تَنوير

BIOLOGY

Lec no : 9

File Title : Chapter 8

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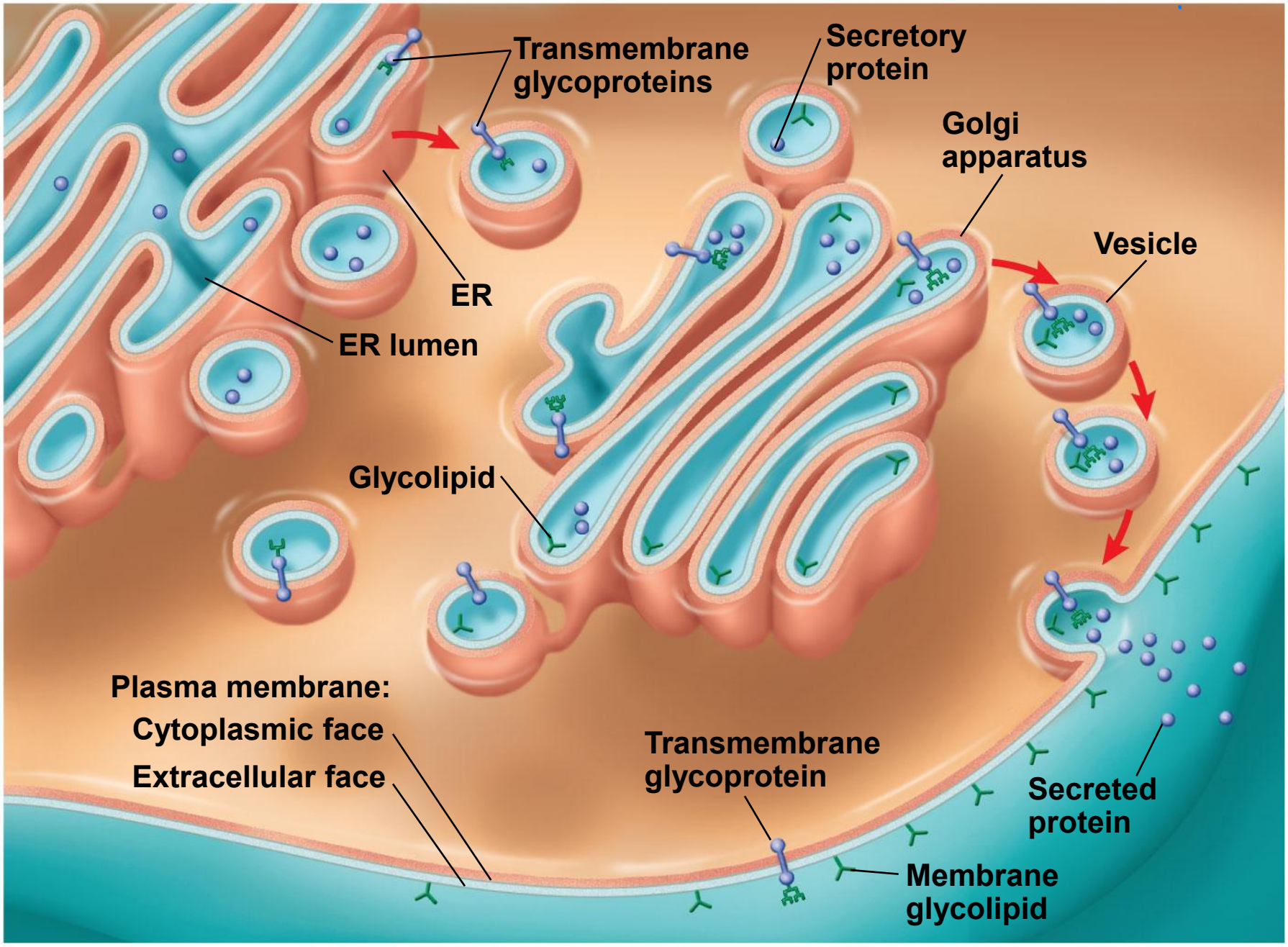
وَقُل رَّبِّ زِدْنِي عِلْمًا

Synthesis and Sidedness of Membranes

- Membranes have distinct inside and outside faces
- The asymmetrical distribution of proteins, lipids, and associated carbohydrates in the plasma membrane is determined when the membrane is built by the ER and Golgi apparatus

Figure 7.12



vesicles from ER → Golgi → vesicles from Golgi → Plasma membrane

exocytosis: The process of transporting macromolecules from the inside to the outside

carbohydrates are only found on the plasma membrane from the outside as shown in the figure above

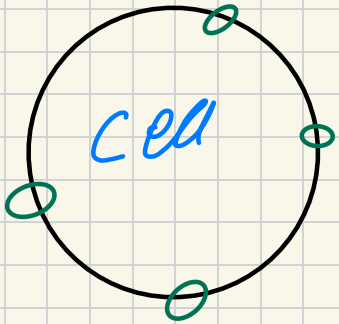
Concept 7.2: Membrane structure results in selective permeability

- A cell must exchange materials with its surroundings, a process controlled by the plasma membrane
- Plasma membranes are selectively permeable, regulating the cell's molecular traffic

substances rather pass through the phospholipids in the plasma membrane or through the proteins

transportation based on kind of substances:

1) small, non-polar, gas → pass through phospholipids



2) small, polar, Ions → pass through proteins

3) water → pass through a specific kind of proteins
water channels (aquaporins)

