Cell

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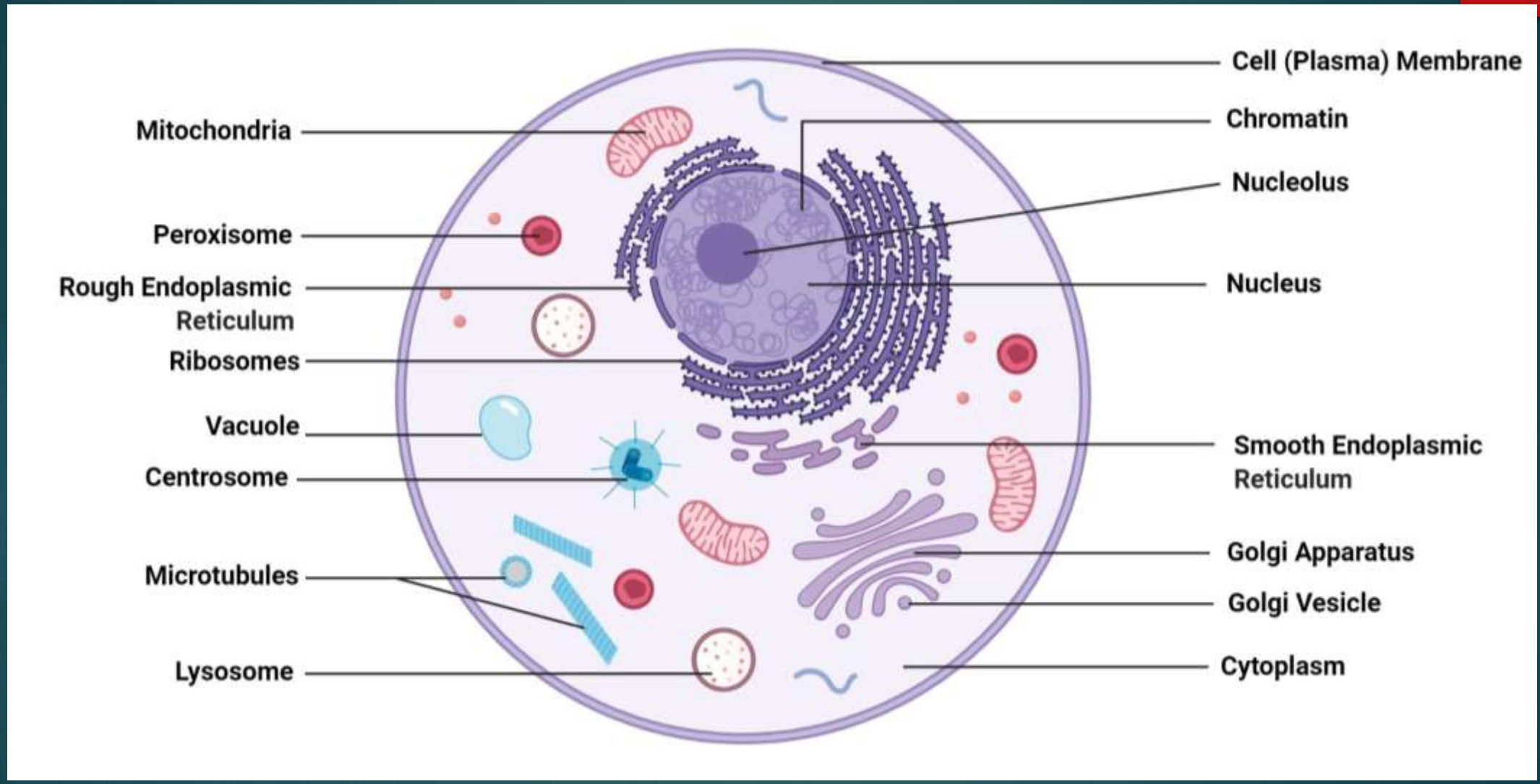
Introduction

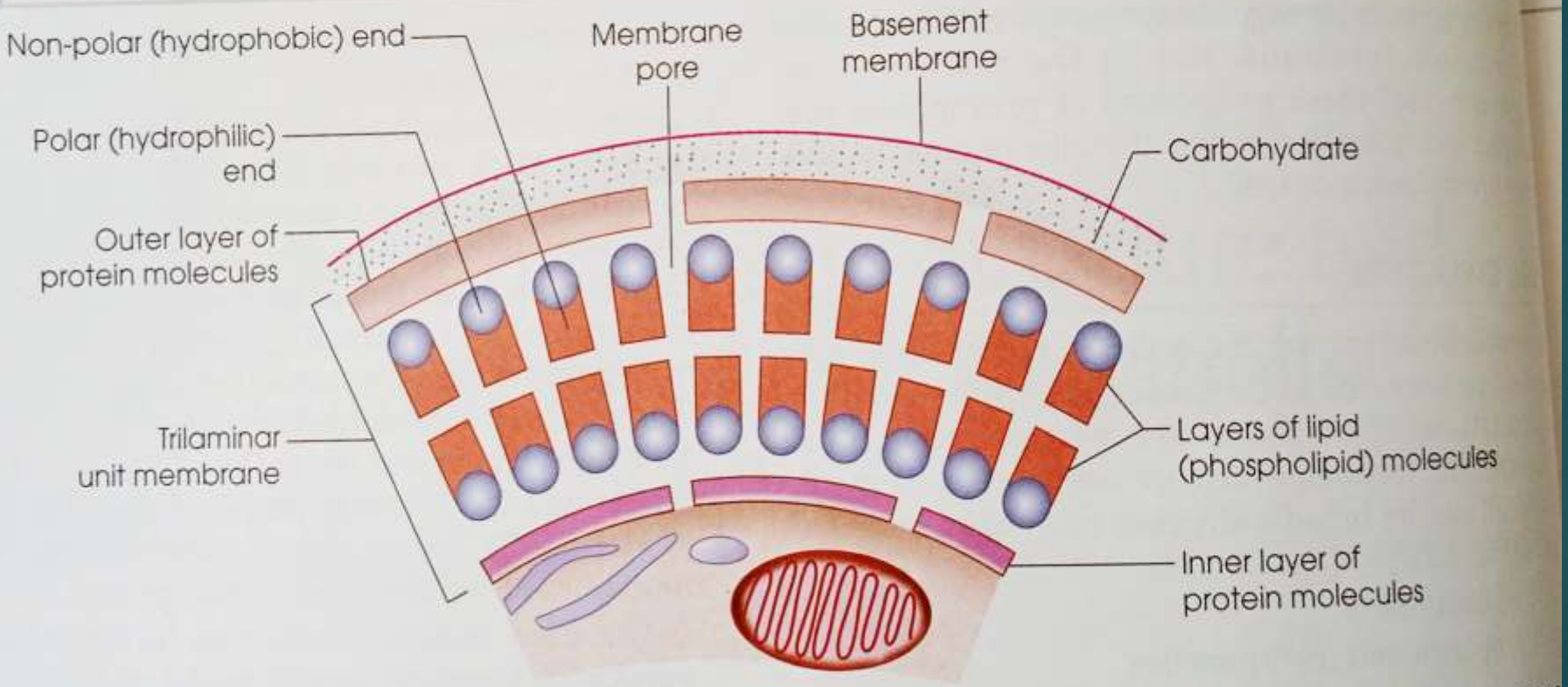
- ***Protoplasm –*** The living substances of plants and animals which is bounded by a delicate membrane and contains various microscopic and submicroscopic structures.
- ***Cell-*** The cell is the structural and functional unit of living matter and is capable of carrying on the process of life independently.
- ***In multicellular organism -*** The cells are not of same size and shape but there are certain structural characteristic features which are common to them.
- Each cell can be broadly divided into three principal units-

1. Cell membrane
2. Cytoplasm and its organelles
3. Nucleus and its contents

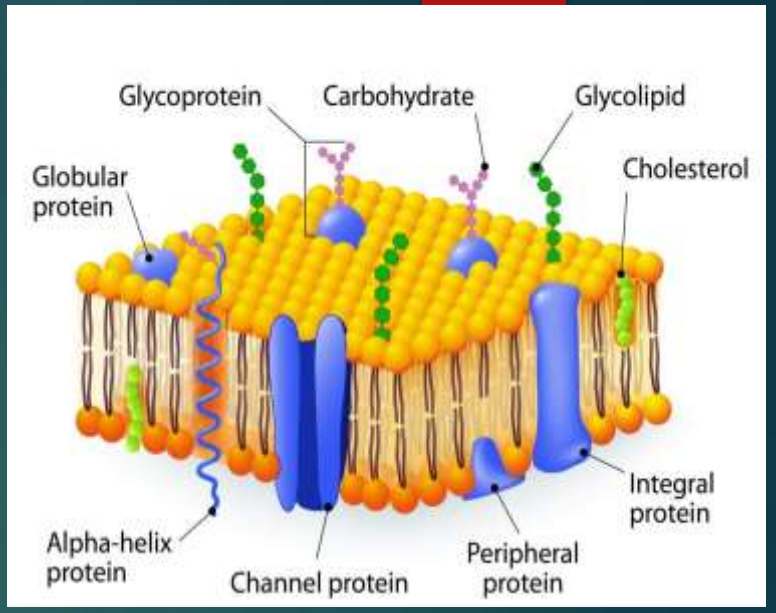

Cell (Plasma) Membrane
Chromatin
Nucleolus
Nucleus
Smooth Endoplasmic Reticulum
Golgi Apparatus
Golgi Vesicle
Cytoplasm
Mitochondria
Peroxisome
Rough Endoplasmic Reticulum
Ribosomes
Vacuole
Centrosome
Microtubules
Lysosome

Cell Membrane

- The ***plasma membrane*** or ***plasmalemma*** *or* ***cell membrane*** – outer covering of the cell, flexible, responsive and dynamic structure.
- ***Under electron microscope*** – The cell membrane is 7.2 to 8 nm thick and is a **trilaminar** (triple layered).
- It consist of double (bimolecular) layer of lipid molecules, which are sandwiched within the two densely stained protein layers.
- ***The Fluid mosaic model (SJ Singer and GL Nicolson)*** – 55% protein, 25% phospholipids, 13% cholesterol, 4% other lipids, 3% carbohydrate.
- Cell membrane composed of phospholipid bilayer with admix protein molecules freely floating around it.
- It is called fluid because **individual phospholipids and proteins move side-to-side** within the layer like it is liquid.
- And is termed mosaic because of **the topographic pattern** produced by the scattered protein molecules.


Non-polar (hydrophobic) end
Membrane pore
Basement membrane
Polar (hydrophilic) end
Carbohydrate
Outer layer of protein molecules
Trilaminar unit membrane
Layers of lipid (phospholipid) molecules
Inner layer of protein molecules

- The lipid bilayer consists of phospholipid molecules.
- ***Fatty acid portion-*** hydrophobic, faces the interior of the membrane.
- ***Phosphate end-*** hydrophilic, faces the exterior of the membrane.



- The protein of cell membrane are glycoprotein and lipoprotein.
- ***Glycoprotein-*** Act as receptors for hormones and neurotransmitters.
- ***Lipoproteins-*** function as ion channels and enzymes.

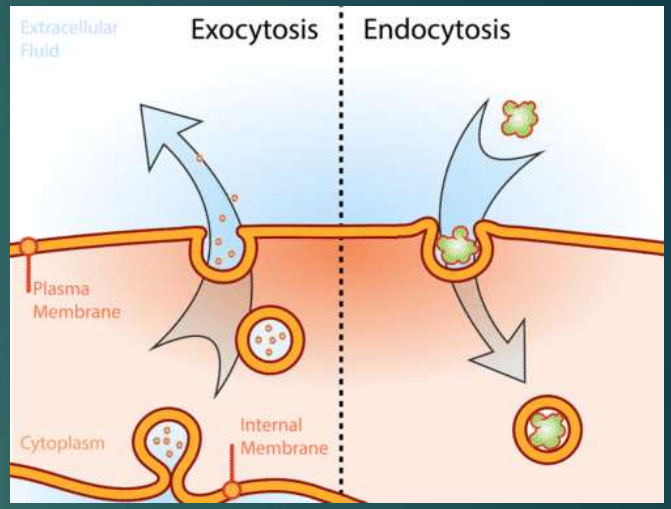
- Intrinsic proteins- they completely span the bilayer. These are channel proteins which allow movement of molecules that are normally too large to pass through the membrane.

- Other intrinsic proteins are transport proteins (carrier proteins) which used energy in the form of ATP to actively move substances across the membrane.

Function of cell membrane

1. ***Transport*** – It facilitate the transport of materials across it. Selectively permeable to certain substance and helps transport of substances needed for survival.
2. ***Various transport mechanism*** -

- Diffusion
- Endocytosis
- Exocytosis



3. Helps in ***protection of cells.***
4. It anchors to the cytoskeleton to the extracellular matrix and thereby ***provide shape to the cell*** and ***maintains its structural integrity*.**
5. ***Receives stimuli from the outside***. The protein component of cell membrane acts as ligand receptors.
6. Take in food and excretes waste products.

Transport across cell membrane

- Transport of substances across the cell membrane is necessary to maintain the normal functioning of the cell in our body.
- Lipid-soluble substances can easily pass through the lipid bilayer of the cell membrane.
- The lipid bilayer is impermeable to a lipid-insoluble substance such as ions and charged or polar molecules.
- These substances pass through specialized protein channels, carrier proteins, and active pump mechanisms.
- Large molecules are transported through vesicles.

