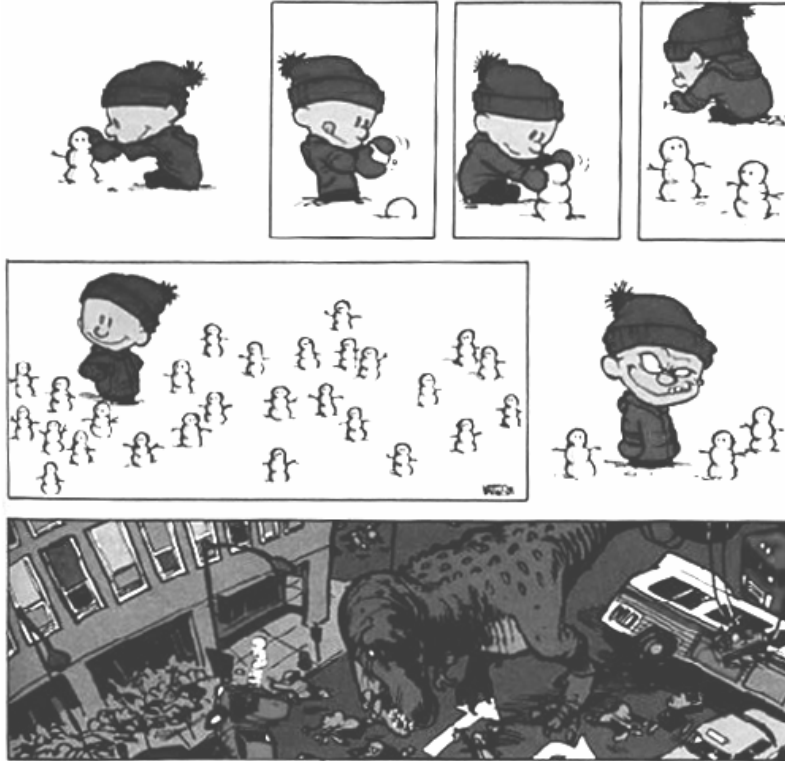


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**CHEM 641 Biochemistry Final**  
**Thursday, December 15, 2005**

Please put your name on the front, initial each subsequent page, and check to make sure that your exam copy contains all 10 pages.



Question	Points	Score
I	15	
II	10	
III	10	
IV	10	
V	20	
VI	10	
TOTAL	75	

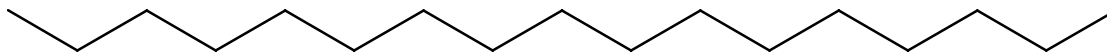
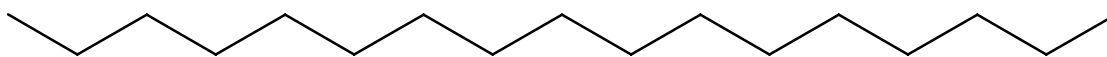
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CHEM 641 BAHNSON SECTION

I. Review from before 1<sup>st</sup> exam – 3 questions

a) [5 pts] Draw how two peptide planes align in an  $\alpha$ -helix showing the H-bond formed. Based on your drawing, predict the overall dipole of this  $\alpha$ -helix. Explain briefly.

b) [5 pts] Starting from the two extended chains below, draw a parallel  $\beta$ -sheet showing all mainchain atoms and H-bonds. You can label the side chains with the R-group label.



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The 10<sup>th</sup> reaction of glycolysis is catalyzed by pyruvate kinase:  
phosphoenolpyruvate + ADP → pyruvate + ATP

- c) [5 pts] Using the data below, determine the  $\Delta G^{\circ\prime}$  for the reaction catalyzed by pyruvate kinase. Show work with balanced equations.

