Biochemistry 463, Summer II **Your Name:** _____

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

Biochemistry and Physiology **Prof. Jason Kahn**

Exam I (100 points total) **July 22, 2013**

You have 80 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. I have given you more space than you should need. There is extra space on the last page if you need it.

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.

Useful Equations:

$\Delta S_{system} - \Delta H_{system}/T \geq 0$ $\quad pH = -\log([H^+])$ $\quad E = mc^2$

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

$K_a = [H^+][A^-]/[HA]$ $\quad \Delta G° = -RT\ln K_{eq}$ $\quad e^{i\pi} + 1 = 0$

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. (30 pts) Amino acid structure, the peptide bond, and acid-base

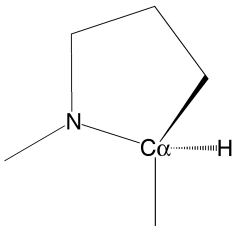
(a; 3 pts) Why is histidine frequently found in protein active sites?

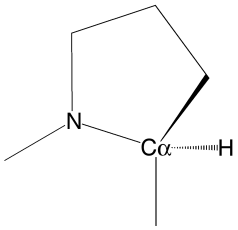
(g; 4 pts) Calculate the ratio between the protonated and deprotonated forms of the histidine side chain at pH 7.2, The protonated form has a pKa of 6.04.

Score for the page_____

(b; 14 pts) Draw the tripeptide His-Pro-Val in its predominant ionic form at pH 5, with all of the peptide bonds in the trans conformation. Start from the ring given below. It's there twice in case you need to redraw.

(e; 9 pts) Indicate on your structure the four atoms that define the Φ angle for the proline residue. Assuming that the proline side chain ring is constrained to be flat, estimate the permitted value of Φ. Would your answer be substantially different if the His-Pro peptide bond were *cis*? Why or why not?





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2. (40 pts) Protein Folding

(a; 9 pts) The thermodynamics of protein folding: What are the two main contributors to ΔS, and what are their signs and the sign of the overall ΔS? What is the sign of ΔH? What is the sign of ΔG for protein folding?

(b; 6 pts) Explain why H-bonds and electrostatic interactions make contributions to stability that are quantitatively much smaller than the binding energies of the H-bonds and electrostatic contacts seen in proteins. Why are they still important for the specificity of folding?

Score for the page_____

Here is a proposed mechanism for the GroEl/ES folding machine.

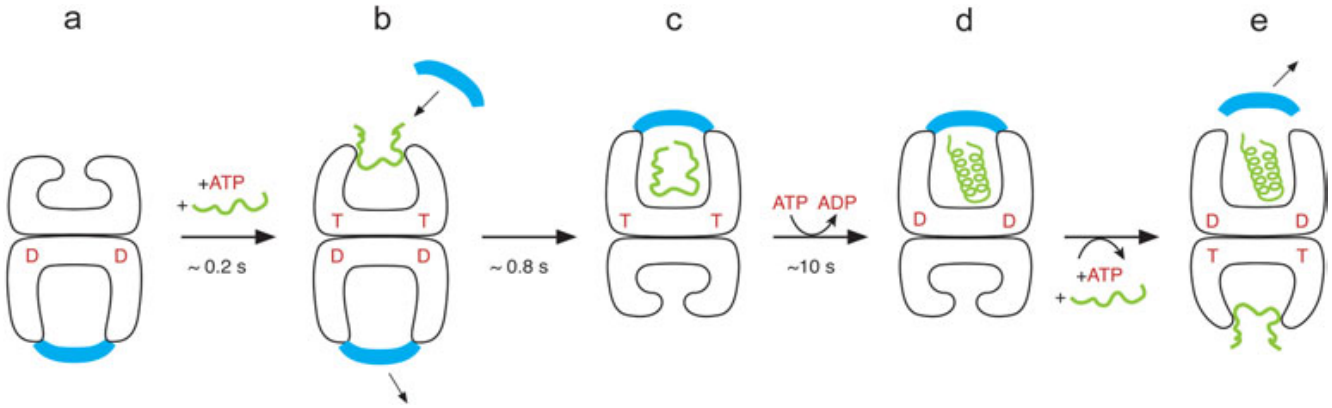


Fig. 2. The polypeptide folding cycle at GroEL. (*a*) The initial polypeptide acceptor state *in vivo* and in a

(c; 6 pts) We listed two related but distinct functions for the chaperonin. What are they; in other words, what does it mean to chaperone the process of protein folding?