Types of Transport

1. Passive transport

A. Diffusion – Simple and Facilitated diffusion

B. Osmosis

2. Active transport

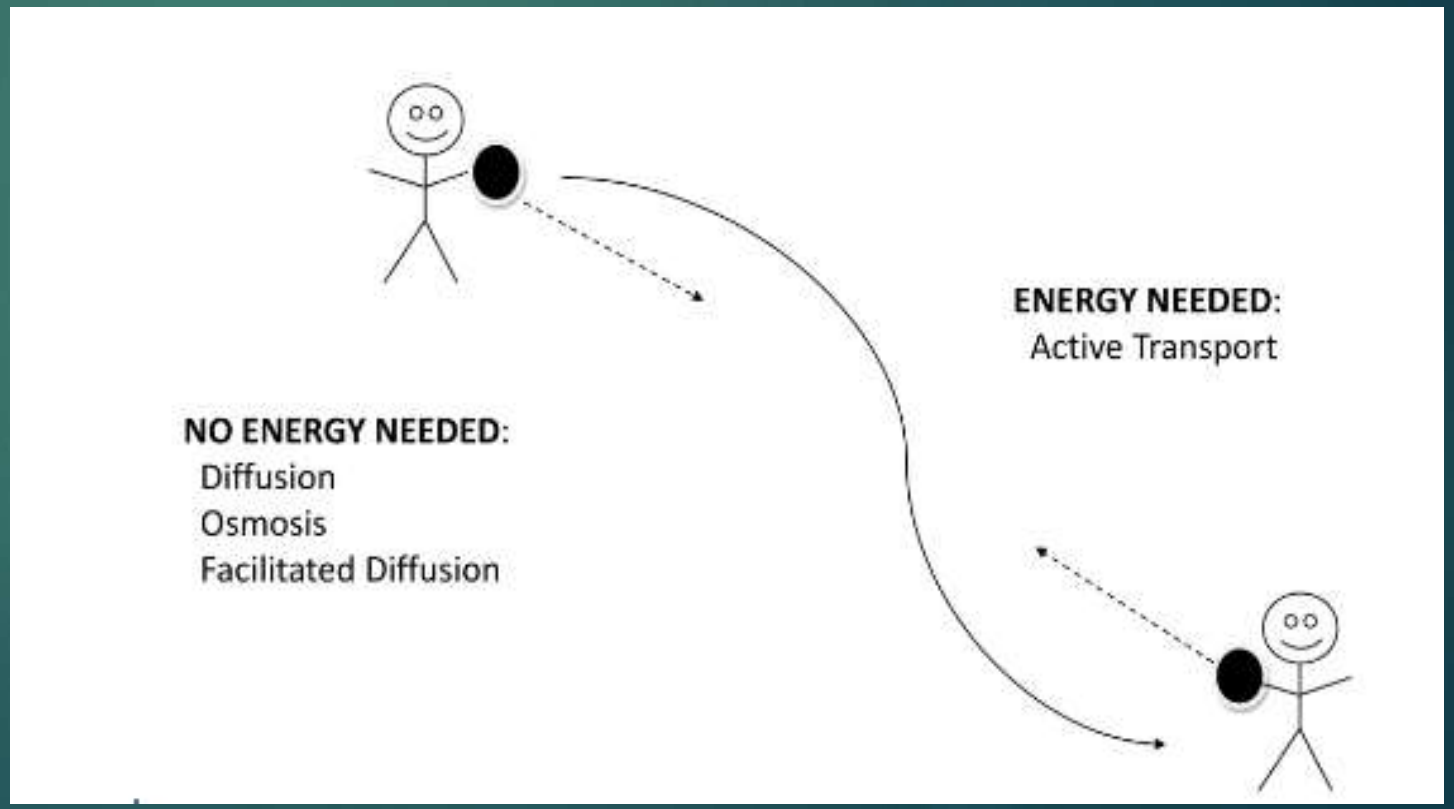
A. Primary

B. Secondary

3. Vesicular Transport

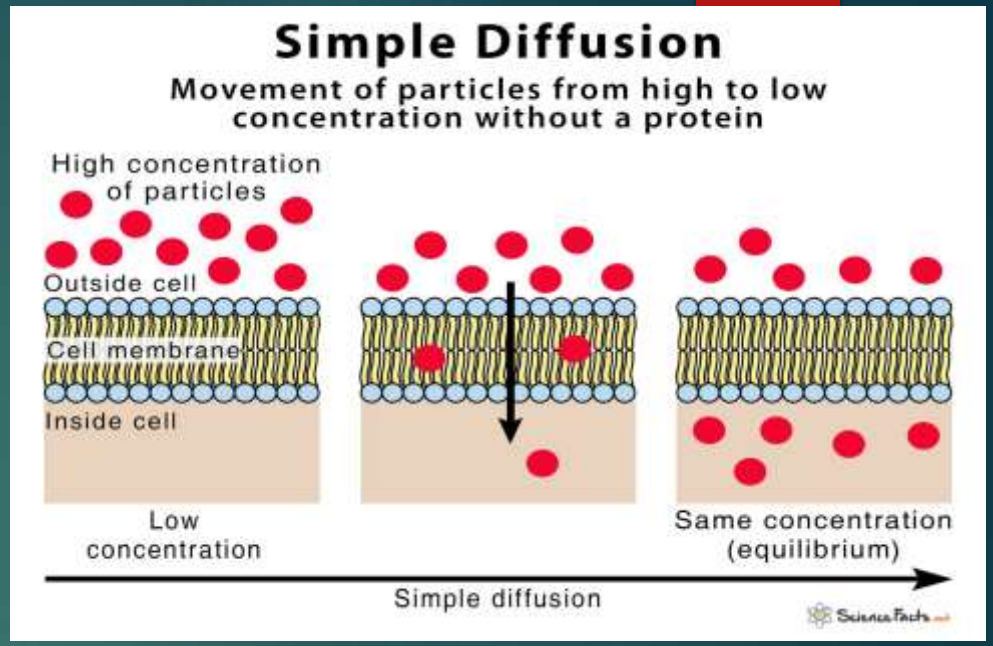
A. Endocytosis

B. Exocytosis



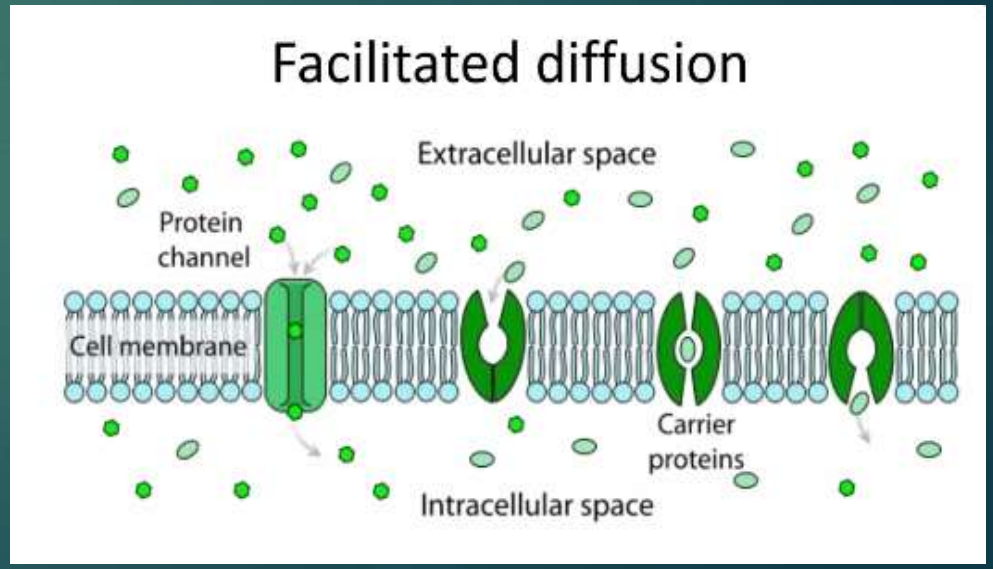
Simple Diffusion

- Movement of ions or molecules from the region of their higher concentration to the region of their lower concentration, without using energy.



Facilitated Diffusion

- Facilitated diffusion is the movement of specific molecules or ions across the plasma membrane, assisted by a carrier protein.
- No energy required.

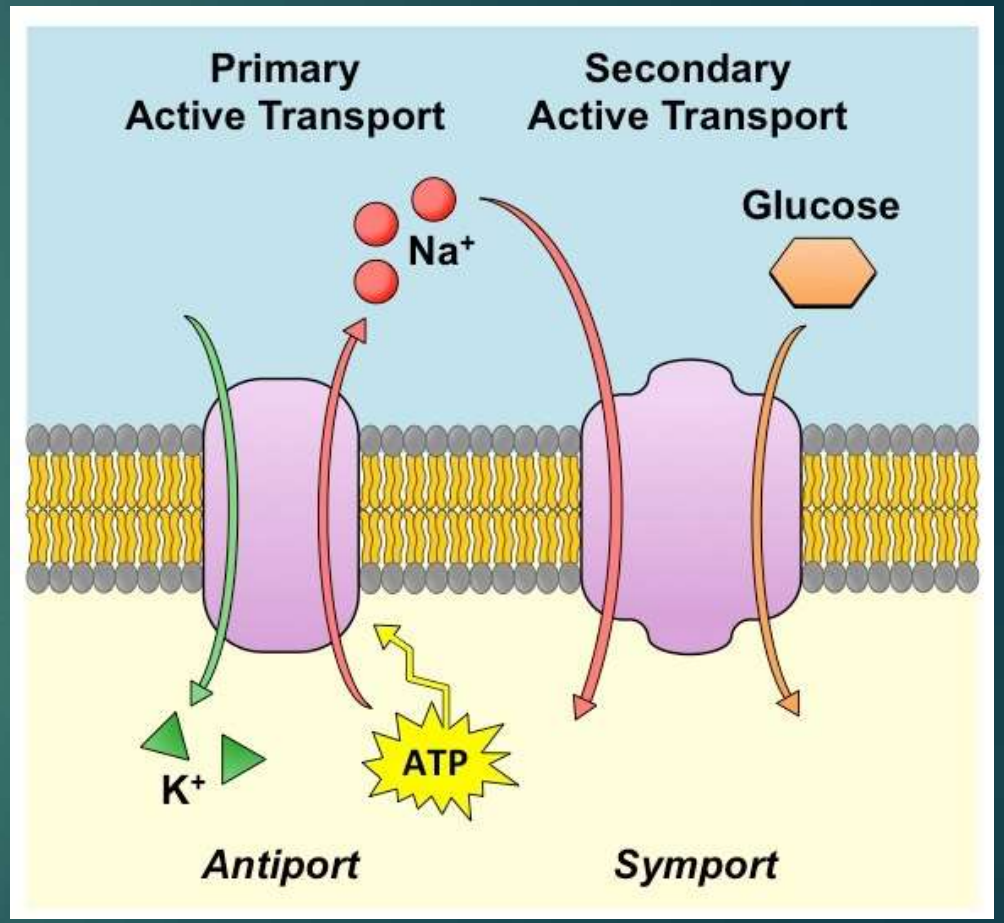


Active Transport

- Movement of ions or molecules from the region of their lower concentration to the region of their higher concentration, by using energy.
- Divided into two types according to the source of energy used to cause transport

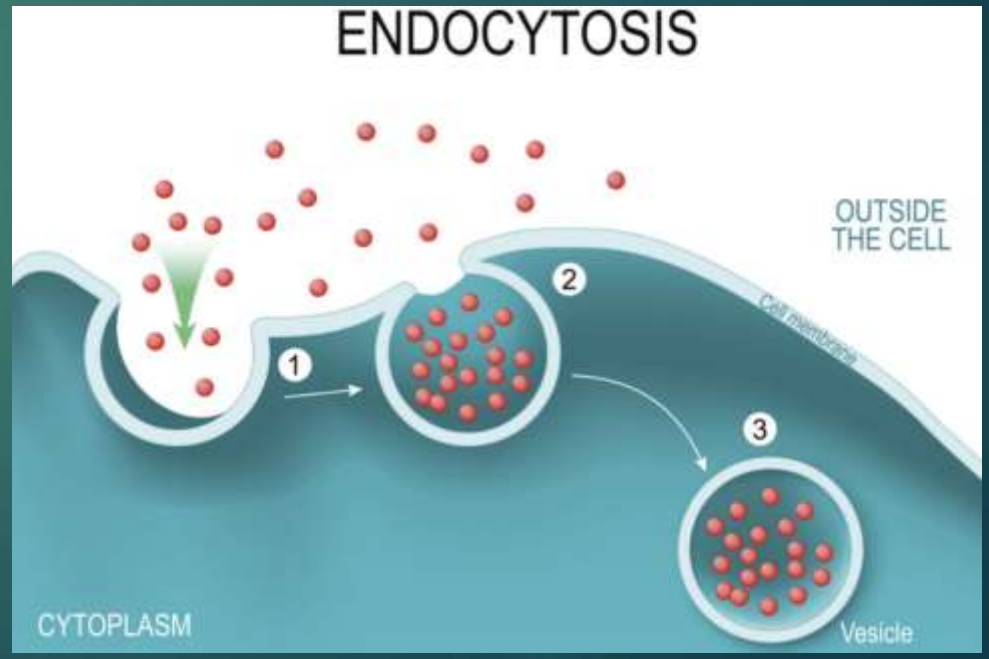
  1. Primary active transport
  2. Secondary active transport

- ***Primary Active Transport:*** Used energy directly from the hydrolysis of ATP.
- ***Secondary Active Transport (Co-transport):*** one item moves down to its concentration gradient, which releases energy, and that energy is used to move another item irrespective of its concentration gradient.

