

Module 10 LO5

Electrical Signals

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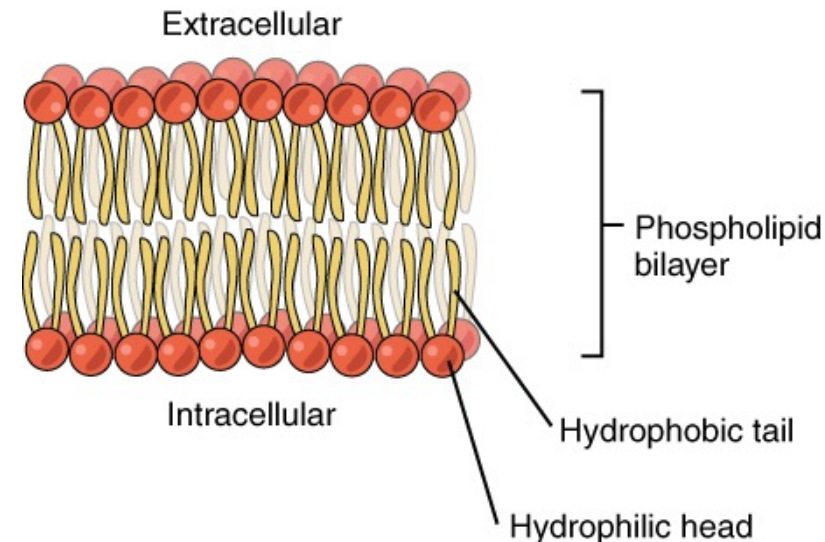
5. Electrical Signals

- Electrical signals = action potentials
 - Ability to:
 - Perceive our environment
 - Perform complex mental activities
 - Respond to stimuli
- Membrane potential – measure of electrical properties of plasma membrane.
 - Due to two major characteristics:
 - A. Ionic concentration differences across plasma membrane
 - B. Permeability characteristics of plasma membrane

} Action potential

Transport across cell membrane

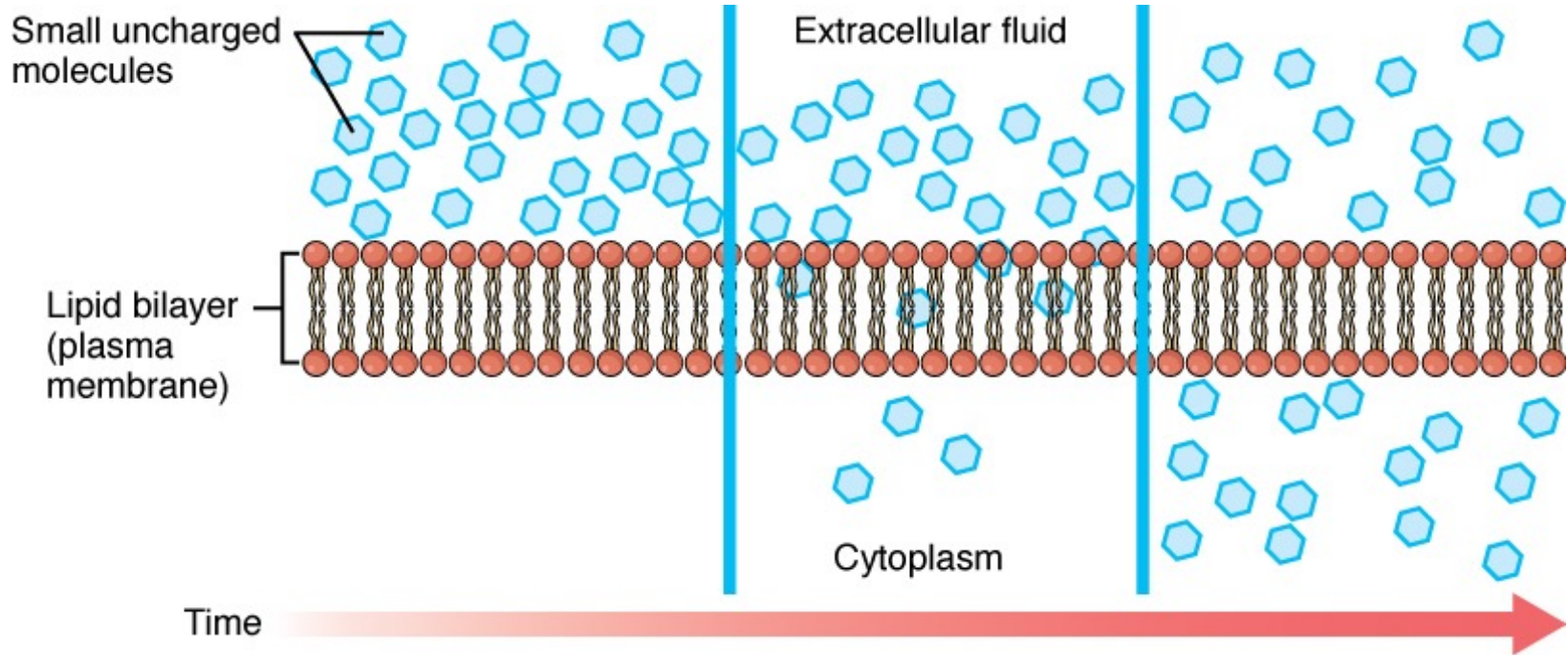
- Regulates concentration of substances inside cell
 - Ca^{+2} , Na^{+} , K^{+} , and Cl^{-} ; nutrients including sugars, fatty acids, and amino acids
 - Waste products, particularly CO_2 must leave the cell
- Methods of movement:
 - A. Passive transport
 - No ATP need
 - B. Active transport
 - ATP needed



