eLearning

by Dr. M.G.R EDUCATIONAL AND RESEARCH INSTITUTE

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EDUCATIONAL AND RESEARCH INSTITUTE

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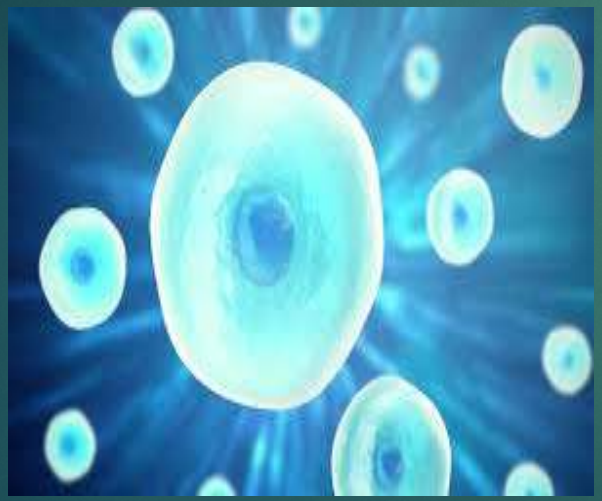
What is Cell?



- Cell is the basic Structural and functional unit of living organisms.
- In other words, cells make up living things and carry out activities that keep a living thing alive.

Cell Theory

Cell theory is a collection of ideas and conclusions from many different scientists over time that describes cells and how cells operate.

- All known living things are made up of one or more cells.
- All living cells arise from pre-existing cells by division.
- The cell is the basic unit of structure and function in all living organisms.

Cell Theory Timeline

Alex Moore

Time Line

1665
Robert Hooke

Hooke termed the word cell for describing biological organisms, because he said they resembled monks' cells.

1674
Anton van Leeuwenhoek

Leeuwenhoek is commonly known as the "Father of Microbiology", as he was the first person to ever see microorganisms. He later improved the microscope, and contributed towards the establishment of microbiology.

1827
Robert Brown

Robert Brown was known for discovering the cell nucleus, and gave one of the earliest detailed descriptions of the cell nucleus.

1839
Jakob Schlieden & Theodor Schwann

Jakob Sclieden was a german botanist that found cells in plants, and Theodor Scwann was a zoologist that found cells in animals. They were both co-founders of the cell theory.

1855
Rudolph Carl Virchow

Rudolph Carl Virchow concluded that cells were made from existing cells, because existing cells divided to form new cells.

1855
Louis Pasteur

Pasteur made significant discoveries in chemistry, including treatments and research of many diseases, and a resolution to the problem concerning the nature of tartaric acid.

Three Principles of Cell Theory

The three principles of cell theory are: 1) All organisms are composed of one or more cells, 2) The cell is the most basic unit of structure, function, and organization in all organisms, and 3) All cells arise from pre-existing, living cells.

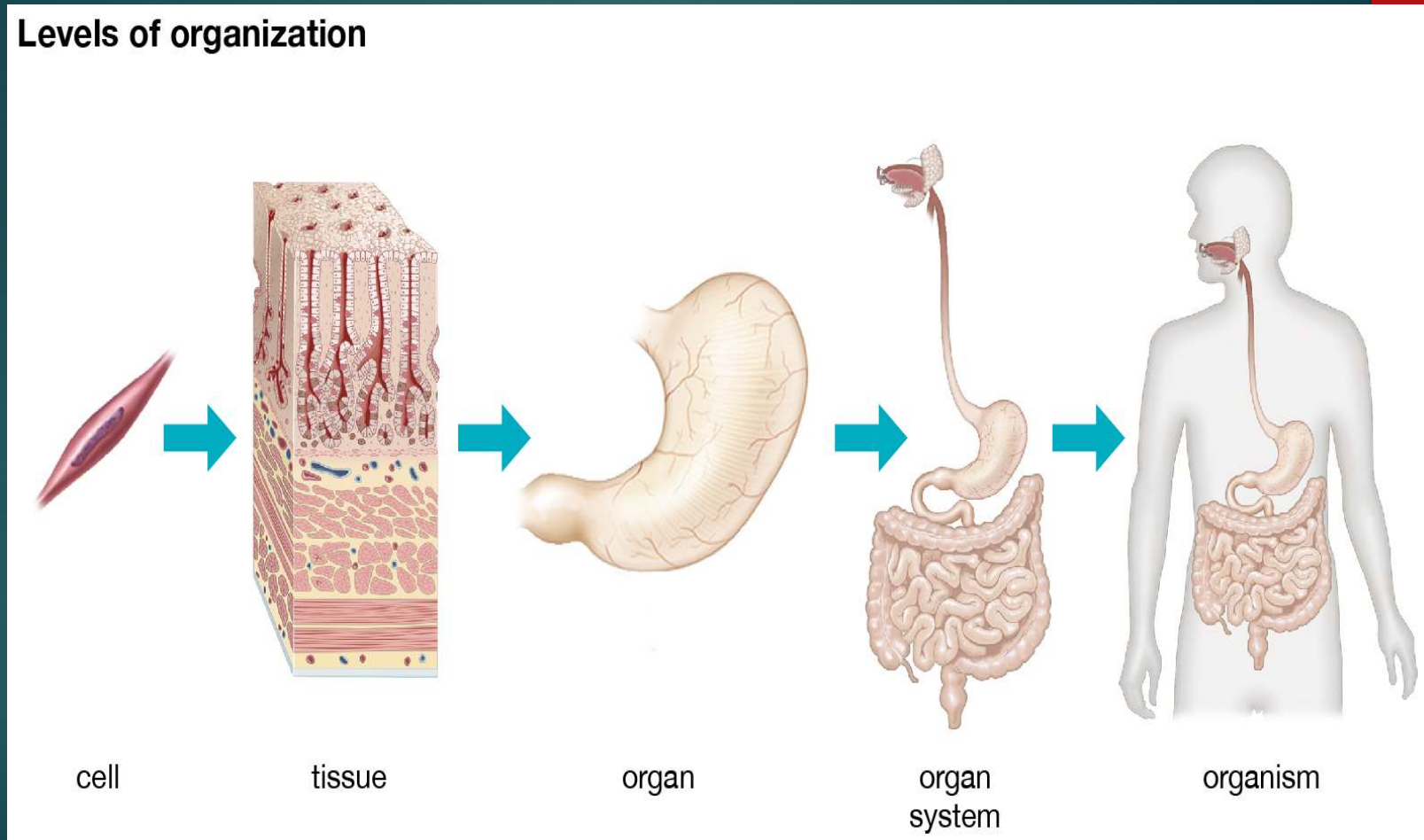
One Exception to the Cell Theory

One exception to the cell theory is a virus. Viruses are considered alive by some, yet they are not made up of cells. Viruses have many features of life, but according to the cell theory, they are not alive.

Cell Theory Timeline

1. 1665 Cell Theory Timeline Robert Hooke Discovered cell 1674 Anton Van Leeuwenhoek Observed living cell 1883 Robert Brown Discovered nucleus
2. 1835 Felix Dujardin Discovered fluid content of cell 1838 Matthias Schleiden Proposed all plants are made up of cells 1839 J. E. Purkinje Named fluid content of cell as protoplasm Cell Theory Timeline
3. 1839 Theodor Schwann Proposed all animals are made up of cells 1845 Carl Heinrich Braun Proposed cell is the basic unit of life 1855 Rudolf Virchow Proposed all cells arise from pre-existing cells

LEVEL OF ORGANISATION



- Unicellular Organisms - An organism that is made up of only one cell is called as unicellular organism. Euglena, Paramecium, Yeast

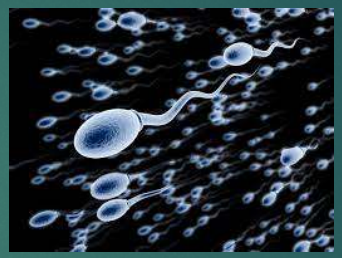
- Multicellular Organisms - An organism that is made up of more than one cell is called as multicellular organism. Plants, Animals, Fungus

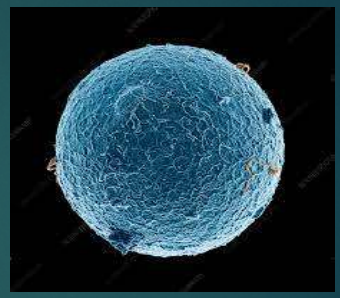
Size of Cells

- Cells vary in size.
- Most cells are very small (microscopic),
- some may be very large (macroscopic).
- The unit used to measure size of a cell is micrometer.
- • Smallest cell • Mycoplasma • Size: 0.1 µm •
- Largest cell • Ostrich egg • Size: 18 cm 1 µm = 1/1000 millimeter

Size of Cells in Humans

- Smallest cell - Sperm cell Size: 5 µm
- Largest cell - Ovum cell Size: 120 µm
- Longest cell - Nerve cell Size: 1 m





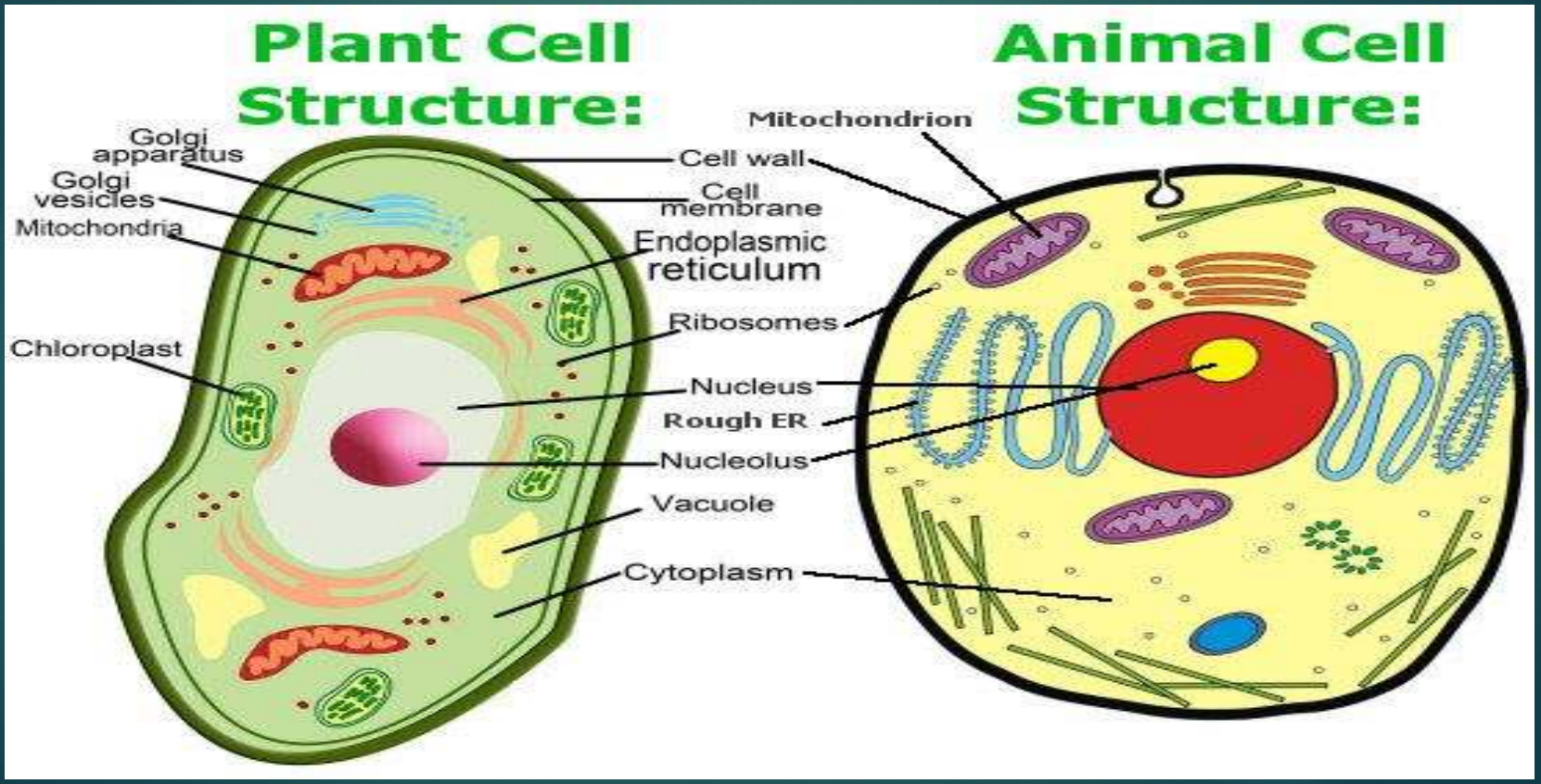
Shape of Cells

- Cells vary in shape.
- Variation depends mainly upon the function of cells.
- Some cells like Euglena and Amoeba can change their shape, but most cells have a fixed shape.
- Human RBCs are circular biconcave for easy passage through human capillaries. Nerve cells are branched to conduct impulses from one point to another.
- Human WBCs can change their shape to engulf the microorganisms that enter the body.

