



لجان الترقيات

PHYSIOLOGY

MORPHINE ACADEMY

MORPHINE
ACADEMY



PHYSIOLOGY

FACULTY OF PHARMACEUTICAL SCIENCES

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LECTURE 2, PART (2): TRANSPORT PROCESSES OF SOLUTES AND WATER

Membrane permeability:

* بتنتقل المواد من خارج لداخل الخلية عن طريق
Plasma membrane

- The permeability of the plasma membrane to different substances varies.
- The **hydrophobic interior** of the plasma membrane allows **nonpolar molecules** to rapidly pass through, but prevents passage of ions and large, uncharged polar molecules.
- Because **water and urea** are **small polar** molecules that have **no overall charge**, they can **move from one gap** (small gaps appear in the hydrophobic environment of the membrane's interior) to **another** until they have crossed the membrane **without** any assistance.
- **Transmembrane proteins that act as channels and carriers** (very selective) increase the plasma membrane's permeability to a variety of **ions and uncharged polar molecules** (need assistance).

Gradients across the Plasma Membrane:

فرق التركيز [من التركيز الأعلى للأقل]  Chemical or electrical
يمكن يكون

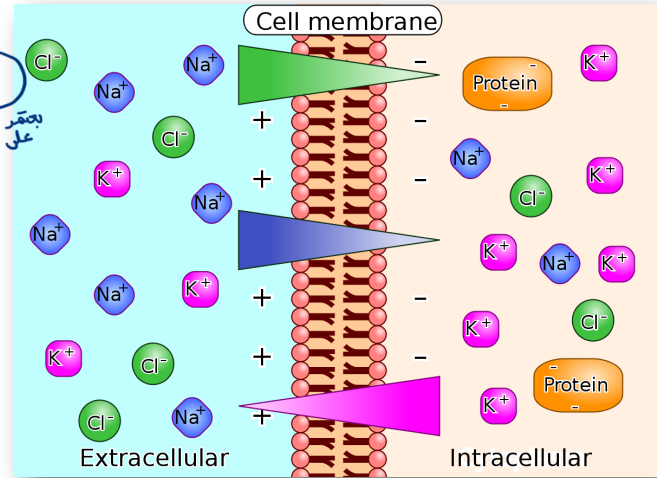
- A (concentration gradient) is a difference in the concentration of a chemical from one place to another, such as from the inside to the outside of the plasma membrane. A substance will move “downhill,” from where it is more concentrated to where it is less concentrated, to reach equilibrium.
- The plasma membrane also creates a difference in the distribution of positively and negatively charged ions between the two sides of the plasma membrane.

Gradients across the Plasma Membrane:

- The difference in electrical charges between two regions constitutes an electrical gradient. This is termed the membrane potential. A positively charged substance will tend to move toward a negatively charged area, and a negatively charged substance will tend to move toward a positively charged area.

المادة إلى عليها شحنة موجبة بتحب تروح للمنطقة إلى شحنتها سالبة والعكس صحيح

- The combined influence of the concentration gradient and the electrical gradient on movement of a particular ion is referred to as its electrochemical gradient. → فرق التركيز والشحنة



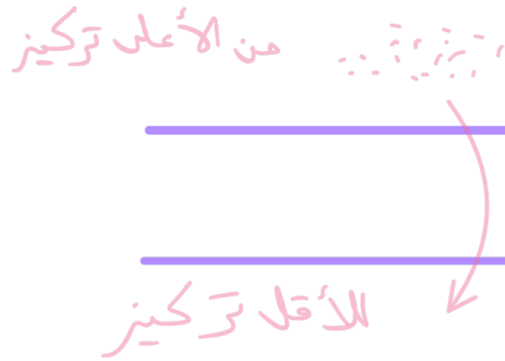
TRANSPORT ACROSS THE PLASMA MEMBRANE

- Substances generally move across cellular membranes via **transport processes** that can be classified as passive or active, depending on whether they require cellular energy.

المواد تنتقل من منطقة التركيز الأعلى للمادة لمنطقة التركيز الأقل
الطريقة الأكثر استخدامًا
- In **passive processes**, a substance moves down its concentration or electrical gradient to cross the membrane using only its own kinetic energy (energy of motion).
بـتـعـمـد على الطاقـة الحركية للمادة نفسها (يعني الخلية ما بتبذل جهد أو طاقة في عملية النقل)

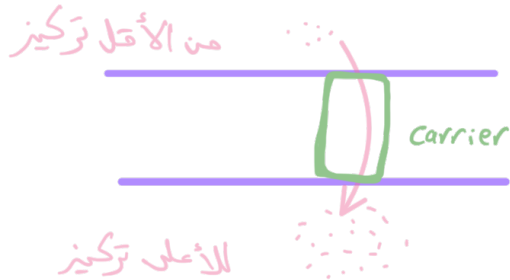
- In **active processes**, cellular energy (in the form of adenosine triphosphate (ATP)) is used to drive the substance “uphill” against its concentration or electrical gradient.

