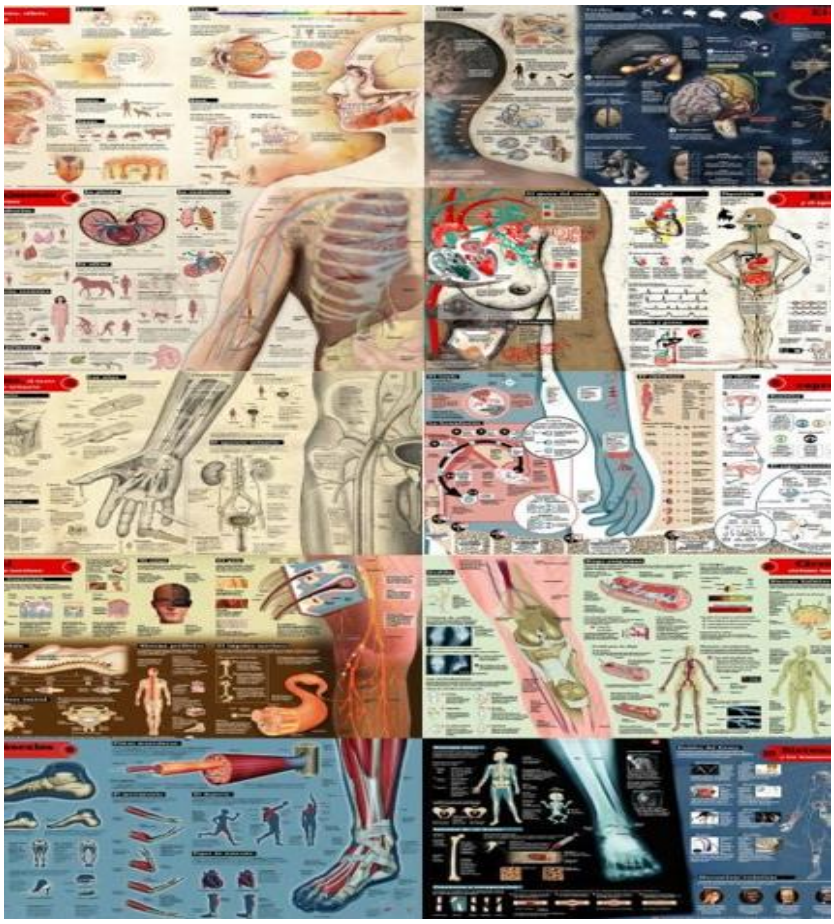
The University of Jordan

Dentistry 020

Physiology



Title: Forth sheet/Introduction to physiology(4)

