Chapter 6 Outline

- **Extracellular Environment**
- **Diffusion**
- **Osmosis**
- **Carrier-Mediated Transport**
- **The Membrane Potential**
- **Cell Signaling**

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Extracellular Environment

- Includes all constituents of body outside cells
- 67% of total body H_2O is inside cells (intracellular compartment)
- 33% is outside cells (extracellular compartment-ECF)
  - 20% of ECF is blood plasma
  - 80% of ECF is interstitial fluid contained in gel-like matrix

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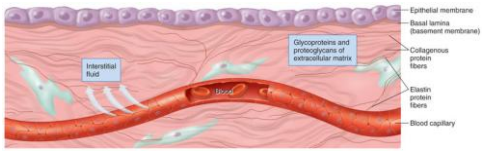
Extracellular Matrix

- Many organ composed of connective tissue
  - Hense, cells surrounded by matrix
- Meshwork of collagen & elastin fibers linked by molecules of gel-like ground substance and to plasma membrane (integrins)
  - = glycoprotein adhesion molecules link intracellular and extracellular compartments
- Interstitial fluid resides in hydrated gel of ground substance



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The Selective Permeable Membrane!!

- permeable to some molecules (water)
- transmembrane proteins act as specific channels for some particles
- Vesicles can transport in and out
- Why move things in and out?

2.-4

Transport Across Plasma Membrane

- Passive transport moves compounds down concentration gradient; requires no energy
- Active transport moves compounds against a concentration gradient; requires energy and transporters
- Many important molecules have transporters and channels
  - Carrier-mediated transport involves specific protein transporters
  - Non-carrier mediated transport occurs by diffusion

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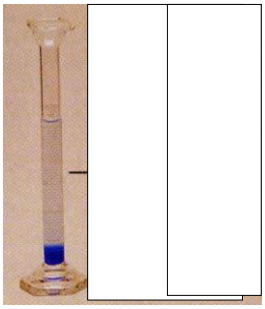
How things get in the cell

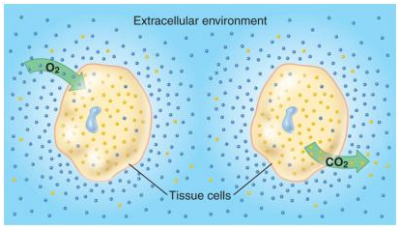
- Diffusion- -
- Dye placed in water
- Molecules move from a high concentration to region of lower conc.
- Equilibrium reached in the far right cylinder



2.-6

Diffusion

- Non-polar compounds readily diffuse thru cell membrane
  - Also some small molecules such as CO_2 and H_2O
    - Gas exchange occurs this way



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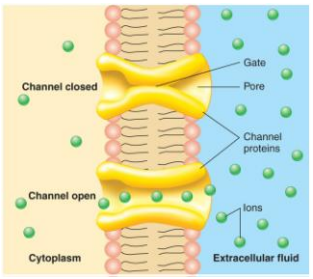
Diffusion

- Cell membranes are impermeable to charged and most polar compounds
- Charged molecules & ions must have a channel or transporter



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Diffusion Rate

- Factors affecting diffusion rate through a membrane:
  - temperature - ↑ temp., ↑ motion of particles
  - molecular weight - larger molecules move slower
  - steepness of concentrated gradient - ↑difference, ↑ rate
  - membrane surface area - ↑ area, ↑ rate
  - membrane permeability - ↑ permeability, ↑ rate

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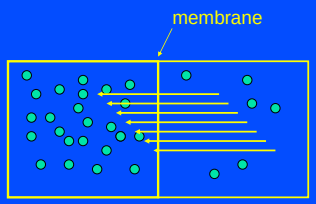
Osmosis: The movement of water across a semi-permeable membrane



2.-10

Osmosis

- **H_2O diffuses down its concentration gradient until its concentration is equal on both sides of a membrane**
- **Some cells have water channels (aquaporins) to facilitate osmosis**

Osmotic Pressure:

- **Force needed to stop osmosis**
  - **Indicates how strongly H_2O wants to diffuse**
  - **Is proportional to solute concentration**

Hydrostatic Pressure: pressure inside cell (or vessel) resulting from osmosis

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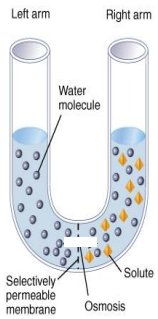