Metabolite	$\Delta G^{\circ\prime}_{\text{hydrolysis}}$ (kJ mol <sup>-1</sup> )
Phosphoenolpyruvate	-62
1,3-Bisphosphoglycerate	-49
Phosphocreatine	-43
Pyrophosphate	-33
Phosphoarginine	-32
ATP to AMP + PP <sub>i</sub>	-32
Acetyl CoA	-32
ATP to ADP + P <sub>i</sub>	-30
Glucose 1-phosphate	-21
Glucose 6-phosphate	-14
Glycerol 3-phosphate	- 9

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**II. Protein Heterogeneity [10 pts]** List and briefly describe 5 different ways proteins can display heterogeneity. With each of the 5 ways you chose, briefly state how the protein could be purified of the heterogeneity, or describe how each type of heterogeneity could be avoided.

1.

2.

3.

4.

5.

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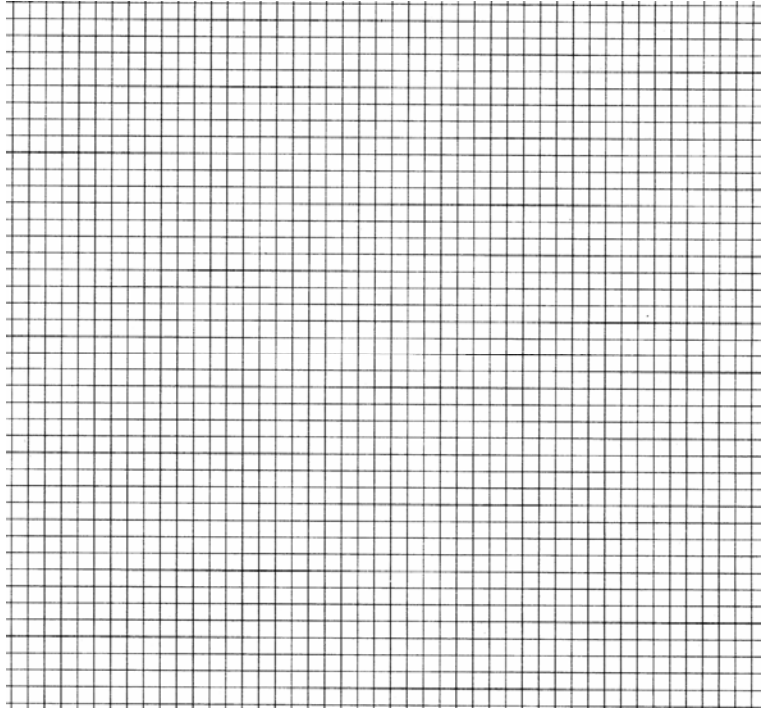
*CHEM 641 BAHNSON SECTION*

**III. Protein Folding**

- a) **[5 pts]** Consider the folding of a single subunit cytosolic water soluble protein. As we have discussed in class, proteins are highly ordered structures. Succinctly, rationalize why the formation of a native protein fold does not defy the 2<sup>nd</sup> Law of Thermodynamics.
- b) **[5 pts]** For protein's that have a native structure made from more than one subunit, succinctly describe the weak force interactions that determine this higher ordered oligomeric state.

#### IV. Allostery and Cooperativity

**a) [4 pts]** Suppose that you are studying a newly discovered enzyme that displays V-system allostery (hint: changes  $V_{\max}$ ). ATP is a positive allosteric effector and ADP is a negative allosteric effector. Sketch out a saturation curve to the right that qualitatively demonstrates each of these conditions.

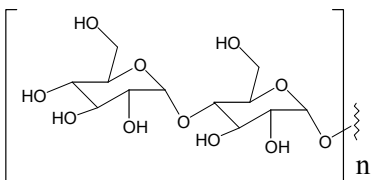


**b) [3 pts]** What are the relative binding affinities for the R-state and T-state of the substrate, activator and inhibitor from part **a.** above.

**c) [3 pts]** From the information listed above, would you define the allosteric enzyme as also being a cooperative enzyme? Briefly explain.

