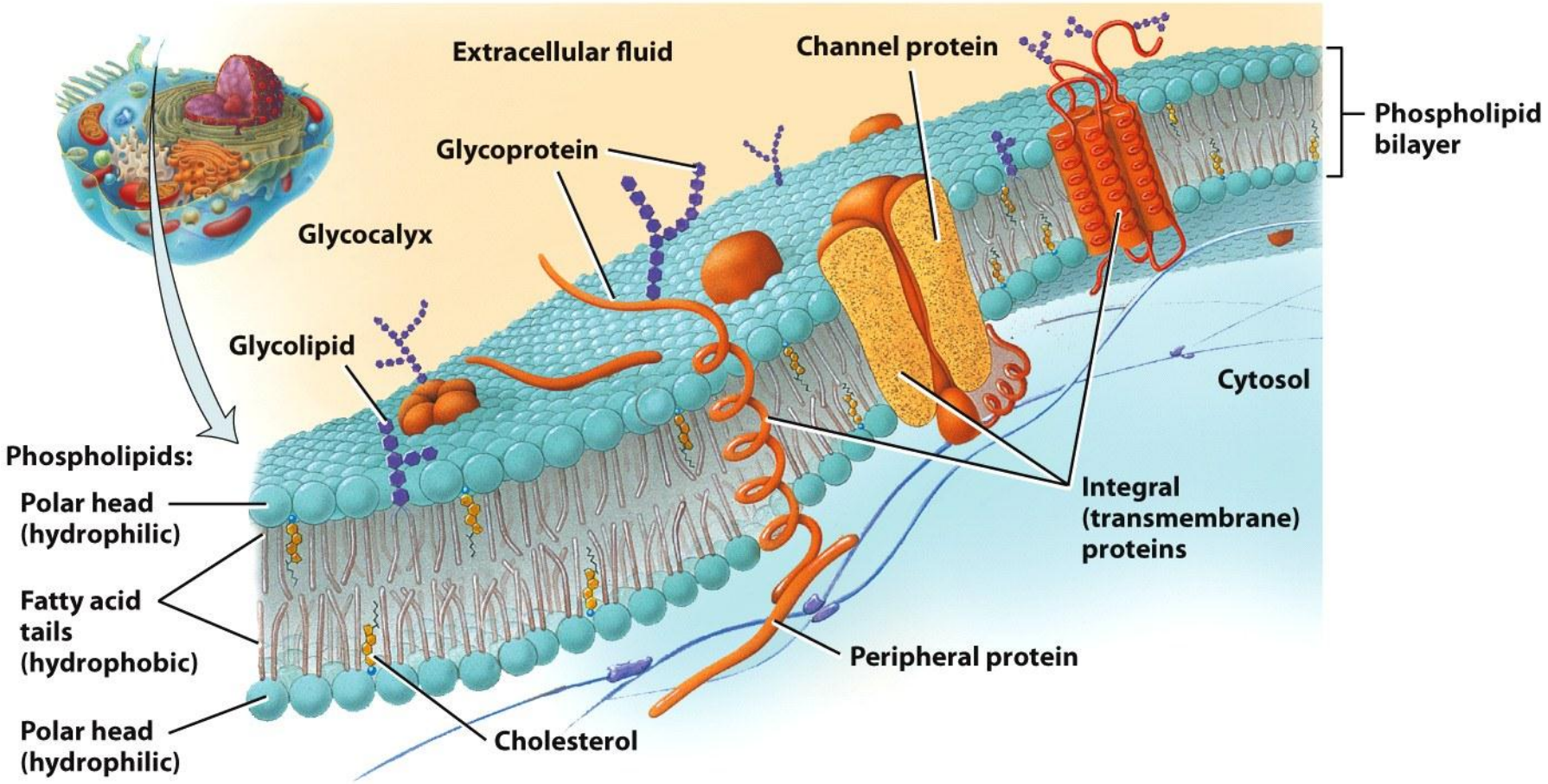
Lectures 7,8

Biological Membrane- I &II

The Cell Membrane Separates the Cell From the Extracellular Fluid

- **The cell membrane is composed of *two layers of phospholipids*, which are interspersed with *proteins*, lipids, cholesterol, and sugars**
- **Phospholipids are arranged in a double layer, or bilayer**
  - The hydrophilic, water-loving, polar heads of the phospholipid molecules are oriented toward the aqueous environment both inside and outside the cell
  - The hydrophobic, water-fearing, non-polar lipid portions of the phospholipid molecules are sandwiched in the center of the bilayer
- **Proteins and lipids associated with the cell membrane have sugars attached to their external surface**
  - They are called *glycoproteins and glycolipids*

