

**MMBB 380 - Fall 2005
EXAM 1 - Part I**

You may use a calculator for this portion of the test. Show all your work. Good Luck.

(12,000 pts)

- 1) You have developed a new series of monoprotic buffers (HA) and you are characterizing their pK_a values. You make 125 mM solutions of each and carefully measure the pH of the first buffer as 3.08.**
- a. Determine the pK_a of this buffer.**



$$[\text{H}^+] = 10^{-\text{pH}} = 10^{-3.08} = 8.32 \times 10^{-4} \text{ M}; \quad [\text{A}^-] = \sim[\text{H}^+] = \sim 8.32 \times 10^{-4} \text{ M}$$

$$[\text{HA}] = 0.125 \text{ M} - [\text{A}^-] = 0.125 \text{ M} - 0.000832 \text{ M} = 0.124 \text{ M}$$

$$K_a = [\text{H}^+][\text{A}^-]/[\text{HA}] = (8.32 \times 10^{-4})^2/0.124 = 5.58 \times 10^{-6}$$

$$pK_a = -\log(5.58 \times 10^{-6}) = 5.25 \quad 5.26 \text{ is also acceptable}$$

(9,000 pts)

2) In a 200 mM solution of free glutamic acid ($pK_{a1} = 2.19$; $pK_{a2} = 4.25$; $pK_{a3} = 9.67$), the pH is adjusted to exactly 4.25. The concentration of the completely unprotonated form (A^{-2}) of this amino acid is closest to:

- A. 0 mM** At pH 4.25, $[H_2A^0] = [HA^{-1}] = \sim 200/2 = 100$ mM; $[A^{-2}]$ is quite low
- B. 50 mM
- C. 100 mM
- D. 150 mM
- E. 200 mM

Could glutamic acid be used to effectively buffer a solution at pH 7.0? Briefly justify your answer.

No. There is no pK_a on this molecule that is within 1.0 pH unit of 7.0 (6.0-8.0).

(7,000 pts)

3) A monoprotic buffer, X, has a pK_a of 8.25. A 25.0 mM solution of buffer X has been prepared and the pH has been adjusted to 8.00. Determine the concentration of the protonated form ($[HX^{+1}]$) of X in this solution.

$$pH = pK_a - \log [HX]/[X^{-1}] \qquad [HX] + [X^{-1}] = 25 \text{ mM} = 0.025 \text{ M}$$

$$8.00 = 8.25 - \log [HX]/[X^{-1}]$$

$$8.00 - 8.25 = -0.25 = -\log [HX]/[X^{-1}]$$

$$0.25 = \log [HX]/[X^{-1}]$$

$$10^{(0.25)} = [HX]/[X^{-1}] = 1.78$$

$$[HX] = 1.78 [X^{-1}] = 0.025 \text{ M} - [X^{-1}]$$

$$2.78 [X^{-1}] = 0.025 \text{ M}; \qquad [X^{-1}] = 0.025 \text{ M}/2.78 = 9.0 \text{ mM}$$

$$[HX] = 1.78 (9.0 \text{ mM}) = \underline{16.0 \text{ mM}}$$

NAME _____ **KEY**

**MMBB 380 - Fall 2005
EXAM I - PART II**

**You may not use a calculator for this portion of the exam; please put your calculator away.
Please read and answer each question carefully. Good Luck!**

(5,000 pts)

1) In a typical eukaryotic cell, protein synthesis occurs primarily at/in the:

- A. smooth endoplasmic reticulum
- B. nucleolus
- C. Golgi apparatus
- D. mitochondria
- E. rough endoplasmic reticulum

(5,000 pts)

2) In a typical eukaryotic cell, phospholipid synthesis occurs primarily at/in the:

- A. smooth endoplasmic reticulum
- B. nucleolus
- C. Golgi apparatus
- D. mitochondria
- E. rough endoplasmic reticulum

(5,000 pts)

3) Which one of the following has eukaryotic cellular components arranged in order of *increasing size*?

- A. amino acid, nucleic acid, mitochondrion, ribosome -3500 pt
- B. acetate, protein, ribosome, mitochondrion
- C. acetate, ribosome, protein, chromatin -3500 pt
- D. protein, amino acid, mitochondrion, mitotic spindle
- E. lipid, ribosome, mitochondrion, protein

(5,000 pts)

4) The bonding geometry of the carbonyl carbon in a ketone is best described as:

- A. linear
- B. tetrahedral
- C. trigonal planar
- D. bipyramidal

(6,000 pts)

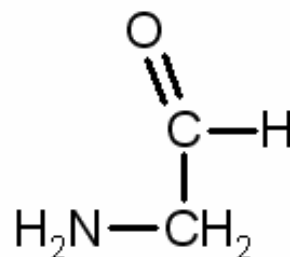
5) For the following biopolymers, provide the appropriate building block (monomer).