**V. Glycogen Phosphorylase (GP)**

**a)** Draw the phosphorolysis mechanism (show arrows from electrons) catalyzed by GP using one of the substrates (glycogen). Make sure you show the products. [3 pts]



**b)**  $GP_b$  is allosterically modified by inorganic phosphate ( $P_i$ ), AMP and ATP. Of the choices below, which statement below is most accurate about the molecules  $P_i$ , AMP and ATP interacting with  $GP_b$ . [3 pts]

Put your answer in the box:

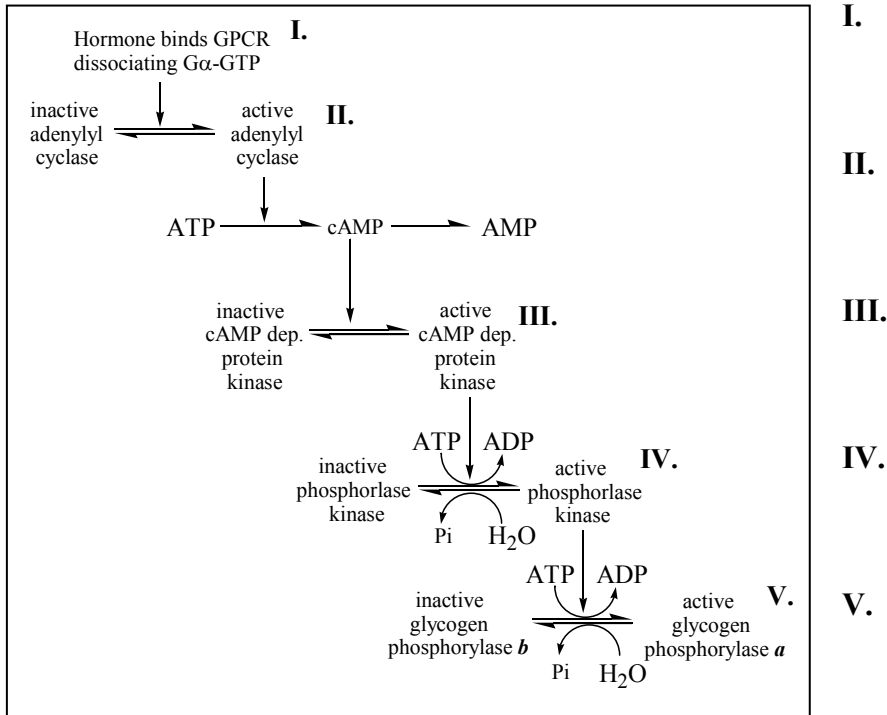
- A. All 3-effectors ( $P_i$ , AMP, and ATP) bind GP simultaneously
- B. Either one or two of the 3-effectors can bind GP at a time.
- C. Only one of these effectors can bind GP at a time
- D. None of these 3-molecules can bind GP.

**c)** GP is activated by a reaction catalyzed by phosphorylase kinase. When GP is in its activated state ( $GP_a$ ) select the choice from above which is most accurate. [3 pts]

Put your answer in the box:

**d)** The hormone activated cascade that regulates  $GP_a$  includes the function of a heterotrimeric G-protein. Briefly explain the functions of the G-protein in this cascade. [3 pts]

**Glycogen Phosphorylase continued**

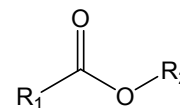


- e) [5 pts] For each activated species above, describe how the signal is **turned on**. Write your brief answer to the right of each step above.
- f) [3 pts] The molecule ATP is involved in steps II., IV. and V. above. Briefly describe **how else** ATP is involved in the reaction catalyzed by glycogen phosphorylase.

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CHEM 641 BAHNSON SECTION

**VI. Enzyme Mechanism and Catalysis [10 pts]** Starting from the ester shown to the right, draw the complete mechanism (with arrows coming from the electrons) of the hydrolysis reaction of the simple ester shown to the right. For maximum points show: 1) a two-step mechanism with a single tetrahedral intermediate. 2) the side chains of two separate amino acid residues (your choice) involved in the mechanism as general acid/base catalysts and 3) a catalytic strategy that your designed enzyme active site would use to preferentially bind the transition state.



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