Structure Of Cell

- The detailed structure of a cell has been studied under compound microscope and electron microscope.
- Certain structures can be seen only under an electron microscope.
- The structure of a cell as seen under an electron microscope is called ultrastructure.
- Compound microscope Magnification 2000X Electron microscope Magnification 500000X

Diffirences Between Plant And Animal Cell :



- Cells contain water and the other small and large molecules, which we examined in .
- Each cell contains at least 10,000 different types of molecules, most of them present in many copies.
- Cells use these molecules to transform matter and energy, to respond to their environments, and to reproduce themselves.

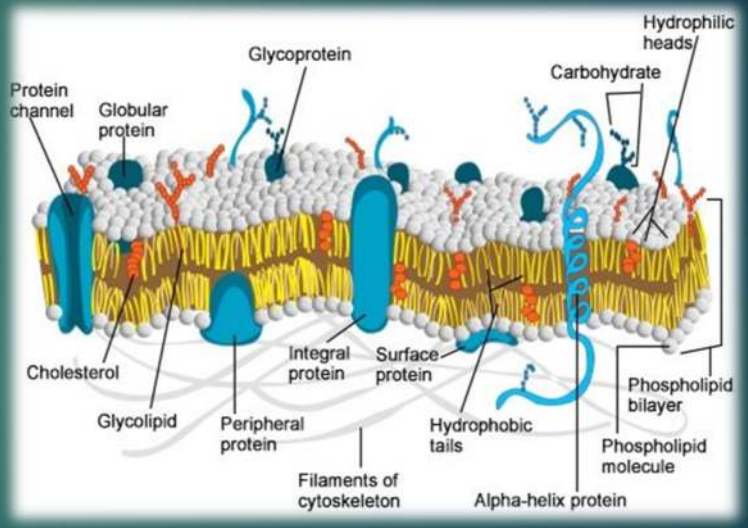
Structure Of Cell

- If we study a cell under a microscope, we would come across three features in almost every cell: plasma membrane, nucleus and cytoplasm.
- All activities inside the cell and interactions of the cell with its environment are possible due to these features.

1. Plasma Membrane
2. Nucleus
3. Cytoplasm
    - A. Cytosol
    - B. Cell Organelles
        - Endoplasmic reticulum
        - Golgi body
        - Lysosomes
        - Mitochondria
        - Centrosome
        - Cytoskeleton

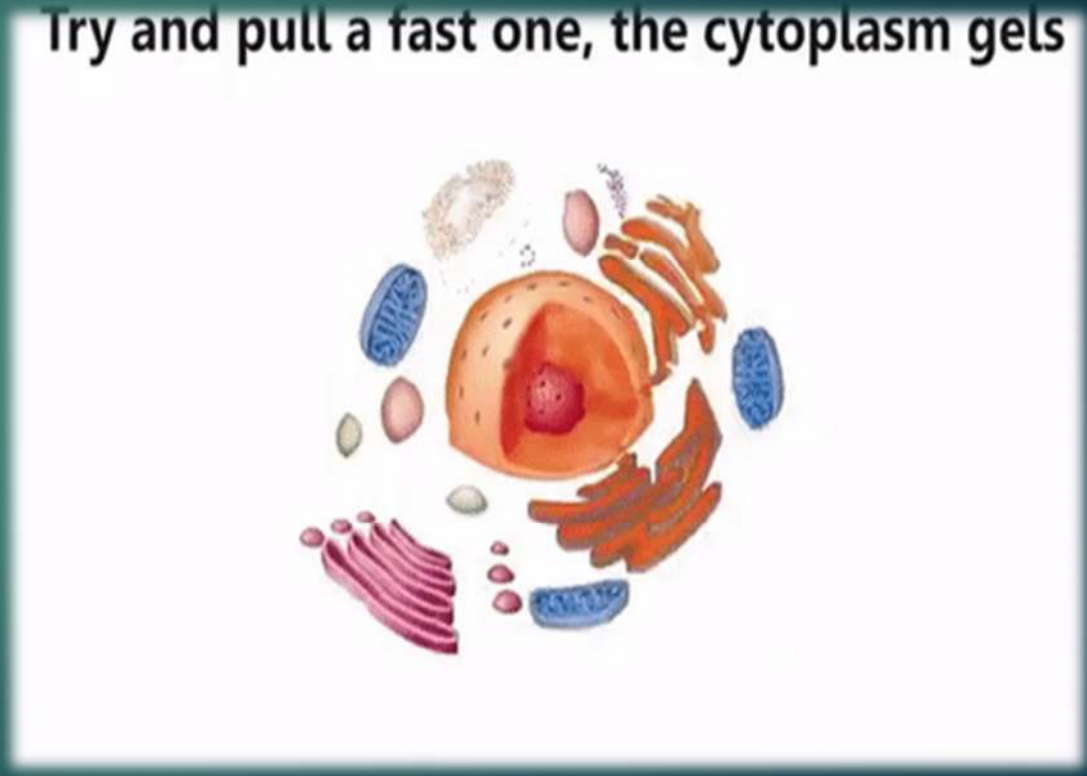
Plasma Membrane

- **S.Jonathan singer and Garth L Nicolson** discovered cell membrane
- Extremely delicate, thin , elastic, living and semi-permeable membrane •
- Made up of two layers of lipid molecules in which protein molecules are floating •
- Thickness varies from 75-110 A˚ • Can be observedunder an electron microscope only
- Functions:
  - • Maintains shape & size of the cell
  - • Protects internal contents of the cell
  - • Regulates entry and exit of substances in and out of the cell
  - • Maintains homeostasis



Cytoplasm

- Jelly-like material formed by 80 % of water.
- Present between the plasma membrane and the nucleus. Contains a clear liquid portion called cytosol and various particles
- The particles which are present in the cytoplasm are:
  1. Organic substances- Proteins, Carbohydrates, Lipids ,etc.,
  2. Inorganic substances- Potassium, Phosphorus, Sulphur ,etc.,
- Also contains many organelles with distinct structure and function. Some of these organelles are visible only under an electron microscope. Granular and dense in human



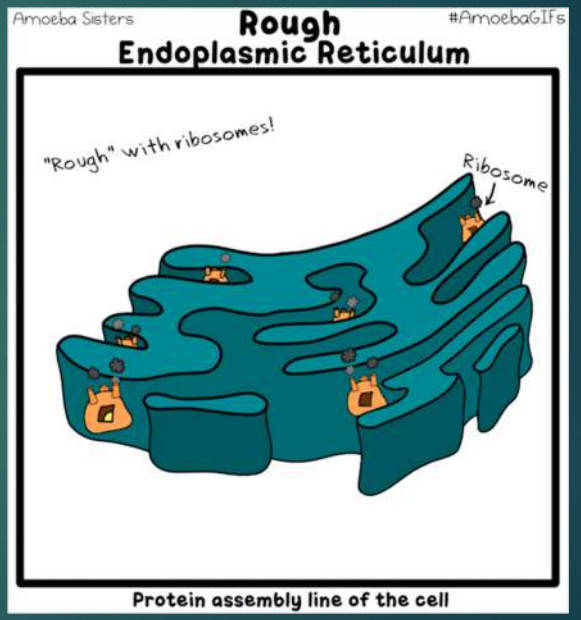
Cell organelles

- The organelles which embedded in the cytoplasm are as follws:
  1. Endoplasmic Reticulum
  2. Golgi Apparatus
  3. Lysosomes
  4. Centrosomes
  5. Secretary vesicles
  6. Mitochondria
  7. Peroxisomes
  8. Ribosomes

Endoplasmic Reticulum

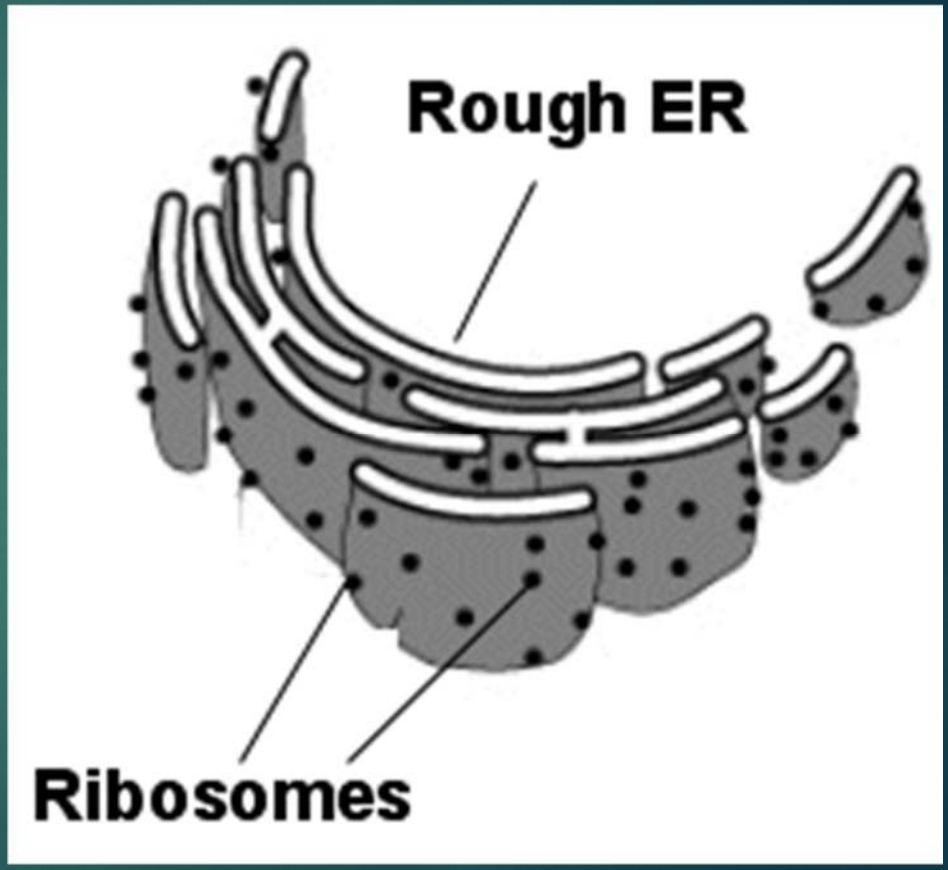
- Network of tubular and vesicular structures which are interconnected with one another.
- Some parts are connected to the nuclear membrane, while others are connected to the cell membrane

- Two types:
  - smooth(lacks ribosomes) and
  - rough(studded with ribosomes)



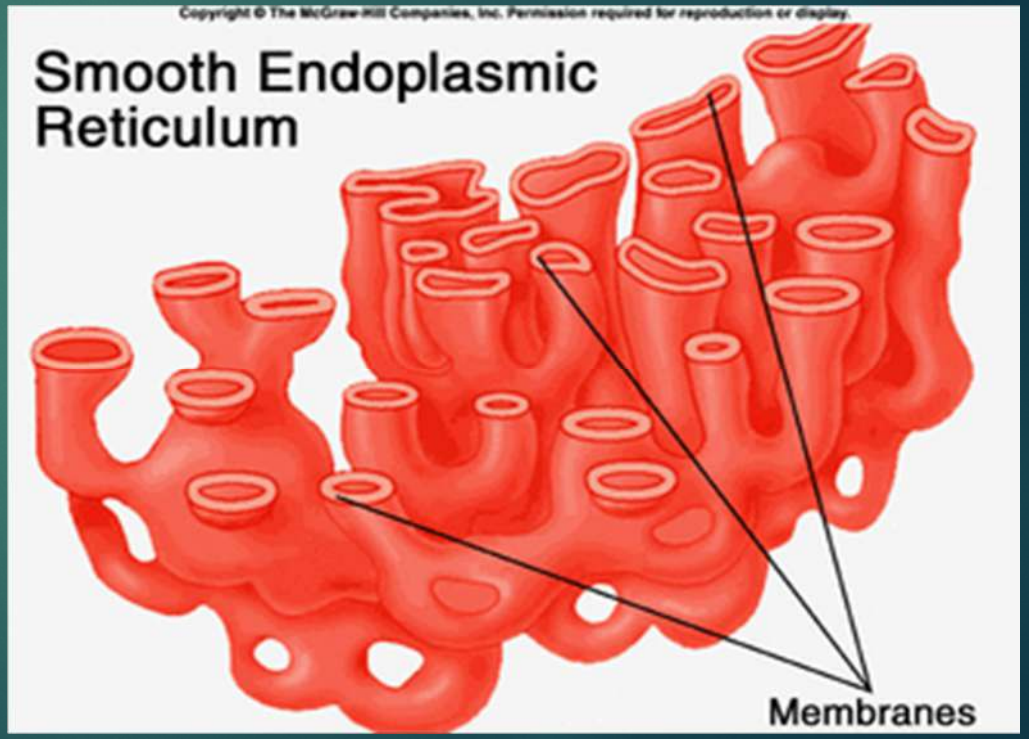
Rough endoplasmic reticulum

- RER also called the granular Endoplasmic Reticulum.
- Functions: Gives internal support to the cytoplasm
  - RER synthesize secretory proteins and membrane proteins
- It involves in the formation of glycoprotein e.g., Immunoglobulin.