- a. Carbohydrates monosaccharides; sugars
- b. RNA nucleotides (Nucleic Acid -2,000 pts)

(5,000 pts)

6) What functional groups are present on this molecule?

- A. amide and ketone
- B. amide and aldehyde -3500 pts
- C. amine and ketone -3500 pts
- D. amine and aldehyde



(6,000 pts)

7) The following peptide is dissolved in a water solution that is maintained at pH 6.8. Predict the net charge of the molecule.

PRAFKND

0+00+0- = side chain charges

- A. -2
- B. -1
- C. 0 -4,000 pts
- D. +1
- E. +2 -4,000 pts

(6,000 pts)

8) Which of the following atoms is *least* likely to participate directly in hydrogen bonding?

- A. hydrogen
- B. carbon
- C. oxygen
- D. nitrogen

(5,000 pts)

9) Which of the following bonds or interactions is usually stronger than the typical ionic bond?

- A. hydrogen bond
- B. covalent bond
- C. van der Waals attractions
- D. hydrophobic interaction
- E. none of the above

(5,000 pts)

10) Which of the following is considered to be a weak acid?

- A. HCl -3500 pts
- B. NaOH
- C. CH₃COOH
- D. NH₃
- E. none of the above acts as a weak acid

(12,000 pts)

11) Please answer the following questions regarding these three buffers.

	<u>pK_a</u>
Buffer 1:	6.25
Buffer 2:	7.25
Buffer 3:	9.25

- a. Which would be best for maintaining pH in a solution with pH 8.1? 2
- b. If all three buffers were in a solution at pH 8.1, which of the buffers, if any, would be mostly in the protonated (HA) form? 3
- c. Which of the three is the weakest acid (i.e. has the most affinity for the proton)?
3

(8,000 pts)

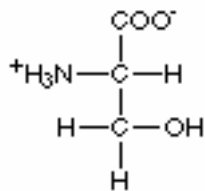
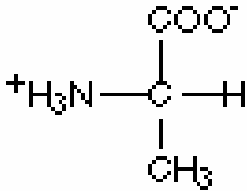
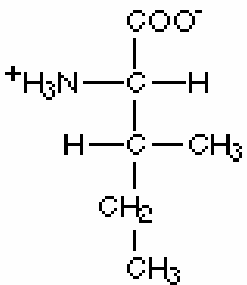
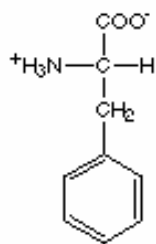
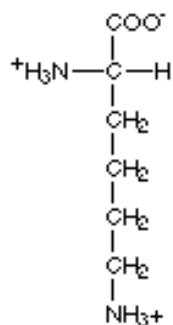
12) In 20 words or less, define the isoelectric point of a molecule.

The isoelectric point is the pH at which the net charge on the molecule is 0.0

-2,000 pt for >24 words

(32,000 pts)

13) Fill out this table describing the following common amino acids; include structures.

<u>Aqueous Structure at pH 7.0</u>	<u>Full Name</u>	<u>3 Letter Code</u>	<u>1 Letter Code</u>	<u>Indicate hydrophobic or hydrophilic R group</u>
a. 	Serine	Ser	S	hydrophilic
b. 	Alanine	<u>Ala</u>	<u>A</u>	<u>hydrophobic</u>
c. 	Isoleucine	<u>Ile</u>	<u>I</u>	<u>hydrophobic</u>
d. 	<u>Phenylalanine</u>	<u>Phe</u>	<u>F</u>	<u>hydrophobic</u>
e. 	<u>Lysine</u>	<u>Lys</u>	<u>K</u>	<u>hydrophilic</u>

(5,000 pts)

14) Brief elastase treatment of the peptide, TERMINALPEPTIDE, should generate the following peptide product(s).

- A. TERM + INALPEPTIDE
- B. TERMINAL + PEPTIDE
- C. TERMINA + LPEPTIDE**
- D. TER + MINALPEPTIDE
- E. TERMINALPEPTIDE (no cleavage)

(8,000 pts)

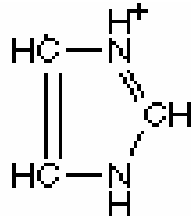
15) Draw the chemical structure of the following functional groups. Indicate by a yes or no if one or more of the 20 common amino acids contains this functional group.

Occurs in 1 or more of the 20 aa

a. thioester group

_____ Yes **X** No

b. imidazole group



X Yes _____ No

(6,000 pts)

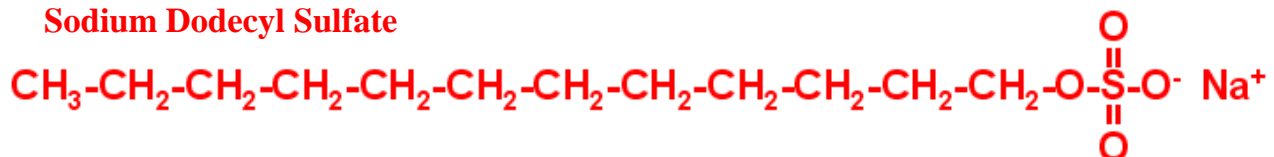
16) If a pentapeptide is made using a completely random choice of the common 20 amino acids, how many different peptide sequences are possible?