1- Passive Process



With concentration gradient
without need of energy

2- Active Process



against concentration gradient
بحاج ATP.

TRANSPORT ACROSS THE PLASMA MEMBRANE

Another way that some substances may enter and leave cells is an **active process** in which tiny, spherical membrane sacs referred to as **vesicles** are used. Examples include **endocytosis**, in which vesicles detach from the plasma membrane while bringing materials into a cell, and **exocytosis**, the merging of vesicles with the plasma membrane to release materials from the cell.

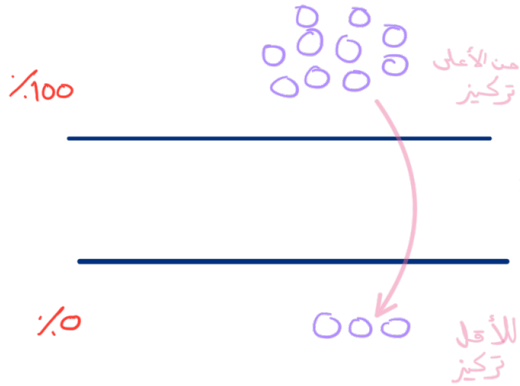
رح حكي عنهم بالتفصيل في السلايدات الجايين

PASSIVE PROCESSES

الانتشار

- **Diffusion** is a passive process in which the random mixing of particles (solutes, the dissolved substances, and the solvent) in a solution occurs because of the particles' kinetic energy.
- If a particular solute is present in high concentration in one area of a solution and in low concentration in another area, solute molecules will diffuse toward the area of lower concentration—they move **down their concentration gradient** (the solution after diffusion is said to be at **equilibrium**).

Extra cellular



يجب أن ينتقل
لحدا ما يصل التناوب
--->

50%

50%

10%

رح ينتقل من
جوا الخلية لبرا

90%

لومبار التركيز جوا الخلية أكثر
(بصير العكس)

Intra cellular

PASSIVE PROCESSES

- Substances may also diffuse through a membrane, if the membrane is permeable to them.
Several factors influence the diffusion rate of substances across plasma membranes:

1. Steepness of the concentration gradient (the greater the difference in concentration between the two sides of the membrane, the higher is the rate of diffusion).
لازم يكون عندى اختلاف التركيز
Concentration
2. Temperature (the higher the temperature, the faster the rate of diffusion).
الحرارة كلما كانت أعلى يكون معدل الانتشار أسرع
3. Mass of the diffusing substance (the larger the mass of the diffusing particle, the slower its diffusion rate).
كلما كان حجم المادة أقل يكون أحسن وأسهل للانتشار
4. Surface area (the larger the membrane surface area available for diffusion, the faster is the diffusion rate).
كلما كانت أوسع أفضل
5. Diffusion distance (The greater the distance over which diffusion must occur, the longer it takes).
كلما كانت المسافة أطول رح يستغرق الانتشار وقت أطول

DIFFUSION

1- Simple diffusion

Cell membrane بين

a substance moves across the lipid bilayer of the plasma membrane without the help of membrane transport proteins

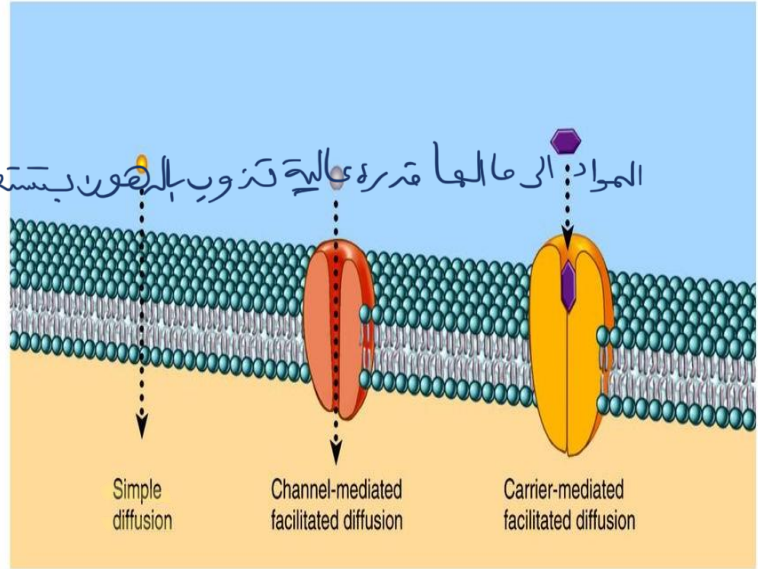
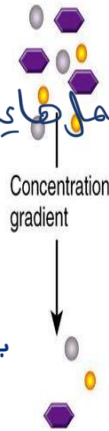
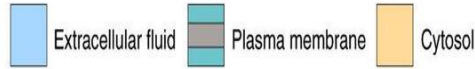
2- Facilitated diffusion

