

NAME _____ **KEY**

**MMBB 300 - Fall 2004
EXAM I**

**You may not use a calculator for this exam. Please read and answer each question carefully.
Good Luck!**

(3 pts)

1. In a bacterial cell, the DNA is in the:

- A) cell wall
- B) cell membrane
- C) **nucleoid**
- D) nucleus
- E) ribosomes

(3 pts)

2. Which of the following involves a treatment with 6 M HCl at 110°C?

- A) SDS PAGE
- B) mass spectrometry
- C) **amino acid analysis**
- D) Edman degradation

(3 pts)

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

- A) Amino acid < protein < mitochondrion < ribosome -2 pts
- B) **Amino acid < protein < ribosome < mitochondrion**
- C) Amino acid < ribosome < protein < mitochondrion -2 pts
- D) Protein < amino acid < mitochondrion < ribosome
- E) Protein < ribosome < mitochondrion < amino acid

(3 pts)

4. The four covalent bonds in methane (CH₄) are arranged around carbon to give which one of the following geometries?

- A) linear
- B) **tetrahedral**
- C) trigonal planar
- D) trigonal pyramidal -2 pts

(4 pts)

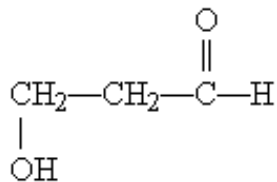
5. For the following biopolymers, provide the appropriate building block (monomer).

- a. Carbohydrate **Monosaccharides**
- b. Nucleic Acid **Nucleotides**

(3 pts)

6. What functional groups are present on this molecule?

- A) ether and ketone
- B) hydroxyl and aldehyde
- C) hydroxyl and carboxylic acid
- D) hydroxyl and ester
- E) hydroxyl and ketone -2 pts



(3 pts)

7. Hereditary information in eukaryotes and prokaryotes is preserved in:

- A) deoxyribonucleic acid
- B) membrane structures
- C) nucleoli
- D) polysaccharides
- E) ribonucleic acid

(3 pts)

8. Which of these statements about hydrogen bonds is *not* true?

- A) Hydrogen bonds account for the high boiling point of water.
- B) In liquid water, the average water molecule forms hydrogen bonds with three to four other water molecules.
- C) Individual hydrogen bonds are weaker than covalent bonds.
- D) Individual hydrogen bonds in liquid water exist for many seconds and sometimes for minutes.

(3 pts)

9. The chirality observed in most amino acid results from the fact that its α -carbon:

- A) has no net charge.
- B) is symmetric.
- C) is bonded to four different chemical groups.
- D) is in the L absolute configuration in naturally occurring proteins.

(3) pts

10. Please provide the Henderson-Haselbalch equation.

$$\text{pH} = \text{pK}_a - \log [\text{HA}]/[\text{A}^-] \quad \text{or} \quad \text{pH} = \text{pK}_a + \log [\text{A}^-]/[\text{HA}]$$

(6 pts)

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

	<u>pK_a</u>
Buffer 1:	6.20
Buffer 2:	6.80
Buffer 3:	8.50

- a. Which would be best for maintaining pH in a solution with pH 7.40? Buffer 2
- b. If all three buffers were in a solution at pH 7.4, which of the buffers, if any, would be mostly in the protonated (HA) form? Buffer 3
- c. Which of the three is the strongest acid (i.e. has the least affinity for the proton)?
Buffer 1

(3 pts)

12. Valine has two pK_a's; the second pK_{a2} = 9.62. The second pK_a is due to protonation-deprotonation of the:

- A) α-carboxylic acid
B) α-amino group
C) γ-hydroxyl group
D) ε-amino group

(3 pts)

13. The peptide alanylglutamylglycylalanylleucine has:

- A) a disulfide bridge
B) five peptide bonds **-2 pts**
C) **four peptide bonds**
D) no free carboxyl group

(3 pts)

14. At the isoelectric point of a tetrapeptide:

- A) only the amino and carboxyl termini contribute charge.
B) the amino and carboxyl termini are not charged.
C) **the total net charge is zero.**
D) there are four ionic charges.

