

THE UNIVERSITY OF MANITOBA

DATE: October 27, 1998

Mid term EXAMINATION

PAPER NO.:    

PAGE NO.: 1 of 8

DEPARTMENT & COURSE NO.: 2.277/60.277

Time: 2 HOURS

EXAMINATION: Elem. of Biochemistry I

EXAMINER: Drs. Eze & Scoot

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**GENERAL INSTRUCTIONS**

1. You must mark the answer sheet with pencil (not pen).
  2. Put your name and enter your student number on the answer sheet.
  3. The examination consists of multiple choice questions. Choose what you think is the best, correct answer and record your choice on the answer sheet. There is only **ONE CORRECT** answer.
  4. This exam will count for 25% of your final mark.
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**MULTIPLE CHOICE QUESTIONS**

1. Interactions among the subunits of an oligomeric protein molecule lead to \_\_\_\_\_ Structure.  
A) Secondary      B) Tertiary      C) Fifth      D) Quaternary      E) Sixth
2. A weak acid is \_\_\_\_\_ ionized in solution.  
A) completely      B) only partially      C) not at all      D) 100 per cent      E) none of the above
3. When a weak acid has lost its proton, it becomes \_\_\_\_\_.  
A) a conjugate base      B) a conjugate acid      C) an ammonium ion  
D) a chloride ion      E) a sodium ion
4. pKa is defined as the pH of a weak acid at \_\_\_\_\_ titration  
A) half      B) one third      C) one quarter      D) one tenth      E) one fifth
5. The isoelectric point (pI) of histidine is about \_\_\_\_\_. (For histidine,  $pK_1 = 1.82$ ;  $pK_2 = 9.17$ ;  $pK_{(R)} = 6.0$ )  
A) 1.82      B) 9.2      C) 7.6      D) 6.0      E) 0
6. Solution X has pH of 7.0. The  $[H^+]$  in solution Y is 100,000 larger than that in solution X. The pH of solution Y is \_\_\_\_\_.  
A) 1.0      B) 2.0      C) 5.0      D) 12.0      E) 13.0
7. 50 mL of 0.1 M NaOH are added to 150 mL of 0.2 M acetic acid. pKa (acetic acid) = 4.76. The resulting solution has a pH which is closest to \_\_\_\_\_.  
A) 3.5      B) 4.0      C) 4.0      D) 5.0      E) 5.5

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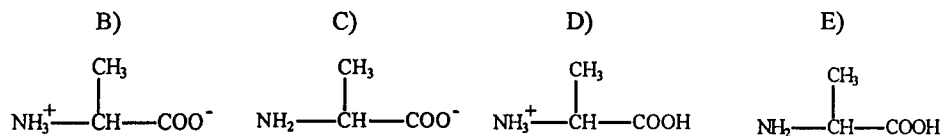
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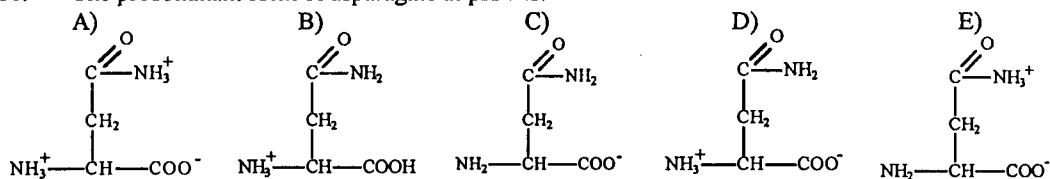
8. The conjugate base of the cationic form of alanine is \_\_\_\_\_ . A) None of B-E



9. We have 10 mL of a 0.1 M phenylalanine solution at pH 9.13. How many mL of 0.2 M HCl must be added to this solution to make the pH equal to the pI for Phe? The pKa values for Phe are 1.83 and 9.13.

