



لجان الرِّفَعَات

PHYSIOLOGY

MORPHINE ACADEMY

MORPHINE
ACADEMY



PHYSIOLOGY

FACULTY OF PHARMACEUTICAL SCIENCES

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LECTURE 2, PART (1): CELLULAR LEVEL OF ORGANIZATION

Objectives

1. Discuss **cellular level of organization. (Continue the previous lecture)---Part (1)**
2. Describe **transport processes of solutes and water .----- Part (2)**

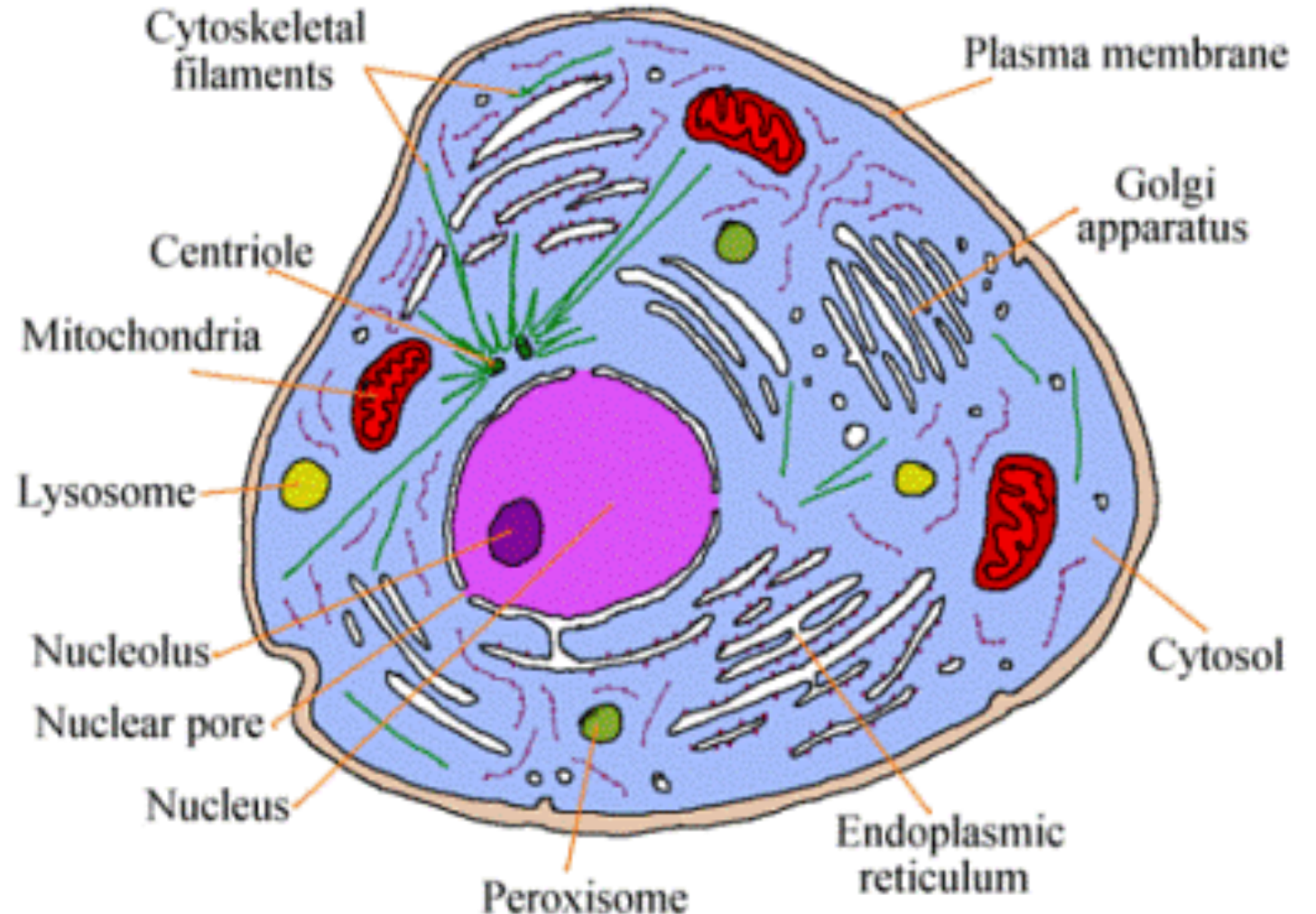
(Pages 60-84 of the reference)

THE ORGANELLES

Organelles are **specialized structures** within the cell that have characteristic shapes, and they perform specific functions in cellular growth, maintenance, and reproduction. They often cooperate to maintain homeostasis.

بتعاونوا عشان يحافظوا على التوازن الداخلي

Organelles of the Cell



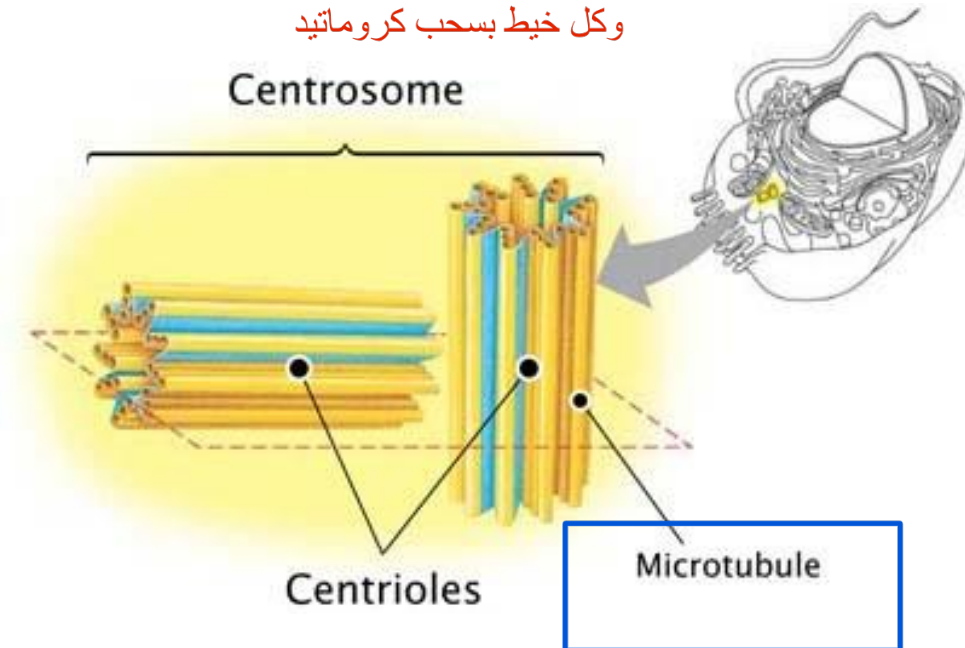
THE ORGANELLES

1. Centrosome.
2. Cilia and Flagella.
3. Ribosomes.
4. Endoplasmic Reticulum.
5. Golgi Complex.
6. Lysosomes.
7. Peroxisomes.
8. Proteasomes.
9. Mitochondria.
10. Nucleus.

Centrosome

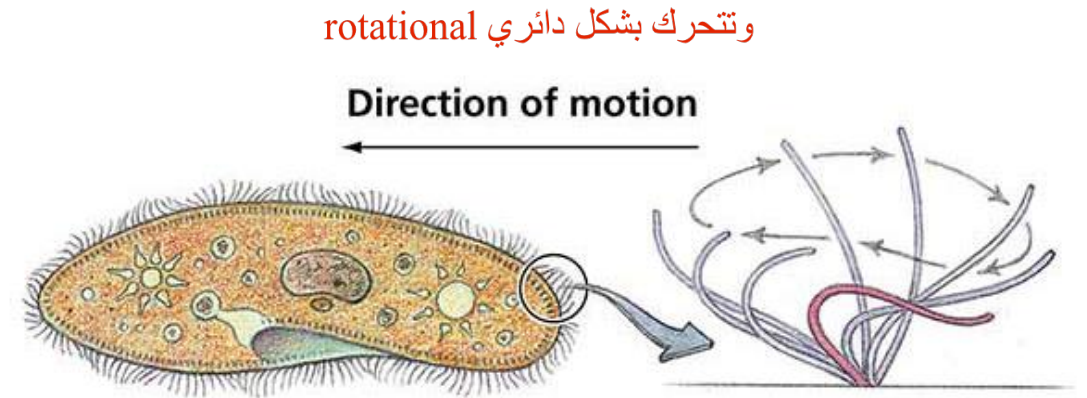
- Is located near the nucleus and it consists of two components: **a pair of centrioles and pericentriolar material**.
- **The centrioles** are cylindrical structures (microtubules). Surrounding the centrioles is **pericentriolar material** which contains the **tubulin complexes**.
- These complexes organize centers for growth of the mitotic **spindle** (cell division).