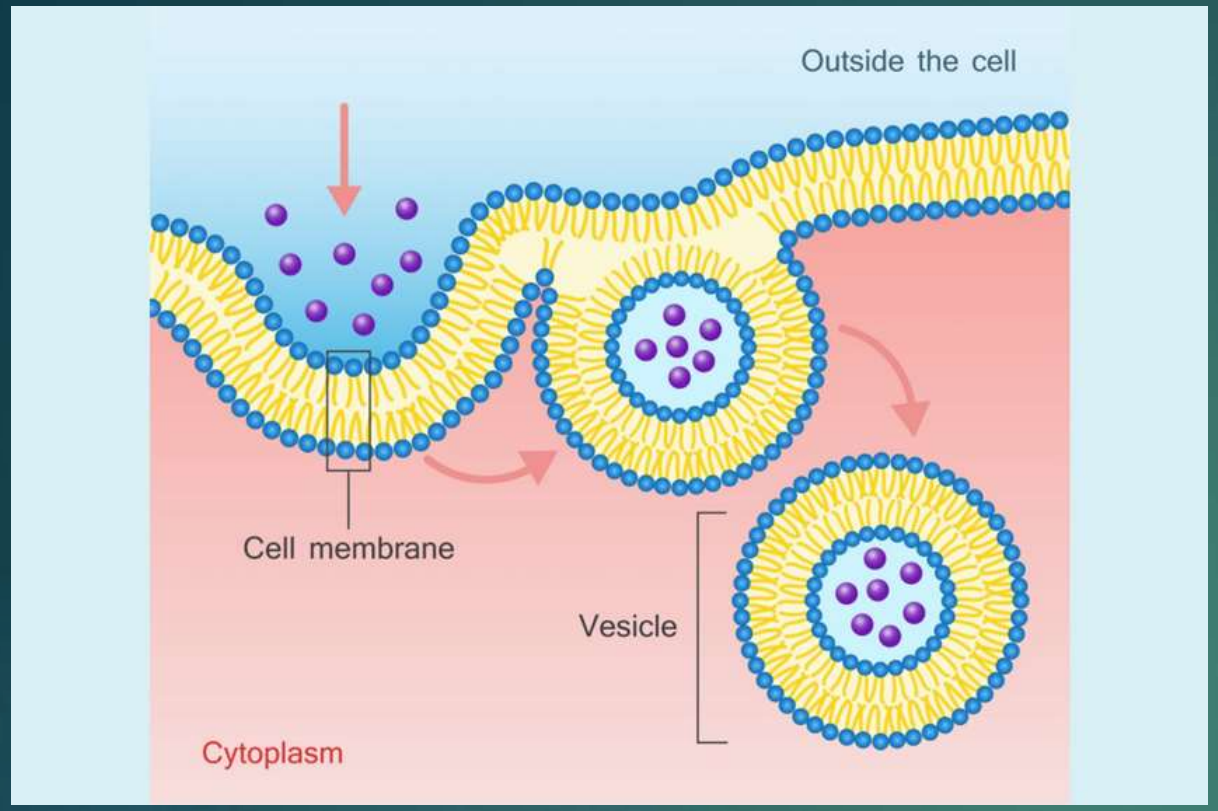


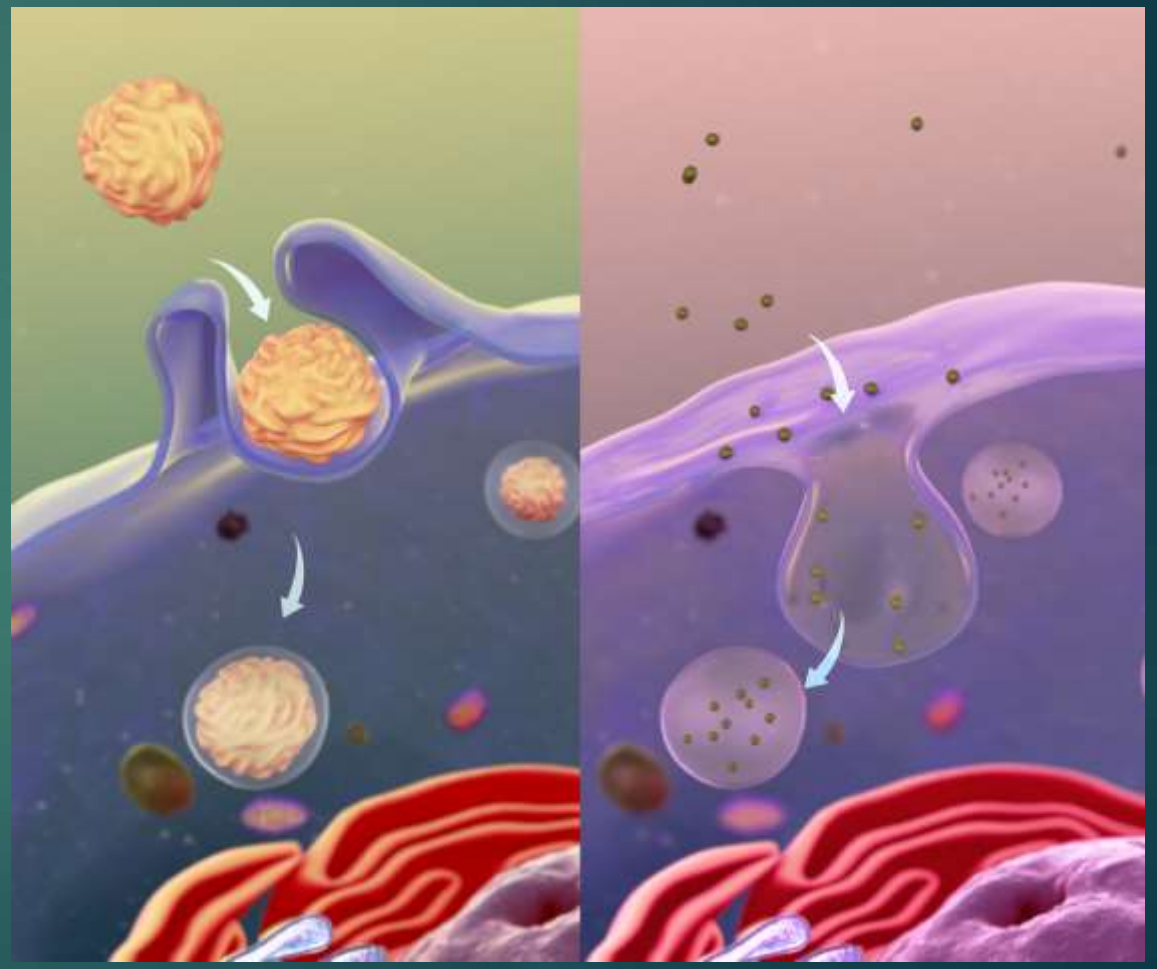
Vesicular Transport

- ***Endocytosis***
- **Endocytosis** is a cellular process in which substances are brought into the cell.
- The material to be internalized is surrounded by an area of the cell membrane, which then buds off inside the cell to form a vesicle containing the ingested material.
- It is a form of active transport.
- Endocytosis is of two types:
- ***Pinocytosis (cell drinking)***
- ***Phagocytosis (cell eating)***



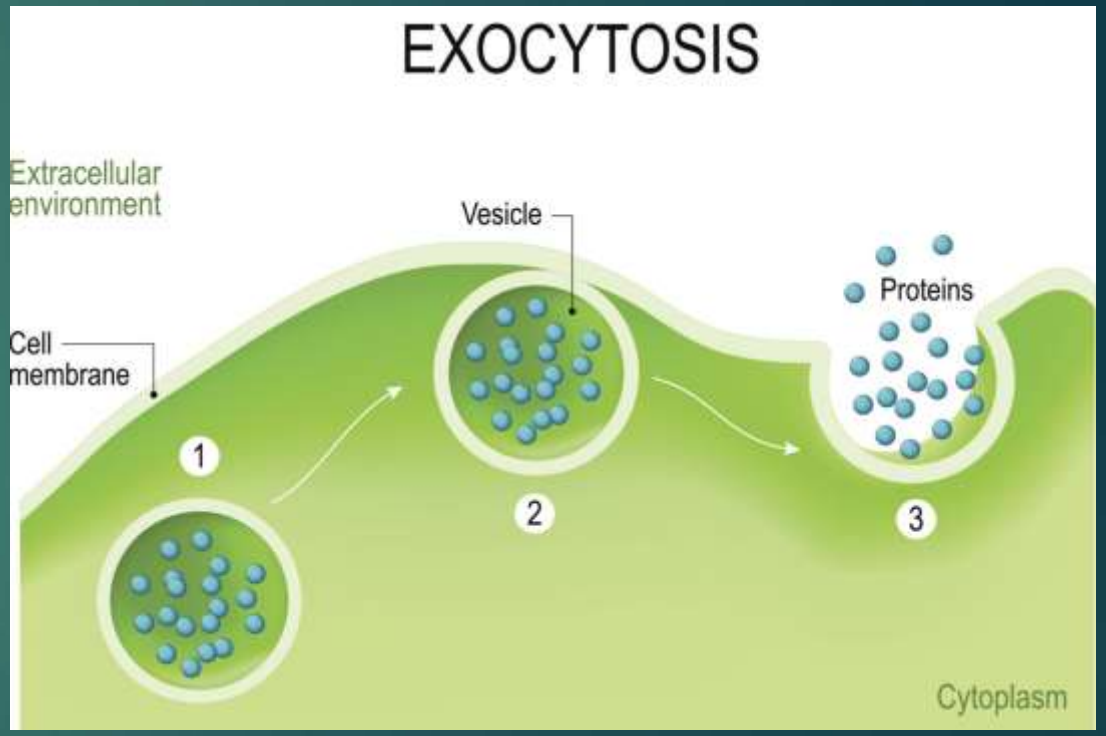
- ***Pinocytosis:*** Cellular uptake of fluid and fluid content.
- ***Phagocytosis:*** It involves the ingestion of large particles such as viruses, bacteria, and dead cells.
- Receptors are present on the outer surface of cell Membrane
- Receptors coated on cytoplasmic sites with protein(Clathrin) and contractile filaments i.e. Actin and Myosin
- Once the macromolecules are bound to the receptor, the entire pit invaginates inward
- Invaginated pit causes it to close over the attached molecules
- Invaginated portion of the membrane breaks away from the surface
- Forming endocytic vesicle inside the cytoplasm of the cell


Outside the cell
Cell membrane
Vesicle
Cytoplasm



Exocytosis

- The undigested substance called the residual body is excreted through the cell membrane by a process called exocytosis.
- The undigested substance produced within the cytoplasm may be enclosed in a membrane to form vesicles called exocytic vesicles.
- These cytoplasmic exocytic vesicles fuse with the internal surface of the plasma membrane.
- The vesicle then ruptures releasing their content into the extracellular space and their membranes are left behind and reused.



Cytoplasm and its organelles

- The ***gel like substance enclosed within the plasma membrane*** and ***external to the nucleus*** is called as cytoplasm.
- The ***semifluid portion of the cytoplasm*** in which cell ***organelles and inclusions are suspended*** is called as ***cytosol or intracellular fluid.***
- Cytosol is ***transparent, viscous gel like fluid*** containing 75-90% ***of water and proteins, lipids*** and ***carbohydrate, inorganic substances*** and ***salt*** suspended and dissolved in it.
- The cell organelles are embedded in the cytosol.
- **Cell organelles:**
- Endoplasmic reticulum
- Golgi apparatus
- Mitochondria
- Lysosomes
- Ribosomes

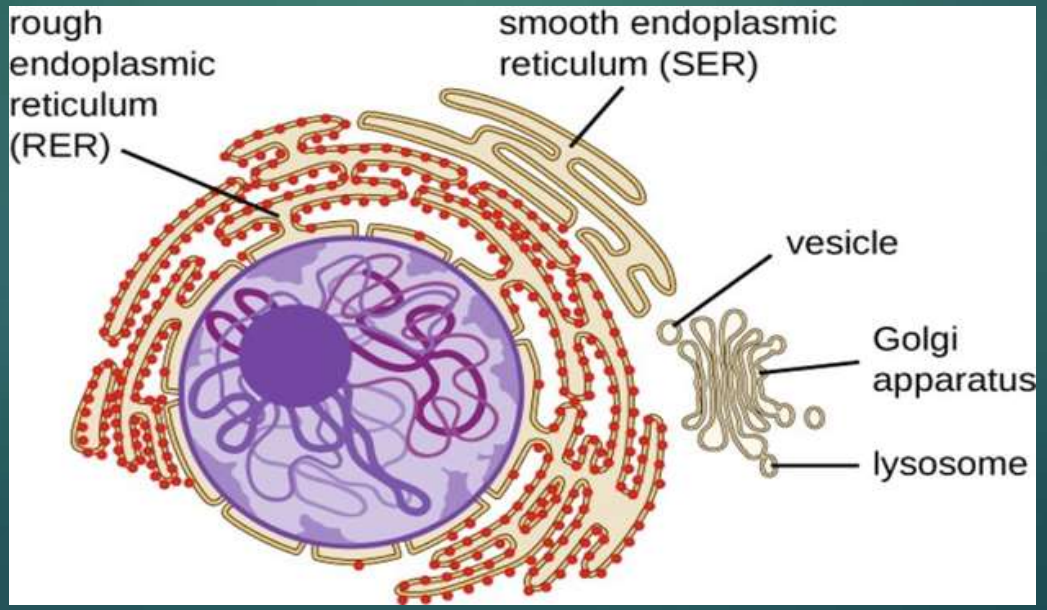
Endoplasmic reticulum (Ergastoplasm)

- It consist of **network of canals (tubules) and vesicles (cisternae).**
- Connect intermittently with the plasma membrane at onehand and on the other hand with the outer nuclear membrane.
- Two types of endoplasmic reticulum have been recognized-

1. ***Rough surface endoplasmic reticulum*** – The ribosomes lie in a rows in contact with the membrane of the endoplasmic reticulum. The roughness of the membrane is due to the presence of these granules.
2. ***Smooth surface endoplasmic reticulum*** – This type of endoplasmic reticulum does not possess osmiophilic granules. The ribosomes lie at the outer border of the membrane. This is why it is smooth.

