The Cell

I. Introduction.

- cell: smallest unit of living matter capable of independent existence; structural and functional unit of all living things.

- other premises of cell theory: continuity of life has a cellular basis.

- ration surface area to volume considerations

- cell has two major parts: a plasma membrane, cytoplasm

II. The plasma membrane.

A. General structure.

- a thin membrane that surrounds cells; a bilayer of phospholipid molecules with globular proteins dispersed in it -- the fluid-mosaic model

B. Molecular structure.

1. Phospholipid bilayer naturally results from structure of phospholipid molecule, a hydrophilic head and hydrophobic tail; confers membrane unique permeability properties.

2. Proteins are dispersed about the phospholipid bilayer, responsible for many functions of plasma membrane

- transport
- adhesion
- receptors
- recognition

3. Highly branched sugar groups found attached to external side of some membrane proteins -- glycocalyx.

C. Functions of plasma membrane: functions of proteins found within membrane.

1. Membrane transport.

- membrane is selectively permeable.

- substances can be transported across either passively or actively.

    a. passive transport processes: substances are moved down a concentration gradient.

i. simple diffusion: lipid soluble substances can move across the membrane down a concentration gradient; small non lipid soluble substances will use a channel protein

ii. facilitated diffusion: used to move large, lipid insoluble molecules across membrane; involves a transport or carrier protein

iii. osmosis: diffusion of solvent across selectively permeable membrane.

b. active transport processes: energy (ATP) is expended to move substances across a membrane against a concentration gradient.

c. bulk transport processes: means by which very large molecules and particles are transported across membranes.

i. exocytosis: process that moves substances from cell interior to exterior

ii. endocytosis: process that moves large particles from extracellular space to cell interior

2. Generation and maintenance of resting membrane potential.

- sodium/potassium pump sets up a unique distribution of sodium and potassium ions across the membrane; Na+ at greater concentration outside cell, K+ at greater concentration inside cell.

- the plasma membrane is differentially permeable to sodium and potassium (pK+ > pNa+); thus potassium leaks out (down gradient) at a much greater rate than sodium leaks in; this results in a loss of positive ions inside the cell relative to outside; therefore, the inside becomes "negative" relative to the outside of the cell.

- there is a voltage difference across a membrane, the resting membrane potential (-20 - -200 mV depending on cell type).

III. The cytoplasm

- cellular material inside plasma membrane, outside the nucleus; site where most cellular activity is accomplished

- major components of the cytoplasm are cytosol, organelles, inclusions, cytoskeleton.

A. Cytosol: viscous matrix where everything else in the cell is suspended.

B. Organelles: membrane bound structures, specialized cellular components each performing a particular function.

- delineating membrane allows organelles to maintain internal environments different from surrounding cytosol -- important to perform specific functions that require a very specific environment very different from that of cytosol.

- compartmentalization--an organization to biochemical activity?

1. Nucleus

- control center of the cell; contains genetic information of a cell; codes for all proteins; largest cell organelle; a few cells are multinucleate.

- nuclear envelope: double membrane, each membrane is a phospholipid bilayer.

- nucleoli: most prominent structure in the nucleus; not membrane bound; involved in RNA synthesis

- chromatin: a complex, highly coiled structure composed of DNA/protein (histones); visible as chromosomes during cell division.

2. Mitochondria: powerplants of the cell, ATP production.

- composed of two membranes, inner and outer mitochondrial membranes.

- contain their own DNA and RNA, can self-replicate.

3. Ribosomes: composed of two globular proteins and rRNA; site of protein synthesis.

- free in cytoplasm or attached to membranous system of RER.

4. Cytomembrane system: system of interconnected parallel membranes and tubes enclosing a fluid-filled cavity (cisterna)

a. RER: flattened membrane sacs studded with ribosomes, important in synthesis of proteins secreted from the cell or for incorporation in cellular membranes.

b. SER: structural continuation of RER, not functional continuation.

- more tubular, no ribosomes and no role in protein synthesis.

- role in lipid metabolism: synthesis of cholesterol, lipoproteins, steroid hormones, absorption of fats, drug detox

c. Golgi apparatus: sorting/shipping of proteins

5. Lysosomes: spherical membranous units, contain digestive enzymes.

C. Cytoskeleton.

- structural framework of a cell; maintains shape, stabilizes attachments, plays a vital role in cell movement, organelle movement.

- includes various filamentous structures such as microtubules, microfilaments, and intermediate filaments.

1. Microtubules: cytoskeletal element with the largest diameter.

- hollow tubes made up of spiral arrangements of molecules of the globular protein tubulin.
- radiating arrangement determines cell shape, distribution of organelles (motor proteins associated with MTs), critical cellular movements in cell division.

2. Microfilament: thin strands made of polymers of G-actin molecules (a contractile protein).

- movement

3. Intermediate filaments: intermediate in size between MTs/MFs.

- controversial functions

4. Cilia: whiplike, motile cellular extensions that occur in exposed surfaces of certain cells; move substances in one direction across the cell surface

- flagella: similar in structure to cilia; occur singly, involved in cell motility.