جامعة الملك سعود
King Saud University

college of sciences
Zoology Department

Cell Biology and Physiology

ZOO (242)

Objectives

Cell Membrane Structure:

Cell membrane is mosaics of structure and function.

- **The plasma membrane has a unique collection of proteins.**
- **These proteins may provide a variety of major cell functions.**
- **Specific proteins facilitate passive transport.**

Cell Membrane Functions:

- **Selective permeability.**
- **Passive transport.**
  - **A. Diffusion**
  - **B. Osmosis**
    - **Osmoregulation**
  - **C. Facilitated Diffusion.**

A) Structure of Cell Membrane

- **The plasma membrane separates the living cell from its nonliving surroundings.**
- **This thin barrier, 8 nm thick, controls traffic into and out of the cell.**
- **Like other membranes, the plasma membrane is selectively permeable** مُنفِذ إختياريا**,** *allowing some substances to cross more easily than others*.
- **The most abundant lipids in the cell membrane are phospholipids.**
- **Phospholipids and most other membrane constituents are amphipathic molecules.**
  - **Amphipathic molecules have both hydrophobic regions and hydrophilic regions.**

Membrane Structure

- The lipid molecules in the bilayer طبقة مزدوجة are arranged as hydrophobic fatty acid tails that are sheltered محمية from water while the hydrophilic phosphate groups interact with water.
- Some membrane proteins are amphipathic, with hydrophobic and hydrophilic regions.
- If at the surface, the hydrophilic regions would be in contact with water.
  - In this fluid mosaic model, the hydrophilic regions of proteins and heads phospholipids are in contact with water, while the hydrophobic regions are in a non-aqueous لا مائي environment.

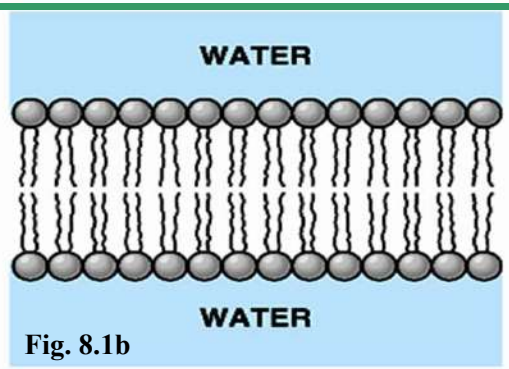
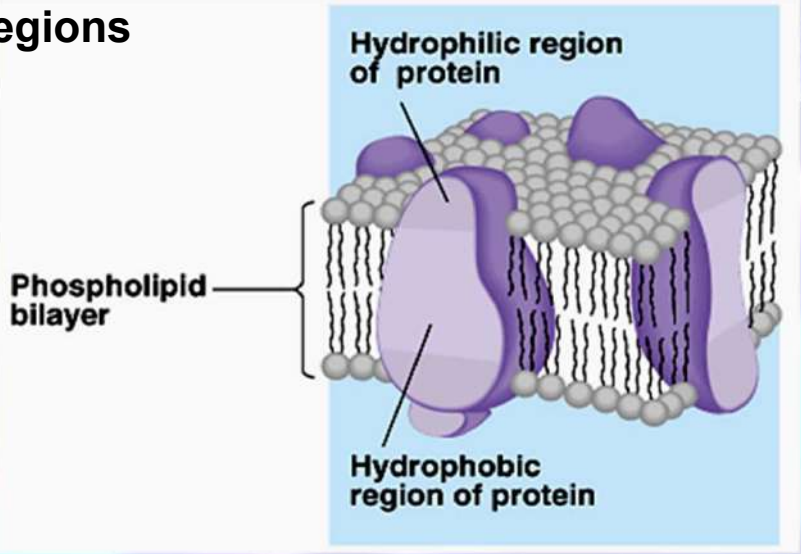


