Name _____

Score _____

Exam 1, BICH 440, Wednesday, September 28, 2005

You MUST sign the following academic integrity statement:
On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work. Signed: _____

Write concise answers to demonstrate effectively your mastery of the subject. Show your work in order to receive maximum credit where applicable.

gas constant R 8.315 J/mol-K

1) (8 pts) Draw the structures of the sidechains of tyrosine and histidine engaged in an optimally-oriented hydrogen bond (pH 8). Tyrosine is the hydrogen bond donor and histidine is the hydrogen bond acceptor.

2) (15 pts) Draw the structure of the tripeptide leu-gln-arg ionized as it would exist at pH6. Proper depiction of stereochemistry is not necessary. In your structure, label one peptide bond, one bond characterized by a phi angle, and one bond characterized by a psi angle.

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3) (15 pts) The addition of 5.0 mL of HCl to 500 mL of 0.3 M phosphate buffer changes the pH from 7.5 to 6.9. What is the molarity of the HCl? The pKa's of phosphoric acid are 2.15, 7.2, and 12.4.

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4) (12 pts) Given the following peptide:

Ac-AMITEFINISH (the amino terminus is acetylated)

Assume the following pKa values: alpha amino: 9; alpha carboxyl: 2; side-chain carboxyl: 4, side-chain amino: 10, side-chain imidazole: 6; side-chain phenol: 10; side-chain guanidino: 12

A) What is the net charge on this peptide at pH5? Also at pH8?
B) Estimate the isoelectric pH for this peptide.

5) (10 pts) Consider the following peptides:

A. leu-cys-met-trp
B. met-pro-ala-gln
C. tyr-ile-ala-lys
D. phe-asp-ala-met
E. thr-arg-his-val

Match a peptide with the following queries (a peptide can be used more than once).

____ lowest isoelectric point

____ highest amount of nitrogen

____ most sulfur

____ highest absorbance at 280 nm

____ least likely to be part of an alpha helix within a protein sequence

Name _____

6) (15 pts) Consider the following reaction that occurs in glycolysis:

1,3-Bisphosphoglycerate + ADP ↔ 3-Phosphoglycerate + ATP $\quad \Delta G^{\circ\prime} = -18.9$ kJ/mol

(a) The standard free energy change for the hydrolysis of ATP is –30.5 kJ/mole. Which molecule has the highest phosphate group transfer potential, 1,3-BPG (1,3-Bisphosphoglycerate) or ATP? SHOW your reasoning.

(b) Calculate the equilibrium constant at 37°C for the hydrolysis of 1,3-Bisphosphoglycerate (i.e., the reaction of 1,3-BPG + H_2O ↔ 3-PG + P_i).

(c) Given the following concentrations: [ATP] = 4.0 mM, [ADP] = 0.5 mM, [1,3-BPG] = 2.0 mM, [3-PG] = 5.0 mM. Determine whether the overall reaction (at the top of this page) proceeds in the direction of ATP synthesis or ATP consumption (37°C).

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7) (25 pts) Short answer.

(A) (3 pts) Draw the structure of a hydrogen bond that stabilizes alpha helices and beta sheets (just the pertinent atoms for that interaction; not the rest of the helix or sheet).

(B) (4 pts) Define specific activity of a protein. When purifying a protein, should the specific activity increase or decrease? Why?

(C) (5 pts) Briefly describe the physical basis for separation of proteins by affinity chromatography. How can a protein be eluted from the affinity resin?

(D) (3 pts) What is the approximate molecular weight of a multisubunit protein with $\alpha_2\beta_2$ structure if the α subunit contains 300 amino acids and the β subunit contains 200 amino acids?

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(E) (3 pts) Name three amino acids for which the quantitation is uncertain upon amino acid analysis of proteins by total hydrolysis with 6N HCl.

(F) (4 pts) Draw the structure of the triphosphate portion of ATP, showing the ionization at pH 7. Point out a phosphoanhydride bond in your structure.

(G) (3 pts) Cyanogen bromide cleaves a protein after this amino acid(s) _____

Trypsin catalyzes cleavage of a protein after these amino acids _____