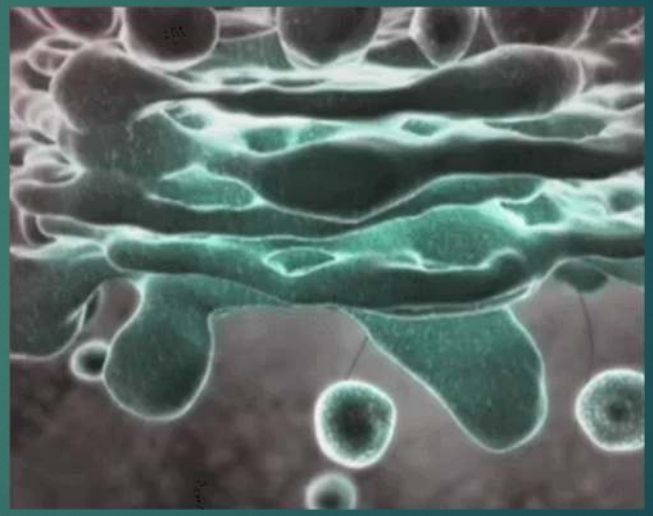
Smooth endoplasmic reticulum

- SER also called as agranular reticulum or tubular endoplasmic reticulum due to its lacking of ribosomes
- SER synthesize lipids for cell membrane
- In liver cells SER detoxify drugs & poisons
- In muscle cells SER store calcium ions for Excitation contraction coupling reaction of muscle



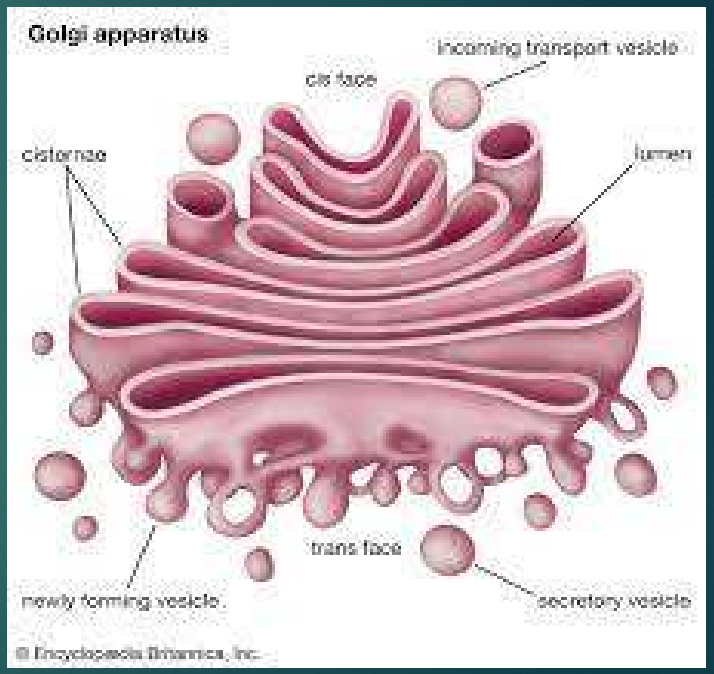
Golgi apparatus

- Discovered by Camillo Golgi
- Formed by stacks of 5-8 membranous sacs
- Sacs are usually flattened and are called the cisternae
- Has two ends: cis face situated near the endoplasmic reticulum and trans face situated near the cell membrane



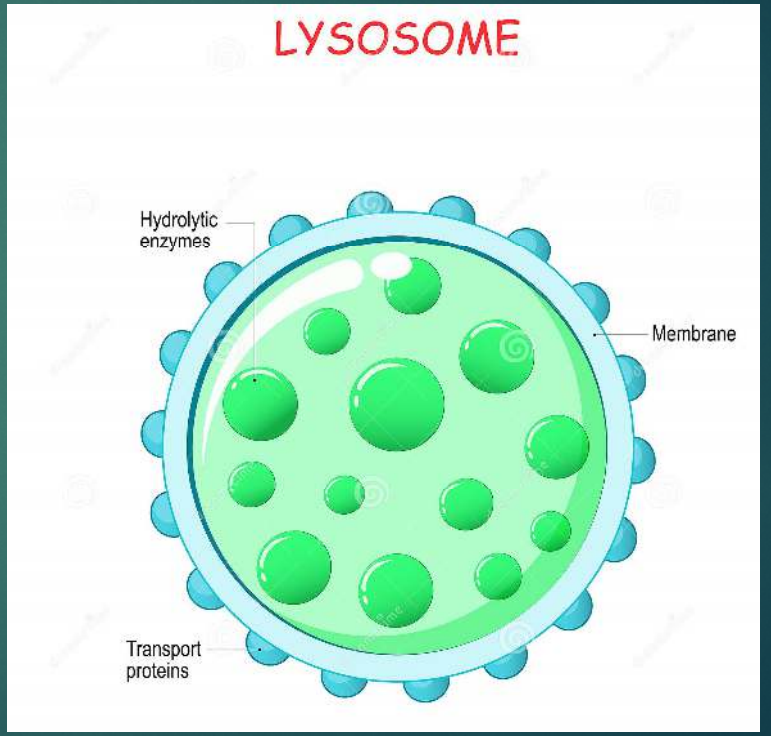
Golgi complex

- Functions:
  - Modifies, sorts and packs materials synthesized in the cell
  - Delivers synthesized materials to various targets inside the cell and outside the cell
  - Produces vacuoles and secretory vesicles
  - Forms plasma membrane and lysosomes Cis face Cisternae Lumen Incoming transport vesicle Outgoing transport vesicle Newly forming vesicle Golgi body



Lysosomes

- Small, spherical, single membrane sac
- Found throughout the cytoplasm
- Filled with hydrolytic enzymes
- lysosomes are formed by Golgi apparatus.



Functions:

- Help in digesting of large molecules
- Protect cell by destroying foreign invaders like bacteria and viruses
- Degradation of worn out organelles
- In dead cells perform autolysis Lysosomes
- often called ‘garbage system’ of the cell
- About 50 different hydrolytic enzymes, known as acid hydroxylases are pre sent in the lysosomes, through which lysosomes exe cute their functions.

- Important lysosomal enzymes :
  1. Proteases, which hydrolyze the proteins into amino acids.

  2. Lipases, which hydrolyze the lipids into fatty acids and glycerides .

  3. Amylases, which hydrolyze the polysaccharides into glucose.

  4. Nucleases, which hydrolyze the nucleic acids into mononucleotides.

Mitochondria- “power house of cell”

- Small, rod shaped organelles bounded by two membranes - inner and outer
- Outer membrane is smooth and encloses the contents of mitochondria
- Inner membrane is folded in the form of shelf like inward projections called cristae
- Inner cavity is filled with matrix which contains many enzymes
- Contain their own DNA which are responsible for many enzymatic actions
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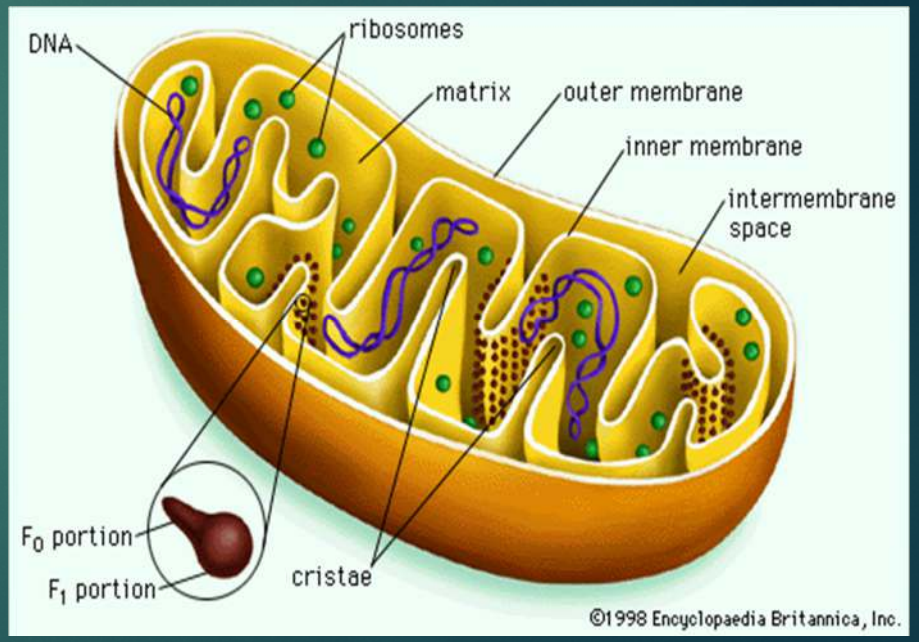
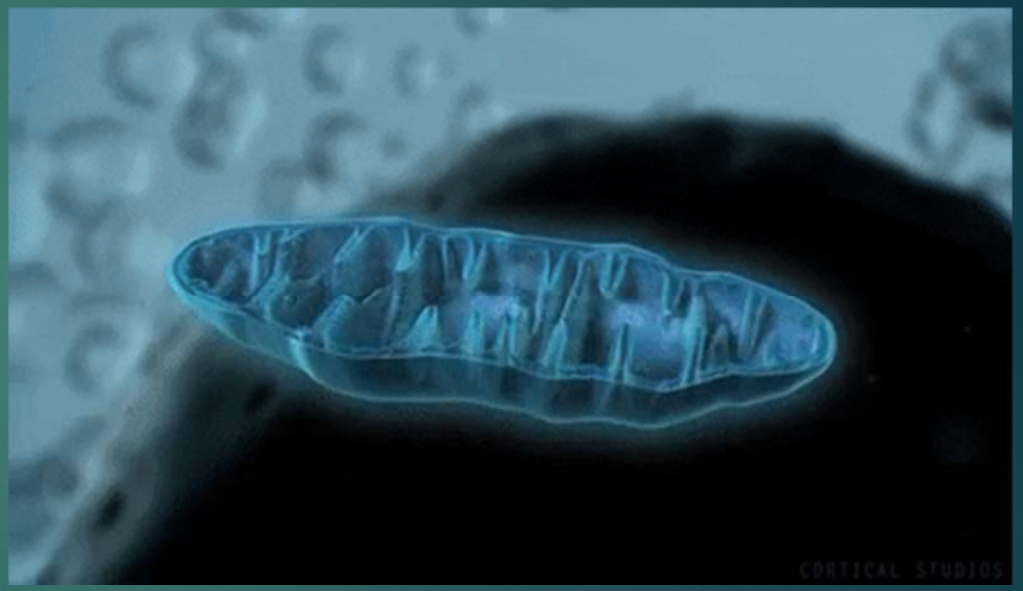


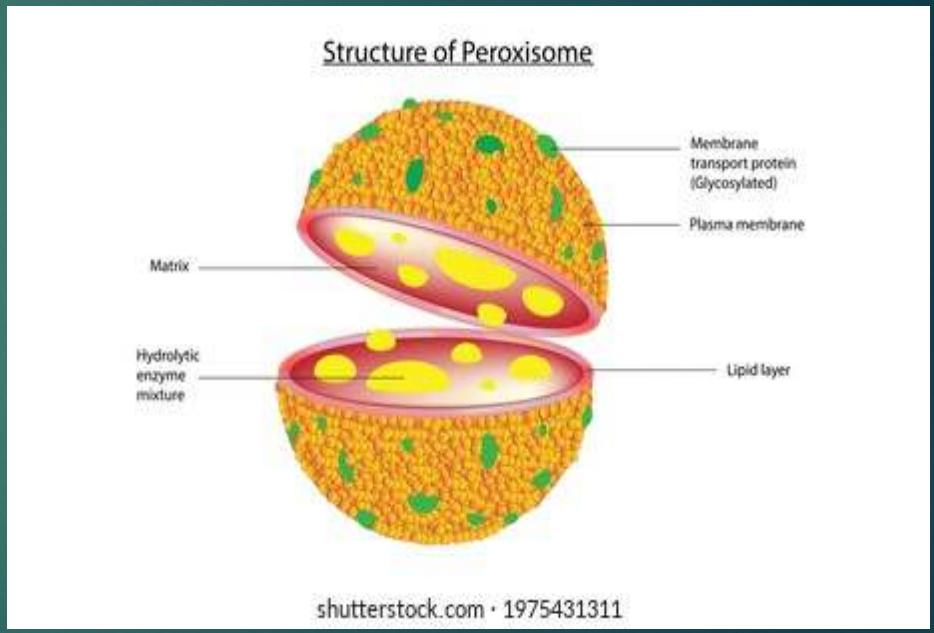
Functions:

- Synthesize energy rich compound ATP
- ATP molecules provide energy for the vital activities of living cells
- Cytochrome C and second mitochondria-derived activator of caspases Secreted in mitochondria are involved in Apoptosis.
- Other functions-storage of calcium and detoxification of Ammonia in liver.