(a) Starting conditions

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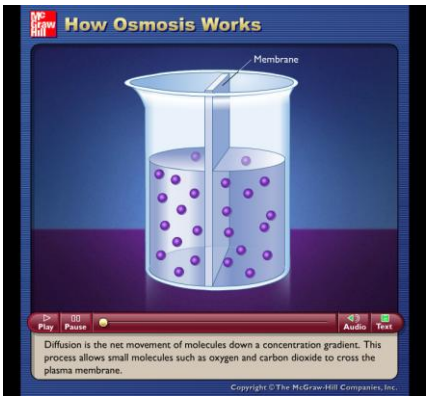

Tonicity

- Tonicity - ability of a solution to affect fluid volume and pressure in a cell
  - depends on concentration and permeability of solute
- Hypotonic solution
  - has a lower concentration of solutes than intracellular fluid (ICF)
    - high water concentration
  - Cell may lyse
- Hypertonic solution
  - has a higher concentration of solutes
    - low water concentration
  - Cell may crenate
- Isotonic solution
  - concentrations in cell and ICF are the same
  - cause no changes in cell volume or cell shape

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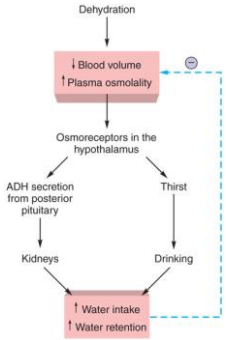
Regulation of Blood Osmolality (no. solutes)

- Blood osmolality is maintained in narrow range around 300mOsm
- If dehydration occurs, osmoreceptors in hypothalamus stimulate:
  - ADH release
    - Which causes kidney to conserve H_2O



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Membrane Transport Systems

- **Non Carrier Mediated Transport**
  - **simple diffusion through membrane**
  - **simple diffusion through ion channels**
- **Carrier-Mediated Transport**
  - **Facilitated Diffusion**
  - **Active Transport**
- Molecules too large & polar to diffuse are transported across membrane by carrier mediated proteins

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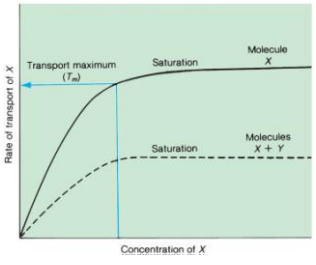
Carrier-Mediated Transport

Use Protein Carriers

- Protein carriers exhibit:
  - Specificity for single molecule
  - Competition among substrates for transport
  - Saturation when all carriers are occupied
    - This is called T_m (transport maximum)



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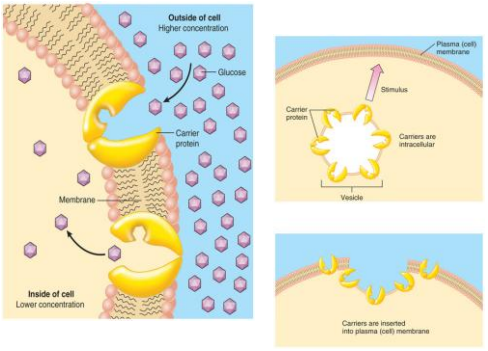
Facilitated Diffusion



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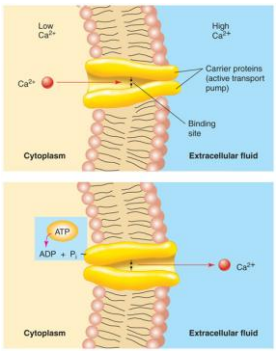
Active Transport Pump

- Transport of molecules against a concentration gradient
  - ATP is required
  - A carrier protein is required
  - Primary active Transport – **ATP responsible for function of carrier**



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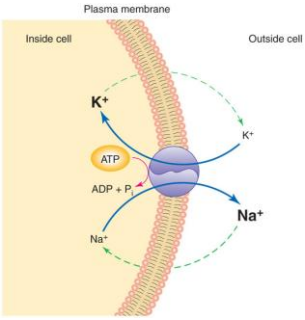
Primary Active Transport

Na^+/K^+ Pump

- Uses ATP to move 3 Na^+ out and 2 K^+ in
  - Against their gradients
- Maintains steep gradient for:
  1. E for cotransport
  2. needed for nerves and muscles function
  3. osmotic reasons



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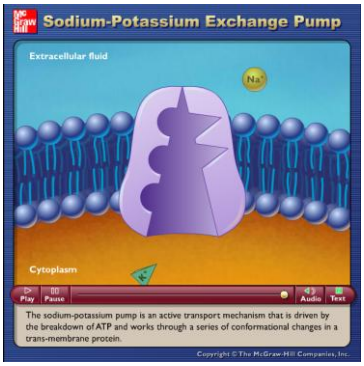

