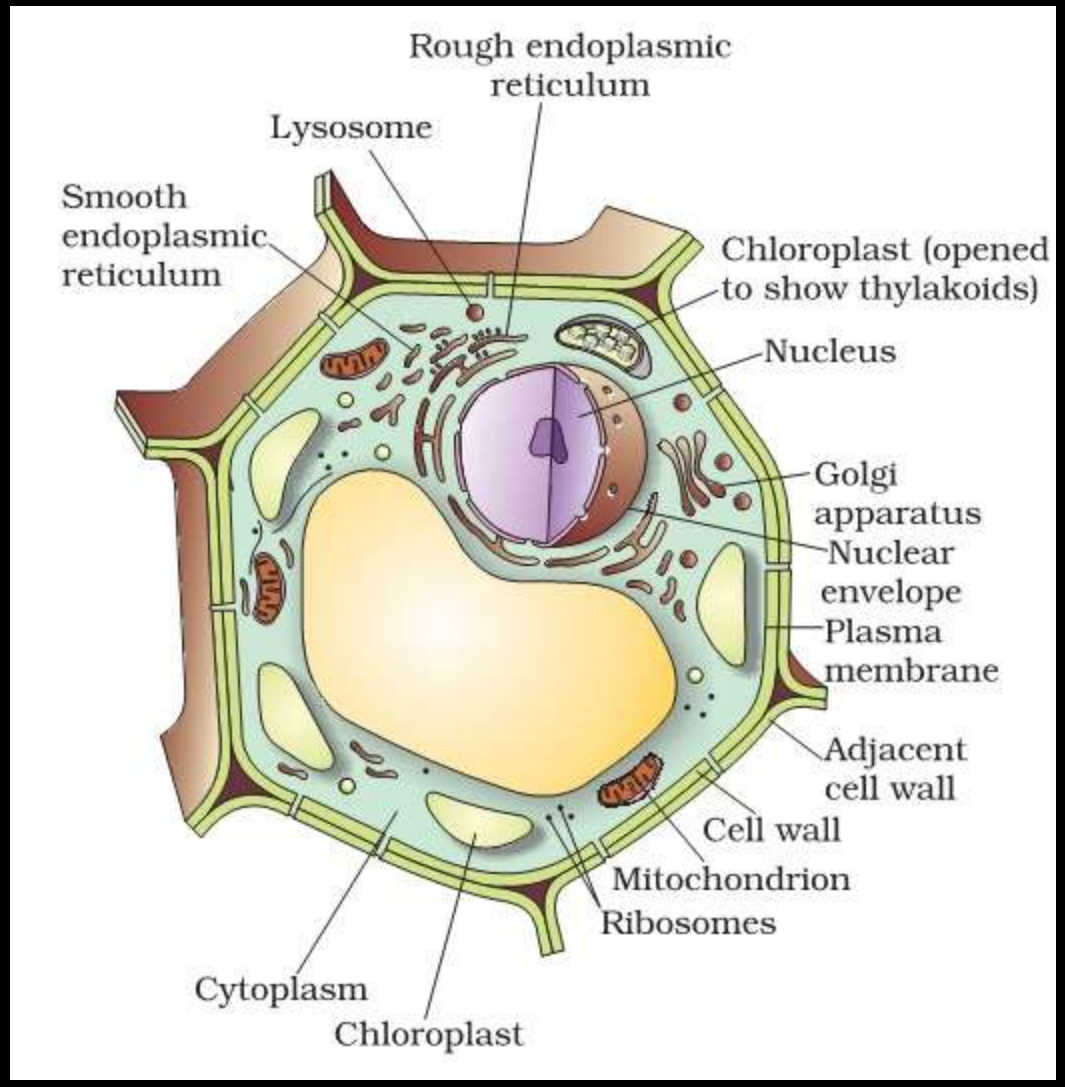
Functions of Cytoplasm

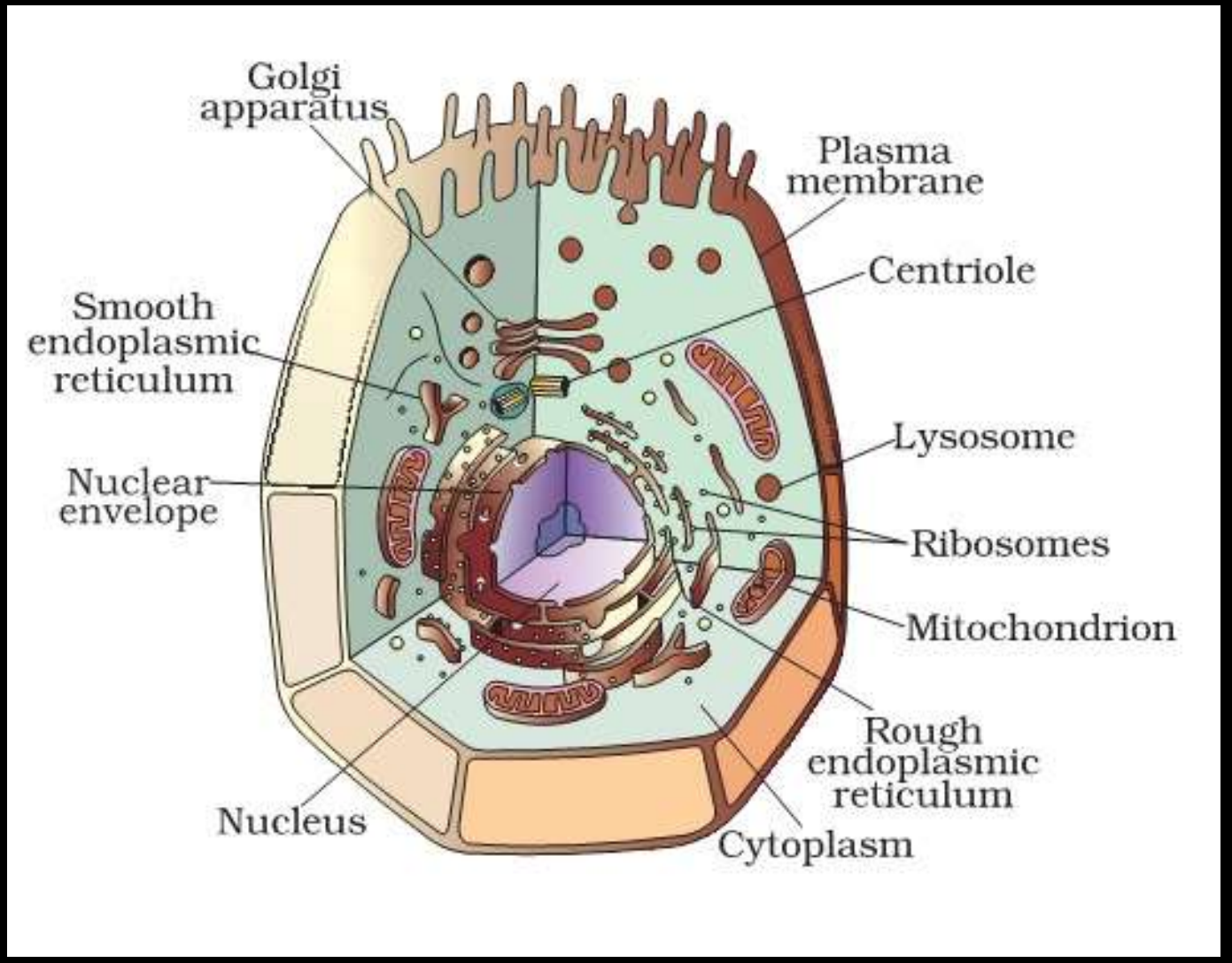
- Helps in exchange of materials between cell organelles.
- Acts as store of vital chemicals such as amino acids, glucose, vitamins, iron, etc.
- Some cellular processes (metabolic processes) occurs inside cytoplasm like formation of protein, breakdown of glucose, etc.
- It dissolves cellular wastes.



Cell Organelles

Cell Organelles





Cell Organelles

- Complex eukaryotic cells performs several chemical activities to support their complex structure.
- Eukaryotic cells contain several membrane bound tiny structures called cell organelles.
  - They perform different functions within the cell.

