The Fundamental Unit of Life

What are Living Organisms Made Up of?

Our earth is inhabited by different organisms like eubacteria, Protista, fungi, plants and animals.

All living organisms are made up of microscopic units called cells.

What is a cell?

A cell is the structural and functional unit of life.

It has the same position in biology as an atom in physical science.

The branch of science which deals with the study of cell its structure, biochemistry and physiology is called Cell Biology.

Characteristics of a cell

Cells are the building blocks of all living organisms.

A cell is capable of independent existence and perform all the basic functions of life.

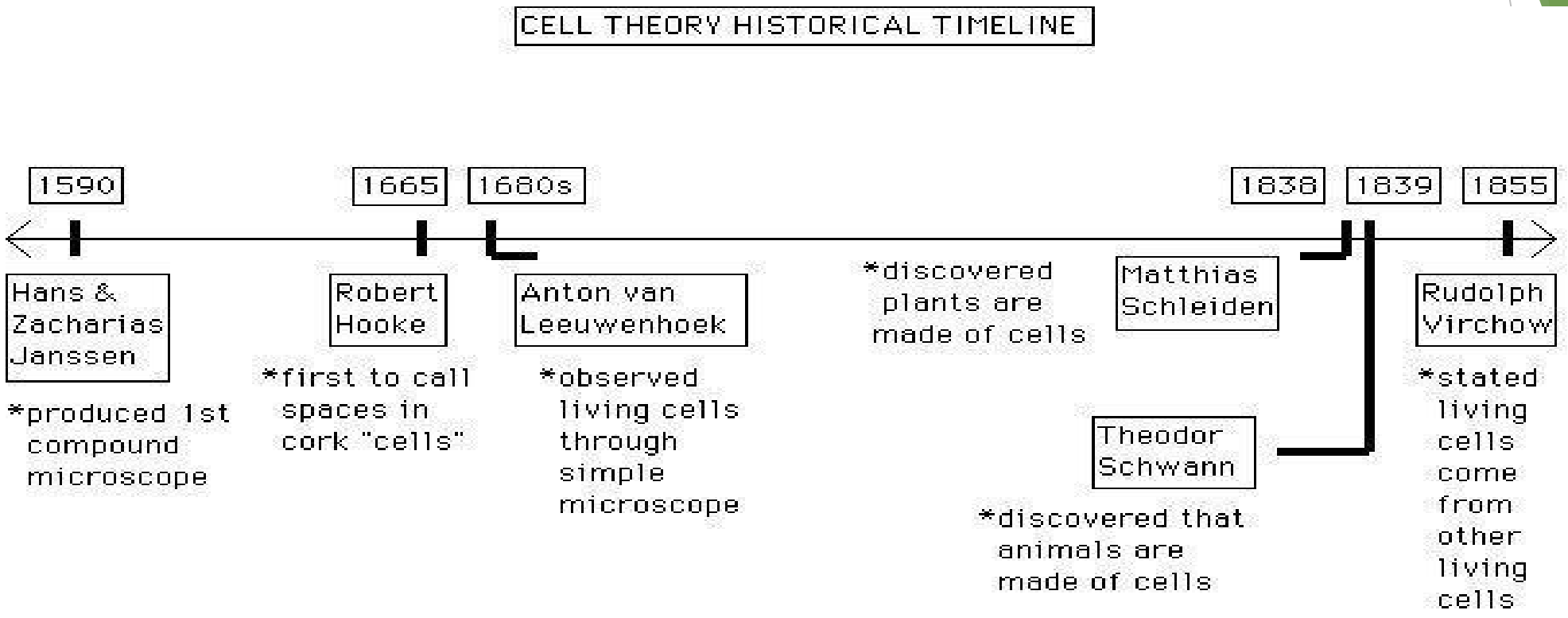
Every organism starts its life as a single cell.

The old and worn out cells are replaced by new ones.

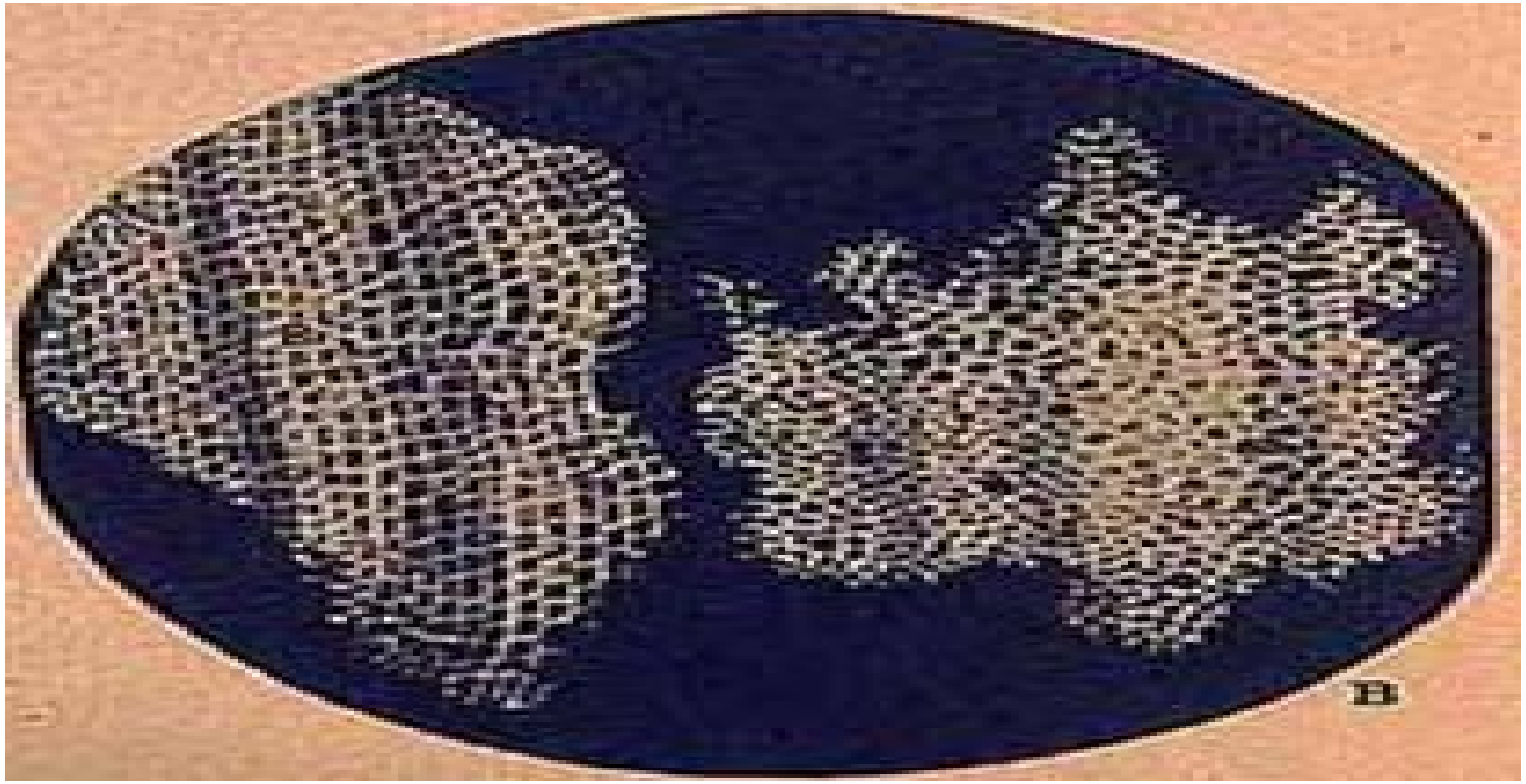
Many cells together form a tissue.

