BIOL 230 (Part II) – Major Terms & Concepts (this is NOT an exhaustive list!!) 10/13/2019

Sadava/Purves Chapter:

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*** , Equilibrium.

Enzymatic coupling; **Enzyme inhibitors** – irreversible, reversible – **competitive** & **noncompetitive**

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

Branches in metabolic pathways, Regulatory enzymes at branch-point enzymes, **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^+).**

9. Glycolysis– net 2ATP, 2NADH+H^+, glucose (6C) → 2 Pyruvate (3C)**;** Glyceraldehyde-3-phosphate (3C), **Substrate-level phosphorylation**

- Pyruvate Oxidation (3C)→ **Coenzyme A**, acetyl-coA (2C), 2 NADH+H^+, 2 CO_2
- Citric Acid Cycle – 2C (acetate) + 4C (oxaloacetate) → 6C (citrate) → 5C, → 4C; [+ 4 CO_2, 2 ATP/GTP, 6 NADH+H^+, 2 $FADH_2$]
- Respiratory chain – **Oxidative Phosphorylation**, ***Chemiosmosis***, **Proton Motive Force**, chemiosmotic mechanism, **ATP Synthase**, Ubiquinone/Q, Cytochrome C, Cytochrome Oxidase, **$O_2 \rightarrow H_2O$**
  ~3ATP/ NADH+H^+, ~2ATP/ $FADH_2$
  Respiratory Uncouplers – *thermogenin, calorigen*; Mitochondria – inner membrane, matrix; Aerobic, anaerobic, metabolic efficiency
  Fermentation – ethanol, lactate, NAD+ recycling.

10. **Photosynthesis:** Light reactions: stomata, CO2, **H_2O-splitting Enzyme**; photons, O_2 evolved (given off); **Thylakoids**, chlorophyll (a, b), absorb red and blue/violet wavelengths; Longer wavelength = lower Energy; ATP, **NADPH**. Light = reflected, transmitted, or absorbed. Absorption Spectrum – Action Spectrum. Excited chlorophyll = reducing agent; **Cyclic and Noncyclic electron flow**. Photosystem II (P680), Photosystem I (P700); Ferredoxin, Plastoquinone, Cytochrome complex, PlastoCyanin, PMF→ Chemiosmosis → **Photophosphorylation**! Stroma, Grana; Calvin-Benson Cycle/ Carbon Fixation: **3-Phosphoglycerate**, glucose, starch, sucrose; **RuBP**, ***RUBISCO***, Photorespiration..

13. **DNA** = Genetic material; structure; replication; repair; applications……

- **Griffith** – **transforming principle** (TP) is genetic material (*Streptococcus*); S- & R-strains.
- **Avery/MacLeod/McCarty** – TP = DNA! (specific, hydrolytic enzymes)
- **Hershey/Chase** – (bacteriophage, blender) DNA= genetic material;
- **Franklin/Wilkins** X-Ray Crystallography, antiparallel strands; Right-handed helix, uniform diameter, info in linear Nucleotide sequence
- **Watson/Crick:** DNA = double helix, sugar-phosphate backbone, Chargaff (A=T, G=C), A(2)T and G(3)C base pairing;

DNA REPLICATION: **semiconservative**, dispersive, conservative;

- **Meselson/Stahl** – CsCl density gradient; **^{14}N, ^{15}N**; intermediate DNA density = semiconservative.
- **Kornberg**, *DNA Polymerase*; Deoxynucleoside triphosphates, pyrophosphate, DNA template 3'-Hydroxyl terminus, 5'-Phosphate terminus
- **Initiation, Elongation, Termination: DnaA, DNA polymerase III**; Origin of replication (***Ori, Ter***), Helicase, ATP, ssDNA-binding proteins, **Primase** (RNA Primer, free 3'-OH), DNA Polymerase I, DNA Ligase, **5'→3'** synthesis; *DNA Gyrase/Topoisomerase*
  Leading strand, lagging strand, Okazaki fragments; **DNA polymerase I, DNA Ligase**

DNA REPAIR: Proofreading, mismatch repair, excision repair – ***"seeker" proteins***, repair endonucleases, Dpol1, Ligase.

