THE UNIVERSITY OF MANITOBA

Oct. 21 20 03 — Mid-term EXAMINATION

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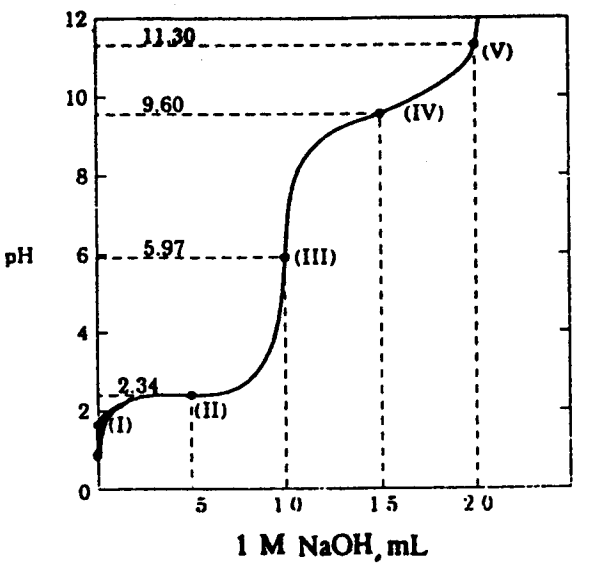
DEPARTMENT & COURSE NO: Chemistry 002.277/60.277 — TIME: 1 HOURS

EXAMINATION: Elem. Biochemistry I — EXAMINER: Dr. D. Burton

GENERAL INSTRUCTIONS

- You must mark the answer sheet with pencil (not pen).
- Put your name and enter your student number on the answer sheet.
- 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.
- This exam will count for 25% of your final mark.

For questions 1, 2 and 3 please refer to the following: A 100 mL solution of 0.1M glycine at pH 1.34 was titrated with 1M 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 V on the graph. For each of the questions below, identify the appropriate key point(s) in the titration.



1. At what point is the average net charge of glycine + 1/2?

A) I B) II C) III D) IV E) V

2. At what point is the amino group of half the molecules charged?

A) I B) II C) III D) IV E) V

3. At what point would glycine be unable to buffer protons?

A) I B) II C) III D) IV E) V

4. Which of the following weak acids would make the best buffer at pH = 5.0?

A) Acetic acid ($Ka = 1.74 \times 10^{-5}$)

B) $H_2PO_4^-$ ($Ka = 1.38 \times 10^{-7}$)

C) Bicarbonate ($Ka = 6.3 \times 10^{-11}$)

D) Tris-hydroxymethylaminomethane ($Ka = 8.32 \times 10^{-9}$)

E) None of the above would be suitable.

5. Which of the following amino acids has two nitrogen atoms in its side-chain (R- group)?

A) histidine B) glutamine C) leucine D) lysine E) tryptophan

6. Which statement is incorrect about the classification of amino acids?

A) At pH 7, lysine, arginine and tryptophan have positively charged R-groups.

B) Alanine and valine have nonpolar, aliphatic R-groups.

C) At pH 7, aspartate and glutamate have negatively charged R-groups.

D) At pH 7, threonine, serine and cysteine have polar, uncharged R-groups.

E) None of the above are incorrect.

7. A 20 mL sample of HCl solution requires 7.2 mL of 0.2M NaOH solution for complete titration. What is the concentration of the HCl?

A) 0.72 M B) 0.072 M C) 0.0072M D) 0.036M E) 0.36M

8. What is the pH of the HCl solution referrred to in question 5?

A) 7.0 B) 1.1 C) 3.1 D) 11.1 E) 1.5

9. To 50 mL of a 0.1M solution of alanine at pH=pI, was added X mL of 0.2M NaOH. The new pH was found to be equal to the pK_a for its amino group. What is the value of X?

A) 12.5 mL B) 25 mL C) 50 mL D) 75 mL E) the problem cannot be solved without knowing the pK_a values.

10. 0.05 mol of HCl was added to a solution containing 0.05 mol of a weak acid and 0.15 mol of its conjugate base. After mixing, the pH of the solution was found to be 4.28. What is the pK_a of the weak acid?

