Physiology

Doctor 2019 | Medicine | JU

◉ Sheet ○ Slides

Done By

Zainab Haj-Yasin

Contributed in the Scientific Correction

Bushra Ghnimat

Contributed in the Grammatical Correction

Bushra Ghnimat

Doctor

Faisal Mohamad

^ all the information in the first 10 minutes is included in the second sheet ^

REVIEW

Passive processes - substances move across cell membranes without the input of any energy; use the kinetic energy of individual molecules or ions.

Active processes - a cell uses energy, primarily from the breakdown of ATP, to move a substance across the membrane, i.e., against a concentration

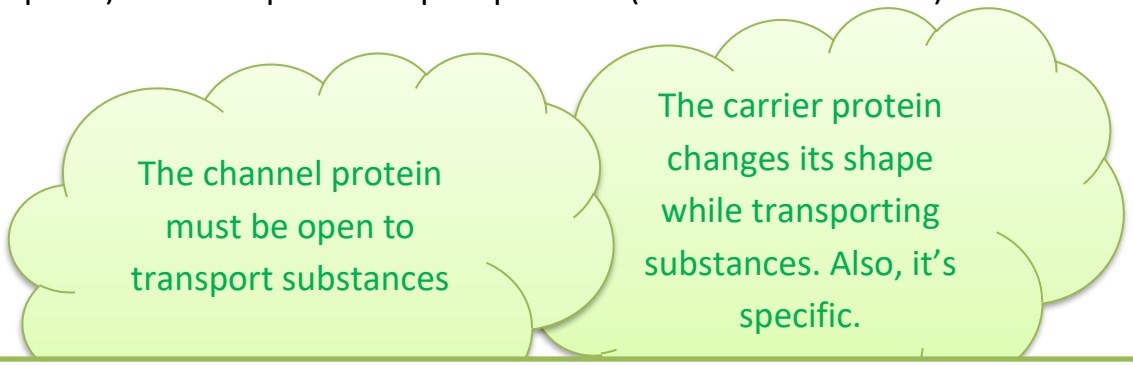
Gradient.

10 - 20

 # simple diffusion: the diffusion in which substances are able to dissolve in the lipid bilayer without needing a protein channel like some gases and fat soluble vitamins (hydrophobic).

NOTE: when doctors do operations, they use **Anaesthetic gases** which diffuse through the membrane rapidly. Consequently, the patient gets unconscious fast. The same way the patient wakes fast when the gas leaves the membrane quickly.

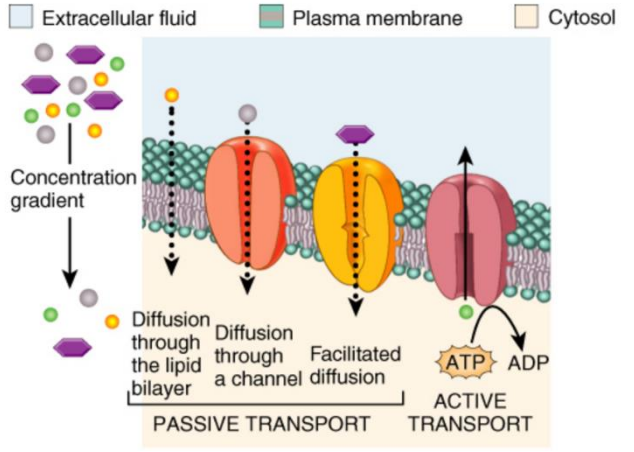
facilitated diffusion: some substances are not soluble in lipid like glucose and ions (hydrophilic) which require transport proteins (channel and carrier).