Cell Membrane Structure



The Glycocalyx

- **The *glycoproteins and glycolipids* form a layer on the cell membrane called the *glycocalyx***
- **The glycocalyx is unique and defines cells as belonging to a specific organism**
  - Both blood type and tissue type are defined by the specific structures on the glycocalyx

The fluid Mosaic Model of cell membrane

- A membrane structure is a **fluid bilayer of phospholipid** molecules with a "mosaic" patterns of various proteins embedded in it when viewed from the top
- **The basic structure of the plasma membrane is a continuously swirling fluid with consistency similar to olive oil**
- **Cholesterol molecules separate phospholipid fatty acid tails, which contributes to the fluid nature of the plasma membrane**
- **The membrane proteins also are in constant motion, floating within the phospholipid bilayer**

The fluid Mosaic Model of cell membrane

- **Membrane fluidity enables membranes to de-form and change their overall shape during cell locomotion**

Types of Membrane Proteins

- **Integral proteins**

- Penetrate the hydrophobic core of the lipid bilayer (extend completely through the membrane)

- **Are often transmembrane proteins, completely spanning the membrane**

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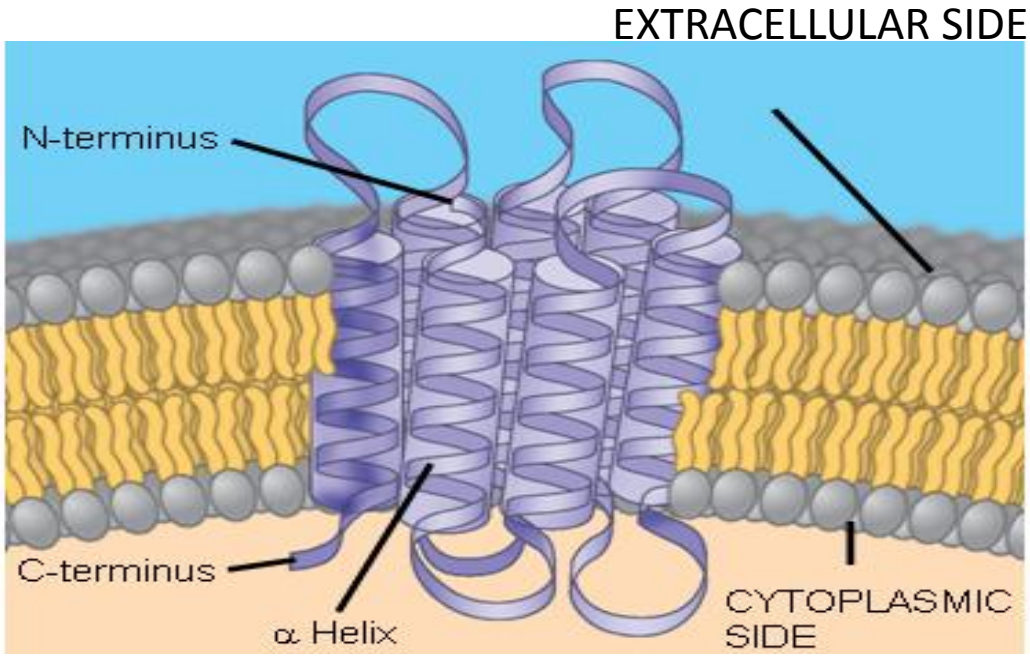
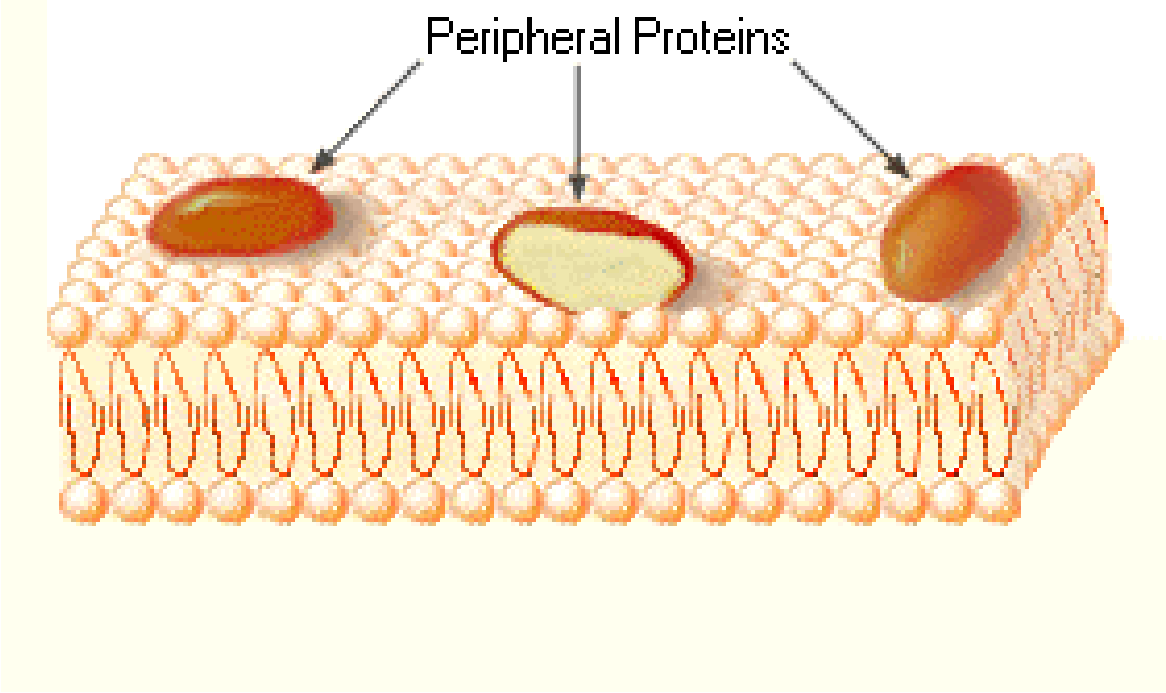