يكون على اقطاب الخلية في انقسامات الخلية ويكون طالع منهم
الخيوط المغزلية spindle fibers وفي بالوسط كروموسومات
chromosome عبارة عن اثنين من الكروماتيدات chromatids
وكل خيط بسحب كروماتيد



Cilia

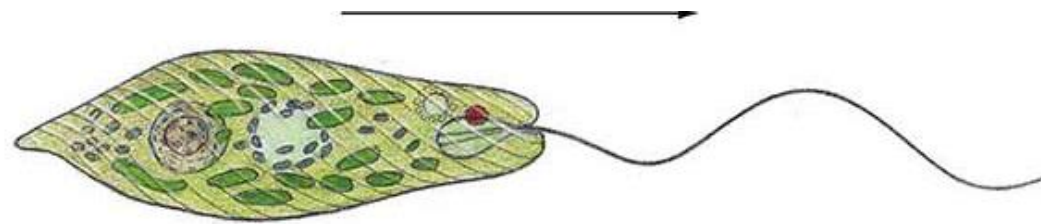
- **Microtubules** are the dominant components of cilia and flagella. Both are motile projections. However, cilia is present throughout the surface of a cell, but flagella is present at both the ends or all over the surface.
- Hair-like structure. بيكون شكلها زي الشعيرات
- The main function of motile cilia is to keep the airways clear of mucus and dust.



(b) Cilia

تنقسم الى نوعين
التي تتحرك **motile cilia** موجودة في الجهاز التنفسي
respiratory system بتمسك المخاط الموجود على الرئتين
عشان اطلعه للخارج
التي لا تتحرك **non-motile cilia** لما نؤخذ عن الحواس
action potential مسؤوله بشكل مباشر عن انتاج

Flagella



(a) Flagella

Direction of motion



حركاتها منسقة، أي أنها
تتحرك معاً في موجة أو
واحدة تلو الأخرى بشكل
منتظم.

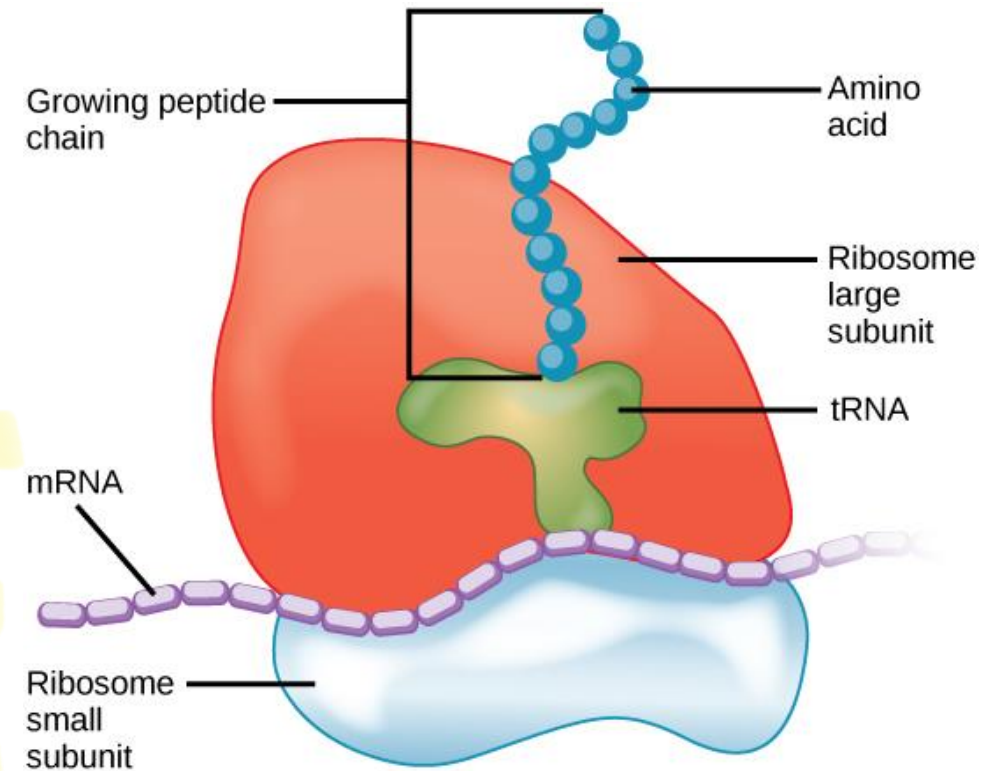
- Flagella are similar in structure to cilia but are typically much longer.
- Flagella usually move an entire cell (i.e. sperm).
- The motion of cilia is rotational, very fast moving. The motion of flagella is rotary movement in prokaryotes whereas it is bending movement in eukaryotes. Cilia beat in coordination or one after the other. Flagella beat independent of each other.

حركاتها مستقلة عن بعضها البعض، أي كل سوط يتحرك
بحرية دون تنسيق مع الآخر

Ribosomes

- **Are the sites of protein synthesis.**
- The name of these tiny structures reflects their high content of one type of ribonucleic acid (ribosomal RNA, or rRNA).
- **منتشرة** "Scattered throughout cytoplasm": Some ribosomes are attached to the outer surface of the nuclear membrane and to an endoplasmic reticulum. Ribosomes are also located within mitochondria. Other ribosomes are "free" or unattached to other cytoplasmic structures.

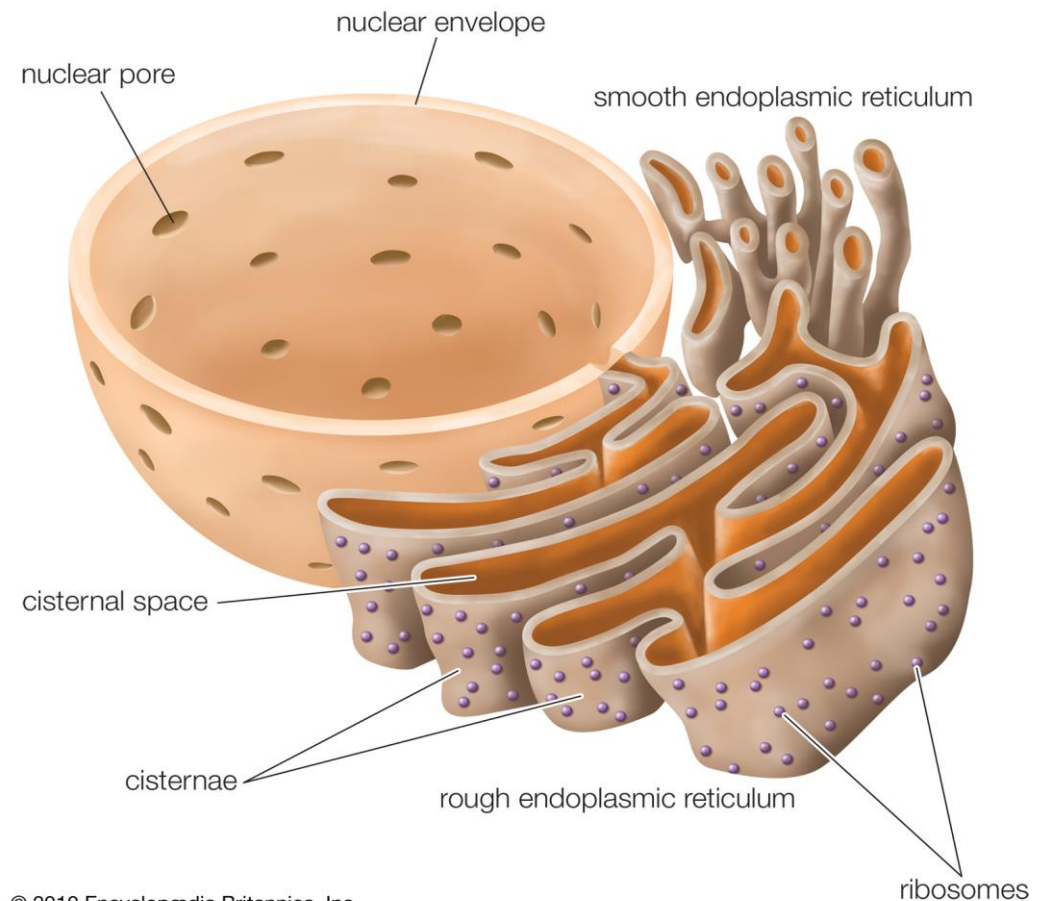
يتم صناعة ribosomes من النواة nucleuse من المادة الواثية DNA وهو مسؤول عن صناعة البروتينات



Endoplasmic Reticulum

- **The endoplasmic reticulum (ER)** is a network of membranes in the form of flattened sacs or tubules.
- The ER extends from the nuclear envelope (membrane around the nucleus), to which it is connected and projects throughout the cytoplasm.
- Cells contain two distinct forms of ER (**rough ER and smooth ER**), which differ in structure and function.

Endoplasmic reticulum



Endoplasmic Reticulum

عليه

- The outer surface of **rough ER** is studded with ribosomes (membrane-bound ribosomes). Proteins synthesized by ribosomes enter spaces within the ER for processing and sorting. Thus, rough ER produces secretory proteins, membrane proteins, and many organellar proteins.

