Al-Mustaqbal University

College of Engineering and Technologies

Biomedical Engineering Department

Systemic Physiology I

Lecture: 2

Body Fluids

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(Body fluids)

-In the average young adult male , 18% of the body weight is protein & related substances , 7% is mineral & 15% is fat .

-The remaining 60% is water .

-Total body water is comprised of **extracellular** & **intracellular** fluid.

-The extracellular fluid can be subdivided into two main sub-compartments :-

-The **plasma** , Which makes up almost one – fourth of the extracellular fluid .

-And the **interstitial** fluid which lies between the tissue cells & amounts to more than three – fourths of the extracellular fluid .

-The extracellular fluid , Which is about 20% of total body weight (plasma = 5% of body weight) & (interstitial fluid = 15% of body weight).

-Whereas , the intracellular fluid accounts for about 40% of body weight .

-Because the plasma & interstitial fluids are separated only by highly permeable capillary membranes , their ionic compositions are similar & they are often considered together as one large compartment of homogeneous fluid .

-The most important difference between plasma & interstitial fluid is the higher concentration of protein in the plasma , which exists because the capillaries have a low permeability to the plasma proteins .

-Both extracellular & intracellular fluid contain nutrients that are needed by the cells , including glucose , amino acids, oxygen & other nutrients.

-Extracellular fluid contains large quantities of sodium and chloride ions ,but only small amounts of potassium ,magnesium and phosphate ions (the major cat ion is Na^+ and the major anions are Cl^- & $HCO3^-$) .

-In contrast, intracellular fluid contains large amounts of K^{+}& phosphate ions , moderate amounts of Mg^{+2} ions & few Ca^{+2} ions (The major cations are K^{+}& Mg^{+2}& the major anions are protein & organic phosphates such as ATP, ADP & AMP) .

-These differences in the ionic composition of the fluids cause a membrane potential to develop across the two sides of the cell membrane – **negative** on the inside and **positive** outside .

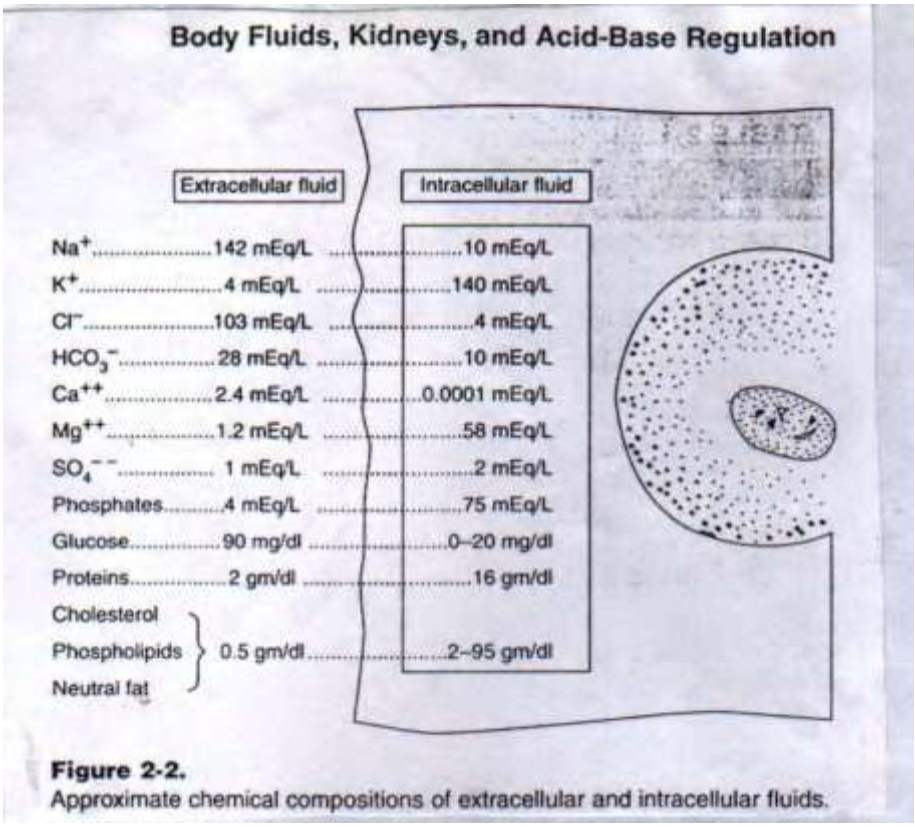

Figure 2-2.
Approximate chemical compositions of extracellular and intracellular fluids.