عملية مسهلة

channel-mediated facilitated diffusion, and carrier-mediated facilitated diffusion

ببساطة على وجود بروتين يسهل دخول المواد

A substance moves across the lipid bilayer aided by a channel protein or a carrier protein



المواد إلى ما إليها قدرة عالية تذوب بالدهون ببساطة على الطريقة عشوائية تدخل الخلية

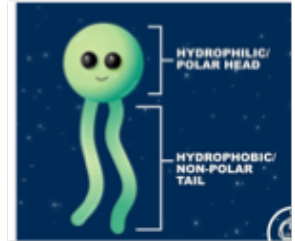
DIFFUSION

Examples of **simple diffusion**

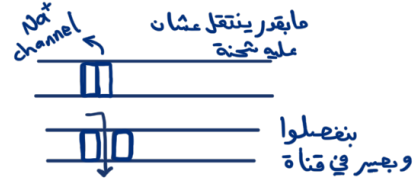
Nonpolar, hydrophobic molecules include oxygen, carbon dioxide, and nitrogen gases; fatty acids; steroids; and fat-soluble vitamins (A, D, E, and K) as well as small, uncharged polar molecules such as water, urea, and small alcohols.

Examples of **facilitated diffusion**

Too polar or highly charged solutes.



FACILITATED DIFFUSION

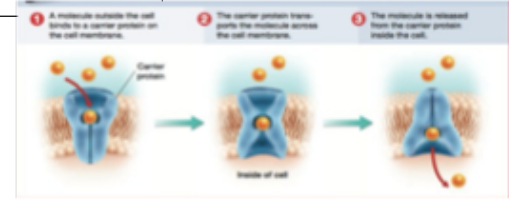


1. Channel- mediated facilitated diffusion

- Most membrane channels are ion channels integral transmembrane proteins that allow passage of small, inorganic ions that are too hydrophilic to penetrate the nonpolar interior of the lipid bilayer.
- Some gated channels randomly alternate between the open and closed positions; others are regulated by chemical or electrical changes inside and outside the cell. When the gates of a channel are open, ions diffuse into or out of cells, down their electrochemical gradients.

FACILITATED DIFFUSION

2. Carrier-mediated facilitated diffusion



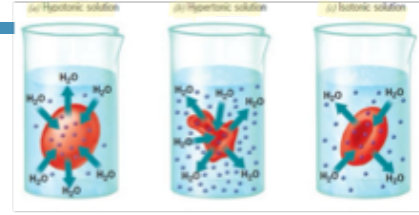
- The solute binds more often to the carrier on the side of the membrane with a higher concentration of solute and is released on the other side after the carrier undergoes a change in shape.
- Once the concentration is the same on both sides of the membrane, solute molecules bind to the carrier on the cytosolic side and move out to the extracellular fluid.
- Substances that move across the plasma membrane by carrier mediated facilitated diffusion include glucose, fructose, galactose, and some vitamins.

انتقال الماء من تركيز الـ solute الأقل إلى
تركيز الـ solute الأعلى

OSMOSIS

- **Osmosis** is a type of diffusion that occurs only when a membrane is permeable to water but is not permeable to certain solutes.
- In living systems, the solvent is water, which moves by osmosis across plasma membranes from an area of **higher water concentration to an area of lower water concentration**. In other words, water moves through a selectively permeable membrane **from an area of lower solute concentration to an area of higher solute concentration**.

OSMOSIS



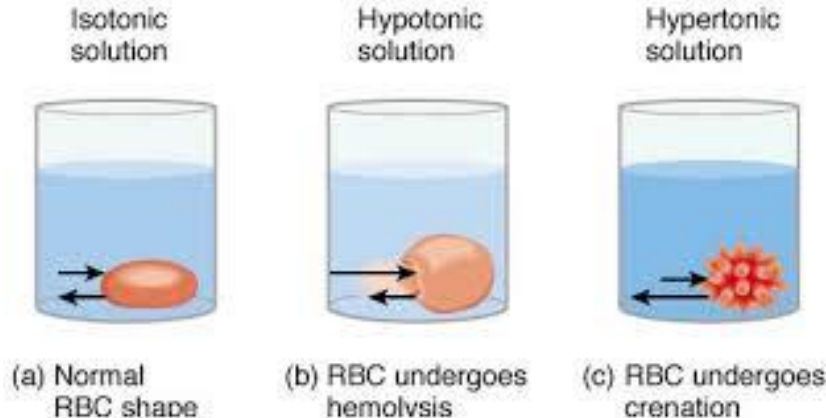
- Any solution in which a cell maintains its normal shape and volume is an isotonic solution. The concentrations of solutes that cannot cross the plasma membrane are the same on both sides of the membrane in this solution.
- A different situation results if the cells are placed in a hypotonic solution, a solution that has lower concentration of solutes than the cytosol inside the cells. In this case, water molecules enter the cells faster than they leave, causing the cells to swell and eventually to burst (lysis).