وظيفتها انها لما يتم تصنيع البروتينات من ribosomes تعمل على تصنيف categorization وترتيبهم وكل مجموعة بروتينات بتعملهم تغليف packaging بطلعهم بكيص vesicles وبروحوا على golgi complex

ما عليها

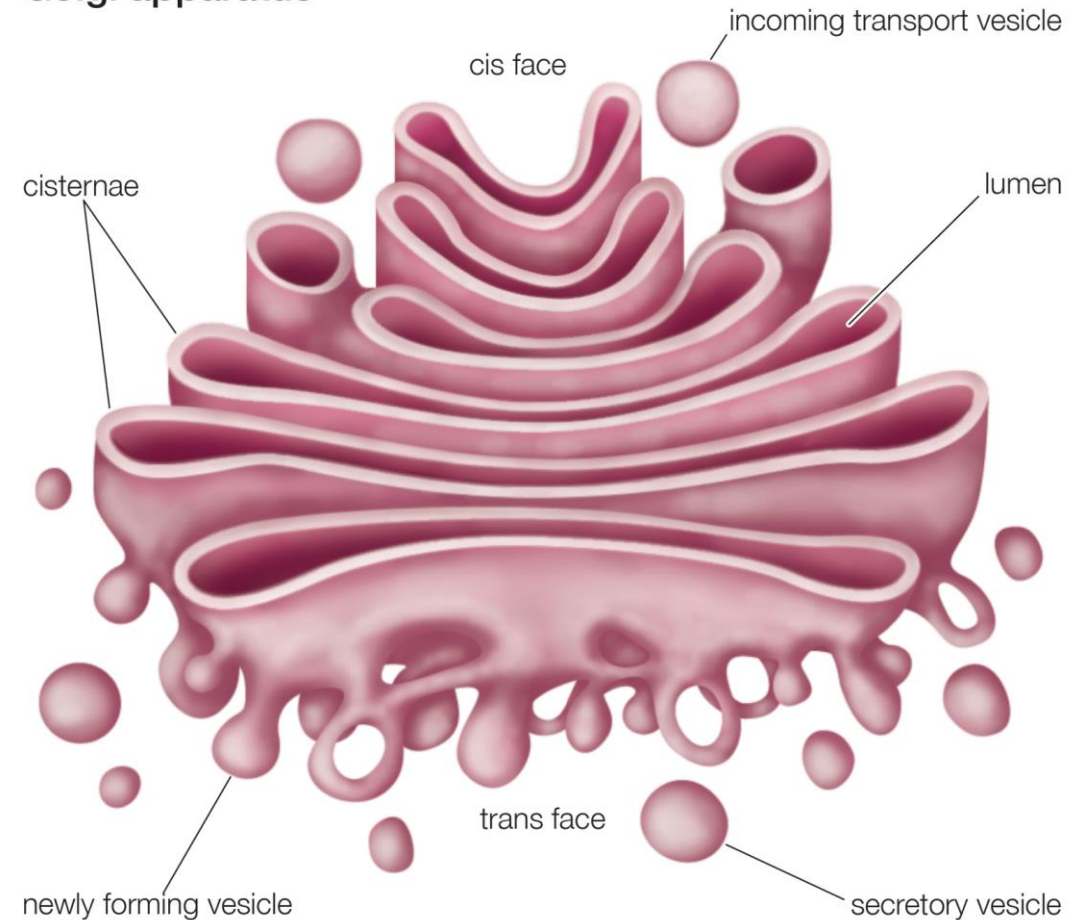
- Unlike rough ER, **smooth ER** does not have ribosomes on its membrane. However, smooth ER contributes to lipids and carbohydrates synthesis, making phospholipids bilayer for cell membranes as well as it stores and releases calcium ions that trigger contraction in muscle cells.

وظيفتها تصنيع الكربوهيدرات والدهون واهم وظيفة هي كما أنه يخزن ويطلق أيونات الكالسيوم التي تحفز الانقباض في خلايا العضلات.

Golgi Complex

- Most of the proteins synthesized by ribosomes attached to rough ER are ultimately transported to other regions of the cell (i.e. **Golgi complex**).

Golgi apparatus



Golgi Complex

■ Functions of Golgi Complex:

في عنا مرحلتين two phases في golgi complex

cis phase

و trans phase

والمواد ممكن تفوت من cis phase وتطلع من trans phase والعكس كمان بس اهم اشئ
عملية دخولها تسمى endocytosis و عملية خروجها exocytosis

1. Modifies, sorts, packages, and transports proteins received from the rough ER (through face or cis entry). Enzymes in the middle site of the Golgi complex modify the proteins to form glycoproteins, glycolipids, and lipoproteins.

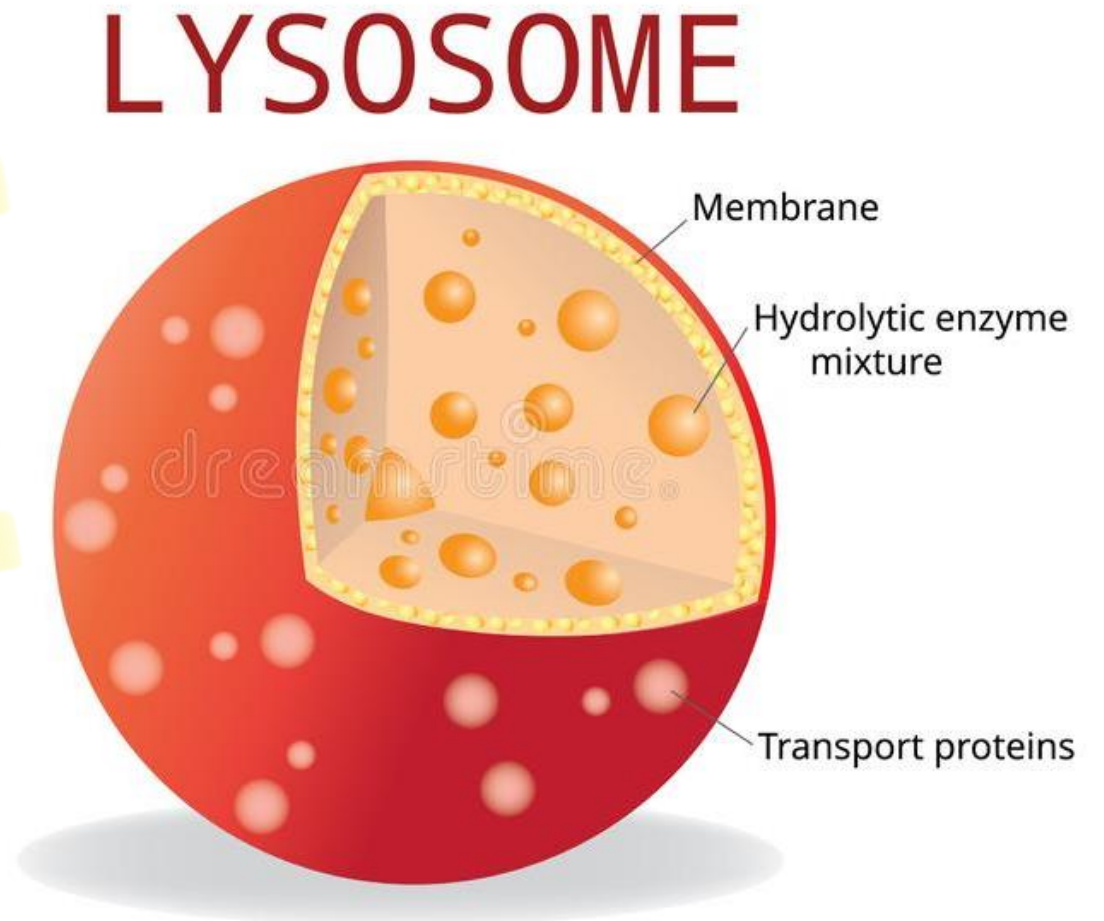
تعمل على تعديل modification يعني البروتين بدل ما هو لحاله بضيف عليه مواد ثانية يعني اذا تم اضافة دهون يسمى lipoprotine وعلى الاغلب بتروح على مركب يسمى proteasomes

2. Forms secretory vesicles that discharge processed proteins via exocytosis (through exist or trans face) into extracellular fluid and forms transport vesicles that carry molecules to other organelles, such as lysosomes.
- يُشكّل حويصلات إفرازية تُفرّغ البروتينات المُعالَجة عن طريق endocytosis إلى خارج الخلية، ويُشكّل حويصلات نقل تحمل الجزيئات إلى عضيات أخرى مثل lysosomes

Lysosomes

يمكن يحلل خليه كاملة او عضيات او فيروسيات او يكمل تحليل مواد لم يتم
اكتمال تحليلها ويحتوي على انزيمات عديدة

- **Lysosomes** are membrane-enclosed vesicles that form from the Golgi complex.
- They can contain as many as 60 kinds of **powerful digestive and hydrolytic enzymes** that can break down a wide variety of molecules.



Lysosomes

■ Functions of lysosomes:

1. **Digest substances (within the cell)** that enter a cell via endocytosis and transport final products of digestion into cytosol.
2. Carry out **autophagy**, the digestion of worn-out organelles.
3. Implement **autolysis**, the digestion of an entire cell.
4. Accomplish **extracellular digestion**.

Peroxisomes

- **Peroxisomes** contain several **oxidases**, enzymes that can oxidize (remove hydrogen atoms from) various organic substances.
- They protect the cells from oxidative damage.
- They protect other parts of the cell from the toxic effects of potentially toxic compounds.
- Peroxisomes are very abundant in the liver, where **detoxification of alcohol** and other damaging substances occurs.
- Peroxisomes also contain the enzyme **catalase**, which decomposes by-product of the oxidation reactions which is hydrogen peroxide (H_2O_2); thus, it decomposes hydrogen peroxide to water and oxygen.