Secondary Active Transport (coupled transport)

- Moving Na+ down its concentration gradient helps move something else against its concentration gradient
  - i.e., Na+ moves down something else moves up grandient
- Secondary active transport is coupled to Na+/K+ pumps (active transport)
  - Helpt maintain Na+ gradient

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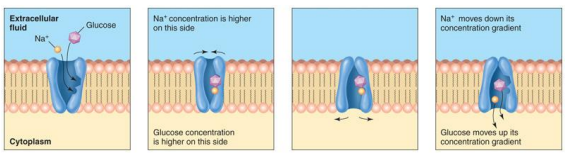
Secondary Active Transport

- Cotransport (symport) is secondary transport in same direction as Na^+
- Countertransport (antiport) moves molecule in opposite direction to Na^+



What maintains the Na+ concentration gradient?

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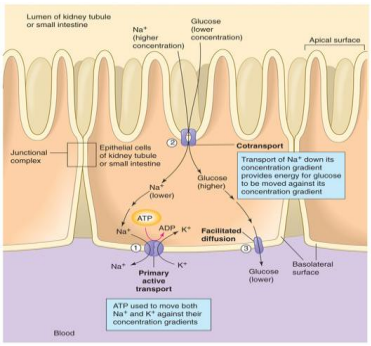
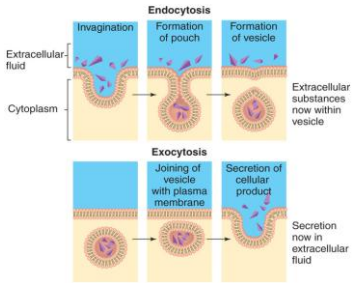
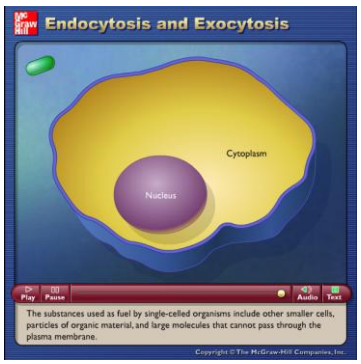
Secondary Active transport is tied to Active Transport



Bulk Transport

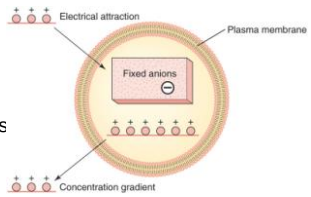
- Moves large molecules and particles across plasma membrane
- Occurs by endocytosis and exocytosis





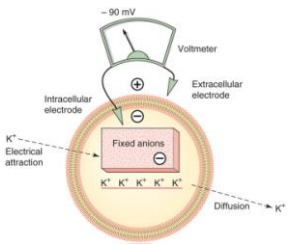
Membrane Potential

- Is difference in charge across membranes
- Results in part from presence of large anions trapped inside cell
- Diffusable cations such as & Na^+ are attracted into cell by anions
- Na^+ is not as permeable and is actively transported out
- K^+ diffuses out readily



Equilibrium Potential

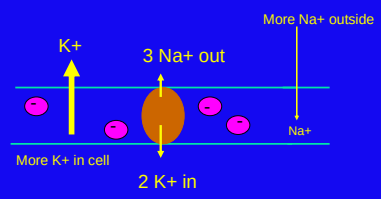
- Describes voltage across cell membrane if only 1 ion could diffuse
- If membrane permeable only to K^+, it would diffuse until it reaches its equilibrium potential (E_K)
  - K+ is attracted inside by trapped anions but also diffuses out by its concentration gradient
  - At K+ equilibrium, electrical and diffusion forces are = and opposite
  - Inside of cell has a negative charge of about --90mV



Resting Membrane Potential (RMP)

- Is membrane voltage of cell not producing impulses
- RMP of most cells is –65 to –85 mV
- RMP depends on concentrations of ions inside and out
  - And on permeability of each ion
  - Affected most by K^+ because it is most permeable

Resting membrane potential



1. Anions
2. Sodium-potassium pump
3. K+ can leak out & Na+ leak in (diffusion)

- Lots of K leaks out – little Na+ leaks in

Ionic Basis of Resting Membrane Potential

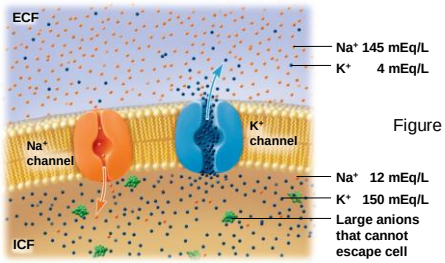


Figure 12.11

- Na^+ concentrated outside of cell (ECF)
- K^+ concentrated inside cell (ICF)