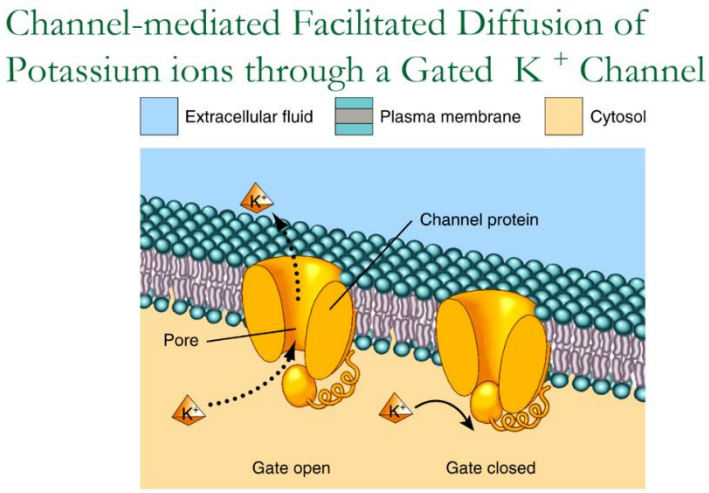


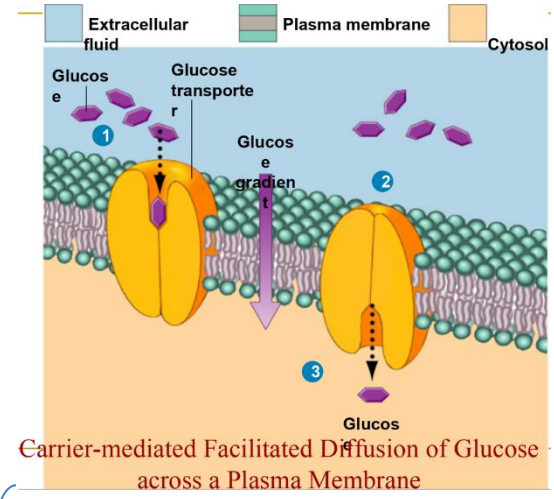
If the transport protein is channel, then the diffusion is called **Channel-mediated facilitated diffusion**, if it is carrier, the diffusion is **called Carrier-mediated facilitated diffusion**

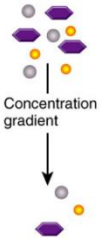
**Both types (facilitated + simple) diffusion are passive transport

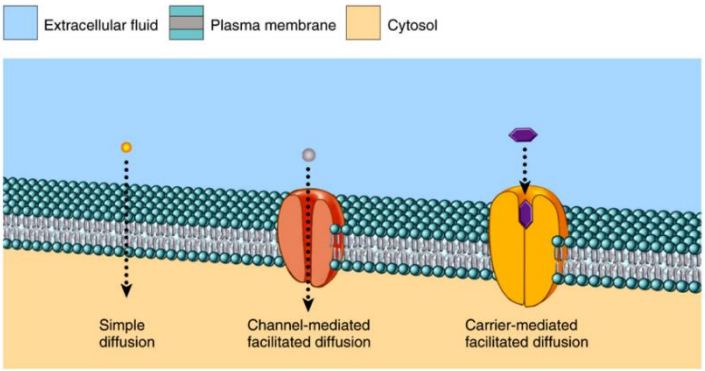
*look at the pictures for further understanding











(glucose can't pass through the membrane , The carrier protein at the membrane binds to the glucose and alters its shape such that it can easily to be transported from one side of the membrane to the other)

(Each molecule has a specific carrier protein that assists the molecule across the cell membrane. That molecule can only cross the cell membrane if the particular carrier protein is available).

Facilitated diffusion Vs Simple diffusion

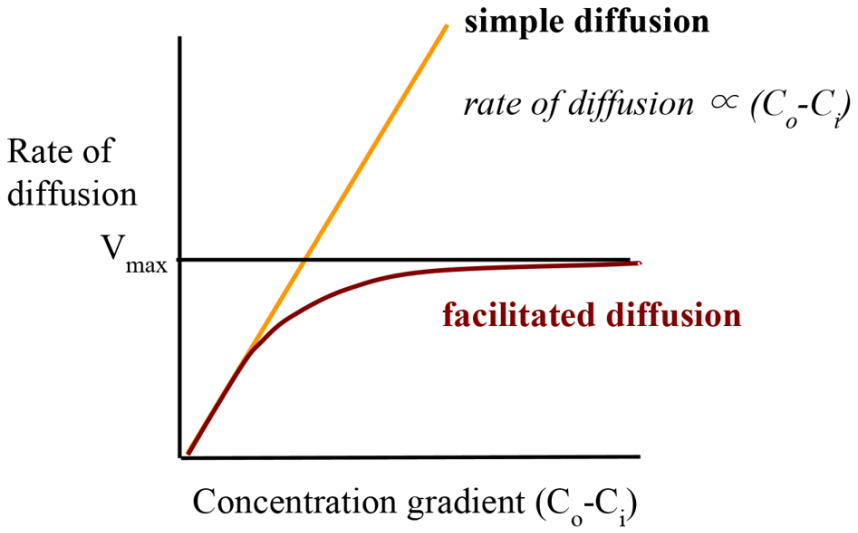
Facilitated diffusion **specifically the carrier mediated diffusion** is saturable because the binding sites are limited and has transport maximum (T max) or velocity maximum (V max) **unlike** the simple diffusion that has no limit as long as there is a concentration gradient.