4) macromolecule → through a way called
Bulk transport → inside vesicles

The Permeability of the Lipid Bilayer

- Hydrophobic (nonpolar) molecules, such as hydrocarbons, can dissolve in the lipid bilayer and pass through the membrane rapidly
- Polar molecules, such as sugars, do not cross the membrane easily

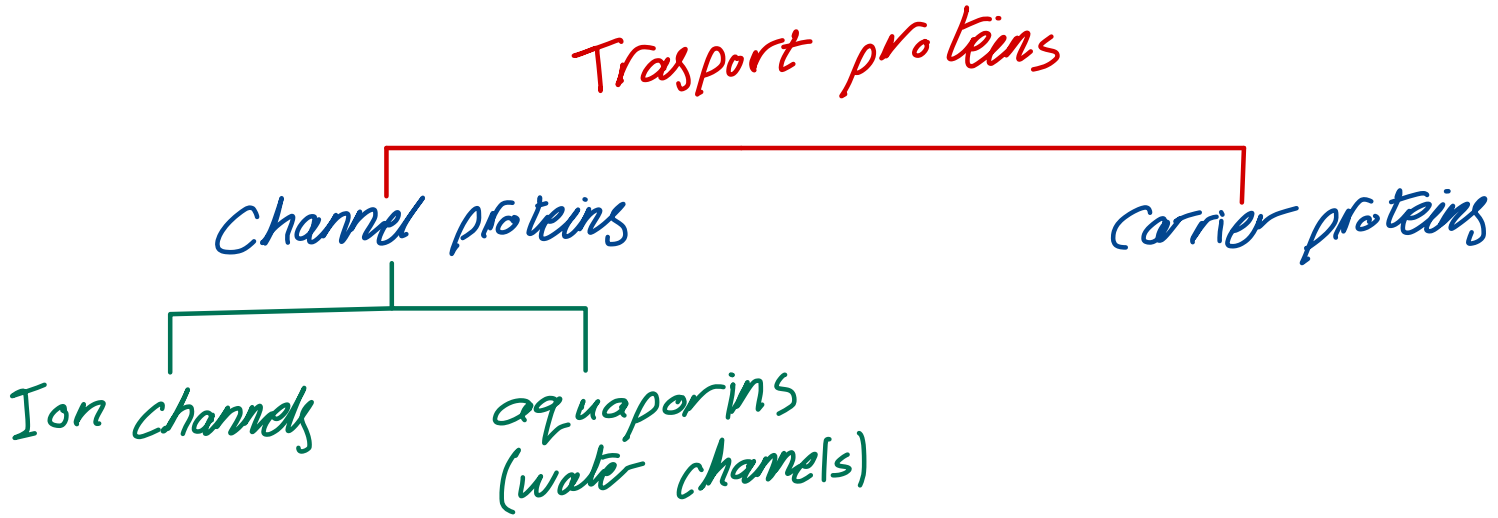
monomers

Transport Proteins

- **Transport proteins** allow passage of hydrophilic substances across the membrane
- Some transport proteins, called channel proteins, have a hydrophilic channel that certain molecules or ions can use as a tunnel
- Channel proteins called **aquaporins** facilitate the passage of water

need ATP

- Other transport proteins, called carrier proteins, bind to molecules and change shape to shuttle them across the membrane
- A transport protein is specific for the substance it moves



Concept 7.3: Passive transport is diffusion of a substance across a membrane with no energy investment

- **Diffusion** is the tendency for molecules to spread out evenly into the available space
- Although each molecule moves randomly, diffusion of a population of molecules may be directional
- At dynamic equilibrium, as many molecules cross the membrane in one direction as in the other