A cell has different cell organelles.

Discovery of cell



1831- Robert brown discovered the nucleus in the cell.
1839- Purkinje coined the term protoplasm for the fluid present in cell.
1940- devised electron microscope.



Dead cork cells observed by Robert Hooke

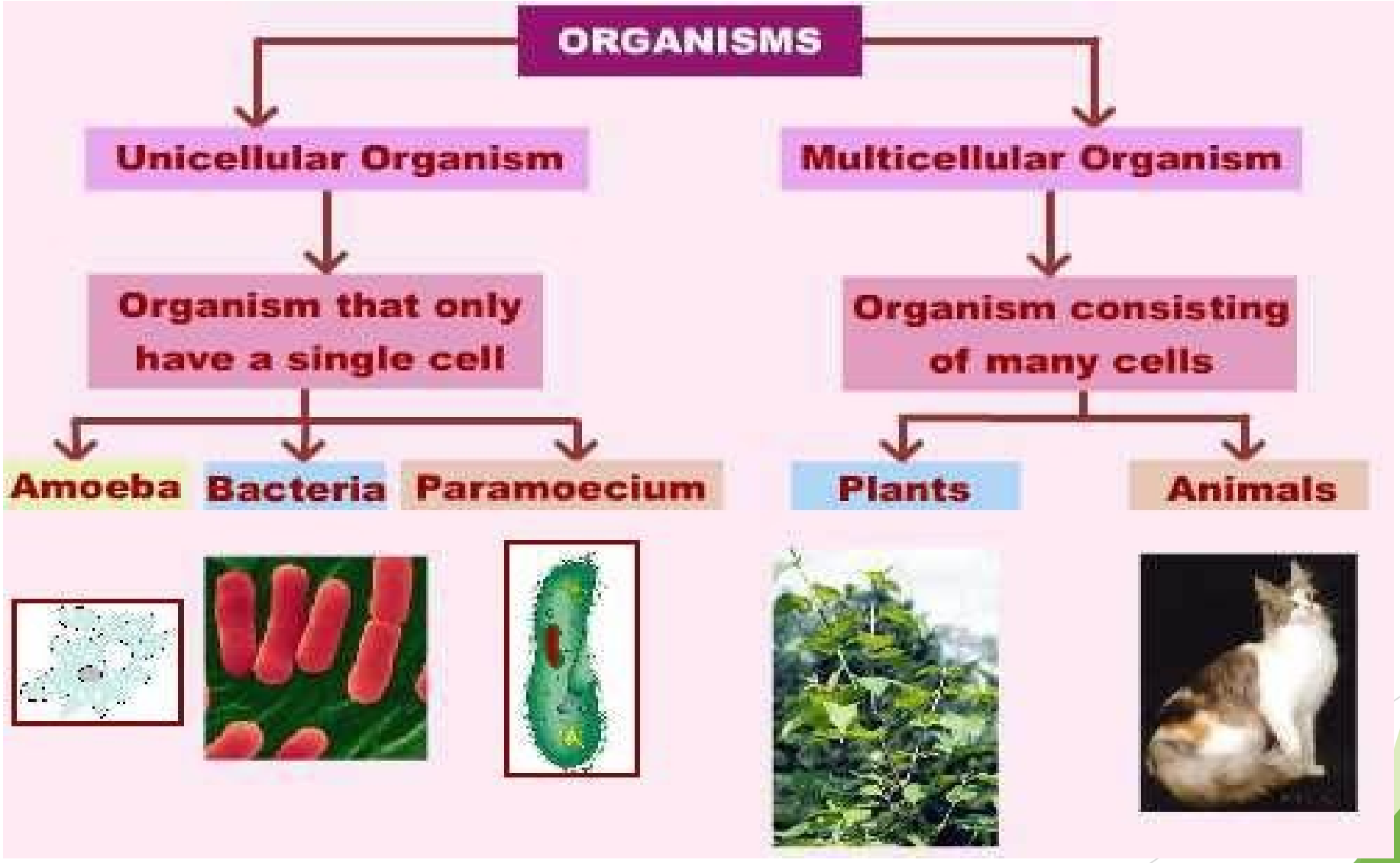
Cell Theory

A German botanist M.J.Scleiden and German zoologist Theodor Schwann collectively formulated Cell Theory.

Salient Features of Cell Theory

1. Cell is the basic structural unit of life.
2. Cell is the basic unit of function as all the metabolic reactions take place in side the cell.
3. Cell is the unit of heredity as it contains hereditary material.
4. All living cells arise from the pre existing cells.