A. Passive Transport

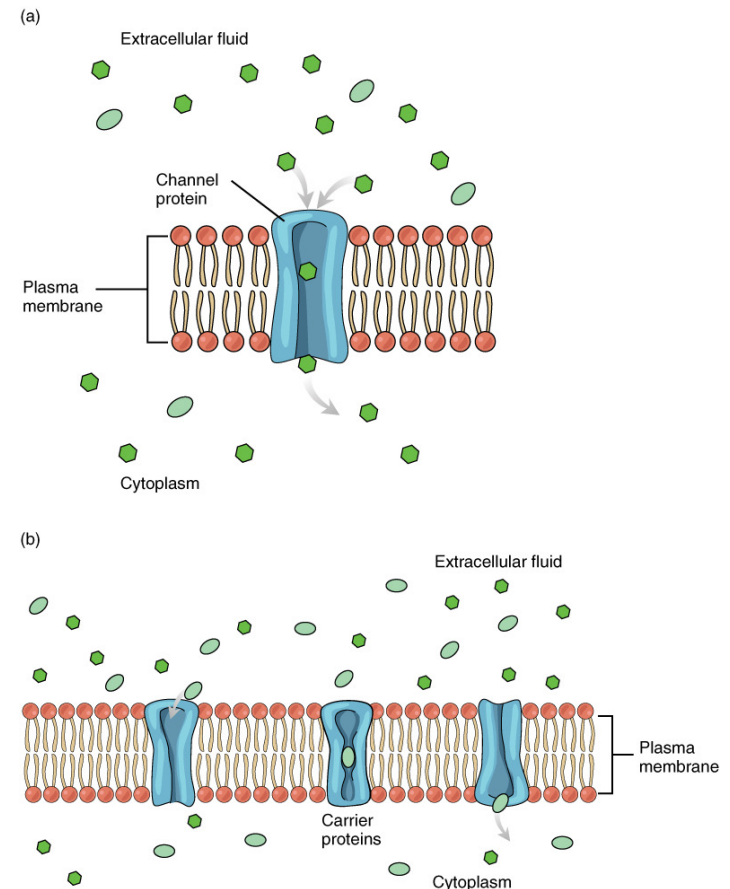
1. Concentration gradient
 - Difference in concentration of substance across a space
 - Molecules spread/diffuse from more concentrated to less concentrated -> move down their concentration gradient.
2. Diffusion – movement of particles from higher concentration to lower concentration
 - a) Simple diffusion
 - b) Facilitated diffusion
 - c) Osmosis