توجد بشكل كبير في الكبد liver الذي يعتبر detoxification organ

يحلل



يتم التخلص من H_2O_2 المادة جدًا سامة عن طريق انزيم catalase ويحولها الى ماء واكسجين



Proteasomes

هذا الجزء الخارجي بمسك هذه البروتينات بعرف اذا هذه البروتينات نحتاجها او لا او فيها خطأ او لا اذا تم تحديد انها خاطئة يدخلها الى الجزء الداخلي ويكسر ها ويحولها الى احماض امينية amino acid ويمكن نستخدمها عشان انسوي بروتينات ثانية اذا بدنا

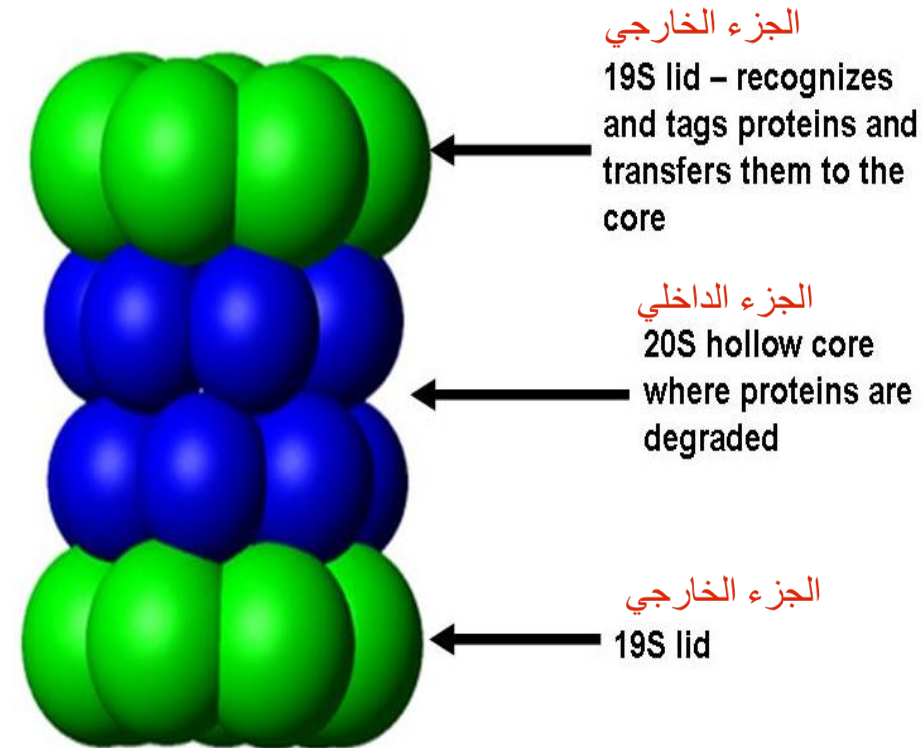
التخلص من البروتينات الموجودة في cytosol

- Cytosolic proteins require disposal at certain times in the life of a cell. Continuous destruction of unneeded, damaged, or faulty proteins is the function of tiny barrel-shaped structures consisting of four stacked rings of proteins around a central core called **proteasomes**.

يحتوي على انزيمات تحلل البروتينات فقط

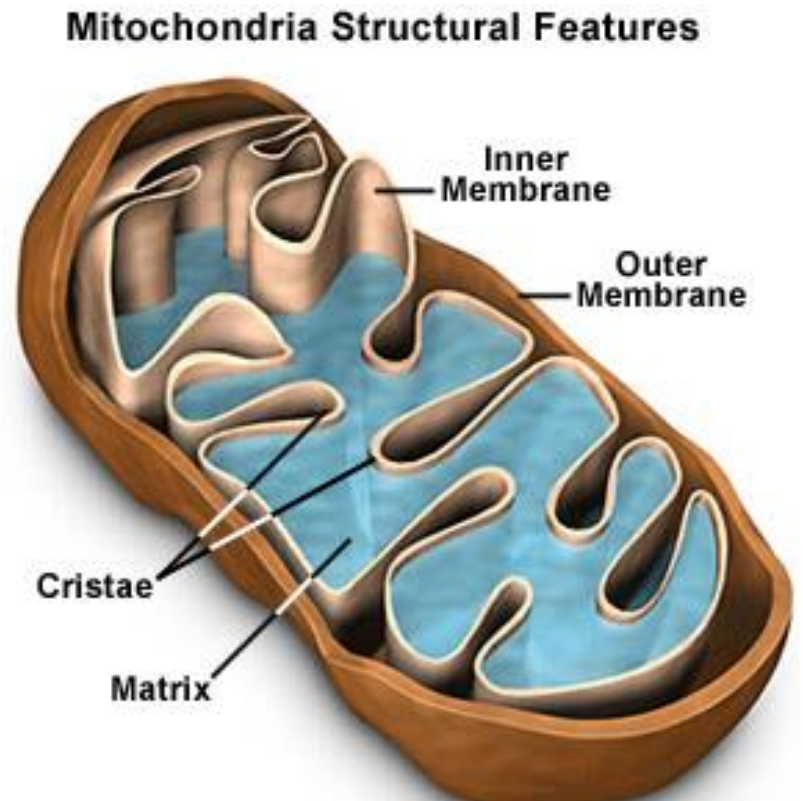
- Proteasomes were so named because they contain **proteases, enzymes that cut proteins into small peptides**. Once the enzymes of a proteasome have chopped up a protein into smaller chunks, **other enzymes then break down the peptides into amino acids, which can be recycled into new proteins.**

26S proteasome



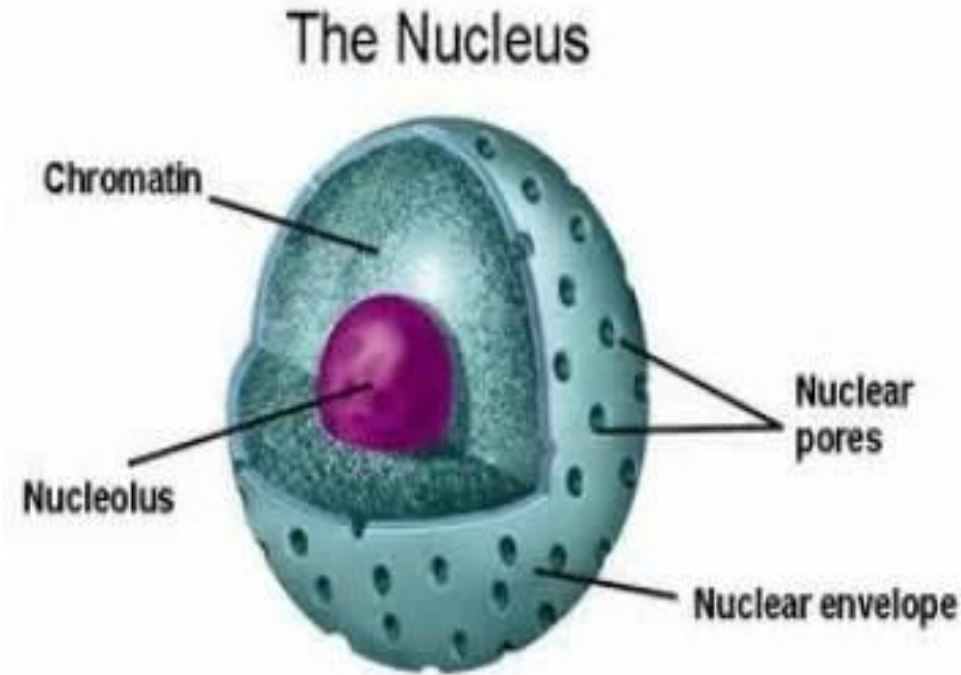
Mitochondria

- **Mitochondria** generate most of the ATP through aerobic (oxygen requiring) respiration, (“**powerhouses**” of the cell). The enzymes that catalyze the chemical reactions which are part of the aerobic phase of cellular respiration are located in the mitochondria.
- Active cells that use ATP at a high rate—such as those found in the muscles, liver, and kidneys—have a large number of mitochondria.
- A mitochondrion consists of an **outer mitochondrial membrane** and an **inner mitochondrial membrane** with a small fluid-filled space between them (**mitochondrial matrix**).



Nucleus

- **The nucleus** is a ^{كروية} spherical or ^{بيضوية} oval-shaped structure that usually is the most prominent feature of a cell.
- Most cells have a single nucleus, although some, such as mature **red blood cells**, have none. Other types of cells have multiple nuclei.
- A double membrane called the nuclear envelope separates the nucleus from the cytoplasm. Many openings called nuclear pores extend through the nuclear envelope.
- The complex of DNA, proteins, and some RNA is called chromatin. The total genetic information carried in a cell, or an organism is its genome.



Nucleus

■ Functions of nucleus:

1. Controls cellular structure.
2. ^{يُوجِّه} Directs cellular activities.
3. Produces ribosomes in nucleoli.
4. Nuclear pores control the movement of substances between the nucleus and cytoplasm.

Membrane permeability:

- 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:

- 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.