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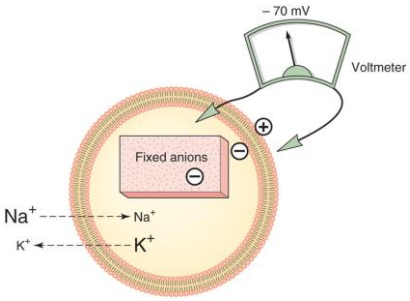
Resting Membrane Potential (RMP)



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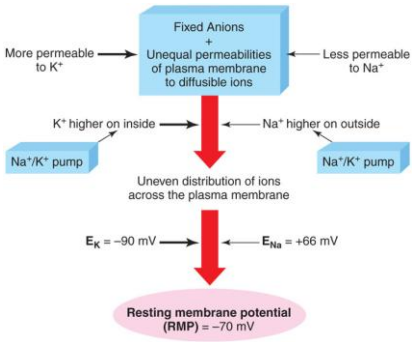
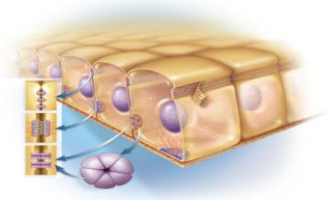
Summary of Processes that Affect the Resting Membrane Potential



6-44

Cell Signaling

- How cells communicate with each other
- Some use gap junctions thru which signals pass directly from 1 cell to next
- Some release chemicals into extracellular environment



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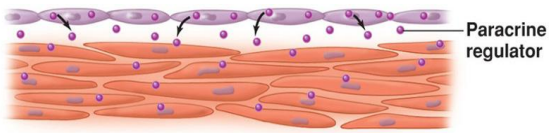
Cell Signaling

- **3 types of cell signaling**
  - **1. Paracrine**
  - **2. Synaptic**
  - **3. Endocrine**
- **Target cells must have a receptor proteins for it**

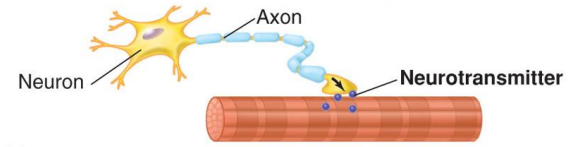
1. Paracrine signaling (local signaling – a particular organ)



(a)

Cell Signaling

2. **Synaptic signaling: Neurons communicating with target cells**
   - **Via a synapse**
   - **Use neurotransmitters as regulatory molecules**



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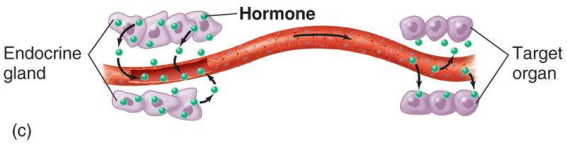
Cell Signaling

- Endocrine signaling
  - Chemical regulators are hormones



(c)

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How Regulatory Molecules Influence Target Cells

- Nonpolar (lipid-soluble) regulatory molecules pass through plasma membrane, bind to receptors in cell, and can affect transcription
  - e.g., steroid and thryroid hormones and nitric oxide
- Polar (water soluable) regulatory molecules bind to cell surface receptors – can't diffuse through membrane
  - Activates 2nd messengers system
- NOTE: Water is polar molecule that can diffuse through membrane!!!!!!!!!!!!!!!! Its not a regulatory molecule!

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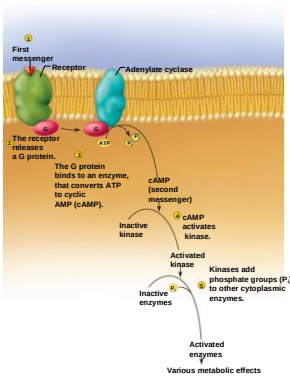
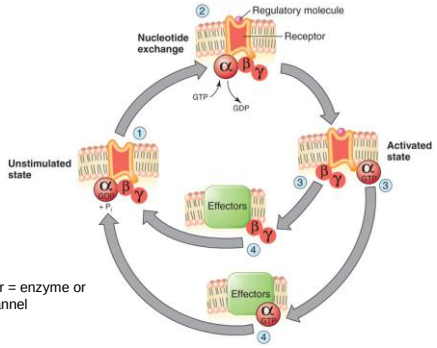
Second Messenger System



G-proteins



Effector = enzyme or ion channel

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