Chapter 7- Membrane Structure and Function

(Key Concepts are Underlined)

Membrane Structure

Membrane models have evolved to fit new data: *science as a process*

- cell plasma membranes have **selective permeability**
- phospholipids are **amphipathic** (*both* hydrophobic and hydrophilic regions), as are membrane proteins

fluid mosaic model- "the membrane is a mosaic of protein molecules bobbing in a fluid bilayer of phospholipids"

A membrane is a fluid mosaic of lipids, proteins, and carbohydrates

- membranes are not static sheets- membranes are fluid; phospholipids move and some proteins drift
- cholesterol helps in maintaining fluidity at lower temperatures and rigidity at higher temperatures
- membrane must remain fluid to be permeable
- a *mosaic* of different types of proteins (with different functions) inside and outside of the membrane (i.e. embedded/integral, peripheral); membranes have distinctive inside (cytoplasmic) and outside (extracellular) faces
- glycolipids and glycoproteins located on the extracellular face of membranes function in cell-cell recognition

Traffic Across Membranes

A membrane's molecular organization results in selective permeability

- due to the hydrophobic core of the membrane, only hydrocarbons, and small polar, uncharged molecules (e.g. water) and small nonpolar molecules can pass through the membrane rapidly; the bilayer is not very permeable to larger, uncharged molecules (e.g. sugar) and water encased ions

Transport proteins- proteins which span the membrane, allowing hydrophilic substances to pass through; substrate/class specific

Diffusion- the tendency of molecules to spread into available space

- substances diffuse down their OWN **concentration gradient**; spontaneous

Passive Transport- diffusion of substances across a biological membrane

<u>Osmosis is the passive transport of water</u>

Hypertonic

Hypotonic

Isotonic

Osmosis- diffusion of water across a selectively permeable membrane (type of passive transport); direction determined by difference in TOTAL solute concentration

<u>Cell Survival depends on balancing water uptake and loss</u>

- animal cells can shrivel and lyse

Osmoregulation- control of water balance (e.g. paramecium and contractile vacuole)

- plant cells can **plasmolyze** (plasma membrane pulls away from the wall), or become **flaccid** or **turgid**

Specific proteins facilitate the passive transport of selected solutes

Facilitated diffusion- passive transport with the aid of transport proteins; transport proteins can become saturated

Gated channels- transport proteins open and closed by stimuli (e.g. neurotransmitters)

Active transport is the pumping of solutes against their gradients

Active transport- the movement of molecules across the membrane against its gradient- at an expenditure of energy; maintains concentration gradients

- it is common for ATP to phoshorylate transport proteins to induce a change in their conformations (e.g. **sodium-potassium pump**, which exchanges 3 Na^+ for 2 K^+)

Some ion pumps generate voltage across membranes

- all cells have voltage across their membranes (cytoplasm is more negative than the extracellular fluid)
- this voltage/**membrane potential** ranges from –50 to –200 millivolts; favors the transport of cations inside and anions out

Electrochemical gradient- the combined forces of the concentration gradient and membrane potential

Electrogenic pump- a transport protein, which generates voltage across the membrane (e.g. sodium-potassium pump- major pump in animal cells); store potential energy in the form of voltage

Proton Pump- main electrogenic pump in plant, bacteria, and fungi; protons transported across the membrane

In cotransport, a membrane protein couples the transport of one solute to another

Cotransport- the indirect transport of several other solutes by the active transport of another; a solute actively transported will diffuse back down its concentration gradient along with another, but against its gradient (e.g. plants sucrose-H^+ cotransport)

Exocytosis and endocytosis transport large molecules

Exocytosis- secretion of vesicles via the plasma membrane; vesicles from the golgi fuse with the plasma membrane and releases their contents (e.g. hormone secretory cells and neurotransmitters)

Endocytosis- macromolecules or relatively large pieces of matter taken in by the formation of new vesicles from the plasma membrane; three types: **phagocytosis** (by means of pseudopodia), **pinocytosis** (formation of vesicles), **receptor-mediated endocytosis** (formation of vesicles by means of receptors called **ligands**)