بتكبر وبتنفجر الخلية

OSMOSIS

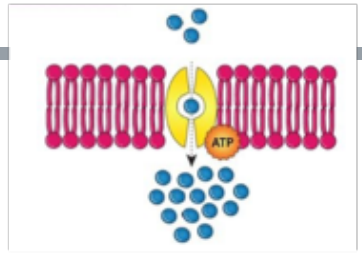
- A hypertonic solution has a higher concentration of solutes than does the cytosol inside cells. In such a solution, water molecules move out of the cells faster than they enter, causing the cells to shrink. Such shrinkage of cells is called crenation.

بتنكمش الخلية



نحتاج طاقة ←

ACTIVE PROCESSES

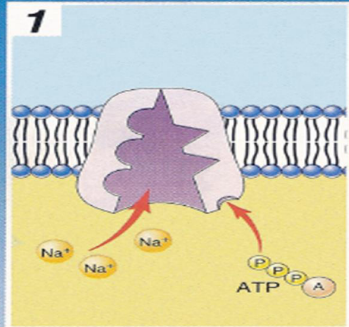


- **Two sources of cellular energy can be used to drive active transport:**
 1. Energy obtained from hydrolysis of adenosine triphosphate (ATP) is the source in primary active transport.
 2. Energy stored in an ionic concentration gradient is the source in secondary active transport.
- Carrier proteins that mediate primary active transport are often called pumps.

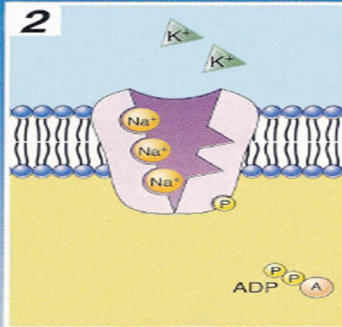
ACTIVE PROCESSES

The most prevalent primary active transport mechanism expels sodium ions from cells and brings potassium ions in (sodium-potassium pump). All cells have thousands of sodium-potassium pumps in their plasma membranes.

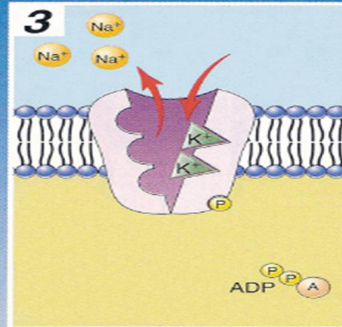
SODIUM-POTASSIUM PUMP



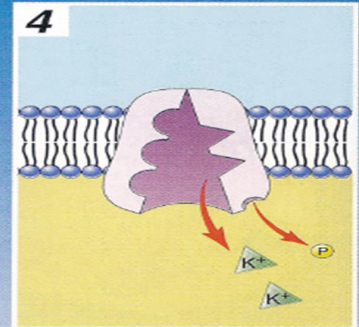
The sodium-potassium pump binds three sodium ions and a molecule of ATP.



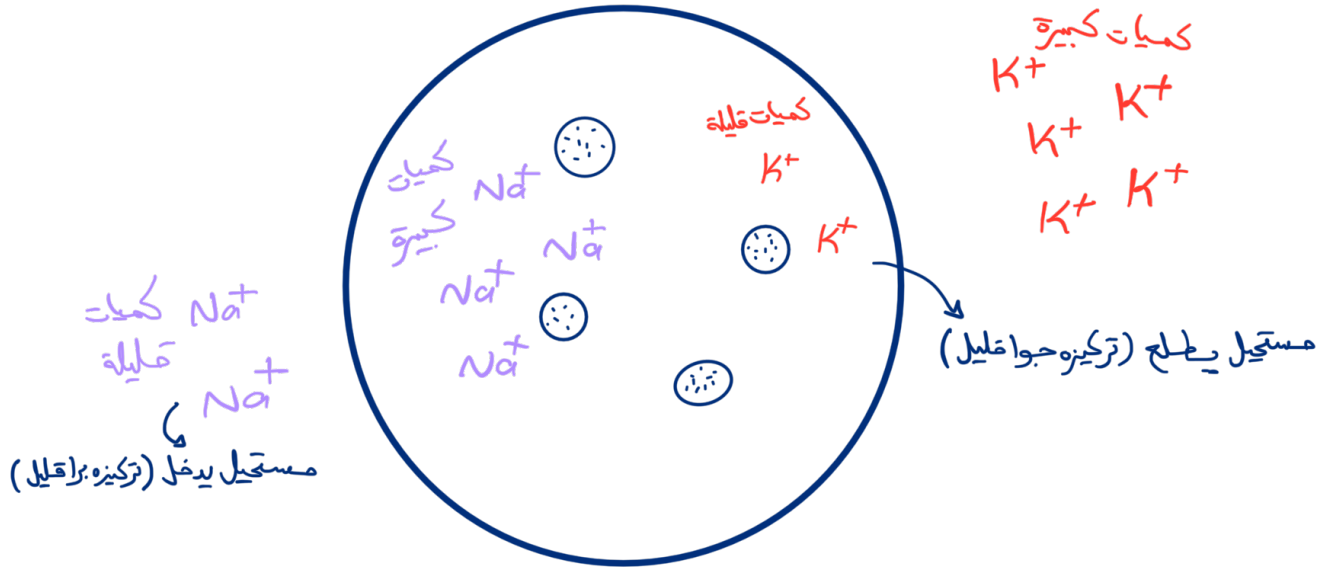
The splitting of ATP provides energy to change the shape of the channel. The sodium ions are driven through the channel.



