Diffusion

The movement of a solute from an area of its high concentration to an area of its low concentration

- Solutes move "down their concentration gradient"

- Cell membranes are barriers that block most solutes from diffusing through the membrane because the membrane's phospholipids are hydrophobic

  √ Most solutes are hydrophilic and so they cannot pass through the hydrophobic cell membrane

  √ Water molecules can pass through cell membranes

  √ Hydrophobic solutes can pass through the hydrophobic cell membrane

Fig 3.3

Solute molecules can cross cell membranes in three ways:

1) By simple diffusion
2) Through channel proteins
3) By endocytosis and exocytosis

Simple diffusion

The diffusion of a molecule directly through the membrane phospholipids

- Only hydrophobic solutes can cross the cell membrane by simple diffusion

  √ Examples: Steroid hormones, O_2, CO_2

Fig 3.5

Channel proteins (carrier proteins, pores)

Proteins in the cell membrane that form a tunnel to allow solutes to pass through the membrane

- Each channel protein is highly specific to transport only the solute molecules that it is supposed to transport

√ Cotransport = The channel protein transports two different solute molecule types simultaneously

Figs 3.4 and 26.8

Facilitated diffusion (Passive transport)

The movement of solutes across a membrane from their high concentration side to their low concentration side through a channel protein

- Facilitated diffusion does not require any energy

Figs 3.6 and 26.8

Active transport (“pumping”)

The movement of solutes across a membrane from their low concentration side to their high concentration side through a channel protein

- Active transport always requires energy
- The energy can be from ATP ("1° active transport")
- The energy can be from a different solute moving down its concentration gradient through the same channel protein ("2° active transport")

Fig 3.9

Solutes can cross cell membranes by endocytosis and exocytosis

- Endocytosis = A process that brings solute molecules into a cell by the solutes bending the membrane inward, followed by the bend pinching off from the membrane to form a vesicle (with the solutes) inside the cell

- Exocytosis = A process that brings solute molecules out of a cell by a vesicle (containing the solutes) in the cell fusing with the cell membrane

Figs 3.10 and 3.11

Osmosis

The movement of water across a cell membrane towards whichever side of the membrane has the highest solute concentration

• "Water always moves towards solutes"

• Hypertonic = A solution with a higher solute concentration than a cell

√ Cells lose water by osmosis in hypertonic solutions

√ The cell will shrink and crenate (shrivel)

• Hypotonic = A solution with a lower solute concentration than a cell

√ Cells gain water by osmosis in hypotonic solutions

√ The cell will enlarge and may lyse (burst)

• Isotonic = A solution with an equal solute concentration to a cell

√ Cells stay the same size in isotonic solutions because they don't gain or lose water through osmosis

√ Blood and other body fluids are isotonic solutions

√ Most hospital IV solutions are also isotonic solutions

√ Common isotonic intravenous solutions used in hospitals:

- 0.9% Saline (NaCl) ("Normal saline")
- Ringer's lactate
- 5% Glucose ("5% dextrose")

Figs 3.7 and 3.8

Terms related to solutes passing through cell membranes:

- Penetrating solute = A solute that can diffuse across a membrane
  - √ Hydrophobic solutes
  - √ Hydrophilic solutes that the membrane has a passive transport protein for

- Non-penetrating solute = A solute that cannot diffuse across a membrane
  - √ Hydrophilic solutes that the membrane does not have a passive transport protein for

Tips for solving osmosis problems:

1) Compare the total solute concentration (using osmolarity (OsM) concentration units) inside the cell to outside the cell
   - Do not include any penetrating solutes when totaling the solute concentrations
     - √ Penetrating solutes cannot cause any osmosis because they diffuse to equal concentrations inside and outside the cell

2)Water always moves by osmosis to whichever side of the membrane has the highest total solute concentration

Fluid compartments of the body

The regions of the body that contain body fluids

- The intracellular compartment = All the fluid that is contained inside all the cells of the body (the cytoplasm of all the cells)

  √ The intracellular compartment contains about 30 liters of fluid

- The extracellular compartment = All the fluid outside the cells of the body. The blood plasma and the tissue fluid (the liquid that surrounds the cells) together are the extracellular compartment

  √ The blood plasma contains about 3 liters of fluid

  √ The tissue fluid contains about 12 liters of fluid

  √ Liquids and solutes in the blood can easily enter the tissue fluid and *vice versa*

    - Any solutes that are put into the blood very quickly pass into the tissue fluid and *vice versa*