

THE UNIVERSITY OF MANITOBA

DATE: Oct. 23, 2001

Midterm EXAMINATION

PAPER NO.:

PAGE NO.: 1 of 5

DEPARTMENT & COURSE NO.: 2.277/60.277

Time: 1 HOURS

EXAMINATION: Elements of Biochemistry I

EXAMINER: Drs. 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.

1. Which of the following amino acids does **not** have a methyl (-CH₃) group in its side-chain?
A) valine B) tryptophan C) leucine D) alanine E) isoleucine

2. 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.

3. A 10 mL sample of HCl solution requires 14.4 mL of 0.05M NaOH solution for complete titration. What is the concentration of the HCl?
A) 0.05M B) 0.072M C) 0.036M D) 0.72M E) 0.144M

4. X mL of 1M HCl solution was added to a solution containing 0.1 mol of a weak acid (pK_a 4.76) and 0.1 mol of its conjugate base. After mixing, the pH was found to be 4.28. The value of X is:
A) 0.5 mL B) 5 mL C) 25 mL D) 50 mL E) 100mL

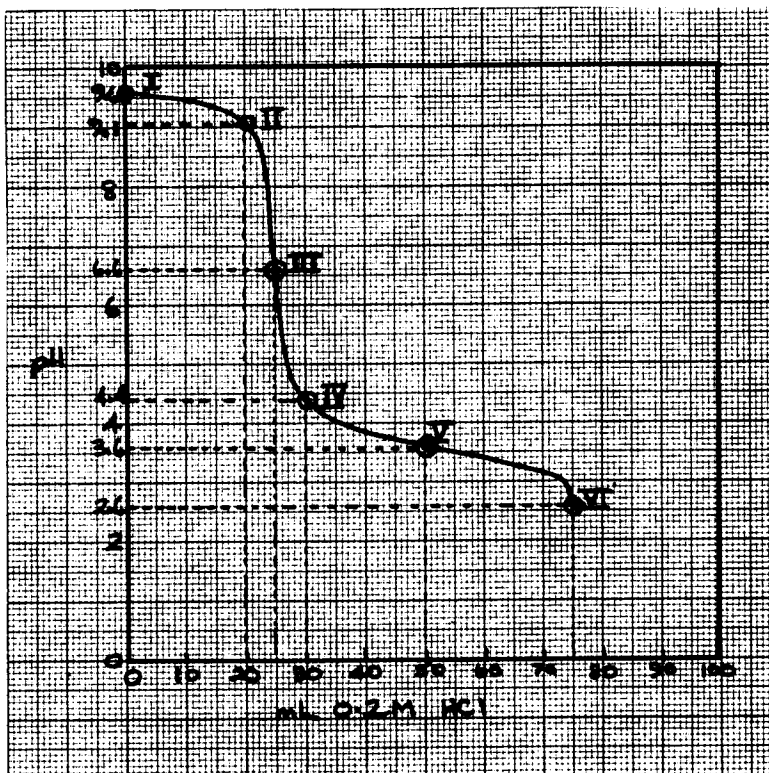
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For questions 5, 6, 7 and 8 refer to the following

100 mL of 0.1 M aspartate solution, pH 9.6, was titrated with 0.2 M HCl until the pH of the solution was reduced to pH 2.6. The pK_a values for aspartate are 1.6, 3.6 (R-group) and 9.6.

The results are plotted on the graph shown below where certain points in the titration are designated I to VI



5. At what point does the pI of aspartate occur?
A) II B) III C) IV D) V E) VI
6. At what point is the average net charge of aspartate -1?
A) I B) II C) III D) V E) VI
7. At what point is the R-group carboxyl of half the molecules ionized?
A) I B) II C) IV D) V E) VI
8. If the titration were continued beyond the end of the graph shown above, how many mL of 0.2 M HCl would have been added in total in order to titrate to a point where the aspartate has a charge of +1 ?
A) 25 B) 50 C) 75 D) 100 E) 125