Solution: 1) solute : مذاب
2) solvent : مذيب

Transport

Passive (no ATP) — down hill — down it's concentration gradient

The transportation way is determined by concentration gradient

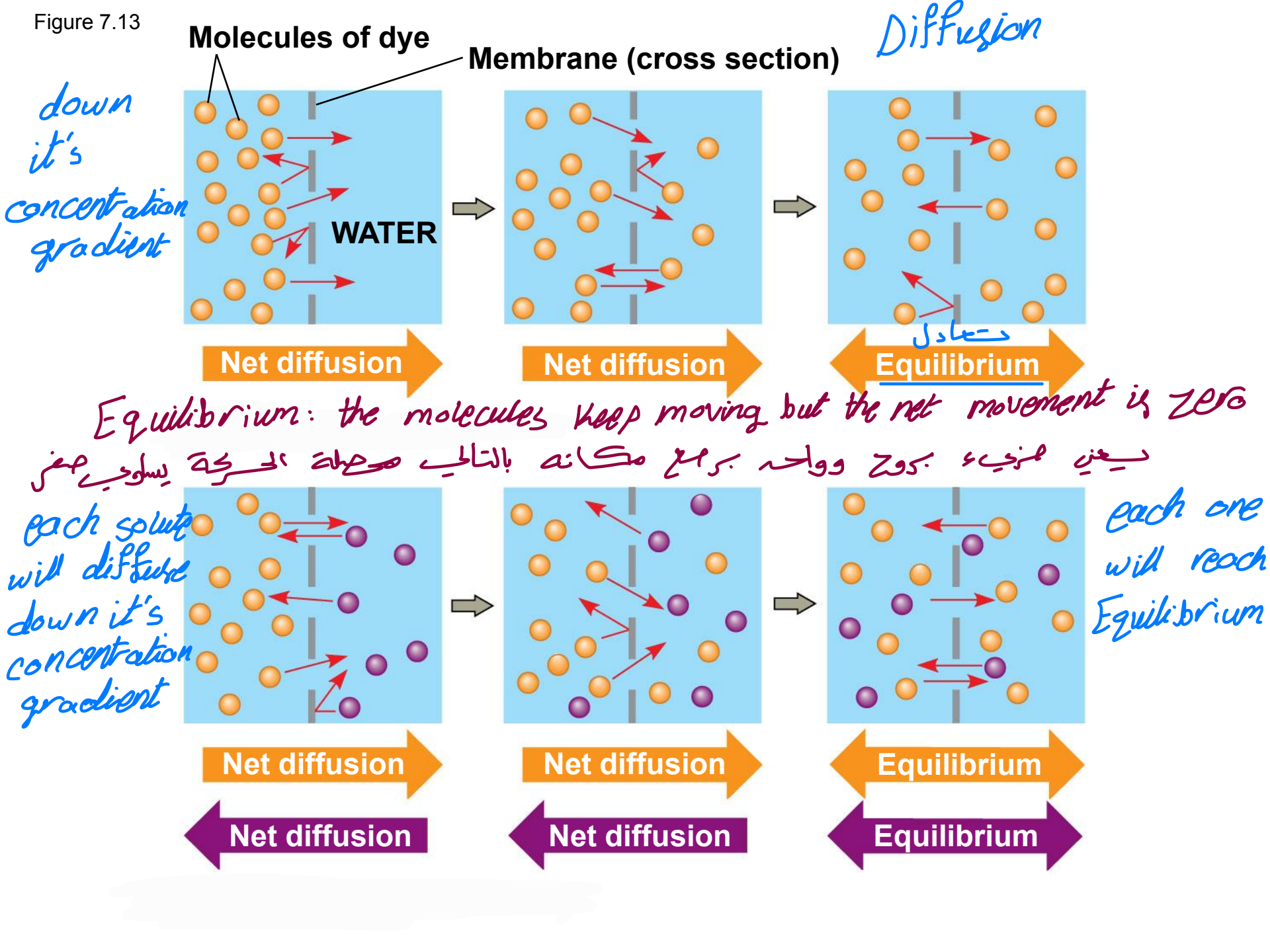
فرق تركيز المادة داخل وخارج الخلية

(needs ATP) Active — up hill — against it's concentration gradient

Examples:

1) Diffusion
2) Osmosis
3) Facilitated diffusion

Figure 7.13



Diffusion

down it's concentration gradient

متعادل

Equilibrium: the molecules keep moving but the net movement is zero

يعني لمزيء بروح وواحد برجع مكانه بالتالي صحيحة الحركة بس لكن صفر

each solute will diffuse down it's concentration gradient

each one will reach Equilibrium

- Substances diffuse down their **concentration gradient**, the region along which the density of a chemical substance increases or decreases
- No work must be done to move substances down the concentration gradient
- The diffusion of a substance across a biological membrane is **passive transport** because no energy is expended by the cell to make it happen