The sodium ions are released to the outside of the membrane, and the new shape of the channel allows two potassium ions to bind.

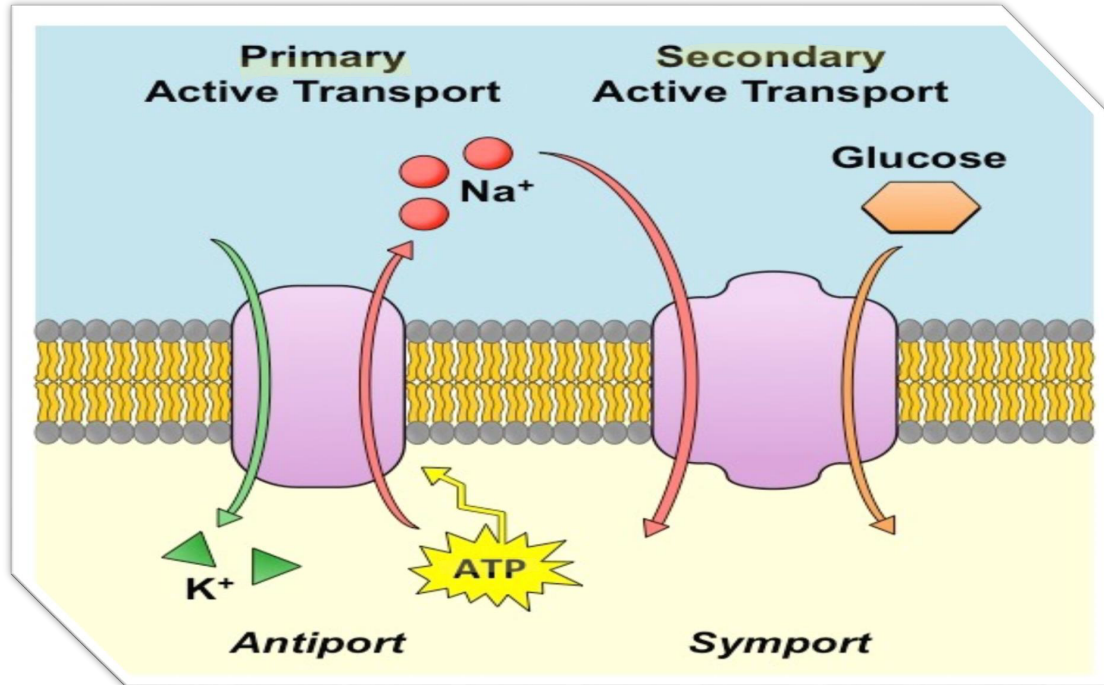


Release of the phosphate allows the channel to revert to its original form, releasing the potassium ions on the inside of the membrane.