Types of Membrane Proteins

- **Peripheral proteins**
- **Are appendages loosely bound to the *surface* of the bilayer membrane**



Movement Across the Membrane

- **The membrane is a semipermeable barrier**
- **It provides a means for**
  - Nutrients to enter the cell
  - Waste products to exit the cell

- **Movement across the membrane occurs in two ways**
  - Passive transport
  - Active transport

Passive Transport

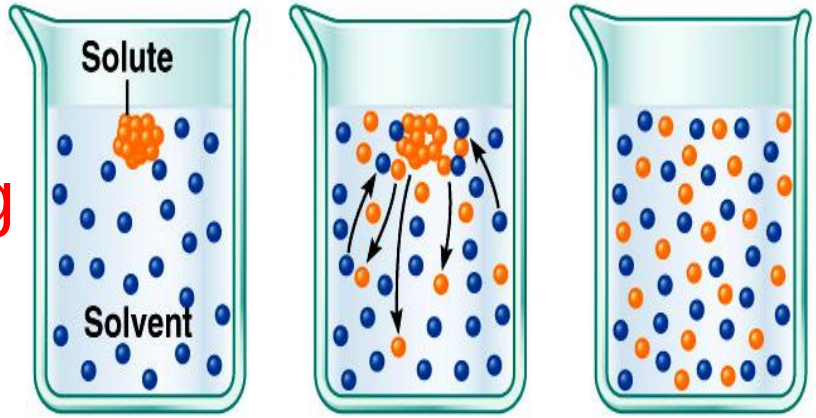
- **Passive transport *does not* require *energy* to move molecules across membranes *down their concentration* gradients**
  - Includes diffusion, facilitated diffusion and filtration

Diffusion

- ***Diffusion* is the movement of a substance from area of *higher* toward the area of *lower* concentration**
  - --Includes simple diffusion and osmosis

Simple diffusion

Substance moves across phospholipids from an area of *high* to an area of *low concentration*, without using energy.