للتوضيح ..... ممكن الناقلات البروتينية تتعبّى وتصير مشبعة بس الغشاء البلازمي مو ممكن يصير له هيك عشان هيك ازا زاد تركيز المواد المنقولة الغشاء البلازمي بضل يدخّل المواد بدون مشكلة، بس النواقل ممكن توصل لـ V max. فمثلاً، نفرض إنه عدد النواقل 200 وعنا 400 جزيء بدهم يمرقوا من الغشاء، النواقل بس بتقدر تدخّل 200.

Note: saturated means having maximum amount of substances that can be transported.

Another note: the simple diffusion can be limited (it can stop) only if the concentration of the substance is equal inside and outside the cell.

*This graph clarifies the idea



CAUTION!!!!!!

The channel mediated diffusion is not what we are talking about

The protein channels keep being opened (no traffic, no saturation)

What we're talking about is the carrier mediated diffusion only!

V max: maximum amount that can be transported.

(V represents velocity)

EXAMPLE

Receptors of hormones in the membrane are for example 100 If there are 200 hormones, half of them only get in, but if they were 50, all of them get into the cell.

20-30

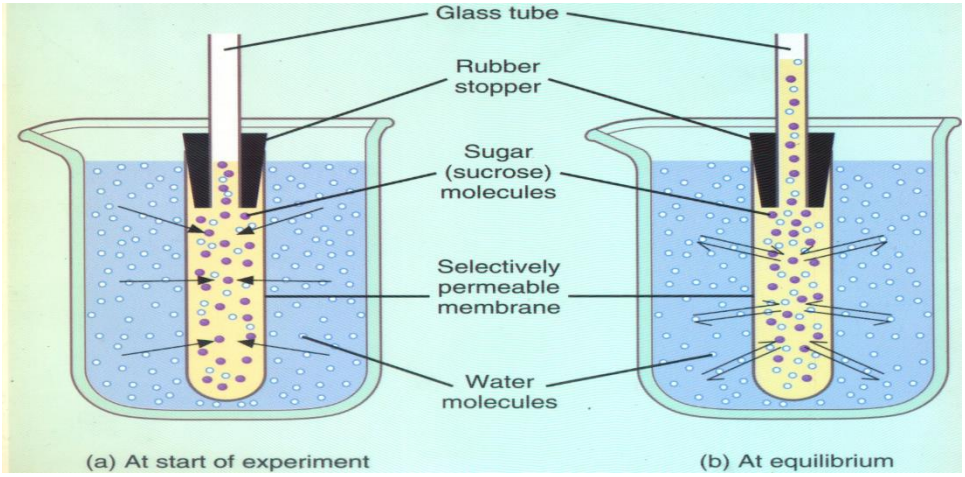
Osmosis

*It is the net movement of water through a selectively semi permeable membrane from an area of high concentration of water (lower concentration of solutes) to one of lower concentration of water(higher concentration of solutes).

***Water can pass through plasma membrane in two ways:**

1) Through lipid bilayer by simple diffusion

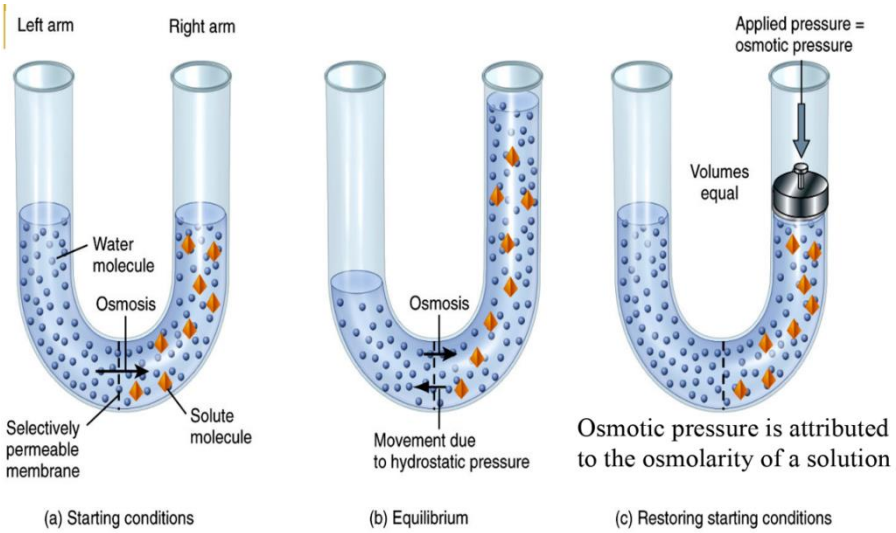
2) Through aquaporins, integral membrane proteins.