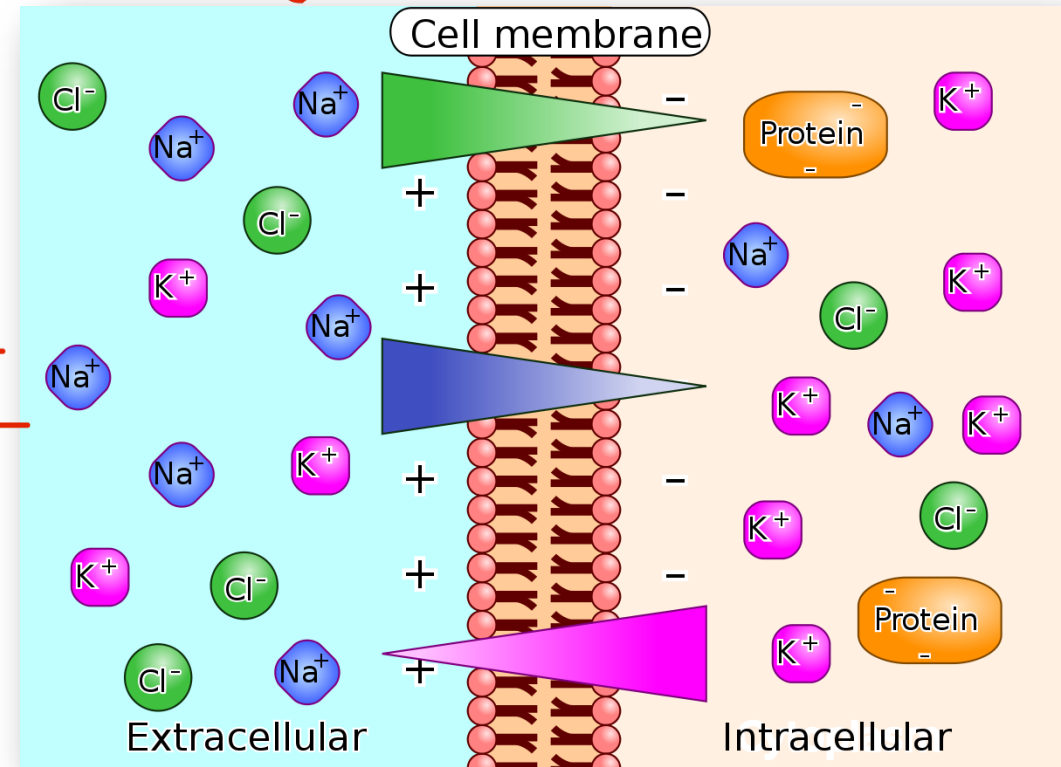
يعني اذا بحكي عن مادة غير مشحونة وبتقدر تفوت الغشاء بسهولة فبدنا ننتبه على اختلاف التركيز بين المنطقتين داخل وخارج الخلية

concentration gradient

Gradients across the Plasma Membrane:

- The difference in electrical charges between two regions constitutes an electrical gradient. This 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.
- The combined influence of the concentration gradient and the electrical gradient on movement of a particular ion is referred to as its electrochemical gradient.

الخلية لما تكون في حالة الراحة resting فرق الجهد voltage بين داخل الخلية وخارجها سيكون لازم يكون -70 يعني لما احكي electrical gradient هو gradient الي بحتاجه بحيث اوصل الخلية لوضع الراحة باستثناء cardiac muscle وضع الراحة تبعها -90



اما اذا المادة مشحونة وغير متعادلة فبدنا ننتبه concentration gradient
وكمان electrical gradient

يعني المواد الي شحنتها موجبة رح تفضل تروح على المنطقة المشحونة
بالشحنة السالبة والعكس صحيح

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.

لا تحتاج طاقة ATP

لأنه تنتقل المواد من المكان التركيز العالي الى المكان التركيز قليل

- 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).

تحتاج طاقة ATP

لأنه تنتقل المواد من المكان التركيز القليل الى المكان التركيز العالي

- 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.

TRANSPORT ACROSS THE PLASMA MEMBRANE

وعملية دخول المواد الى الخلية تسمى endocytosis
وعملية خروج المواد من الخلية تسمى exocytosis

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.

PASSIVE PROCESSES

Diffusion

Osmosis

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. الطاقة الحركية
- 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).
ينتقل solute من منطقة التركيز العالي الى منطقة التركيز المنخفض

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. **direct** التناسب طردي 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). يعني كل ما كان فرق التركيز والجهد بين داخل وخارج الخلية كل ما كان الانتقال والانتشار أسرع
2. **direct** التناسب طردي Temperature (the higher the temperature, the faster the rate of diffusion).
3. **Inverse** التناسب عكسي Mass of the diffusing substance (the larger the mass of the diffusing particle, the slower its diffusion rate).
4. **direct** التناسب طردي Surface area (the larger the membrane surface area available for diffusion, the faster is the diffusion rate). هي المساحة المتاحة على الغشاء التي يمكن للجزيئات أن تمر من خلالها.
5. **Inverse** التناسب عكسي Diffusion distance (The greater the distance over which diffusion must occur, the longer it takes). هي المسافة التي لازم الجزيئات تمشيها عشان تنتقل من جهة إلى أخرى (عبر الغشاء أو في السائل)

DIFFUSION

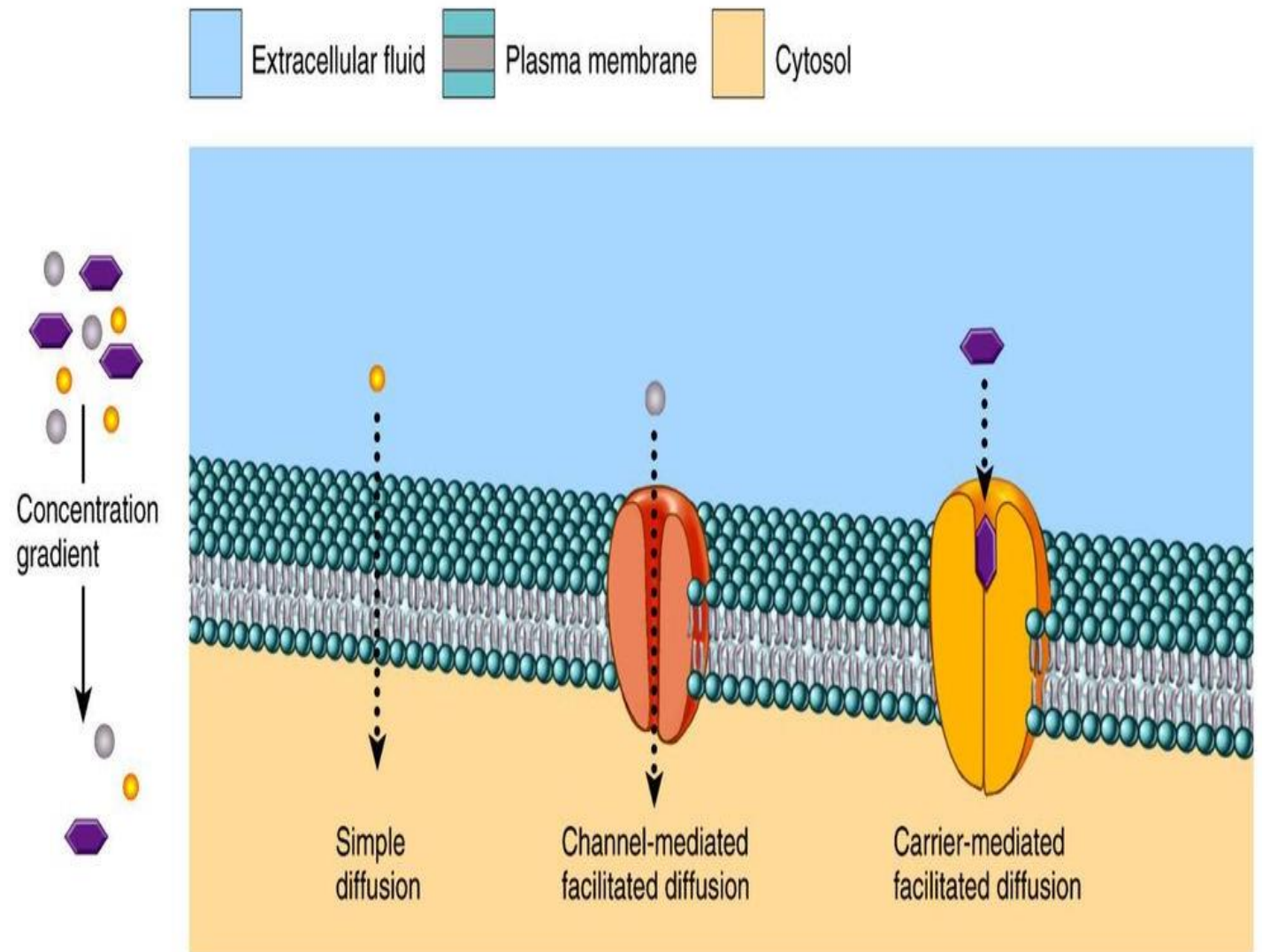
1- Simple diffusion

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

2- Facilitated diffusion

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

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



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.

OSMOSIS

انتقال الماء من تركيز الماء فيه عالي الى المكان تركيز الماء فيه قليل
انتقال الماء من المكان تركيز solute فيه قليل الى المكان تركيز sloute فيه عالي

- **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

التركيز داخل الخلية يساوي التركيز خارج الخلية ↗

- 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.