Functions of endoplasmic reticulum

1. The rough endoplasmic reticulum which is abundant in liver cells **is site of protein synthesis**.
2. Smooth endoplasmic reticulum is **concerned with synthesis of steroid hormone** and **detoxification site.**
3. In the skeletal muscle, it is concerned in some way with **binding of the ca^{++} ions** and also plays role in **conducting impulses** in the substances of muscle cells.

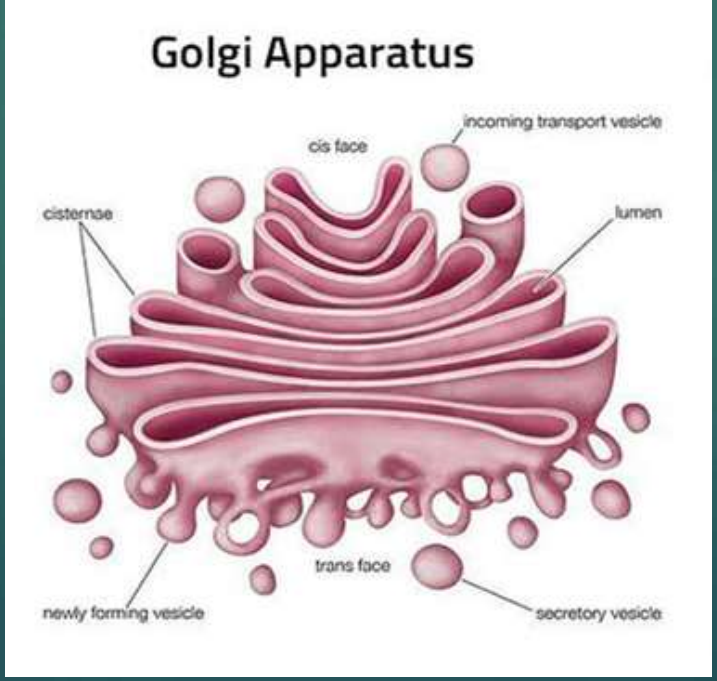


Golgi apparatus (Golgi complex)

- First discovered ***in 1898 by Camillo Golgi.***
- The structure looks like a ***network of fine threads*** (Golgi network) ***or irregular granular material*.**
- It consist of ***four to six flattened sacs called the cisterns***, stacked upon each other in a bent semicircular shape.
- Each stack of Golgi sacs has two defined regions- ***cis and trans.***
- Protein synthesized by the ribosomes are brought to the lumen of ER and then to Golgi apparatus through transfer vesicles.
- The ***vesicles fuse with the cis regio*n** of the golgi ***releasing their contents into the internal portion*.**
- These ***proteins are modified and secreted outside*** the cell when needed through the secretory vesicles on the trans end.
- Golgi apparatus ***stores proteins and is also responsible for modifying them*.**

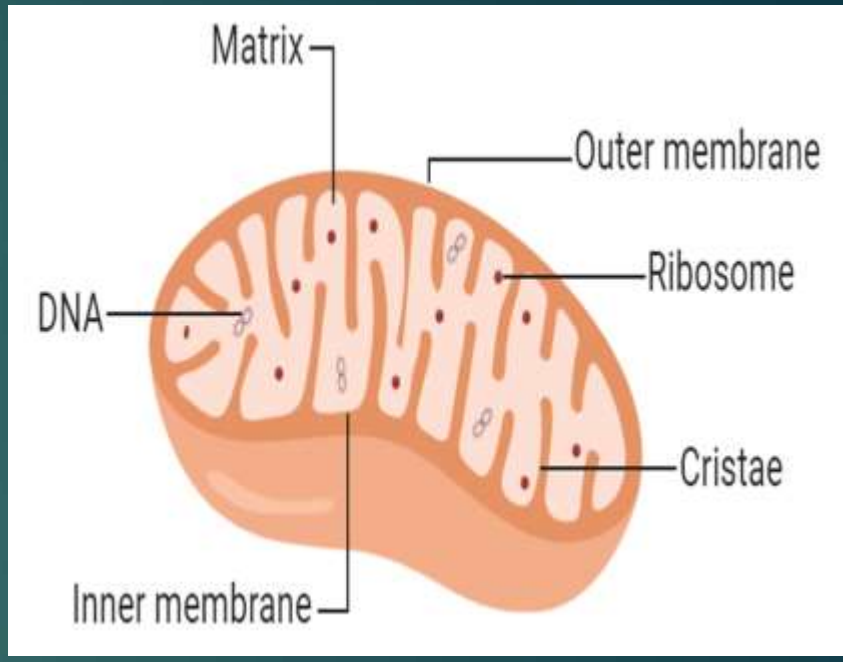
Functions of Golgi apparatus

1. it is concern with ***synthetic process of the cell, specially secretion***.
2. Golgi apparatus independently ***synthesizes polysaccharide part of glucoprotein*** secretion.
3. It is ***site of formation of lysosomes***.
4. It ***produces secretory granules*** which store hormones and enzymes.



Mitochondria

- These are relatively ***solid bodies***, ***granular, rod-shaped*** or ***filamentous*** in form and scattered throughout the cytoplasm.
- Surrounded by a ***trilaminar double membrane***, the inner one of which remains folded and forms a number of partitions, the ***cristae mitochondriales.***
- Numerous projecting particles known as ***elementary particles*** are present on the inner mitochondrial membrane and cristae.
- The fluid of the intra mitochondrial space is called ***matrix.*** This may contain small dense granules.
- ***Enzymes of mitochondria***- present on ***elementary particles***, ***coenzymes- in matrix***, inorganic ions like ***calcium and magnesium- in the granules.***
- The number and size of mitochondria give an indication of the energy requirement of a particular cell.
- They are more ***numerous and longer*** in **the** ***young and active cells.***



Functions of Mitochondria

1. ***Oxidative phosphorylation and ATP formation –***

- In presence of oxygen, the ***Krebs cycle runs within the mitochondria*** with the catalyzing help of enzymes ***– respiratory enzymes.***
- These are ***flavoprotein*** enzymes and ***cytochrome***, and present in the inner membrane of the mitochondria. These respiratory enzymes use certain product of Krebs cycle as a ***substrate.***
- These enzymes present in mitochondria ***help in oxidative phosphorylation*** and are the ***site for formation of adenosine triphosphate (ATP)*** which is the high energy producing substance in the cell.
- The mitochondria supply ***95% of cell's energy*** and are called ***powerhouse*** or ***power plant*** of the cell.

2. ***Cell replication –***

- It posses ***some amount of DNA. Controls the replication of the cells*** of mitochondria.

3. It plays vital role in ***apoptosis.***

Lysosomes

- Membranous vesicles having a ***spherical and bags-like structure***
- filled ***with hydrolytic enzymes capable of demolishing large molecules (protein, carbohydrate, lipids and nucleic acids) into fragments*** which may then be oxidized by the mitochondria.
- The enzymes of lysosomes are ***potent enough to digest to its own cellular contents*** and for this reason it is sometimes describes dramatically as ***suicide bag.***
- ***Lysosomal enzymes*** – synthesized by the ***ribosome*** of granular endoplasmic reticulum – **transported to Golgi apparatus** in the form of micro-vesicles for storage.
- Stored enzymes ultimately ***budded off from the stack of Golgi saccules – developed into primary*** or ***inactive lysosomes.***
- ***Fusion of primary lysosomes*** with the particles brought into surface of the cell (phagosome) or the ***intracellular materials*** give rise ***to secondary or active lysosomes.***
- Lysosomes that digest degenerated mitochondria or other intracellular structure are specifically describe as ***cytolysosome.***

Lysosomal enzymes (Synthesized by ribosome)

↓

transported to Golgi apparatus

↓

Budded off from the stack of Golgi saccules – developed into primary or ***inactive lysosomes.***

↓

Fusion of primary lysosomes with intracellular materials

↓

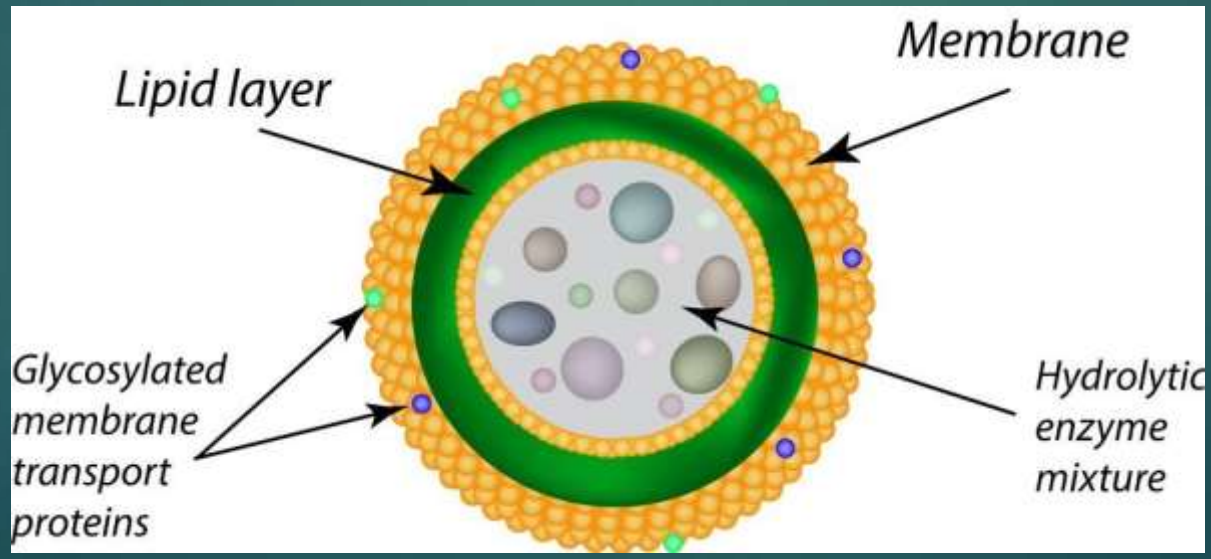
secondary or active lysosomes.

↓

cytolysosome.

Functions of lysosomes

1. ***Digestion*** - The general function of the lysosomes is the intracellular digestion and for this reason it is sometimes described as ***digestive apparatus*** of the cell. ***Hydrolysing enzymes*** of the lysosomes ***digest the food particles.***
2. ***Cell necrosis or autolysis*** – When the cell is damage, the lysosomal digestive enzymes are released and digest off cellular elements.
3. ***Phagocytosis*** – The lysosomes engulf exogenous substances Ex-bacteria and are degraded by its enzymes.



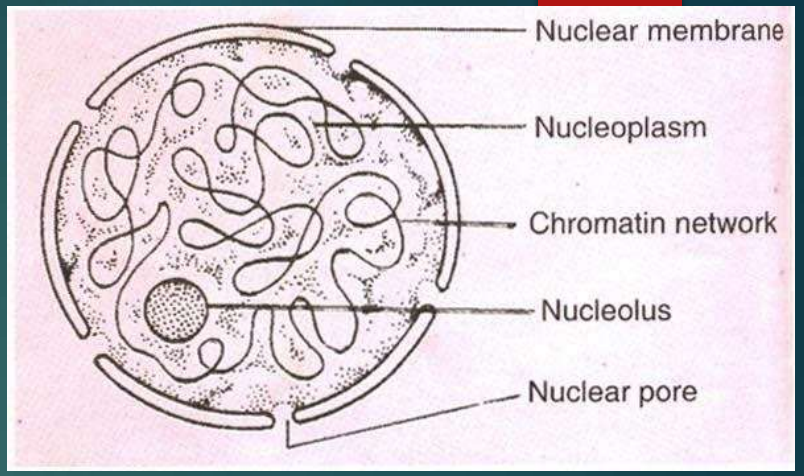
Ribosomes or Claude's particles

- Ribonucleoprotein in nature, scattered throughout the cytoplasm either single or in group (polyribosomes or polysomes).
- They are so rich in RNA that they may contain as much as ***60% of total RNA*** in the entire cell.
- These ribonuleo-proteins are concern with ***protein synthesis*** and their presence gives the membrane a ***strong basophilia.***

Functions of Ribosomes

- Being attached to the rough surfaced endoplasmic reticulum ribosome synthesises protein and canal of the reticulum work as passageways through which proteins move on way to Golgi apparatus.
- So ribosomes are ***protein factories.***

Nucleus



- Generally ***spherical body*** occupying the ***centre of the cell*.**
- Nuclear material differs from the cytoplasm in several aspect –

1. It is ***more opaque*** to the ultraviolet rays.
2. It shows many selective staining reaction but ***usually takes basic stain***, while cytoplasm may ***take natural, basic or acidic stain*.**
3. Nucleus is very ***rich in deoxyribonucleic acid (DNA),*** while cytoplasm is rich in ribonucleic acid (RNA).

- In the apparently quite permeable membrane of the nucleus, pores (area of dicontinuity) of about 6 micron diameter are closed by a thin homogenous membrane which permit passes of molecules from nucleus to the cytoplasm.
- This indicate ***connecting link between the genes and ribosomes***, the site for cytoplasmic protein sysnthesis.