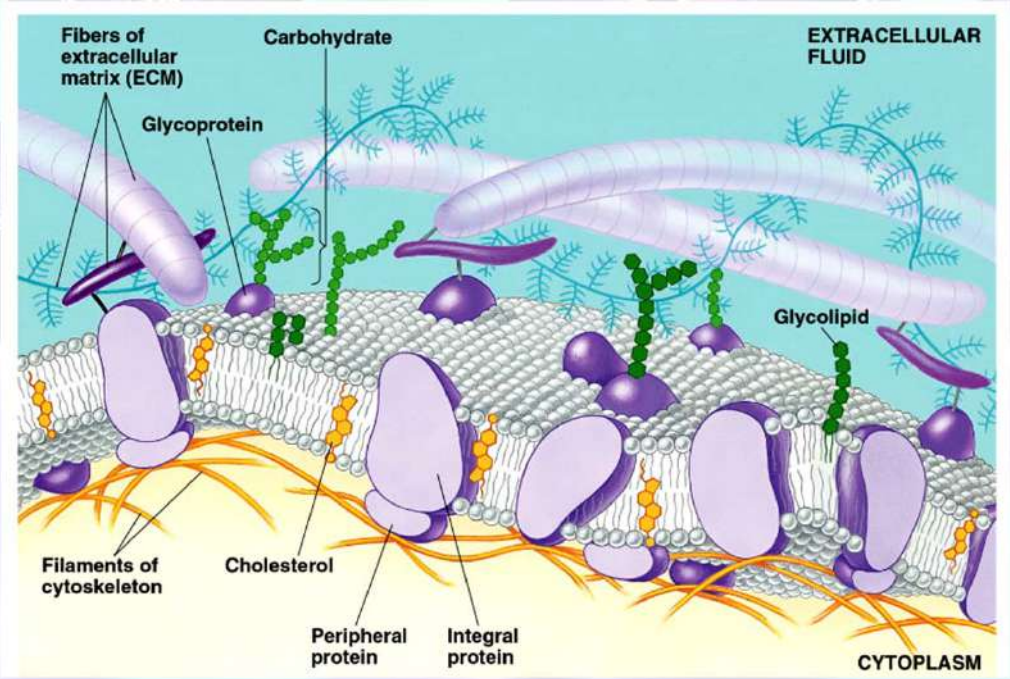
Fig. 8.1b



Cell membrane is mosaic of structure and function

- **A membrane is a collage تَـجَمُّع of different proteins embedded مُـنْـغَمِس in the fluid matrix of the lipid bilayer.**

To work properly with permeability, membrane must be fluid about as fluid as oil.



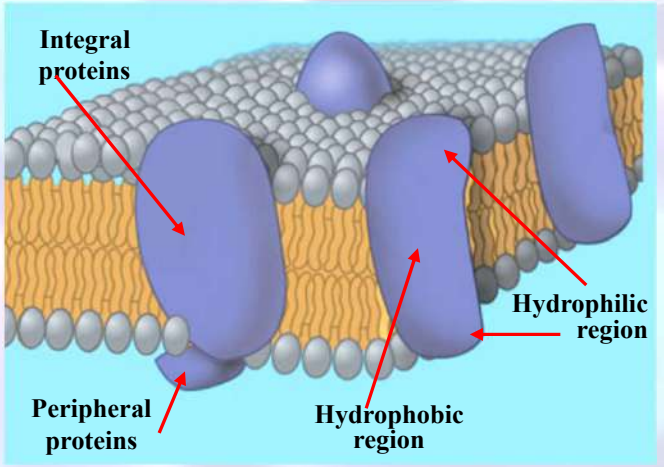
B)- The plasma membrane has a unique collection of proteins.

There are two populations of MEMBRANE PROTEINS.

