Biochemistry 461, Summer I, 2015, 0101 **Your Name:** _____

University of Maryland, College Park **Your SID #:** _____

Biochemistry and Physiology **Prof. Jason Kahn**

Exam I (100 points total) **June 12, 2015**

You have 75 minutes for this exam.

Exams written in pencil or erasable ink will not be re-graded under any circumstances.

Explanations should be concise and clear. Use the extra space on the last page if you need more space.

You will need a calculator for this exam. No other study aids or materials are permitted.

Partial credit will be given, *i.e.*, if you don't know, guess.

$\Delta S_{system} - \Delta H_{system}/T \geq 0$ $\quad$ $p\mathrm{H} = -\log([\mathrm{H}^+])$ $\quad$ $R = 8.314$ J/mol K

$S = k\ln W$ $\quad$ $\Delta G = \Delta H - T\Delta S$ $\quad$ $p\mathrm{H} = pK_a + \log([\mathrm{A}^-]/[\mathrm{HA}])$

$K_a = [\mathrm{H}^+][\mathrm{A}^-]/[\mathrm{HA}]$ $\quad$ $\Delta G^{\circ\prime} = -RT\ln K'_{eq}$ $\quad$ $\Delta G = \Delta G^{\circ\prime} + RT \ln Q$

Honor Pledge: At the end of the examination time, please write out the following sentence and sign it, or talk to me about it:

"I pledge on my honor that I have not given or received any unauthorized assistance on this examination."

1. (15 pts) Thermodynamics

(a; 5 pts) What is the origin of the hydrophobic effect (at least at room temperature and below)? What is the sign of ΔS for dissolving a nonpolar solute like octane in water?

Score for the page_____

(b; 4 pts) The free energy change for a process is given by $\Delta G = \Delta G^{\circ\prime} + RT\ln Q$. Why is it especially important for biochemists to be able to calculate ΔG, whereas chemists are often content to just use the fact that $\Delta G^{\circ} = -RT\ln K$?

(c; 6 pts) Give an example of an endothermic disordering process, specify the signs of ΔH and ΔS, and describe the temperature dependence of the process.

Score for the page_____

2. (24 pts) Peptide Structure

(a; 12 pts) Draw the structure of the dipeptide (phospho-Y)C disulfide-linked to the dipeptide CR. Draw the predominant ionic form at pH 7. The pKa's of protonated phosphotyrosine are about 2 and 5.8. The pKa's for protonated C- and N-termini are about 3 and 8. Assume all *trans* peptide bonds, and give correct stereochemistry for Cα's.

(b; 12 pts) Fill in the table for the charge of the peptide above, to the nearest integer or half-integer. You do not need a calculator.

pH	**0**	**3**	**7**	**10**	**14**
Charge on peptide	**+3**				

From your table, without doing any more calculations, specify a range for the possible pI of the peptide and give your reasoning.

Why is the pI important for protein separation procedures?

Why does the cytoplasm have to be a reducing environment?

Score for the page_____

3. (15 pts) Lipids and Carbohydrates

(a; 5 pts) Sketch the structural aspect of a lipid molecule that determines whether it will form a micelle vs. a lipid bilayer. How does *cis*-unsaturation in the lipid chain increase membrane fluidity (or cause lipids of the same molecular weight to be liquids rather than solid)?

(b; 4 pts) Give two reasons that fat packs more dietary calories per gram than carbohydrates.

(c; 6 pts) What are the three functions of carbohydrates that we discussed? Name carbohydrate-containing molecules that carry out each of the three functions.

Score for the page_____

4. (36 pts) Secondary Structure in Proteins

(a; 4 pts) What was the point of drawing the simple lattice models for the compaction of chains into small areas (volumes)?

(b; 4 pts) List the two essential structural characteristics of stable secondary structures discussed in class.

(c; 8 pts) Draw a Newman projection for ψ(Psi) = –90°, with the Cα being the forward end of the bond that is going straight into the page for the Newman projection. Explain why ψ values between about –90° and –150° are a forbidden region of the Ramachandran diagram.

(d; 4 pts) Sketch a picture explaining the direction and structural origin of the macrodipole of the alpha helix.

Score for the page_____

(e; 8 pts) We emphasized the idea of "sidedness" of alpha helices and beta sheets. **Why is this important in protein folding?**

For the two sequences below, identify which one is more likely to be two strands of a beta sheet:_____and which one is more likely to be an alpha helix:_____.