Writer: Ayham Daoud

Doctor: Fasial Mohammad

Final Correction Deema Albaik

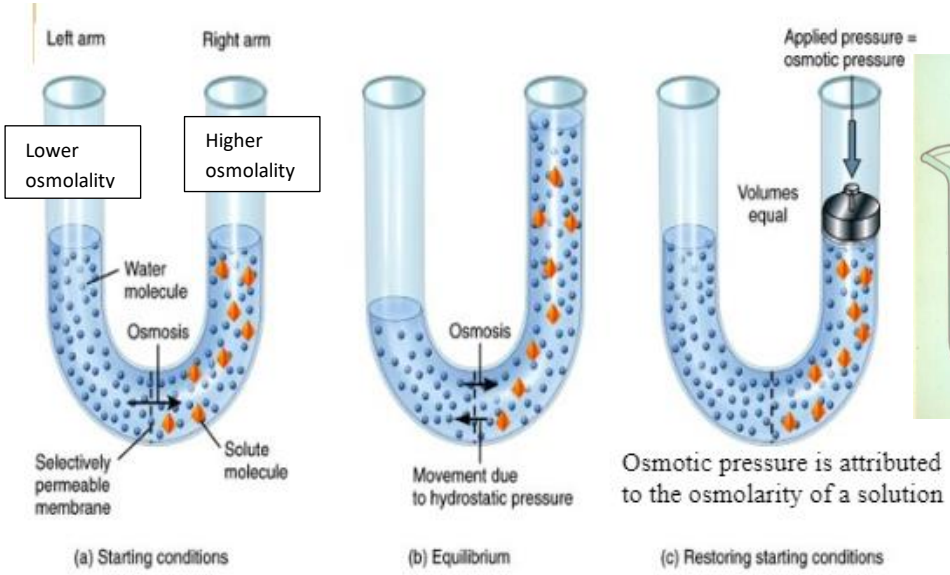
Osmosis

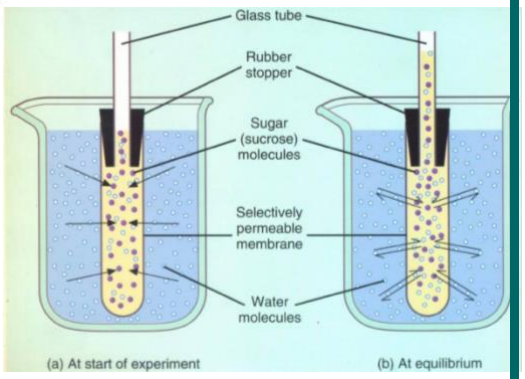
*it is the net movement of water through a selectively permeable membrane from an area of high concentration of water (lower concentration of solutes) to one of lower Concentration of water (higher concentration of solutes)

*Water can pass through plasma membrane in two ways(methods):

1)Through lipid bilayer by simple diffusion (less amount)

2)Through aquaporins (water channel), integral membrane proteins





###IMPORTANT NOTES###

* The semi permeable membrane is only permeable to water molecules

* when water passes from the left side to right one, a pressure exerted prevents more water from passing

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

شرح مختصر للعملية: مبدئيًا كل محلول الو hydrostatic pressure والآن بسبب اختلاف تركيز الماء بين الطرفين
رح ينتقل الماء من الطرف اليسار للطرف اليمين عن طريق ال osmosis
بنلاحظ عند (b) بالطرف اليمين انو ارتفع عمود الماء وزاد وزنو فعمل ضغط اسمو osmaotic pressure وكمان
بنلاحظ انو ال hydrostatic pressure عاليمين صار اكتر من اليسار
فممكن من البداية امنع حركة المي واعمل pressure يساوي ال osmotic pressure ويرجع زي ال starting condition

☒ Osmotic pressure and the factors on which it depends: Vant's Hoffs Equation

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

-According to Vant's hoff, osmotic pressure(π) depends on the molar concentration and the temperature (T) in kelvin

$$\pi = nRT \quad \text{where R is the gas constant}$$

Osmotic pressure

*__Osmotic pressure__ is higher when molar concentration is higher, or temperature is higher and the molecular weight is lower

*__Osmotic pressure__ depends mainly on the molar concentration or molarity of solution

*__Osmotic pressure__ is 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:

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

$$\pi = i\,nRT$$

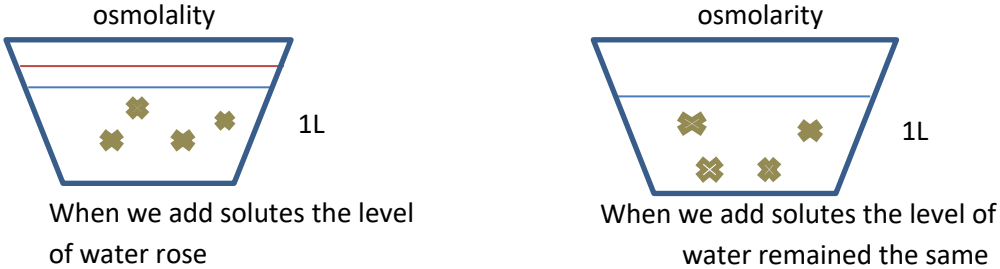
(also i=the number of osmoles)

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

Osmolarity/osmolality

- **Osmolarity:** Is used to describe the total no. of osmotically active particles per liter of solution
- **Osmolality:** Is used to describe the total no. of osmotically active particles per kilogram of water

Note:



When we add solutes the level of water rose

When we add solutes the level of water remained the same

#Note# two solutions can have the same molarity but may have different osmolarities such as:

OsM of 1 M glucose solution =1 OsM

OsM of 1 M NaCl solution = 2 OsM

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

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

Pressures of a solution

***osmotic pressure** (the pulling pressure) of 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 solution is the pressure exerted by a stationary fluidic part of the solution on an object (semi permeable membrane in case of osmosis