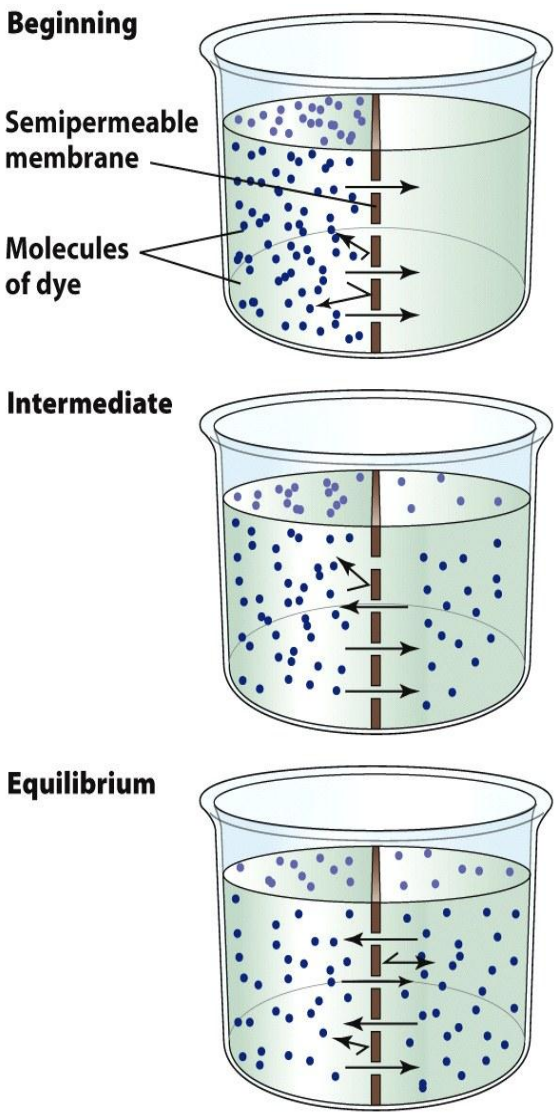


Substance moves *down its concentration gradient.*

Ex. Lipid soluble compounds and gases : O_2, CO_2

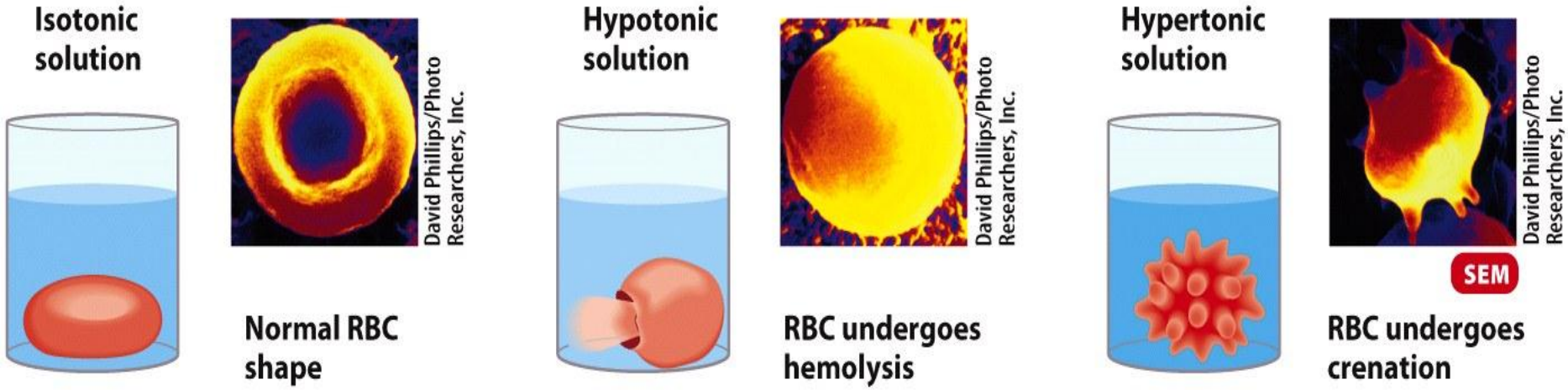
Osmosis

- **Diffusion of *water* across a semipermeable membrane is termed *osmosis***
  - -Water moves in a direction across the cell membrane that *equalizes* solute concentrations *on each side* of the membrane
  - -Locations with *higher solute* concentrations have *lower water* concentrations
  - **•"Pull" water toward them**
  - **• Water moves *down its concentration* gradient**



