

THE UNIVERSITY OF MANITOBA

October 25, 2011

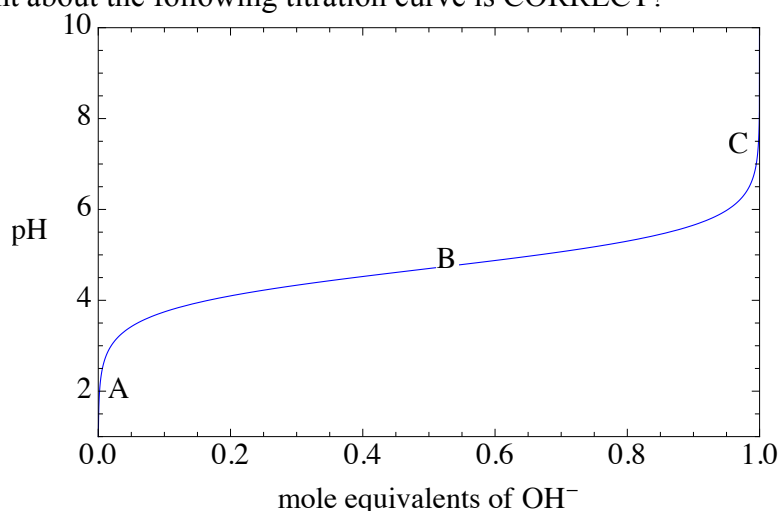
Mid-Term EXAMINATION

PAPER NO: 1 LOCATION: 217 / 221 WallacePAGE NO: 1 of 5DEPARTMENT & COURSE NO: CHEM / MBIO 2770TIME: 1 HOUREXAMINATION: Elements of Biochemistry IEXAMINER: J. O'Neil**Instructions**

- Please mark the Answer Sheet using **PENCIL ONLY**.
- Enter your **NAME** and **STUDENT NUMBER** on the Answer Sheet.
- The exam consists of multiple-choice questions. Enter your answers on the Answer Sheet.
- There is only 1 correct answer for each question.
- **PLEASE READ ALL THE QUESTIONS CAREFULLY!**

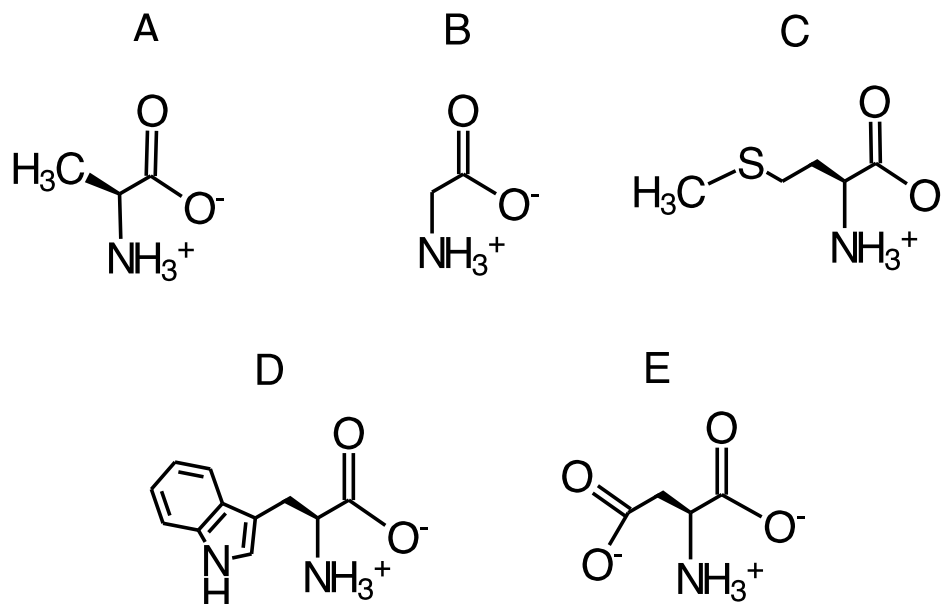
1. Ice melts spontaneously at room temperature
 - A) because the entropy of water is greater than the entropy of ice.
 - B) despite the fact that its free energy change is positive.
 - C) because ice is less ordered than liquid water.
 - D) because heat naturally flows from a cold body.
 - E) in order to maximize the enthalpy content of the ice.
2. If the free energy change ΔG for a reaction is +7.5 kJ/mol, the reaction is:
 - A) at equilibrium.
 - B) up the free energy hill.
 - C) down the enthalpy hill.
 - D) exergonic.
 - E) exothermic.
3. Which list correctly ranks bond strength?
 - A) Covalent > van der Waal's > H-bond.
 - B) Van der Waal's > H-bond > Electrostatic
 - C) Electrostatic > Van der Waal's > H-bond.
 - D) Double covalent > H-bond > Van der Waal's.
 - E) Covalent > Triple covalent > Van der Waal's.
4. The First Law of Thermodynamics states:
 - A) Proteins fold in order to maximize their free energy.
 - B) The universe tends to become less disordered over time.
 - C) The entropy of the universe increases.
 - D) Energy is the capacity of a system to do work or release heat.
 - E) The energy of the universe is constant.
5. Identify the **CORRECT** statement about hydrogen bonding.
 - A) It is a covalent attraction between polarized molecules containing O-H, N-H, or F-H.
 - B) It is strongest when at a 90 degree angle.
 - C) NH is a good H-bond acceptor.
 - D) A H-bond is about 28 nm in length.
 - E) C=O is a good H-bond acceptor.