عشان هيك لازم يكون في Pump

ACTIVE PROCESSES



TRANSPORT IN VESICLES

الموصلات

endocytosis

exocytosis

داخل الخلية

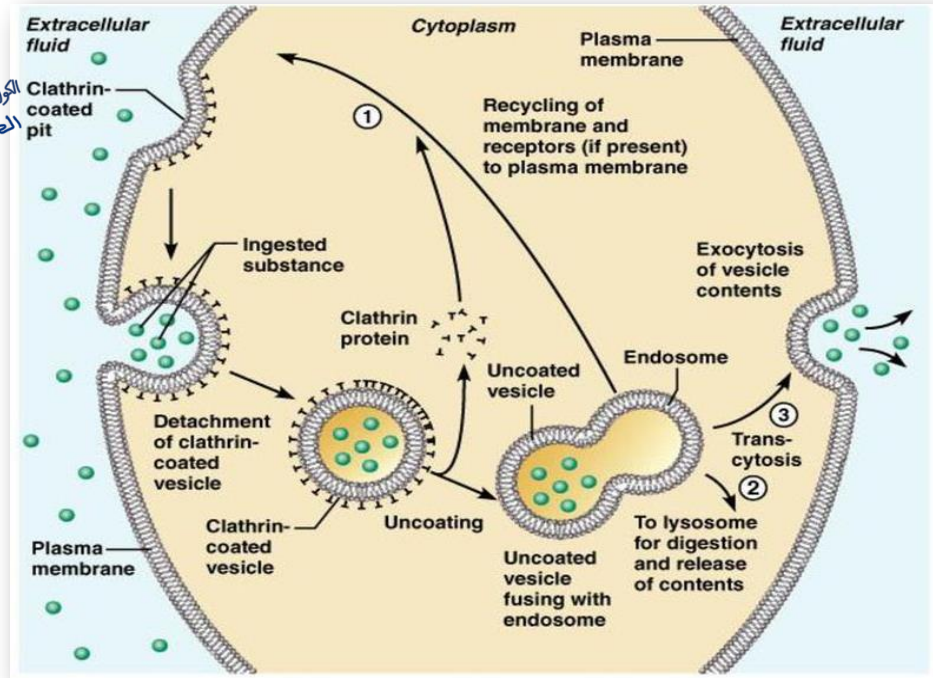
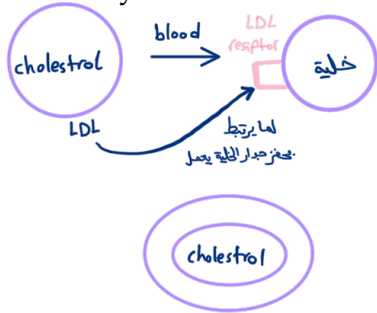
- During endocytosis, materials move into a cell in a vesicle formed from the plasma membrane.
- In exocytosis, materials move out of a cell by the fusion with the plasma membrane of vesicles formed inside the cell.
- Both endocytosis and exocytosis require energy supplied by ATP. Thus, **transport in vesicles is an active process.**

يحتاجوا طاقة

- The three types of endocytosis:
 1. Receptor-mediated endocytosis.
 2. Phagocytosis.
 3. Bulk-phase endocytosis.

RECEPTOR-MEDIATED ENDOCYTOSIS

- Cells take up cholesterol-containing low-density lipoproteins (LDLs), transferrin (an iron-transporting protein in the blood), some vitamins, antibodies, and certain hormones by receptor-mediated endocytosis.