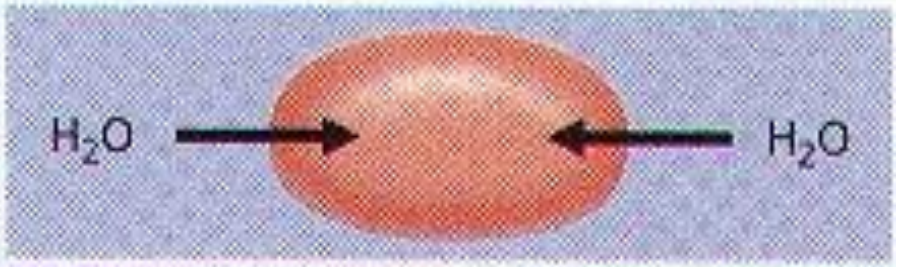
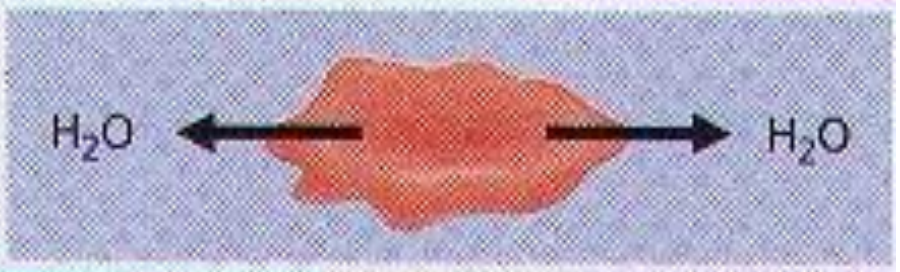
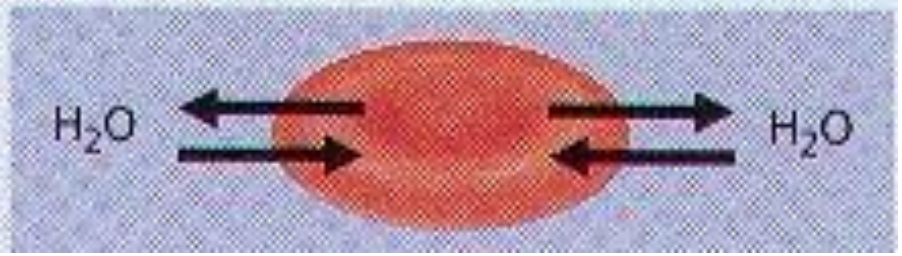
Osmosis

- **Usually, the extracellular fluid is isotonic to the cells**
  - Water flows equally into and out of the cell
- **A *hypotonic* solution may cause a cell to *swell and burst***
  - Has water with a lower concentration of solutes than the cytosol
- **A *hypertonic* solution may cause a cell to *shrink and shrivel up***
  - Has water with a higher concentration of solutes than the cytosol



