STUDY GUIDE – BIOMOLECULES.

Learning Resources:

- Lecture Recording
- Written Synopsis
- Study Guide
- Supplemental Reading (if available):
  Lodish Molecular Cell Biology, Chapters 1 and 2
  Marks Basic Medical Biochemistry, Chapters 4 and Lehningers
  Principles Of Biochemistry, Chapters 1 and 2
- Block Assessment Questions (supplied and on-line from Board Review Books)

It is strongly recommended that you learn this material as best you can from the supplied resources (according to the manner in which you learn best). Assess yourself within a day after completing the session to determine your level of competency, understanding, and short-term retention. Go back to the resources immediately to improve your comprehension of any less understood topics. Finally, you should review the topic again within 3-5 days to assess long-term retention. Whenever problematic concepts are discovered, you should correct them immediately.

Introduction:

To understand how more complex cellular processes function, one must first appreciate the smaller components, the biomolecules that react with one another in both a biophysical and biochemical sense. These biomolecules are based on carbon, which primarily reacts with hydrogen, oxygen, nitrogen, phosphorus, and sulfur. The combination of carbon with these atoms forms specific functional groups, each with a unique set of properties (charge, hydrophobicity, etc...). Most biomolecules are combinations of numerous functional groups. The sum of these functional groups dictates (1) the overall properties of the molecule, (2) the way it will interact with its solvent and other molecules, and (3) the overall structure and function of the molecule. Of critical importance is the importance of water and four weak interactions that are caused by the very nature of these functional groups. In this lecture, we discuss these issues.

Learning Objectives:

Students will be expected to understand:

1. the different common functional groups that comprise more complex biomolecules.
2. the importance of water in biochemistry.
3. the four weak forces that functional groups and domains exert.
4. The importance of biological buffers in maintaining pH.
5. that combined, all of the sum total of properties, forces, ionization states and interactions exerted by functional groups and domains will dictate the overall structure of the biomolecule, as well as its function.

Important Concepts:

1. Biomolecules (proteins, nucleotides, lipids, carbohydrates) are comprised of covalent bonds between Carbon and Hydrogen, Oxygen, Nitrogen, Phosphorus and/or Sulfur. Biochemistry explains biology in chemical terms, ... in this case, carbon biochemistry. Carbon has two interesting characteristics that make it the obvious choice for the backbone of biochemistry: (1) its ability to form up to four covalent bonds, which enables linear, branched or and cyclic structures, and (2) its ability to form single, double or triple bonds. No other atom has such versatility, and may be why nature has chosen carbon to play such a central role in biochemistry.

2. These atoms come together in functional groups, possessing special characteristics or properties. Complex biomolecules are actually combinations of numerous functional groups, the sum total of which helps to dictate the structure of molecule, its ability to interact with other molecules, and its overall function.

3. The properties of these functional groups, in combination with water (the solvent of life), create four weak interactions (ionic, hydrogen bonds, hydrophobic interactions and Van der Waals interactions). These interactions are much weaker than covalent bonds, but a molecule may possess many of these weak interactions at any given time. Since these interactions are weak, they can form and break relatively quickly, and are therefore very helpful in stabilizing molecules, or alter structure (to favor association between substrate and enzyme). As such these weak interactions are critical to cellular function.

Key terms, phrases or disease states (Can you put these terms in context? If not, look over the material more):

Amphipathic, amino group, carboxyl group, carbon, oxygen, nitrogen, hydrogen, phosphorus and sulfur, tetrahedral arrangement, planar arrangement, hydrocarbons, methyl group ($-CH_3$), ethyl group ($-C_2H_5$), R group, phenyl group, carbonyl group (C=O), aldehyde, ketone, carboxylic acid, carboxyl group, anhydride, ester, alcohol, hydroxyl group, ketone, amino group ($-NH_2$), amido group ($-CONH_2$), guanidine group, imidazole group, thiols, mercaptans, sulfhydryl group (-SH), disulfide group, Cysteine, Cystine, thioester, Phosphoryl group, phosphoanhydride, mix anhydride, hydrogen bonding, electronegative, electropositive, ionic interaction, hydrophobic interactions, polar, nonpolar, ionic, nonionic, hydrophilic, hydrophobic, acid, base, zwitterion, buffer, Carbonic acid/bicarbonate buffer system, carbonic anhydrase, van der Waals interactions,.