Organelles which carry out important activities in a Cell –

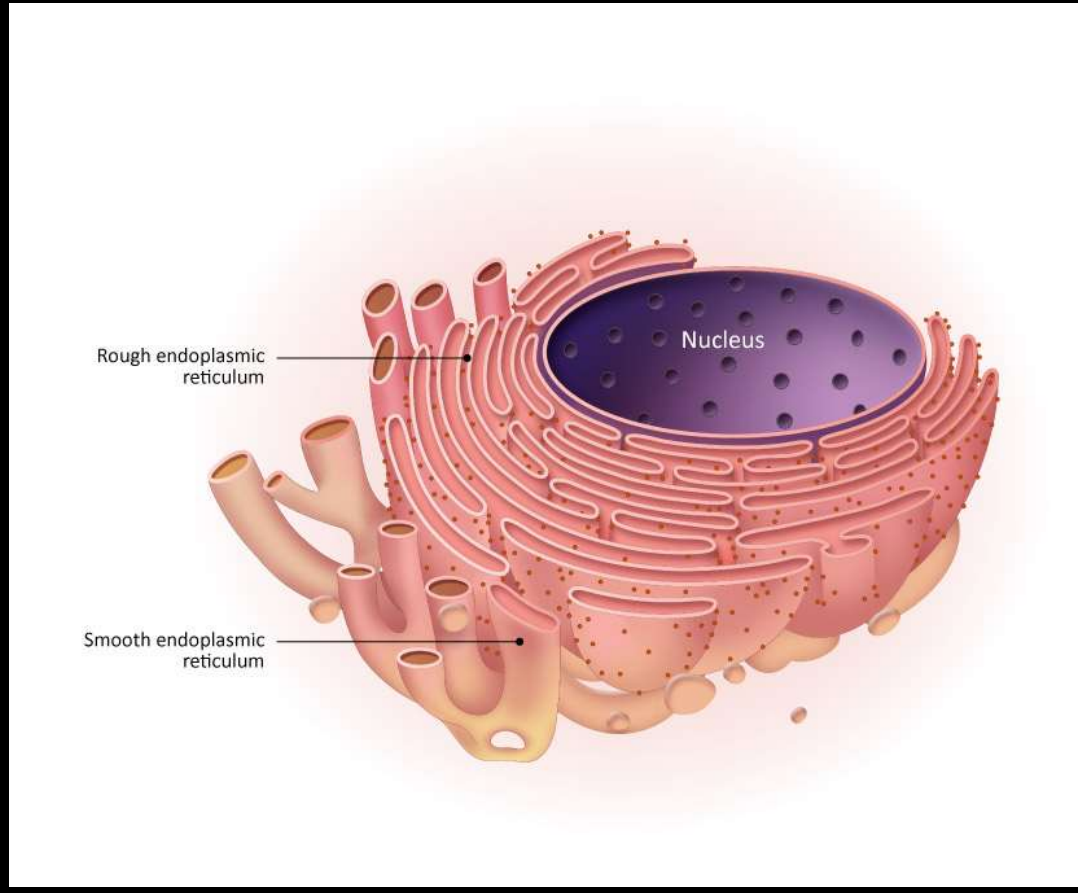
1. Endoplasmic Reticulum ✓
2. Golgi Apparatus ✓
3. Lysosomes ✓
4. Mitochondria ✓
5. Plastids ✓
6. Vacuoles ✓
7. Centrioles ✗
8. Ribosomes ✓
9. Peroxisomes ✗

1. Endoplasmic Reticulum

- ER structure is similar to Plasma Membrane.
- It is a large network of membrane bound tubes and sheets.

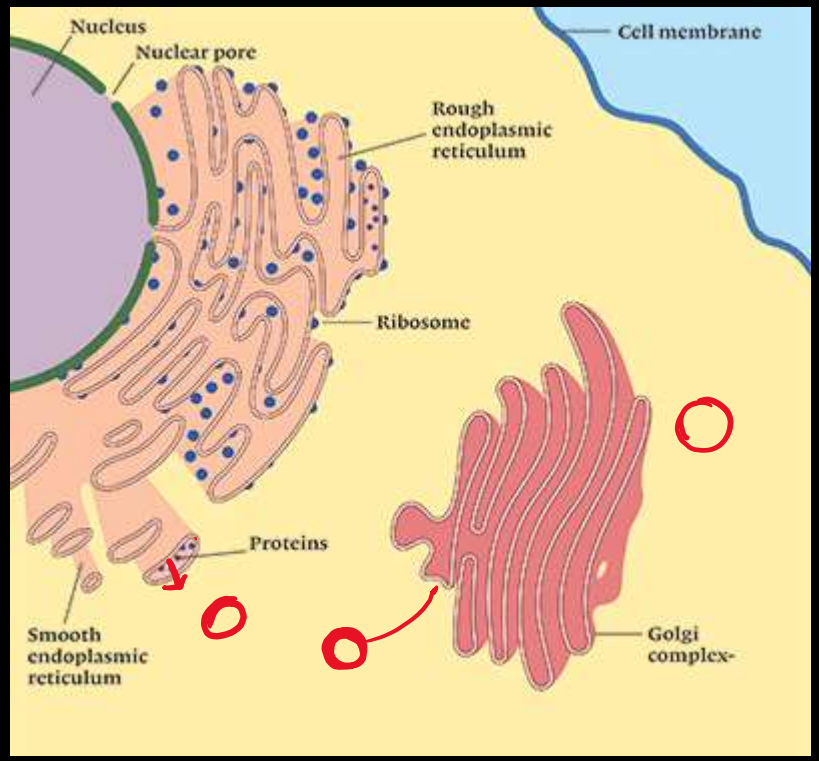
Two types of ER –
- Rough ER (RER)
- Smooth ER (SER)

- RER has ribosomes attached to their surface that are responsible for manufacture of proteins in the cell.
- SER helps in the manufacture of fat or lipids, important for cell function



Functions of Lipids and Proteins

- Lipids and proteins synthesized in ER are used for making cell membrane.
  - This processes is known as Membrane Biogenesis.
- Proteins can act as enzymes.
- Both proteins and lipids can act as hormones.