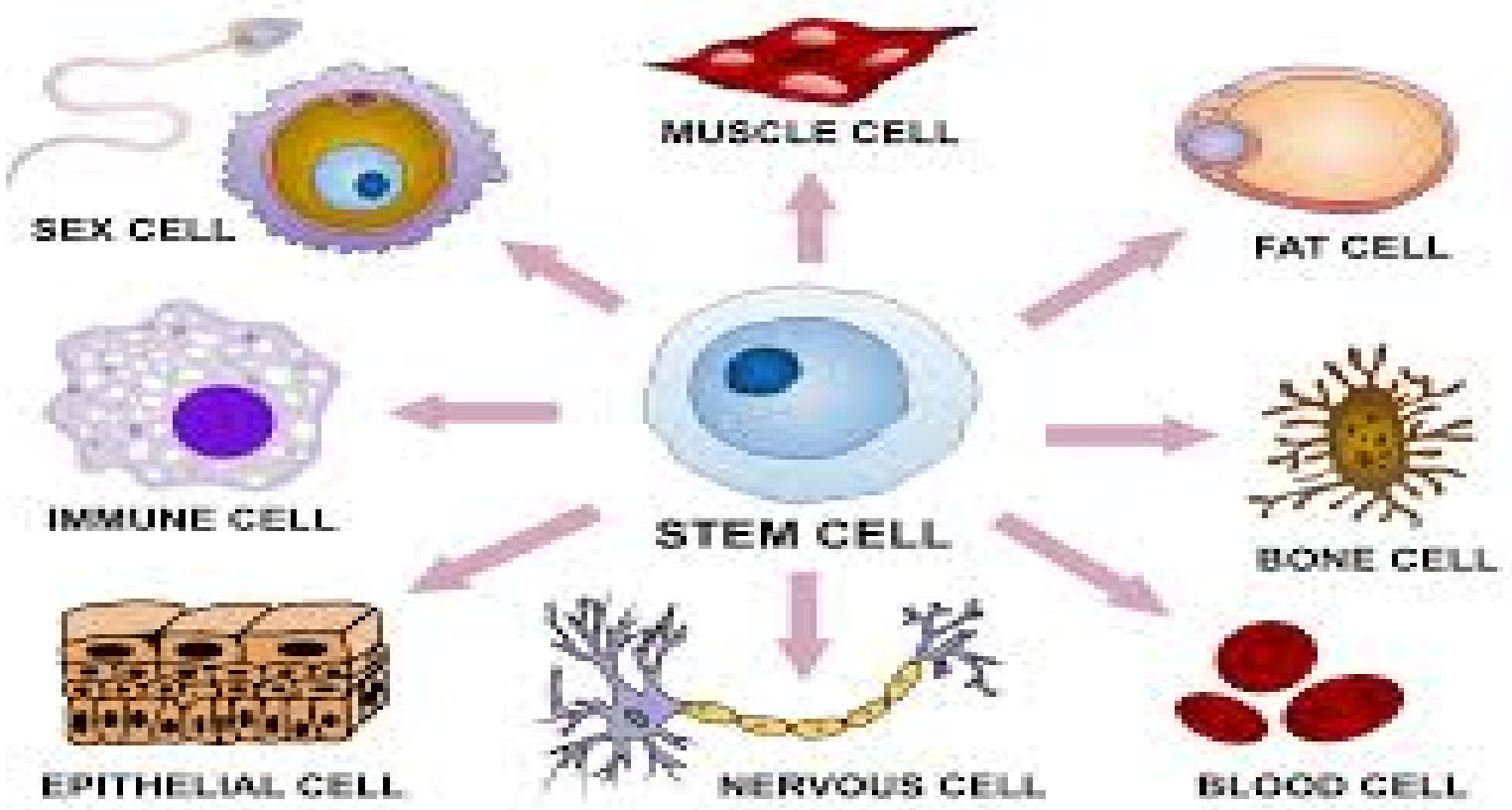
Unicellular and Multicellular Organisms



Prokaryotic cell	Eukaryotic cell
Most prokaryotic cells are unicellular.	Most eukaryotic cells are multicellular.
Size of the cell is generally small (0.5-5 µm).	Size of the cell is generally large (50- 100 µm).
Nuclear region is poorly defined due to the absence of a nuclear membrane or the cell lacks true nucleus.	Nuclear region is well-defined and is surrounded by a nuclear membrane, or true nucleus bound by a nuclear membrane is present in the cell.
It contains a single chromosome.	It contains more than one chromosome.
Nucleolus is absent.	Nucleolus is present.
Membrane-bound cell organelles such as plastids, mitochondria, endoplasmic reticulum, Golgi apparatus, etc. are absent.	Cell organelles such as mitochondria, plastids, endoplasmic reticulum, Golgi apparatus, lysosomes, etc. are present.
Cell division occurs only by mitosis.	Cell division occurs by mitosis and meiosis.
Prokaryotic cells are found in bacteria and blue-green algae.	Eukaryotic cells are found in fungi, plants, and animal cells.

Shapes of cell

In order to perform different functions, the cells exhibit different shapes.



Structural Organisation of a cell

An animal cell is broadly formed of three major parts.

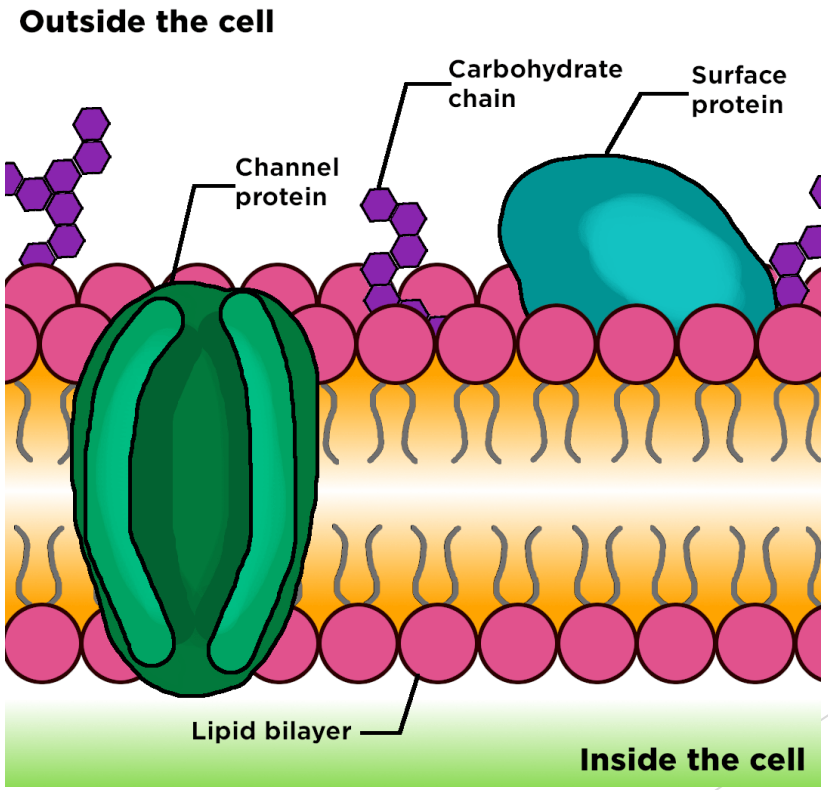
Plasma membrane
Nucleus
Cytoplasm

A plant cell is slightly different from an animal cell. It has cell wall and vacuole in addition to these structures.

Plasma Membrane or Cell Membrane

It is the outermost covering of all cells. It separates the cell contents from the outer environment. It is very thin , elastic and selectively permeable.

- It gives definite shape to cell.
- It acts as a mechanical barrier.
- It allows only selective substances to pass through
- Because of elasticity enables the cell to engulf large molecules
- Chemicals present on its surface defend against diseases.



How substances move in and out of cells

Diffusion
Osmosis
Endocytosis
Phagocytosis

Diffusion: Movement of particles of a substance in a gas or liquid form from a region of higher concentration to lower concentration until uniform concentration is achieved at both ends.
Ex. The exchange of respiratory gases between the cell and its external environment.