1. **Peripheral protein** طرفي **(hydrophilic) is not embedded in the lipid bilayer at all. Instead, it is loosely bounded to the surface of the protein, often connected to the other population of membrane proteins.**

2. **Integral protein** مُنغمس **penetrates the hydrophobic core of the lipid bilayer, often completely spanning the membrane (*a transmembrane protein*). It is amphipathic, because:**

- **Where it is in contact with the core, it has a hydrophobic region.**
- **Where it is in contact with the aqueous environment outside the membrane, it has a hydrophilic region.**



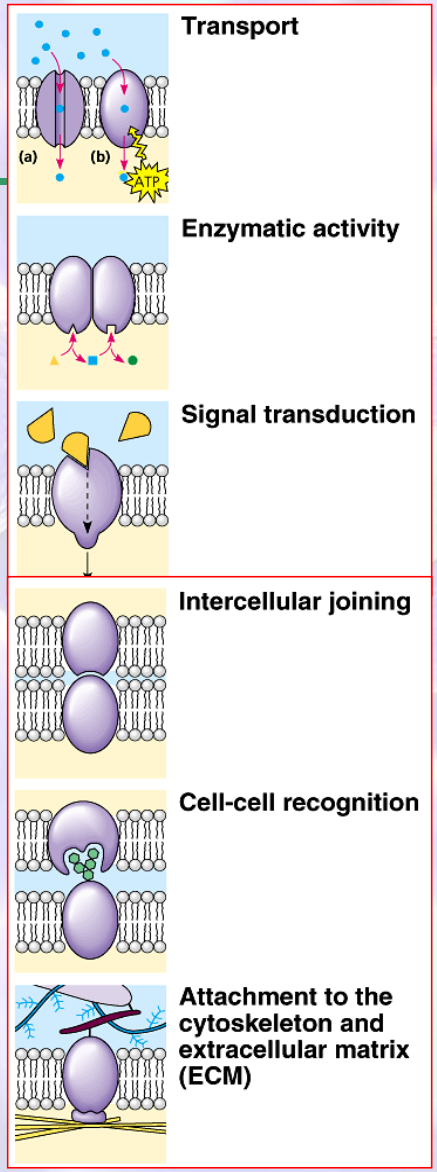
The proteins in the plasma membrane may provide a variety of major cell functions.

Aquaporins (*channel proteins*): are transport proteins that function by having a **hydrophilic channel** that facilitate the passage of **water** molecules through the membrane in certain cells. Without aquaporins, only a tiny fraction of water molecules would pass through the cell membrane.

Carrier protein (*glucose transporter*): in the plasma membrane of red blood cells transports **glucose** across the membrane 50,000 time faster than glucose can pass through on its own.

Nonpolar molecules, such as **hydrocarbons**, **CO_2**, and **O_2**, are **hydrophobic** and can therefore dissolve in the lipid bilayer of the membrane and cross it easily, without the aid of membrane proteins.

Thus, **the selective permeability** of a membrane depends on both the discriminating barrier of the lipid bilayer and the specific transport proteins built into the membrane