Functions of ER

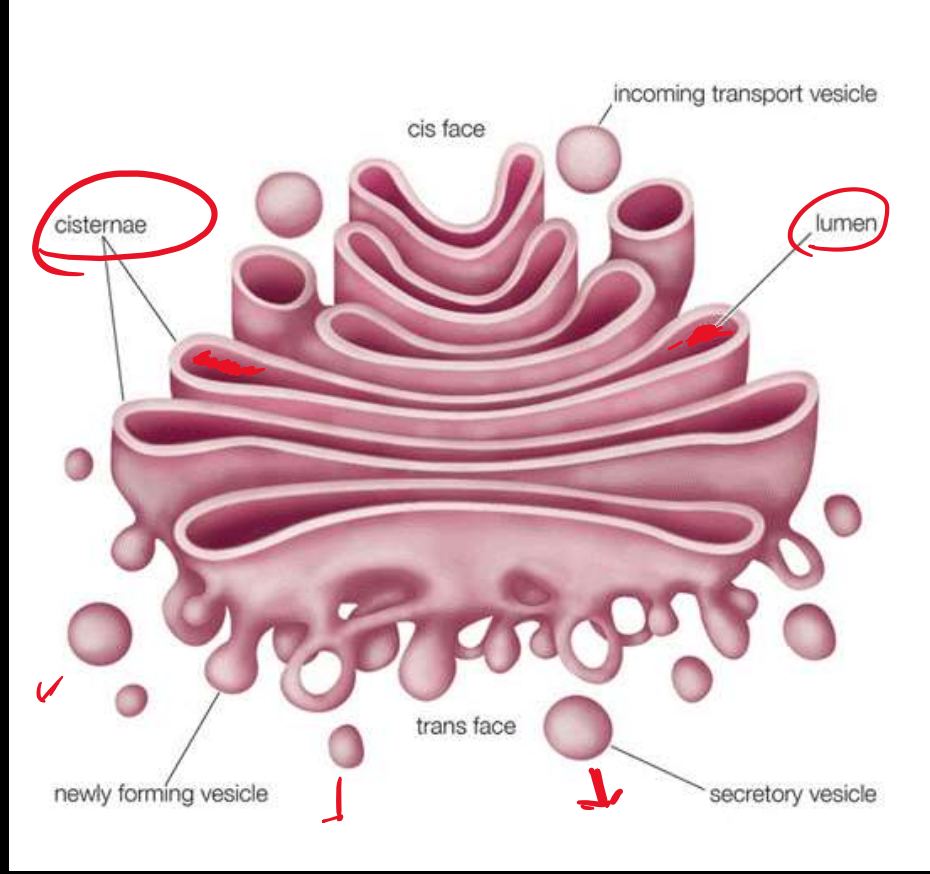
- Transportation of material between different parts of the cytoplasm and also between the nucleus and cytoplasm
- Folding of proteins which are synthesised by ribosomes on RER.
- Detoxifying poisons and drugs out of the cell is the function of SER in liver cells of vertebrates.

Golgi Apparatus

- Discovered by Camillo Golgi
- It contains vesicles that are arranged parallel in stacks.
  - These stacks are called Cisterns.
- These vesicles have their own membranes. These membranes are sometimes connected to those of the ER.

Functions of Golgi Apparatus

- Golgi apparatus carries materials synthesized by the ER to different parts of the cell. The material is stored and packaged in vesicles.
- Formation of complex sugar
- Formation of lysosomes



Lysosomes

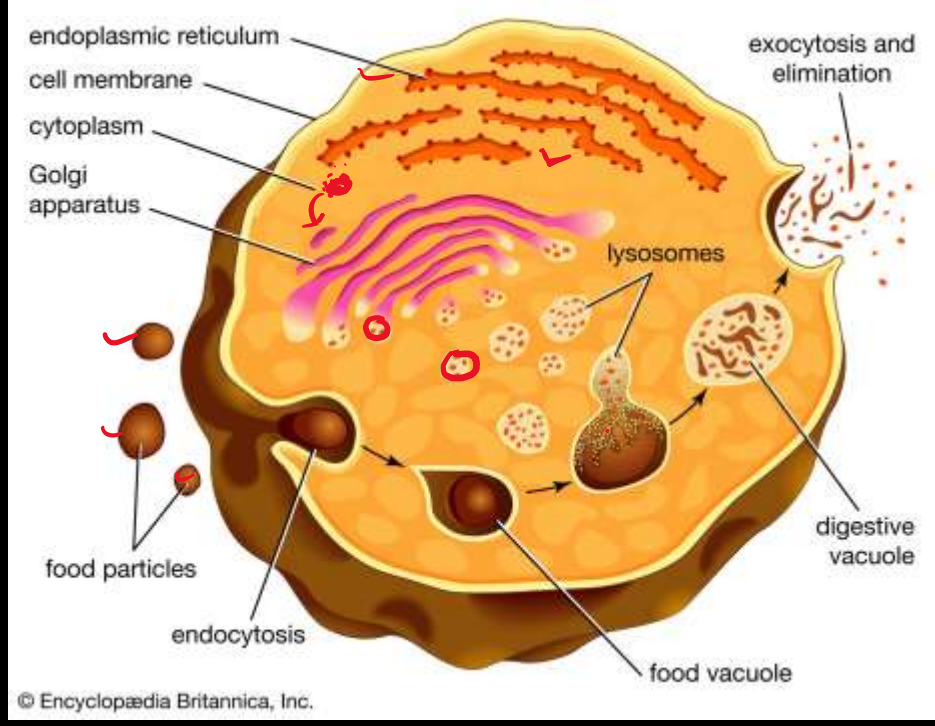
- Lysosomes are waste disposal system of the cell.
- It keeps the cell clean by digesting any foreign materials like food, bacteria and worn-out cell organelles.
- It is a membrane bound structure filled with digestive enzymes.