Nucleolus

- Inside a nucleus there is usually ***single or may be from two to five smaller bodies*** known as ***nucleolus*** or ***nucleoli.***
- The nucleolus comprises the ***irregular network or rows of fine granules, nucleolonema.***
- The nucleolus loses its identity during cell division.
- The nucleolus contain still smaller nucleus known as ***nucleololus*** or ***nucleolinus*** or ***nucleolonucleus.***

Functions of Nucleus

1. The genetic material DNA of nucleus act as ***template for RNA synthesis***. These RNA regulates protein synthesis in the cytoplasm.
2. It is responsible for ***development of chromosomal*** thread from the network of the chromatin initiating cell division and thus play important role in ***cell reproduction and multiplication.***
3. It contains genetic unit i.e genes which ***determine the individuals genetic characters.***

Cell Division

- Cell division is the process by which a parent cell divides into two or more daughter cells.
- There are two types of cell division-

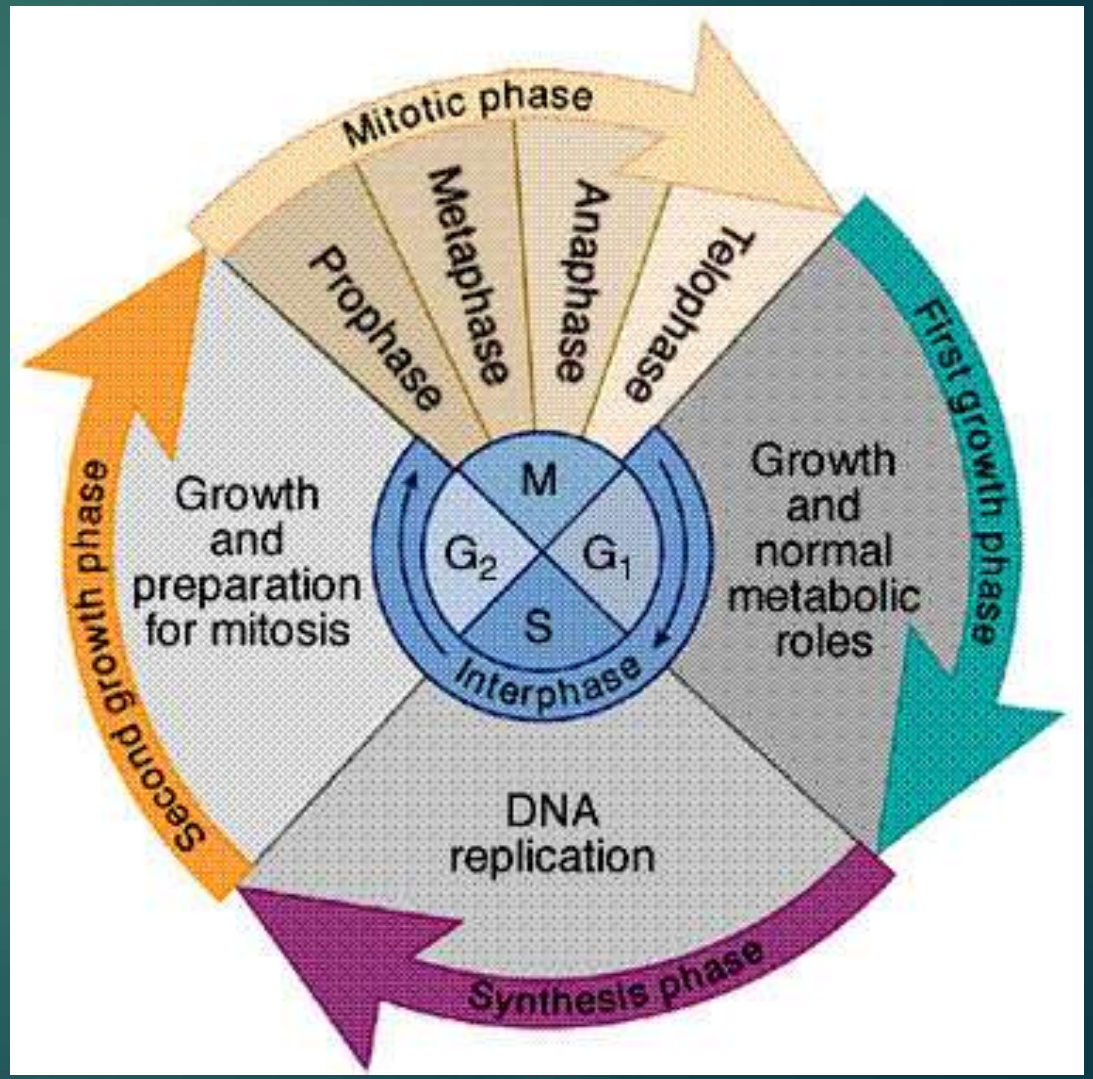
1. Somatic cell division
2. Reproductive cell division

Somatic cell division: ***A cell undergoes a nuclear division called mitosis and a cytoplasmic division called cytokinesis to produce two identical cells, each with the same number and kind of chromosomes as the original cell.***

Reproductive cell division: ***A cell undergoes a division called meiosis, in which the number of chromosomes in the nucleus is reduced by half. This mechanism produces gametes- the cells needed to form the next generation of sexually reproducing organisms.***

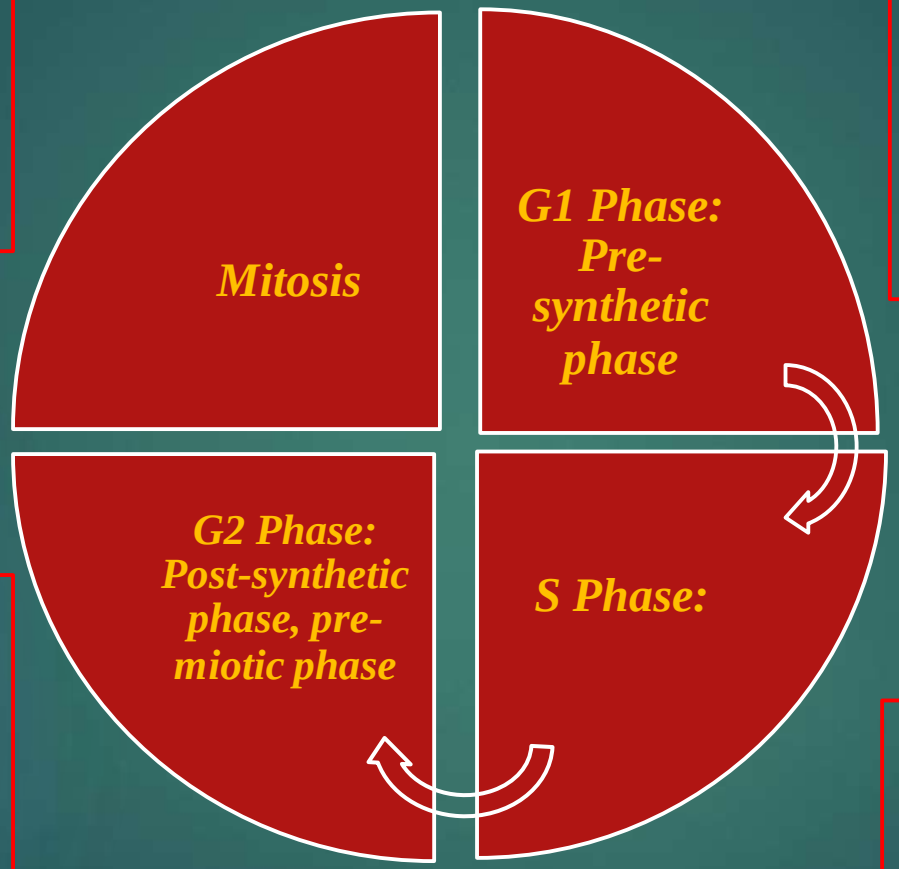
Somatic Cell Division (Cell Cycle)

- The cell cycle is an orderly sequence of events by which a somatic cell duplicates its contents and divides into two.
- The cell cycle is divided into two basic phases:
- ***Interphase:*** when a cell is not dividing
- ***Mitotic Phase:*** when a cell is dividing



It is divided into Four stages:

1. Prophase
2. Metaphase
3. Anaphase
4. Telophase



- Cell metabolically active
- Produce proteins, and enzymes, increase cytoplasm, enzymes which are helpful in DNA replication.
- Replicate most of its organelles and cytosolic components **but not its DNA.**
- Last for 8 to 10 hours.

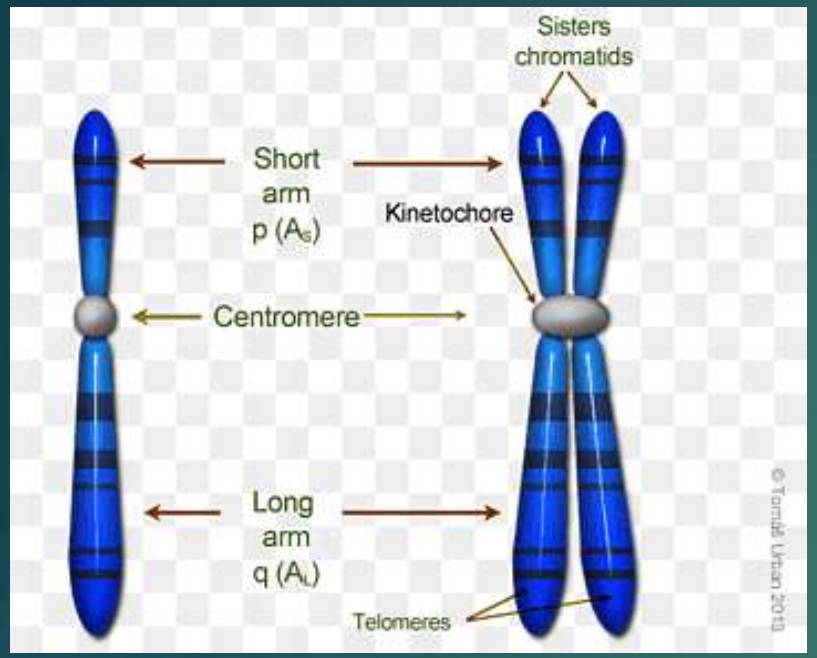
- Preparing itself to divide genetic material equally into two daughter nuclei.
- Cell growth continue, enzymes and other proteins are synthesized in preparation for cell division.

- Synthesis of DNA
- Last for 8 hours.

Mitotic Phase

- The mitotic phase of the cell cycle consists of a nuclear division (mitosis) and a cytoplasmic division (Cytokinesis) to form two identical cells.
- The process results in the exact distribution of genetic information.
- It is divided into Four stages:

1. Prophase
2. Metaphase
3. Anaphase
4. Telophase

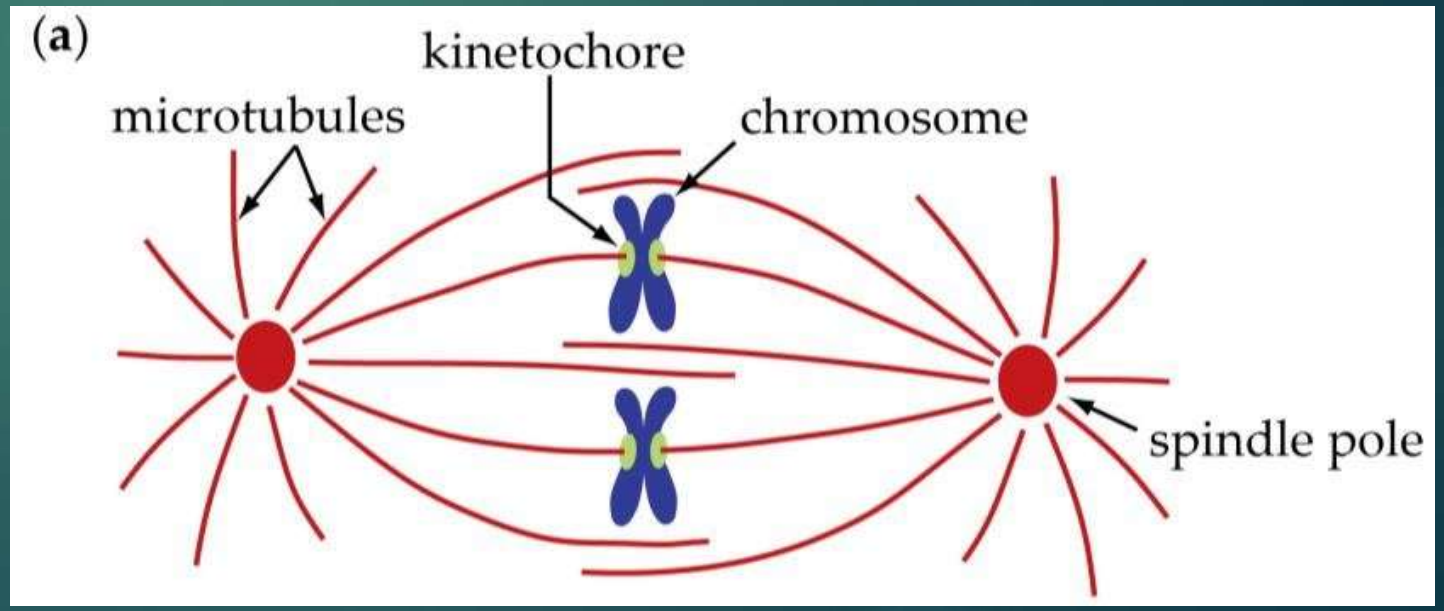


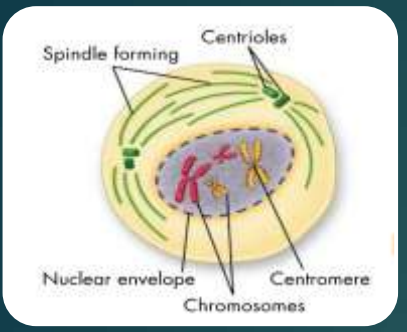
Microtubules

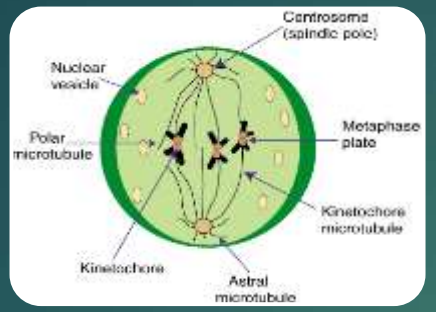
A rope-like component of the cytoskeleton.

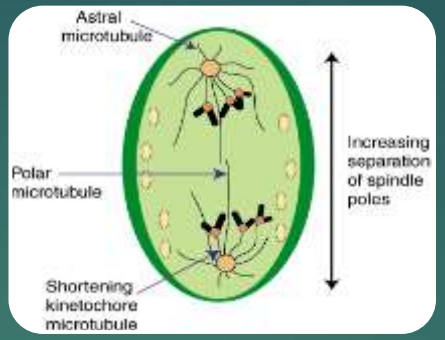
Mitotic Spindle

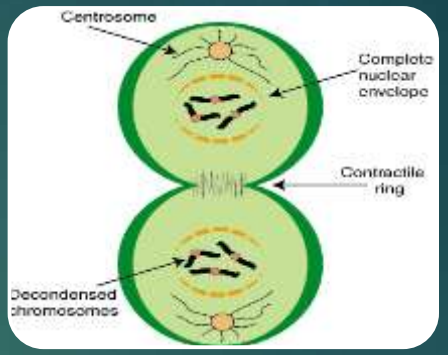
a structure composed of microtubules which segregates chromosomes

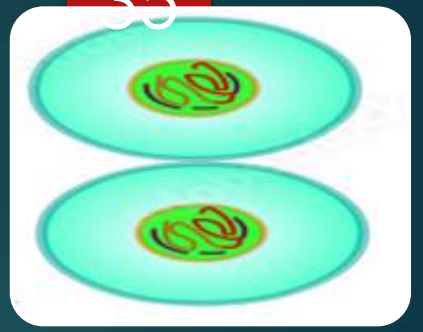












Prophase

- Chromatin fibre condense and form chromosome
- Centrosomes start to form mitotic spindle
- Microtubule lengthen, push centrosome to the end of cell.

Metaphase

Microtubules align the centromeres of chromatid pairs at the exact centre of miotic spindle called as metaphase plate.

Anaphase

Centromeres split separating the two member of each chromatid pair which move toward apposite poles of the cell.

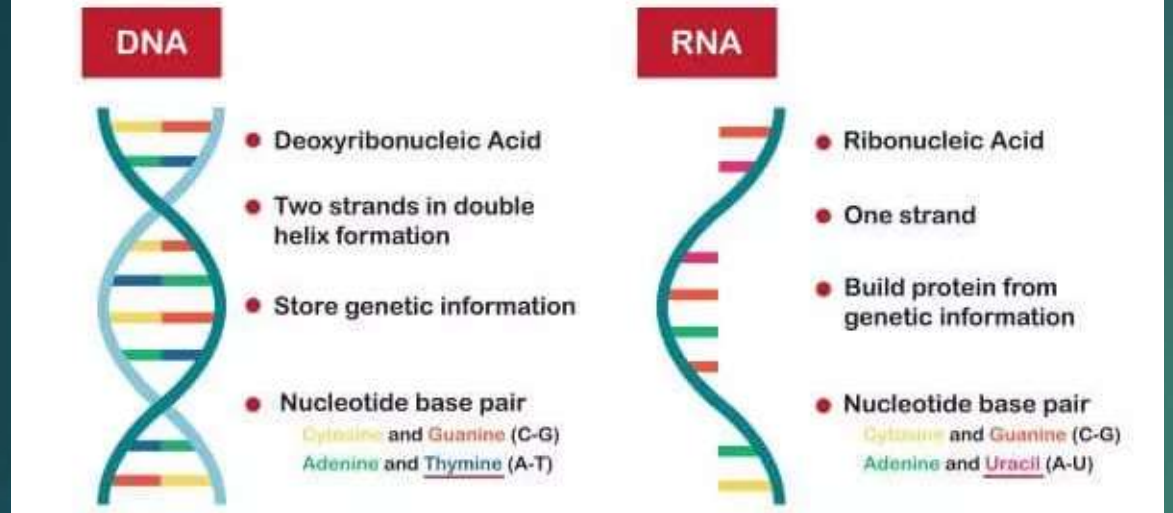
Telophase

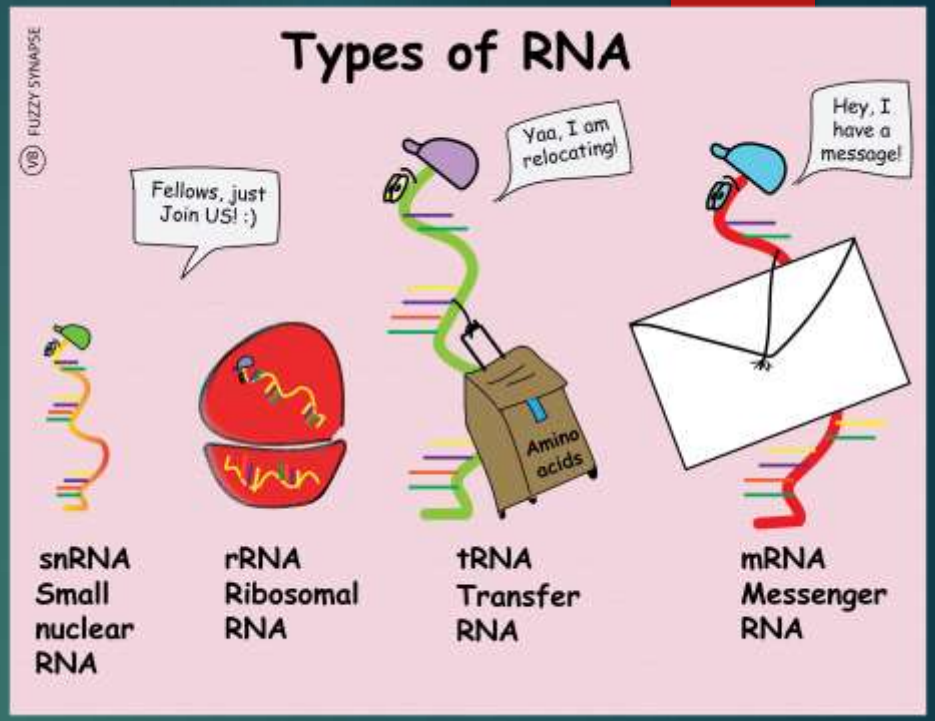
- Identical sets of chromosomes now at the opposite poles of the cell, uncoil and forms threadlike chromatin.
- Nuclear envelope forms around each chromatin mass.

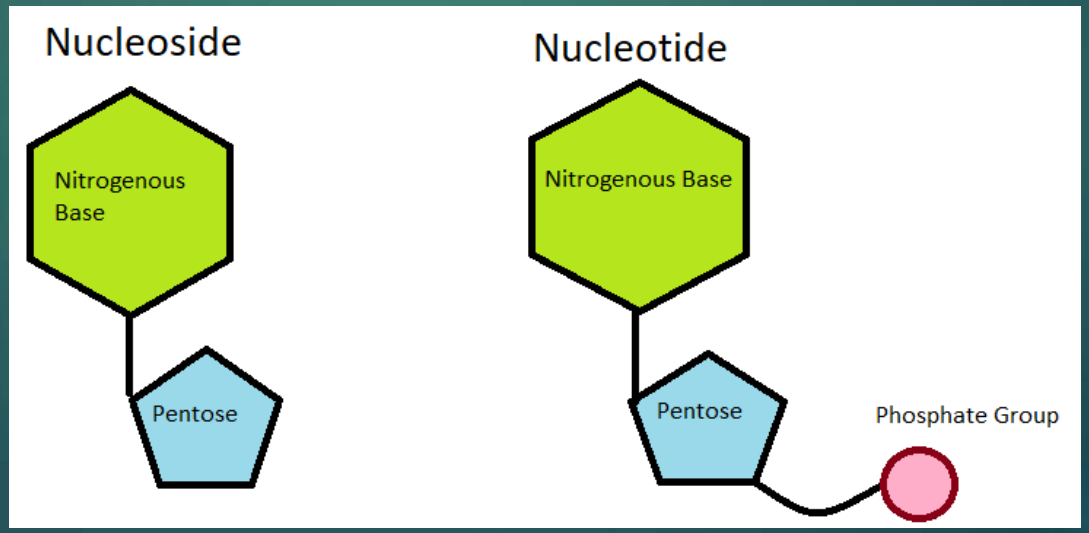
Cytokinesis

Cytoplasm and organelles divide into 2 and cell membranes separate

Differences of DNA and RNA







Protein Synthesis

- Production of proteins
- Consists of two processes — ***Transcription and Translation.***
- In eukaryotic cells, ***transcription takes place in the nucleus.*** During transcription, DNA is used as a template to make a molecule of messenger RNA (mRNA).
- The molecule ***of mRNA then leaves the nucleus and goes to a ribosome in the cytoplasm***, where ***translation*** occurs.
- During translation, the genetic code in mRNA is read and used to make a protein.
- These two processes are summed up by the central dogma of molecular biology: **DNA → RNA → Protein**.

Transcription

- **Transcription** is the first part of the central dogma of molecular biology: ***DNA → RNA.*** It is the ***transfer of genetic instructions in DNA to mRNA***. During transcription, a strand of mRNA is made to complement a strand of DNA.
- Transcription takes place in three steps: ***Initiation, Elongation, and Termination***
- **Initiation** is the beginning of transcription. It occurs when the enzyme ***RNA polymerase*** binds to a region of a gene called the ***promoter.*** This signals the DNA to unwind so the enzyme can "read" the bases in one of the DNA strands. The enzyme is ready to make a strand of mRNA with a complementary sequence of bases.
- **Elongation** is the addition of nucleotides to the mRNA strand.
- **Termination** is the ending of transcription. The mRNA strand is complete, and it detaches from DNA.