Osmosis

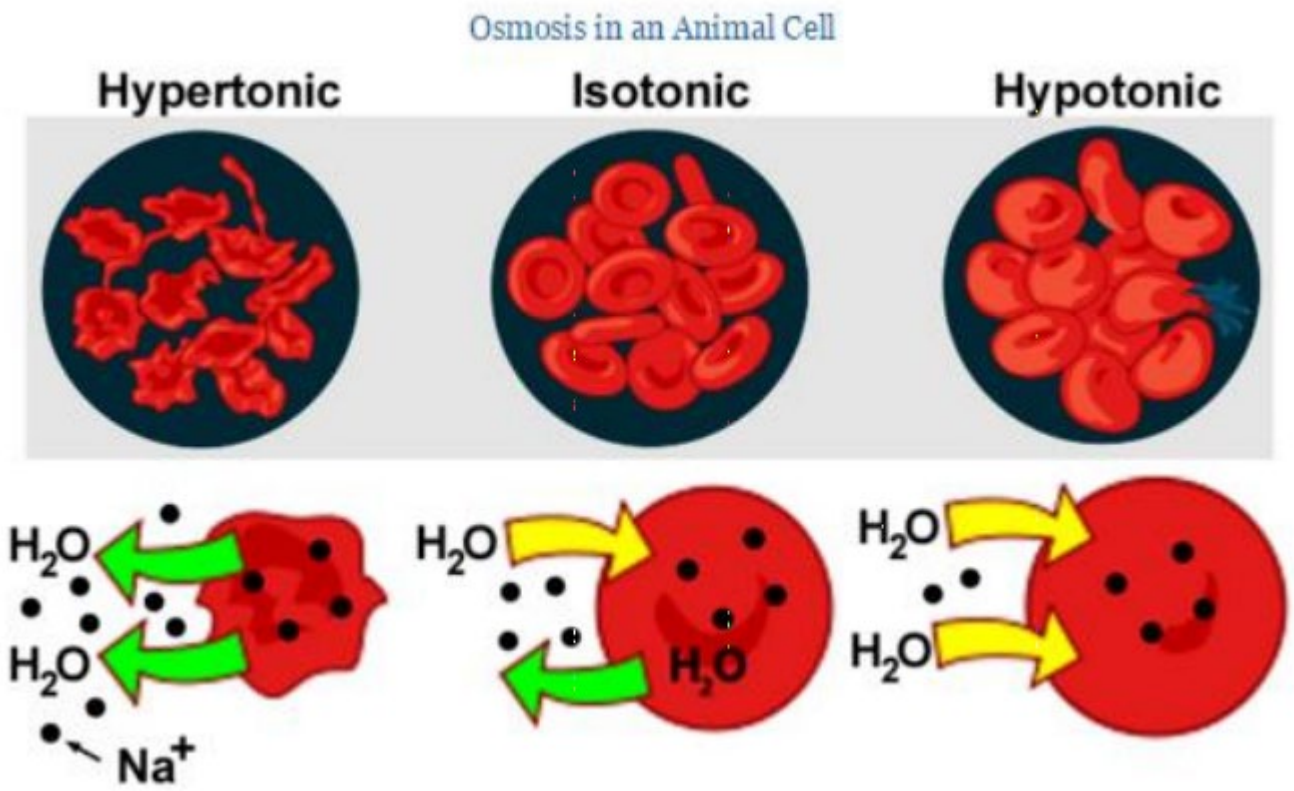
The movement of water molecules through a selectively permeable membrane from a region of higher water concentration to a region of lower water concentration.

Types of osmotic solutions

1.Isotonic solutions: These solutions have same solute concentration. Therefore, water neither moves in nor out of through the cell membrane.

2. Hypotonic solutions: If the medium around the cell has a higher water concentration than the cell, its called hypotonic solution.In this case cell will absorb the water.

Hypertonic solution: If the medium around the cell has a lower water concentration than the cell, its called hypertonic solution. In this case the cell will shrink.



Importance of Osmosis

1. Roots absorb water from soil by osmosis.
2. Cell to cell movement of water absorbed by roots also occur by osmosis.

Passive and Active Transport

Passive Transport : The movement of molecules by diffusion or osmosis without the use of energy by the cell .

Active Transport: The movement of substances against concentration gradient. The cell spends energy during this movement.

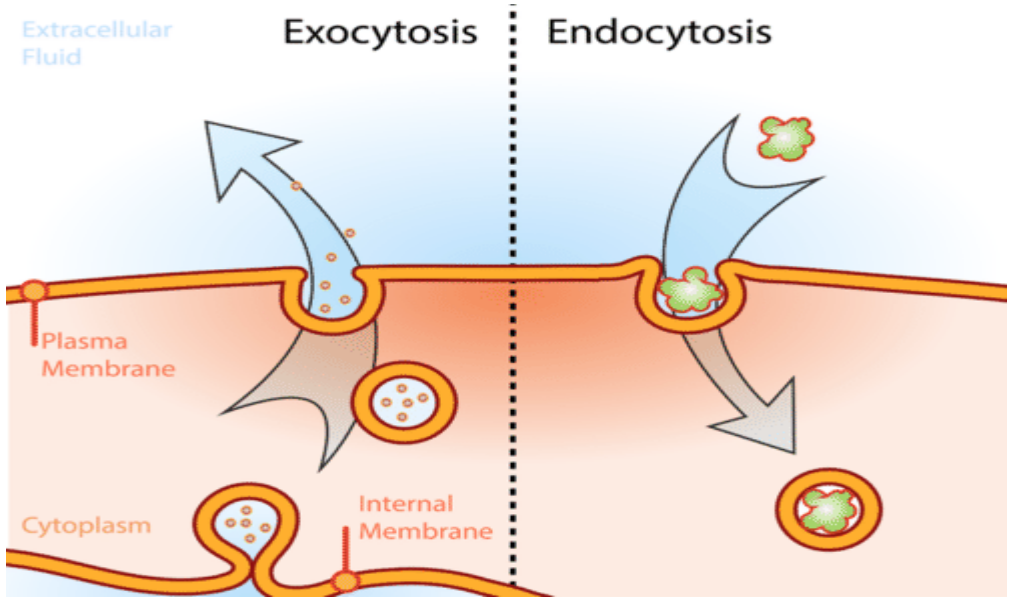
Osmosis	Diffusion
It is limited only to the liquid medium.	Occurs in all mediums – Solid, Liquid and gas.
Requires a semipermeable membrane.	Do not require a semipermeable membrane.
Depends on the number of solute particles dissolved in the solvent.	Depends on the presence of other particles.
Requires water for the movement of particles.	Do not require water for the movement of particles.
Only the solvent molecules can diffuse.	Both the molecules of solute and solvent can diffuse.

Endocytosis and Phagocytosis

Taking in the macromolecules by the cell is called **endocytosis** and engulfing solid food particles is called **phagocytosis.**

Exocytosis

Throwing out unwanted material from the cell to the outer environment is called **cell vomiting or exocytosis.**



Cell wall

It is found only in plant cells. It is formed of cellulose. It provides structural support and mechanical strength to the cell.

Functions

1. It provides a definite shape to the cell.
2. It protects internal structures and plasma membrane.
3. It is freely permeable to water and substances in solutions.
4. The cell wall of adjacent cells are linked through middle lamella.

Nucleus

It is an oval shaped structure usually in the centre of animal cell. It was discovered by Robert Brown in 1831. Nucleus is consist of

Nuclear Membrane – It is surrounded by a double layered membrane called nuclear membrane. It is perforated by several minute nuclear pores. These pores help in exchange of materials between nucleus and cytoplasm

Nucleoplasm- The viscous fluid enclosed by nuclear membrane. It contains enzymes, ribosomes, nucleolus and chromatin thread.

Nucleolus – It is a dense spherical body clearly visible in non dividing cells. During cell division it disintegrates. It is consist of DNA, RNA, proteins and enzymes.