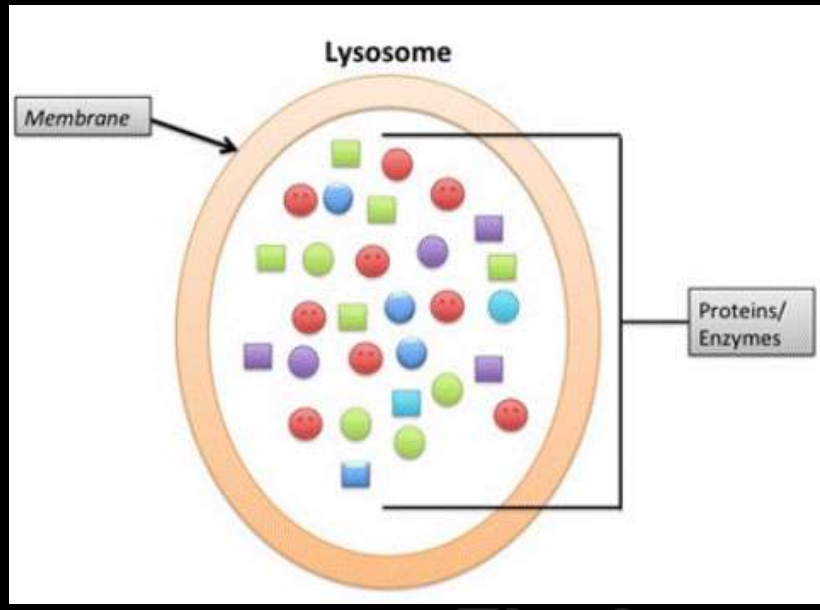
How can lysosomes digest any foreign material that enters the cell?

Lysosomes can do so because they have digestive enzymes in them. These enzymes break the materials and digest them. These enzymes are synthesised by RER and packaged into lysosomes by Golgi bodies.

Why are lysosomes called "suicide bags" ?

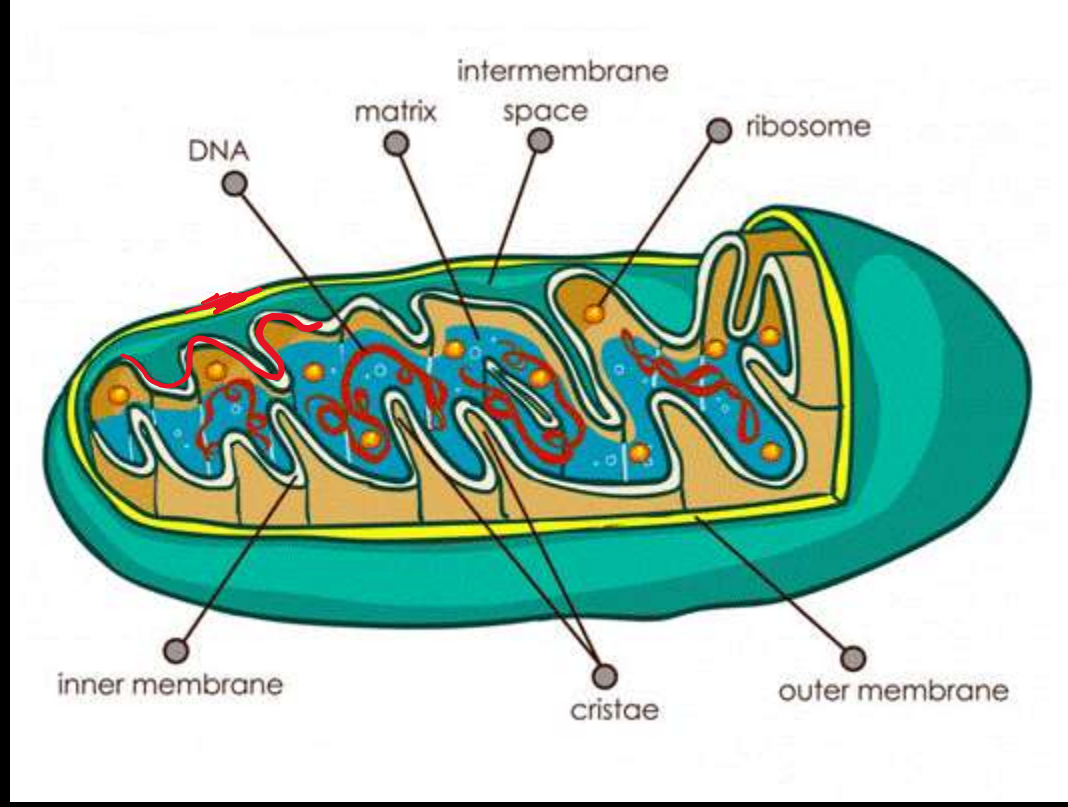
If the cell's own material gets damaged or dead, there are chances that lysosomes burst out, thus digesting its own cell. Hence they are called suicide bags.