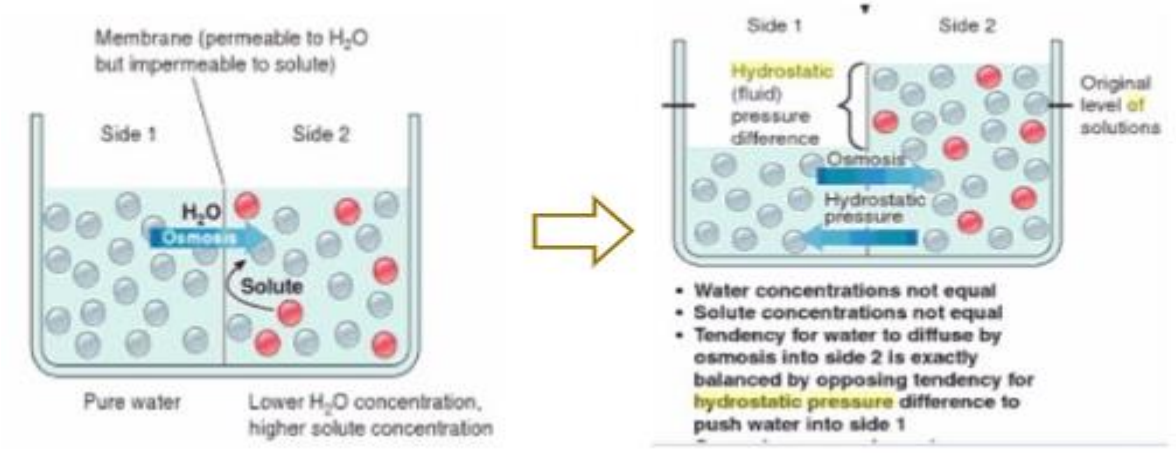
-Net hydrostatic pressure of a solution= hydrostatic pressure _ osmotic pressure

EXAMPLE:

-Separate pure water from sugar solution with semi permeable membrane

- Both have same hydrostatic pressure

-Osmosis take water from side one to side two because solution on side 2 has greater pulling tendency_Will all water go to side 2? No, it stop after some time (equilibrium state)



-As water moves by osmosis to side 2 , solution on side 2 has two tendencies:

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

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

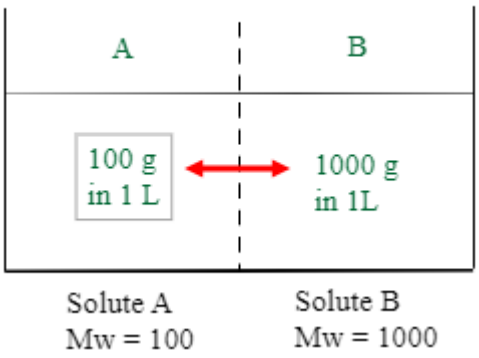
*Equilibrium is achieved when tendency to pull water to side 1 and to push water into side 2 balances out (hydrostatic= osmotic)

ANOTHER EXAMPLE

-Which solution has the greatest osmolarity?

-which has the greatest molar concentration?

-which has the greatest no. of molecules?
(6.02 * 10^23 particles)



ANSWERS

THE same, the same , the same

There's no net movement

Relation between osmolarity and molarity

- mOsm (milisomolar) or mOsm/L=index of the concn of particles per liter solution