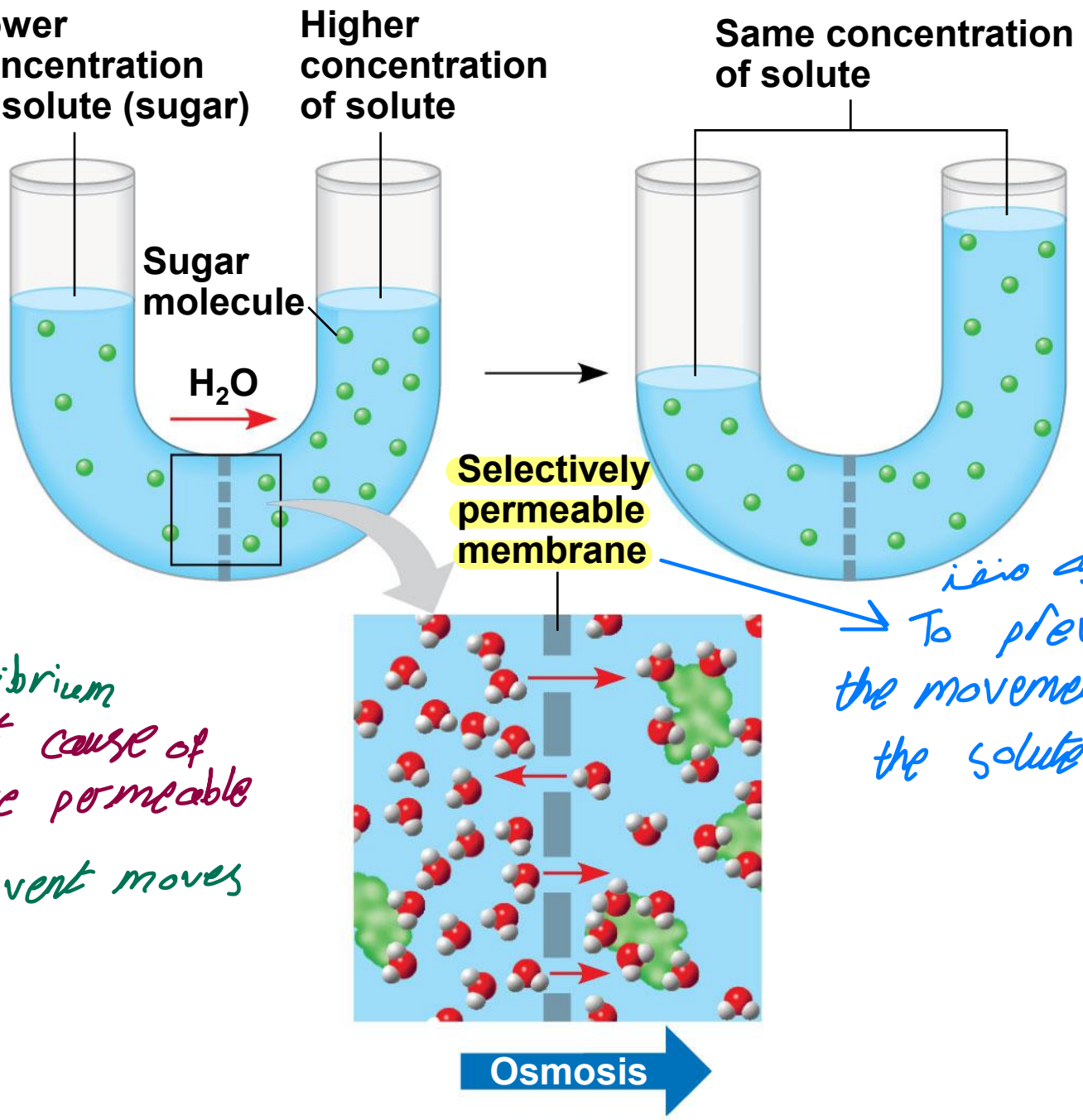
Effects of Osmosis on Water Balance

for the solvent usually water

- **Osmosis** is the diffusion of water across a selectively permeable membrane
- Water diffuses across a membrane from the region of lower solute concentration to the region of higher solute concentration until the solute concentration is equal on both sides

المذاب (عادة الماء) يتحرك من المنطقة اللي بكون فيها تركيز المذاب فيها قليل للمنطقة اللي بكون فيها تركيز المذاب عالي

Figure 7.14



At first the solute will try to move and reach equilibrium but couldn't cause of the selective permeable membrane so the solvent moves instead

To prevent the movement of the solute

Water Balance of Cells Without Walls

- **Tonicity** is the ability of a surrounding solution to cause a cell to gain or lose water
- **Isotonic** solution: Solute concentration is the same as that inside the cell; no net water movement across the plasma membrane
- **Hypertonic** solution: Solute concentration is greater than that inside the cell; cell loses water

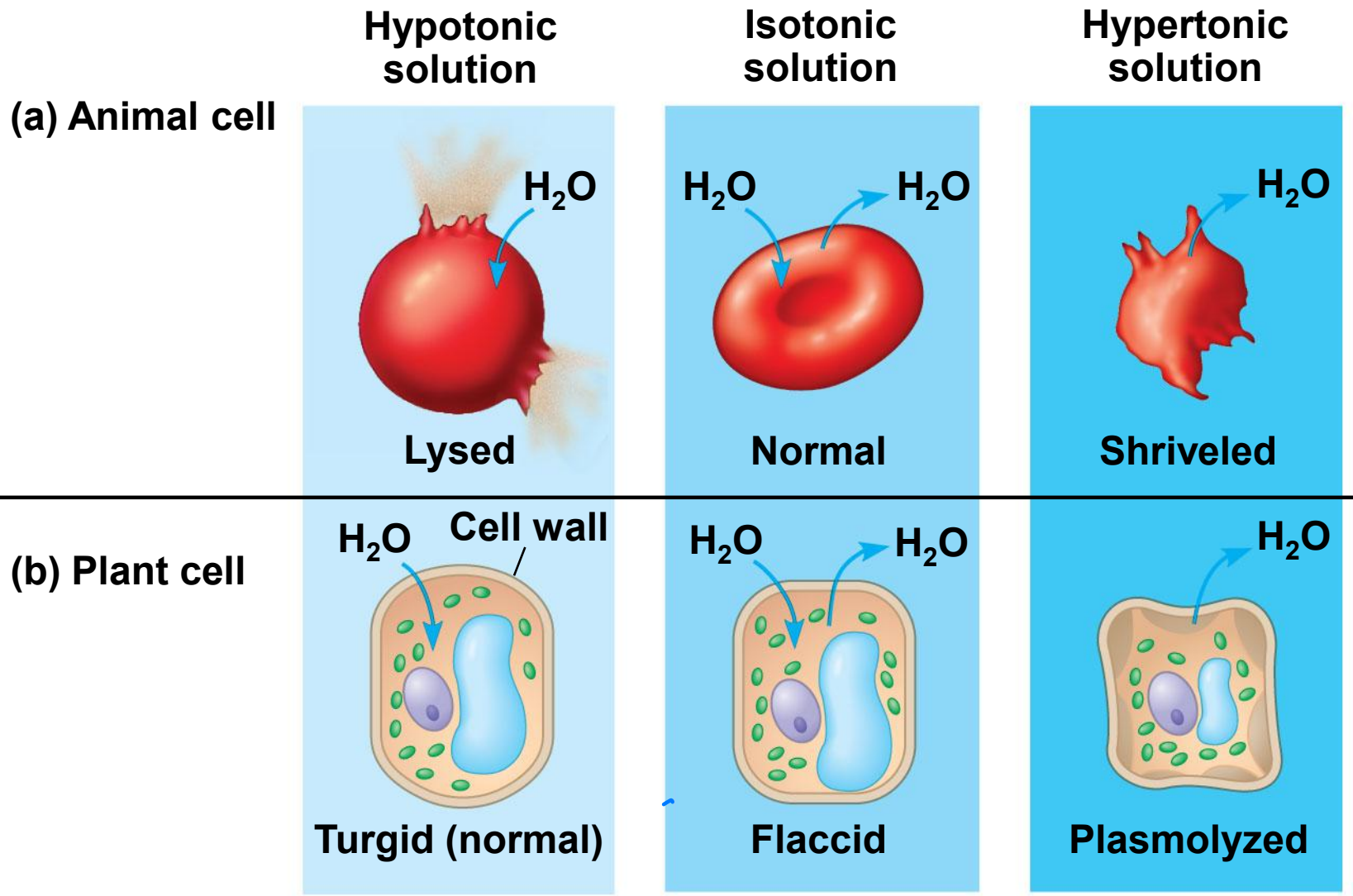
High solute concentration, low solvent (water) concentration