Mitochondria

- It is a double membrane organelle that has its own DNA and that is why often called 'Semi-Autonomous Organelle'.
- Aka Powerhouses of the Cell.



Structure of Mitochondria

- Mitochondria have two membrane covering.
  - Outer membrane is very porous while inner membrane is deeply folded.
  - These folds create large surface-area for ATP-generating chemical reactions

Function of Mitochondria

- The energy required for various chemical activities needed for life is released by mitochondria in the form of ATP (Adenosine Triphosphate) molecules.
- ATP is aka energy currency of the cell.
  - Body uses energy stored in ATP for making new chemical compounds and mechanical work.
- Mitochondria has its own DNA and Ribosomes.
  - Therefore, mitochondria can make some of its own protein.
  - AKA Semi-autonomous organelle

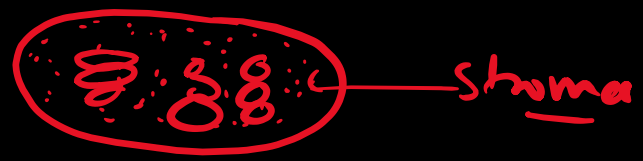
Plastids

- They are present only in plant cells.
- There are three types of plastids.
  - Chromoplast (coloured plastids)
  - Chloroplast (contains chlorophyll)
  - Leucoplast (white or colourless plastids)

white

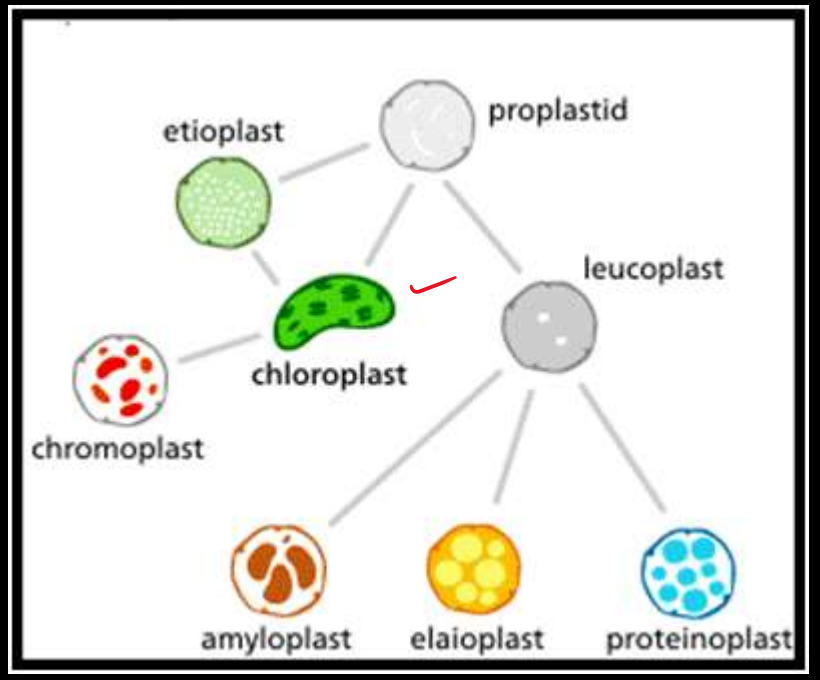
Structure of Plastids

- Internal organization of plastid consists of numerous membrane layers embedded in material called stroma.
- Plastids also have their own DNA and Ribosomes.



