Name _____

Chem 352 - Spring 2011 - Exam I

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)

$R = 8.314\ J/(mol \bullet K) = 0.08206\ (L \bullet atm)/(mol \bullet K)$

1. Match the following pioneers in the field of biochemistry with the contributions they have made:

a. ___Emil Fischer	A. Demonstrated that living systems use the same chemistry as non-living systems by demonstrating that the organic molecule urea could be synthesized from inorganic ammonium cyanate.
b. ___Ramachandran	B. First proposed the "central dogma" of biology concerning the flow of information in biology.
c. ___Max Perutz	C. First to demonstrate that natural polypeptides have a defined sequence.
d. ___Francis Crick	D. A world renowned expert on the physical properties of water and a UWEC chemistry graduate.
e. ___Friedrich Wöhler	E. One of the first people to determine the 3-D structure of a protein
f. ___Richard Saykally	F. Determine the sterically favorable combinations of the φ and ψ backbone dihedral angles in polypeptides.
g. ___Frederick Sanger	G. Characterized the components of yeast extracts the carry out fermentation reactions as biological catalysts that are now called enzymes.

2. Water displays some unusual properties for a molecule of its size and mass, such as high melting point, high heat of fusion and high boiling point. Explain at the molecular level the source of these unusual properties? (*Please answer in three to four complete sentences*.)

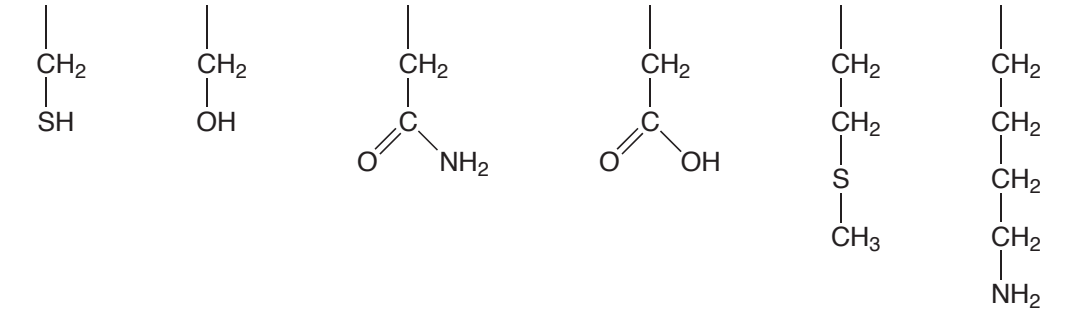
   a. Which one of the following molecules do you expect to be the *least* soluble in water (*Circle your choice*):

   $CH_3CH_2CH_2OH$ H_2SO_4 N_2 $CH_3CH_2CH_2CH_3$

   Explain:

3. Using the three-letter codes, identify the amino acids that contain the side chains shown below:

A. _____ B. _____ C. _____ D. _____ E. _____ F. _____



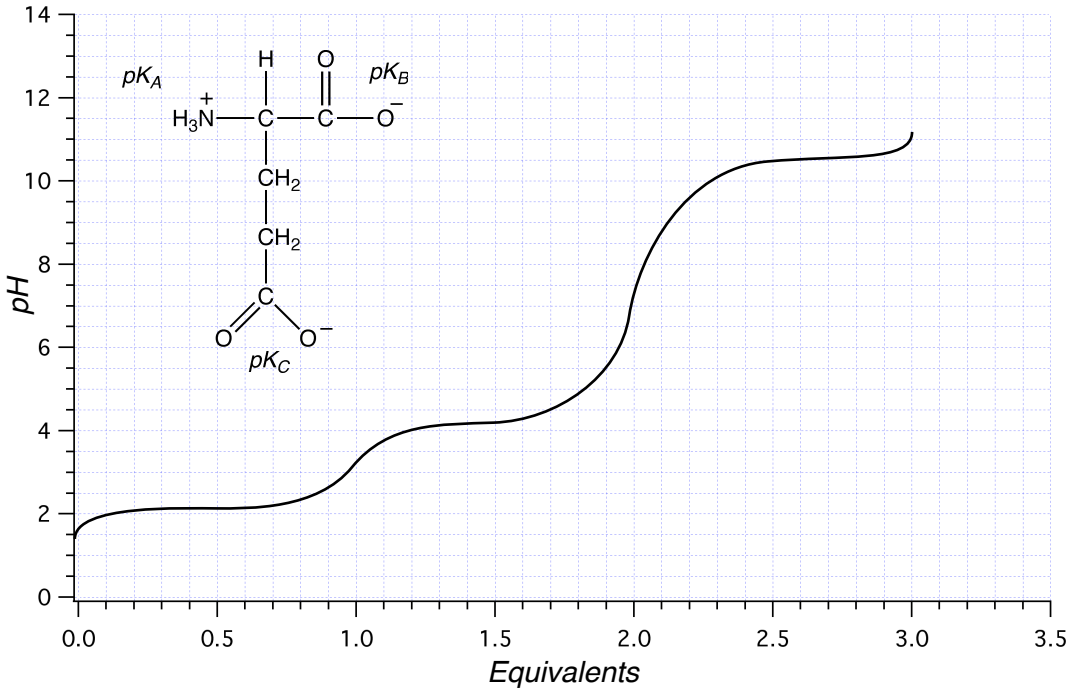
a. Which of these is aliphatic? (*Circle all that apply.*) A B C D E F
b. Which of these can hydrogen bond to water? (*Circle all that apply.*) A B C D E F
c. Which of these is aromatic? (*Circle all that apply.*) A B C D E F
d. Which of these is charged at neutral *pH* values? (*Circle all that apply.*) A B C D E F
e. Which of these is hydrophobic? (*Circle all that apply.*) A B C D E F
f. Which of these is basic? (*Circle all that apply.*) A B C D E F

4. Draw the chemical structure for the tripeptide **Asn-Lys-Cys** in its proper charged state at *pH* 10.

a. On your structure, label one example of a φ, a ψ and an ω bond.
b. On your structure, label one example of a *peptide bond*.

5. In class we discussed we discussed the sequencing of the proteins insulin by Frederick Sanger. In his procedure he used the reagent 2,4-dinitrofluorobenzene (FDNB)? What does this reagent do?

6. The chemical structure and titration curve for an α-amino acid is shown below:



a. What are the *pK* values for each of the titratable groups on this amino acid?

pK_A = _____ pK_B = _____ pK_C = _____

b. At what *pH* does the species shown predominate? *pH* _____

c. What is the isoelectric *pH* (*pI*) for this amino acid? (*i.e.*, where its net charge = 0) *pH* _____

d. What is the name of this amino acid? _____

e. Extra credit (2 pts): What is the approximate concentration of the amino acid solution that was used to construct the titration curve shown above? (Show your calculations)

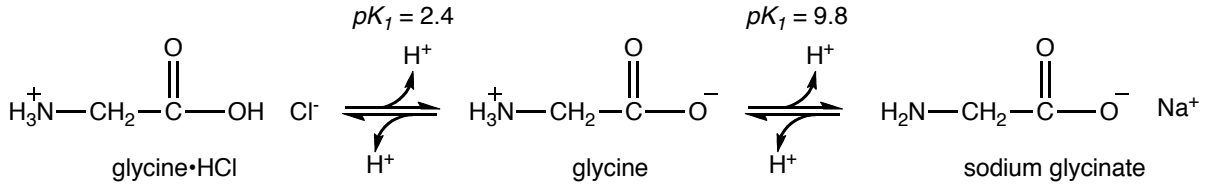
7. The structures of biological molecules are determined in large part by the noncovalent interactions that they have with themselves and with water. Describe the noncovalent interactions that can occur between the side chains of the following pairs of amino acids.

a. asparagine and serine

b. cysteine and methionine

c. Aspartic acid and lysine

8. The amino acid *glycine* is often used as a buffer in biochemistry labs. Describe how you would make 1 L of a 50 mM buffer solution that will buffer at *pH* 3.0. You have available to you 50 mM solutions of glycine•HCl, glycine and sodium glycinate. (Show your calculation.)



Extra Credit:

1. Ask the one question that you wanted me to ask, but I did not ask. (Up to 2 points will be awarded for an insightful, probing and well-worded question, which could be used on the Final Exam.)

2. Answer the question you posed in part 1. (Up to 1 point will be awarded for answering your question correctly.)