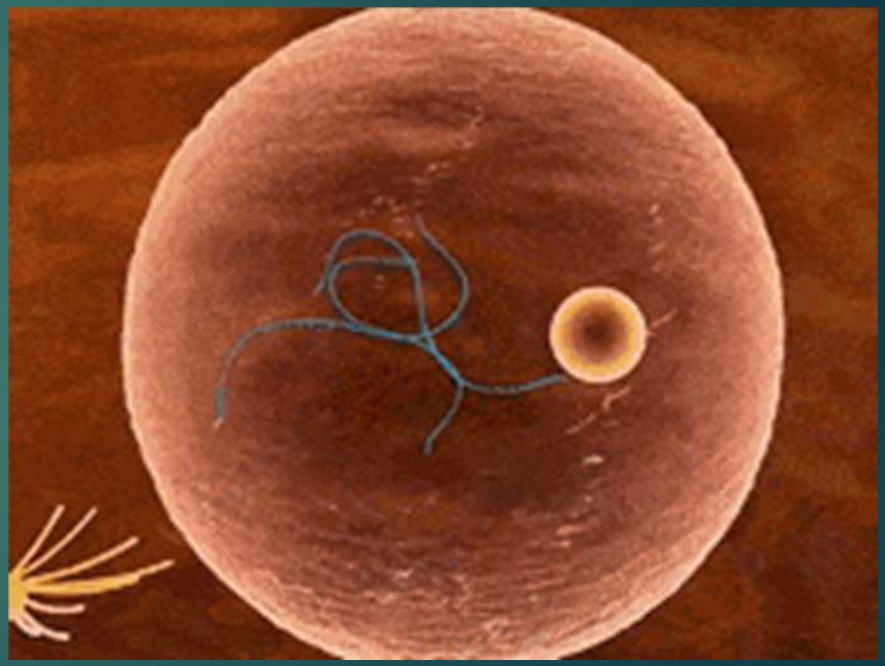
Peroxisomes

- Peroxisomes or microbodies are the membrane limited vesicles like the lysosomes.
- Peroxisomes contain some oxidative enzymes such as catalase, urate oxidase and Damino acid oxidase.
- Functions:
  1. It performs Beta-oxidation.
  2. Accelerate gluconeogenesis from fats.
  3. Degrade purine to uric acid.
  4. Participate in the formation of myelin.
  5. Play a role in the formation of bile acids.



Centrosome

- Centrosome is the membrane bound organelle present near the nucleus
- Consists of two structures called centrioles
- Centrioles are hollow, cylindrical structures made of microtubules
- Centrioles are arranged at right angles to each other
- Functions:
  - Form spindle fibres which help in the movement of chromosomes during cell division



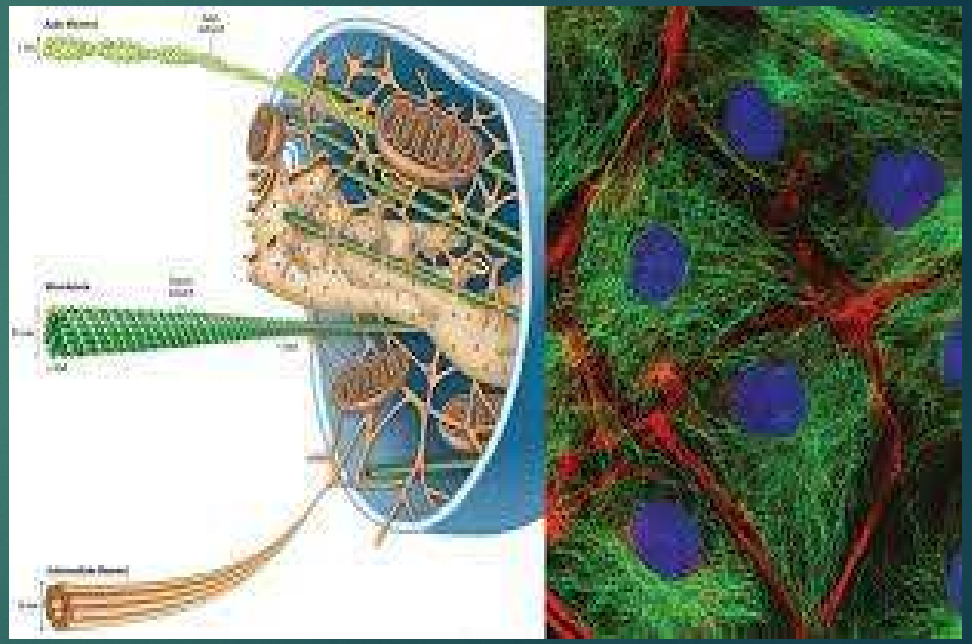
Cytoskeleton

- Formed by microtubules and microfilaments
- Microtubules are hollow tubules made up of protein called tubulin
- Microfilaments are rod shaped thin filaments made up of protein called actin

Functions:

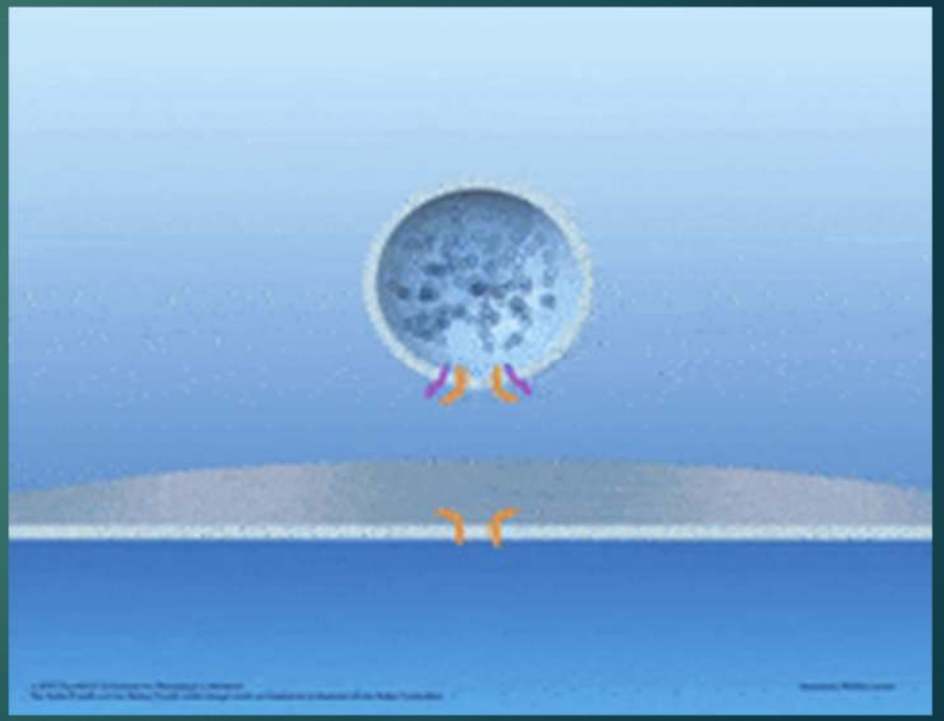
- Determine the shape of the cell
- Give structural strength to the cell
- Responsible for cellular movements

Cytoskeleton Cell membrane
Microtubules Microfilaments



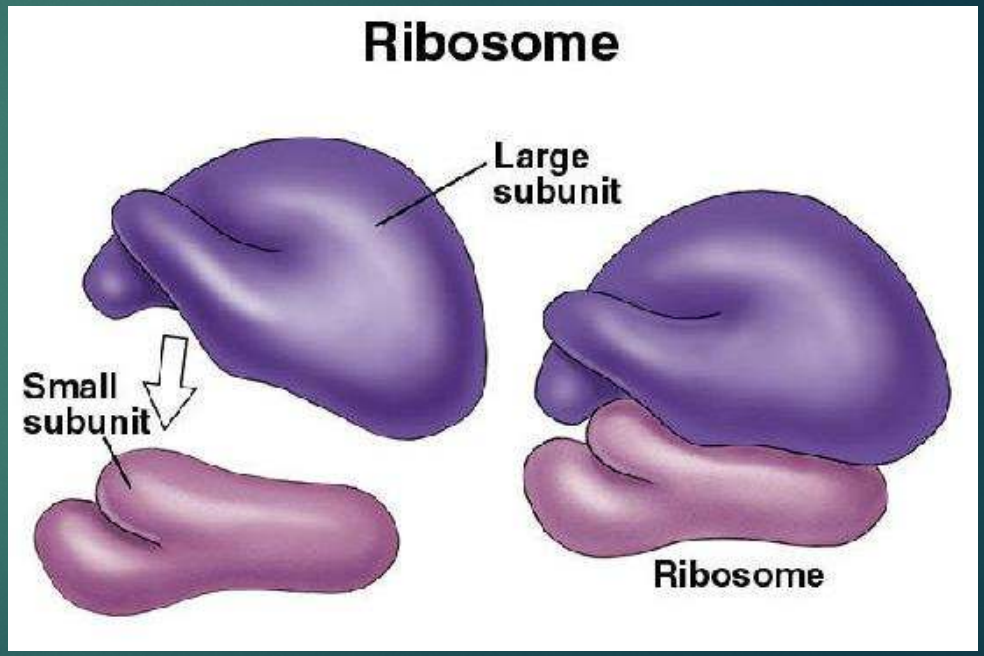
Secretory vesicles

- Secretory vesicles are the organelles with limiting membrane and contain the secretory substances.
- These vesicles are formed in the endoplasmic reticulum and are processed and packed in Golgi apparatus.
- Secretory vesicles are present throughout the cytoplasm.
- When necessary, these vesicles are ruptured and secretory substances are released into the cytoplasm.



Ribosomes

- Ribosomes are the organelles without limiting membrane.
- These organelles are granular and small dot-like structures with a diameter of 15 nm.
- Ribosomes are made up of 35% of proteins and 65% of ribonucleic acid (RNA).
- RNA present in ribosomes is called ribosomal RNA (rRNA).
- Ribosomes are concerned with protein synthesis in the cell.
- Two types:
  - Ribosomes that are attached to rough endoplasmic reticulum.
  - Free ribosomes that are distributed in the cytoplasm

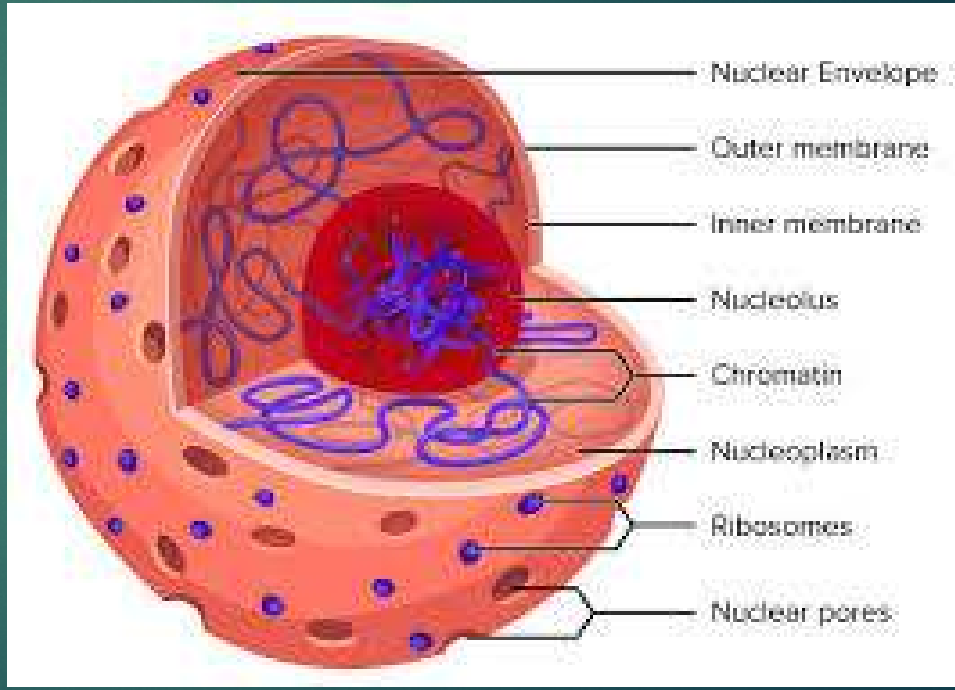


Functions

- Also called as Protein factories (protein synthesis).
- Messenger RNA (mRNA) carries the genetic code for protein synthesis from nucleus to the ribosomes.
- The ribosomes, in turn arrange the amino acids into small units of proteins.
- Ribosomes attached to RER synthesize enzymatic proteins, hormonal proteins, lysosomal proteins and the proteins of the cell membrane.
- Free ribosomes are responsible for the synthesis of proteins in hemoglobin, peroxisome and mitochondria.