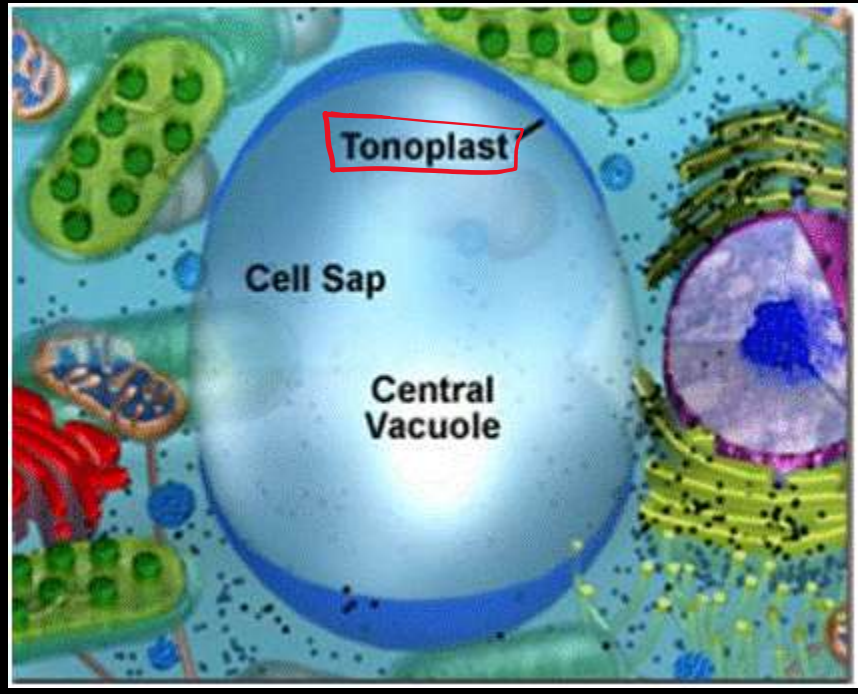
Functions of Plastids

- Chloroplasts is responsible for photosynthesis in plants
- Chloroplast also contains yellow/orange pigments apart from chlorophyll.
- Leucoplasts are organelles which stores starch, oils and protein granules.



Vacuole

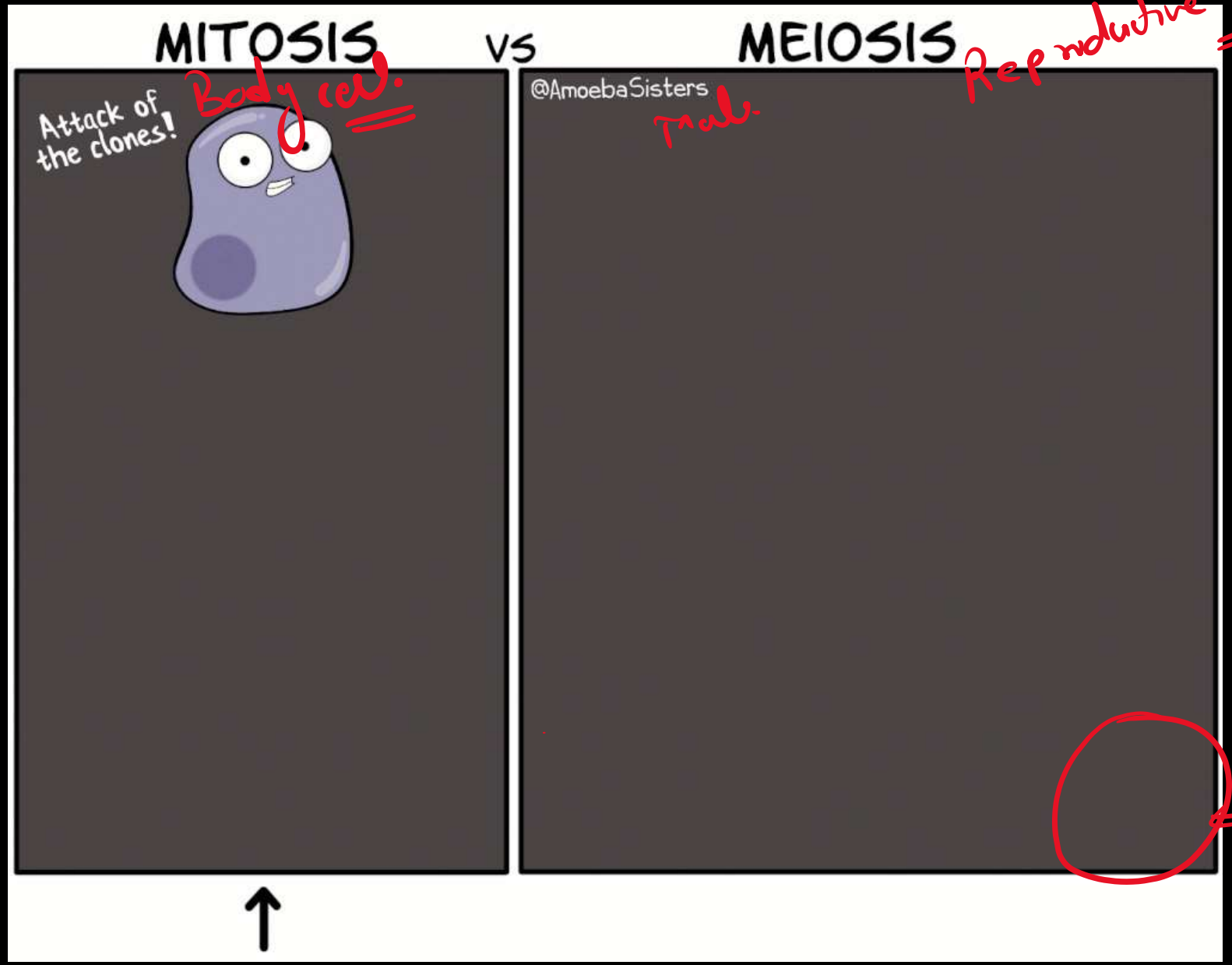
- Vacuoles are the places where cells can store liquids and solids.
- They are present in both plants and animals but the plant vacuoles are bigger in size than the animal vacuoles.