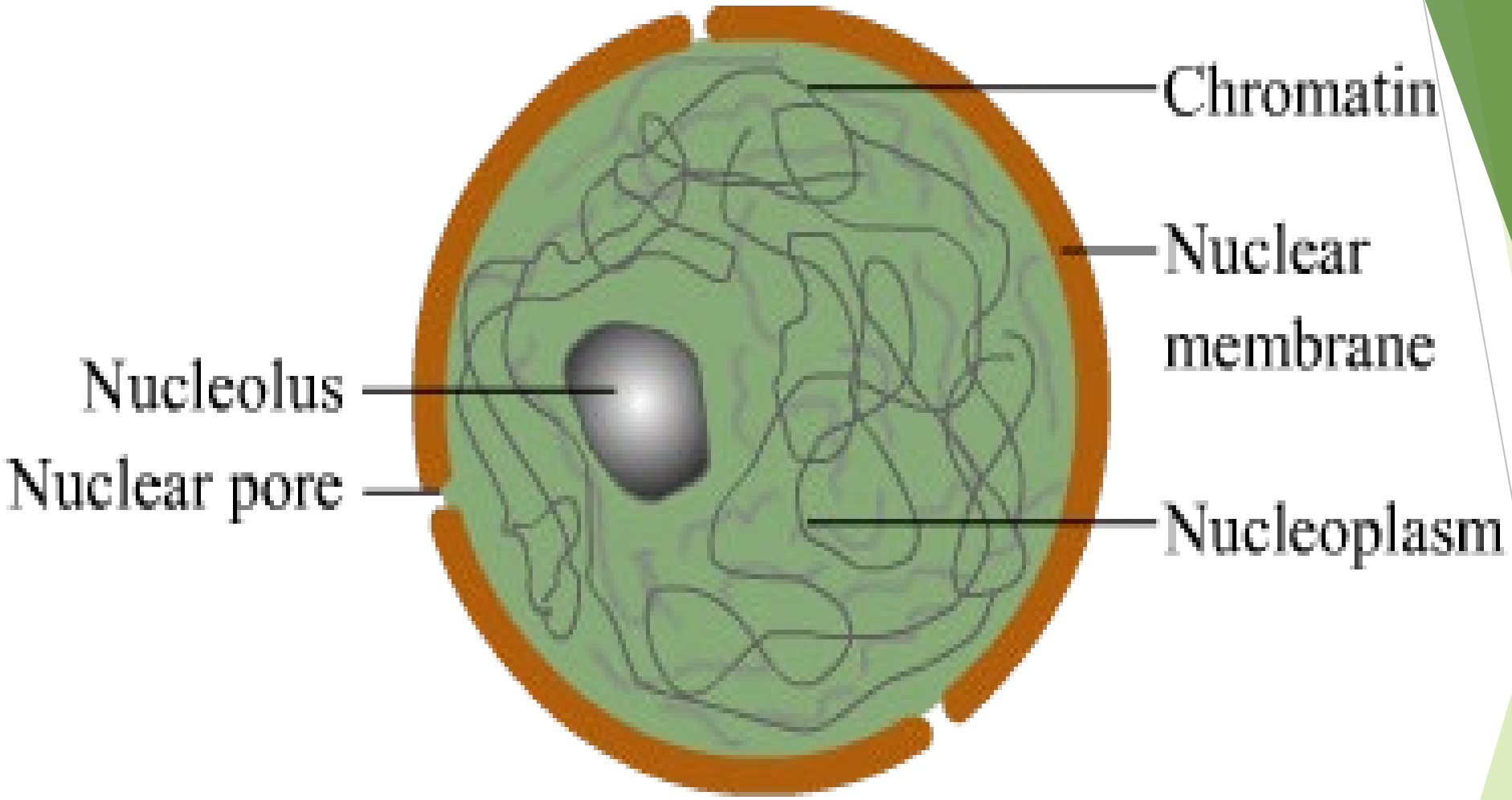
Chromatin Material

These are formed of DNA and proteins. In non dividing cells they are highly entangled but during cell division ,they condense into short rod like structures called Chromosomes. Chromosomes carry Genes.

Functional segments of DNA are called Genes. They are the hereditary units and DNA is hereditary material.

Functions of Nucleus

1. It is the control centre of cell.
2. It is the storehouse of genetic information.
3. It controls the cell division.
4. It helps in the formation of ribosomes and different types of RNA.



Structure of a Nucleus

Cytoplasm

- Description
- Gel like fluid where organelles are found
  Cytosol- fluid portion of cytoplasm
- Mostly water
- Function
- Gives the cell its shape
- Many necessary chemical reactions happen here

Cell Organelles

Endoplasmic Reticulum

It is a complex network of channels bounded by membranes. At one end it is connected to the outer membrane of nucleus and on other end to the plasma membrane. ER occurs in three forms: cisternae, vesicles and tubules.

Rough endoplasmic reticulum (with ribosomes)

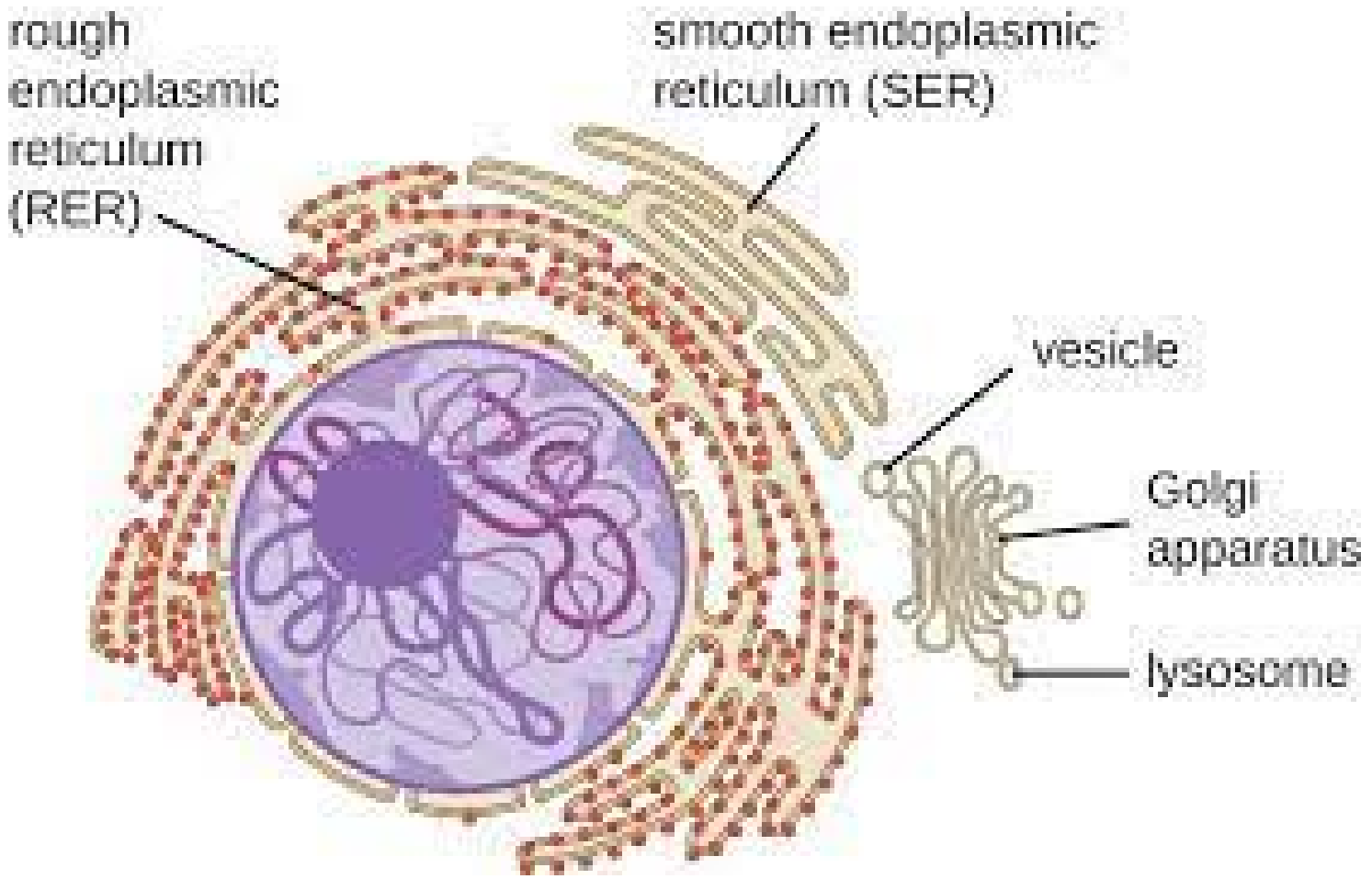
Smooth endoplasmic reticulum (without ribosomes)