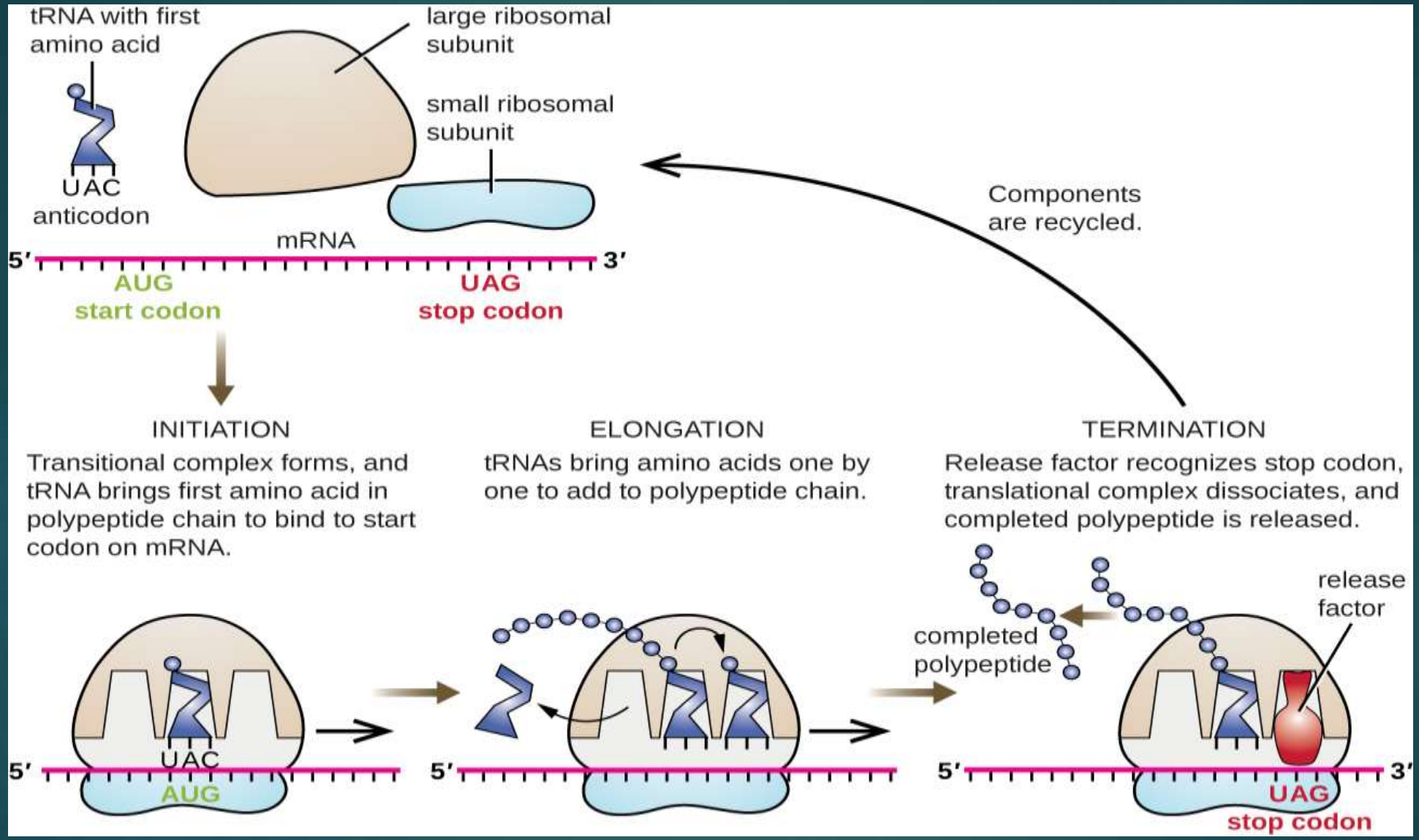
Processing mRNA

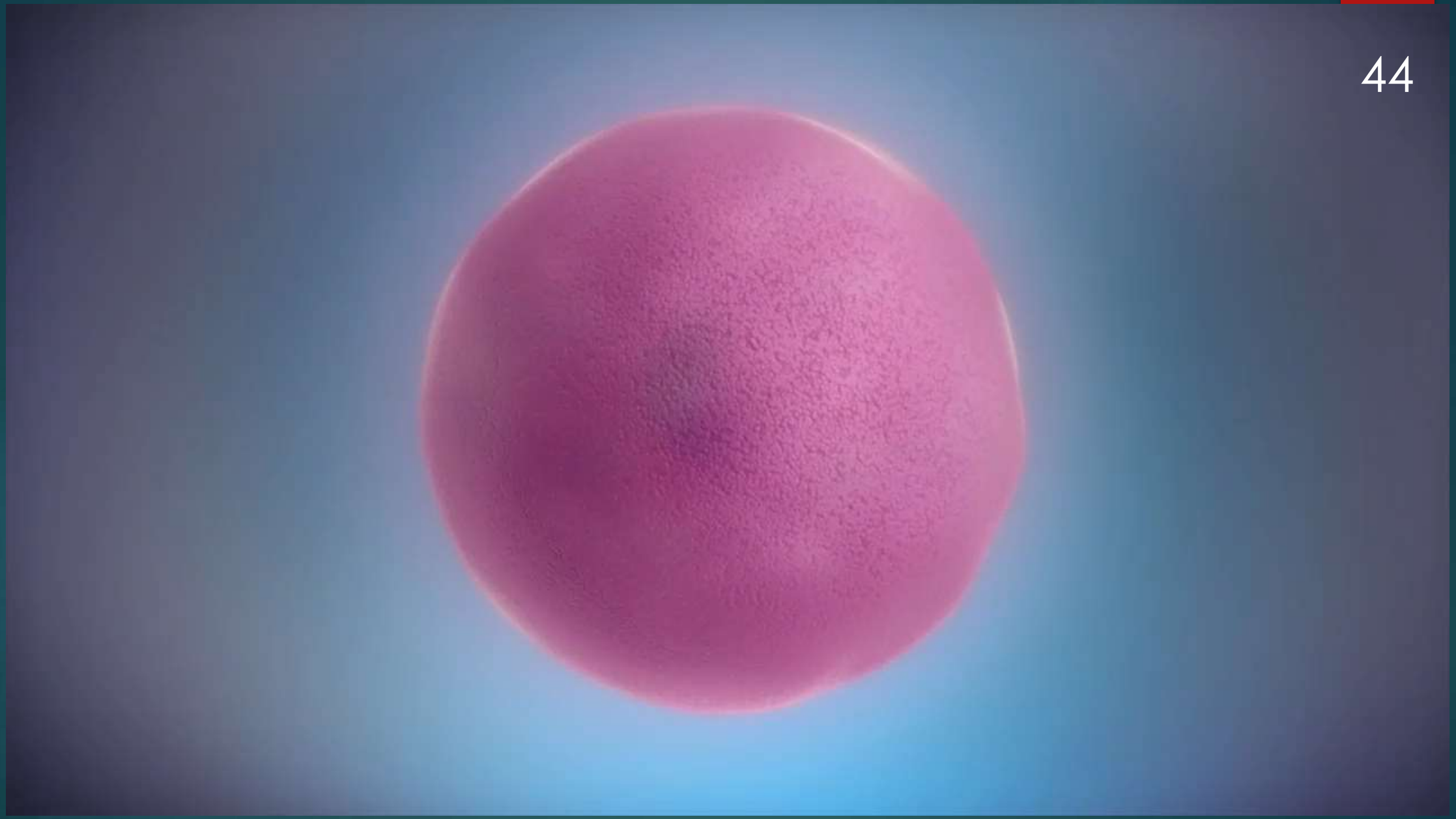
- In eukaryotes, the new mRNA is not yet ready for translation. At this stage, it is called pre-mRNA, and it must go through more processing before it leaves the nucleus as mature mRNA.
- The processing may include the addition of a 5' cap, splicing, editing, and 3' polyadenylation (poly-A) tail.
- 5' cap protects mRNA in the cytoplasm and helps in the attachment of mRNA with the ribosome for translation.
- Splicing removes introns from the protein-coding sequence of mRNA. **Introns** are regions that do not code for the protein. The remaining mRNA consists only of regions called **exons** that do code for the protein
- Editing changes some of the nucleotides in mRNA.
- Polyadenylation adds a "tail" to the mRNA. The tail consists of a string of As (adenine bases). It signals the end of mRNA. It is also involved in exporting mRNA from the nucleus, and it protects mRNA from enzymes that might break it down.

Translation

- **The translation** is the second part of the central dogma of molecular biology: **RNA --> Protein.** It is the process in which the genetic code in mRNA is read to make a protein.
- After mRNA leaves the nucleus, it moves to a ribosome which consists of rRNA.
- Translation happens on the ribosomes floating in the cytosol or on the ribosomes attached to the rough endoplasmic reticulum. The ribosome reads the sequence of codons in mRNA, and molecules of tRNA bring amino acids to the ribosome in the correct sequence.
- Each tRNA molecule has an anticodon for the amino acid it carries. An **anticodon** is complementary to the codon for an amino acid. For example, the amino acid lysine has the codon AAG, so the anticodon is UUC.

- **Translation Initiation:** The small subunit binds to a site upstream (on the 5' side) of the start of the mRNA. It proceeds to scan the mRNA in the 5'-->3' direction until it encounters the START codon (AUG). The large subunit attaches and the initiator tRNA, which carries methionine (Met), binds to the P site on the ribosome.
- **Translation elongation:** the ribosomes interact with other RNA molecules to make chains of amino acids called polypeptide chains, due to the peptide bond that forms between individual amino acids. Inside the ribosome, three sites participate in the translation process, the A, P, and E sites.
- **Translation termination:** When the ribosome encounters the stop codon, the growing polypeptide is released with the help of various releasing factors and the ribosome subunits dissociate and leave the mRNA.


tRNA with first amino acid
large ribosomal subunit
small ribosomal subunit
UAC
anticodon
mRNA
5′
3′
AUG
start codon
UAG
stop codon
Components are recycled.
INITIATION
Transitional complex forms, and tRNA brings first amino acid in polypeptide chain to bind to start codon on mRNA.
ELONGATION
tRNAs bring amino acids one by one to add to polypeptide chain.
TERMINATION
Release factor recognizes stop codon, translational complex dissociates, and completed polypeptide is released.
release factor
completed polypeptide
UAC
AUG
UAG
stop codon



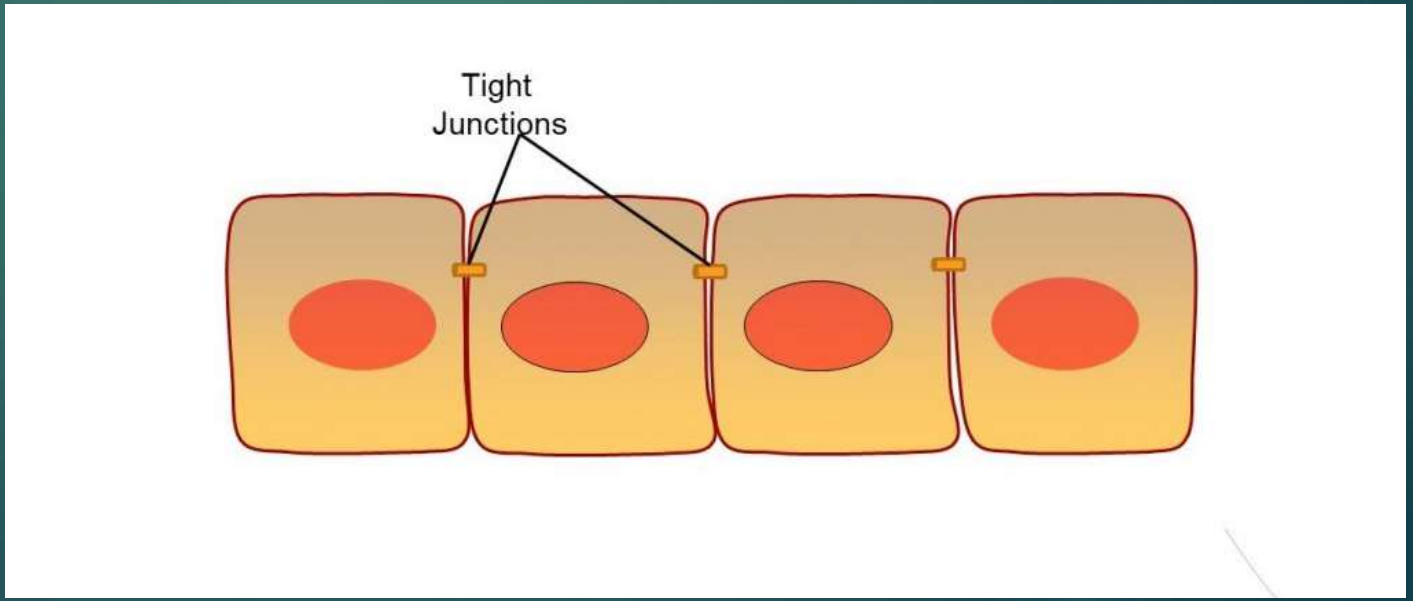
Cell Junction

- **Cell junctions** (or **intercellular bridges**) are a class of cellular structures consisting of multi-protein complexes that ***provide contact or adhesion between neighboring cells or between a cell and the extracellular matrix in animals.***
- cell junctions are especially abundant in epithelial tissues. Combined with cell adhesion molecules and extracellular matrix, cell junctions help hold animal cells together.
- In vertebrates, there are three major types of cell junction:

1. Adherence junctions (anchoring junctions)
2. Gap junctions (communicating junction)
3. Tight junctions (occluding junctions)

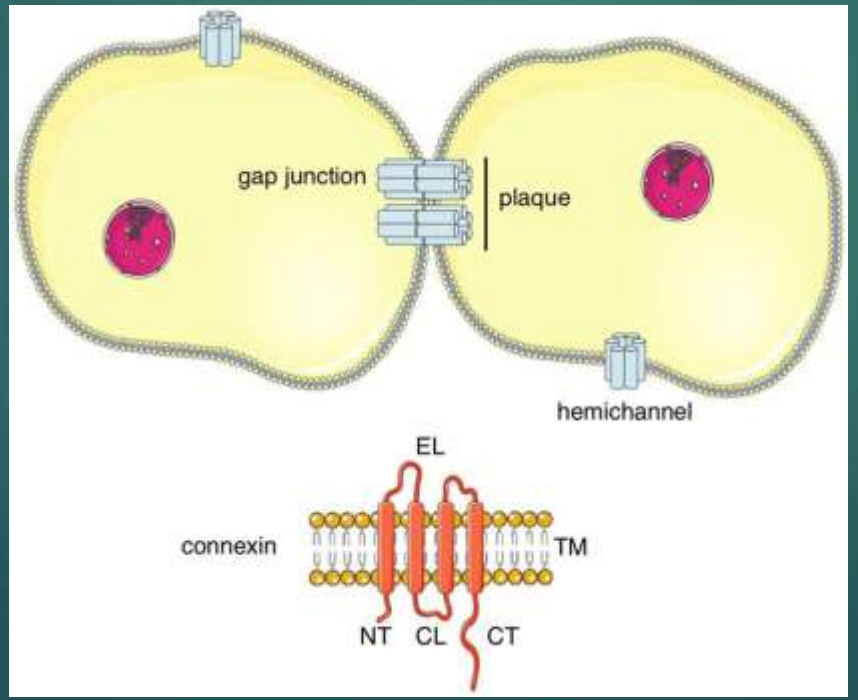
Tight junctions (occluding junctions)

- Found in epithelial cells
- Located at very apical part of epithelial cell
- They connect cell together and its like a glue that connect cell really tight.
- Function as barrier that regulate the movement of water and solutes between epithelial layers.



Gap junctions(communicating junction)

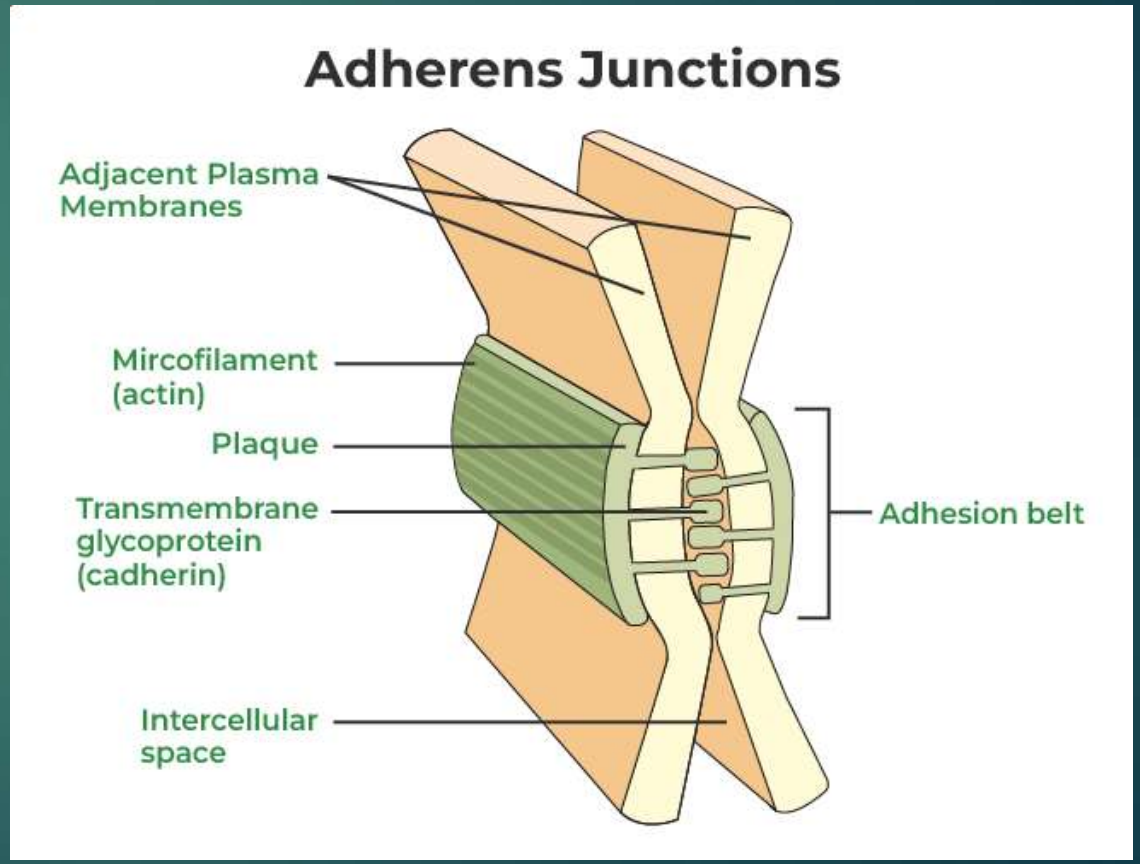
- These are communicating junctions that occur frequently between epithelial cells.
- They have direct contact with the cytoplasm of an adjacent cell.
- They allow ions and small molecules to diffuse freely between neighboring cell.
- It prevents diffusion of protein and nucleic acid.

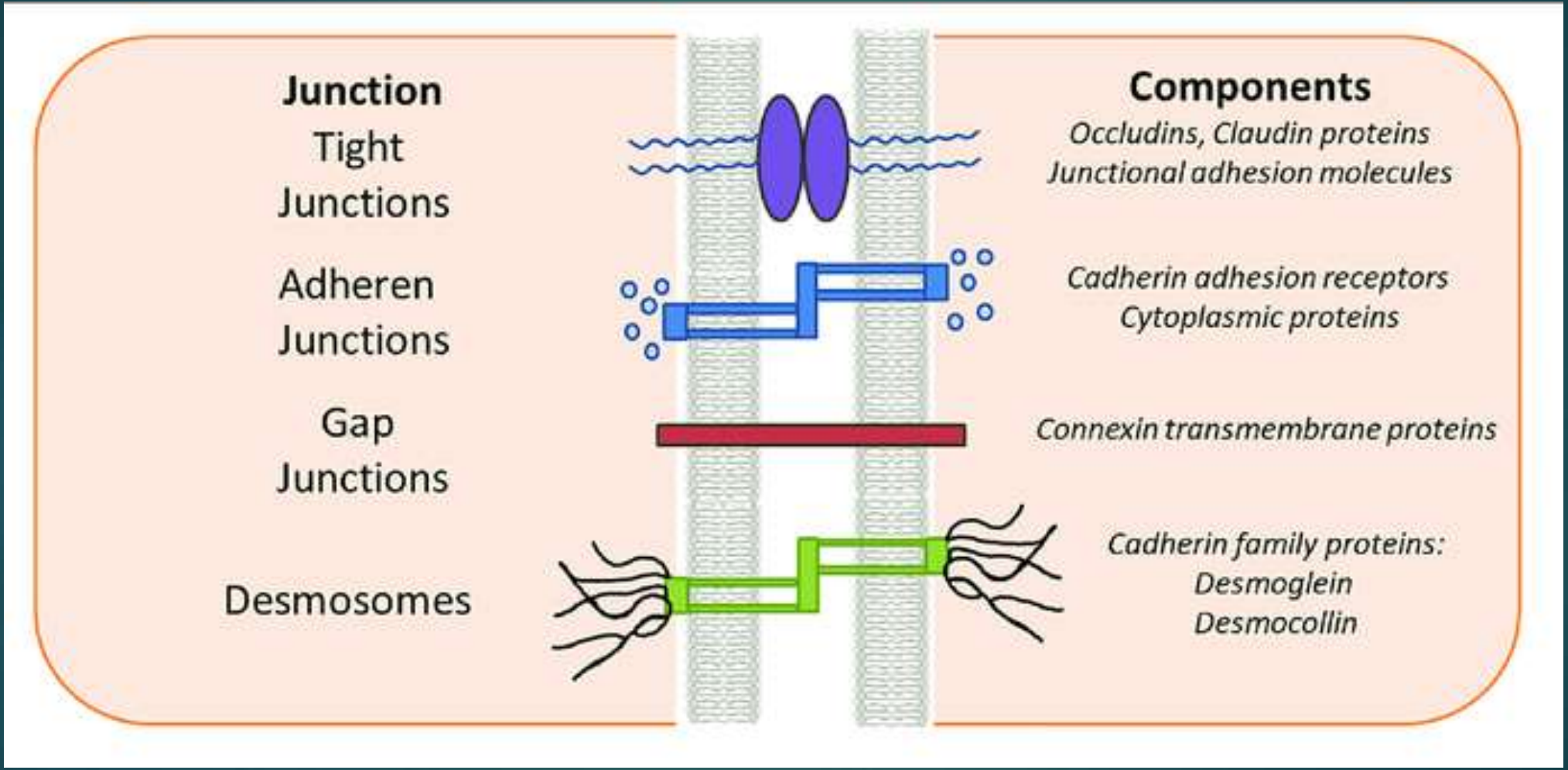


Adherens junctions (anchoring junctions)

- Helps in cell to cell attachment.
- Types:

1. Zonula adherence
2. Fascia adherence
3. Desmosomes
4. Hemidesmosomes



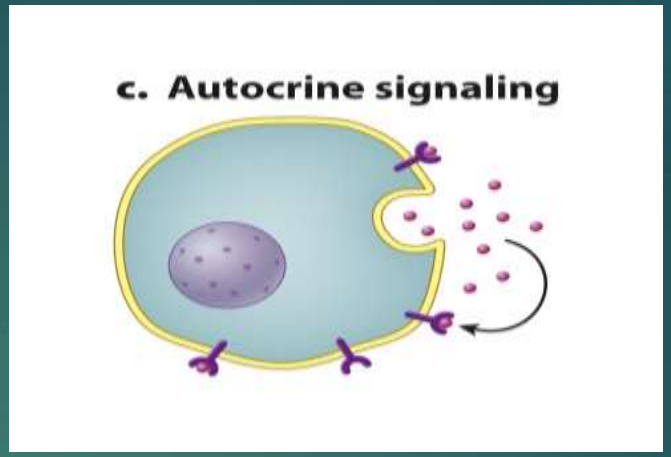

Junction
Components
Tight Junctions
Occludins, Claudin proteins
Junctional adhesion molecules
Adheren Junctions
Cadherin adhesion receptors
Cytoplasmic proteins
Gap Junctions
Connexin transmembrane proteins
Desmosomes
Cadherin family proteins:
Desmoglein
Desmocollin

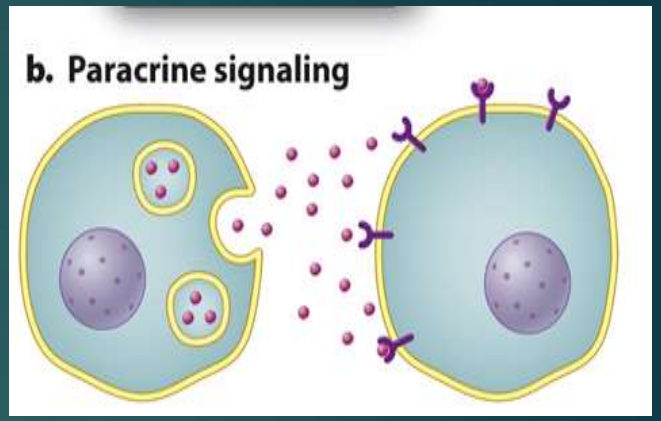
General principles of cell communication

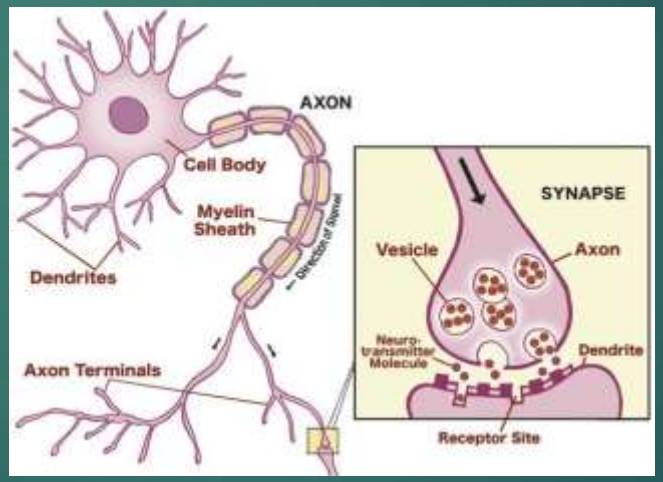
- All organisms, whether unicellular or multicellular, need to respond to their ever-changing environment in order to survive and flourish. Such responses are governed by the ability of cells to sense physical changes and chemical cues occurring around them. ***The process of sensing and responding to extrinsic signals is often termed cellular communication, although scientists also use terms such as 'signal transduction' or 'signaling'.***
- Cells respond to a wide range of extrinsic signals that include chemical messengers (e.g. hormones, growth factors, neurotransmitters), electrical impulses, mechanical forces, pH, heat, and light.
- The principle mode of intercellular communication are:

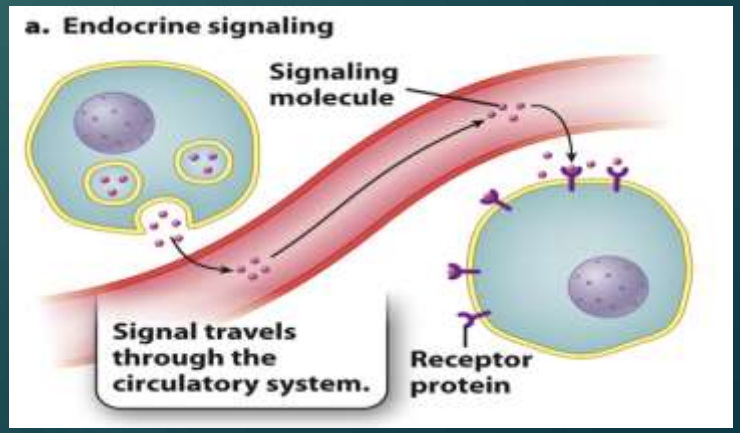
1. Autocrine communication
2. Paracrine communication
3. Neuronal communication
4. Endocrine communication

- ***Autocrine communication:*** cell secret an autocrine agent. Example: hormone or chemical messenger that binds to autocrine receptors of same cell.
- ***Paracrine communication:*** cell secret chemical mediators which act immediately on neighboring cells.
- ***Neuronal communication:*** it is an electrochemical event in which neurotransmitters are released at the synaptic junction which acts on postsynaptic membrane receptors.
- ***Endocrine communication:*** the hormones released from pituitary glands are carried in circulation to the target organ and act via the second messenger mechanism.







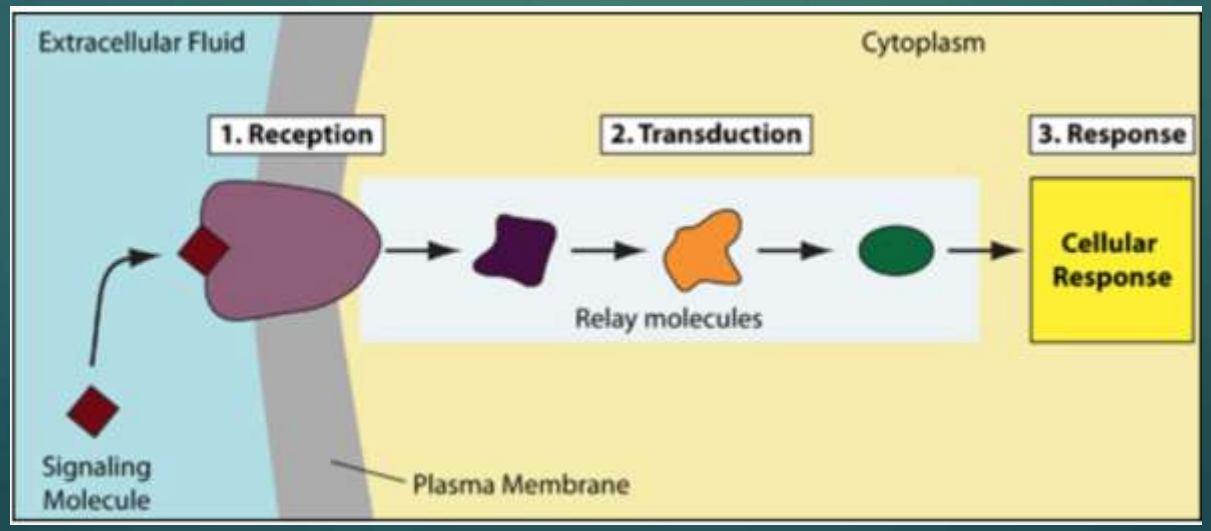


Cell signaling can be divided into 3 stages

1. Reception: A cell detects a signaling molecule from the outside of the cell. A signal is detected when the chemical signal (also known as a ligand) binds to a receptor protein on the surface of the cell or inside the cell.

2. Transduction: When the signaling molecule binds the receptor it changes the receptor protein in some way. This change initiates the process of transduction. Signal transduction is usually a pathway of several steps. Each relay molecule in the signal transduction pathway changes the next molecule in the pathway.

3. Response: Finally, the signal triggers a specific cellular response.



Exam Oriented Questions

1. what is cell? Explain using a neat labelled diagram. (5M)
2. Define and enlist the different parts of a cell. (3M)
3. Write a note on cell membrane. (5M)
4. Draw a neat labelled diagram of cell.
5. Explain in detail structure of cell membrane. (5M)
6. Enlist major body cavities along with their location. (5M)
7. Enlist the organelles in cell. Describe the structure and function of any two organelles. (10M)
8. Describe the structure and function of mitochondria, endoplsmic reticulum, and Golgi apparatus. (10M)
9. Short note on: functions of nucleus, mitochondria, lysosomes. (5M)

References

1. CC Chatterjee, Human physiology, volume 1st, 13th edition, CBS Publishers and distributors, pp. 1-21.
2. DK Ingawale, SK Mandlik, Human anatomy and physiology,3rd edition, Nirali Prakashan, pp21-43.