A) 4.28 B) 4.40 C) 4.76 D) 5.04 E) 5.18

11. The linear sequence of peptide-bonded amino acids in a polypeptide is called ___?

A) primary structure B) secondary structure C) tertiary structure
D) random coil structure E) alpha-helical structure

12. The peptide bond is planar because ___?

A) the large >C=O group causes steric hindrance
B) the H in the >N-H group is small
C) free rotation is possible around the bond between the alpha carbon and the carbonyl (>C=O) carbon
D) the C-N bond has partial double bond character
E) H-bonds can form between polar R-groups

13. In the alpha helix, the R-groups of the amino acids ___?

A) are found on the outside of the helix
B) generate H-bonds to stabilize the helix
C) stack within the interior of the helix
D) cause only right-handed helices to form
E) alternate between the inside and outside of the helix

14. Which factors will influence the native conformation of a protein?

1) pH of the solution
2) Temperature
3) Its sequence of amino acids
4) The presence of ethanol in the solution
5) Intrachain disulfide bonds

A) 1, 2,& 4 B) 1, 2,& 3 C) 1, 2, 3 & 4 D) 1, 2, 3 & 5 E) All of the above

15 Alpha helices are stabilized primarily by which of the following?

A) Hydrogen bonds between groups in the polypeptide backbone.
B) Electrostatic interactions between R groups.
C) Hydrophobic interactions between the alpha-carbons of the polypeptide backbone.
D) Hydrogen bonding between the R groups
E) None of the above.

16. Quaternary structure is associated with which of the following?

A) The overall shape of a polypeptide chain
B) The sum of the secondary and tertiary interactions
C) Simple proteins with only one subunit
D) The relative orientation of one polypeptide to another polypeptide in a multi-subunit protein
E) None of the above

17. Which of the following correctly depicts interchain H-bonding in the Beta-sheet?

A) >N-H //// H-N< B) >C=O //// H-C- C) >C=O //// H-N<
D) >N-H //// H-R- E) >C=O //// O=C<

18. Which of the following statements about the fibrous protein silk fibroin are TRUE?

1) Fibroin consists of stacked beta-sheets
2) Fibroin consists of right handed helices arranged into left-handed superhelices
3) Fibroin has a high content of glycine
4) Disulfide bonds are important in stabilizing the structure of fibroin
5) The stacked beta-sheets of fibroin are held together by van der Waal's forces

A) 1,2 & 5 B) 2,4 &5 C) 1, 2 &4 D) 1,3 & 5 E) 2,3 & 4

19. Which of the following statements about the fibrous protein keratin are TRUE?

1) Keratin consists of stacked beta-sheets
2) Keratin consists of right-handed helices arranged into left-handed superhelices
3) Keratin has a high content of glycine
4) The stability of keratin is due to electrostatic interaction between adjacent helical chains
5) Disulfide bonds are important in stabilizing the structure of keratin

A) 1 & 2 B) 2 & 4 C) 3 & 4 D) 2 & 5 E) 3 & 5

20. Which of the following statements are TRUE?

1) H-bonding between amino acid side chains (R-groups) stabilizes the alpha helix
2) The >C=O and >N-H groups of peptide bonds are involved in H-bonding that stabilizes the alpha helix
3) The H-bonds that stabilize the alpha helix are parallel to the axis of the helix
4) The alpha helix is stabilized by interactions between hydrophobic R-gps stacked in the interior of the helix
5) All the peptide bonds in an alpha helix are involved in H-bonding