They are absent in prokaryotic cells and mammalian RBCs

Functions of Endoplasmic Reticulum

- Mechanical support and distribution of cytoplasm
- Surface area for chemical reactions
- Intracellular transport system
- Storage of synthesized molecules
- Protein (RER) and lipid (SER) synthesis
- Detoxification of certain molecules
- Release of calcium ions in muscles

	SER	RER
(i)	It does not bear ribosomes over the surface of its membrane.	It possess ribosomes attached to its membrane.
(ii)	Its main function is synthesis of lipids.	Its main function is synthesis of proteins.
(iii)	Formed of vesicles and tubules.	Formed of cisternae and few tubules.
(iv)	It is usually found in periphery.	It is found deep inside the cytoplasm.
(v)	It may develop from RER.	It may develop from nuclear envelope.


rough endoplasmic reticulum (RER)
smooth endoplasmic reticulum (SER)
vesicle
Golgi apparatus
lysosome

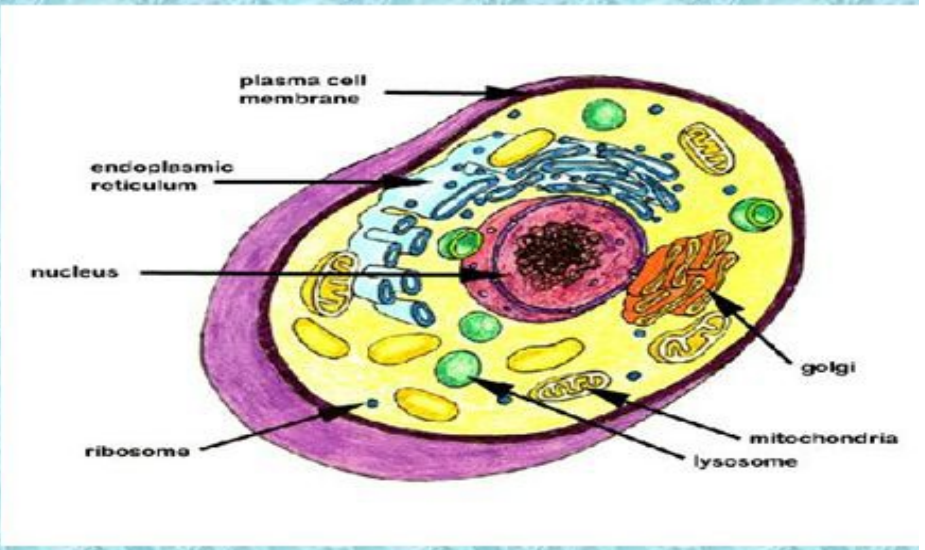
Ribosome

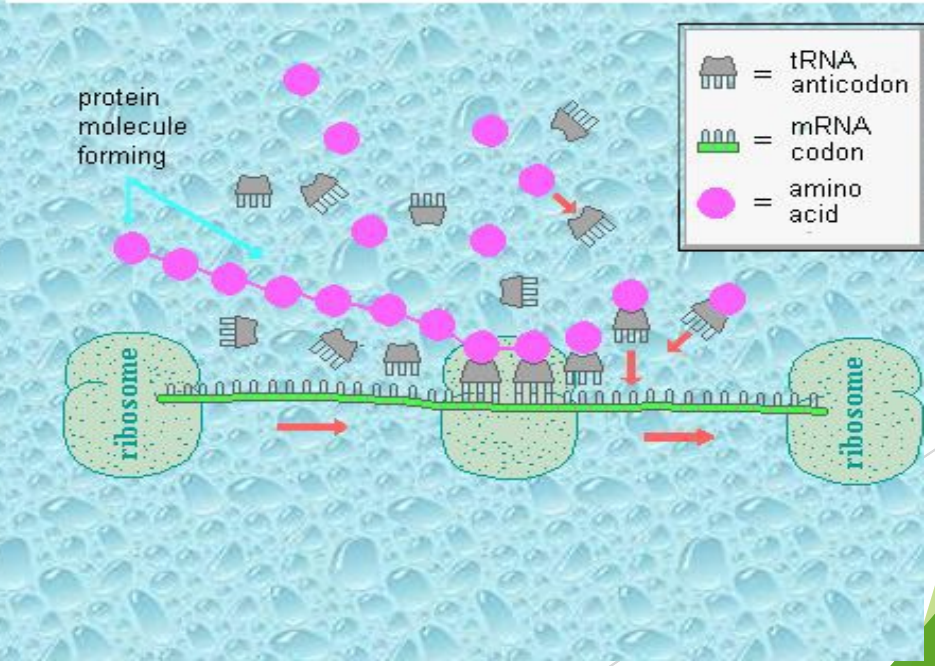
Location?

- In nucleus, cytoplasm, and Rough E.R.

Function?

- Produce proteins following coded instruction that come from the nucleus. They are made of RNA and protein.
- Can be found in animal and plant cells.

