BIOL 230 (Part I) – Important Terms and Concepts 9/14/2019 (this is NOT an exhaustive list!)

***LIFE, 11e* Chapter:**

1. Definition of **Life** (metabolism, sense/respond, cells, reproduce, homeostasis, adapt/evolve, DNA), **Scientific Method** (Observe, question, hypothesize, predict, test).

Plasma Membrane, Nucleus, Nucleolus, Ribosomes, Mitochondria, Rough ER, Smooth ER, Golgi Apparatus, Cytoskeleton.

2. Carbon, Hydrogen, Nitrogen, Oxygen, Phosphorus, Sulfur (**CHNOPS**). Electron shells; Protons, neutrons, atomic mass, atomic number, Octet Rule. Covalent bond – polar, nonpolar.

Hydrogen bond; Ionic bond; **Van der Waals** forces;"hydrophobic interactions"; WATER: cohesion, adhesion, tetrahedral, polar, H-bonding.

Heat capacity**; pH buffer**, acid , base.

3. ***Structure/shape→Function.*** **Functional Groups:** Carboxyl, amino, hydroxyl, **phosphate**, **sulfhydryl.**

Monomers, polymers, **Condensation reactions, Hydrolysis reactions.**

Monosaccharide, polysaccharide, **Glycosidic** linkages (alpha, beta); Cellulose, starch, glycogen.

Lipids – fatty acids, **triglycerides**, phospholipids, cholesterol; **Ester** bond; Saturated, unsaturated hydrocarbons; phospholipid bilayer.

Lateral diffusion, no transverse diffusion (flip-flop)

Amino acids – polar, nonpolar, charged; **peptide** bonds.

Proteins, **Protein-structure:** Primary, secondary (alpha helix, beta-pleated sheet), tertiary, and quaternary. Cysteine – **disulfide** bonds.

Molecular chaperones/chaperonins, **denaturation**

4. Nucleic acids & Life Origins – **DNA vs. RNA**; Adenine, Guanine, Cytosine, Thymine, Uracil; sugars Ribose, Deoxyribose; Single-standed, double-stranded; Nucleotides, phosphodiester linkages; **Base-pairing: A-T (A-U) [2 H-bonds], G-C [3 H- bonds].**

Harold Urey-Stanley Miller Experiment *(N_2, CO_2, CH_4, NH_3, H_2, H_2O; electricity).* **Protocells**.

*Louis **Pasteur**: Swan-necked flasks; biogenesis v. spontaneous generation.*

5. **CELL THEORY – Prokaryotic** vs. **Eukaryotic** cells; *Protobionts, protocells*

Prok.: Plasma membrane, nucleoid, ribosomes, Peptidoglycan Cell Wall, Outer Membrane, Capsule, prokaryotic chromatin, chromosomes flagella, Pili.

Nucleus – nuclear envelope, nuclear pores,

Plant vs. Animal cells, nuclear lamina

Endoplasmic Reticulum: Rough, Smooth

Golgi Apparatus – cisternae, **vesicles**; ***cis, medial, trans*** regions. Lysosomes, **phagocytosis**, phagosomes, phagolysosomal fusion .

Mitochondria, Plastids – chloroplasts

ENDOSYMBIOSIS THEORY.

Cytoskeleton – ***Microfilaments***/actin filaments, G-actin. ***Microtubules***, tubulin (alpha,beta), minus-end, plus-end; Microtubule organizing center, basal body, centrioles. Flagella, Cilia; **Dynein (-), Kinesin (+)** – molecular motors.

Plant cell wall – cellulose, pectins, Plasmodesmata.

6. **FLUID MOSAIC MODEL:** Integral and peripheral membrane proteins; Transmembrane proteins; Selective Permeability; Free lateral diffusion, negligible transverse diffusion ("flip-flop").

Cell-Cell Adhesion: gap junctions (connexons), **tight junctions**, **desmosomes**, **Integrins**.

Diffusion; equilibrium, concentration gradient.

Simple diffusion; channel proteins (Passive transp.)

Facilitated diffusion – Passive transport; **Osmosis** ***Tonicity***. Primary and Secondary **Active transport.**

Carrier proteins: Uniport, Coupled transport – symport, antiport. Sodium-potassium pump; Na+/glucose symport.

Bulk Transport (active!): **Endocytosis** – ***Phagocytosis***, ***Pinocytosis***; Exocytosis.

Receptor-mediated endocytosis – coated pits, clathrin; LDL, cholesterol, Receptor protein.