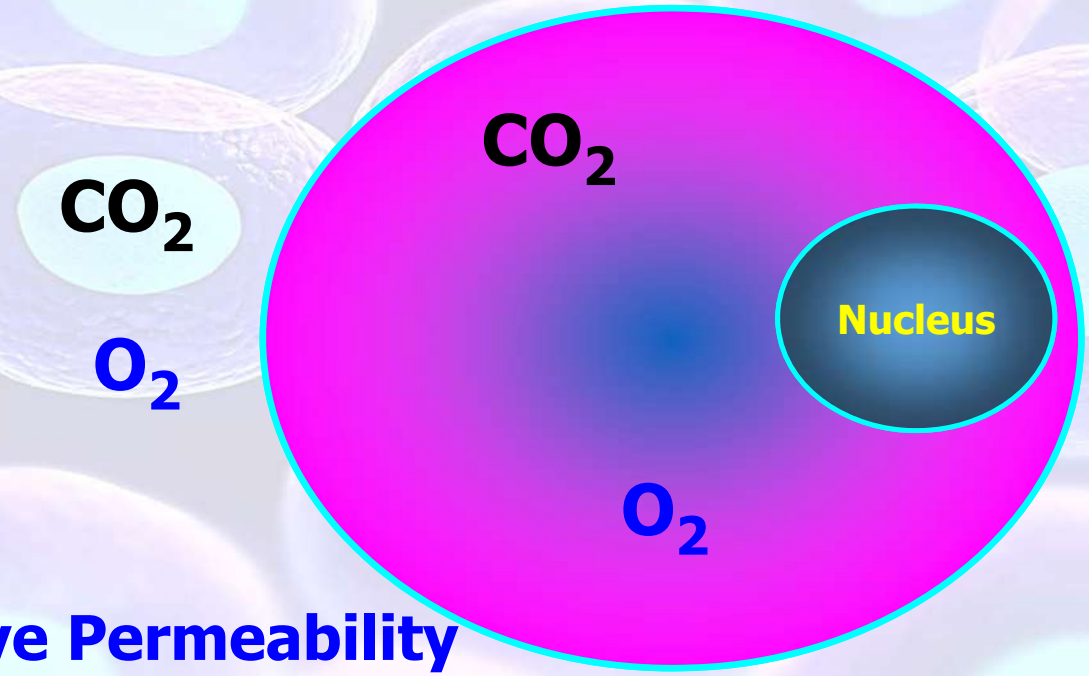


C)- Functions of cell membrane

1- Selective permeability النفاذية الإختيارية

- **A steady traffic** العبور المنتظم **of small molecules and ions moves across the plasma membrane in both directions.**
  - **For example, sugars, amino acids, and other nutrients enter a muscle cell and metabolic waste products leave it.**
  - **The cell absorbs O_2 and expels CO_2.**
  - **It also regulates concentrations of inorganic ions, like Na^+, K^+, Ca^{2+}, and Cl^-, by passing them across the membrane.**
- **However, substances do not move across the barrier indiscriminately** عشوائيا **as membrane is selectively permeable.**
- **Hydrophobic molecules, like hydrocarbons, CO_2, and O_2, can dissolve in the lipid bilayer and cross easily as described in the previous slide.**
- **Ions and polar molecules like H_2O and glucose pass through *channel proteins* as described in the previous slide.**
- **Thus membrane proteins assist and regulate** يساعد و ينظم **the transport of ions and polar molecules.**

C)- Functions of cell membrane



Selective Permeability

The cell is able to take up تنتقي **particular molecules and exclude** تتجنب **others**

C)- Functions of cell membrane

2- Passive transport الإنتقال السلبي

Involves the movement of molecules across the cell membrane without the need of energy by the cell.

No ENERGY is required to move substances across membrane (water, lipids, and other lipid soluble substances).

Rather, the CONCENTRATION GRADIENT represents potential energy and drives diffusion

Types of Passive transport:

I. **Diffusion**

II. **Osmosis**

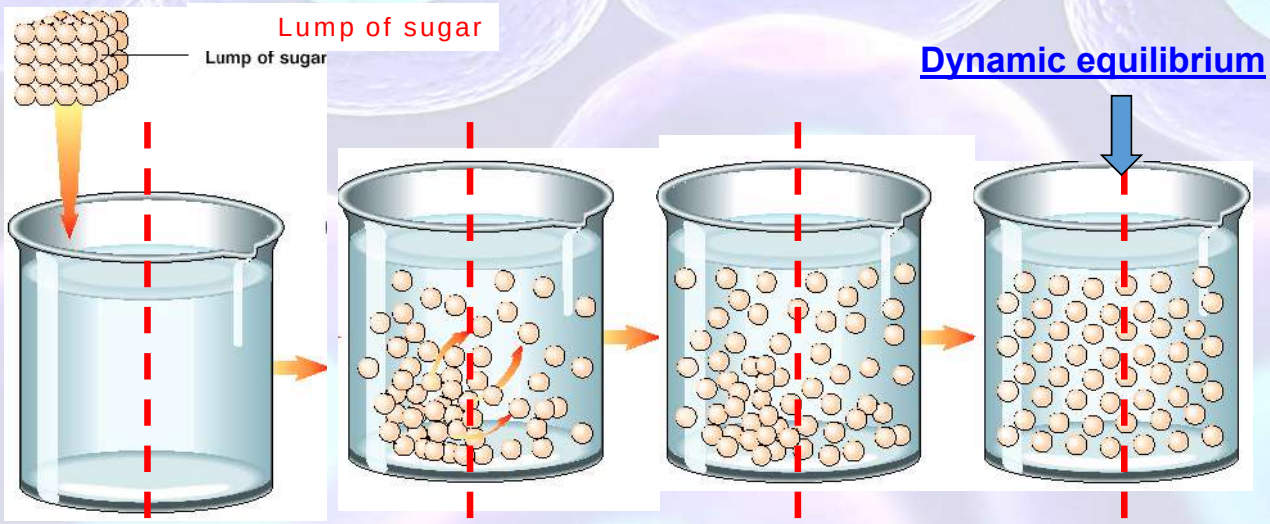
III. **Facilitated Diffusion**

I)- Diffusion:

(The passive transport of solutes molecules)

Is the tendency إستعداد of molecules of any substance to spread out للإنتشار in the available space randomly عشوائيا.

- **For example, a permeable membrane غشاء منفذ separating a solution with sugar molecules from pure water, sugar molecules will cross the barrier randomly.**
- **The sugar molecules will cross the membrane until both solutions have equal concentrations of the sugar (dynamic equilibrium التعادل الديناميكي).**



- **A substance will diffuse from where it is more concentrated to where it is less concentrated, down its concentration gradient مُنحدر التركيز.**

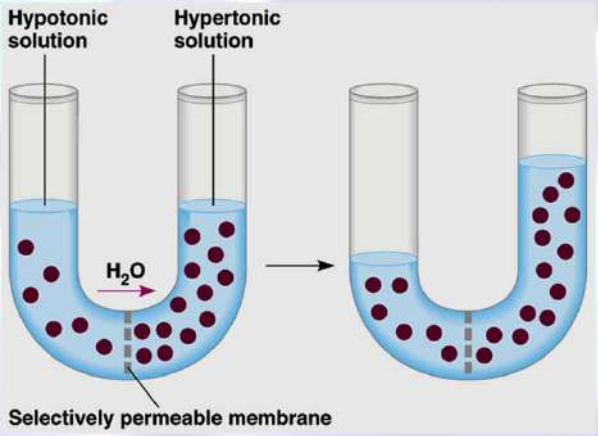
II). Osmosis الأسموزية :
(the passive transport of water)

Differences in concentration of dissolved materials in two solutions can lead to the movement of ions from one to the other.