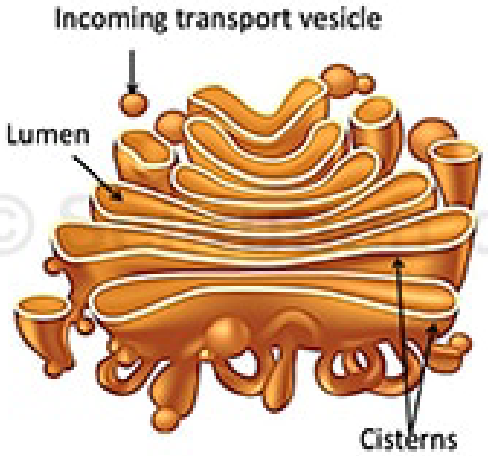




Golgi Apparatus – Structure and Function

Structure

1. These are very small vesicles which occur in different shapes such as granules, filament or rods .
2. It consists of many small groups of hollow tubular structures with membranous walls and is associated with some minute vesicles and vacuoles.
3. These vesicles are arranged parallel in stacks called cisterns.
4. The internal space of the vesicle is called the **lumen.**



Function

1. It is concerned with the synthesis and secretions of enzymes and hormones in the cell.
2. Golgi apparatus carries materials synthesized by the endoplasmic reticulum to different parts of the cell. The material is stored and packaged in vesicles.
3. It forms Glycoproteins and complex sugar (GA lactose) from simple sugar.
4. It also forms, acrosome of sperm (only in animals and human beings)

It was described by Camillo Golgi(1898).It is present in all eukaryotic cells except RBCs.In plant cells, Golgi apparatus consists of several freely distributed subunits, called Dictyosomes.

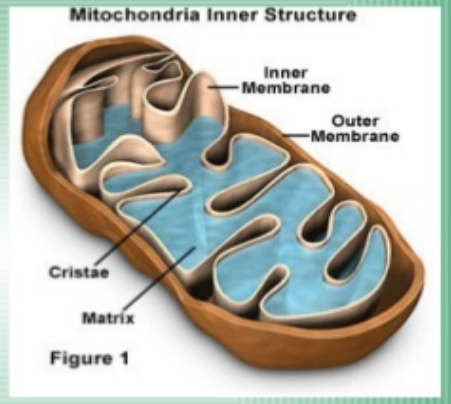
Lysosomes

- Membrane-enclosed vesicles that form from the Golgi complex.
- 60 kinds of powerful digestive and hydrolytic enzymes.
- Lysosomal enzymes also help recycle worn-out cell structures.
- Helps in fertilization.
- Some disorders are caused by faulty or absent lysosomal enzymes. e.g, Niemann pick disease, Gaucher's disease.

Lysosomes as suicidal bags - If the enzymes of lysosomes are released in the cell, they would result in autodigestion of the cell. Hence lysosomes are referred as suicide bags of cell.

Mitochondria

- Sites of chemical reactions that transfer energy from organic compounds to ATP
- ATP- main energy source for cells
- Cells with high energy requirements have more mitochondria ex: muscle and liver cells
- Have 2 membranes
- Smooth outer membrane serves as a boundary between the mitochondria and the cytosol
- Inner membrane has many folds called Cristae – they enlarge the surface area for more chemical reactions
- Have their own DNA (for reproduction)



They are called the **"POWER HOUSE"** of the cell

ATP Is the Universal Currency of Free Energy in Biological Systems

The commerce of the cell – metabolism – is facilitated by the use of a common energy currency, *adenosine triphosphate* (ATP).

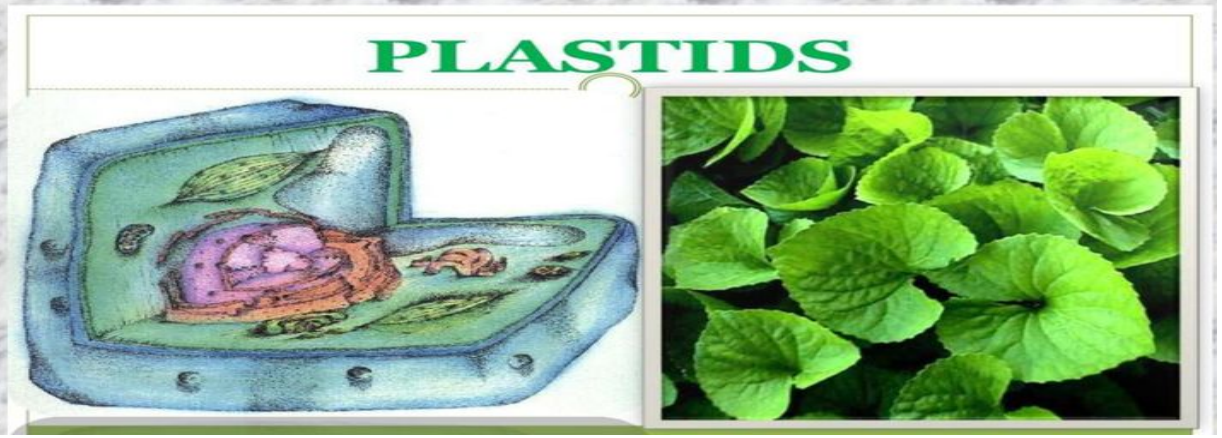
Energy from oxidation of metabolic fuels is transformed into highly accessible ATP molecule, which acts as the free-energy donor in most energy-requiring processes such as motion, active transport, or biosynthesis.

Plastids

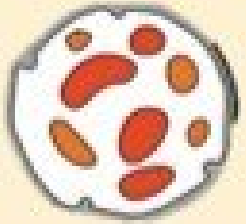
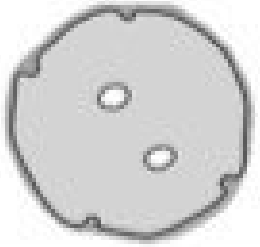
Plastids are double membrane bound organelles found inside plants and algae, which are primarily responsible for activities related to **manufacture and storage of important chemical compounds** used by the cells . the types of pigments present can determine the cell's color.

In plants, plastids may differentiate into several forms, depending upon which function they play in the cell. Undifferentiated plastids (*proplastids*) may develop into of the following:

- **Chloroplasts**
- **Chromoplasts**
- **Leucoplasts**



They are similar to mitochondria in external structure. They also have their own DNA and ribosomes.

Chloroplast		• Contain **chlorophyll** (green pigment) that absorbs sunlight in **photosynthesis** • Produce and store glucose
Chromoplast		• Contain carotenoids (red, orange, and yellow pigments) • Found in flowers and fruit
Leucoplast		• Contain no pigment • Used to store starch