Transport across cell membranes :-

Passive diffusion

1. Simple diffusion :-

-Occurs down an electrochemical gradient ("downhill") which is the net movement of molecules through the cell membrane along chemical or electrical gradients.

-Molecules migrate from a region of high concentration to one lower concentration.

-This form of transport is not carrier mediated.

-Not require metabolic energy , therefore is passive .

-The rate of diffusion across the cell membrane is directly **related to** :-

-(1):-The electrical potential &chemical concentration differences across the membrane

-(2):-The surface area of the membrane .

-(3):- The permeability of the membrane for the solute .

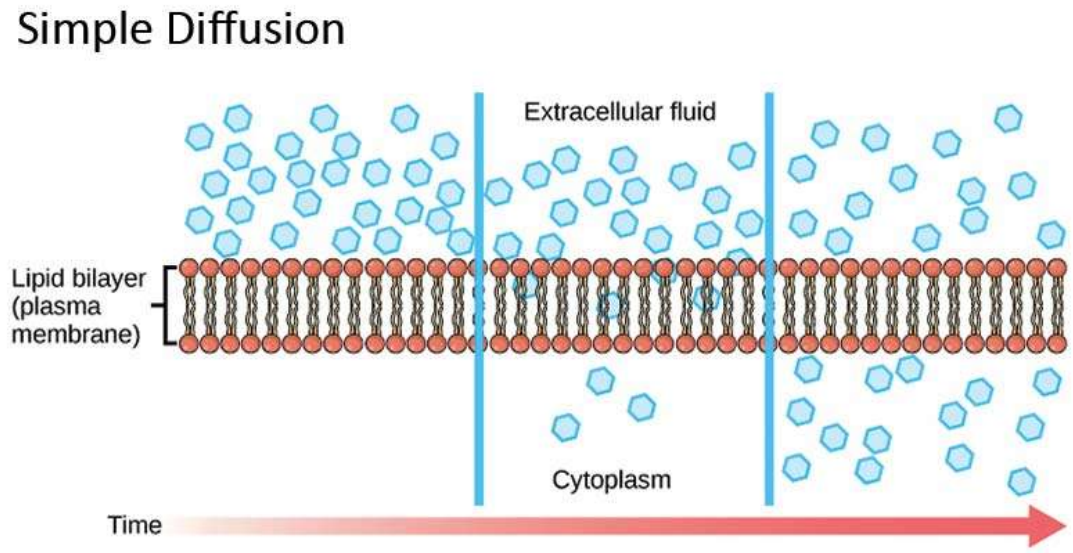

Figure (1). Simple diffusion.

2.**Facilitated diffusion: -**

-Occurs down an electrochemical gradient ("downhill"), similar to simple diffusion.

-Dose not require metabolic energy & therefore is passive.

-Is more rapid than simple diffusion.

-Is carrier – mediated.

-Ex. Glucose transport in muscle & adipose cells is "downhill" is carrier – mediated.

