Membranes 10/31/2014

Cell Membrane: How Things Get In/Out Of Cells

Cell Membrane:

- 1. Unit Membrane Hypothesis
- 2. Photomicrographs show that all membranes look alike
- Source of Study: Plasma Membrane – Red Blood Cell Ghost Pictures
- Red Blood Cell Color, Red Blood Cell Ghost, and SEM

Two Ways To Study Membranes And Transports of Solutes Across Membranes

- 1. Nature of Membrane Itself – molecular make up
- 2. Permeability Studies – Physiological properties of membranes

Current Molecular Model Of Membrane Structure is Fluid Mosaic Model

Fluid Mosaic Model:

- 2 components: lipids and proteins
- Lipids
  - Compose Around upper 30% of plasma membrane
  - In Erythrocyte and Mitochondria, phospholipid is dominant
  - In chloroplast, glycolipid and galactolipid is dominant

- Movement of phospholipid: Lateral movement is frequent (10^7 times per second) and flip flopping of phospholipid is rare (once per month)
- Fluidity vs. Viscous: The unsaturated hydrocarbon tails with kinks are fluid and the saturated hydrocarbon tails are viscous
- There is cholesterol within the membrane
- Lipids spontaneously form bilayers via the hydrophobic effect
    - B.J. Johnson creates Palmolive soap (palm oil 16C and olive oil 18C
    - Soap is a salt (ionized with Na, Cl, or Li) of fatty acid used as surfactant. They form micelles:
    - Micelles: Tiny spheres of fatty acids with polar hydrophilic groups on aqueous side and hydrophobic fatty acid tail on the interior
    - Lipid Bilayer: thin membrane made of two fatty-acid lipid P-molecules
    - Membranes are flat sheets that form a barrier around cells. Almost all cell membranes are made of lipid bilayers
    - Lipids self assemble into lipid bilayer because of hydrophobic effect
        - Energetically unfavorable interaction between hydrophobic lipid tails and water environment
        - Lipid bilayer held by weak non-covalent forces
        - No formation of chemical bonds between individual molecules

- Proteins:
    - Two proteins: integral and peripheral
    - Integral (intrinsic) – proteins are part of and denatured upon release
        - Are literally inside the membrane
    - Peripheral (extrinsic) – easily extractable from membrane
        - Reside on inside part of cell
- Developments that led to current fluid mosaic model
    - 1917: Irving Langmuir – made artificial membranes by creating monolayer of lipids through Langmuir Trough

        - Trough has stationary barrier and movable barrier
        - Polar heads interacted with water
        - Non-polar heads went into ai r
    - 1925: Evert Gorter and F. Grendel – proposed lipids form bilayers around cells (based on lipid content of red blood cell). Extracted RBC lipids and showed enough lipids to form two layers
        - heads are hydrophilic
        - tails are hydrophobic
    - 1935: Hugh Davson and James Danielle – propose model in which phospholipid bilayer lays between two layers of globular proteins (Davson-Danielli model)
    - 1950: J.D. Robertson – electron microscopy shows membranes look like train track (two dark lines and white space in middle)
        - dark lines = phospholipid heads = stained
        - light space = phospholipid tail =
    - 1966: Daniel Branton – Freeze fracture electron microscopy concluded membranes are bilayers because freeze fracture procedure splits membranes in half revealing proteins in leaflets
    - 1972: S. Jonathon Singer and Garth Nicolson proposed fluid mosaic model.
        - Membrane proteins are globular.
        - Span phospholipid bilayer and project from both sides
        - Extracellular matrix:
            - Collagen
            - Fibronectin
            - Proteoglycan complex = core protein + carbohydrates = polysaccharide molecule
            - Integrins: transmembrane receptor proteins that mediate attachment between the cell and its surroundings
- Functions of membrane proteins:
    - Transport – protein that offers hydrophilic channel for particular solute and some proteins use ATP to actively pump across