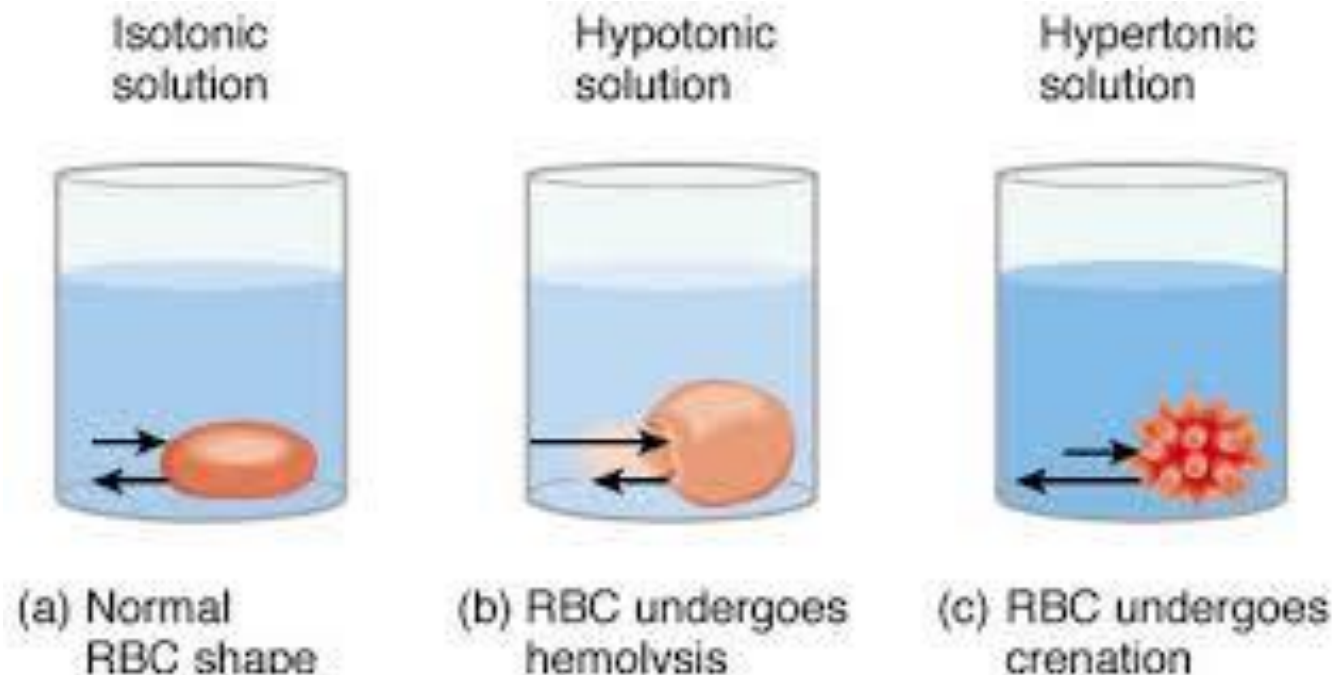
تركيز منخفض خارج الخلية

- 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).

OSMOSIS

تركيز مرتفع خارج الخلية

- 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.



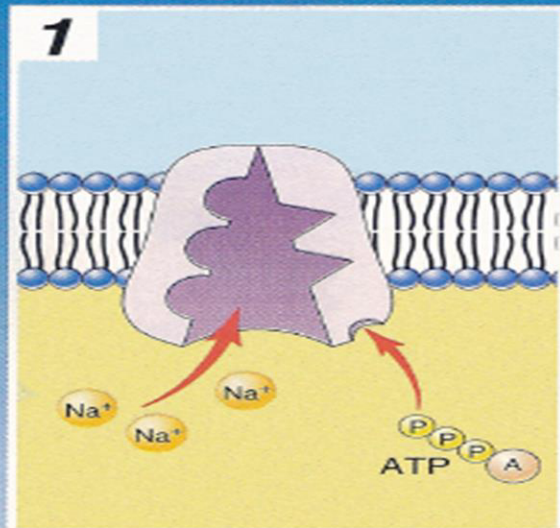
ACTIVE PROCESSES

- **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**.

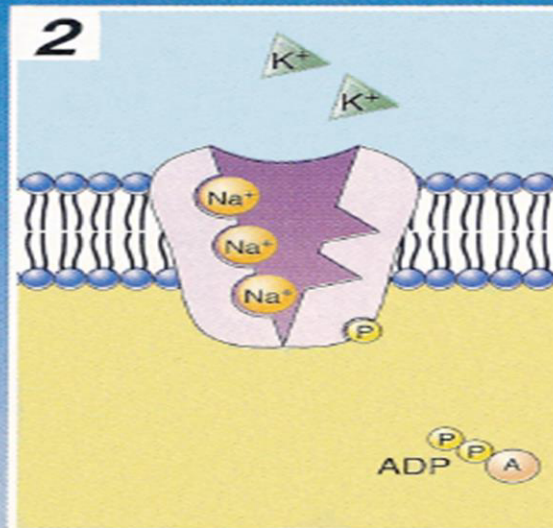
ACTIVE PROCESSES

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.

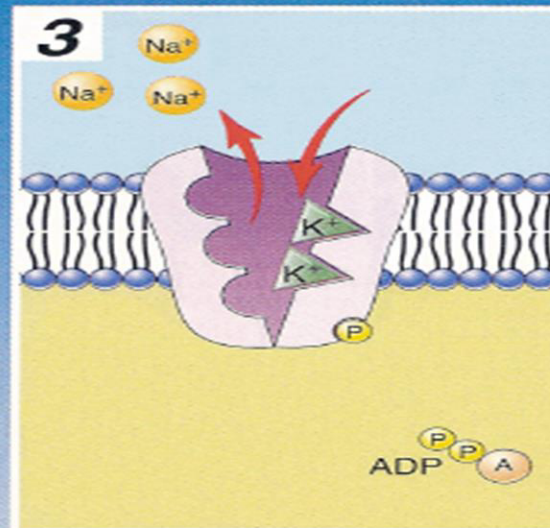
SODIUM-POTASSIUM PUMP



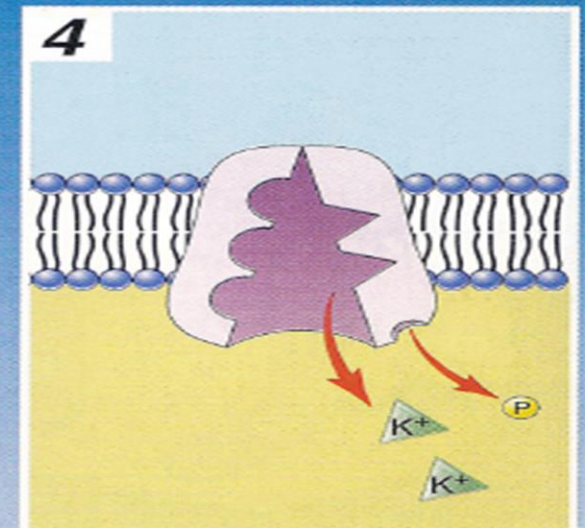
The sodium-potassium pump binds three sodium ions and a molecule of ATP.