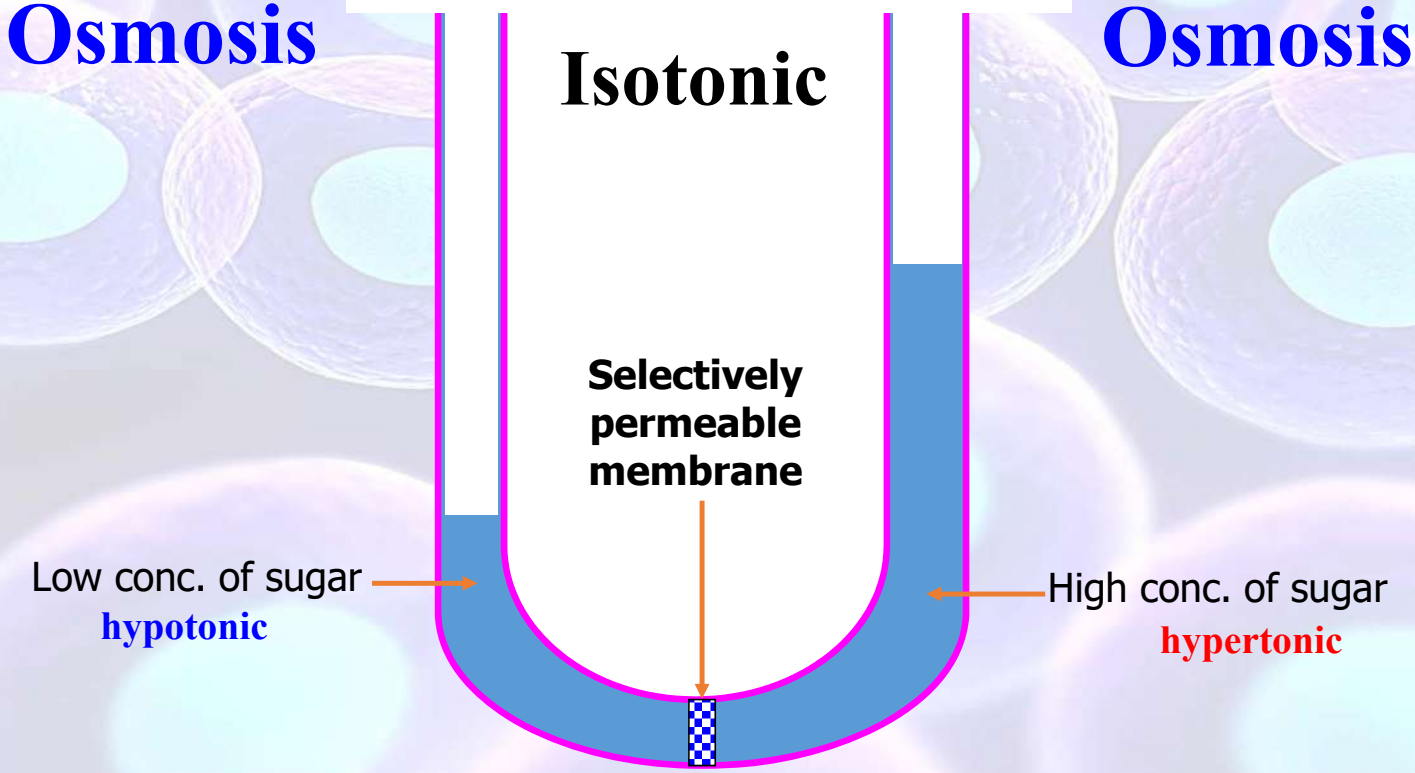
- The solution with the higher concentration of solutes is hypertonic.
- The solution with the lower concentration of solutes is hypotonic.
- Solutions with equal solute concentrations are isotonic.

- **Osmosis:**

  Is a passive transport in which water diffuses across a selectively permeable membrane from the hypotonic solution to the hypertonic solution until the solutions become isotonic.



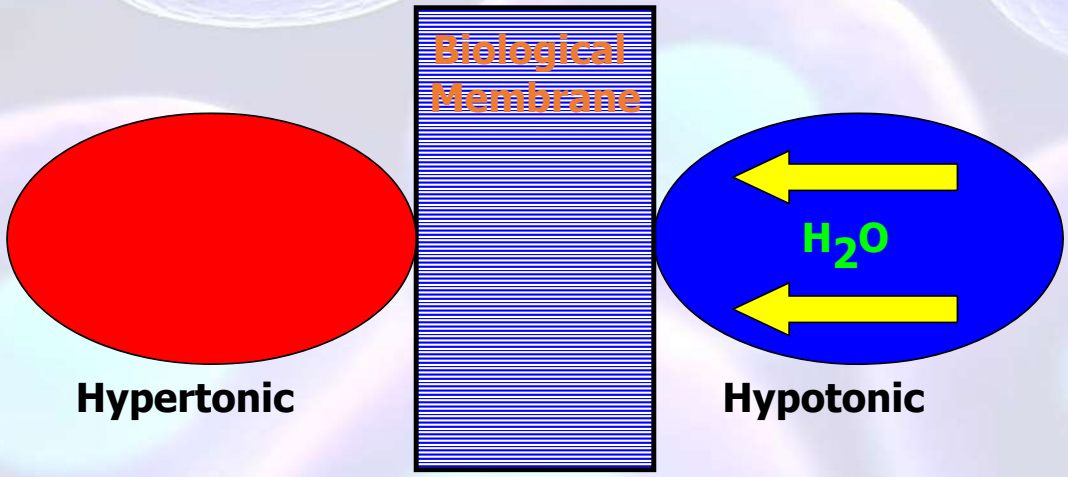
Principal of water movement (Osmosis)