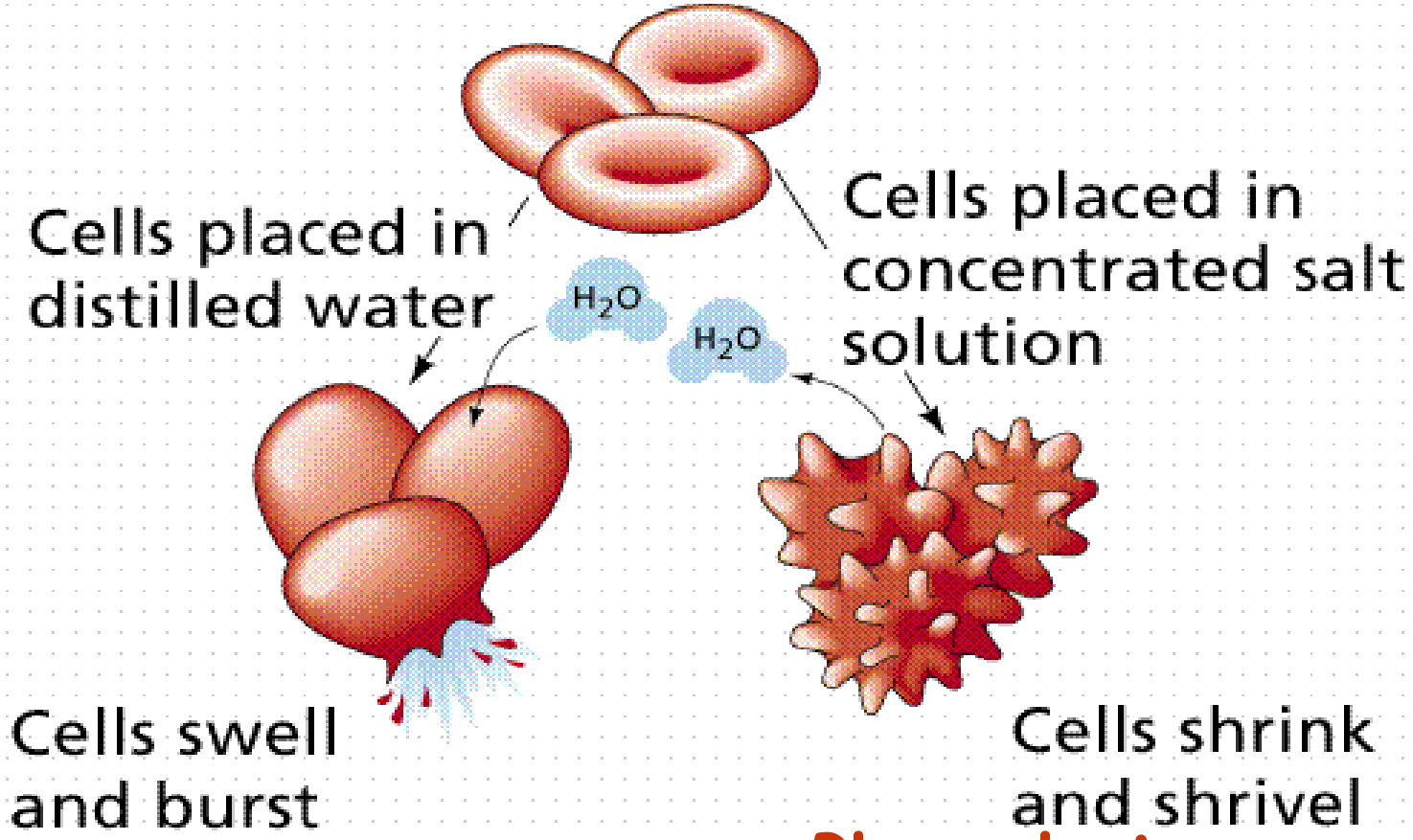
Cells in Solutions

TABLE 5-1 Direction of Osmosis

Condition	Net movement of water	
External solution is hypotonic to cytosol	into the cell	
External solution is hypertonic to cytosol	out of the cell	
External solution is isotonic to cytosol	none	

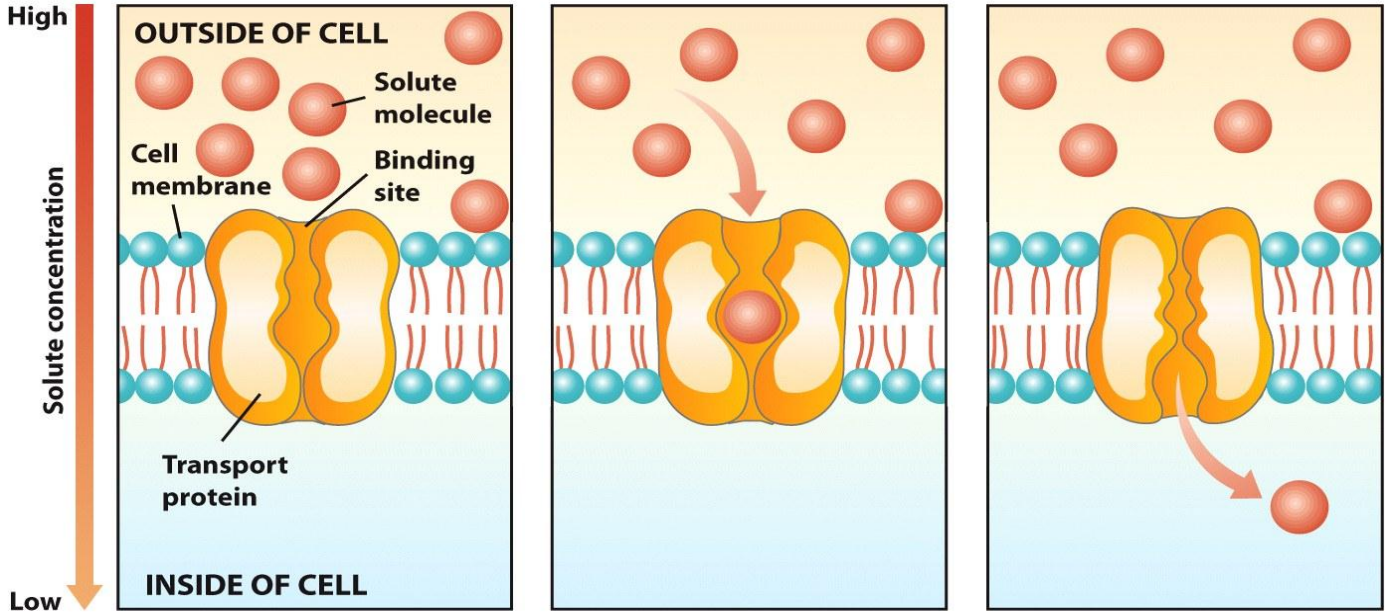
What Happens to Blood Cells?

