Chemistry 375/650 Name _____
EXAM #1 (101 points)
March 5, 2003

Part A. 45 points Circle the best answer. Three (3) points each.

1. Which statement about histidine is false? (R group $pK_a = 6.0$)
($\underline{N.B.}$: pK_a -COOH = 4.0; pK_a -NH_3^+ = 9.0)
a) a polar amino acid
b) has a net charge of +1 at pH = 2
c) has a net charge of -1 at pH = 12
d) can act as an acid and base catalyst
e) can act as a buffer at physiological pH

2. Which statement about lysine is false? (R group $pK_a = 10$)
a) The R group has a charge of +1 at pH = 7
b) The R group is neutral at pH = 12
c) When components of a polypeptide chain, this amino acid can form salt bridge
d) The R group has a positively charged guanidino group
e) Lysine is a polar amino acid

3. In what order would phenylalanine, aspartate, and glycine elute from a $\underline{\text{reverse phase}}$ (hydrophobic resin) chromatography column?
a) Asp, Gly, Phe
b) Gly, Phe, Asp
c) Phe, Asp, Gly
d) Phe, Gly, Asp
e) Gly, Asp, Phe

4. Which method permits separation of proteins as a function of solubility?
a) SDS-PAGE
b) affinity
c) gel filtration
d) partition chromatography
e) anion exchange chromatography

5. Which statement about The Hydrophobic Effect is false?
a) is decreased by increasing the ionic strength
b) increases the entropy of water molecules
c) leads to the aggregation non-polar molecules
d) is the major driving force in protein folding
e) minimizes contacts between non-polar and polar groups

6. Which statement about the Edman Degradation reaction is false?
a) Edman's reagent is phenylisothiocyanate.
b) At the end of the reaction, C-terminal amino acid is also derivatized.
c) Tryptophan is destroyed during this process.
d) Edman's reagent reacts with primary amines.
e) The cleavage step specifically cleaves the N-terminal amino acid residue.

7. The secondary structure of keratin is:
a) α-helix
b) parallel β-pleated sheet plus α-helix
c) triple helix
d) β-barrel
e) anti-parallel β-pleated sheet

8. Michaelis-Menton Kinetics depends upon all of the following except:
a) The ΔG of the reaction
b) initial velocity of the reaction
c) substrate concentration
d) the formation of the ES complex
e) the enzyme concentration

9. Which statement about disulfide bonds is false?
a) stabilize protein structure
b) easily broken by 2-mercaptoethanol
c) maintain the structure of insulin
d) generally found in secreted proteins
e) composed of methionine residues

10. The R state of hemoglobin differs from the T state in:
a) the oxidation state of the hemes
b) the amino acid sequence
c) the position of the disulfide bonds
d) the proportion of β-sheet
e) the quaternary structure

11. The Fe^{+2} in hemoglobin
a) is held in place by an active site serine residue
b) forms a "dome-like" structure when O_2 is not bound
c) is oxidized to Fe^{3+} in oxy-Hb
d) the heme is composed of protoporphrin XI
e) shared by all four subunits

12. Fetal hemoglobin has a higher O_2 affinity than adult hemoglobin because it:
a) has more hemes
b) consists of 4α chains
c) has β-sheet structures
d) has a lower affinity for 2,3-BPG
e) has an extra CO_2 binding site

13. Uncompetitive inhibition is identified by a Lineweaver-Burk Plot that consists of:
a) a family of lines that intersect at the y-axis
b) a family of lines that intersect at the x-axis
c) a family of non-intersecting lines
d) none of the above

14. The overall charge on the peptide Asn-Pro-Asp-Lys-Lys-Met-His-Gly-Arg-His at pH = 2 is:

a) +2
b) +5
c) +6
d) +3
e) none of the above

15. Which statement about K_m is false?

a) The K_m of an enzyme is a constant.
b) The lower the K_m, the higher the affinity of enzyme for substrate.
c) K_m is the substrate concentration that corresponds to 50% Vmax.
d) K_m is increased by a competitive inhibitor.
e) $K_m = \frac{k_{+1} + k_{-1}}{k_2}$

16. **20 points. Match each item with the best description. There is only one answer for each blank.**

a)	DEAE-Sephacel	___	derived from niacin
b)	carboxymethyl Sepharose	___	found in carboxylases
c)	urea	___	derived from riboflavin
d)	nicotinamide adenine dinucleotide	___	cation exchange resin
e)	biotin	___	anion exchange resin
f)	flavin adenine dinucleotide	___	gives prots. constant charge/mass ratio
g)	dithithreitol	___	destroys higher order prot. structures
h)	sodium dodecyl sulfate	___	O_2 binding to myoglobin
i)	hyperbolic kinetics	___	O_2 binding to hemoglobin
j)	sigmoidal kinetics	___	reduces disulfide bonds to free thiols

PART B. 36 points. Of the five questions below, please <u>answer only 4 of them</u>. Show all work in the answer booklet.

17. 9 points (Assume pKa of $-NH_3^+$ = 9 and –COOH = 4.0)

a) Draw the <u>detailed structure</u> of the following peptide as it occurs in solution at pH 10.
Asp-Leu-His-Ala-Glu-Arg-Val
b) Classify each amino acid in the peptide as polar or non-polar
c) What is the net charge on the peptide?
d) What amino acids participate in H-bonds. Draw one H-bond between an amino acid and a water molecule.

18. 9 points.

a) Protein X consists of a high proportion of Asp and Glu residues. Your lab mate has also prepared an antibody that interacts specifically with this protein. If you wanted to isolate Protein X, what type of chromatography and resin would be optimal?
b) Using a crude cell lysate, describe the procedure and chromatography equipment you would use to obtain Protein X.
c) How would you test for the presence of Protein X in the resulting test tubes?

19. 9 points Cleavage of a newly isolated protein with trypsin and CNBr yields the following fragments. What is the sequence of this protein?

TRYPSIN:
Arg
Ala-Cys-Gln-Met-Trp-Leu-His-Lys
Cys-Arg
Gln-Ala-Asn-Gln-Met-Gly-Gly-Gly-Pro-Ser-Met
Phe-Gln-Gln-Met-Gln-His-Leu-Arg
Ile-Pro-Lys
Lys

CNBr:
Trp-Leu-His-Lys-Gln-Ala-Asn-Gln-Met
Gly-Gly-Gly-Pro-Ser-Met
Gln-His-Leu-Arg-Ala-Cys-Gln-Met
Arg-Ile-Pro-Lys-Cys-Arg-Lys-Phe-Gln-Gln-Met

20. 9 points

a) Hemoglobin has a P_{50} of 26 torr. What is Y at pO_2 = 26 torr?
b) Myoglobin has a P_{50} of 2.8 torr. What is Y at pO_2 = 26 torr?
c) Show the effect of 2,3-BPG on O_2 binding in the graph.
d) What are the functions of myoglobin and hemoglobin? How does the difference in their P_{50} values relate to their functions? Use the calculated values of Y to illustrate.

21. 9 points Describe the significance of each of the following to enzyme catalysis.

a) Proximity effects
b) Diffusion-controlled enzyme
c) Energy of activation and the transition state