(16 pts)

15. Fill out this table describing the following common amino acids

<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.	Cysteine	<u>Cys</u>	<u>C</u>	<u>hydrophilic</u>
d.	<u>Tryptophan</u>	<u>Trp</u>	<u>W</u>	<u>hydrophobic</u>
e.	<u>Lysine</u>	<u>Lys</u>	<u>K</u>	<u>hydrophilic</u>

(4 pts)

16. Trypsin treatment of the peptide, TERMINALPEPTIDE, should generate the following peptides.

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

(4 pts)

17. Name the eukaryotic organelle that is responsible for the following functions.

- Golgi Apparatus** sorting and packaging of proteins
- Rough Endoplasmic Reticulum** protein synthesis
- Mitochondrion** ATP production & molecular oxygen consumption
- Smooth Endoplasmic Reticulum** phospholipid biosynthesis

(3 pts)

18. In 1828, Freidreich Wöhler heated ammonium cyanate and produced an organic compound. What is the name of this compound? Please draw the chemical structure.



(3 pts)

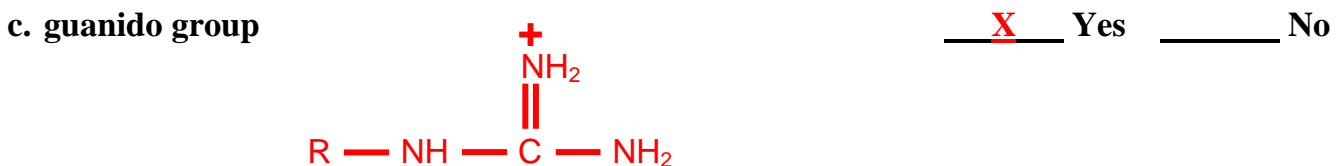
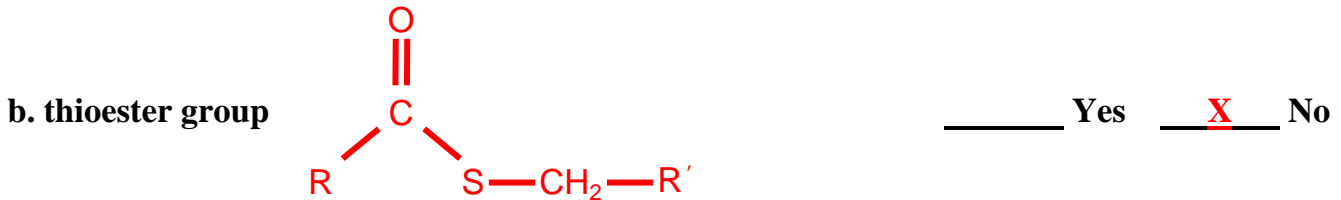
19. Which of the following best describes the pK_a of a weak monoprotic acid (HA)?

- A) $-\log [H^+]$
- B) $+\log K_a$
- C) the pH at which the concentration of HA is equal to that of A^- .**
- D) the pH at the equivalence point

(6 pts)

20. 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



(4 pts)

21. If a tetrapeptide is made using a completely random choice of the common 20 amino acids, how many different peptide sequences are possible?

- A) less than 100
- B) between 100 and 1,000
- C) between 1,000 and 10,000
- D) between 10,000 and 100,000 -3 pts
- E) greater than 100,000

(3 pts)

22. Which of the following best represents the backbone arrangement of atoms and bonds in a peptide?

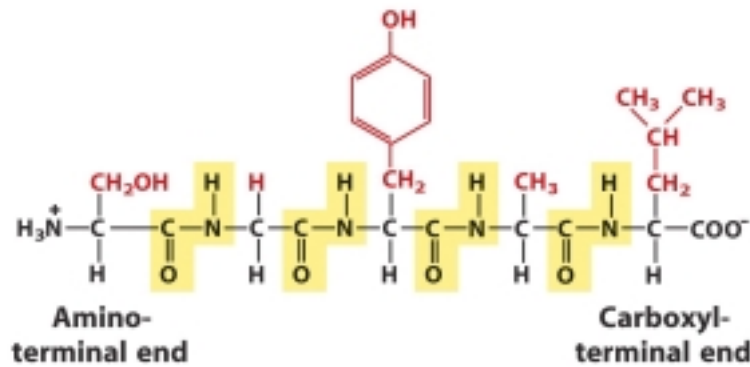
- A) $C_{\alpha}-N-C_{\alpha}-C-C_{\alpha}-N-C_{\alpha}-C$
- B) $C_{\alpha}-N-C-C-N-C_{\alpha}$
- C) $C-N-C_{\alpha}-C_{\alpha}-C-N$
- D) $C_{\alpha}-C-N-C_{\alpha}-C-N$