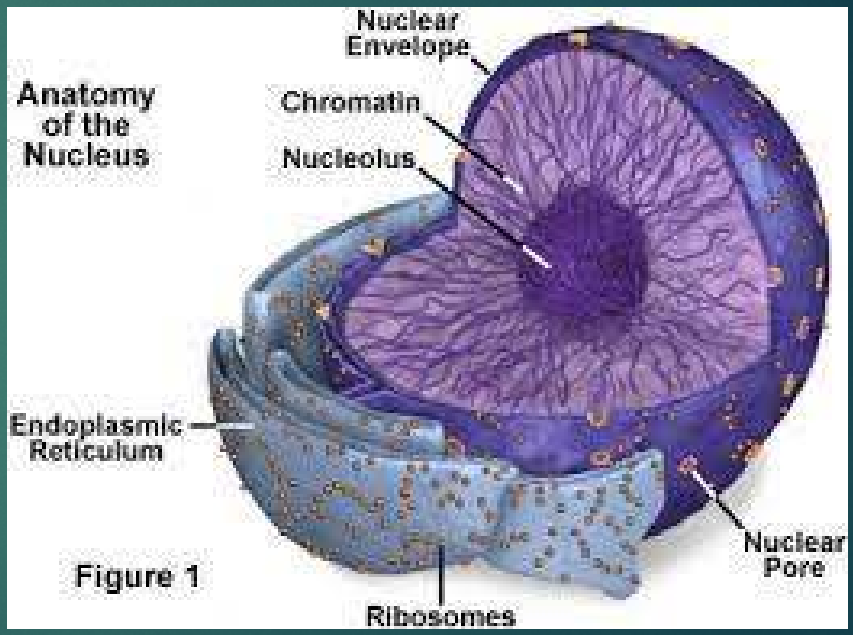
Nucleus

- Dense spherical body located near the centre of the cell
- Diameter varies from 10-25 µm
- Present in all the cells except red blood cells
- Well developed in plant and animal cells
- Undeveloped in bacteria and blue-green algae (cyanobacteria)
- Most of the cells are uninucleated (having only one nucleus)
- Few types of cells have more than one nucleus (skeletal muscle cells)



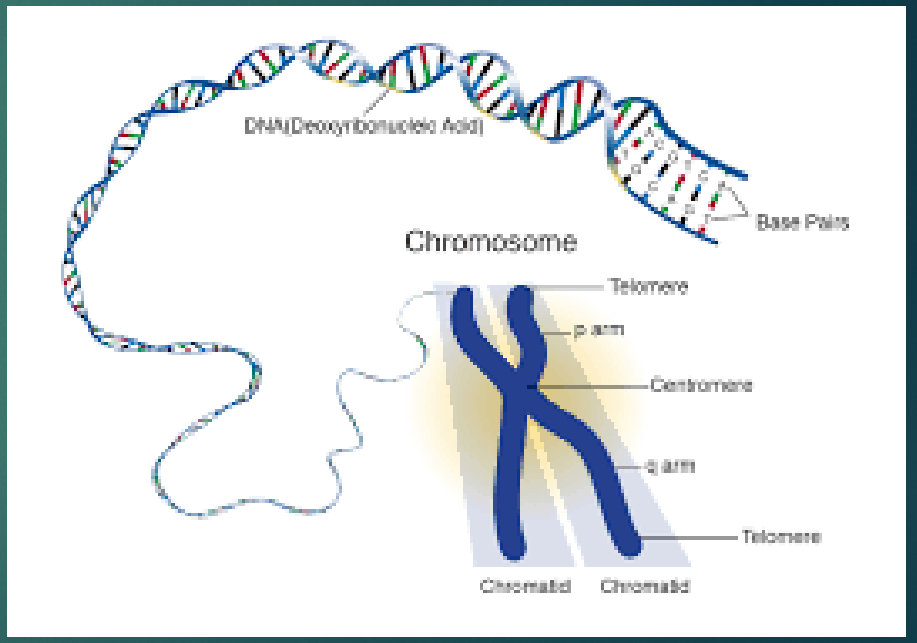
Nucleus

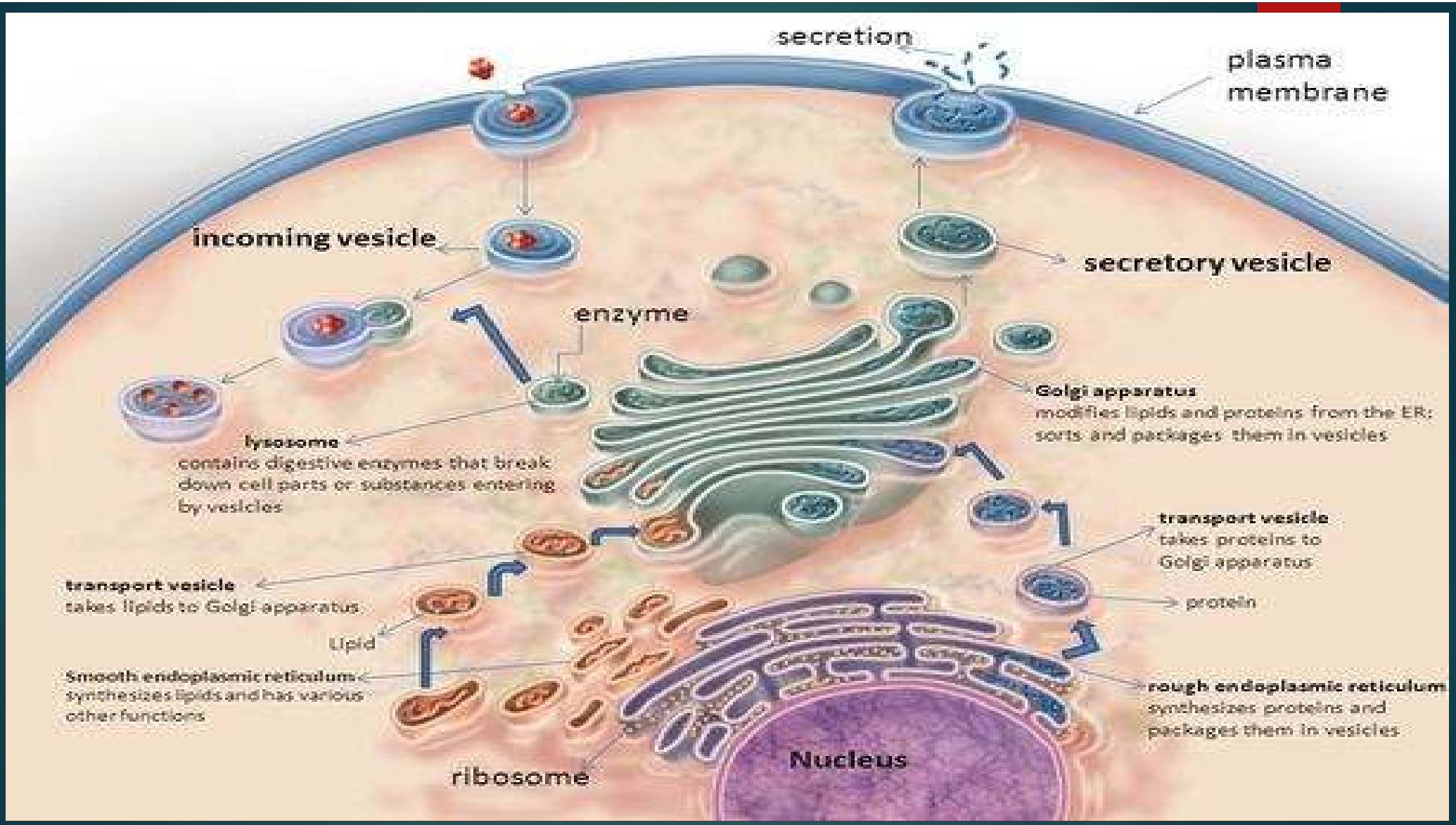
- Nucleus has a double layered covering called nuclear membrane
- Nuclear membrane has pores of diameter about 80-100 nm
- Colourless dense sap present inside the nucleus known as nucleoplasm
- Nucleoplasm contains round shaped nucleolus and network of chromatin fibres
- Fibres are composed of deoxyribonucleic acid (DNA) and protein histone
- These fibres condense to form chromosomes during cell division

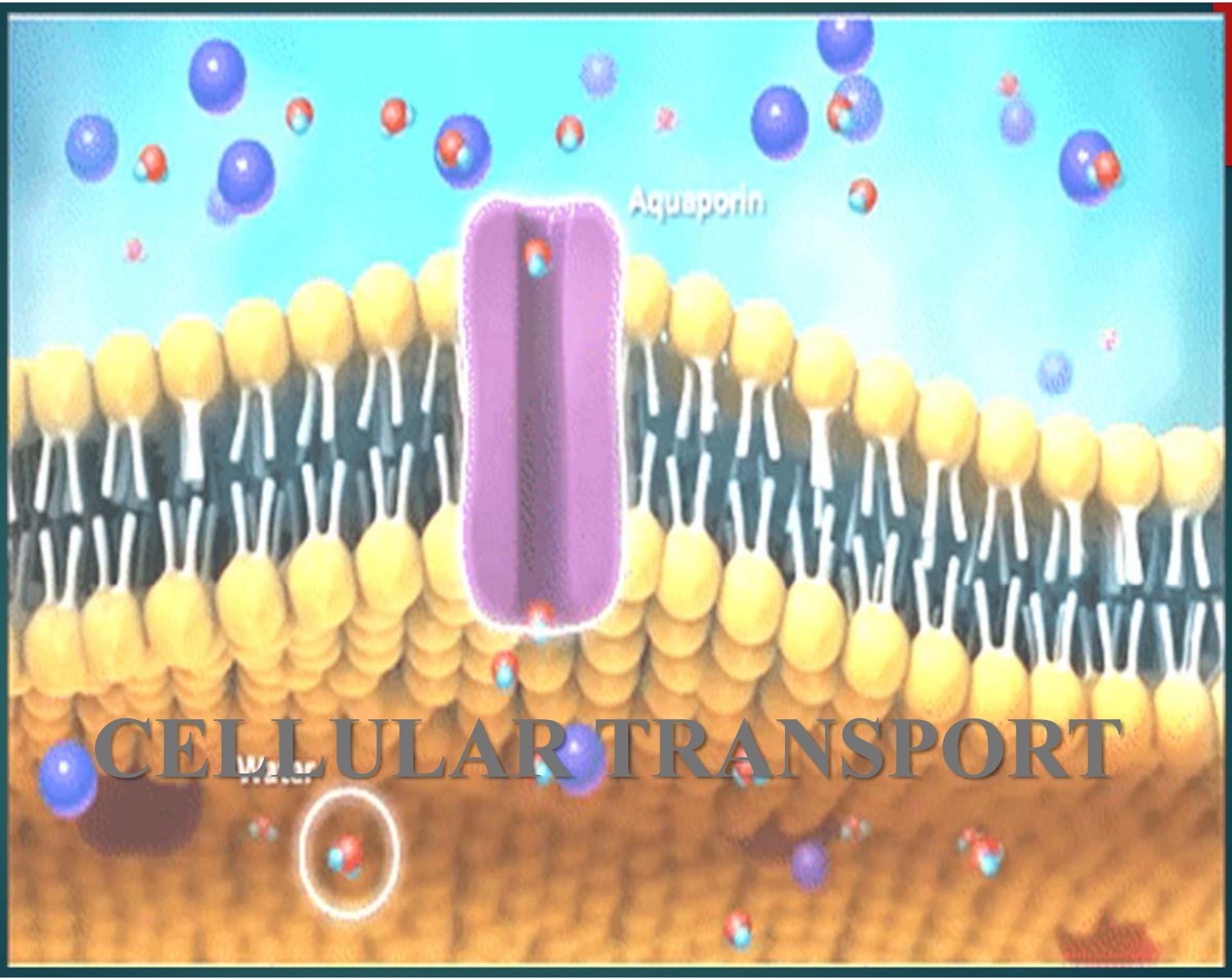


Nucleus

- Chromosomes contain stretches of DNA called genes
- Genes transfer the hereditary information from one generation to the next
- Functions:
  - Control all the cell activities like metabolism, protein synthesis, growth and cell division
  - Nucleolus synthesizes ribonucleic acid (RNA) to constitute ribosomes
  - Store hereditary information in genes




secretion
plasma membrane
incoming vesicle
secretory vesicle
enzyme
Golgi apparatus
modifies lipids and proteins from the ER; sorts and packages them in vesicles
lysosome
contains digestive enzymes that break down cell parts or substances entering by vesicles
transport vesicle
takes proteins to Golgi apparatus
protein
transport vesicle
takes lipids to Golgi apparatus
Lipid
Smooth endoplasmic reticulum
synthesizes lipids and has various other functions
rough endoplasmic reticulum
synthesizes proteins and packages them in vesicles
Nucleus
ribosome



CELLULAR TRANSPORT

CELLULAR TRANSPORT

- Movement of substances across the cell membrane either into or out of the cell.
- It includes Active and Passive transport.
  - Passive Transport Mechanism (does not requires energy)-diffusion and osmosis.
  - Active Transport Mechanism (requires energy)-utilizes ATP as a energy source.