***TELOMERES;* Telomeres**, Telomerase, ….(GGAATT)n…… Protein-RNA enzyme with its own template for synthesis;

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15. **(a.) Restriction Endonucleases**; DNA **gel electrophoresis**, "DNA denaturation", ***Probe***, **Hybridization.** **[Mutations, gene therapy.] 14.7/17.2 – DNA Sequencing. DNA sequencing, *dideoxy Nucleotide triphosphates*** ("chain-terminators", ddNTPs). **Polymerase Chain Reaction (PCR)** – denature, anneal ***DNA Primers (specific!)***, elongate; ***Taq* DNA Polymerase.**

BIOL 230: Cell/Molecular Biology -- Midterm 2 (Fall 2019): Study Questions

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

1. **Ch. 8:** Distinguish between potential and kinetic energy, and give examples of each in living cells.
2. **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 how an enzyme affects ΔG, E_a,** and the **state of** equilibrium of a reaction.
3. **Describe energetic coupling within a living cell, and give an example. Use diagrams if helpful.**

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4. **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?)**
5. Describe energetic coupling within a living cell, and give an example. Use diagrams if helpful.

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6. **Ch. 9: Compare the pathways, and energy inputs and outputs of aerobic respiration and fermentation in living organisms. Include all processes/stages, electron carriers, and phosphorylated compounds. *HOW are these compounds formed in cells? WHERE does each process occur?***
7. **Diagram and describe the flow of all six carbon atoms in glucose through glycolysis and each stage of the respiratory pathways. In what form (molecule) does carbon enter each process/stage, and in what form does it leave? *WHERE does each process occur?* What type of energy is the major type extracted from these carbon compounds/sugars?**
8. **Diagram and describe how ATP synthesis is coupled to electron transport in mitochondria and chloroplasts. Identify and describe the function of at least two proteins, and describe two important processes, involved in energy conversions. Define *energetic coupling*, and identify what cellular molecules perform the coupling process in each case of energy conversion.**

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9. **Ch. 10: Compare 3 similarities and 3 differences between the sources of energy and electrons, *how* energy is converted to different forms and packaged (including "carrier" molecules and coenzymes), and *how* energy is finally harvested as cellular ATP by *Aerobic Respiration* and by *Noncyclic Light Reactions* in Photosynthesis. (***Be sure to state proper terms for each energetic process in cells, and subcellular locations of each process.)***
10. Distinguish between the *absorption spectrum* and the *action spectrum* of a photosynthetic pigment. Using a diagram, describe an experiment that illustrates this difference.
11. What particular properties of pigments, such as chlorophyll, make them such effective cellular components at harvesting light energy for cellular work? Be sure to include where and how they are located in the cell, and how they aid in the conversion of energy.
12. **Diagram and describe the relationship between the *light reactions* and the *dark reactions* in photosynthesis. What enzymes, carriers, and pigments are involved in processing and transferring energy? Identify where in the chloroplast these reactions occur.**
13. Briefly describe **Calvin and Benson's experiments** to discover the source of fixed carbon in plants and algae, and the several intermediate and end compounds in the Calvin-Benson Cycle. *(Be sure to name the important enzyme, and the main input and output molecules – including #C's passing, and energetic inputs.)*

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14. **Ch. 13: How did the experiments of Griffith, Avery et al., and Hershey and Chase contribute to our current understanding of molecular genetics? *Describe and explain* the basics of their experimental design, results, and conclusions.**
15. **Describe 5 main pieces of evidence that lead Watson and Crick to solve the structure of DNA. Describe 5 main characteristics of the structure of DNA, and explain how each contributes to its functions.**
16. **Describe and diagram how Meselson and Stahl's experiments proved the general mechanism of DNA replication.**
17. **Diagram a replicating fork of DNA, and at least 7 protein and nucleic acid (RNA) molecules, in sequential order, that participate on each strand during synthesis. *Briefly explain the function of each molecule involved.* Indicate the proper name and direction of each replicating strand, and the type of synthesis associated with each.**
18. Distinguish between the **three types of DNA repair**, and describe the roles of the several different enzymes involved in each process. What is the effect of these mechanisms on the fidelity (accuracy) of DNA replication (copying)? Why are these mechanisms worth such a large investment of cellular energy?

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19. **Describe how the revolutionary methods of DNA sequencing and PCR were developed simply from the knowledge of DNA structure and replication.**
20. Describe the natural biological functions of **Restriction Endonucleases**, and how these molecular tools can be used in Recombinant DNA Technology (Genetic Engineering).

❖ ***Preparation Note:*** *A good strategy for answering **comparison and contrast questions is to make a TABLE** with a column for each subject/topic to be compared. Then compare related characteristics in the listed rows below each topic. ALWAYS provide **brief but thorough EXPLANATIONS** with **Tables** and **Diagrams**!! ☺*