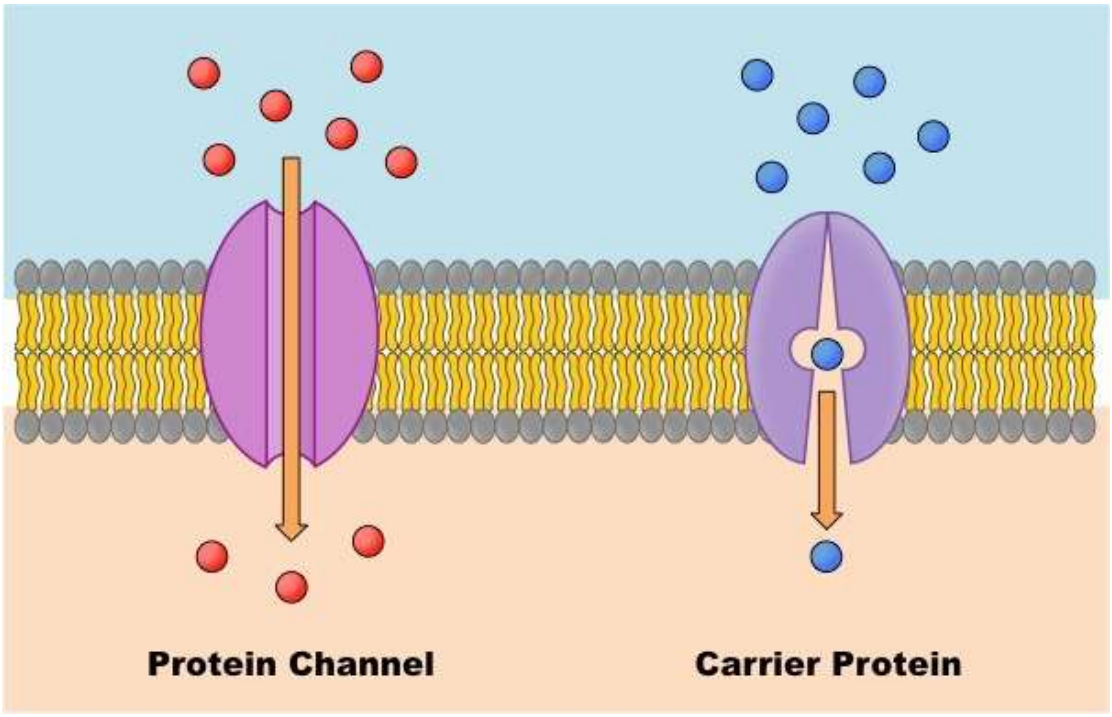

Figure (2). Facilitated diffusion.

3. Osmosis:-

-Is the diffusion of water across amembrane .

-Cell membranes in the body are highly permeable to water & whenever there is a higher concentration of solute on one side of the membrane , water rapidly diffuses across the membrane toward the region of higher solute concentration .

-So, osmosis is the flow of water across a semipermeable membrane from a solution with low solute concentration to a solution with high solute concentration.

-The osmotic pressure increases when the solute concentration increases.

-The higher the osmotic pressure of a solution, the greater the water flow into it.

-Osmolarity is the concentration of osmotically active particles in a solution.

Isotonic , hypotonic & hypertonic fluids:-

-A solution is said to be **isotonic** if no osmotic force develops across the cell membrane when a normal cell is placed in the solution.

-This means that an isotonic solution has the same osmolarity as the cell & that the cells will not shrink or swell is placed in this solution.

-Example of isotonic solutions are: -

- 0.9% Nacl & a 5% glucose solution.

-A solution is said to be **hypertonic** when it contains a higher osmotic concentration of substances than dose the cell.

-In this case , osmotic force develops that causes water to flow out the cell into the solution , thereby greatly concentrating intracellular fluid & shrinking the cell.

-The solution is said to be **hypotonic** if the osmotic concentration of substances in the solution is less than their concentration in the cell.

-An osmotic force develops immediately when the cell is exposed to the solution , causes water to flow by osmosis into the cell until the intracellular fluid has about the same concentration as the extracellular fluid , or until the cell bursts from excessive swelling.