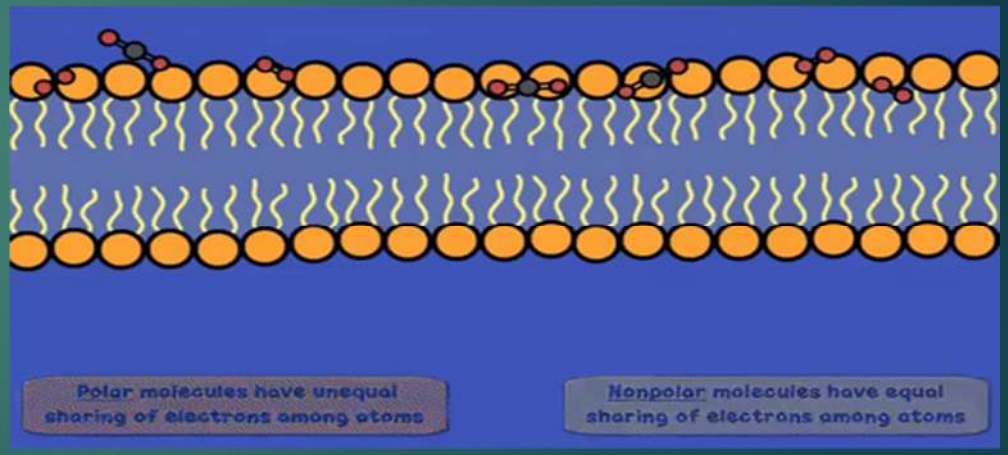
PASSIVE TRANSPORT :

- Passive transport is the transport of substances along the concentration gradient or electrical gradient or both (electrochemical gradient).
- It is also known as diffusion or downhill movement.

- Diffusion :
- It is a net movement of any substances from region higher concentration to lower concentration.
- It has two types.
    1. Simple Diffusion.
    2. Facilitated Diffusion.

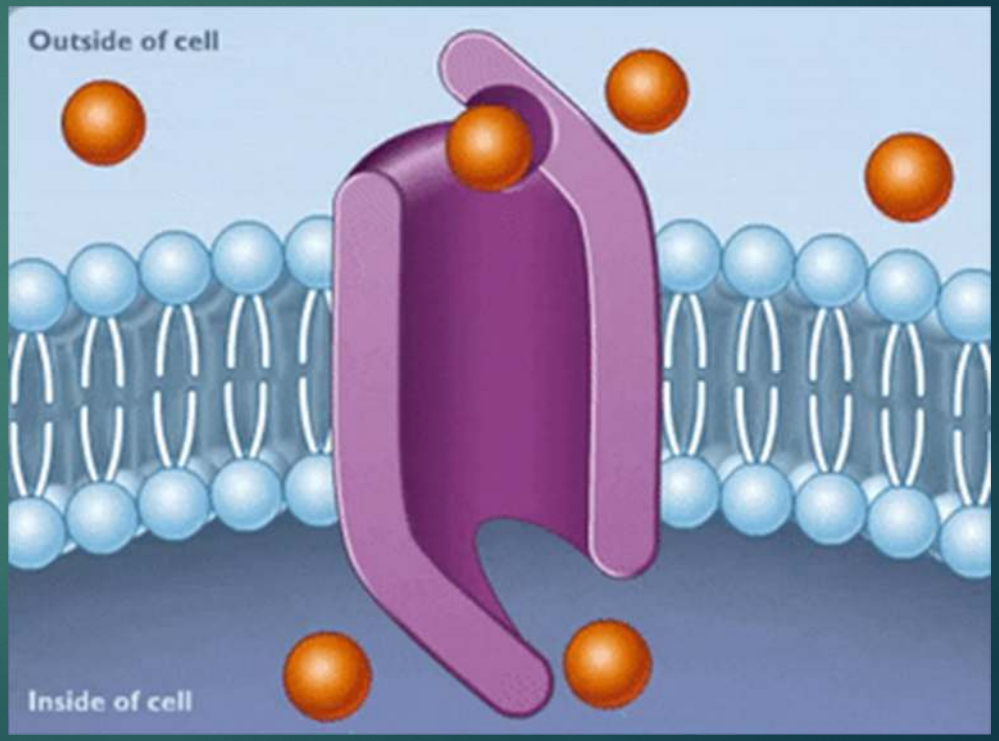
SIMPLE DIFFUSION

- It is a process by which the substance moves through a semi-permeable membrane or without any help of transport proteins.
- Oxygen and Carbon-dioxide dissolved in the blood by this simple diffusion method.



FACILITATED DIFFUSION

- It is a process by which the molecules and ions moves across a cell membrane via specific trans-membrane integral protein.
- Glucose is transported into the cell by this facilitated diffusion method using GluT (Glucose Transporter protein).



FACILITATED DIFFUSION

- Some of the proteins involved in the facilitated diffusion are acts as gated channel.

- They are
  1. Voltage-gated channels-it is activated when there is a change in electrical potential.

  2. Ligand-gated channels-Receptors such as Ach Receptor, dopamine receptor and some of the Hormones like GnRH acts using this kind of channels.

  3. Mechanically gated channels-some of the sensory Receptors such as Pacinian corpuscles (pressure), Hair-cells present in the (organ of cortii) are come under this kind of channels.

SPECIAL TYPES OF PASSIVE TRANSPORT

1. Bulk flow-It is a diffusion of large quantity of substances from a region of high pressure to the region of low pressure. It is due to the pressure gradient of the substance across the cell membrane.

2. Filtration-Movement of water and solutes from an area of high hydrostatic pressure to an area of low hydrostatic pressure is called filtration.

3. Osmosis-It is the special type of diffusion. It is defined as the movement of water or any other solvent from an area of lower concentration to an area of higher concentration of a solute, through a semi-permeable membrane. The semi-permeable membrane permits the passage of only water or other solvents but not the solutes.

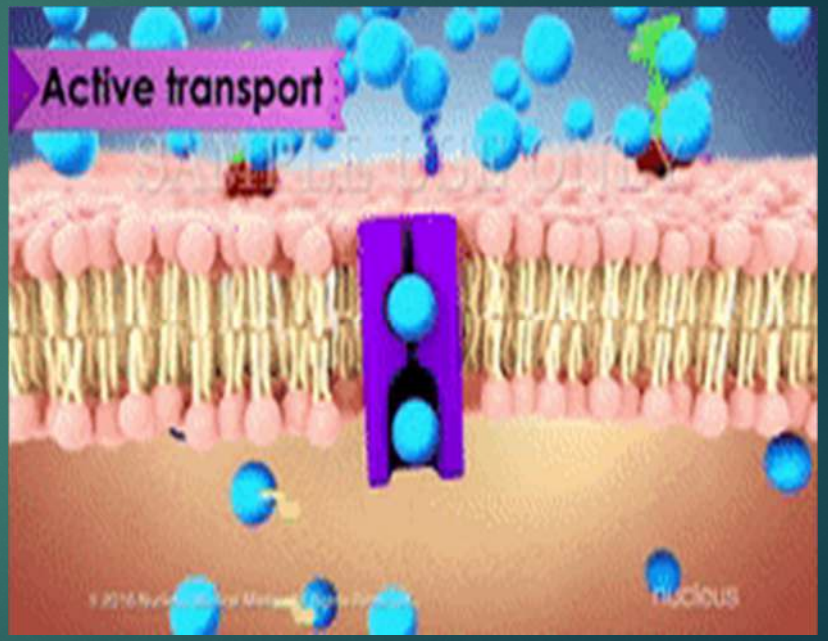
ACTIVE TRANSPORT

- Active transport is the movement of substances against the chemical or electrical or electrochemical gradient.
- It is like swimming against the water tide in a river. It is also called uphill transport.
- Active transport requires energy, which is obtained mainly by breakdown of high energy compounds like adenosine triphosphate (ATP).

ACTIVE TRANSPORT

Active transport is of two types:

1. Primary active transport.
2. Secondary active transport.



PRIMARY ACTIVE TRANSPORT

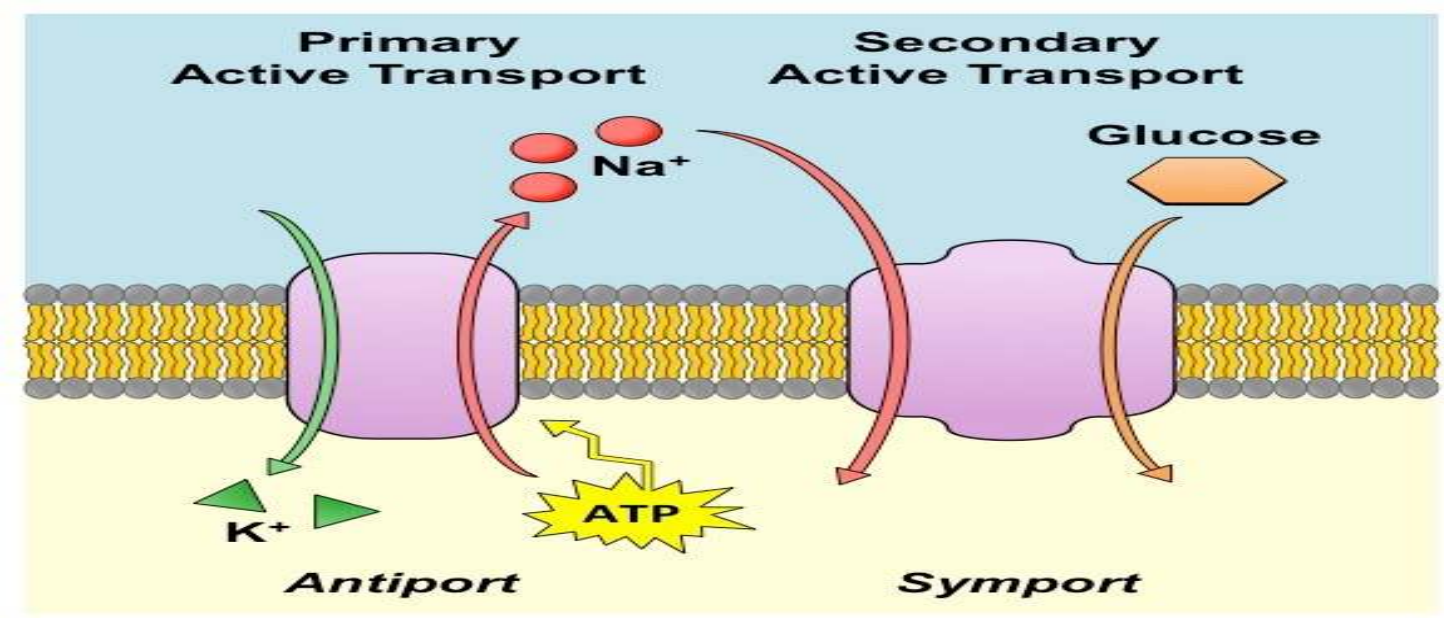
- ✓ Primary active transport is the type of transport mechanism in which the energy is liberated directly from the breakdown of ATP. By this method, the substances like sodium, potassium, calcium, hydrogen and chloride are transported across the cell membrane.
- ✓ e.g., Sodium-potassium ATPase pump

SECONDARY ACTIVE TRANSPORT :

- Secondary active transport is the transport of a substance with sodium ion, by means of a common carrier protein.
- When sodium is transported by a carrier protein, another substance is also transported by the same protein simultaneously, either in the same direction (of sodium movement) or in the opposite direction.
- Thus, the transport of sodium is coupled with transport of another substance (Glucose or Amino acid).
- Two types: 1. Co-transport
  2. Counter transport.