Cytolysis & Plasmolysis



Facilitated Diffusion

- Some molecules such as glucose, require *transport proteins* to provide easier entry into the cell , from *high* concentration to *low* concentration
- *No energy is expended*



Biology: Understanding Life by Sandra and Brian Alters, John Wiley & Sons, Inc. Copyright 2006

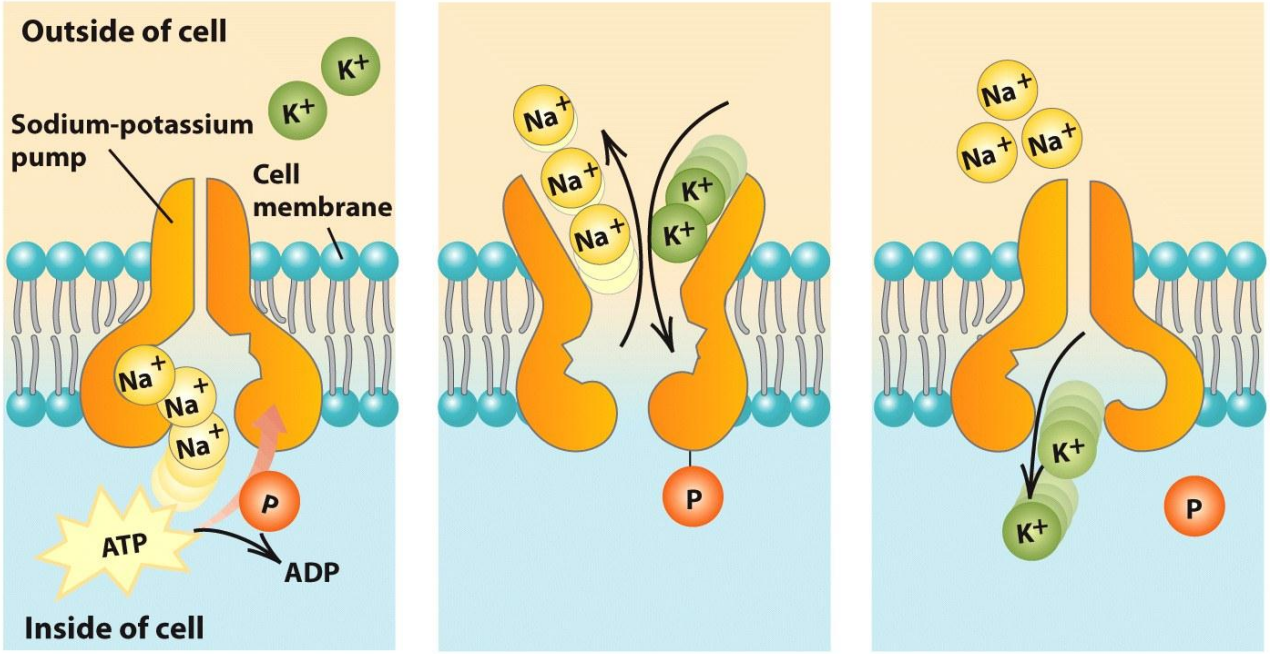
Active Transport

Cell must expend energy to transport molecules or ions across cell membrane (using ATP molecules), and a *transporter protein* ***against*** *their concentration gradients*

- Using energy, the *transporter protein* "pumps" molecule or ion from the side of *lower* concentration to other side of *higher* concentration

Active Transporter Pumps Often Have Reciprocal Functions

- **Pumping one molecule or ion into the cell while simultaneously removing a second from the cell**
  - The sodium/potassium ATPase pumps two K^+ into the cell while pumping three Na^+ out of the cell