- **Hypotonic** solution: Solute concentration is less than that inside the cell; cell gains water

Low solute concentration, high solvent (water) concentration

Figure 7.15

like distilled water



Animal cells

Hypotonic

worst for the cell

- The cell will gain water and burst
- For blood cells it's called hemolysis
  تحلل خلية الدم

Isotonic

best for the cell

- The cell won't lose or gain water
- net movement = zero

Hypertonic

- The cell will lose water which will cause it to shrivel
- Shriveled or crenation تجعد

The normal solution concentration for the animal cell (normal saline) is 0.85% / NaCl

Plant cells

Hypotonic

Best for the cell

- The cell will gain water and will be turgid but won't burst cause of the cell wall

Isotonic

- The net movement = Zero the cell is alive but in a flaccid state

Hypertonic

worst for the cell

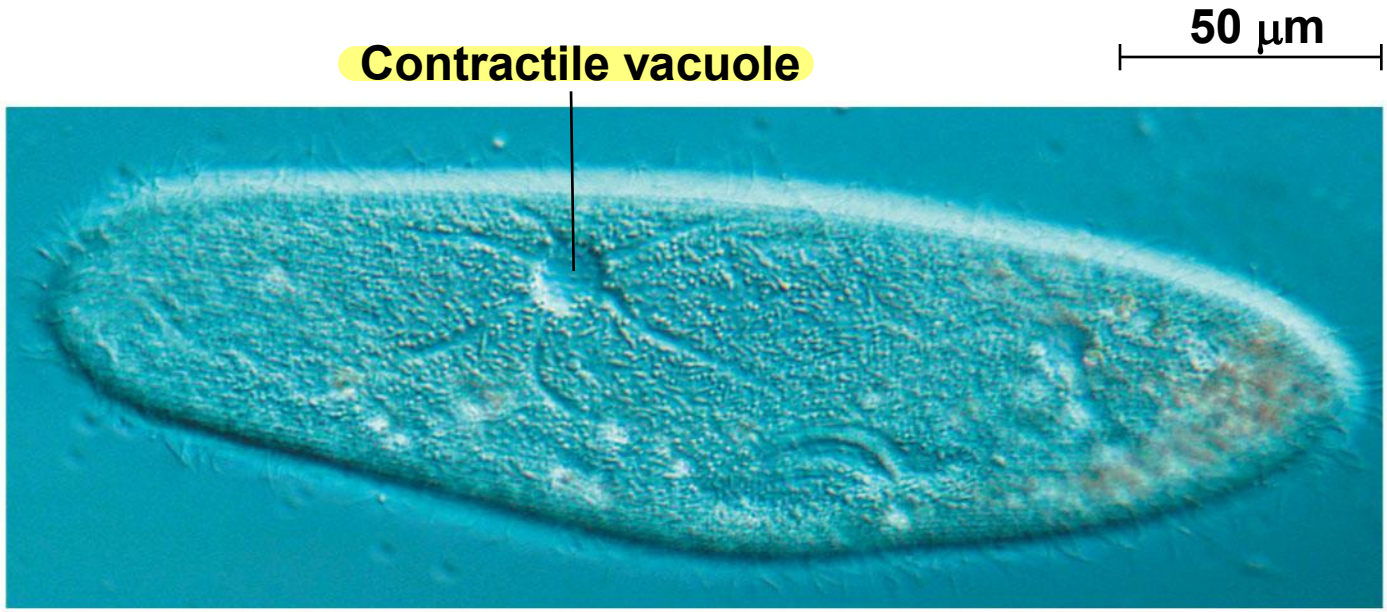
- The cell will lose water and the plasma membrane will shrink on the organelles and the cell is plasmolyzed
- can't function in the right way

- Hypertonic or hypotonic environments create osmotic problems for organisms
- **Osmoregulation**, the control of solute concentrations and water balance, is a necessary adaptation for life in such environments
- The protist *Paramecium,* which is hypertonic to its pond water environment, has a contractile vacuole that acts as a pump

Video: *Chlamydomonas*

Video: *Paramecium* Vacuole

Figure 7.16



Water Balance of Cells with Walls

- Cell walls help maintain water balance
- A plant cell in a hypotonic solution swells until the wall opposes uptake; the cell is now **turgid** (firm)
- If a plant cell and its surroundings are isotonic, there is no net movement of water into the cell; the cell becomes **flaccid** (limp), and the plant may wilt