a) Simple Diffusion



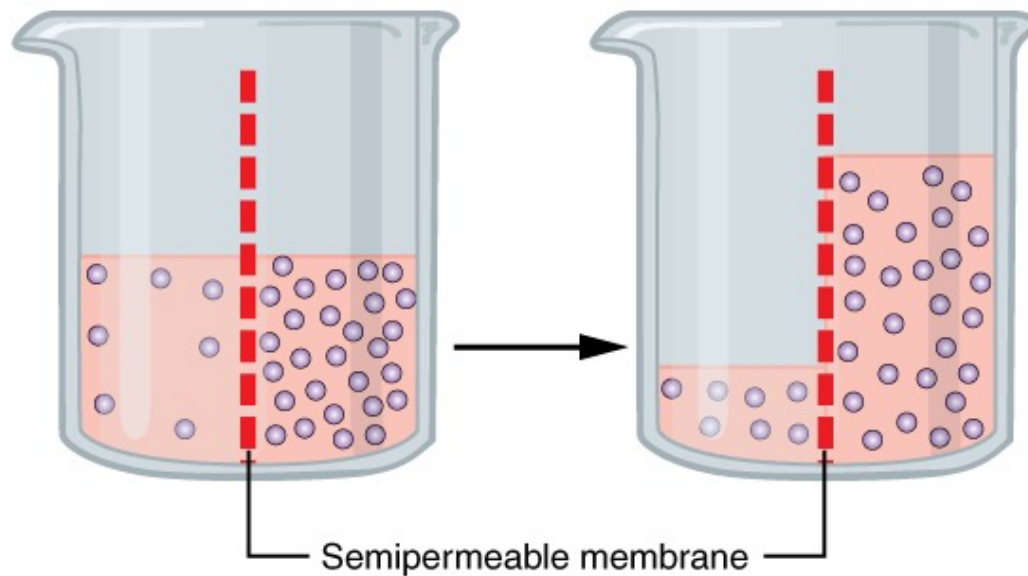
b) Facilitated Diffusion

- Movement occurs with the help of proteins
 - Channel proteins
 - Less selective
 - Carrier proteins
 - More selective



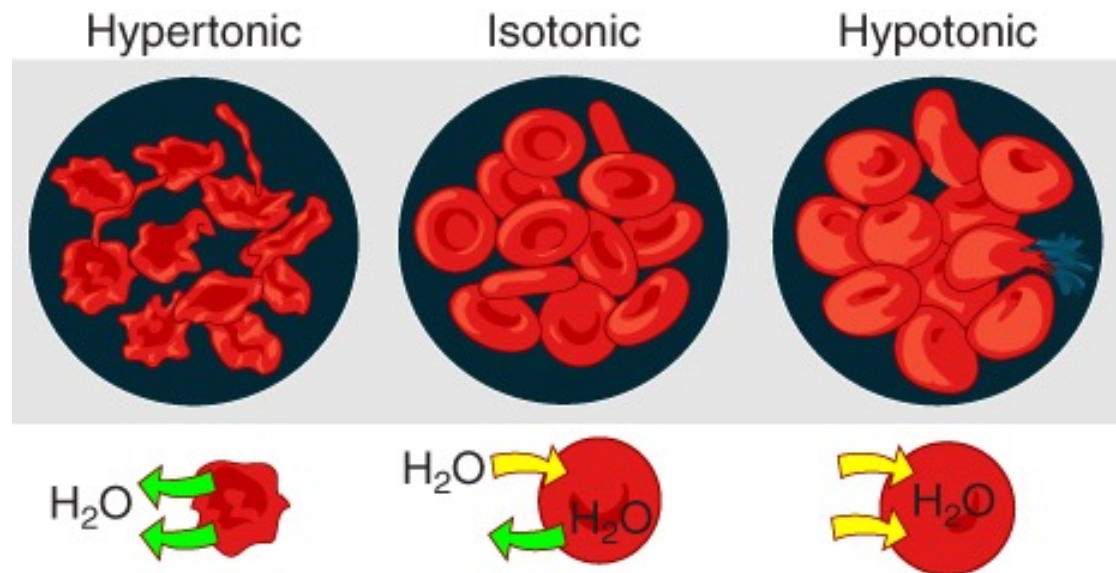
c) Osmosis

- Water diffusion through a semipermeable membrane



Water Movement With Cells

- Isotonic
 - Equal tension
- Osmosis occurs when there is an imbalance of solutes
 - Hypertonic
 - Water leaves
 - Hypotonic
 - Water enters