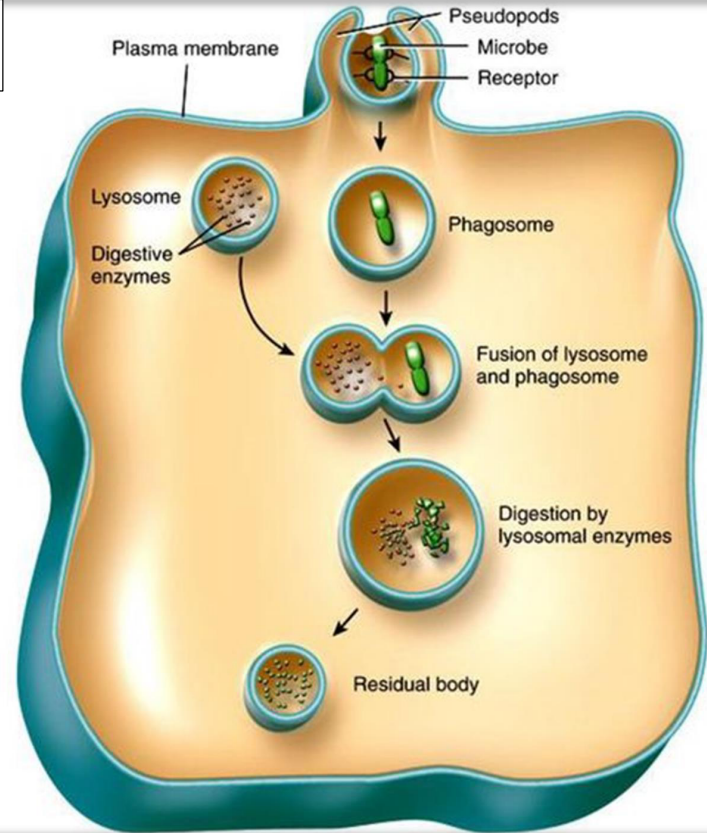
PHAGOCYTOSIS

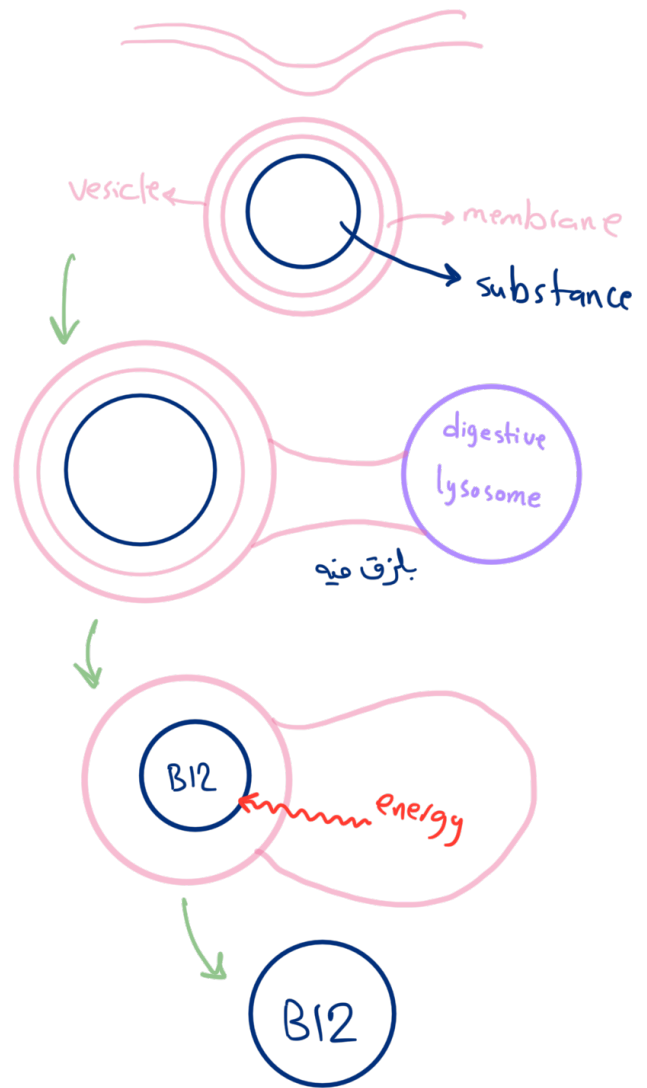
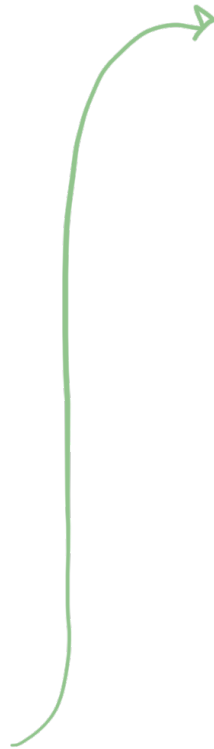
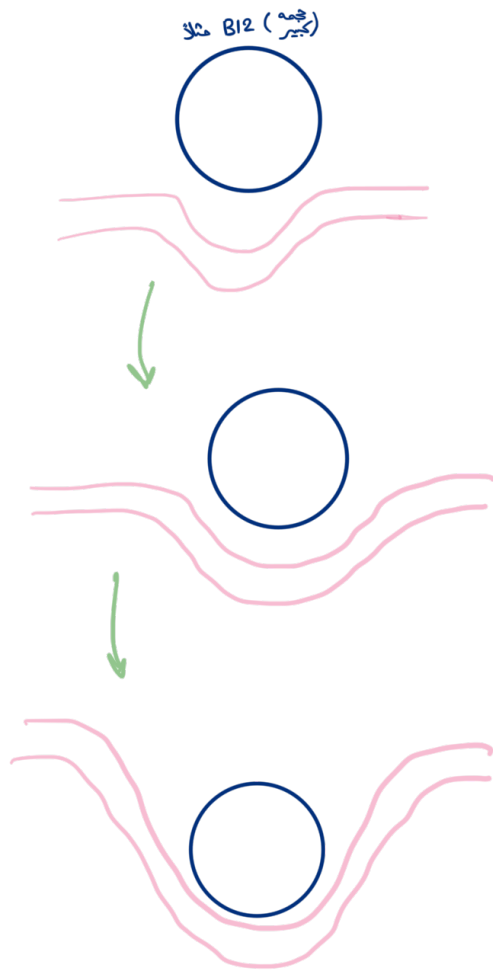
- **Phagocytosis** is a form of endocytosis in which the cell engulfs large solid particles, such as worn-out cells, whole bacteria, or viruses.
- Two main types of phagocytes are macrophages, located in many body tissues, and neutrophils, a type of white blood cell.