- Mm (milimiolar) or Mm/L = index of conc of molecules per liter solution

150 Mm Nacl= 300 mOsm

300 Mm glucose = 300 mOsm

100 Mm $cacl_2$ = 300 mOsm

*Water moves from low osmolarity to high osmolarity

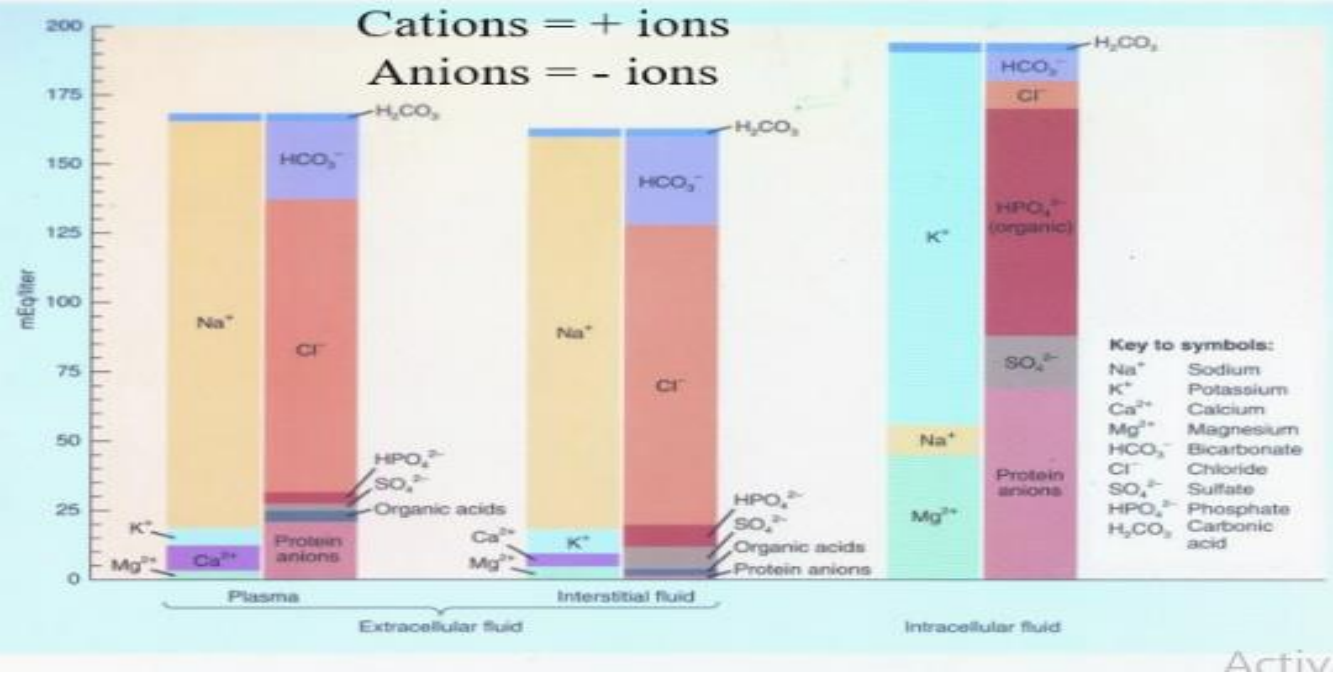
NOTE:

300 mOsM: isotonic/isoosmolar

>300: hypertonic

<300:hypotonic

*Our body fluids (ECF and ICF) have osmolarity around 300 mOsM



*positive ions are called cations, negative ions are called anions ,they are called so because positive ions are attracted to the negative pole (cathode) and the negative ions are attracted to the positive pole (anode)

	Major cation	Major anion
Extracellular fluid	NA+	Cl-
Intracellular fluid	K+	HPO_4^{-2} AND protein anion