Functions of Vacuoles

- Central vacuole in some plant cells may occupy 50-90% of the cell volume.
- In plant cells vacuoles are full of cell sap and provide turgidity and rigidity to the cell.
- Many life supporting substances of the plant cell are stored in the vacuoles like amino acids, sugar, various organic acids and some proteins.
- In single celled organisms like amoeba, food vacuole contains the food item that the organism has consumed.
- In some unicellular organism, specialized vacuole also play important role in expelling excess water and some waste from the cell.

Cell Division



Body cell.

male.

Reproductive cells

46 Chromosome

Parent cell

46

46 chrom

Daughter Cell

23

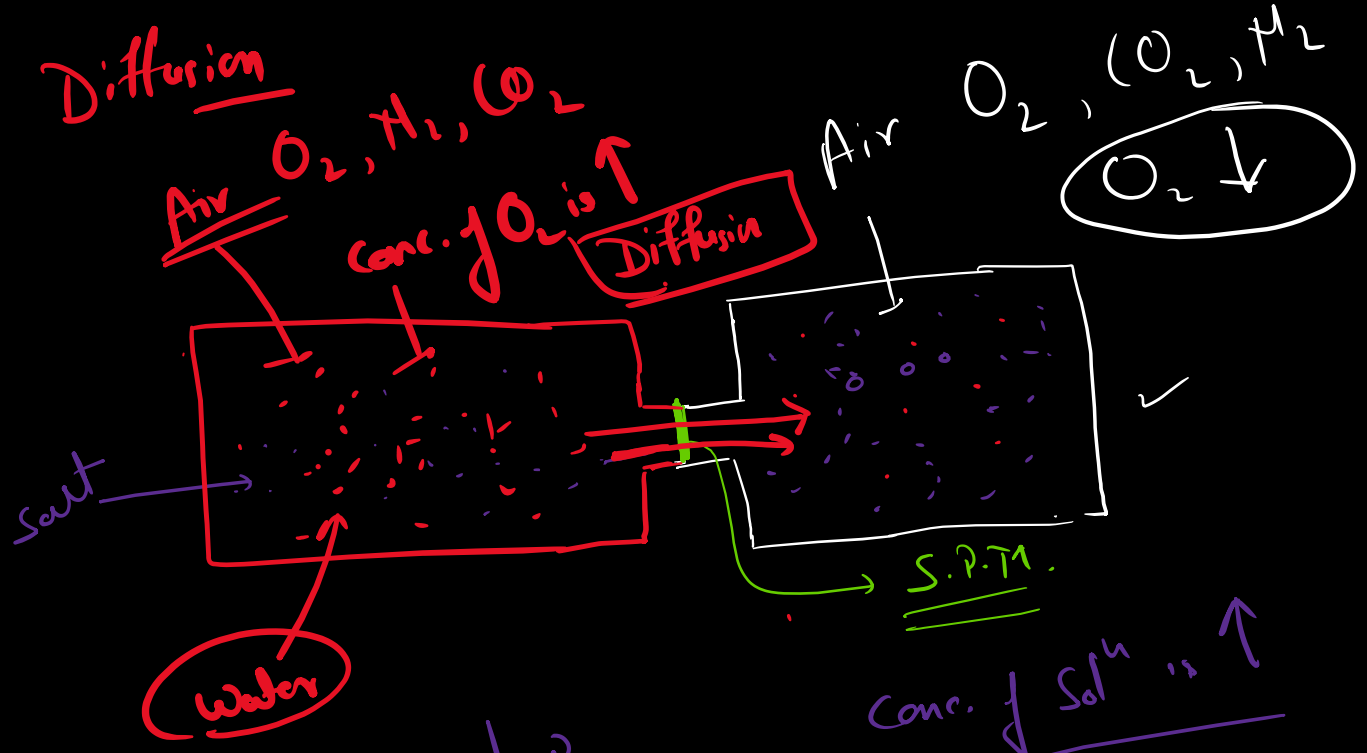
23

gametes.

46

Zygote

Diffusion



Mitosis:

- Takes place in body cells.
- Parent cell divides to form two identical daughter cells.
- No. of chromosomes remains same after mitosis.

Meiosis: