LAB. 3: The modification of plasma membrane

The plasma membrane : is outer thin ,elastic and semipermeable membrane of both prokaryotes and eukaryotes, which acts as the boundary between the outside and inside of a cell, which control traffic of materials in and out of the cell. Also, there are another role of plasma membrane by the modification of it. When the cells connecting with each other.

Modifications of plasma membrane are:

A) Apical (Free) Surface.

Microvilli : are cytoplasmic protrusion covered by plasma membrane, as finger-like 0.6 -0.8 µm in length, 0.1 µm diameter, as extensions derived from the apical cell surface, that increase the surface area of cells there are thousands of microvilli in one cell like in epithelial cells of digestive system, and Kidney proximal tubule (brush border).

Structure of microvilli:

1- Each microvillus has a dense core consist of 20 to 30 tightly bundled actin microfilaments. actin is cross-linked by fimbrin and villin proteins.

2- The outer surface of microvilli is covered by a coat consisting of glycoproteins that can attach with a plasma membrane this coat called **glycocalyx.**

B) Lateral Surface: junctions between neighbouring cells.

1. **Junctional complexes or Adhesion complex**. it are binding sites the adjacent cells, also transport materials between cells ,consist of three parts :

A. Tight junction (zonula occludens):

Tight junctions, the plasma membranes of neighboring cells fuse with one another at one or more points. without intercellular space, found in the epithelial cells such as bladder & intestinal.

Function: prevent diffusion molecules in intercellular space.

B. Belt desmosomes (zonula adherence):

This region consists of actin microfilaments bundle from cell Connect to adjacent cell actin bundle which appear pressed on the surface's adjacent membranes. It has intercellular space about 20 nm between neighboring cells. It's found among epithelial cells, fibroblasts, smooth muscle etc.

Spot desmosomes (macula adherence):

It looks like buttons oval shape appear on the inner surfaces of adjacent cells, membranes consist of protein plaque (consist of desmoplakin, plakoglobin and plakophilin) attach with keratin filaments. The intercellular space about (25-30 nm)_has two protein (desmoglein and desmocollin). Found: among most epithelial cells, skin and heart muscle.

1. Channel-forming junctions (Gap junction) :

It consist of cylindrical structures are called connexons ,each one consist of six sub units ,forming gap extend between two cells that connect them .

Theories of plasma membrane

Type of molecules of plasma membrane are:

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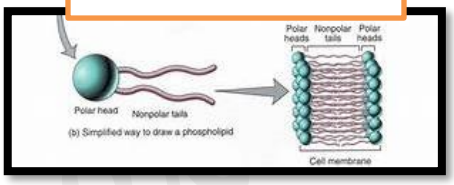


A- Protein .

B- Phospholipid has two ends , hydrophilic polar head (glycerol) and hydrophobic nonpolar tail(fatty acid).

I. sandwich model (lamellar) by Daniel and davson in 1935 :

The layers of plasma membrane are a middle lipid bi layer , covered by outer and inner monolayer of globular protein, that's mean protein –lipid- protein sandwich .

II. Unit membrane model by David Robertson in 1959 :

The layers of plasma membrane under electron microscope are three layers **(dark ,light ,dark**). The two layers of protein and polar head of phospholipids formed dark layer, while nonpolar tail of phospholipid formed light region in the center.

III. Fluid mosaic model by Singer and Nicolson in 1972:

This is most widely accepted model, there is phospholipid bi layers with integral proteins and the peripheral proteins present in the surface of membrane.

LAB. 4: The Function of Plasma Membrane

There are 3 types of transport in cells:

1. Passive Transport.
2. Active Transport.
3. Bulk Transport (sometimes called - **Macrotransfer)** .

1. Passive transport

It is a type of membrane transport that does not require energy to move substances across cell membranes. Fundamentally, substances follow Fick's first law, and move from a region of high concentration to a region of low concentration, The difference in concentration between the two regions is often termed the *concentration gradient*, The rate of passive transport depends on the organization, and characteristics of the membrane lipids and proteins. The four main kinds of passive transport are simple diffusion, facilitated diffusion, filtration, and osmosis.

1. Simple diffusion is the passive movement of solute from a high concentration to a lower concentration until the concentration of the solute is uniform throughout and reaches equilibrium, require none of the cell's ATP energy, **such as (O_2, CO_2, glucose, glycerol, nucleotides, amino acids. and ions)**
2. Osmosis is much like simple diffusion but it specifically describes the movement of water (not the solute) across a permeable membrane until there is an equal concentration of water and solute on both sides of the membrane, require none of the cell's ATP energy
3. Filtration is the process of separating solids from liquids and gases. The selective absorption of nutrients in the body. This process does not require any energy and takes place with the concentration gradient. **The example the blood is filtered by the glomerulus and the necessary molecules are reabsorbed.**

2. *Active transport*

is the movement of molecules across a membrane from a region of lower concentration to a region of higher concentration against the concentration gradient, often assisted by enzymes or carrier protein and requires energy. **The example transport iodide to the thyroid cells.**

3. *Bulk Transport or Macrotransfer*: -

it's involves the cell making membrane bound vesicles to bring materials in or out of the cell. There are **two kinds** of bulk transport:

A. Endocytosis B. Exocytosis:

A. Endocytosis

is a type of active transport that moves particles, such as large molecules, parts of cells, and even whole cells, into a cell. There are variations of endocytosis, but **all share a common characteristic:** ①The plasma membrane of the cell invaginates, forming a pocket around the target particle. ②the pocket pinches off, ③resulting in a newly created **endosome** (intracellular vesicle formed from the plasma membrane).

1- Phagocytosis (cellular eating): The phagocytic cell will engulf and degrade the solid and large particles by using the pseudopod and then formed a vesicle called a phagosome. Ex. in protozoa phagocytosis for feeding, while in neutrophils for defense against microorganism.

The steps of phagocytosis:-

1) a portion of the inward-facing surface of the plasma membrane becomes coated with a protein called clathrin.(why?)

2) The coated portion of the membrane then extends pseudopod from the body of the cell and surrounds the particle, enclosing it. Once the vesicle containing the particle is called phagosome.
3) The clathrin coated disengages from the membrane and the phagosome.
4) The merges a lysosome with phagosome, called phagolysosome to break down the material.

2-Pinocytosis (cellular drinking):

A process that intakes in molecules and including water, which the cell needs. And results in a much smaller vesicle than does phagocytosis, and the vesicle does not need to merge with a lysosome called pinosome. Ex. amoeba use it to transport sugars

A. Exocytosis has three forms:

1-Holocrine secretion

- ❖ The secretion material accumulates in small vesicles inside the cell.
- ❖ Many small vesicles merger to be one very large vesicle.
- ❖ The secretion of large vesicle to the outside of the cell will break down the cell, and releasing the nucleus and part of the cytoplasm
- ❖ Example: a fat secretion from the fatty glands in the skin of mammals

2- Eccrine secretion

- The secretion materials are accumulated in the secretory vesicle.
- the vesicle membrane fuse with cell membrane, and then release the material to the outside of the cell.

- **Example:** ①sweat gland. ② a proteins secretion of milk from mammary glands.

3- Apocrine secretion

♣ The secretion materials are accumulated in under the cell membrane.
♣ The materials will push the cell membrane to be the secretion bodies (it's a small vesicle with short and thin stalk, protrude (project) beyond the surface of the secreting cell).
♣ Secretion bodies will separate from the secreting cell.

Example: ①found in submandibular salivary gland of rabbit.
②A fats secretion of milk from mammary glands.

	Active transport	*Passive transport*
1- In energy	Requires cellular energy.	Does not require cellular energy.
2- Molecules movement	from a region of lower concentration to a region of higher concentration	from a region of higher concentration to a region of lower concentration
3- Use to transportation	Required for the transportation of all the molecules such as proteins, sugars, ions, etc.	Required for the transportation of all soluble molecules, including oxygen, water, lipids, sex hormones, etc.
4- balance level	none	It is use to maintained of the balance level inside the cell.
5- The selective	It is highly selective.	It is partly non-selective
6- fast of movement	is a rapidly process.	is a comparatively slow process.
7- the direction	Transfer in one direction.	Transfer bidirectionally.
8- need carrier proteins	In active transport, carrier proteins are required	In passive transport, carrier proteins are not required

LAB. 5: Cytoplasmic organelles part I

Some Eukaryotic Cells Structure include:

1) Cytoskeleton: The three major structural elements of the cytoskeleton in eukaryotes are microtubules, microfilaments, and intermediate filaments

	microtubules	microfilaments	intermediate filaments
Structure	Hollow tube with a wall consisting of 13 protofilaments	Two intertwined chains of F-actin	Eight protofilaments joined end to end with staggered overlap
Diameter	Outer: 25 nm Inner: 15 nm	7 nm	8–12 nm
Monomers	αtubulin βtubulin	G-actin	Vimentin, Desmin and Nestin
function	1. Organization and maintenance of animal cell shape. 2. Chromosome movements 3. Intracellular transport and movement of organelles	1. Muscle contraction 2. Cytoplasmic streaming 3. Cytokinesis 4. Maintenance of animal cell shape Intracellular transport	1. Maintenance of animal cell shape 2. Keeping muscle fibers

2) Centrosome: In animal cells, the centrosome contains two centrioles and is surrounded by a diffuse granular material known as **pericentriolar material**. The walls of centrioles are composed of nine sets of triplet microtubules

3) Endomembrane System

A. The endoplasmic reticulum (ER): is continuous network of flattened sacs, tubules, and associated vesicles stretching throughout the eukaryotic cell's cytoplasm. The membrane-bounded sacs are called **ER cisternae** (singular: ER cisterna), and the space they enclose is called the **ER lumen**. Has two forms:

1. **Rough ER:** a consists of flattened saccules and site for attachment (studded) with ribosomes, which is on the side of the membrane that faces the cytoplasm (present on its outer surface).
   Function of Rough ER. The ribosomes synthesize polypeptides, then enter the lumen of rough ER for modification.
2. **Smooth ER** has smooth surface without ribosome, and is more tubular in structure when comparted with rough ER structure.

The functions of smooth ER are dependent on the cell type as following

- In some cells synthesizes lipids, such as steroids.
- In the liver cells, which helps detoxify drugs.
- In some cells forms transport vesicles.

B. The Golgi apparatus: Disk-like membranes flattened, curved, consist from 3-50 sacks. works as a transfer station. (How?)

The function of the Golgi apparatus

① First, it receives **transport vesicles** from rough and smooth ER to the receiving side of the Golgi apparatus called **Cis face**, modifies, sorts, and repackages molecules in sacks of Golgi modified as they move between saccules. ② Then the trans face forms **a secretory vesicle**.

C. Vesicles are small membranous sacks that move materials between organelles in the endomembrane system

D. Lysosomes are membrane-bound spherical sacks filled with hydrolytic enzymes; these organelles are found in eukaryotic animal cells.

Lysosomes are known as Suicidal Bags (why?) as they tend to destroy the cell membrane with its digestive enzymes, causing autolysis. what's autolysis?

There are four types of lysosomes:

1. Primary lysosomes: are newly formed vesicles from the Golgi apparatus, small in size.

2. Secondary lysosomes: are created from the fusion of primary lysosomes to endosomes (phagosome and pinosome) to from phagolysosome then digestion occurs.

3. Residual lysosomes: are what remain after the diffusion of materials from phagolysosome, contain indigestible food.

4. Auto-lysosomes: are created by the fusion of several primary lysosomes to remove old intracellular organelles. **The process is known as autophagy or auto-digestion.**

LAB. 6: Cytoplasmic organelles part II

4) Nucleus and Ribosomes:

❖ **The Nucleus:** is one of the most noticeable structures in the eukaryotic cell. The nucleus contains:

1- **The nuclear envelope:** is a double membrane separating the nucleus from the cytoplasm. And contains pores.

2- **Semifluid matrix called the nucleoplasm.**

3- **Chromatin:** is a network of DNA, protein, and a small amount of RNA.

4- **The nucleolus:** is oval in shape within the nucleus, which may have more than one.

The function of nucleolus is produced a ribosomal RNA (rRNA).

The functions of nucleus are:

1. nucleus is the center control of the cell.
2. Storage of genetic information.

❖ **Ribosomes** are found in both prokaryotes and eukaryotes. And composed of two subunits, one large and one small. Each subunit has its mix of proteins and rRNA. The role of large subunit is a site of development and growth of polypeptides. at the same time, the small subunit is a site of mRNA attached.

How nucleus and Ribosomes work to gather? or How work as center control of the cell?

A. The DNA is organized into genes.
B. Transcription.
C. Translation.
D. Then use protein for determining the structure and function of a cell.

5)Mitochondria

Are important cell organelles, small size between 0.5 to 1 micrometer in diameter having a rod or sausage-shaped. Mitochondria are the powerhouse of cells **because** they produce most of the ATP the cell utilizes for different functions.

The function of mitochondria is **cellular respiration.**

Mitochondria Structure:

1. Outer Membrane - It allows small molecules pass through it.
2. Intermembrane Space.
3. Inner Membrane - allow molecules to pass through it by special carrier proteins.
4. Cristae - These are the irregular folds of the inner membrane. They increase the space for chemical reactions.
5. Matrix - It is fluid that fills the cavity of mitochondria. This has all the enzymes required for ATP production, ribosomes, DNA, inorganic and organic molecules.

6) plastid

The plastid is a major double-membrane organelle found in the cells of plants and algae.

Depending upon their color, plastids are:

1- Leucoplasts

These are colorless and non-photosynthetic, it found in parts of plants that are not exposed to sunlight such as seeds, tubers, etc.

2- **Chromoplasts:** These are colored plastids other than green. They are non-photosynthetic, they provide color to the plant's roots, leaves, and flowers.

3- **Chloroplast**

The are present in plant cells and some eukaryotic organisms. The photosynthesis process takes part within it. in red and brown algae they are called chromatophores.