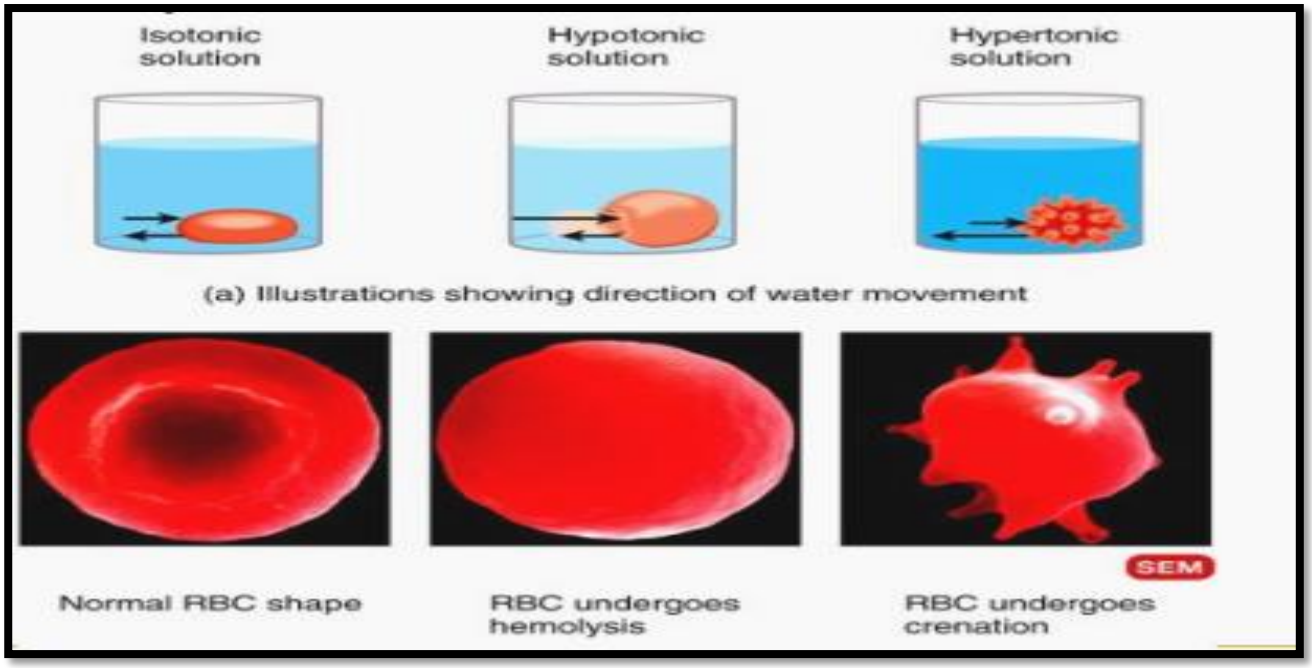
- The main difference between plasma and interstitial fluid is protein anions

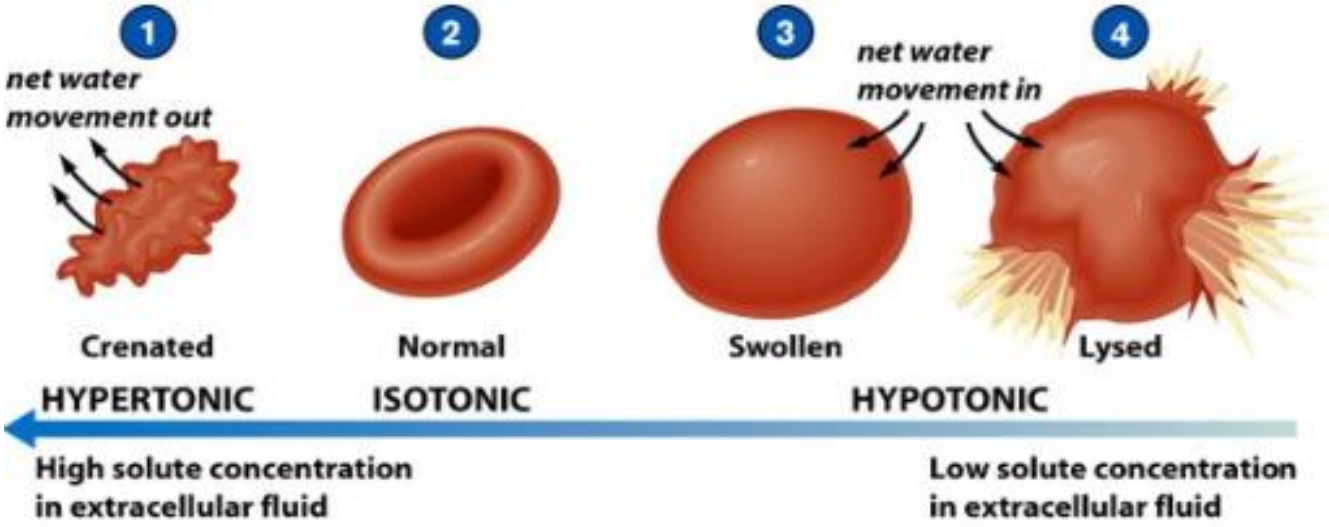
Tonicity and its effect on RBCS

✓ If red blood cell put in an isotonic solution, the net water movement is zero

✓ If put in hypotonic solution, water will move towards the higher osmolarity it will move inside the cell causing hemolysis (blood break)

✓ If put in hypertonic solution the water will move outside the cell, causing crenation (shrink)


Isotonic solution
Hypotonic solution
Hypertonic solution
(a) Illustrations showing direction of water movement
SEM
Normal RBC shape
RBC undergoes hemolysis
RBC undergoes crenation