- In a hypertonic environment, plant cells lose water; eventually, the membrane pulls away from the wall, a usually lethal effect called **plasmolysis**

Video: Plasmolysis

Video: Turgid *Elodea*

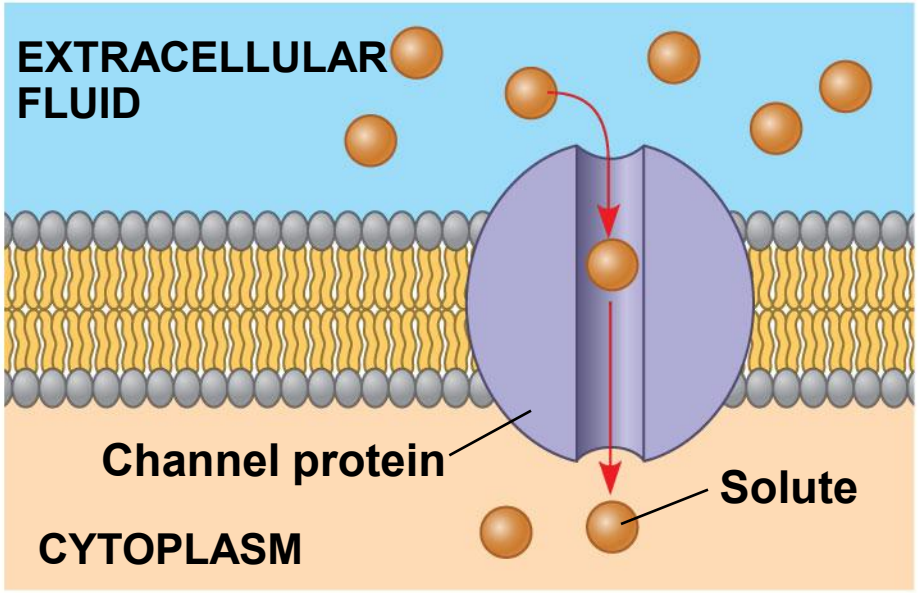
Animation: Osmosis

Facilitated Diffusion: Passive Transport Aided by Proteins

انتشار مسهل required

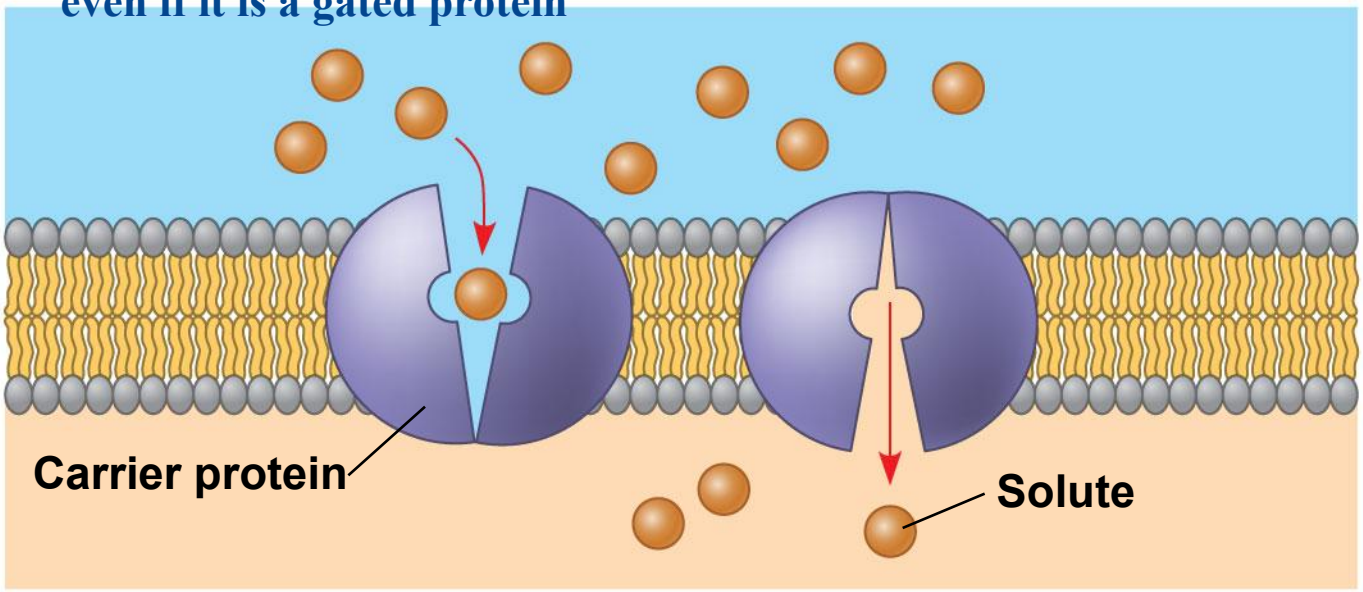
- In **facilitated diffusion**, transport proteins speed the passive movement of molecules across the plasma membrane
- Channel proteins provide corridors that allow a specific molecule or ion to cross the membrane
- Channel proteins include
  - Aquaporins, for facilitated diffusion of water
  - **Ion channels** that open or close in response to a stimulus (**gated channels**)

Figure 7.17



(a) A channel protein

In facilitated diffusion it doesn't need ATP for transportation even if it is a gated protein



(b) A carrier protein

- Carrier proteins undergo a subtle change in shape that translocates the solute-binding site across the membrane