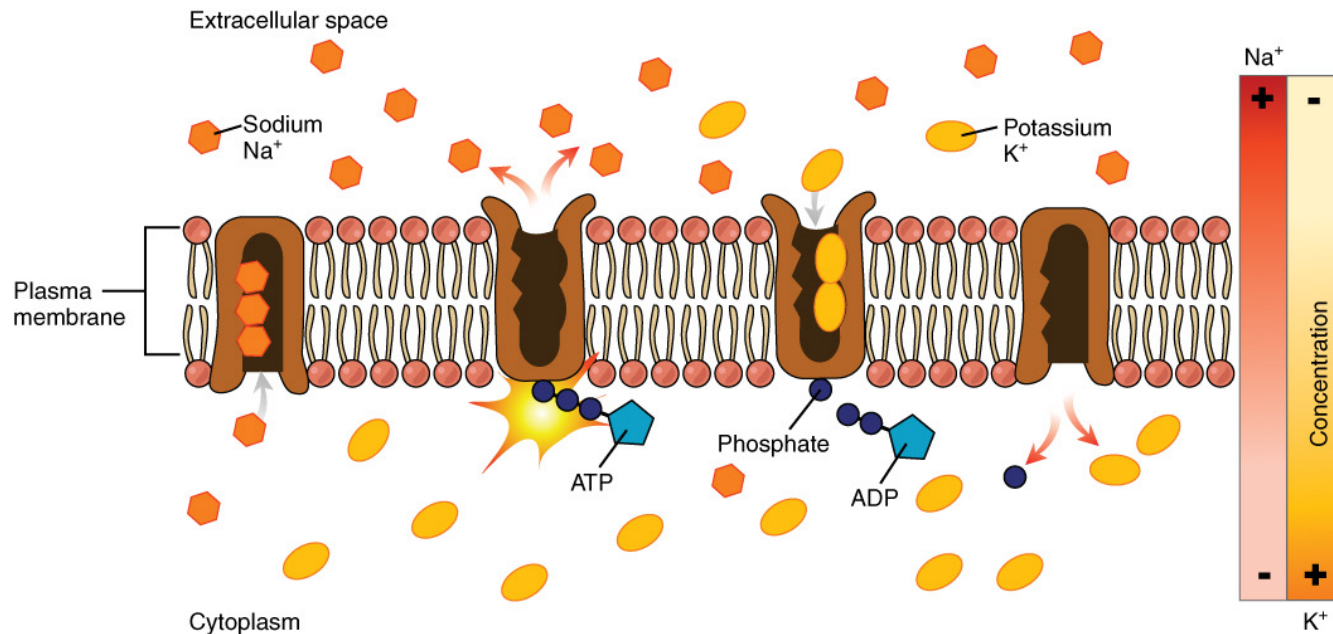


B) Active Transport

- a) Sodium-potassium pump
- b) Endocytosis
- c) Exocytosis

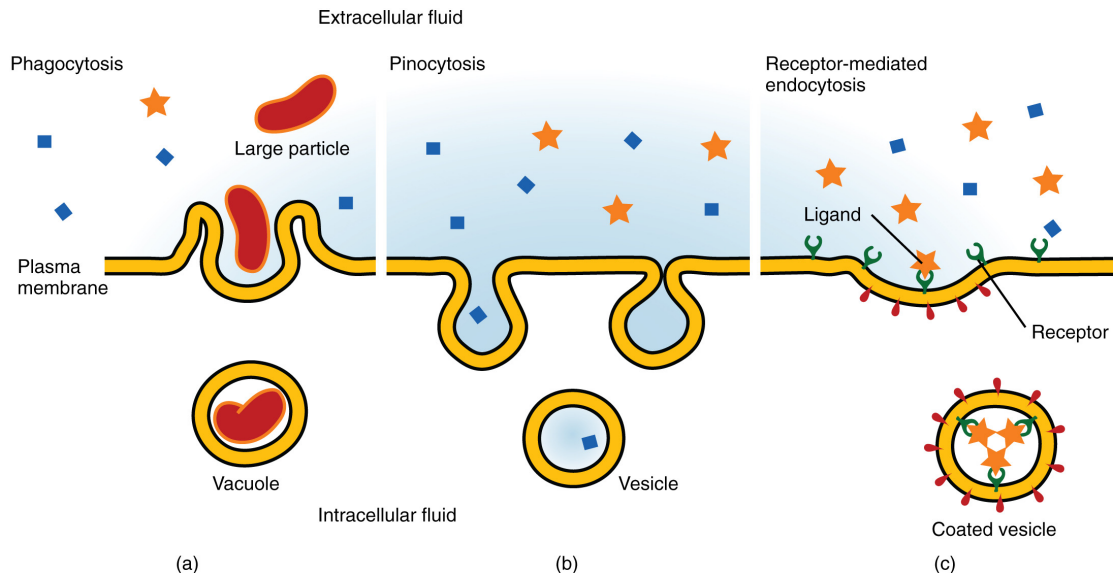
a) Sodium-Potassium Pump

- Needs ATP
- Help of carrier protein
- Usually against its concentration gradient



