Name _____

Chem 352 - Fall 2013 - Exam II

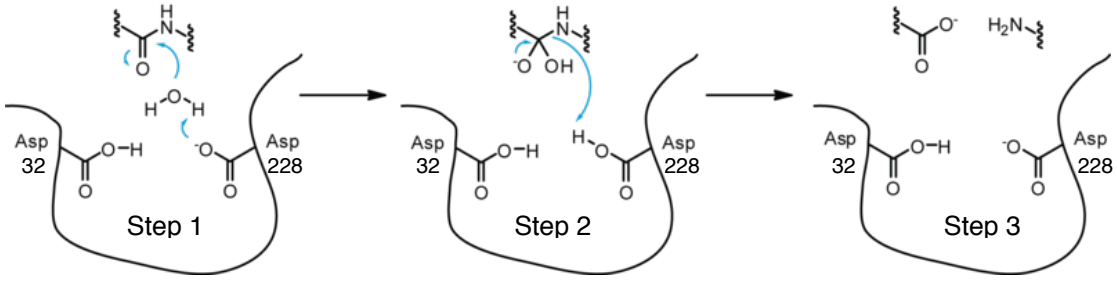
Some potentially useful information:

pK_a values for ionizable groups in proteins: (*α-carboxyl*, 3.1; *α-amino*, 8.0; *Asp* & *Glu* side chains, 4.1; *His* side chain, 6.0; *Cys* side chain, 8.3; *Tyr* side chain, 10.9; *Lys* side chain, 10.8; *Arg* side chain, 12.5)

Ideal gas law constant (R) = 8.314 $J/(mol \bullet K)$ = 0.08206 $(L \bullet atm)/(mol \bullet K)$

Faraday's constant ($\mathcal{F}$) = 9.646 x 10^4 $J/(mol \bullet V)$

1. *β-Secretase* is an aspartic-acid protease that is involved in the pathogenesis of Alzheimer's disease. The figure below illustrates the three steps in the pathway that cleaves a peptide bond in the amyloid precursor protein, and which leads to the formation of the amyloid β-peptide.



a. What class of enzyme is β-secretase?_____

b. In terms of the four modes of enzyme catalysis that we discussed in class, in a sentence describe the role that Asp-228 plays in Step1.

c. Which of these three steps represents the transition state, and what characteristics of this state might the enzyme take advantage of in order to stabilize the transition state and thereby enhance the overall reaction rate?

d. Sketch the expected *pH* activity profile (activity *vs pH*) for β-secretase, if the pK_a for Asp-228 is 2.1, while that for Asp-32 is 4.5. (Be sure to label the axes of your plot.)

e. At what *pH* value do you expect the activity to be maximum? _____

2. Draw the structure of the phospholipid *phosphotidylcholine* containing a stearyl (18:0) acyl group at the C1 position a palmitoleyl (16:1, cis-Δ9) acyl group at the C2 position.

   a. In a couple of sentences, describe the structure that would spontaneously form when phosphotidylcholine is mixed with water. Include in this description a mention of the the intermolecular interactions that lead to the formation of this structure.

3. Out of the 10 reactions in glycolysis, there is just one that is catalyzed by an oxidoreductase; the one that converts the triose glyceraldehyde 3-phosphate to 1,3 bisphosphoglycerate.

   a. Use *structural formulas* for the pathway intermediates to write the *balanced chemical equation* for this reaction:

   b. What is the name for the enzyme that catalyzes this reaction? _____

   c. What is the oxidizing agent in this reaction?_____

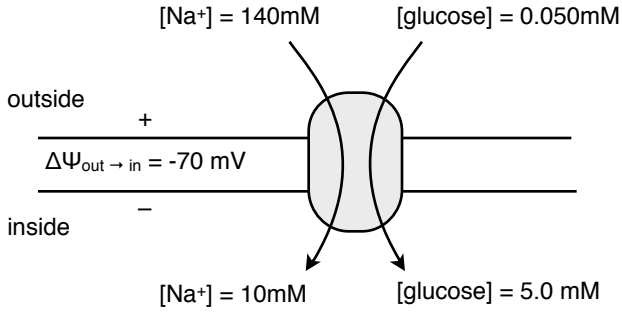
   d. Use *structural formulas* for the pathway intermediates to write the *balanced chemical equation* for the reaction that is used in mammalian muscles to re-oxidize this oxidizing agent when oxygen is not available to do this.

e. Use *structural formulas* for the pathway intermediates to write the *balanced chemical equation* for the reaction in the glycolytic pathway that follows the one described above.

f. What is the name for the enzyme that catalyzes this reaction? _____

g. What class of enzyme catalyzed reactions does this enzyme belong to?_____

4. A transporter of glucose molecules and Na^+ ions across the cell membrane is illustrated in the figure below. For this transporter, one sodium ion and one glucose molecule pass together, from outside to inside, through the cell membrane as shown in the figure. The concentrations for these species on either side of the membrane, along with the membrane potential, are also shown in the figure.



a. Under the conditions shown, will glucose molecules flow spontaneously from the outside to the inside of the cell? (Assume a temperature of 37°C.) *Clearly show the evidence for your claim.*

b. If the membrane potential was 0 mV instead of -70 mV, with everything else being the same, would glucose molecules flow spontaneously from the outside to the inside of the cell? *Clearly show the evidence for your claim.*

c. (*Circle one choice*) Is this an example of a *uniport, symport* or *antiport* transport system?

d. (*Circle one choice*) In terms of glucose transport, is this *active* or *passive* transport?

e. (*Circle one choice*) In terms of glucose transport, is this *secondary* or *primary* transport?

5. Glucose 6-phosphate in the cytosol sits at a metabolic crossroads.
   a. For a liver cell, identify three different pathways that lead *away* from glucose 6-phosphate and describe the metabolic role that each plays:

      i.

      ii.

      iii.

   b. Starting at glucose 6-phosphate, and using *structural formulas* for the pathway intermediates, write a *balanced chemical equation* for the *first* reaction in each pathway identified above. Indicate the names of the enzymes that catalyze each reaction as well the names of the reactants and products.

      i.

      ii.

      iii.

6. Then enzyme phosphofructokinase 1 (PFK-1) catalyzes the first committed step in glycolysis and is therefore regulated by a number of allosteric effectors. Identify whether each of the following allosteric effectors for PFK-1 *activates* or *inhibits* PFK-1 activity. Also indicate the cellular or systemic needs that each is signaling:
   a. Citrate:

   b. AMP:

   c. ATP:

   d. Fructose 2,6-bisphosphate:

7. Amylose and cellulose are both polymers of D-glucose, but their chemical and physical properties are quite distinct.
   a. Using a couple of sentences, describe these differences.

   b. Using structural formulas, illustrate the structural difference that is responsible for the differences you described above.