(d; 3 pts) What causes a candidate client protein to stick to GroEL?

(e; 5 pts) In the c-> d step, the protein is released from binding and is allowed to refold on its own. We called the cavity a particular kind of cage, Name it and describe its function.

(f; 3 pts) The client protein may need to be unfolded and allowed to refold many times. Why does a cyclic process like this require ATP hydrolysis? [If it didn't use an external energy source, what would happen?]

Score for the page_____

(e; 8 pts) Sketch the model that protein aggregation can occur through a combination of steric zipper (=stacked β sheet) formation and domain swapping.

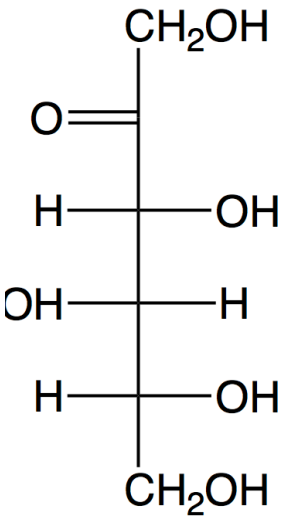
3. (30 pts) Biomolecules and Miscellaneous:

(a; 3 pts) Why do membrane phospholipids have two extended alkyl tail groups? Why not one or three?

(c; 6 pts) Draw a phosphatidylethanolamine (ethanolamine = $-OCH_2CH_2NH_3+$) with one saturated R group and one monounsaturated R group with a cis double bond.

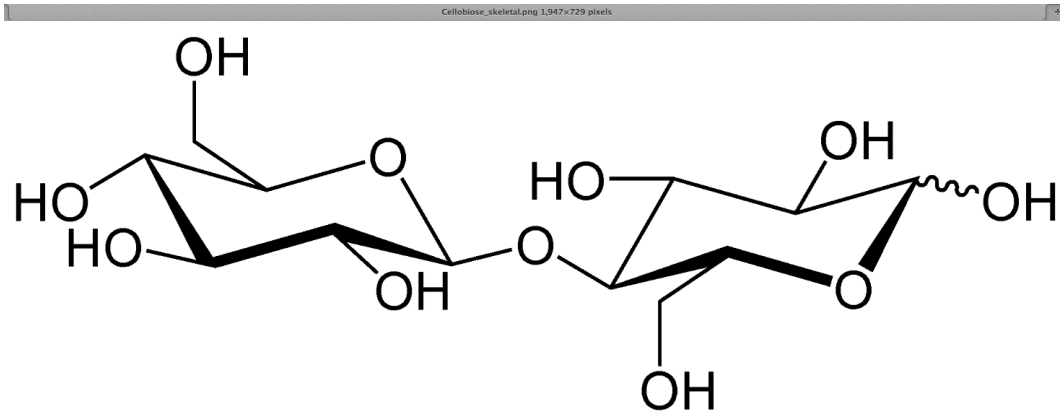
Score for the page_____

(e; 6 pts) Here is the Fischer projection of D-sorbose. Indicate which hydroxyl attacks the ketone to make the furanose form of the ring, and draw the Haworth projection of the furanose ring. Indicate the anomeric carbon stereochemistry with a squiggle.



D-Sorbose

Here is the structure of cellobiose, a disaccharide derived from cellulose.



(3 pts) Circle and name the linkage between the two glucose moieties.

Score for the page_____

(12 pts) We discussed several ligands for Hemoglobin, including CO_2, H^+, and Cl^-. Explain why it makes sense in terms of physiology for each of them to decrease the binding affinity of Hb for O_2.

Page	Score
1	/7
2	/23
3	/15
4	/17
5	/17
6	/9
7	/12
Total	**/100**

Score for the page_____