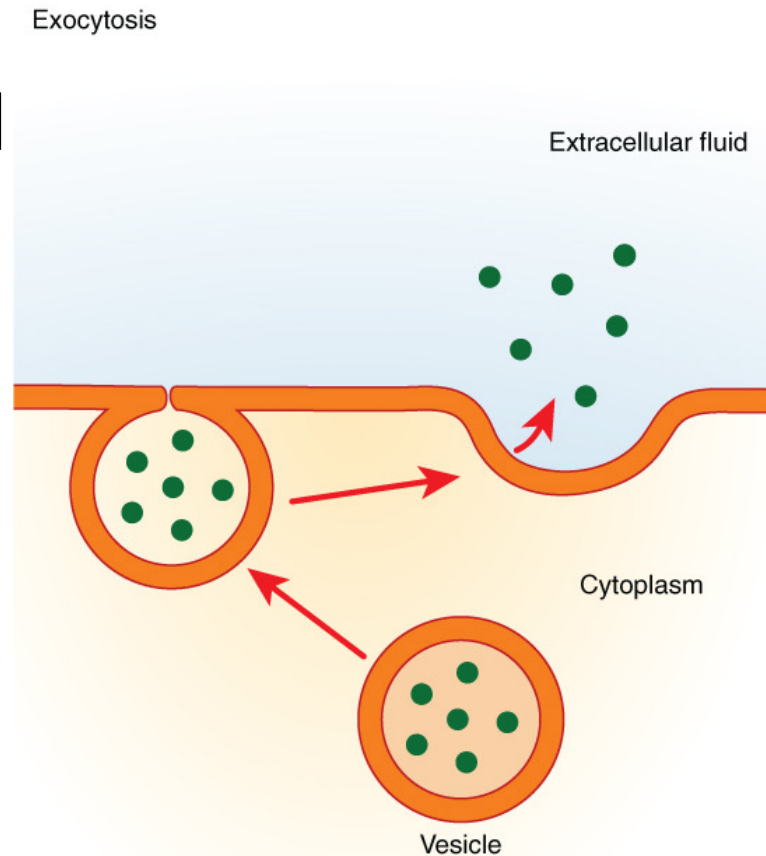
b) Endocytosis

- Active transport - cell envelopes extracellular materials using its cell membrane
 - Phagocytosis - cell takes in a large particle
 - Pinocytosis - cell takes in small particles in fluid
 - Receptor-mediated - external receptors bind specific ligand



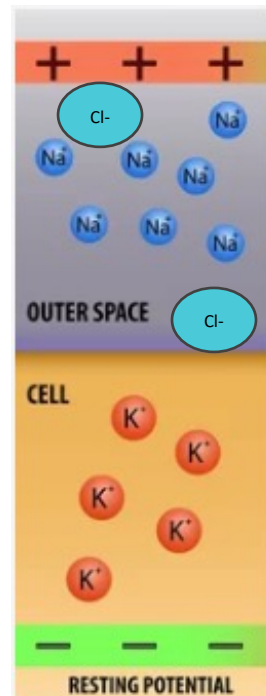
c) Exocytosis

- Like endocytosis in reverse
- Material packaged inside cell
- Vesicle membrane fuses
 - With cell membrane
- Contents are released