Chloroplast structure:

1) Outer membrane & Inner membrane
2) Intermembrane Space - It is usually about 10-20 nm.
3) The stroma, semi-gel-like fluid , & colorless which is protein rich
   ①contains of enzymes and ②the DNA ,③RNA, ④ribosomes,
   ⑤**starch granules called pyrinoid** and ⑥many other proteins.
   and ⑦**disc-like sacs called thylakoids**.

⑧Stack of thylakoids is called a granum. (all granum called grana).

LAB. 7: Cell cycle

The cell cycle include interphase then cell division (M phase).

❖ ***interphase:*** consist of ***(①G1, ②S and ③G2).***

Before mitosis begins, cell prepares to divide by ①synthesis of RNA and ②proteins, ③the cell form ATP molecules ④increasing of nucleus size and ⑤duplication of DNA, ⑥It is worth noting that the chromosomes remain in a chromatin network. all these Processes called **interphase**

❖ ***The cell division (M phase) include:***

First nuclear division called **(karyokinesis).**

Second The cytoplasm divides with organelles by cytoplasmic division called **(cytokinesis).**

Depending on the **nuclear division**, there are two types of cell division in eukaryotic cell: **mitosis and meiosis.**

1- Mitosis: The mitotic division occurs in somatic cells, it helps in multiplication of cells to grow the body of organism and to replace dead cells or to repair damaged tissues. In mitotic division the number of chromosomes in daughter cells is similar to mother cell. in mitosis has 4 phases (prophase, metaphase, anaphase and telophase)

1· Prophase:

a) The chromosomes condense and become short and thick, and each chromosome consist of two **sister chromatids**.
b) Nuclear membrane breaks down.
c) The nucleolus disappears.

2· metaphase:

1) Centrioles separate and migrate in opposite direction and then the mitotic spindles are formed.
2) Chromosomes attach to mitotic spindle by centromere in **kinetochores**, and arranged in an equatorial plane of the cell or metaphase plate.

3· Anaphase:

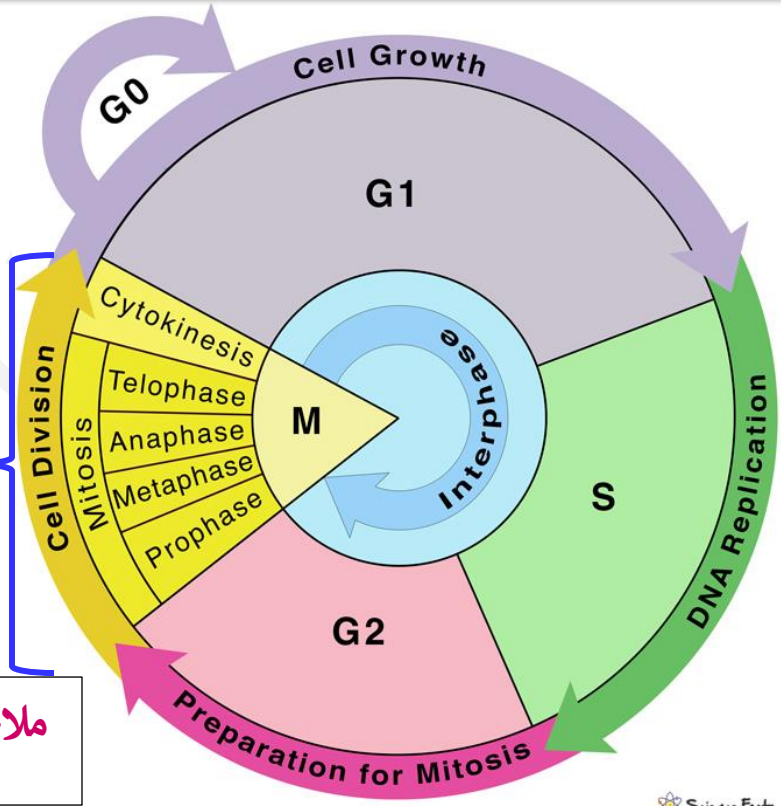
The centromere divided and the two chromatids separate and pulled by mitotic spindles in opposite direction.

4· Telophase:

A) Chromatids are enclosed in nuclear membrane in each side of the cell.
B) Chromatin looks like filament.
C) The genetic material divides between two **daughter nuclei**.
D) **Then the cell started to form nucleus.**

- ***Second: -* Cytokinesis** begins with the end of the formation of the two daughter nuclei, the cytoplasm divided with organelles by to form two daughter cells from one mother cell.
  - Cytokinesis in animal cell start from outside to inside.
  - Cytokinesis in plant cell is by the formation of a **cell plate** from inside to outside.

The cell cycle



Cell division

(M phase of cell cycle)

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