6. Which statement about the following titration curve is CORRECT?



- A) Point "A" is the good buffering region.
- B) The pK_a of the compound is about 6.
- C) At point "C" the fraction of conjugate base is high.
- D) At point "B" the compound exists mainly in the weak acid form.
- E) The compound being titrated is an amino acid.
7. 25 mL of 0.1 M HNO_3 (a strong acid) solution is added to 200 mL of pure water. What is the pH of the resulting solution?
- A) 2.95
- B) 2.60
- C) 1.95
- D) $10^{-0.025}$
- E) 1.0
8. Fever, lack of oxygen, salicylate poisoning, liver and lung disease can lead to alkalosis, a condition in which the pH of body fluids rises above 7.8. How much more acid is present in normal fluid at pH 7.4 compared to alkaline fluid at pH 8.0?
- A) 0.6
- B) 2
- C) 4
- D) 6
- E) 10.
9. Pulmonary problems, head trauma, anesthetics, and brain tumours can lead to respiratory acidosis caused by build-up of CO_2 in the blood. The main buffer in blood is H_2CO_3 / HCO_3^- . If the K_a of H_2CO_3 is 8.1×10^{-7} what is its pK_a ?
- A) It is impossible to calculate without knowing the pH.
- B) 8.8
- C) 6.1
- D) 5.09
- E) 1.1
10. A buffer solution is prepared by mixing 50 mL of 0.2 M sodium lactate and 50 mL of 0.4 M lactic acid. The resulting pH of the solution is 3.56. What is the pK_a for lactic acid?
- A) 5.86
- B) 3.56
- C) 4.16
- D) 6.14
- E) 3.86

11. Which amino acid below absorbs ultraviolet light?



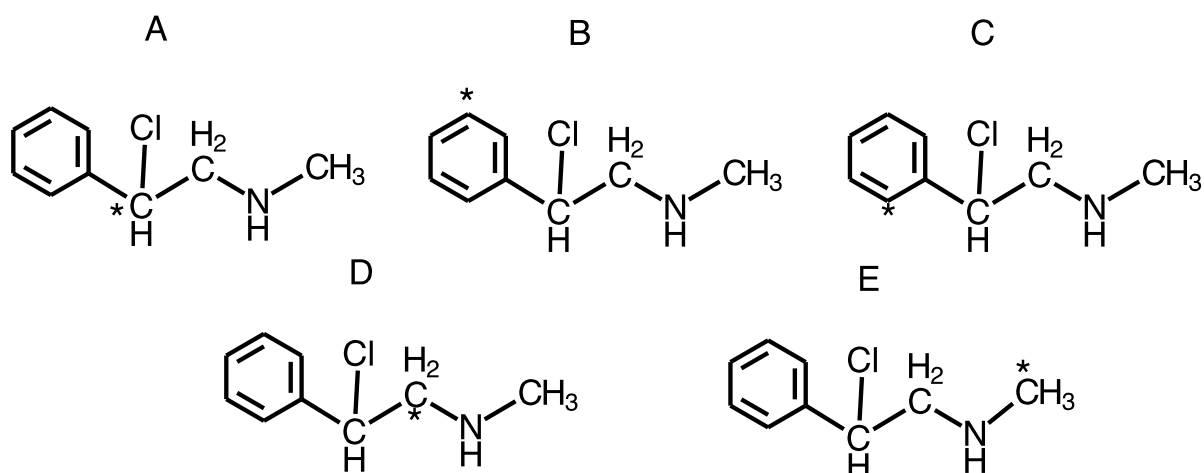
12. Identify the INCORRECT statement:

- A) Leucine and isoleucine are isomers because they can be interconverted by a conformational change.
- B) The α -helix is one possible conformation of a polypeptide.
- C) Peptides can adopt many conformations because of rotation about single covalent bonds.
- D) Unfolding or denaturation of a protein usually leads to a loss of biological activity.
- E) The concept of “*induced fit*” involves a change in the conformation of an enzyme to obtain the proper orientation of the active-site amino acids.

13. Which of the following amino acids contains a hydrophobic side-chain?

- A) Lysine.
- B) Glutamine.
- C) Leucine.
- D) Histidine.
- E) Glycine.