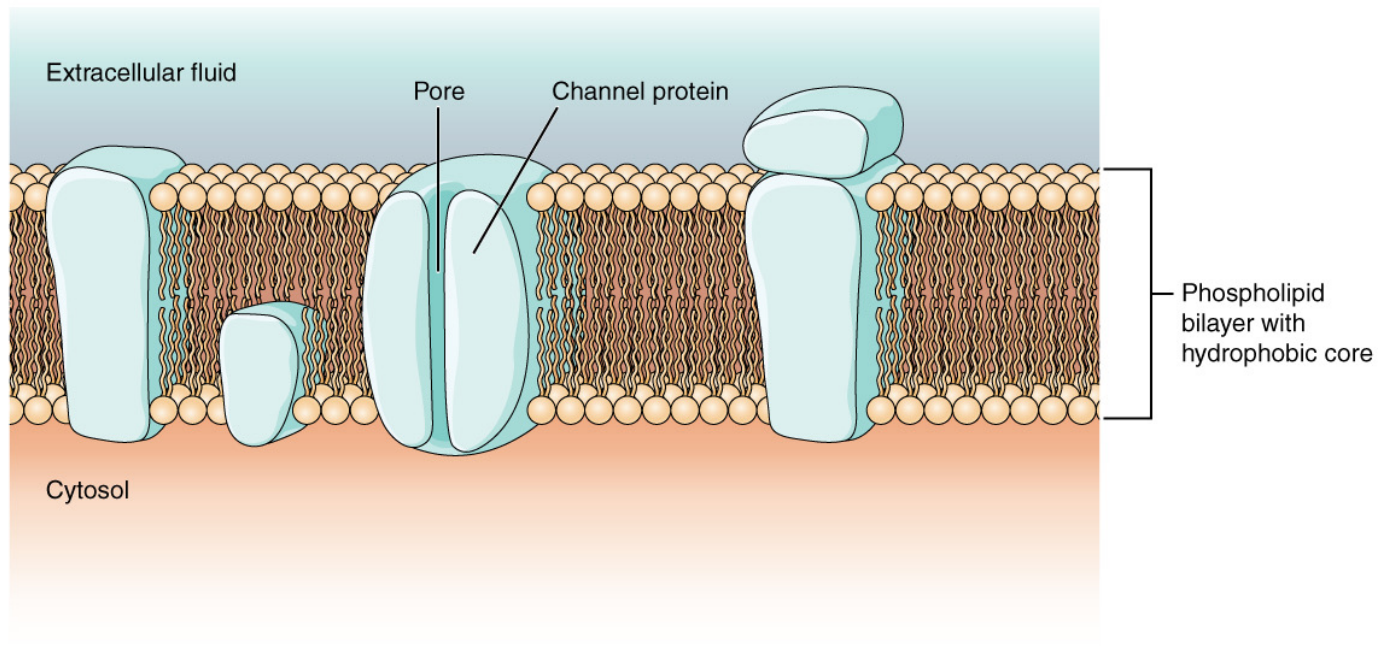
Ionic Concentration Differences

- Cells – have different concentrations of ions
 - Cytoplasm
 - Extracellular fluid
- This difference that electrically excitable cells use to carry out their function



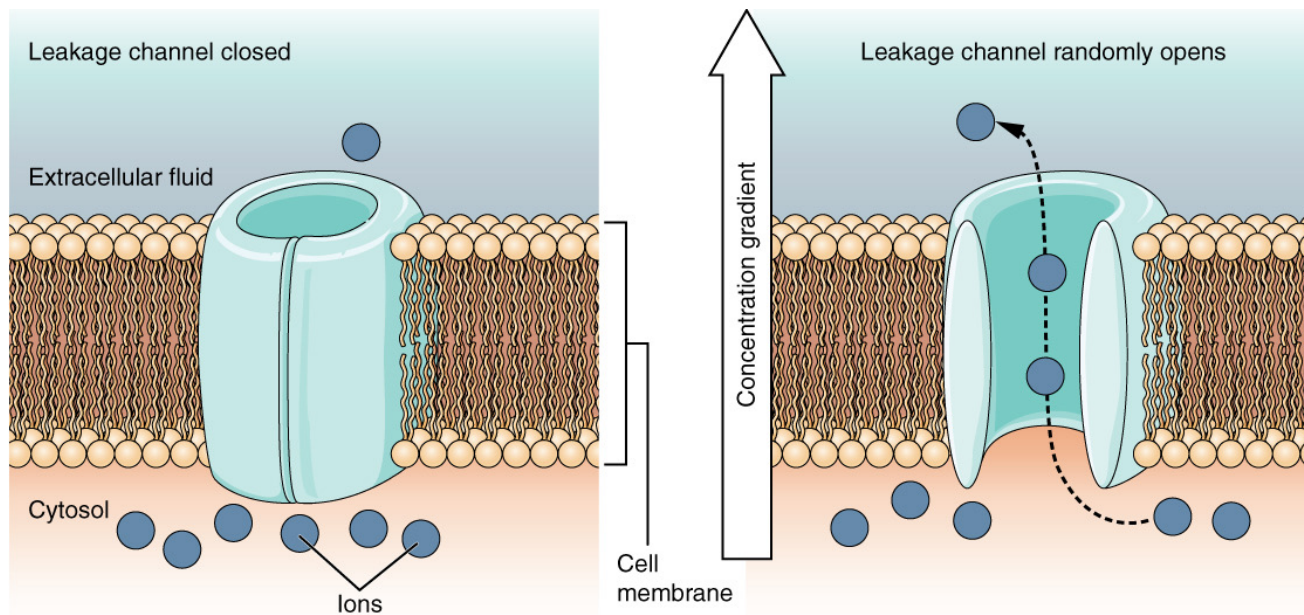
Plasma Membrane Permeability

- Ions pass through ion channels
 - A. Leak channels
 - B. Gated channels



A. Leak Channels

- Non-gated ion channels
- Always open
- Permeable to ions when plasma membrane is at rest