(3 pts)

23. Which of the following pairs of bonds within a polypeptide backbone show free rotation around both bonds? It might help to draw part of a polypeptide.

- A) $C_{\alpha}-C$ and $N-C_{\alpha}$
- B) $C=O$ and $C-N$
- C) $C=O$ and $N-C_{\alpha}$
- D) $C-N$ and $C_{\alpha}-C$ -2 pts
- E) $N-C_{\alpha}$ and $N-C$ - 2 pts

The yellow highlight shows the $C-N$ bond which can't rotate



(2 pts)

24. Please provide the full name for the following acronym: SDS PAGE

Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis

(3 pts)

25. As described in class, two-dimensional protein electrophoresis would involve which of the following events in chronological order:

- A) 1. SDS & β -ME 2. IEF 3. 6 M Urea 4. SDS PAGE -2 pts
- B) 1. 6 M Urea 2. IEF 3. SDS & β -ME 4. SDS PAGE
- C) 1. SDS & β -ME 2. SDS PAGE 3. 6 M Urea 4. IEF
- D) 1. 6 M Urea 2. SDS PAGE 3. SDS + β -ME 4. IEF

(3 pts)

26. A primary function of β -mercaptoethanol (β -ME) in protein electrophoresis is to:

- A) reduce disulfide bonds
- B) denature/unfold protein
- C) break hydrogen bonds
- D) disrupt hydrophobic interactions

Bonus Question - Choose *only* BQ1 or BQ2

(4 pts)

BQ1. The average molecular weight of the 20 standard amino acids is 138, but biochemists use 110 when estimating the number of amino acids in a protein of known molecular weight. Why?

- A) The number 110 is based on the fact that the average molecular weight of a protein is 110,000 with an average of 1,000 amino acids. **+2 pt**
- B) **The number 110 reflects the higher proportion of small amino acids in proteins, as well as the loss of water when the peptide bond forms.** + 4 pts
- C) The number 110 reflects the number of amino acids found in the typical small protein, and only small proteins have their molecular weight estimated this way.
- D) The number 110 takes into account the relatively small size of nonstandard amino acids.
- E) The number 138 represents the molecular weight of conjugated amino acids.

(4 pts)

BQ2. A nonapeptide was determined to have the following amino acid composition: (Lys)₂, (Gly)₂ (Phe)₂, His, Leu, Met. The native peptide was incubated with phenylisothiocyanate (PITC) and then hydrolyzed; phenylthiohydantoinhistidine (PTH-His) was identified by HPLC. When the native peptide was exposed to cyanogen bromide (CNBr), an octapeptide and free glycine were recovered. Incubation of the native peptide with trypsin gave a pentapeptide, a tripeptide, and free Lys; PTH-His was recovered from the pentapeptide, and PTH-Phe was recovered from the tripeptide. Incubation of the native peptide with chymotrypsin yielded a tetrapeptide, a tripeptide and a dipeptide. The native sequence was eventually determined to be:

- A) Gly–Phe–Lys–Lys–Gly–Leu–Met–Phe–His
- B) His–Leu–Gly–Lys–Lys–Phe–Phe–Gly–Met
- C) **His–Leu–Phe–Gly–Lys–Lys–Phe–Met–Gly** + 4 pts
- D) **His–Phe–Leu–Gly–Lys–Lys–Phe–Met–Gly** +2 pts
- E) Met–Leu–Phe–Lys–Phe–Gly–Gly–Lys–His

Page #	Points Possible	Points
2	16	
3	15	
4	15	
5	16	
6	14	
7	13	
8	11	
Bonus	4	
Total	100	