- A) 0.5      B) 1.5      C) 2.5      D) 3.5      E) 4.5

10. The predominant form of asparagine at pH 7 is:



11. In  $\beta$ -conformation of protein secondary structure the backbone of the polypeptide chain is \_\_\_\_\_?

- A) in extended zig-zag structure.      B) an  $\alpha$ -helix      C) a double helix  
D) a left-handed helix      E) not in the protein

12. True (A) or False (B): Silk is composed mainly of proteins with an  $\alpha$ -helical conformation.

13. Which of the following amino acids has a hydroxyl group in its side chain?

- A) histidine      B) tyrosine      C) asparagine      D) isoleucine      E) None of A to D

14. In the active site of an enzyme molecule, noncontiguous amino acid residues along the polypeptide chain can come together to participate in substrate binding and catalysis. One of the following, in the active site of chymotrypsin illustrates this:

- A) Ser 195, Asp 102, His 57 and Gly 193 are together at the active site.  
B) Ser 195, Asp 102, His 57 and Gly 193 are not together.  
C) His 195 is not hydrogen-bonded to Ser 195.  
D) His 57 is not hydrogen-bonded to carboxylate of side chain of Asp 102.  
E) None of A to D.

15. Chymotrypsin will cleave a peptide bond on the carbonyl side of phenylalanine. Thus, there is a \_\_\_\_\_ pocket at the active site in which the side chain benzene ring of Phe fits.

- A) Hydrophobic      B) Positively charged      C) Negatively charged  
D) Positive-plus-negative      E) Sulfhydryl

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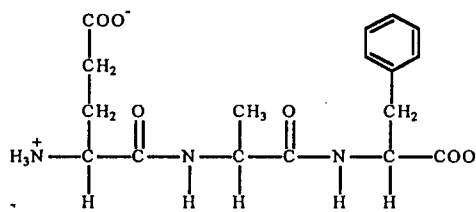
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16. Sulfonamide antibiotics kill bacteria because they are structural analogs of para-aminobenzoate, constituent of tetrahydrofolate (THF). Thus, these drugs serve as \_\_\_\_\_ Inhibitors of bacterial synthesis of THF.
- A) Activator    B) Noncompetitive    C) Competitive    D) Uncompetitive    E) Irreversible
17. The sulfhydryl reagent  $\text{ICH}_2\text{CONH}_2$  (iodoacetamide) irreversibly inhibits the enzyme glyceraldehyde-3-phosphate dehydrogenase by alkylating an essential \_\_\_\_\_ (Amino acid) at the active site.
- A) Cysteine    B) Glycine    C) Alanine    D) Isoleucine    E) Phenylalanine
18. Enzymes increase the rates of reactions in the cell by specifically:
- A) Decreasing the free energy of activation for the reaction.  
 B) Increasing the free energy of activation.  
 C) Decreasing the volume of the cell.  
 D) Increasing the volume of the cell.  
 E) Plasmolysing the cell.
19. The myoglobin molecule consists of only one polypeptide chain. The complete three-dimensional structure involving the spatial relationships among all amino acid residues in the chain is called \_\_\_\_\_ structure.
- A) Primary    B) Carbohydrate    C) Secondary    D) Tertiary    E) Nucleic acid
20. One of the following interactions is not a weak interaction which contributes to binding energy at the enzyme active site:
- A) Electrostatic interaction    B) Hydrophobic interaction    C) Hydrogen bonding  
 D) Ionic interaction    E) Covalent bonding
21. The artificial sweetener, "Aspartame" is:
- A) an amino acid    B) a dipeptide    C) a tripeptide    D) a polypeptide    E) an oligopeptide