- A. 20
- B. between 20 and 100
- C. 20 + 20 + 20 + 20 + 20
- D. 20 x 20 x 20 x 20 x 20**
- E. none of the above

(6,000 pts)

17) Provide the full name and draw the structure of the molecule, SDS.

Sodium Dodecyl Sulfate



(6,000 pts)

19. SDS treatment of a protein in the absence of additional reagents (besides H₂O) should result in:

- A. cleavage of disulfide bonds
- B. unfolding of the protein**
- C. oxidation of the protein
- D. all of the above
- E. none of the above

(6,000 pts)

20. As described in class, standard two dimensional gel electrophoresis of proteins consists of which two techniques? Provide the full name for each.

1st Dimension: **IEF, Isoelectric Focusing**

2nd Dimension: **SDS PAGE; Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis**

(6,000 pts)

21) Prior to certain types of electrophoresis, a protein sample can be treated with 6 M urea.

The purpose of the urea is to:

- A. reduce disulfide bonds within the protein
- B. coat the protein, 1 urea/2 amino acids
- C. disrupt hydrophobic interactions**
- D. all of the above

(10,000 pts)

22) Draw the dipeptide, Cys-Asn. Identify the peptide bond. Identify any additional atoms that lie in the same plane as the two atoms forming the peptide bond.

(6,000 pts)

23) Sequential Edman degradation is performed on the following tetrapeptide: MAGS

Following three cycles, which amino acid(s) has/have *not* been modified with PITC?

- A. Methionine
- B. Alanine
- C. Glycine
- D. Serine**
- E. all of the above
- F. none of the above

(8,000 pts)

24) Identify the primary amino acid sequence of this heptapeptide. The following was observed.

a. Amino acid analysis (hydrolyzes all peptide bonds) gave a relative ratio of one each of the following: Asp Val Gly Lys Met Trp Leu NH₄⁺

aa analysis identifies the aa present; NH₄⁺ indicates Asn or Gln

b. Trypsin treatment generated Leu and a hexapeptide.

Trypsin cleaves after Lys & Arg; Lys must be 6th residue to produce Leu

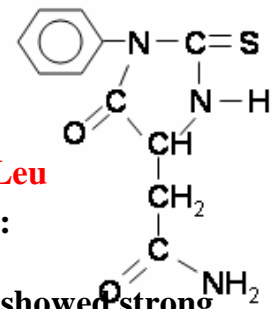
c. Edman degradation generated the PTH derivative shown to the right:

Edman always identifies NH₂-terminal aa which is Asn

d. Chymotrypsin treatment yielded two products, one tripeptide which showed strong absorbance at 280 nm and one tetrapeptide that contained an amino acid with a basic side chain. **Chymotrypsin cleaves after Phe, Tyr & Trp. To form a tripeptide, Trp must be at the 3rd or 4th position. Since the tripeptide showed strong OD₂₈₀, it must contain Trp.**

e. Brief elastase treatment generated a dipeptide and a pentapeptide; the pentapeptide contained no amino acids with acidic or basic side chains. **To generate a dipeptide, Gly must be at the 2nd or 5th position. Since the pentapeptide did not contain a basic aa (Lys), then Gly must be at the 5th position.**

f. CNBr treatment yielded a tripeptide and a tetrapeptide. **Met must be at the 3rd or 4th position. Since Trp is already identified as the 3rd aa, Met must be the 4th aa. Val is the only aa left and position 2 is the only position not yet identified; thus, Val is aa two.**



b	_____	_____	_____	_____	_____	<u>Lys</u>	<u>Leu</u>
c	<u>Asn</u>	_____	_____	_____	_____	_____	_____
d	_____	_____	<u>Trp</u>	_____	_____	_____	_____
e	_____	_____	_____	_____	<u>Gly</u>	_____	_____
f.	_____	_____	_____	<u>Met</u>	_____	_____	_____

optional worksheet

<u>Asn</u>	<u>Val</u>	<u>Trp</u>	<u>Met</u>	<u>Gly</u>	<u>Lys</u>	<u>Leu</u>	FINAL ANSWER
N	V	W	M	G	K	L	

+1,000 pt for each amino acid in correct position.

(8,000 pts)

Bonus Question: Illustrate the Merrifield Synthesis of Leu-Pro starting with prolyl acyl resin.

Page #	Points Possible	Points
Part I	28,000	
2	26,000	
3	22,000	
4	25,000	
5	32,000	
6	25,000	
7	28,000	
8	14,000	
Bonus	8,000	
Total	200,000	