NAME _____Key_____

MMBB 380 - Fall 2002
EXAM I - PART I

You may use a calculator for this portion of the exam. Show your work.

(8 pts)

1) The pH of a 0.150 M solution of a pure weak acid (no other solutes) was measured at 4.25.

a. What is the pK_a of this acid?

pH = 4.25
$[H^+] = 10^{-4.25}$ M = 5.623×10^{-5} M

Since HA $\rightleftharpoons$ $H^+ + A^-$ $[A^-] = \sim[H^+] = 5.623 \times 10^{-5}$ M

[HA] = 0.150 M - 5.623×10^{-5} M = 0.150 M

And since pH = pK_a - log[HA]/[A-]

pK_a = pH + log[HA]/$[A^-]$ = 4.25 + log (0.150 M)/(5.623×10^{-5}) = 4.25 + log 2668

pK_a = 4.25 + 3.43 = 7.68

b. Could this weak acid be used to buffer a solution at pH 4.40? Explain.

No! It will only be an effective buffer between pH 6.7 to 8.7 (7.68 ± 1.0)

(6 pts)

2. Arginine can act as a triprotic acid with 3 pK_a values of 2.17, 9.04, and 12.48.

1) Draw the structure of the predominant form in an aqueous solution of pH 7.0.

The carboxylic acid is unprotonated (charged)
The alpha-amine and the guanido groups are protonated (charged)

H_2A^{+1} predominates

2) What is the concentration of the structure from part (a) in a 0.80 M arginine solution after the pH is adjusted to 9.04.

Because the pH is equal to the second pK_a, pH = pK_a, there should be equal concentrations of H_2A^{+1} and HA^0. The concentrations of the other two forms (H_3A^{+2} & A^{-1}) will be small compared to the first two. If this is true, then

$[H_2A^{+1}] = [HA] = 0.80\ M/2 = 0.40\ M$

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EXAM I - PART II

You may not use a calculator for this portion of the exam. Good Luck!

Page	Points Possible	Points
Part I	14	
3	11	
4	11	
5	9	
6	16	
7	10	
8	12	
9	13	
10	4	
Bonus	4	
Total	104	

(3 pts)

2) Following the molecular hierarchy of cells, number the following in the correct order from smallest (# 1) to largest (# 6).

__6__ **cell**

__3__ **macromolecules**

__1__ **inorganic precursors**

__5__ **organelles**

__2__ **metabolites**

__4__ **supramolecular complexes**

(2 pts)

3) For the following biopolymers, provide the appropriate building block.

a. Carbohydrates __Monosaccharides__

b. Nucleic Acids __Nucleotides__

(3 pts)

3) Which of the following is characteristic of eukaryotic cells but not of prokaryotic cells?

a. membrane-bounded nucleus

b. cytoskeleton

c. tubulovesicular membrane network

d. all of the above

e. none of the above

membrane-bounded nucleus was worth ½ credit

(3 pts)

4) Every organelle performs specific functions for the cell. Name the most appropriate organelle for each of the following functions.

__Golgi Apparatus__ **sorting and packaging of proteins**

__Smooth Endoplasmic Reticulum__ **phosopholipid biosynthesis**

__Cilia or Flagella__ **sensory organelle**

(3 pts)

5) What is the maximum number of hydrogen bonds that each of the following molecules is capable of forming in an aqueous solution.

4.0 **H_2O**

Each water molecule is capable of forming 4 hydrogens in liquid or solid.

0 **benzene (C_6H_6)**

(3 pts)

6) Which of the following order of bond strength (weakest to strongest) is correct.

a. ionic < van der Waals < covalent

b. ionic < hydrogen < covalent

c. van der Waals < ionic < hydrogen

d. van der Waals < hydrogen < covalent

e. none of the above

(2 pts)

7) Which of the following attributes would contribute the most to making a molecule hydrophobic?

a. polar

b. charged

c. nonpolar

(3 pts)

8) If the pK_a of a weak acid is 3.8 & the pH of a solution containing the acid is 4.0, is there more of the acid form or base form?

Base form

As long as the pH is higher than the pKa, the concentration of base form will be greater than that for the acid form. If the pH was less than the pKa, then the acid form would predominate.