1
net water movement out
2
3
net water movement in
4
Crenated
Normal
Swollen
Lysed
HYPERTONIC
ISOTONIC
HYPOTONIC
High solute concentration in extracellular fluid
Low solute concentration in extracellular fluid

Active transport

Solutes are transported across plasma membrane with the use of energy, from an area of lower concentration to an area of higher concentration sodium potassium pump

The types of active transport

A) primary active transport

-Molecules are pumped against a concentration gradient at the expense of energy (ATP)

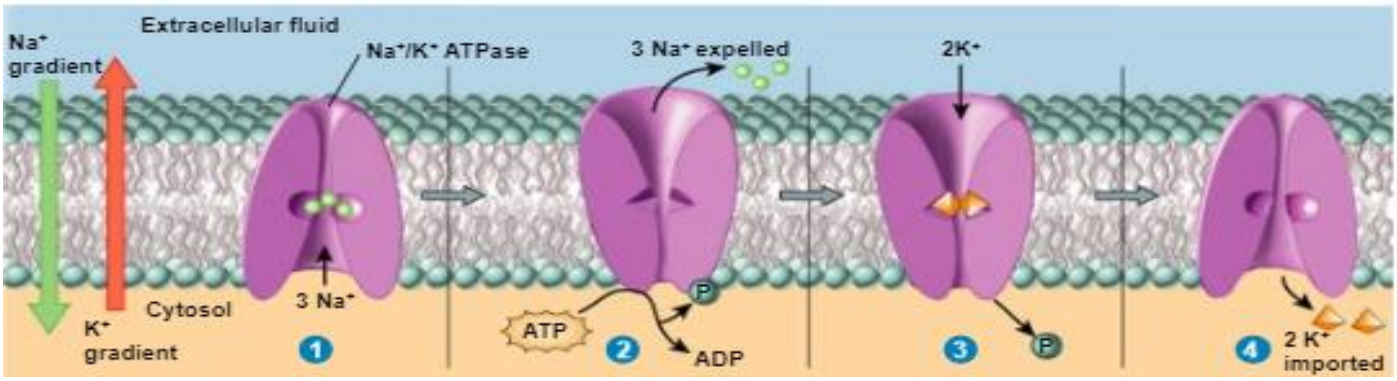
-Direct use of energy

B) Secondary active transport

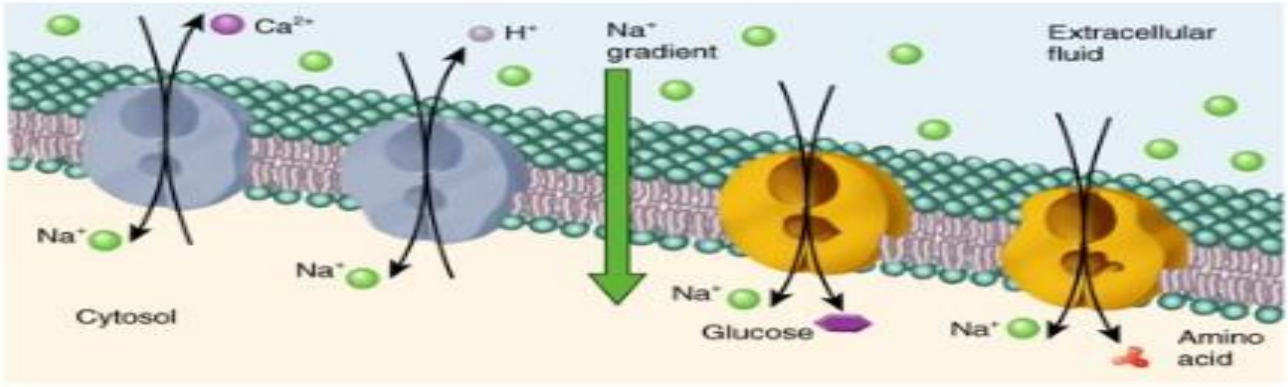
- Transport is driven by the energy stored in the concentration gradient of another molecule (Na^+)

-Indirect use of energy

Primary:



secondary:



(a) Antiporters

Counter-transport

(b) Symporters

Co-transport

The first type of secondry active transport is antiport or counter transport

-An example for counter transport is sodium hydrogen pump

-The second type of secondry active transport is symport (co-transport), example are the sodium glucose co-transporter and sodium amino co-transporter

-The number of transport proteins are limited, that means they have T_{max} (transport maximum as a saturation)

- up to 90% of cell energy expanded for active transport and this Energetics

Transport in vesicles#

-Vesicle a small spherical sac formed by budding off from a membrane

-**Endocytosis** materials move into a cell in a vesicle formed from the plasma membrane

Three types: a) receptor mediated endocytosis

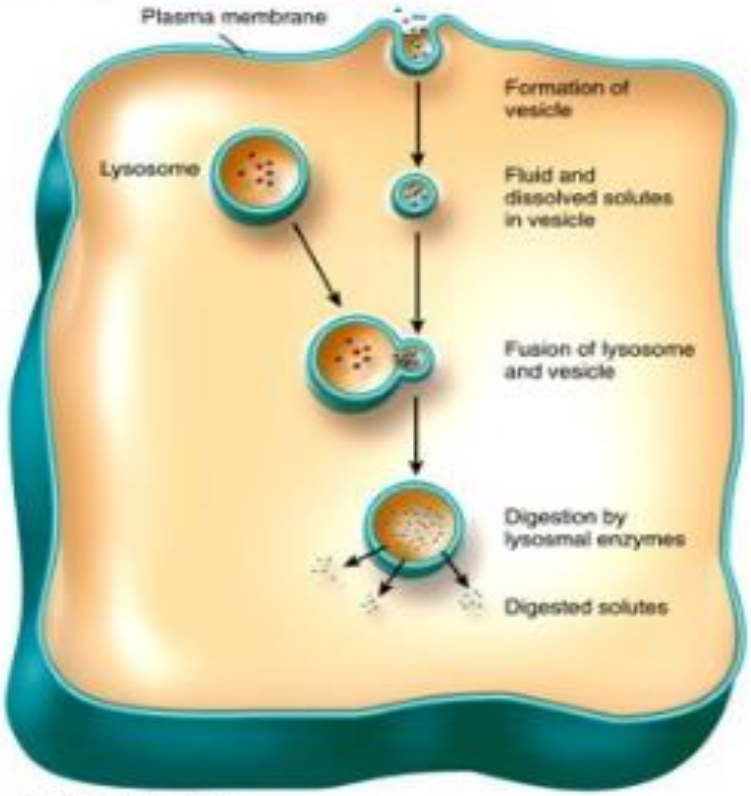
b) phagocytosis

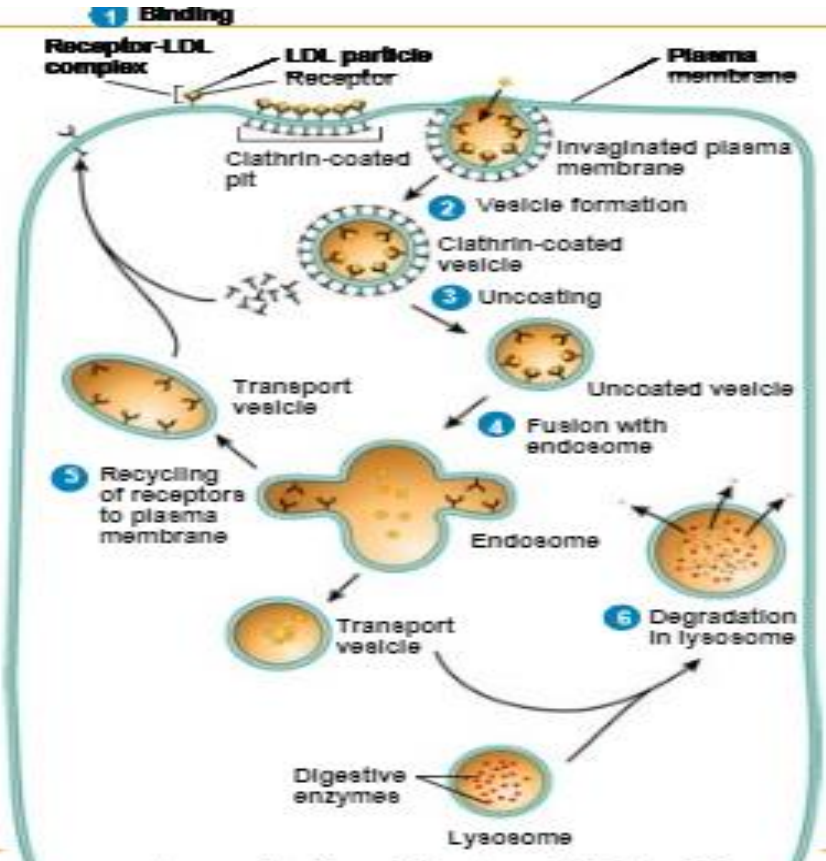
c) bulk_phase endocytosis (pinocytosis)