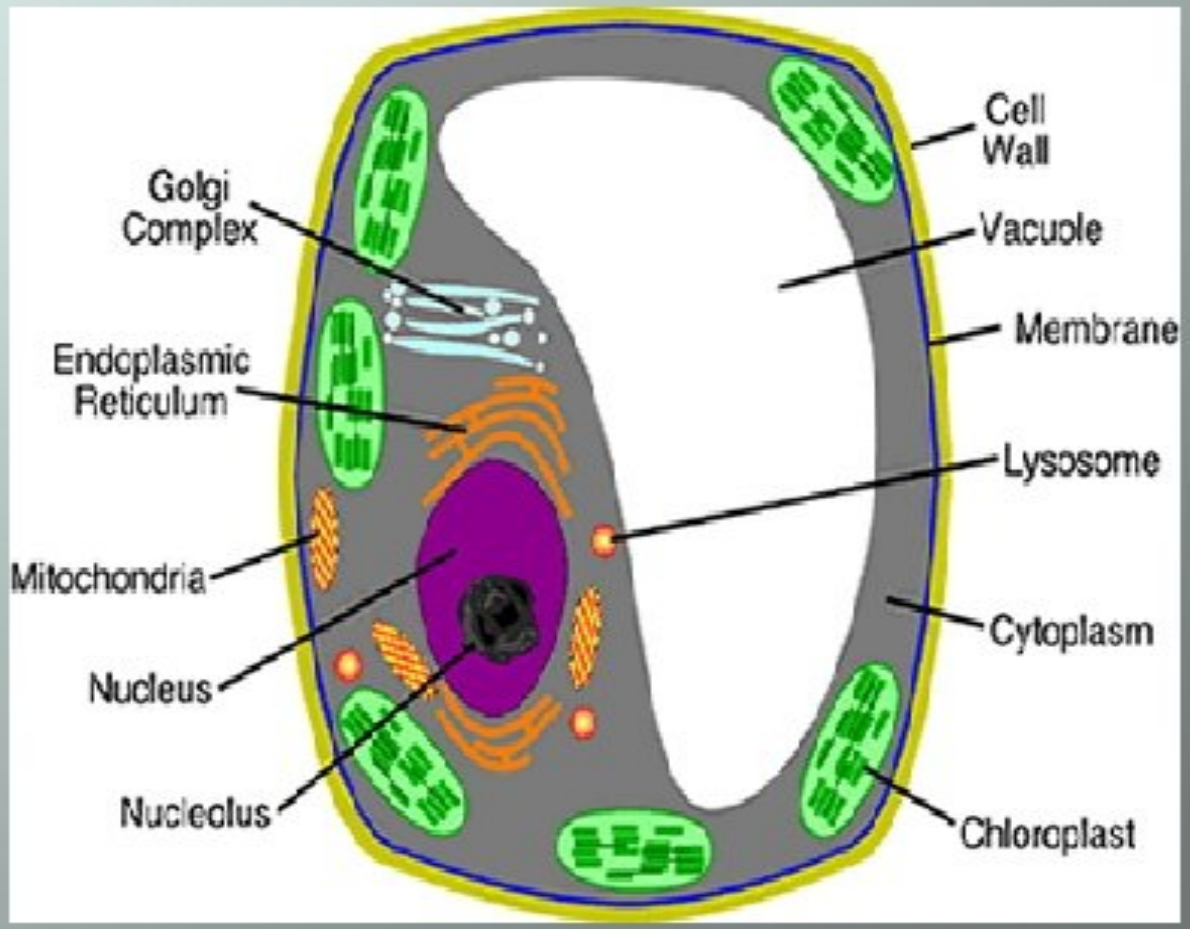
Vacuoles

Location?

- Saclike structure in the cytoplasm
- Plant cells – Single, large central vacuole
- Small or absent in animals

Function?

- Store materials such as <u>water</u>, salts, proteins and carbohydrates
- Pressure in plant vacuole aid in support of plant cell (lack of water – wilting)



Cell Division

The process by which new cells are made is called cell division. New cells are made in order to grow, to replace old cells and to form gametes required for reproduction.

Cell Division is of two types:

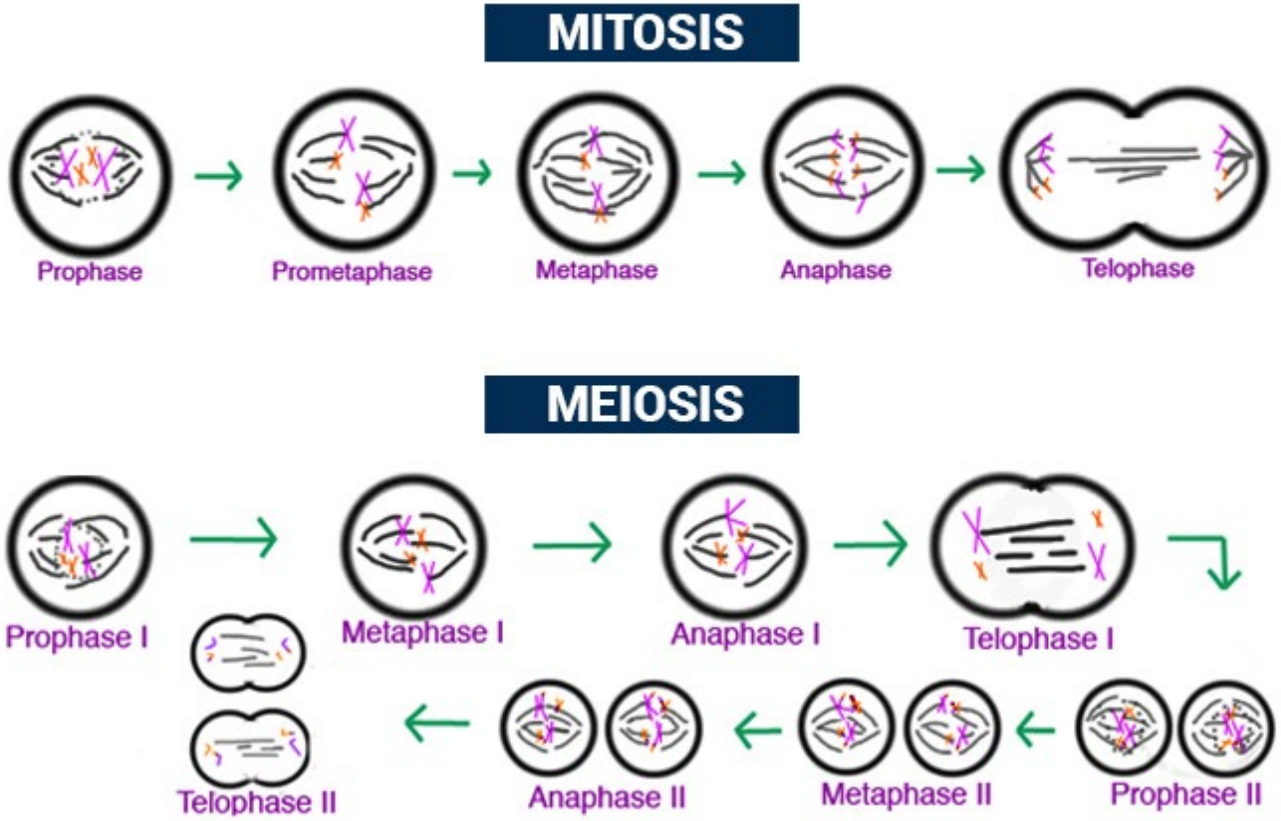
Mitosis

Meiosis

Mitosis - Mitosis is a process of cell division in which one parent cell divides in two genetically identical daughter cells. In mitosis Chromosome number remains same in daughter cells.

Meiosis - Meiosis is involved in the formation of gametes. This process results in four daughter cells developing from a single parent cell. Chromosome number reduce to half in daughter cells in case of meiosis.

Types of Cell Division



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