Endocytosis and Exocytosis

Active transport also can move molecules into or out of the cell, in bulk

- ***In endocytosis***

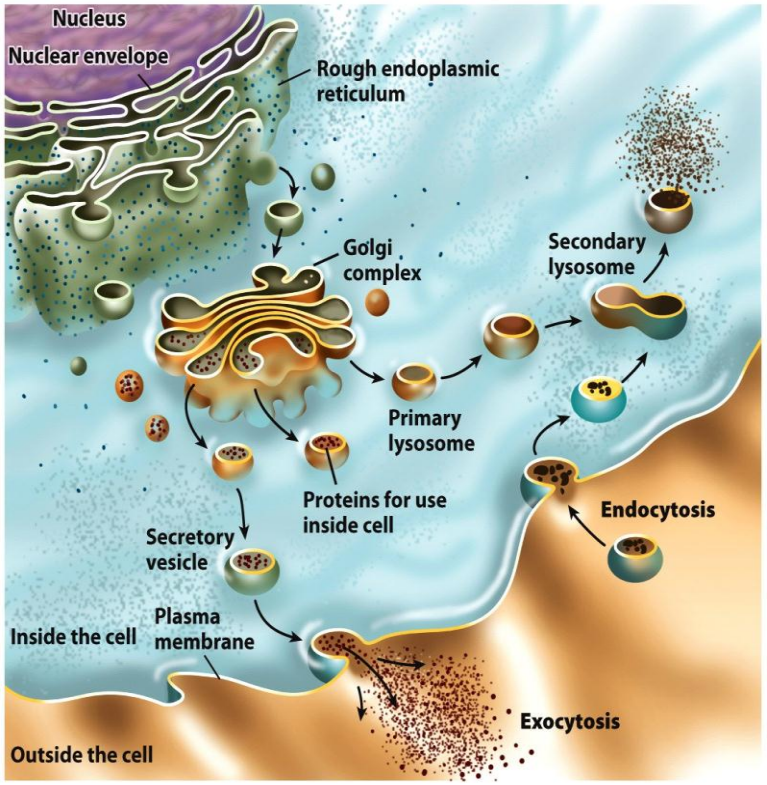
  - Extracellular molecules and particles are taken into the cell via vesicle formation

  – **Pinocytosis (cell drinking):** vesicle brings water containing substances into the cell.

  – **Phagocytosis (cell eating):** vesicle brings large clumps of nutrients into the cell. [WBCs phagocitize bacteria].

- ***In exocytosis***

  – Secretory products or waste products are removed from the cell



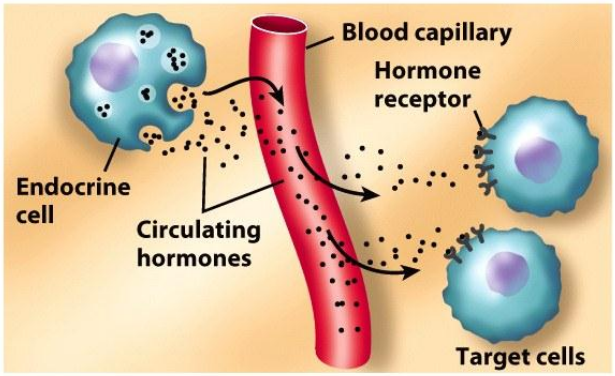
Cell Communication

- Cells communicate with one another to function as a tissue
- ***Cell signaling occurs via three ways:***

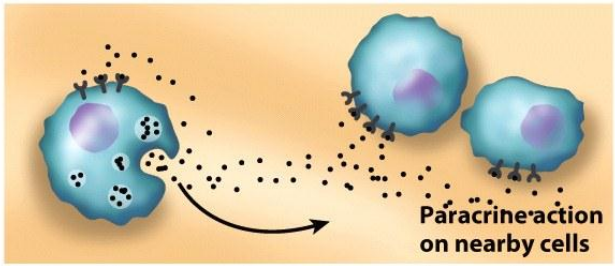
- ***Blood hormones:*** when cells are long-distance: can be released into the bloodstream

- ***Paracrines (local hormones) :*** **can be released to cells in the same tissue**
  - Used when *quick responses* are required

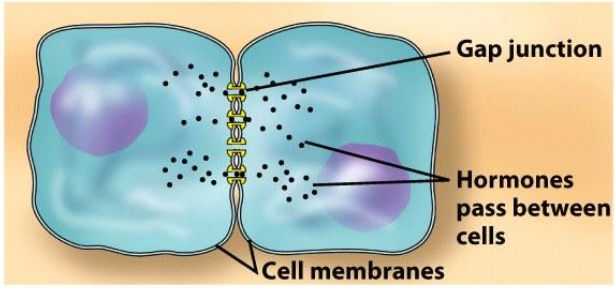
- ***Cell-to-cell junctions:*** cells are in direct contact with one another
  - Ex. Gap junctions: Important between heart cells
    - Immediate and short-lived (فورية وقصيرة الأجل)



a. Circulating hormones



b. Local hormones (paracrine and autocrine)



c. Gap junctions