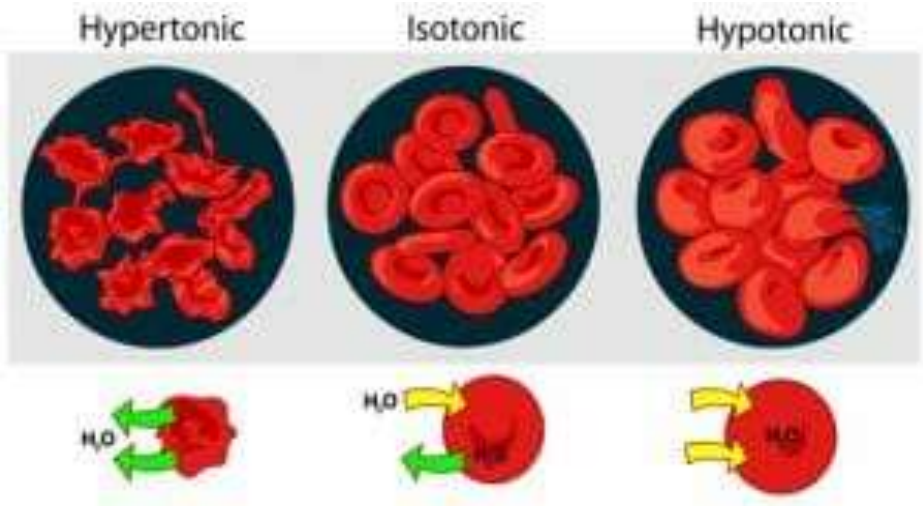

Figure (3). Osmotic Solutions.

Active transport:-

-Occurs against an electrochemical gradient ("uphill").

-Requires direct input of metabolic energy in form of ATP & is active.

-Is carrier – mediated?

-Examples of primary active transport:-

-(c):- H^+, K^+ – ATPase (or proton pump) in gastric parietal cells transports H^+ into lumen of the stomach against its electrochemical gradient .

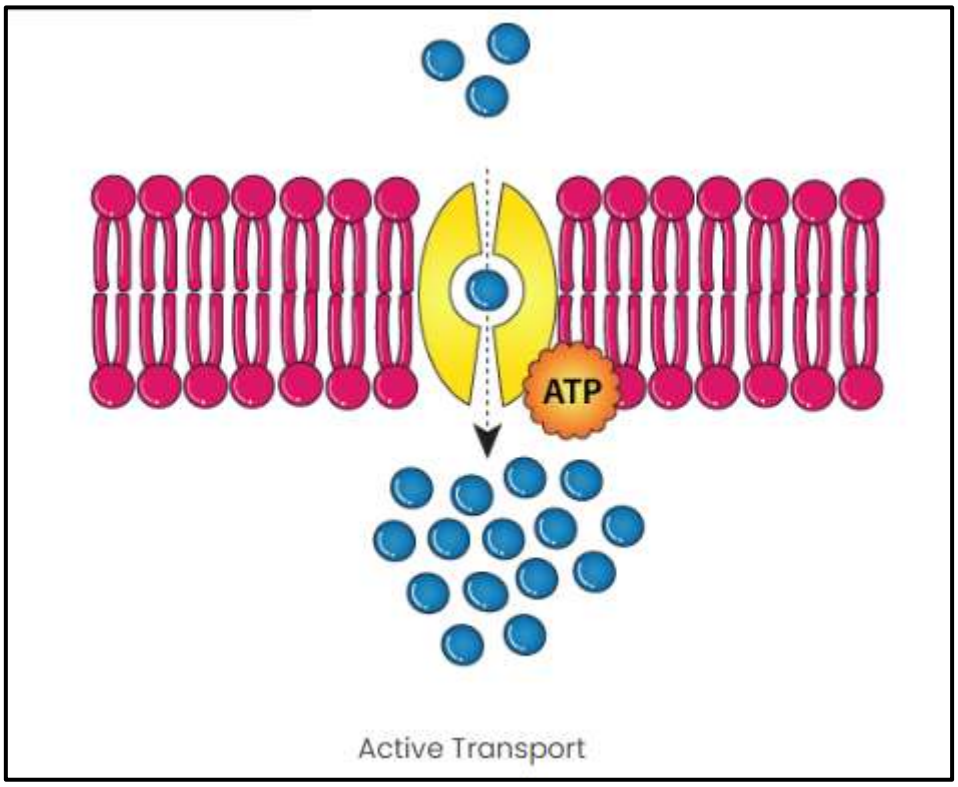

Figure (4). Active transport.