

Name: _____

2006 7.012 Problem Set 1

Due before 5 PM on FRIDAY, September 15, 2006.

Turn answers in to the box outside of 68-120.

PLEASE WRITE YOUR ANSWERS ON THIS PRINTOUT.

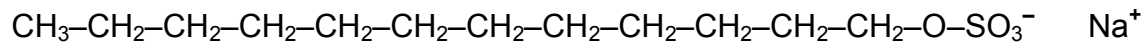
1. For each of the following parts, pick the best answer out of the choices: covalent bonds, hydrogen bonds, ionic bonds, hydrophobic forces.

What kinds of bonds hold together:

- (a) ...the O and two Hs in one water molecule?
- (b) ...molecules of water with each other in a glass of water?
- (c) ...lipids with each other when placed in water?
- (d) ...the atoms in a single 6 carbon sugar?
- (e) ...sugars in a chain of glycogen or starch?
- (f) ...the primary structure of a protein?
- (g) ...an alpha helix?
- (h) ...a beta sheet?
- (i) ...two cysteines in a disulfide bond?

Name: _____

2. Below is a molecule called sodium dodecyl sulfate, which is a detergent.



- (a) Put a circle around the part of this molecule that is hydrophobic.
- (b) Draw a box around the part of this molecule that is hydrophilic.
- (c) What do you think would happen to cells if you added detergent to them?

3. ****For this problem, you will need to use the internet, so as to view the structure of the protein lysozyme using a program that allows you to view protein structures.****

To begin, go to the site:

<http://web.mit.edu/viz/7.01x/>

Then click on "Problem Set 1 Problems." To print out the instructions for this problem, click on "Problem 3 (word document)." To do the problem on the internet while following the instructions, click on "Problem 3 (pdf with live links)."

If you do not have a computer easily available, room 37-212 has an Athena PC cluster that will run the program you need.

For the 37-212 cluster schedule, see <http://web.mit.edu/acis/labs/37-312.html>

If you would like to do this problem in the presence of technical staff who are familiar with this computer program, there will be staff present on Thursday 9/14/06 from 4-9pm in 26-152. You are welcome to stop by anytime during that interval to use one of the computers in that room to do the problem, or to ask the staff questions about the program.

Please write your answers to the protein viewing question entitled "Problem 3" in the space below. NOTE: The protein viewing question entitled "Ungraded Exercise" (that can be found on the same website) will not be graded and is available for your interest.

In this problem, we examine the primary, secondary, and tertiary structure (see Fig 3.6 on p. 42 of your text) of a specific protein (lysozyme, see Fig 3.7 on p. 43).

- (a) Lysozyme consists of 129 amino acids.
 - i) List in order the 12 amino acids numbered 4 through 15 in lysozyme.

Name: _____

ii) What level of protein structure does this represent?

(b) These 12 amino acids also make up an α -helix in lysozyme.

i) What level of protein structure do α -helices and β -sheets represent?

ii) Do the side chains of the amino acids in a helix point into or out of the helix?

iii) What type of bond is primarily responsible for maintaining secondary structure?

iv) What part of the amino acid participates in this bond (side chain or backbone)?

(c) The tertiary structure of a protein is formed by bending and folding, with the interactions between the amino acid side chains determining this structure. Below we list four kinds of tertiary interactions between side chains that are possible and four sets of residues.

i) Match up which set of residues belongs to which type of interaction (you will need information from Fig 3.2 on p. 39 to answer this). Draw a line from each choice on the left to one choice on the right.

A. Hydrogen bond

I. Residues 76, 94

B. Ionic bond

II. Residues 51, 68

C. Disulfide bridge

III. Residues 58, 63, 98, 108

D. Hydrophobic cluster

IV. Residues 1, 7

ii) Which set of residues represent the strongest interaction?

iii) Which set of residues represent the weakest interaction?

Name: _____

4. (a) Draw the peptide leu – ala – arg in the form it would be at pH = 7.

(b) Label the N and C termini.

(c) Circle each peptide bond in your drawing above.

(d) Which of the amino acids listed below do you think could have a phosphate group covalently added onto their R groups? Circle all that apply.