بتحمي الجسم من الفيروسات والبكتيريا بهذه الطريقة (بتبلعه وتقتله)

PHAGOCYTOSIS

- Any undigested materials in the phagosome remain indefinitely in a vesicle called a residual body. The residual bodies are then either secreted by the cell via exocytosis or they remain stored in the cell.

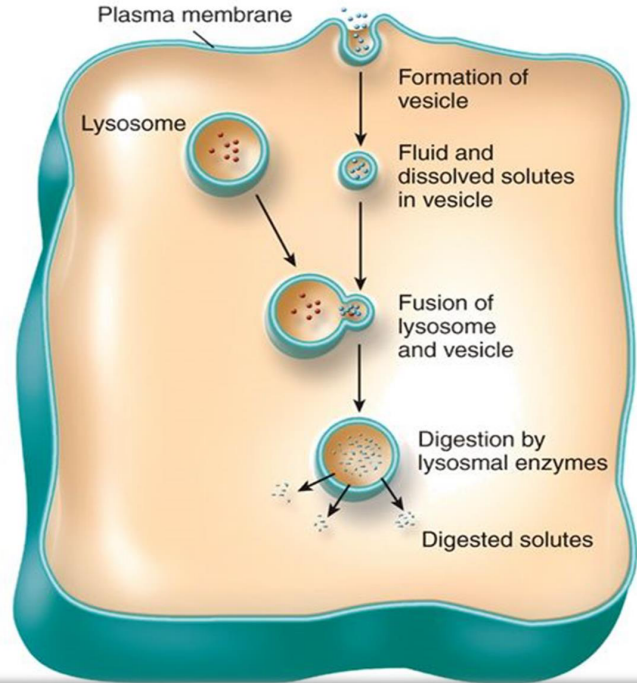




BULK-PHASE ENDOCYTOSIS (PINOCYTOSIS)

- Bulk-phase endocytosis is a form of endocytosis in which tiny droplets of extracellular fluid are taken up (all solutes dissolved in the extracellular fluid are brought into the cell.).
- **No receptor proteins are involved.**
- Bulk-phase endocytosis occurs in most cells, especially absorptive cells in the intestines and kidneys.
- The resulting smaller molecules leave the lysosome to be used elsewhere in the cell.

Bulk-phase Endocytosis

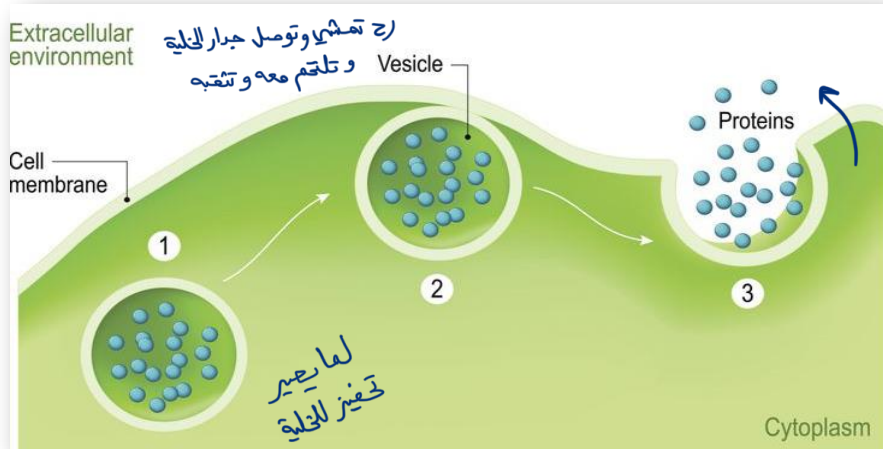


EXOCYTOSIS

- In contrast with endocytosis, which brings materials into a cell, exocytosis releases materials from a cell.
- All cells carry out exocytosis, but it is especially important in two types of cells: **(1) secretory cells that liberate digestive enzymes, hormones, mucus, or other secretions and (2) nerve cells that release substances called neurotransmitters.**

EXOCYTOSIS

- In some cases, wastes are also released by exocytosis. During exocytosis, membrane-enclosed vesicles called **secretory vesicles** form inside the cell, fuse with the plasma membrane, and release their contents into the extracellular fluid.



Segments of the plasma membrane lost through endocytosis are recovered or recycled by exocytosis. The balance between endocytosis and exocytosis keeps the surface area of a cell's plasma membrane relatively constant.

- Vesicles **undergo endocytosis on one side of a cell, move across the cell, and then undergo exocytosis on the opposite side.**
- **Transcytosis occurs most often across the endothelial cells that line blood vessels** and is a means for materials to move between blood plasma and interstitial fluid.
- For instance, when a woman is pregnant, some of her antibodies cross the placenta into the fetal circulation via transcytosis.





THANK YOU

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