-Exocytosis vesicles fuse with the plasma membrane, releasing their contents into extracellular fluid

- **Transcytosis** a combination of endocytosis and exocytosis

Bulk-phase Endocytosis





Receptor-Mediated Endocytosis

Phagocytosis

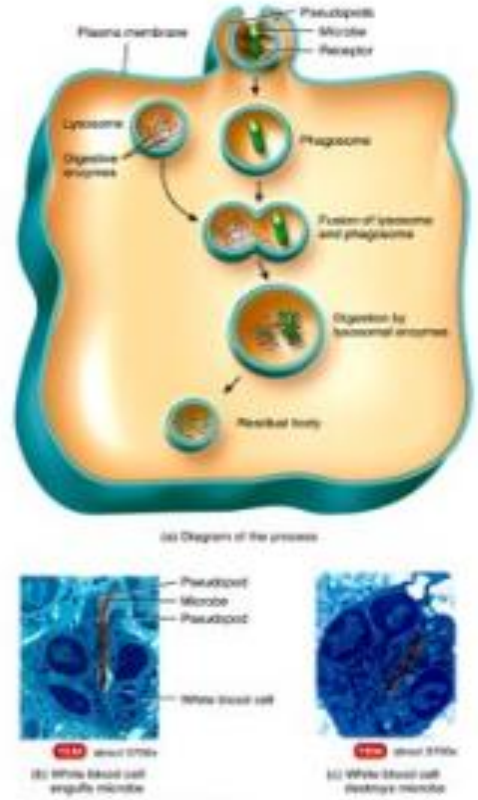
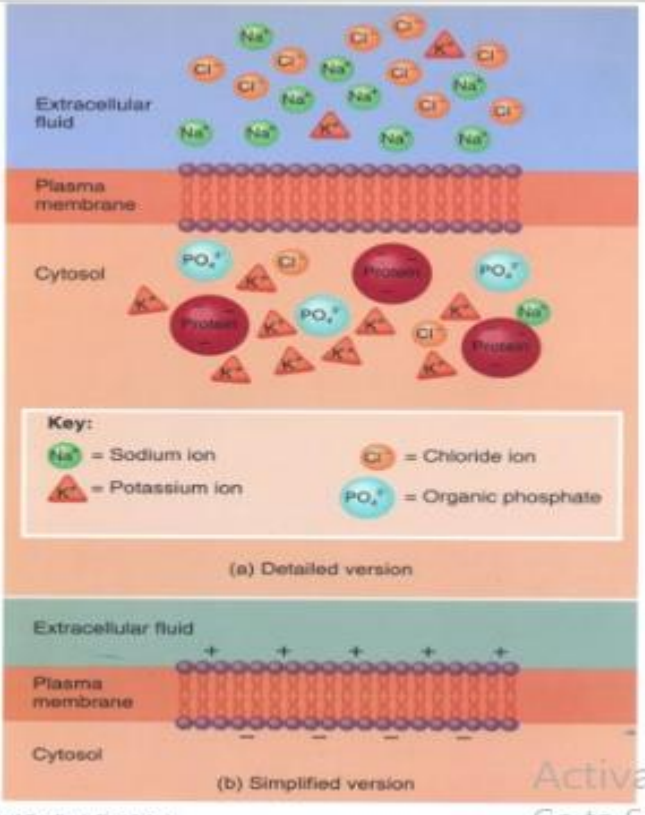


Figure 03.13 Tortora - PAP 12/e

Resting Membrane Potential and polarization of cell membranes



Electrochemical Gradient, Fig# 3.4a-b

Good luck for all of you