A) 1 & 2 B) 1,2 & 3 C) 2 & 4 D) 3 & 4 E) 2, 3 & 5

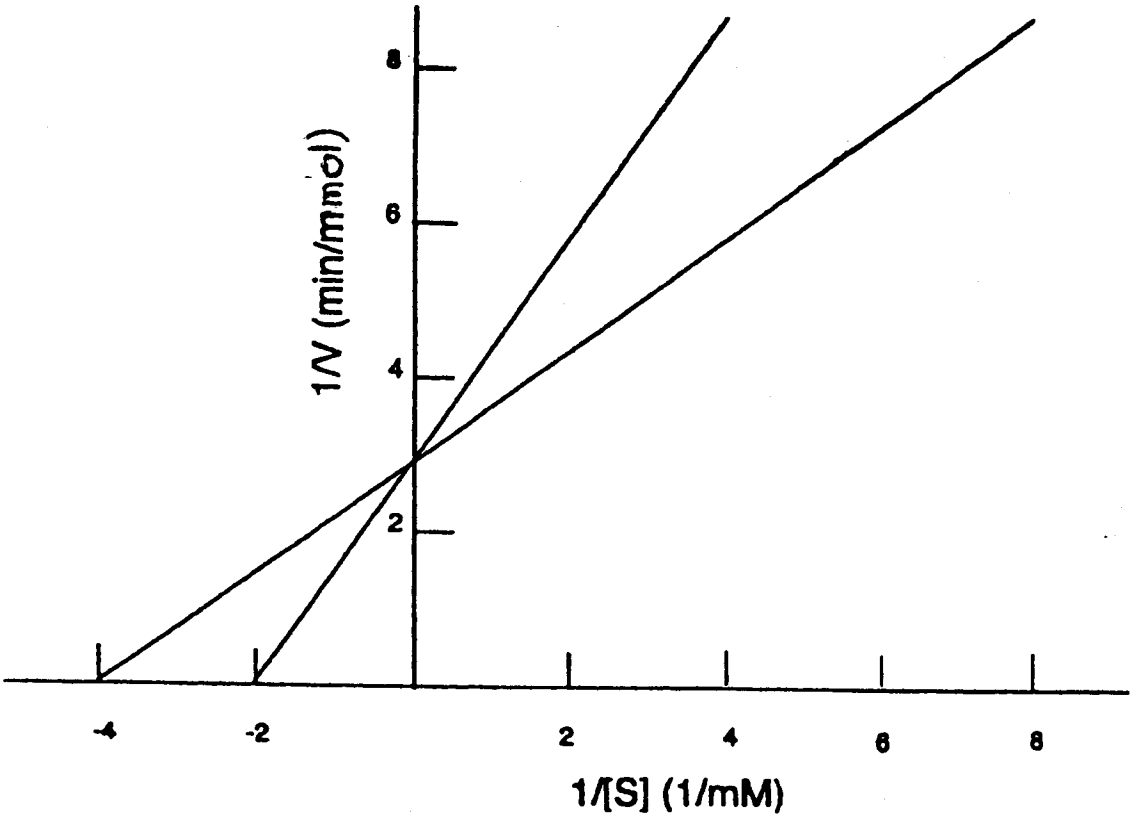
21. Which of the following are true in relation to the Michaelis - Menten equation and its constants?

1) The equation assumes that the system is in a steady state, ie rate of ES formation = rate of ES breakdown
2) The amount of S bound by E at any given time is negligible compared to the total concentration of S.
3) K_M is the substrate concentration at which enzyme velocity is equal to V_{MAX}
4) The affinity of an enzyme for a substrate increases as K_M increases.
5) All enzymes that follow Michaelis - Menten kinetics exhibit a hyperbolic dependence of v on [S]

A) 1 and 2 B) 1, 2 and 3 C) 1, 2, 3 and 4 D) 3, 4 and 5 E) 1, 2 & 5

For questions 22-25 please refer to the following:

The dependence of velocity of an enzyme catalyzed reaction on the substrate concentration was determined and plotted below using a double reciprocal plot. Its dependence was then determined in the presence an inhibitor and plotted below. Answer the following questions.



22. What is the value of Km in units of mM for the substrate used in this assay?

A) 4 B) 0.25 C) 0.33 D) 0.5 E) Cannot be determined

23. What is the value of V_{max} in units of mmol/min?

A) 0.5 B) 0.33 C) 3 D) 0.25 E) Cannot be determined.

24. What type of inhibition is displayed by the inhibitor?

A) Competitive B) Noncompetitive C) Mixed D) Uncompetitive E) Impossible to deduce

25. Using the answers you have calculated for questions 22 and 23, calculate the velocity (in mmol/min) of the reaction at a substrate concentration of 0.05 mM and in the absence of the inhibitor. The velocity is:

A) 0.075 B) 0.055 C) 18.20 D) 0.028 E) 9.10