Appreciable notes:

-The semi permeable membrane must be permeable to water only. (Solutes must not pass)

-When water passes from the left side to the right side, a pressure is exerted (hydrostatic pressure) which prevents more water from passing from left to right.(hydrostatic=osmotic)



-If the membrane is permeable to solutes, then the solutes will pass from right to left (down the gradient)

-It is the osmotic pressure which pulls the water from left to right.

-If we have for example 100 molecules of solute in the right side, water will pass and the concentration of it will decrease in the left side. If we have 200 molecules, the conc of

water decreases more and so on.

30-40

-Osmotic Pressure and the factors on which it depends: **Van't Hoffs Equation**

*All non-penetrable solutes in a solution exerts osmotic pressure

* According to Van't Hoff, osmotic pressure (π) depends on the molar concentration and the temperature T in kelvin.

π = nRT where R is the gas constant

Note: the doctor said in the lecture: the osmotic pressure depends on the number of moles But actually -in the slides- n represents the molar concentration

Osmotic pressure

* **Osmotic pressure** is higher when molar concentration is higher, or temperature is higher and the molecular weight is lower. (Remember the law .. n=mass/molecular weight)

* **Osmotic pressure** depends mainly on the molar concentration or molarity of a solution.

* **Osmotic pressure** is a colligative property meaning that the property depends on the concentration of the solute but not on its identity.

- The osmotic pressure of an ionic solution is **π = i nRT**

where "i" is the number of ions formed by dissociation per molecule

The I for NaCl is 2 and for CaCl2 is 3 as explained in the next page

* The greater the no of ion/molecule when dissolved greater the osmotic pressure (direct proportion)

Osmolarity Vs Osmolality

***Osmolarity**: A term used to describe the total number of osmotically active particles (not permeable solutes) per liter of solution.

EXAMPLE

-If 39 g of potassium are dissolved in water, we say: the osmolarity of the solution is 1 OsM.

***Osmolality**: A term used to describe the total number of osmotically active particles per kilogram of water.

-Two solutions can have the same molarity but may have different osmolarities.

EXAMPLE: OsM of 1 M glucose solution =1 OsM **AND** OsM of 1 M NaCl solution = 2 OsM

(1 mole of NaCl is dissolved completely, the Na osmolarity is 1, the Cl osmolarity is 1, so the total is 2)

(The osmolarity of 1 mole CaCl2 is 3 because there are 2 atoms of Cl)

The molarity is the number of moles per liter

-The relation between the osmolarity and osmotic pressure?

The higher the osmolarity, the greater the osmotic pressure of the solution.

40-50

-If we have water only (without solutes) then the osmolarity is 0.

Pressures of a solution

- Osmotic pressure (the pulling pressure) of a solution is the measure of tendency of a solution to pull water into it by osmosis because of the relative concentration of non penetrating solute and water.

- Hydrostatic pressure of a solution is the pressure exerted by a stationary fluidic part of the solution on an object (semi permeable membrane in case of osmosis).

- Net hydrostatic pressure of a solution = hydrostatic pressure – osmotic pressure.