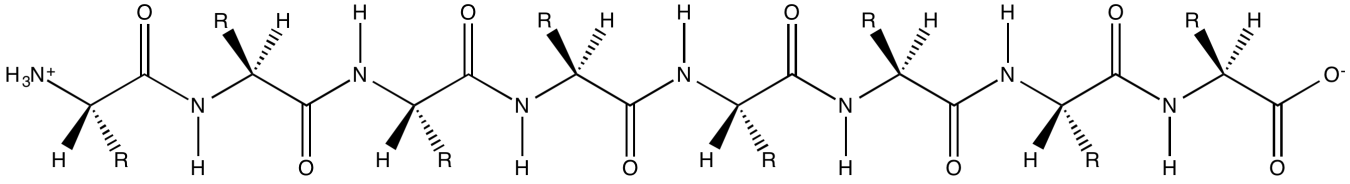
Sketch how each one exhibits sidedness – either draw a picture or add labeling to make your point.

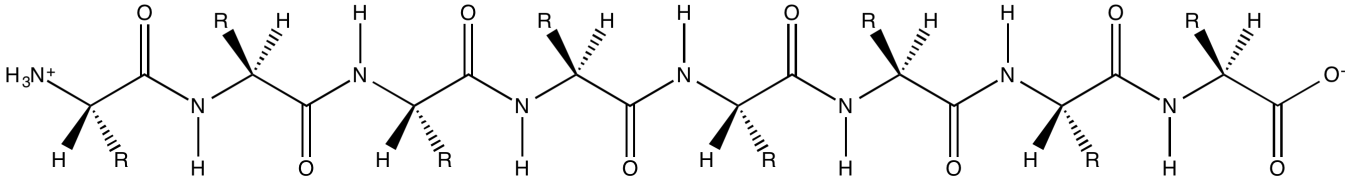
(1) PELAKVARTLDQMLENLAGA

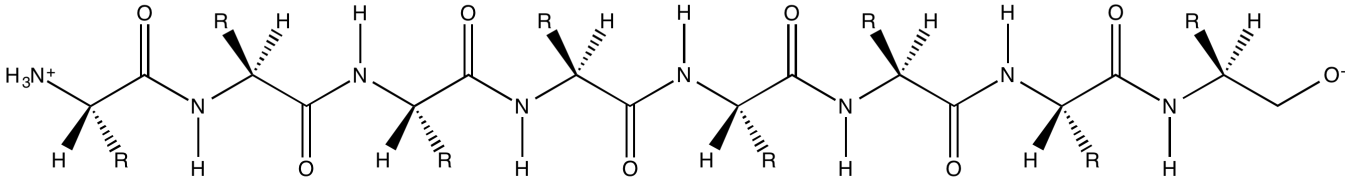
(2) WRFSINVDAPGLSICWKYSM

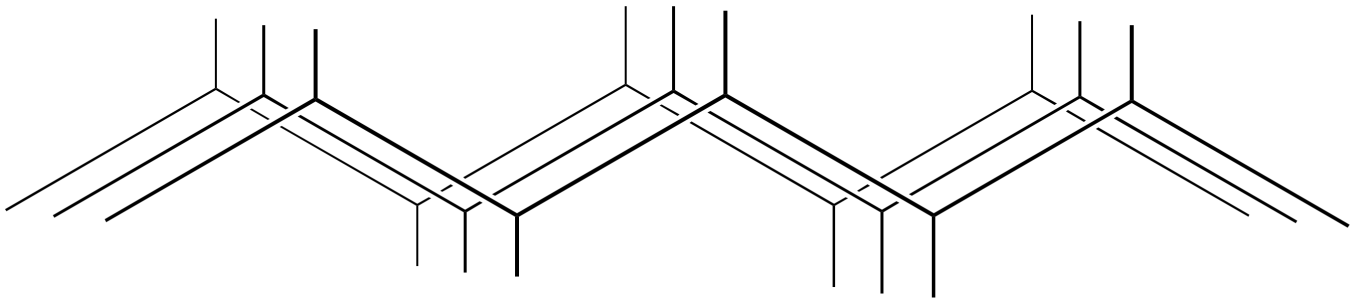
Score for the page_____

(f; 8 pts) On the extended polypeptides below, sketch in the H-bonding pattern of the parallel beta sheet. Sketch on the picture how and why the backbone is deformed out of the plane to make the pleated sheet conformation. Label the R groups and draw in H bonds on the pleated picture at the bottom.









Score for the page_____

5. (10 pts) Buffers

(a; 2 pts) Calculate the pH for a solution of acetic acid/Na acetate composed of 50 mM HOAc and 50 mM NaOAc. The pKa of acetic acid (HOAc) is 4.75.

(b; 3 pts) Adding 10 mM HCl will give 60 mM HOAc and 40 mM OAc^-. What is the new pH?

(c; 2 pts) Adding an additional 31 mM HCl will give 91 mM HOAc and 9 mM NaOAc. What is the new pH?

(d; 3 pts) What will the pH after the addition of a further 10 mM HCl? [Hint: HCl will be in excess, which we assume will completely suppress the dissociation of HOAc.]

Page	Score
1	/5
2	/10
3	/24
4	/15
5	/20
6	/8
7	/8
8	/10
Total	**/100**

Score for the page_____