**Answer the next three questions with reference to compound X below:**



Compound X

22. Compound X is
- A) a pentapeptide    B) a protein    C) a decapeptide    D) a tripeptide    E) a lipid

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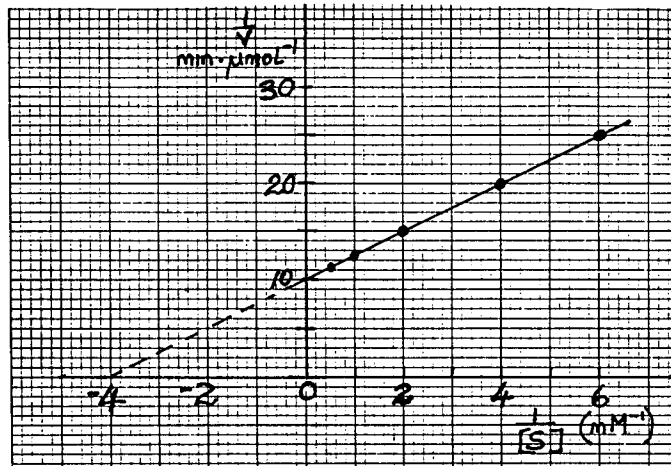
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23. At pH 1, X will have a net charge of:  
 A) +1      B) +2      C) -1      D) zero      E) -2
24. At pH 12, X will have a net charge of:  
 A) -3      B) +1      C) -1      D) +3      E) -2
25. True (A) or False (B): A pentapeptide has 5 peptide bonds.
26. Many glutamate residues occurring in a cluster in an  $\alpha$ -helix destabilize this secondary structure under physiological pH, because:  
 A) Side chain negatively charged  $\text{COO}^-$  of adjacent Glu residues repel each other strongly.  
 B) Side chain  $\text{NH}_3^+$  on adjacent Glu attract each other.  
 C) Side chain aliphatic side chains on Glu repel each other.  
 D) Glutamate has no side chain functional group.  
 E) Glutamate is not an amino acid.

**Identify the only correct statement among A, B, C, D & E in the next two questions 27 and 28:**

27. A) Every peptide bond in an  $\alpha$ -helix is engaged in H-bonding  
 B) This Hydrogen bond does not stabilize the  $\alpha$ -helix  
 C) The Hydrogen bonds are not parallel to the helix main axis  
 D) Only  $\frac{1}{3}$  of peptide bonds in an  $\alpha$ -helix are involved in H-bonding  
 E) None of the above.
28. A) Proline destabilizes the  $\alpha$ -helix      B) Proline stabilizes the  $\alpha$ -helix  
 C) Proline does not occur in proteins      D) Glycine is not an amino acid      E) Proline is a dipeptide

**Use the kinetic data plotted in the accompanying Lineweaver-Burk plot to answer questions 29, 30 & 31.**



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29. The magnitude of  $V_{max}$  is about \_\_\_\_\_  $\mu \text{ mol} \cdot \text{min}^{-1}$   
A) 0.1      B) 1.0      C) 10.0      D) 5.0      E) 7.0
30. The magnitude of  $K_m$  is about \_\_\_\_\_ mM.  
A) 0.1      B) 10      C) 0.25      D) 25      E) 2.5
31. The largest substrate concentration used in the Kinetic study was about \_\_\_\_\_ mM.  
A) 2mM      B) 20mM      C) 0.2 mM      D) 5mM      E) 50mM
32. A positive allosteric modulator \_\_\_\_\_ an allosteric enzyme.  
A) Inhibits substrate binding by  
B) Enhances substrate binding by  
C) Inhibits catalysis by  
D) Has no effect on catalytic rate of  
E) Has no effect on substrate binding by
33. An allosteric enzyme \_\_\_\_\_  
A) Obeys Michaelis-Menten kinetics  
B) Does not obey Michaelis-Menten kinetics  
C) Consists of only one polypeptide chain  
D) Does not contain peptide bonds  
E) Is not a regulatory enzyme.
34. The correct statement about the  $K_m$  for a reaction catalyzed by an enzyme that shows a hyperbolic v versus  $[S]$  curve is \_\_\_\_\_  
A) If two substrates can bind to the same active site, the substrate with the smallest  $K_m$  is the more strongly bound.  
B) The enzyme active sites are saturated with substrate when the substrate concentration is equal to the  $K_m$ .  
C) It is called the Lineweaver-Burk constant.  
D) The rate of the reaction is equal to the product of  $K_m$  and  $V_{max}$ .  
E) Enzyme saturation occurs when  $K_m = V_{max}$ .
35. Which of the following statements about Hemoglobin (Hb) is true?  
A) Hb is a good example of a simple protein.  
B) Hb molecule has four subunits  
C) Hb has three subunits only  
D) Hb has no quaternary structure  
E) Hb is not globular protein.