(3 pts)

9) Which of the following best describes pK_a?

a. $-\log [H^+]$

b. the pH at which [HA] = [A]

c. $+\log K_a$

d. the pH at the equivalence point

(6 pts)

10) Draw the following functional groups. Indicate by a yes or no if one or more of the 20 common amino acids contains this functional group.

	Occurs in 1 or more of the 20 aa	
a. hydroxyl group	**X**	**Yes** / **No**
b. aldehyde group		**Yes** / **X** **No**
c. guanido	**X**	**Yes** / **No**

(16 pts)

11) Fill out this table describing the following common amino acids.

Structure	Full Name	3 Letter Code	1 Letter Code	Side Chain Behaviour (acidic, basic, polar, hydrophobic, etc)
a.	**Cysteine**	**Cys**	**C**	**Sulfur-Containing**
b.	**Tryptophan**	**Trp**	**W**	**aromatic, hydrophobic**
c.	**Glutamine**	**Gln**	**Q**	**polar, hydrophilic**
d.	**Serine**	**Ser**	**S**	**polar, hydrophilic**
e.	**Leucine**	**Leu**	**L**	**aliphatic, hydrophobic**

(10 pts)

12) a. Draw the following dipeptide, AG. Use the trans-configuration shown in class.

b. On this diagram, use arrows to indicate only the backbone bonds that can not freely rotate.

This would be the peptide bond and there is only one peptide bond in a didpeptide; it is the bond between the carbonyl and the backbone nitrogen.

c. Use this peptide to illustrate hydrolysis. For full credit, use the nucleophyllic acyl substitution mechanism.

Hydrolysis is when a molecule of H_2O is consumed while breaking a single bond (the peptide bond in this case). Many of you supplied the opposite reaction of forming the dipeptide AG from Alanine and Glycine.

(3 pts)

13) Indicate the net charge of the following peptide in an aqueous solution at pH 7.0

EFGKLMNPQRST

a. -3
b. -2
c. -1
d. 0
e. +1
f. +2
g. +3

(3 pts)

14) Using a line, show where the following treatments would cleave the following peptide:

a. CNBr Treatment **EFGKLM NPQRST**

b. Tryptic digestion **EFGK LMNPQR ST**

c. Elastase digestion **EFG KLMNPQRS T**

Elastase will cut after Cys (C) & Ser (S) if given enough time

(3 pts)

15) Define the isoelectric point of a protein. Limit your answer to 20 words or less.

The pH at which the net charge on the protein is zero.
An answer of "the point at which..." was only eligible for ½ the points.

(3 pts)

16) *Briefly* describe the function/purpose of Edman degradation (structures are not necessary).

Edman degradation uses PITC to modify and remove the amino-terminal amino acid which is subsequently identified. This is N-terminal amino acid sequencing.

(6 pts)

17) Describe the *effect* of the following reagents on proteins (i.e. describe their function not their structure?). *Be brief*

a. b-**ME, beta mercaptoethanol**

Reduces disulfide bridges (cystines); used in SDS PAGE to help denature proteins.

b. SDS, sodium dodecyl sulfate

Detergent used to unfold proteins; produces a consistent charge to mass ratio which is used to help estimate the mass of proteins.

c. urea

Chaotropic agent used to denature/unfold proteins in Isoelectric focusing.

(4 pts)

18) Two dimensional gel electrophoresis uses what forms of electrophoresis? How does each separate proteins? *Use short answers*.

	Name	**Separates proteins based on:**
First:	**Isoelectric Focusing**	**pH gradient; pI; charge**
Second:	**SDS PAGE**	**mass; size**

(3 pts)

19) Cadaverine, shown here, is a volatile molecule with an unpleasant odor that occurs in dead animal tissue by a simple decarboxylation of a common amino acid. That amino acid is most likely to be

a. Arginine

b. Glutamine $H_2N\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}NH_2$

c. Valine

d. Lysine **when lysine loses CO_2, it becomes cadaverine**

e. Putrescine **when ornithine loses CO_2, it becomes putrescine**

f. None of the above