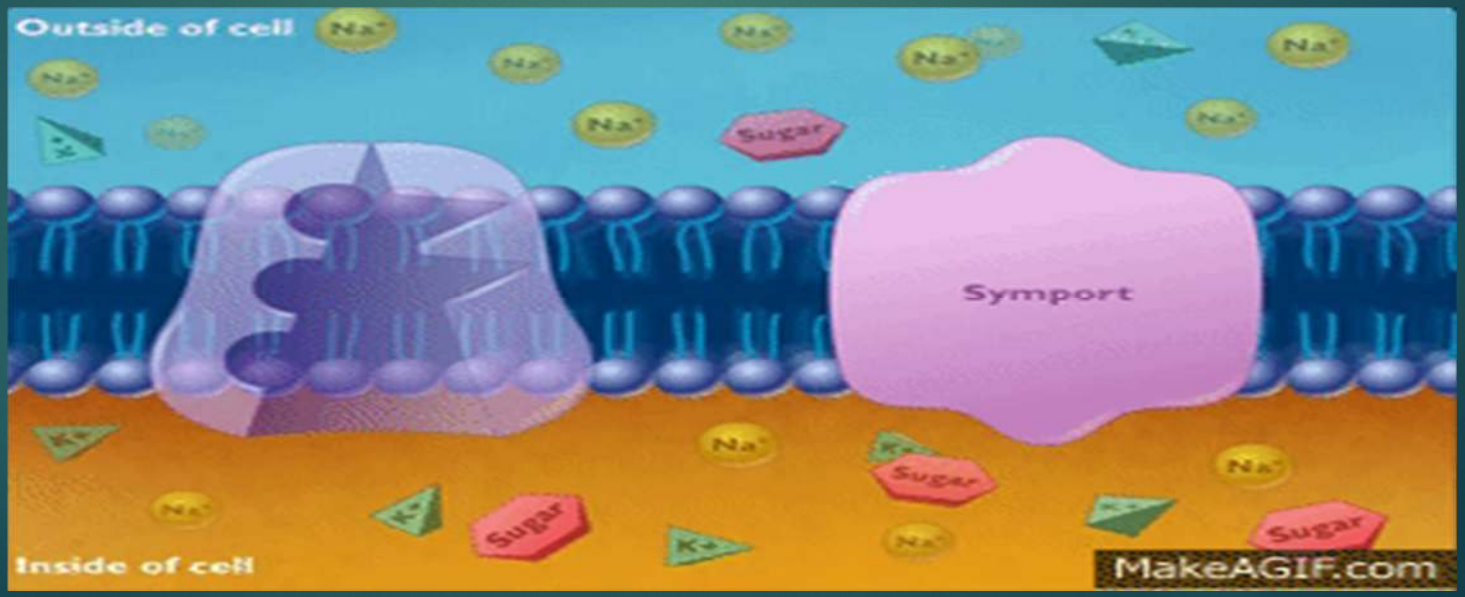
CO-TRANSPORT :

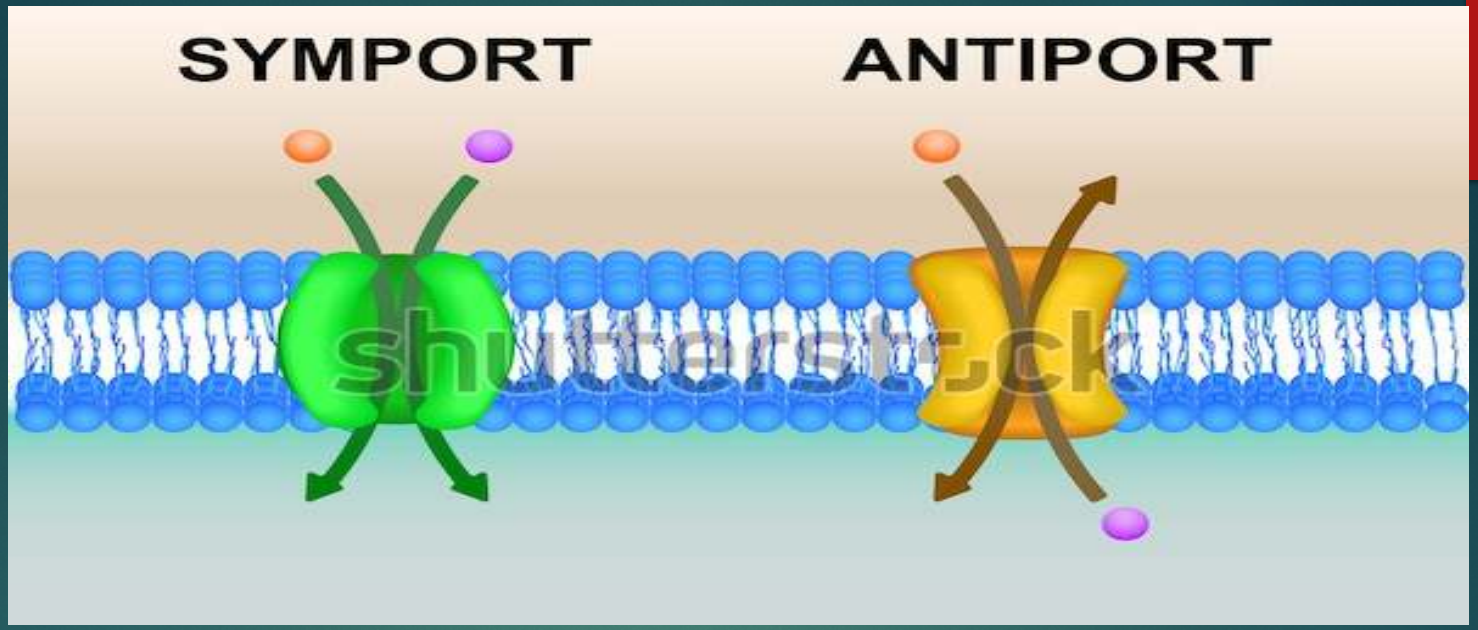
- Co-transport are a sub-category of membrane transport proteins that couple the favourable movement of one molecule with its concentration gradient and unfavourable movement of another molecule against its concentration gradient.
- e.g., Na-Glucose co-transport



COUNTER-TRANSPORT :

- It means that two different molecules or ions are transported at the same time but opposite directions.
- One of the species is allowed to flow from lower concentration to higher, while the other species is transported simultaneously by other side.
- Exchanging of ions during mechanism of Hcl production takes place in the parietal cells present in the stomach





- SYMPORT-A molecule or ions across the cell membrane at the same time.
- ANTIPORT-A molecule or ions across the cell membrane at Opposite direction

SPECIAL TYPES OF ACTIVE TRANSPORT :

- In addition to primary and secondary active transport systems, there are some special categories of active transport which are generally called the vesicular transport.
- Special categories of active transport:

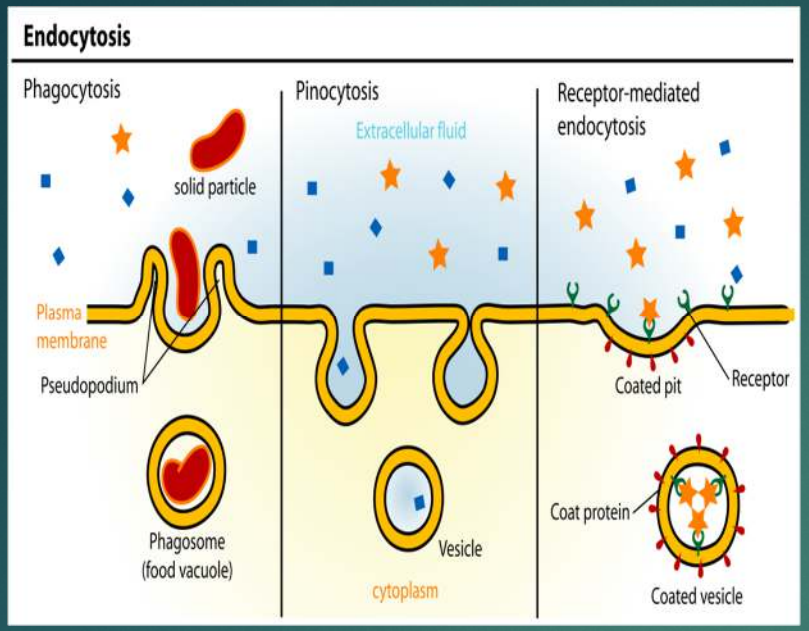
Endocytosis-Substances brought into the cell.

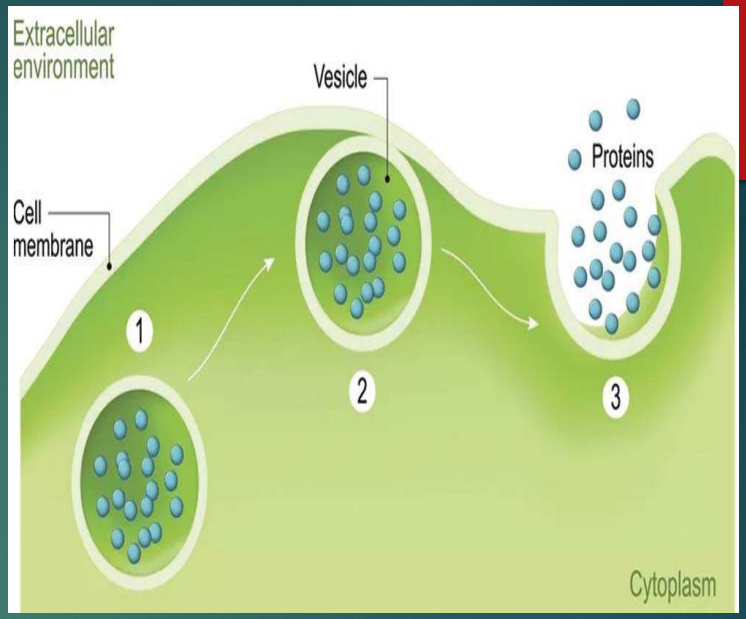
i. Phagocytosis-engulfing

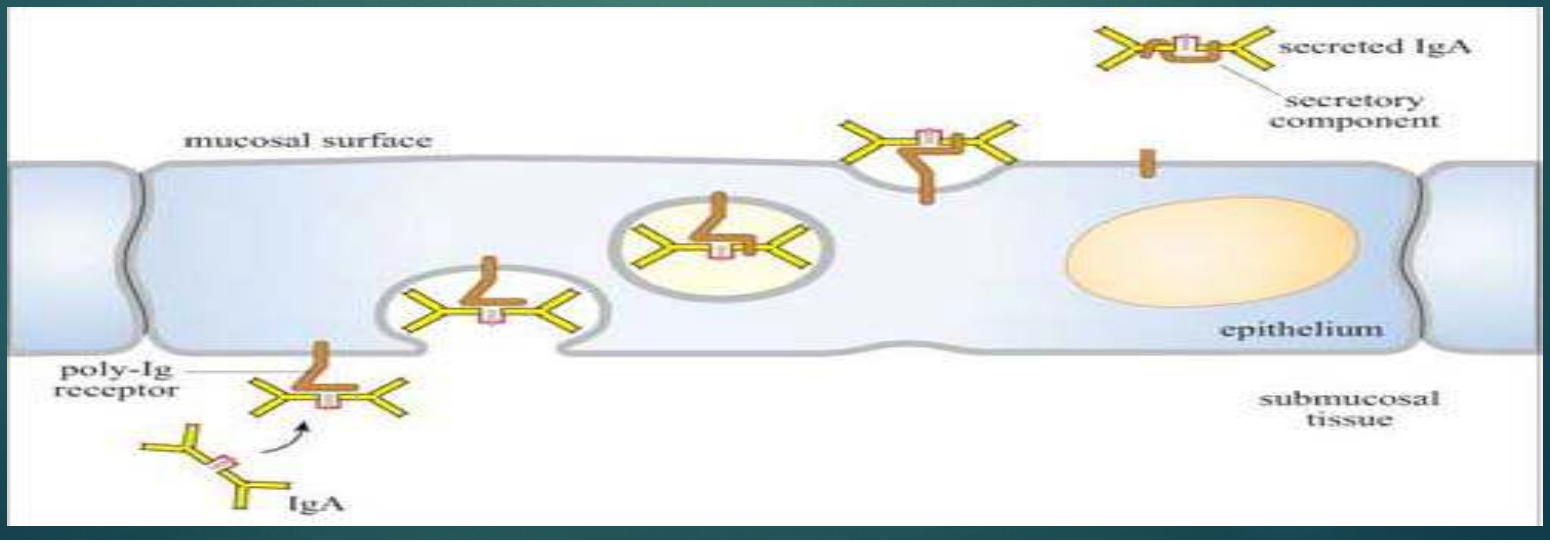
ii. Pinocytosis-cell drinking

- Exocytosis-Synthesized substances secreted out from the cell. E.g., Hormonal, Enzyme and Neuro-transmitter secretion

3. Transcytosis-Transport across interior of a cell, the substances drawn from one side across the cell and ejected out on the other side.