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36. Oxygen binding by Hb \_\_\_\_\_ ?
- A) Obeys Michaelis-Menten kinetics
  - B) Exhibits allosteric behaviour
  - C) Exhibits no regular behaviour
  - D) Does not occur at all
  - E) May not be possible.
37. Which of the following statements about enzymes is true?
- A) The optimum pH of pepsin the stomach enzyme is around 1.5
  - B) The optimum pH of pepsin is 7.4
  - C) Chymotrypsin does not hydrolyze proteins
  - D) Trypsin is not a protein-digesting enzyme
  - E) Thrombin does not have an essential serine residue.
38. FAD component of flavoproteins is referred to as a prosthetic group because it \_\_\_\_\_ .
- A) Is strongly attached to the enzyme protein
  - B) Is weakly attached.
  - C) Is not required by the enzyme
  - D) has no function
  - E) Does not participate in electron transfer.
39. Which of the following statements about allosteric enzymes are correct?
- i) They usually have only one active site.
  - ii) Both substrate and allosteric inhibitor bind at the active site.
  - iii) They are oligomeric proteins.
  - vi) They show "cooperative substrate binding"
  - v) They usually show hyperbolic  $v$  versus  $[S]$  plots with a large  $V_{max}$ .
- A) i & ii    B) ii & iii    C) iii & iv    D) iv & v    E) iii & v
40. The coenzyme  $NAD^+$  of glyceraldehyde 3-phosphate dehydrogenase is referred to as a cosubstrate because \_\_\_\_\_ .
- A) It is covalently bound to the enzyme protein
  - B) It easily detatches form the enzyme protein
  - C) It is not involved in oxidation-reduction reactions
  - D) It is a hydrocarbon
  - E) It is a protein.

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41. Which of the following would result in a 1 in 50 dilution of an original solution Y.
- A) A 5 mL aliquot of Y was diluted with 20 mL of buffer. This was further diluted by taking a 2 mL aliquot and adding 18 mL buffer.
  - B) A 10 mL aliquot of Y was diluted by adding 40 mL of buffer.
  - C) A 0.5 mL aliquot of Y was diluted with 9.5 mL of buffer. This was further diluted by taking a 0.3 mL aliquot and adding 8.7 mL buffer.
  - D) All of the above.
  - E) None of the above.
42. The R-group carboxyl of glutamate has a  $pK_a$  of 4.2. What fraction of this group is protonated at a pH of 4.5?
- A) 20.0%    B) 30.0%    C) 33.3%    D) 50.0%    E) 66.6%
43. In your experience in the biochemistry labs which of the following statements about paper chromatography are true?
- 1) Separation of sample components is based upon their partition between two immiscible liquid phases.
  - 2) Water forms the stationary phase while a less polar solvent forms the moving phase.
  - 3) The less polar a component the less it moves.
  - 4) The more polar a component the more it moves.
  - 5) The  $R_f$  is calculated by taking the ratio of the distance moved by a sample component over distance moved by solvent
- A) 1 and 2    B) 1, 2 and 5    C) 1, 3 and 4    D) All of the above    E) None of the above
44. Which of the following are required conditions for measuring protein by the Biuret method?
- 1) Alkaline conditions
  - 2) The presence of  $Cu^{2+}$
  - 3) Titration with acid and base
  - 4) Establishment of a calibration curve
  - 5) Formation of a complex whose absorbance can be determined.
- A) All of the above    B) 1, 2, 3 and 4    C) 1, 2, 4 and 5    D) 4 and 5    E) 3
45. Using the Biuret method, the absorbance of a tube containing 0.2 mL of a 1 in 5 dilution of unknown protein solution was found to be 0.300. In the same size cuvette, 1.5 mL of a standard bovine serum albumin solution containing 6 mg BSA/mL, gave an absorbance reading of 0.450. What is the protein concentration of the original protein solution?
- A) 1.2 mg/mL    B) 6 mg/mL    C) 30 mg/mL    D) 100 mg/mL    E) 150 mg/mL