8. **METABOLISM** – **anabolic** and **catabolic** reactions. 2 Laws of thermodynamics, Free Energy (G), Entropy, Enthalpy, $\Delta G = \Delta H - T\Delta S = G_p - G_r$

Chemical reactions run both backward and forward

Chemical Equilibrium; **$-\Delta G$ = spontaneous = exergonic; $+\Delta G$ = nonspontaneous = endergonic; ATP (12 kcal/mol),** phosphate-transfer, energetic coupling

Catalyst, **ENZYME**, Energy Barrier, **Activation Energy**, Transition-state species; Substrate, Product, **Active Site** – Lock and Key, Induced-Fit ,

Enzymatic coupling; Enzyme inhibitors – irreversible, reversible – competitive and noncompetitive

Allosteric enzymes – effector molecules (activators, inhibitors), Allosteric (regulatory) subunits, catalytic subunits; **Cooperative binding**

Branches in metabolic pathways, Regulatory enzymes at branch-points, **First Committed step**, **Feedback inhibition.**

Glucose (6C), oxidative respiration, ATP (12 kcal/mol)

Step-by-step (incremental) packaging of free energy (G)

Oxidation-Reduction (redox) reactions: Oxidizing agent, Reducing agent; NAD^+, **NADH + H^+ (52 kcal/mol);** FAD, **$FADH_2$**, **Hydride Ion (2e- + H^+).**

Cell & Molecular Biology – Midterm 1 (Fall 2019): Study Questions

Possible Short Essay Topics (be prepared to draw diagrams as well!):

1. Describe the steps in the Scientific Method of inquiry, and for each step describe how you would proceed for YOUR OWN scientific investigation that you might like to perform some day.
2. List and explain 6 factors that distinguish life from non-life. Provide specific examples of each in the living world.
3. **Describe 5 special properties of water that make it so valuable to living systems, even though it is an "inorganic" molecule itself.**
4. **Diagram and explain how two different biochemical polymers, composed of the exact same monomer (eg: glucose) or very similar monomers, might have very different chemical properties and biological functions (eg: easily broken down for energy, vs. strong and stable for cell structural support). *Give a specific example of each type of macromolecular polymer that you mention above.***
5. Describe 4 structural properties of **phospholipids** that contribute to their cellular function.
6. **Using simple diagrams, compare and contrast the component monomers, general chemical structures, and shapes of each major type of macromolecule. Briefly explain how these structures directly contribute to the main cellular functions of each type of molecule.**
7. **Use diagrams to describe and provide specific examples of each level of protein structure. Include the types of molecular bonding/interactions that are important at each level.**
8. Describe 5 structural properties of **DNA and RNA** that directly contribute to their cellular functions.
9. Describe and diagram the Urey-Miller experiment, and explain how it contributes to current theories on the origin of life.
10. **Briefly explain how Louis Pasteur's experiments disproved the prevailing theories of the origin of life during his time, when the scientific community did not accept previous results or interpretations from experiments by other scientists. Also, explain how Pasteur's conclusions are consistent with the current Cell Theory.**
11. **Compare/contrast and describe at least 8 characteristics that distinguish between Prokaryotic and Eukaryotic cells. Use diagrams to help explain the significance of these characteristics.**
12. Diagram and describe the synthesis and modification pathway of eukaryotic proteins and lipids that are targeted for export to the cell membrane or outside of the cell.
13. **Use diagrams to explain the prevailing Theory for the origin of mitochondria and chloroplasts I n eukaryotic cells, and list 5 examples of supporting evidence.**
14. **Using diagrams, name and describe the prevailing Model of the structure of biological membranes. Be sure to include and define ALL relevant components of membranes and their associated functions.**
15. **Using diagrams, explain 3 differences between simple diffusion, and primary and secondary active transport across a biological membrane. Also, what are three properties of a transported substance that strongly affect its rate of diffusion across a membrane?**

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16. Distinguish between potential and kinetic energy, and give examples of each in living cells.
17. **Describe and explain three ways in which an enzyme can interact with a substrate in order to speed up a chemical reaction. Be sure to explain the effect of an enzyme on ΔG, E_a, and the state of equilibrium of a reaction.**
18. **Describe energetic coupling within a living cell, and give an example. Use diagrams if helpful.**

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19. **Describe five ways by which a metabolic (enzymatic) pathway can be regulated. Be sure to include physical properties of the protein enzymes themselves, especially those involved in branched pathways. (What is *allostery*? What is *feedback inhibition*? What are the effects of physical conditions?)**

*** Strategy Tip:* *When answering comparison or contrast questions, try using a TABLE, but still provide some brief definitions and explanations of factors or characteristics that you list.*

***** NOTE: All essay questions, or versions thereof, are possible for inclusion on the Midterm Exam. Questions printed in BOLD are especially probable. However, the concepts represented in EVERY question are very likely to appear on some portion of the exam!!***