Serine

Alanine

Threonine

Valine

Glycine

Phenylalanine

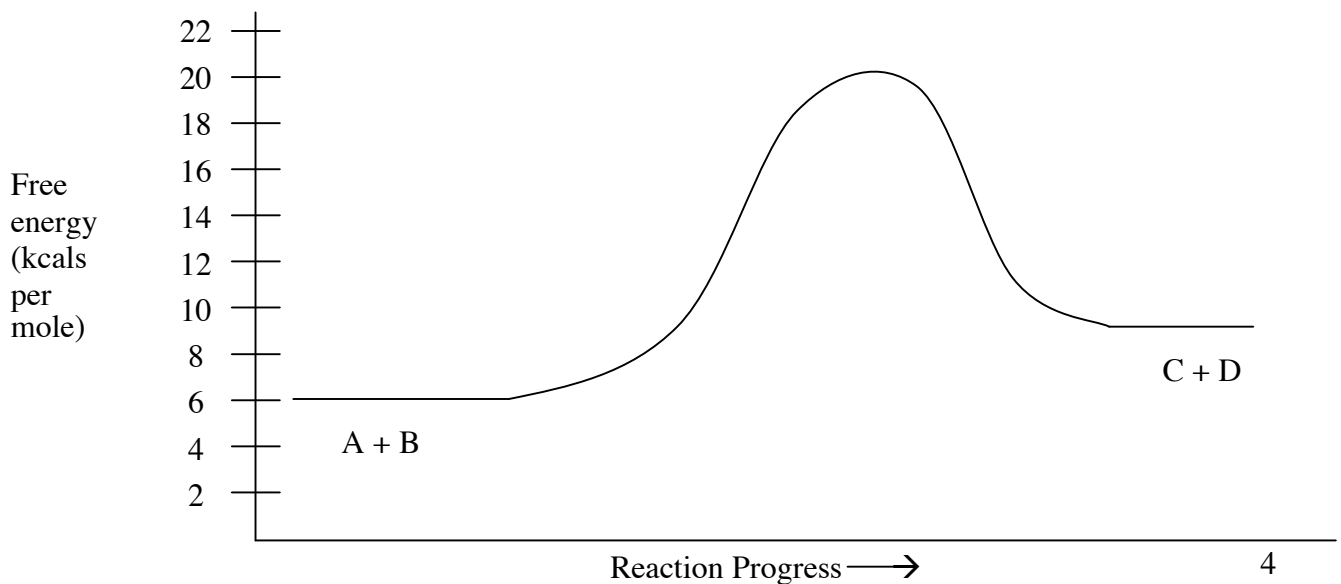
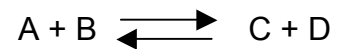
Methionine

Leucine

Isoleucine

Tyrosine

5. Below is drawn the energy profile of the reaction:
where A and B are the reactants, and C and D are the products.



Name: _____

- (a)** What is the value of ΔG for the forward reaction (reactants to products)?

- (b)** What is the value ΔG for the backward reaction (products to reactants)?

- (c)** What is the value of the activation energy for the forward reaction?

- (d)** What is the value of the activation energy for the backward reaction?

- (e)** Which of the reactions would occur spontaneously: forwards only, backwards only, both, or neither?

This reaction is catalyzed by the presence of a specific enzyme.

- (f)** Would the enzyme affect ΔG for the forward reaction (reactants to products)?

- (g)** Would the enzyme affect ΔG for the backward reaction (products to reactants)?

- (h)** Would the enzyme affect the activation energy for the forward reaction?

- (i)** Would the enzyme affect the activation energy for the backward reaction?

- (j)** Which of the reactions are catalyzed by this specific enzyme: forwards only, backwards only, both, or neither?

Name: _____

6. (a) Draw the di-nucleotide sequence 5'-GC-3'.

(b) Label the 5' and 3' ends in your drawing above.

(c) Circle each phosphodiester bond in your drawing above.

(d) Which of these secondary structures are legitimate folding structures that could be formed by RNA? (The sets of four short dashes indicate hydrogen bonds.) Circle all that are possible.