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

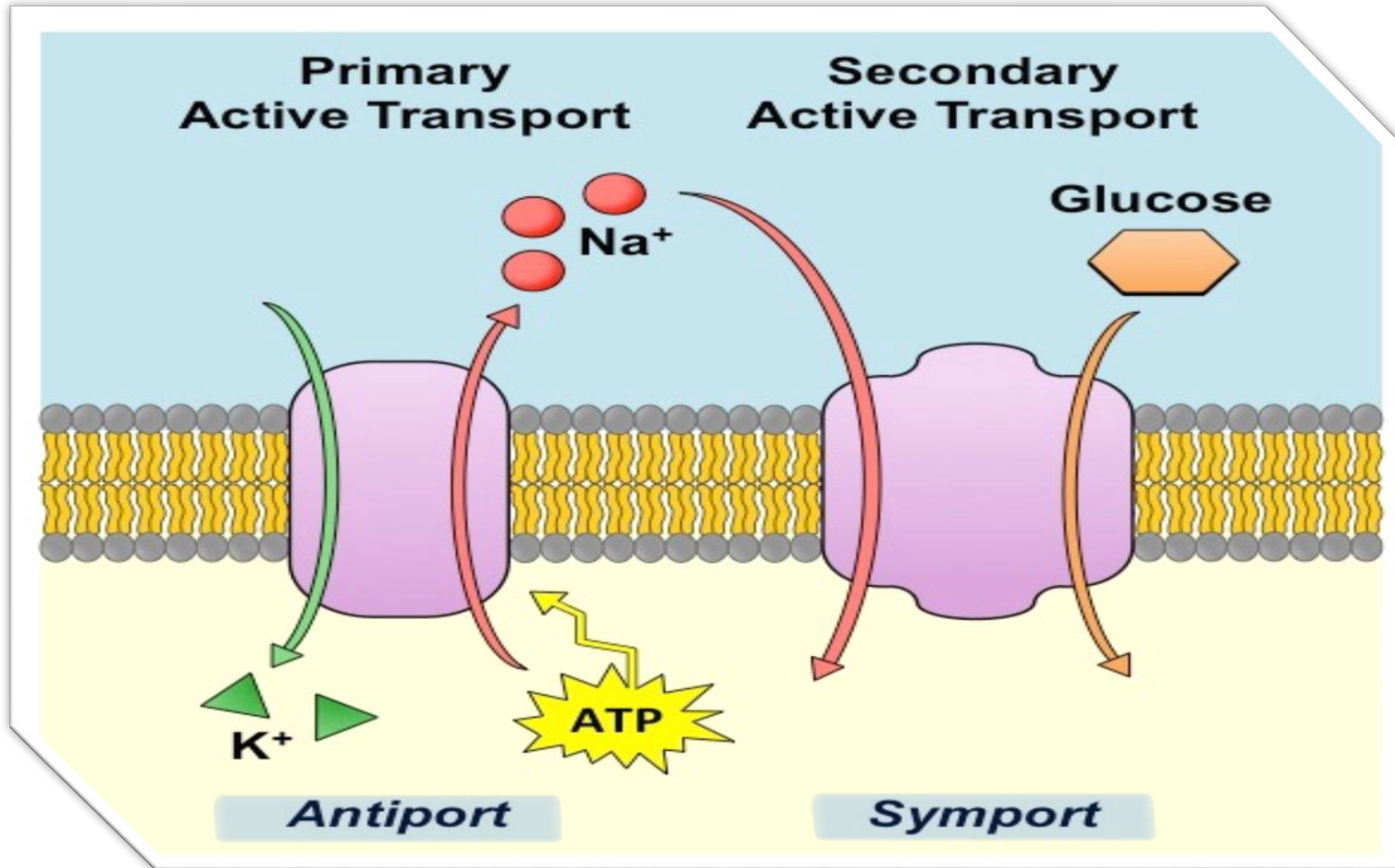


The sodium ions are released to the outside of the membrane, and the new shape of the channel allows two potassium ions to bind.



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

ACTIVE PROCESSES



TRANSPORT IN VESICLES

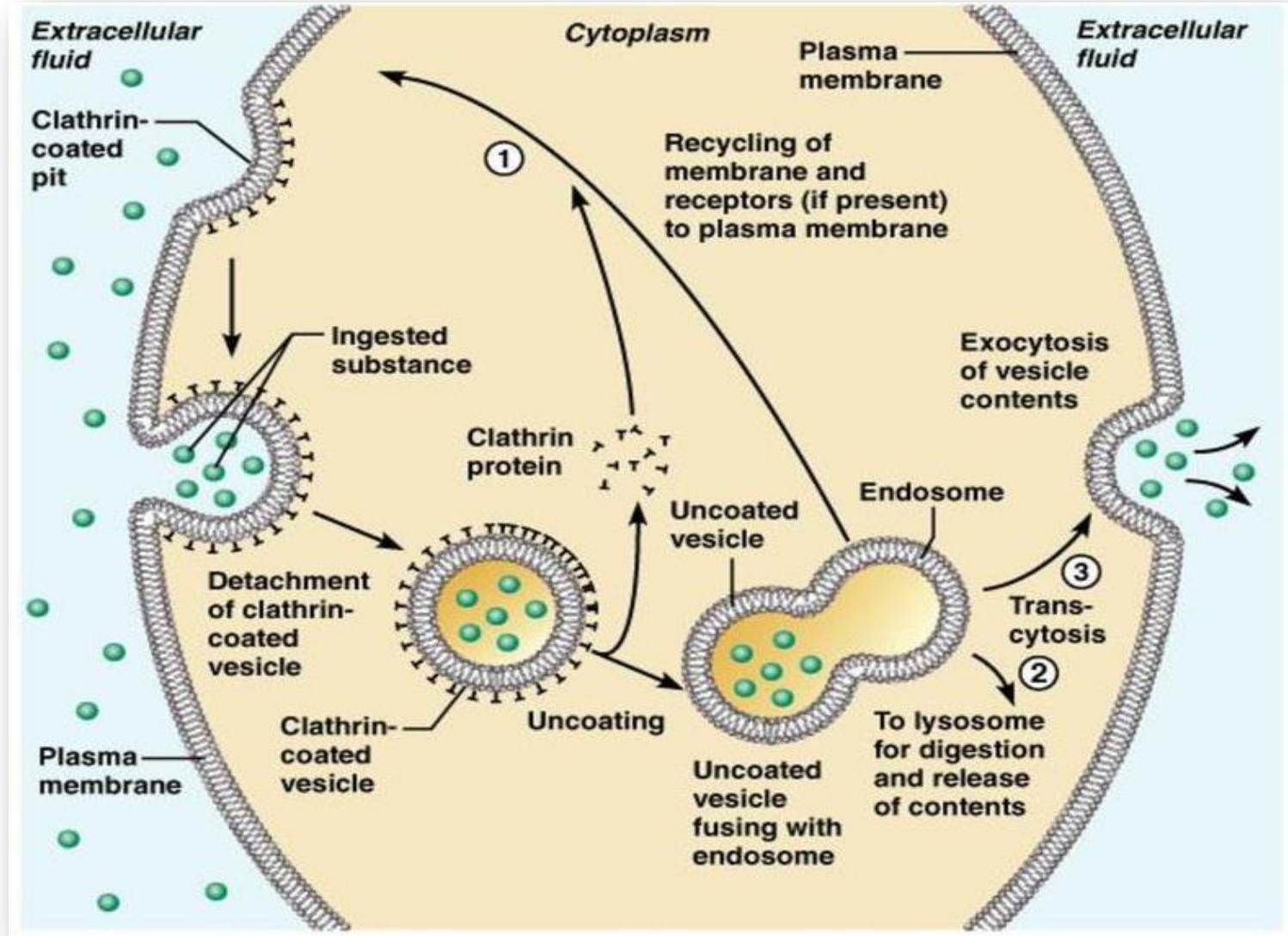
- During endocytosis, materials move into a cell in a vesicle formed from the plasma membrane.
- In exocytosis, materials move out of a cell by the fusion with the plasma membrane of vesicles formed inside the cell.
- Both endocytosis and exocytosis require energy supplied by ATP. Thus, **transport in vesicles is an active process.**
- **The three types of endocytosis:**
 1. Receptor-mediated endocytosis.
 2. Phagocytosis.
 3. Bulk-phase endocytosis.

RECEPTOR-MEDIATED ENDOCYTOSIS

زي ما حكينا من قبل انه يكون على المستقبل موقع نشط عشان يرتبط مع (المادة ligands زي LDL, والمضادات الحيوية antibiotics, وبروتين في الدم transferrin, الهرمونات)

- 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.

يرتبط هذا المستقبل (LDL reseptor) مع مادة LDL وياخذوا جزء من plasma membran ويعملوا زي غطاء coat ويدخلوا داخل الخلية وبصير زي اندماج fusion مع lysosomes الي بيحطم المادة بس لما يخرجوا ، المستقبل reseptor يرجع الى plasma membran عشان يستقبل LDL جديد وبطلعوا اي اشئ ما بدها الخلية



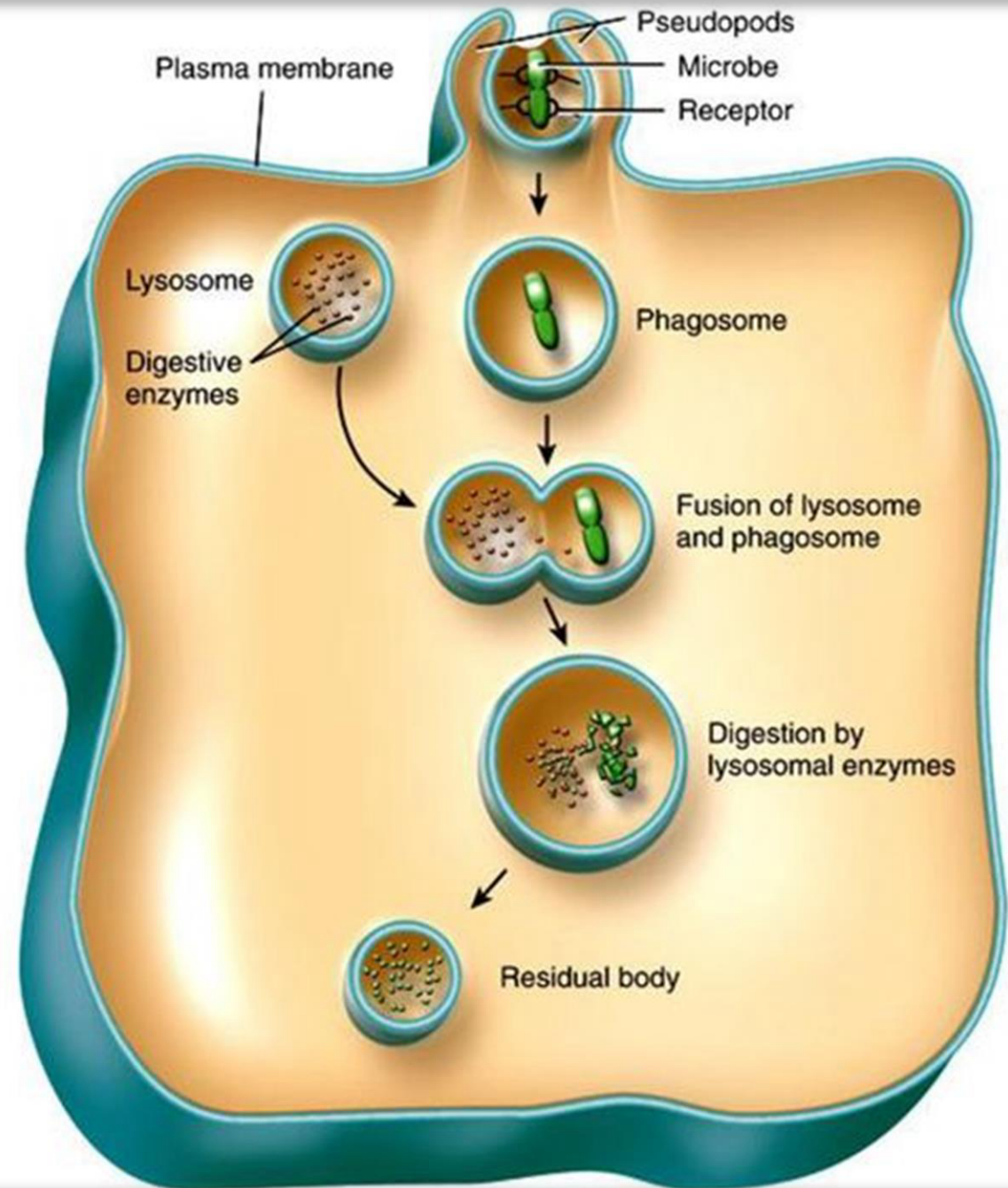
PHAGOCYTOSIS

- **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.

