BC351 – Principles of Biochemistry
Study Guide for Exam 1

Lecture 01

1. What are types of bonding within chemistry and biochemistry? How do they differ?
2. How is a permanent dipole formed (such as seen in the water molecule)? What is electronegativity?
3. What is free energy? What is an exergonic/endergonic reaction? Which is spontaneous?
4. I would know the thermodynamic equation and what each term stands for. What does it mean if a particular term is negative or positive? How does this affect the other terms? How does this affect spontaneity? Be able to apply this knowledge to examples of chemical reactions/process such as evaporation or condensation of water (see question 6).
5. What is the thermodynamic basis for the hydrophobic effect? How does this force differ from the other intermolecular forces talked about?
6. Why does water/ethanol evaporate spontaneously? Is the change in enthalpy for this reaction positive or negative? What does this tell us about the sign on entropy? What does this tell us about bond breaking and forming with respects to enthalpy?
7. What are the factors affecting the strength of an ionic bond? Why is the same ionic bond stronger in benzene (nonpolar) than in water?
8. What is equilibrium? What is the equilibrium constant? What does it tell us about the reaction? If this is large will the reaction favor products? How do these concepts relate to changes in free energy?

Lecture 02

1. Know what the properties of each amino acid are. Be able to recognize an amino acid if given the structure and name it based off of it's one-letter, three-letter or full name. What is unique about Gly, Pro and Cys?
2. What is a stereoisomer? Do we find D-amino acids in proteins?
3. What is an acid? What is a base?
4. What does the K_a tell us about the affinity of an acid for its proton? What is the pK_a? How can the pK_a be used to predict if a chemical is an acid or a base?
5. If an amino group is deprotonated what will its charge be? If a carboxyl group is deprotonated what will its charge be? What if they are protonated?
6. What two equilibrium expressions are being affected in an acid titration done with sodium hydroxide? I want you to understand how the disruption of a reaction at equilibrium will affect the other chemical species.
7. Given pK's be able to predict the form (charge and structure) of an amino acid based on pH. Be able to apply this to given situation, you must think on these. Be able to due this if the amino acid is in a protein.
8. **Problems from the Textbook:** pg. 68 #12, #14; pg. 69 #28; pg. 108 #2 (NOT (b), (f), (h), (i), (m), (o)) and #4;

Lecture 03

1. Can an amino acid in a peptide chain have 3 acid/base groups? Can it have 1 acid/base group? What amino acids would you expect to have at least one acid/base group in a peptide chain? What amino acids would you expect to have two acid/base groups in a peptide chain?
2. What is the peptide bond? Is the formation of this bond energetically favorable? What does this tell us about protein production in the cell?
3. What does it mean for the peptide bond to have partial double bond character? How does this restrict this bond? Is the peptide bond cis or trans in proteins? Are there exceptions?
4. What are the phi and psi angles? What is the ramachandran plot? How is it generated? Why are these angles restricted?
5. What is the N and C-terminus?
6. What is secondary structure? What is a recurring pattern?
7. What are the features of an alpha helix? How is it stabilized? If the backbone did not participate in any non-covalent interactions in the primary structure would the formation of the helix have a negative or positive change in enthalpy? Why is this a simplified statement?
8. What are the features of a beta sheet? What is the difference between a strand and a sheet? How do parallel and anti-parallel strands differ? Which is more stable?
9. What are loops or undefined regions of protein structure?
10. For tertiary and quaternary structure I tried to illustrate some very important points using pymol. These questions relate to those illustrations:
    a. What is a long-range interaction? What types of bonds can be long range interactions?
    b. What are prosthetic groups? How do these relate to function?
    c. The "hydrophobic core" is a term Biochemist often use to talk about the interior of a protein. What does this mean?
    d. Are loops ill-defined structures in proteins? In other words do they have specific structure or are they just kind of wobbling around in each copy of the protein in question?
    e. What is quaternary structure? Is it found in all proteins? What is a subunit? How are subunits held together?
11. What does Anfinsen's experiment tell us about protein folding? Why could this conclusion be made? What was this experiment?
12. What does Levinthal's paradox tell us about protein folding?
13. What are the major forces that stabilize and destabilize protein structure? This is one you need to think about. For instance what would happen if you started mutating different residues within a protein? How would this stabilize or destabilize the structure? Think about steric clashes introduced by going from a small to a large amino group. Think about like charges repelling and the introduction of a polar group in the hydrophobic core. How would pH affect these interactions? What about temperature?
14. Why does a salt bridge on the interior of a protein have a greater strength than those on the surface? What happens to the strength of a salt bridge as two opposite charges get further apart?

15. What is the overall sign on the change in entropy for a protein when it goes from the unfolded to the folded state? What contributes to this entropy term? What are the individual signs on these contributions?
16. What is the sign on the change in enthalpy for a protein when it goes from the unfolded to the folded state? Why is this sign difficult to quantitate? In other words why is this debated? In general, what would a good argument be for the fact that this sign should be negative (think environment)?
17. **Problems from the Textbook:** pg. 109 #11 (NOT (b)); pg 149 #1; pg 150 #4; pg 151 #11

To do well on my test you must not only know the facts but you must know WHY!! You must know the principles and think about them. I will give questions that are digging for your understanding of the principles. They may be over a protein we haven't talked about, but the principles from what we have talked about will still apply. Apply the principles and answer the questions.