Summary:

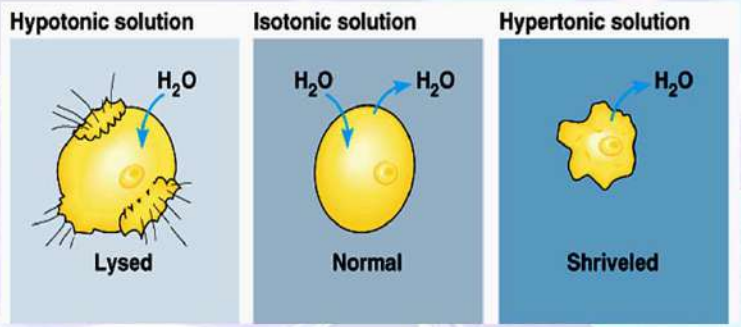
Types of solutions and Osmosis

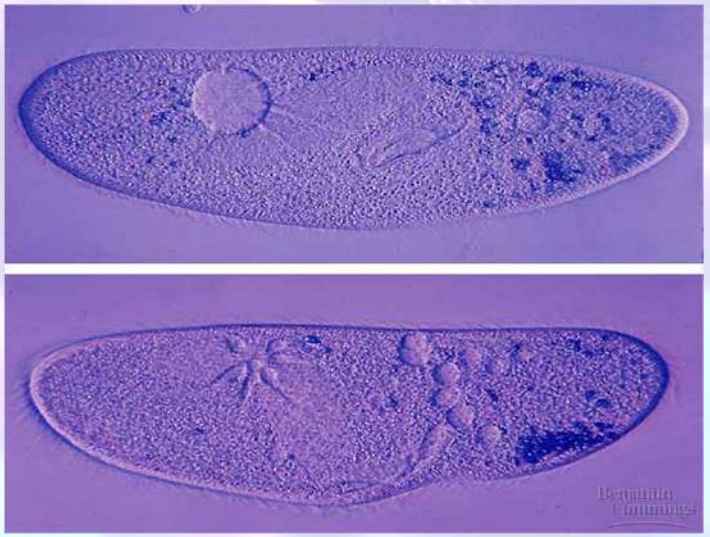
- **Hypertonic solution:** عالي التركيز
  contains high concentration of solute مُذاب molecules.
- **Hypotonic solution:** منخفض التركيز
  contains low concentration of solute molecules.
- **Isotonic solutions:** متعادل
  contain equal concentrations of solute molecules.



Osmoregulation التوازن الأسموزي

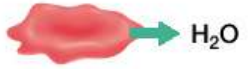
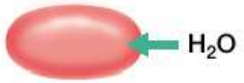
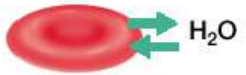
- The cell in a **hypertonic** environment will loose water, shrivel تتكمش, and die.
- A cell in a **hypotonic** solution will gain تسحب water, swell, and burst.
- Nothing will happen for a cell in an **isotonic** solution
  - ✓ Organisms without rigid walls have osmotic problems in either a hypertonic or hypotonic environment and must have adaptations for **osmoregulation** to maintain للحفاظ على their internal environment.
  - ✓ Example, *Paramecium* has a specialized organelle (**the contractile vacuole**), that functions as a pump to force يطرد water out of the cell.