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.

الاقدام الكاذبة pseudopods داخلها يوجد reseptor ويرتبط فيه
microbe وبنفس الطريقة تدخل الخلية وبصير اسمها phagosome
وبصير تحليل digestion لهذا microbe

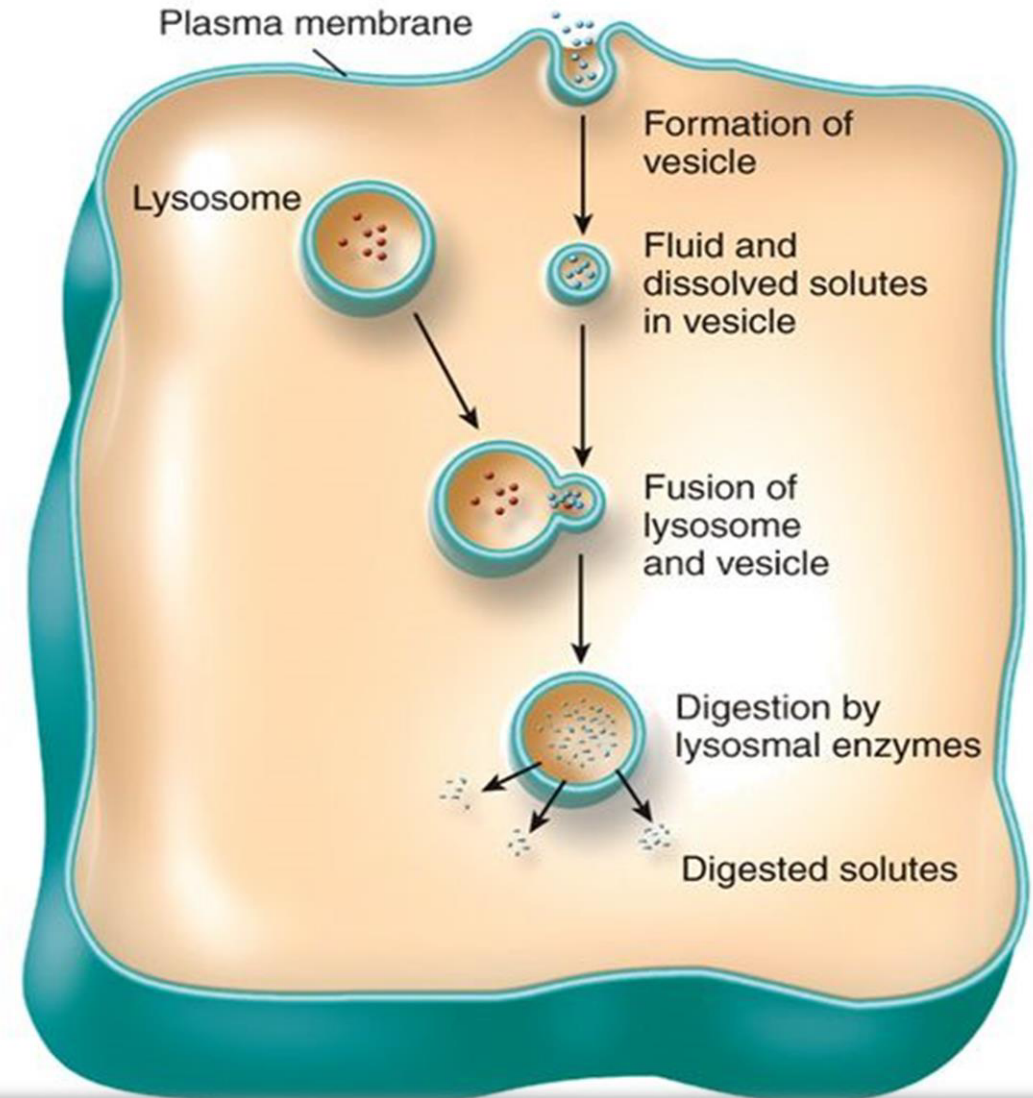


BULK-PHASE ENDOCYTOSIS (PINOCYTOSIS)

- 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.**
النوع الوحيد من endocytosis الي ما له reseptor
- Bulk-phase endocytosis occurs in most cells, especially absorptive cells in the intestines and kidneys.
الكلية الامعاء
- The resulting smaller molecules leave the lysosome to be used elsewhere in the cell.

water + solute

Bulk-phase Endocytosis



EXOCYTOSIS

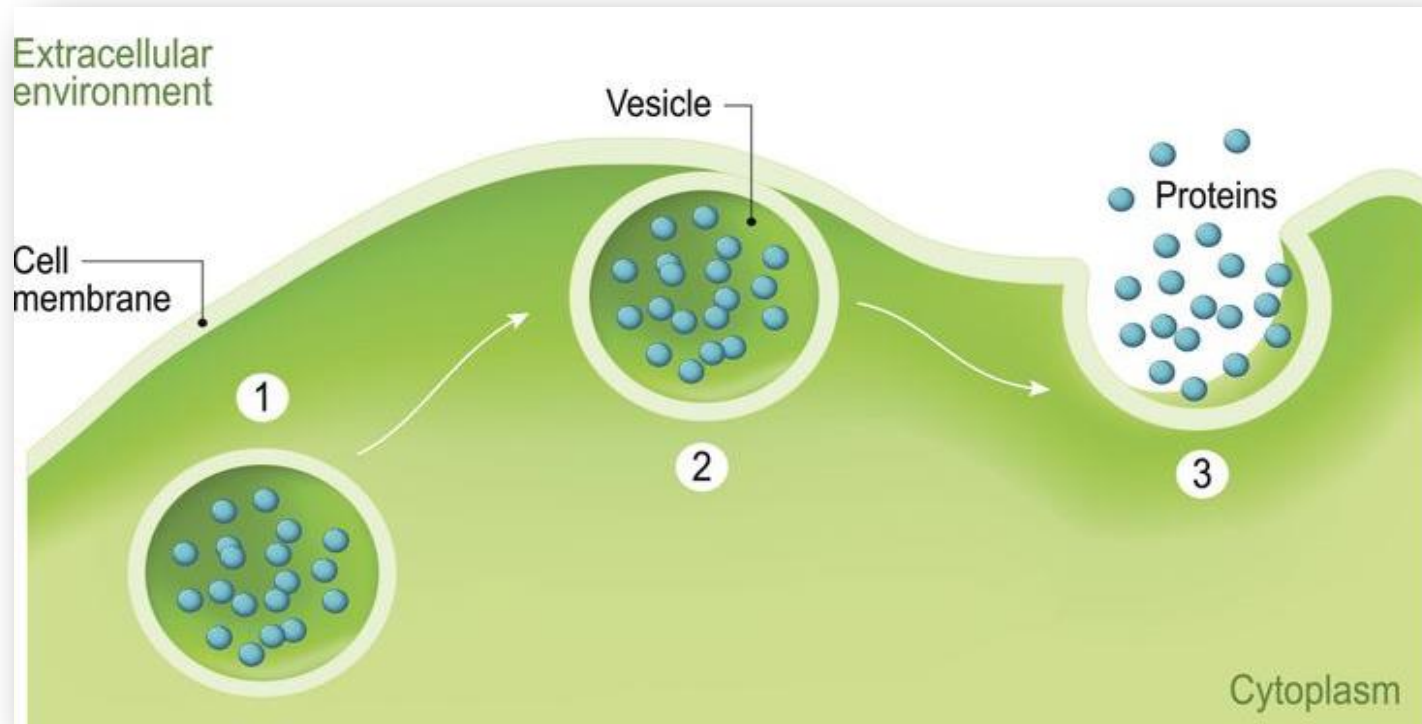
- In contrast with endocytosis, which brings materials into a cell, exocytosis releases materials from a cell.
- All cells carry out exocytosis, but it is especially important in two types of cells: **(1) secretory cells that liberate digestive enzymes, hormones, mucus, or other secretions and (2) nerve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

انه في عملياته endocytosis بخسر جزء من plasma membran عشان لما تدخل المادة الى الخلية لازم تكون محاطة بغشاء ويتم تعويض هذه الخسارة عن طريق عملية exocytosis

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.



TRANSCYTOSIS

- 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.
عبر المشيمة الأجسام المضادة
الدورة الدموية للجنين



THANK YOU

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