- Some diseases are caused by malfunctions in specific transport systems, for example the kidney disease cystinuria

وجود خلل في البروتين الناقل المسؤول عن نقل السستين
مما يؤدي الى وجود سستين في البول

Concept 7.4: Active transport uses energy to move solutes against their gradients

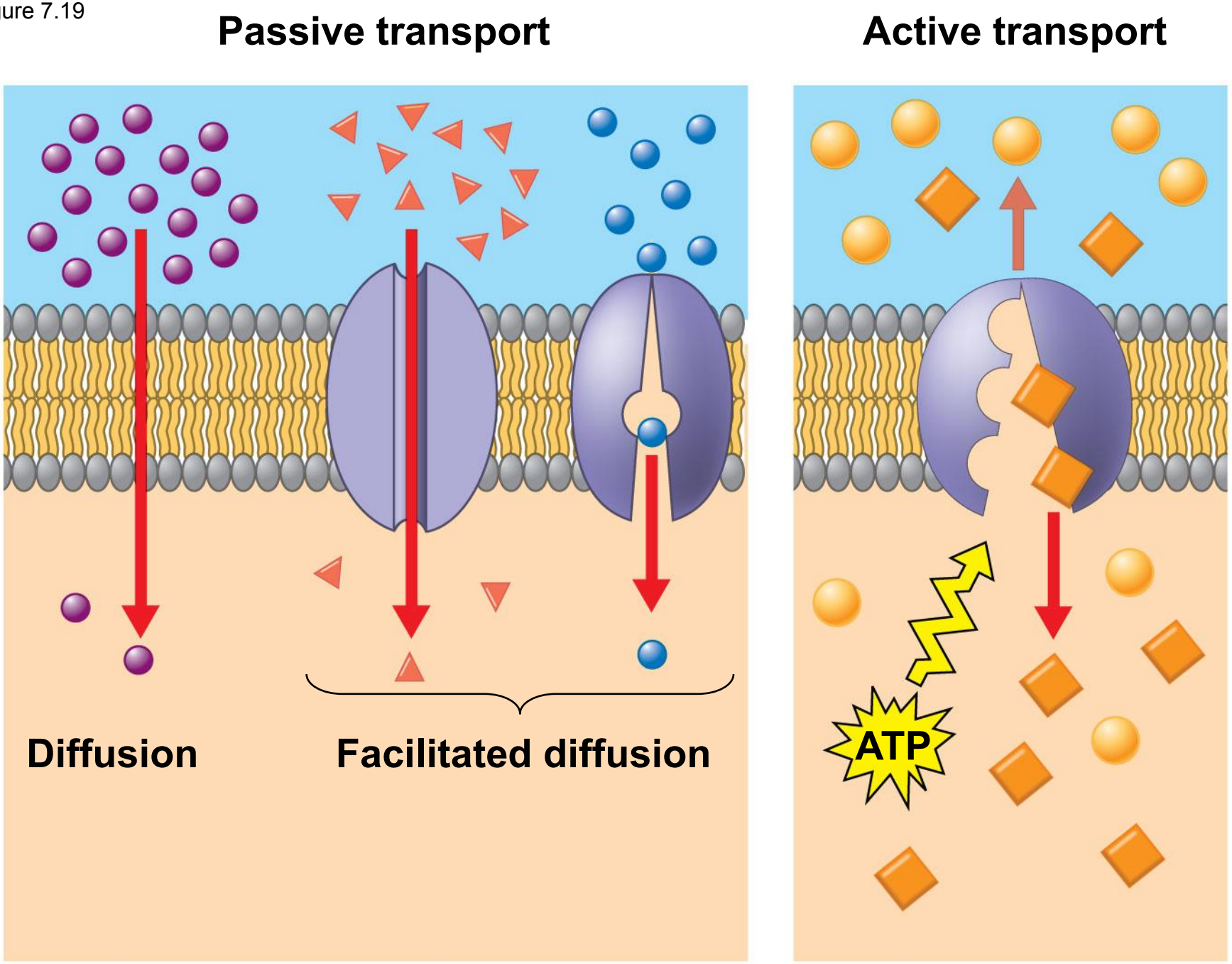
- Facilitated diffusion is still passive because the solute moves down its concentration gradient, and the transport requires no energy
- Some transport proteins, however, can move solutes against their concentration gradients

The Need for Energy in Active Transport

- **Active transport** moves substances against their concentration gradients
- Active transport requires energy, usually in the form of ATP
- Active transport is performed by specific proteins embedded in the membranes

PLAY Animation: Active Transport

Figure 7.19



- Active transport allows cells to maintain concentration gradients that differ from their surroundings
- The **sodium-potassium pump** is one type of active transport system