Endocytosis
Phagocytosis
Pinocytosis
Receptor-mediated endocytosis
Extracellular fluid
solid particle
Plasma membrane
Pseudopodium
Coated pit
Receptor
Phagosome (food vacuole)
Vesicle
cytoplasm
Coat protein
Coated vesicle


Extracellular environment
Vesicle
Proteins
Cell membrane
1
2
3
Cytoplasm


secreted IgA
secretory component
mucosal surface
epithelium
poly-Ig receptor
submucosal tissue
IgA

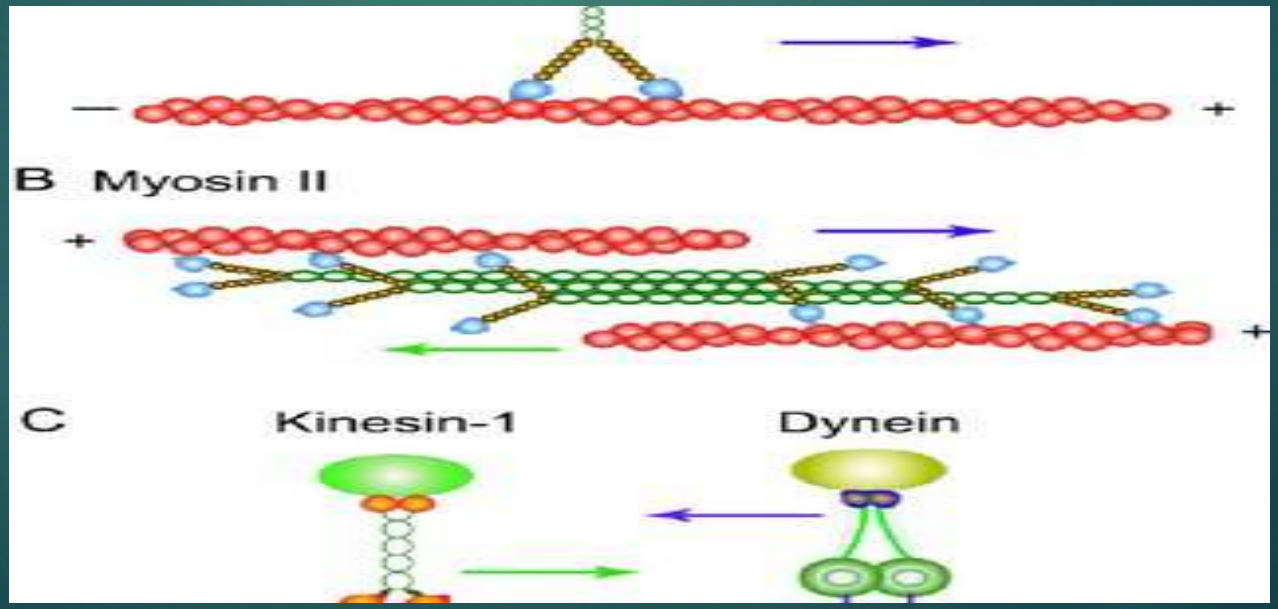
MOLECULAR MOTORS :

- Molecular motors are the protein-based molecular machines that perform intracellular movements in response to specific stimuli.
- Functions:
  - 1. Transport of synaptic vesicles containing neurotransmitters from the nerve cell body to synaptic terminal
    2. Role in cell division (mitosis and meiosis) by pulling the chromosomes
    3. Transport of viruses and toxins to the interior of the cell for its own detriment.

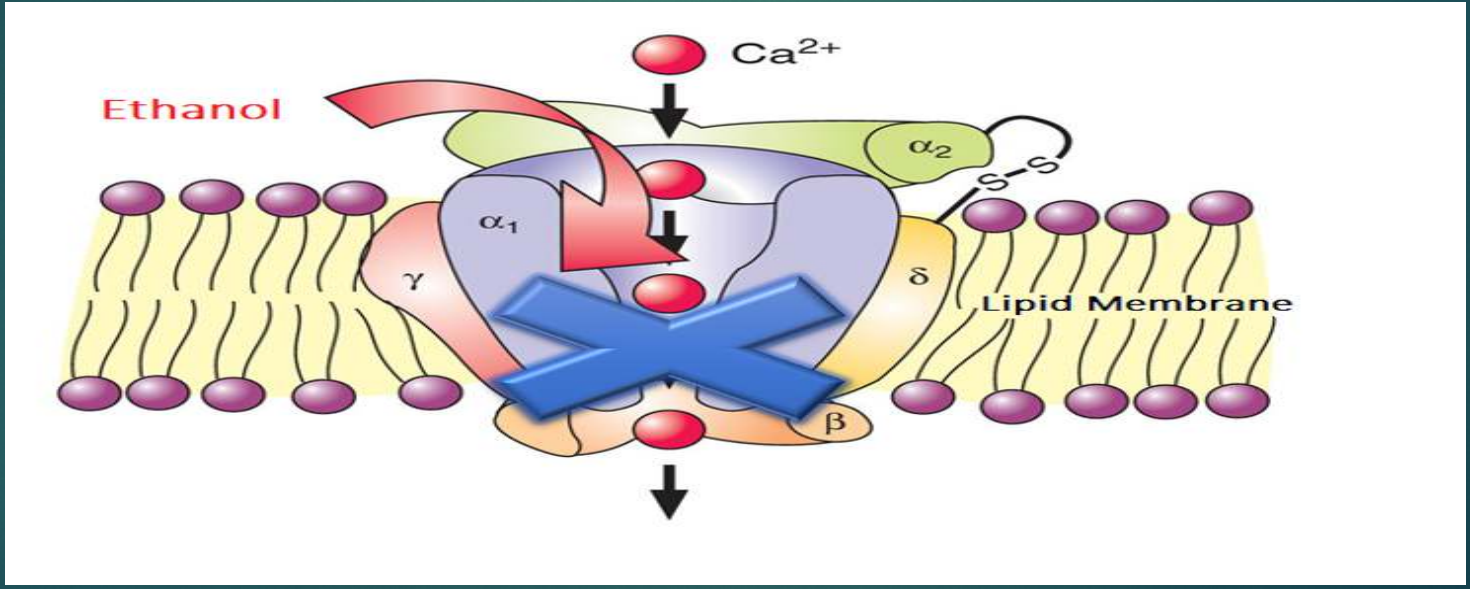
TYPES OF MOLECULAR MOTORS :

Molecular motors are classified into three super families:

1. Kinesin
2. Dynein
3. Myosin



CHANNEL BLOCKERS & ITS APPLICATIONS



INTRODUCTION

- A channel blocker is the biological mechanism in which a particular molecule is used to prevent the opening of ion channels in order to produce a physiological response in a cell.
- Channel blocking is conducted by different types of molecules, such as cations, anions, amino acids, and other chemicals.
- These blockers act as ion channel antagonists, preventing the response that is normally provided by the opening of the channel.

TYPES OF CHANNEL BLOCKERS

- Sodium-channel blocker.
- Potassium-channel blocker.
- H+ ion-channel blocker.
- Calcium-channel blocker.
- NMJ blocker.

SODIUM-CHANNEL BLOCKER

- Saxitoxin (STX) – From shellfish
- Neosaxitoxin (NSTX) – from Algae
- Tetrodotoxin (TTX) – from puffer fish

- Sodium channel blockers are used in the treatment of cardiac arrhythmia.

- Sodium channel blockers are also used as local anesthetics and anticonvulsants.
- Sodium channel blockers have been proposed for use in the treatment of cystic fibrosis.

POTASSIUM CHANNEL BLOCKERS

- Dofetilide blocks only the rapid K channels; this means that at higher heart rates, when there is increased involvement of the slow K channels, dofetilide has less of an action potential-prolonging effect.
- Sotalol is indicated for the treatment of atrial or ventricular tachyarrhythmias, and AV re-entrant arrhythmias.
- Ibutilide is the only antiarrhythmic agent currently approved by the Food and Drug Administration for acute conversion of atrial fibrillation to sinus rhythm.
- Azimilide

H+ ION CHANNEL BLOCKERS

- Pantoprazole and Omiprazole are hydrogen ion channal blocker.

- Omeprazole is used to treat certain stomach and esophagus problems (such as **acid reflux**, ulcers). It works by decreasing the amount of acid your stomach makes.

  It relieves symptoms such as heartburn, difficulty swallowing, and persistent cough.

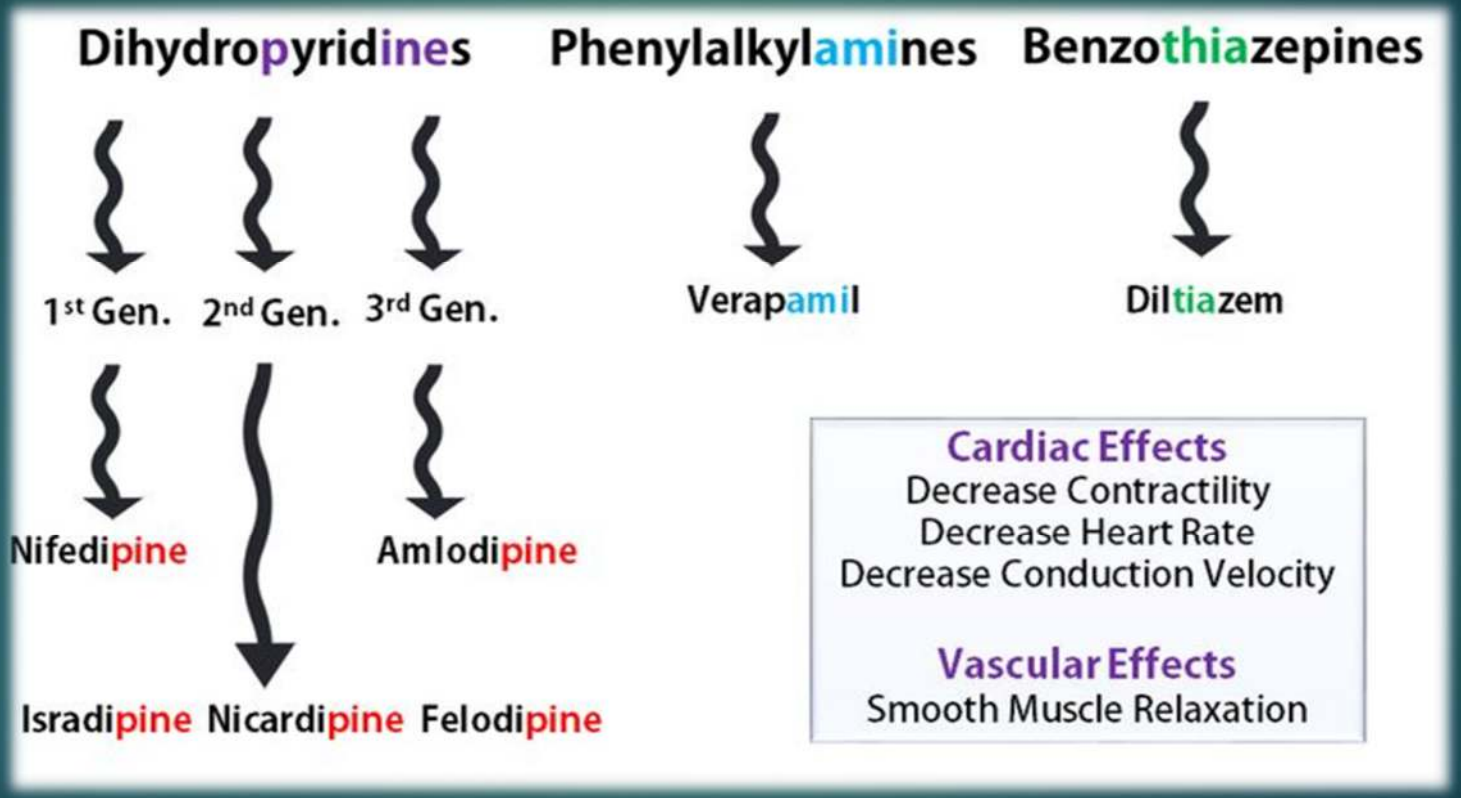
- Pantoprazole reduces the amount of acid your stomach makes. It's used for **heartburn, acid reflux and gastro-oesophageal reflux disease** (GORD) – GORD is when you keep getting acid reflux.

  It's also taken to prevent and treat stomach ulcers.

CALCIUM CHANNEL BLOCKERS

- Calcium channel blockers are **medications used to lower blood pressure**.
- They work by preventing calcium from entering the cells of the heart and arteries.
- Calcium causes the heart and arteries to squeeze (contract) more strongly.
- By blocking calcium, calcium channel blockers allow blood vessels to relax and open.

CALCIUM CHANNEL BLOCKERS



NMJ BLOCKERS

- Neuromuscular-blocking drugs block neuromuscular transmission at the neuromuscular junction, causing paralysis of the affected skeletal muscles.

- This is accomplished via their action on the post-synaptic acetylcholine (Nm) receptors.

- Neuromuscular blocking agents (NMBAs) come in two forms:

  Depolarizing neuromuscular blocking agents (e.g., succinylcholine).

  Nondepolarizing neuromuscular blocking agents (e.g., rocuronium, vecuronium, atracurium, cisatracurium, mivacurium).


Thank you!

Dr. M.G.R

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