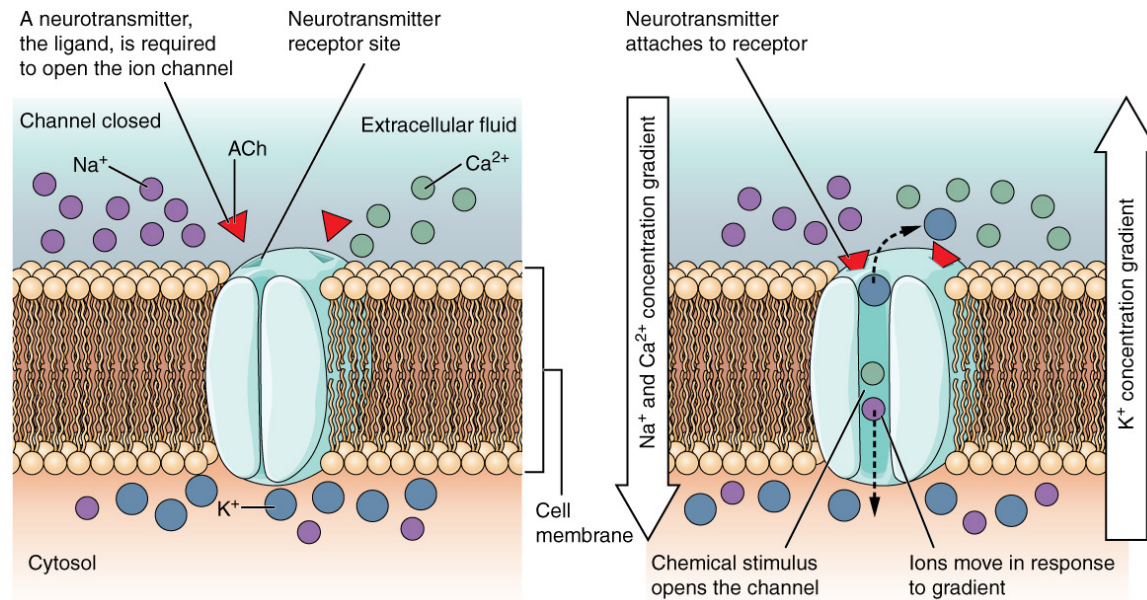


B. Gated Ion Channels

- Closed until opened by specific signals
- Can change permeability of plasma membrane
- a) Ligand-gated ion channels
- b) Voltage-gated ion channels
- c) Other gated ion channels

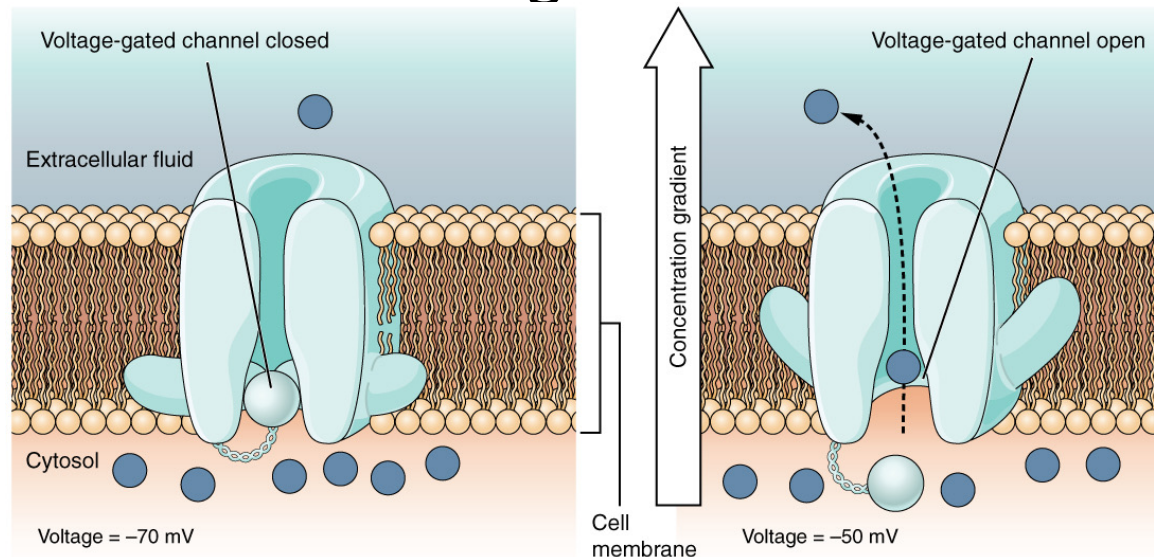
a) Ligand-gated Ion Channels

- Specific molecule (ligands) binds to receptor site
- Receptor site – located on extracellular side
- Ligands – neurotransmitters or hormones