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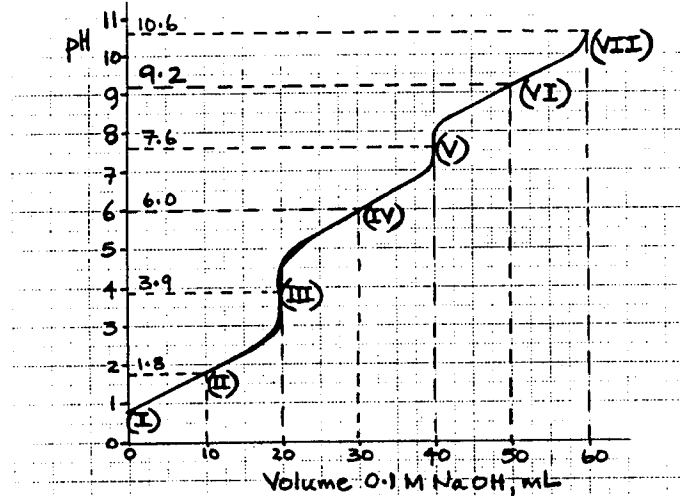
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For questions 46 to 50 please refer to the following: A 10 mL solution of 0.2M histidine at pH 0.8 was titrated with 0.1 M NaOH solution. During the titration the pH was monitored and the results were plotted on the graph shown. The key points in the titration are designated I to VII on the graph. For each of the questions below, identify the appropriate key point(s) in the titration.



46. At what point is the average net charge of histidine + 1.5?  
 A) II      B) III      C) IV      D) V      E) VI
47. At what point or points is the pH equal to the pI?  
 A) III      B) II, IV and VI      C) I      D) V      E) III and V
48. At what point is the R- group amino of half the molecules ionized?  
 A) III      B) IV      C) V      D) VI      E) VII
49. At what points does histidine have its maximum general buffering capacity?  
 A) I, III and V      B) III, V and VII      C) III and V      D) I and VII      E) II, IV and VI
50. At what point would histidine be unable to buffer hydroxyl ions (OH<sup>-</sup>)?  
 A) I      B) III      C) V      D) VI      E) VII



Answers for 2.277/60.277 Exams 96/97, 97/98 and 98/99

Question Number	277 Midterm			277 Final		
	96/97	97/98	98/99	96/97	97/98	98/99
1.	B	E	D	D	E	D
2.	B	C	B	B	E	E
3.	C	C	A	B	A	A
4.	F	E	A	D	C	B
5.	A	C	C	B	B	D
6.	G	B	B	C	E	D
7.	G	B	B	A	D	A
8.	C	B	B	E	A	B
9.	D	A	C	B	B	D
10.	B	D	D	A	B	E
11.	F	D	A	F	A	A
12.	C	C	B	A	B	C
13.	B	B	B	A	C	A
14.	H	E	A	D	D	E
15.	D	E	A	D	B	C
16.	D	D	C	D	C	A
17.	F	A	A	C	A	E
18.	E	E	A	A	E	D
19.	B	B	D	E	A	C
20.	B	E	E	A	D	C
21.	F	B	B	C	D	D
22.	C	E	D	B	D	C
23.	A	A	A	D	C	C
24.	B	A	E	A	E	A
25.	A	C	B	C	E	E

Continued....

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	96/97	97/98	98/99	96/97	97/98	98/99
26.	C	B	A	C	A	B
27.	D	C	A	B	C	E
28.	E	D	A	E	E	A
29.	D	D	A	B	C	C
30.	B	B	C	C	A	B
31.	D	C	A	E	C	B
32.	E	E	B	E	E	E
33.	B	E	B	A	B	A
34.	B	A	A	B	E	B
35.	E	B	B	C	D	D
36.	D	B	B	D	A	E
37.	E	A	A	C	A	B
38.	A	C	A	E	B	C
39.	C	C	C	C	E	B
40.	C	B	B	D	B	A
41.	B	B	A	A	D	D
42.	A	C	C	E	B	C
43.	B	A	B	D	E	B
44.	D	B	C	D	A	B
45.	C	C	E	C	A	B
46.	B	B	A	A	B	E
47.	D	A	D	E	E	D
48.	D	D	B	A	C	B
49.	C	A	E	B	A	A
50.	A	B	E	B	B	E