فش سنترو سوز فقط
موجود في الخلايا الحيوانية

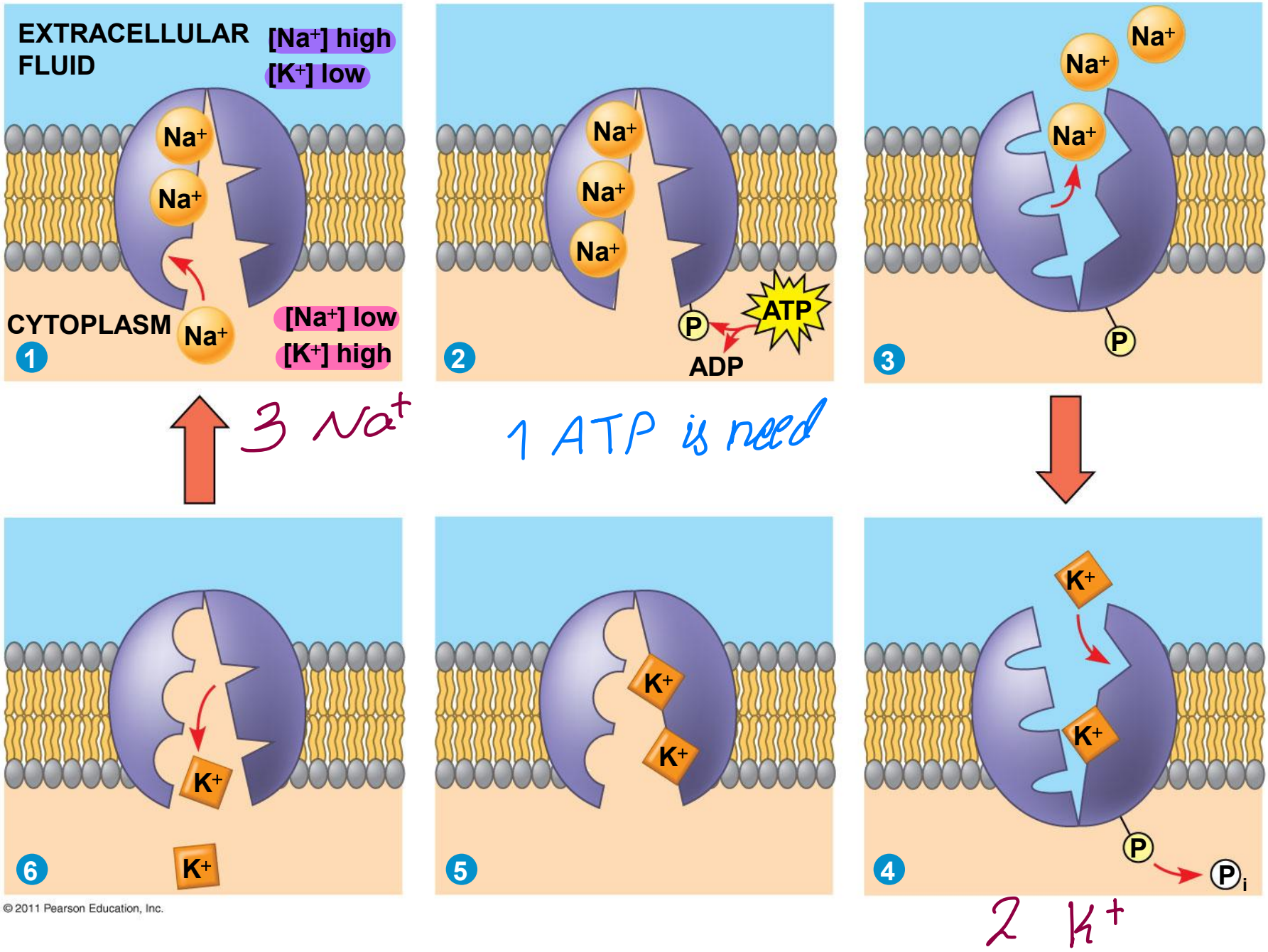
Active transport:

1) Na^+ / K^+ pump → in animal cells

2) proton H^+ pump → found in both animal and plant cells

Figure 7.18-6

like neuron cell خلية عصبية



How Ion Pumps Maintain Membrane Potential

- **Membrane potential** is the voltage difference across a membrane
- Voltage is created by differences in the distribution of positive and negative ions across a membrane

resting potential = −70 mV (ميلي)
membrane potential at rest

inside the cell is more negative than the outside

ممكن جوا الخلية سالب و برا موجب
او
جوا موجب و برا موجب بس تركيز الشحنات برا اعلى من تركيزهن جوا

عند دراسة السيال العصبي في الخلايا العصبية استخدموا جهاز الفولتميتر (voltmeter) لقياس فرق الجهد بين داخل الخلية و خارجها و لقوا انه في فرق جهد (لا يساوي صفر)، مما يعني انه تركيز الايونات بين داخل الخلية و خارجها يختلف
لقوا انه تركيز ايونات الصوديوم برا الخلية اعلى من جوا و العكس لايونات البوتاسيوم جوا عالي و برا قليل
في بروتين مخصص بحافظ على فرق تركيز الايونات بين داخل و خارج الخلية بحيث باستمرار بطلّع ٣ ايونات صوديوم برا و بدخّل ايونين ٢ بوتاسيوم لجوا فسموه مضخّة لإنه بضخ عكس اتجاه التركيز و بالتالي بحتاج الى طاقة (ATP) عشان يشتغل

يوجد قوتين يؤثرن على حركة الايونات

- Two combined forces, collectively called the **electrochemical gradient**, drive the diffusion of ions across a membrane
  1. – A chemical force (the ion's concentration gradient)
  2. – An electrical force (the effect of the membrane potential on the ion's movement)

مضخة مولدة للكهرباء

- An **electrogenic pump** is a transport protein that generates voltage across a membrane
- The sodium-potassium pump is the major electrogenic pump of animal cells
- The main electrogenic pump of plants, fungi, and bacteria is a **proton pump**
- Electrogenic pumps help store energy that can be used for cellular work