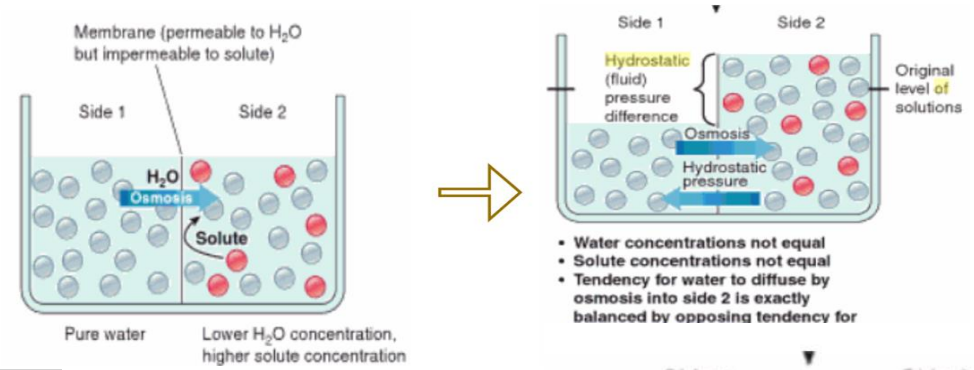
EXAMPLE

- Separate pure water from a sugar solution with semi permeable membrane.

- Both have same hydrostatic pressure.

- Osmosis take water from side 1 to side 2 because solution on side 2 has greater pulling tendency.

- Will all water go to side 2? No it stops after some time. This is the equilibrium state.



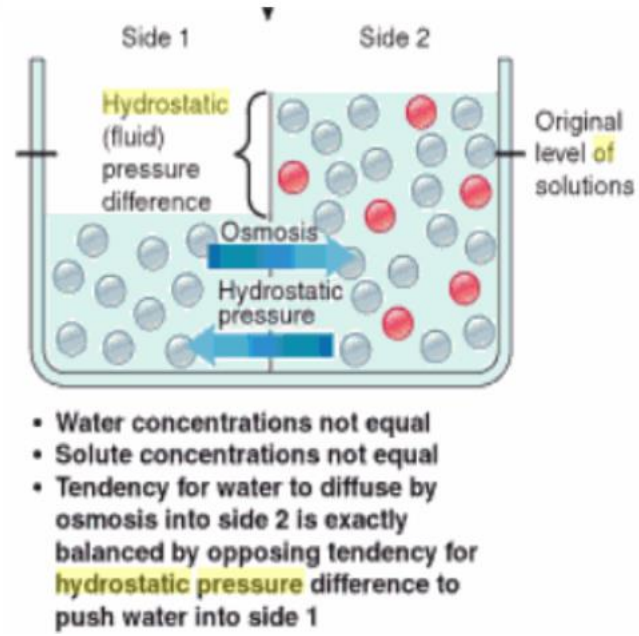
Equilibrium state

As water moves by osmosis to side 2, Solution on side 2 has two tendencies now:

1) Tendency to push water back to side 1 due to greater hydrostatic pressure

2) Tendency to pull water by osmosis back to side 2

Equilibrium is achieved when tendency to pull water to side 1 and to push water into side 2 balances out (hydrostatic=osmotic)



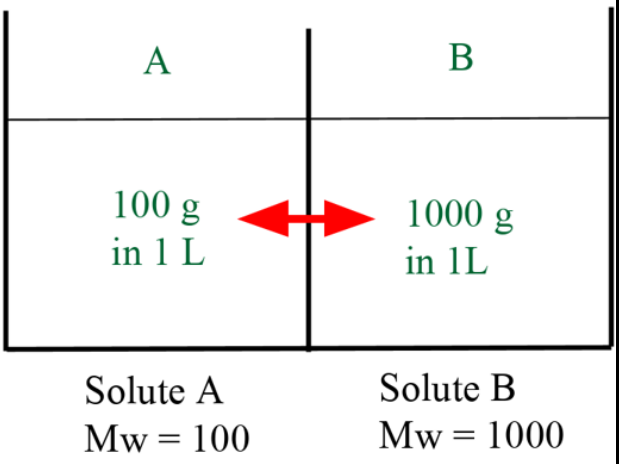
Try to answer

*Which solution has the greatest osmolarity?

*Which has the greatest molar concn?

*Which has the greatest number of molecules?

(6.02x10^23 particles)



No net movement

Answers

The same , the same, the same

Relation between osmolarity and molarity

mOsm (millisomolar) or mOsm/L = index of the concn of particles per liter soln

mM (millimolar) or mM/L = index of concn of molecules per liter soln

mM NaCl 150 = 300 mOsm

mM glucose 300 = 300 mOsm

They are iso osmolar

Water moves from low osmolarity to high osmolarity

Intracellular=extracellular=aroud 300 mOsm

Very small information may not be important: the thickness of the membrane may vary and this variation indicates a disease

The End