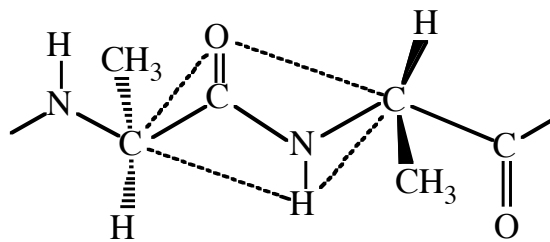
14. Select the diagram below that correctly identifies the chiral carbon with *:



15. X-ray diffraction:

- A) uses X-rays to determine the 3D structure of protein crystals.
- B) uses large magnets to determine the 3D structures of small proteins dissolved in water.
- C) is a technique for separating proteins based on affinity for a ligand.
- D) uses X-rays for determining the sizes of crystalline proteins.
- E) is used to measure protein concentration with the use of Beer’s law.

16. In the diagram below, the plane drawn behind the peptide bond indicates:



- A) the possible torsion angles that can be occupied by the ϕ and ψ angles in the polypeptide.
- B) the plane of rotation around the C_{α} —N bond.
- C) that the peptide is planar, trans, and rigid because of its partial double-bond character.
- D) the region of steric hindrance determined by the large C=O group.
- E) the region of the peptide bond that contributes to a Ramachandran plot.
17. Identify the INCORRECT statement about the β -strand:
- A) The polypeptide is in an extended conformation.
- B) It is located in the upper left quadrant of the Ramachandran diagram.
- C) β -strands often associate by H-bonding to an adjacent β -strand forming a parallel or antiparallel sheet.
- D) Side chains protrude from the sides of a β -sheet.
- E) The side chains may be hydrophilic or hydrophobic.
18. Identify the CORRECT statement about the amino acid sequence of a protein:
- A) Protein folding is a random process unrelated to the sequence of the protein.
- B) A single amino acid change to the sequence of a protein can have no effect on its biological activity.
- C) All 22,000 human proteins have identical sequences in all humans. If not, we would not be human.
- D) The greater the phylogenetic (evolutionary history) difference between 2 species, the greater the number of AA differences in their proteins.
- E) Many different protein sequences fold into a similar conformation giving rise to a large number of structural families.
19. Soft and flexible silk fibroin is composed of:
- A) a triple helix.
- B) antiparallel β -pleated sheets.
- C) a double helix.
- D) a helix-turn-helix motif.
- E) coiled coils.
20. All of the following are considered “weak” interactions in proteins, *except*:
- A) peptide bonds.
- B) hydrogen bonds.
- C) NH---O=C.
- D) ionic bonds.
- E) van der Waals forces.
21. In a mixture of the five proteins listed below, which should electrophorese fastest in SDS-PAGE?
- | | | | | |
|----|---------------------|-------|---|---------|
| A) | cytochrome <i>c</i> | M_r | = | 13,000 |
| B) | immunoglobulin G | M_r | = | 145,000 |
| C) | calmodulin | M_r | = | 16,700 |
| D) | RNA polymerase | M_r | = | 450,000 |
| E) | serum albumin | M_r | = | 68,500 |

22. What factor does NOT explain how enzymes work?
- Enzymes bind specific molecules in their active sites.
 - Enzymes provide special environments where bond breakage and formation is easier.
 - Enzymes lower the free energy of the transition state.
 - Enzymes participate in reactions they catalyse by donating and accepting electrons through their side chains.
 - Enzymes increase the entropy of reactant molecules.
23. Identify the INCORRECT statement about the Michaelis-Menten constant:
- It is equal to $(k_{-1} + k_2) / k_1$.
 - It is numerically equal to the [ES] at $\frac{1}{2} V_{\max}$.
 - It is numerically equal to the [S] at $\frac{1}{2} V_{\max}$.
 - It is equal to the ES dissociation constant when $k_2 \ll k_{-1}$.
 - It equals the product of V_{\max} and the slope of a graph of $1/V_0$ vs $1/[S]$.
24. For any enzyme that follows simple Michaelis-Menten kinetics, when the initial Velocity of the reaction is 80% of V_{\max} what is the Substrate concentration?
- $[S] = \frac{1}{2}K_m$
 - $[S] \ll K_m$
 - $[S] = K_m$
 - $[S] = 4K_m$
 - $[S] = 0.8K_m$

25. The following data were obtained in a study of an enzyme known to follow Michaelis-Menten kinetics:

V_0 ($\mu\text{mol}/\text{min}$)	Substrate added (mM)
0.66	0.005
3.04	0.025
5.0	0.050
16.0	0.25
25.4	1.0
31.6	2.5

The V_{\max} and K_m for this enzyme are approximately:

- 25 $\mu\text{mol}/\text{min}$ and 0.005 mM.
- 32 $\mu\text{mol}/\text{min}$ and 0.25 mM.
- 16 $\mu\text{mol}/\text{min}$ and 0.25 mM.
- 5 mmol/min and 0.005 mM.
- 0.66 mmol/min and 2.5 mM.

SCRATCH