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9. To 50 mL of a 0.1M solution of isoleucine at $\text{pH}=\text{pK}_a$ for its amino group, was added X mL of 0.05M HCl. The new pH was found to be equal to the pK_a for its carboxyl group. What is the value of X?
- A) 12.5 mL B) 25 mL C) 50 mL D) 100 mL
E) the problem cannot be solved without knowing the pK_a values.
10. The regular folding pattern of adjacent (contiguous) portions of the polypeptide chain is called ?
- A) primary structure B) secondary structure C) tertiary structure
D) quaternary structure E) covalent structure
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 $>\text{C}=\text{O}$ group causes steric hindrance
B) the H in the $>\text{N}-\text{H}$ group is small
C) free rotation is not possible around the bond between the alpha carbon and the carbonyl ($>\text{C}=\text{O}$) carbon
D) the C-N bond has partial double bond character
E) H-bonds can form with polar amino acid R-groups
13. 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.
14. Which of the following does NOT contribute to the formation and stability of tertiary structure in proteins?
- A) electrostatic interaction between amino acid R-groups
B) entropy increase resulting from a decrease in the number of ordered water molecules forming a solvent shell ("cage") around non-polar amino acid R-groups
C) formation of disulfide bonds
D) formation of covalent bonds between amino acid R-groups containing -OH groups
E) Van der Waal's forces
15. The polypeptide backbone in the beta-sheet conformation is ?
- A) in an extended zig-zag structure B) a right handed helix C) a double helix
D) a left-handed helix E) a randomly coiled structure

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16. 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) About half the peptide bonds in an alpha helix are involved in H-bonding
 - 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) 2, 3 & 5 E) 3 & 4
17. Which of the following statements about protein structure is true?
- A) proteins are generally loosely structured
 - B) In water-soluble proteins, hydrophobic (non-polar) amino acid side chains are usually buried and not exposed to water
 - C) In water-soluble proteins, hydrophilic (polar) amino acid side chains are usually buried and not exposed to water
 - D) proteins that contain beta sheet regions always also contain regions of alpha helix
 - E) fibrous proteins are always exclusively alpha helical
18. Hydrophobic interactions most likely occur between which of the following R groups in amino acids?
- | | |
|----------------------------------|------------------|
| (1) Tyrosine and glycine | A) 1, 2, 3 and 4 |
| (2) Arginine and histidine | B) 3, 4 and 5 |
| (3) Phenylalanine and tryptophan | C) 2 and 3 |
| (4) Valine and asparagine | D) 3 and 5 |
| (5) Alanine and leucine | E) All of them |
19. Beta sheet structure is stabilized primarily by which of the following?
- A) Hydrogen bonds between the peptide bonds of antiparallel polypeptide chains.
 - 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) Van der Waal's forces between adjacent sulfhydryl (-SH) groups.
20. Which of the following are true in relation to the Michaelis-Menten equation and its constants?
- 1) The rate equation assumes that the system is in a steady state, ie $[ES]$ is constant
 - 2) The amount of S bound by E at any given time is equal 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 sigmoidal dependence of v on $[S]$.
- A) 1 B) 1 and 2 C) 1, 2, 3 and 4 D) 3, 4 and 5 E) None of these

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21. A competitive inhibitor will change the kinetic parameters in an enzyme-catalyzed reaction showing simple Michaelis-Menten kinetics as follows:
- A) Increase K_m leaving V_{max} unchanged B) Decrease both K_m and V_{max}
 C) Increase both K_m and V_{max} D) Decrease V_{max} leaving K_m unchanged
 E) Decrease K_m leaving V_{max} unchanged
22. Which of the following are true statements?
- 1) Enzymes increase reaction rates by supplying energy to increase the number of molecules in the transition state.
 2) When an enzyme acts as a catalyst it is able to alter the equilibrium of a reaction so that it always favours the product.
 3) An enzyme brings about an increase in reaction rate by increasing the activation energy required for the reaction.
 4) Small changes in pH (one or two pH units) do not cause any marked changes in enzyme activity.
- A) 1 and 2 B) 1 and 3 C) 3 and 4 D) All are true E) None are true
23. Which of the following statements about enzymes is UNTRUE?
- A) weak, non-covalent, forces are important in the binding between enzyme and substrate
 B) optimal catalysis occurs when the active site binds most strongly with the transition state between the substrate and product
 C) formation of an enzyme-substrate complex increases the entropy of substrates
 D) amino acid R-groups in the active site often participate in enzyme-catalyzed reactions
 E) their catalytic activity is affected by temperature

USE THE FOLLOWING DATA TO ANSWER QUESTIONS 24 AND 25.

An enzyme "X" has K_m for its substrate of 2×10^{-6} M. The reaction catalyzed by this enzyme was carried out at $[S] = 2 \times 10^{-3}$ M, using an appropriate concentration of the enzyme. After 10 min of reaction, 0.1% of the substrate had been consumed and 3.0 micromoles of product had been formed.

24. What would the velocity of the reaction be if it were carried out with $[S] = 2 \times 10^{-6}$ M?
- A) 0.1 micromole/min B) 0.15 micromole/min C) 0.3 micromole/min
 D) 1.5 micromole/min E) 3.0 micromole/min
25. If one sixth as much enzyme and three times as much substrate had been used, how long would it take for the same amount of product (3.0 micromoles) to be formed?
- A) 5 min B) 12 min C) 30 min D) 45 min E) 60 min