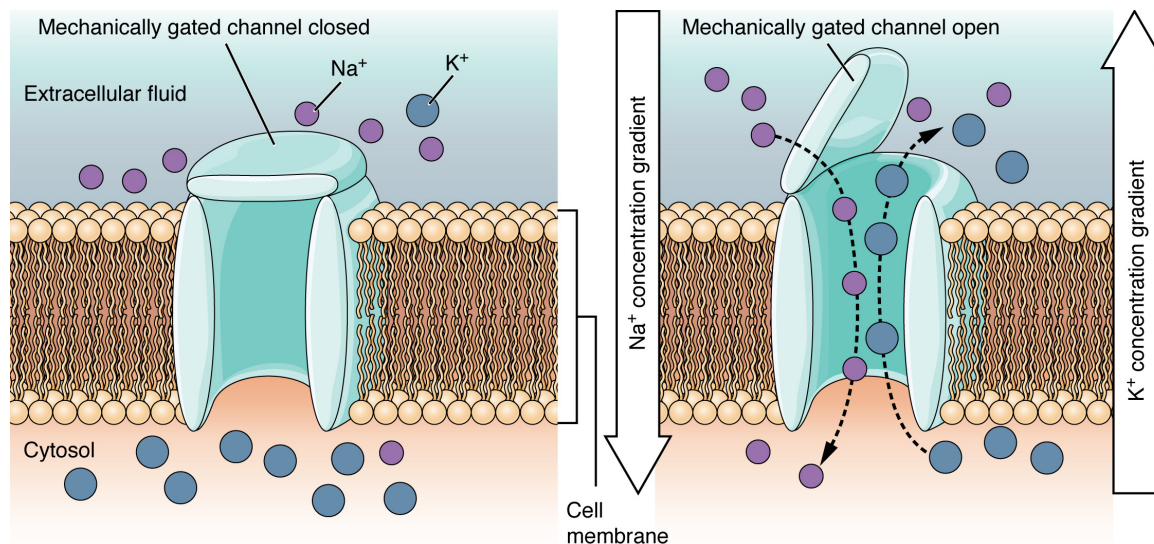
b) Voltage-gated Ion Channels

- Channel that responds to changes in membrane electrical properties
- Inside = negative voltage
- When it becomes less negative -> allows ions to move



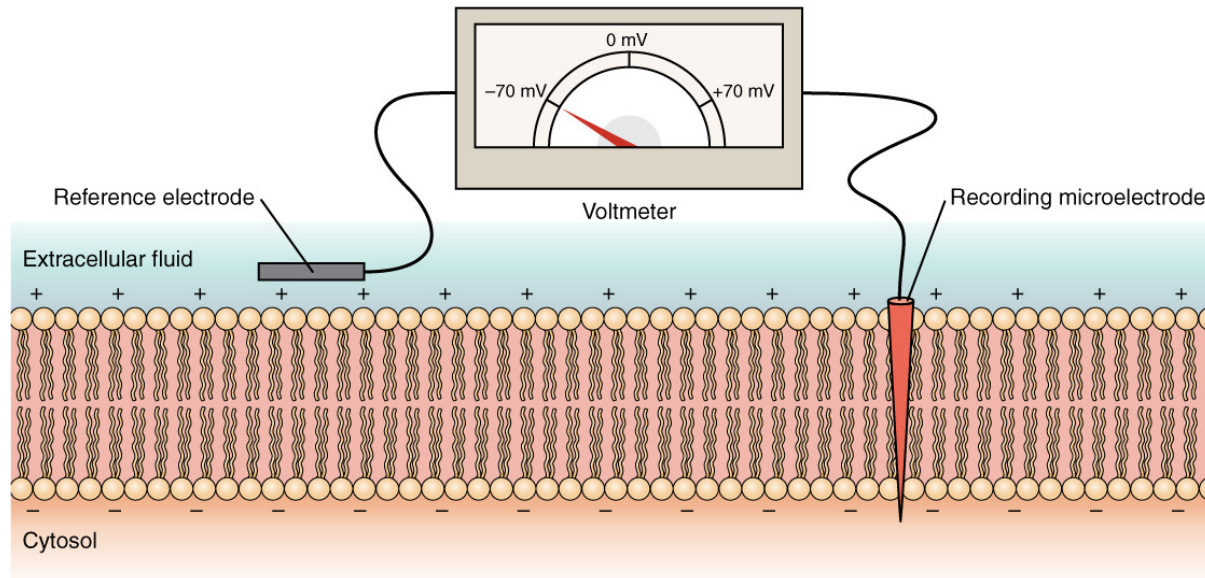
c) Other Gated Ion Channels

- Mechanically gated channels
 - Open due to cell membrane physical distortion
- Thermal receptors
 - Respond to skin changes in temperature



Membrane Potential

- Uneven distribution of positive and negative ions across the plasma membrane
 - Inside of cell is negative compared to outside of cell
- Resting membrane potential = -70mV



Action Potential

- Action potential to occur – change in membrane potential
- Influx of Na^+ - membrane become less negative \Rightarrow depolarization
- Efflux of K^+ - membrane voltage moves back \Rightarrow repolarization