Summary of Types of solutions

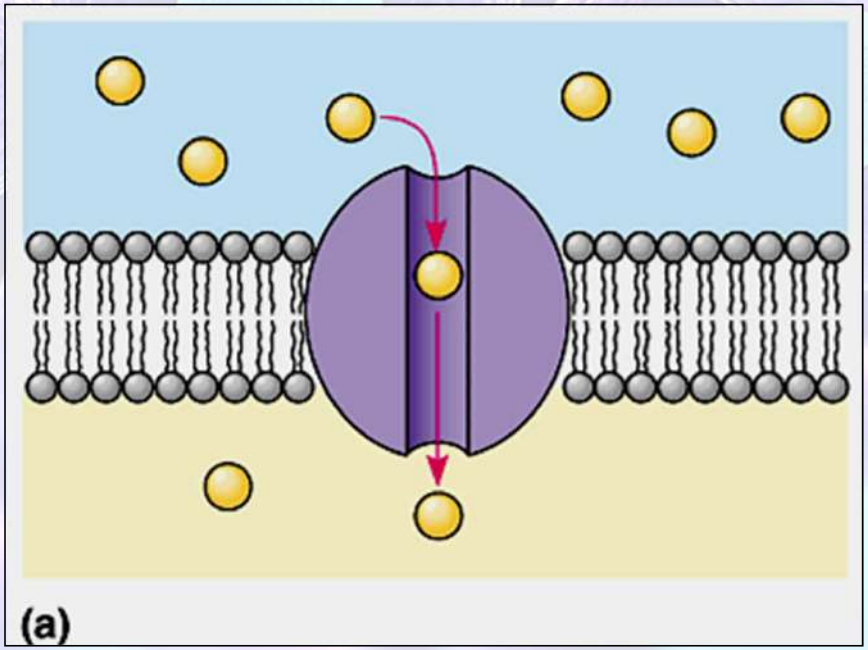
Behavior of water when a living cell is placed in Hypertonic, Hypotonic or Isotonic solutions

If the fluid outside the cell has…	Then outside fluid is…	Water diffuses…	Effect on cell
…lower free water molecule concentration than cytosol	…hypertonic.	…out of cell. 	Cell shrinks.
…higher free water molecule concentration than cytosol	…hypotonic.	…into cell. 	Cell swells.
…same free water molecule concentration as cytosol	…isotonic.	…into and out of cell at equal rates. 	Cell stays same size.

III)- Facilitated Diffusion:

passive transport تسهيلSpecific proteins facilitate

- **Many polar molecules and ions diffuse passively through the lipid bilayer with the help of transport proteins (gated channels قنوات مُبَوبة).**
- **The passive movement of molecules down its concentration gradient via a transport protein is called facilitated diffusion.**



- **Many transport proteins simply provide channels allowing a specific molecule or ion to cross the membrane.**

Summary

- **Membrane structure results in selective permeability.** A cell must exchange molecules and ions with its surroundings, a process controlled by the **selective permeability** of the plasma membrane. Hydrophobic substances are soluble in lipid and pass through membranes rapidly, whereas polar molecules and ions generally require specific **transport proteins** to cross the membrane.
- **Passive transport is diffusion of a substance across a membrane with no energy investment.**
- **Diffusion** is the spontaneous movement of a substance down its **concentration gradient**.

Summary

- Water diffuses out through the permeable membrane of a cell (**osmosis**) if the solution outside has a higher solute concentration (**hypertonic**) than the cytosol; water enters the cell if the solution has a lower solute concentration (**hypotonic**). If the concentrations are equal (**isotonic**), no net osmosis occurs.
- Cell survival depends on balancing water uptake and loss. Cells lacking walls (as in animals and some protists) are isotonic with their environments or have adaptations for **osmoregulation**. Plants, prokaryotes, fungi, and some protists have relatively inelastic cell walls, so the cells don't burst in a hypotonic environment.
- In a type of **passive transport** called **facilitated diffusion**, a transport protein speeds the movement of water or a solute.

References

- **"membrane structure and function" Biology by Jane B Reece; Neil A Campbell; et al** Boston : Benjamin Cummings / Pearson, ©2011. English : 9th ed. chapter 07