THE UNIVERSITY OF MANITOBA

October 21, 2008 Mid-Term EXAMINATION

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DEPARTMENT & COURSE NO: CHEM / MBIO 2770 TIME: 1 HOUR

EXAMINATION: Elements of Biochemistry I EXAMINER: 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 QUESTIONS CAREFULLY!*

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1. If the free energy change ΔG^o for a reaction is 0 kJ/mol, the reaction is:
   - A) Endergonic.
   - B) At equilibrium.
   - C) Endothermic.
   - D) Exergonic.
   - E) Exothermic.

2. Identify the correct statement about the free energy of a reaction ΔG^o.
   - A) It is a constant of the reaction unaffected by temperature.
   - B) There is no situation in which energy is free as there is always a price to pay for every reaction.
   - C) It depends on the pathway that the reaction follows
   - D) It is the difference between the enthalpy of the reaction and its entropy multiplied by the absolute temperature.
   - E) It is unrelated to the equilibrium constant K_{eq}.

3. The major essential atoms found in all life forms are:
   - A) Calcium, hydrogen, oxygen, and sodium.
   - B) Calcium, carbon, helium, hydrogen, iron, and oxygen.
   - C) Beryllium, calcium, nitrogen, oxygen, and silicon.
   - D) Carbon, iron, nitrogen, oxygen, and sodium.
   - E) Carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulphur.

4. Saturated hydrocarbons:
   - A) Are molecules rich in C-C and C-H covalent bonds.
   - B) Are amino acids that absorb ultraviolet light because of electron delocalization.
   - C) Are polar molecules rich in hydrogen bond donors.
   - D) Contain many polar C-O bonds.
   - E) Are molecules rich in C=C and C=N double covalent bonds.

5. Human saliva at pH 6.3 contains about ___ times as much H^+ as human blood at pH 7.4.
   - A) 1.1
   - B) 12.6
   - C) 3.0
   - D) 1.17
   - E) $10^{-1.1}$

6. $pH = pK_a$ when:
   - A) $\log([A^-]/[HA]) = 1$
   - B) $[A^-]/[HA] = 0$
   - C) $\log([HA]/[A^-]) = 1$
   - D) $[A^-] >> [HA]$
   - E) $[HA] = [A^-]$

7. To 5000 mL of a 0.1 M solution of threonine at pH = pK_a for its amino group was added X mL of 0.5 M HCl. The new pH was found to be equal to the pK_a for its carboxyl group. What is the value of X?

A) 1.0 L
B) 5000 mL
C) 2500 mL
D) 5 L
E) The problem cannot be solved without knowing the pK_a values.

8. 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

9. 10 mL of 0.1 M NaOH were added to 6 mL of 0.2 M lactic acid. No lactate is present. The K_a for lactic acid is 1.41×10^{-4}. What is the new pH of the solution?

A) 3.55
B) 3.85
C) 4.15
D) 4.54
E) Insufficient information is provided.

10. What is the pH of a histidine solution in which the α-COOH group (pK_a 1.8) is three-quarters dissociated?

A) 1.3
B) 1.8
C) 2.3
D) 3.2
E) The problem cannot be solved without knowing the pK_a value of the amino group.

11. The amino acid with a side-chain pK_a near neutrality and which therefore plays an important role as proton donor and acceptor in many enzyme-catalyzed reactions is:

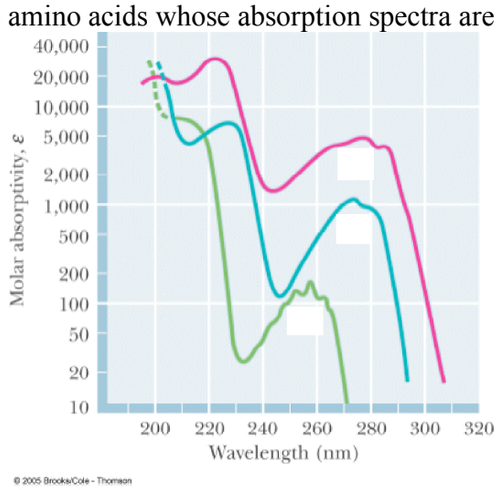
A) Glutamine
B) Histidine
C) Serine
D) Methionine
E) Proline

12. Which of the following amino acid side-chains will interact through a hydrophobic interaction?:

i. Glutamic acid and aspartic acid.
ii. Glutamine and asparagine.
iii. Leucine and valine.
iv. Histidine and lysine.
v. Glycine and glutamine.

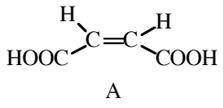
A) v.
B) ii and iv.
C) i and iv.
D) iii.
E) None of the above are incorrect.

13. Identify the three amino acids whose absorption spectra are shown below:

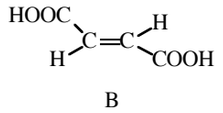


A) Glu, Gln, Gly
B) Trp, Tyr, Phe
C) Arg, His, Lys
D) Leu, Ile, Val
E) Pro, His, Ala

14. Molecules A and B are:



A



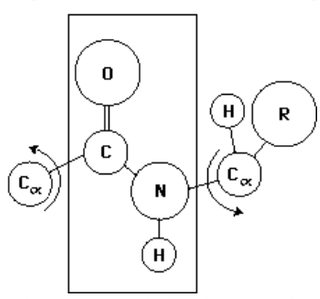
B

A) Moronic acid and Fumaric acid.
B) Non- superimposable mirror images.
C) Dextrorotatory and levorotatory.
D) Epimers at C2.
E) Stereoisomers but not enantiomers.

15. Quaternary structure is associated with which of the following?
A) The sum of the primary and tertiary interactions.
B) The relative orientation of one polypeptide to another polypeptide in a multi-subunit protein.
C) The right or left-handedness of the α-helical twist.
D) The overall shape of a polypeptide chain.
E) Simple proteins with only one subunit.

16. β-sheet structure is stabilized primarily by which of the following?
A) Van der Waals forces between adjacent SH groups of Cys.
B) Hydrogen bonding between the side-chains.
C) Hydrogen bonds between the peptide groups of parallel or anti-parallel chains.
D) Hydrophobic interactions between the α-H of the polypeptide backbone.
E) Electrostatic interactions between side-chains.

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



A) Plane of rotation around the C_α—N bond.
B) Absence of rotation around the C—N bond because of its partial double-bond character.
C) Region of steric hindrance determined by the large C=O group.
D) Region of the peptide bond that contributes to a Ramachandran plot.
E) Theoretical space between –180 and +180 degrees that can be occupied by the ϕ and ψ angles in the peptide bond.

18. Which of the following best represents the backbone arrangement of two peptide bonds?
    A) N—C_α—C—C_α—N—C_α—C
    B) N—C—C—N—C_α—C_α—N
    C) N—C_α—C_α—C—N —C_α—C_α
    D) N—C_α—C—N—C_α—C—N
    E) N—C_α—C_α—C—N—C_α—C

19. All of the following are considered "weak" interactions in proteins, *except:*
    A) Disulphide bonds.
    B) Electrostatic repulsions.
    C) Electrostatic attractions.
    D) Hydrogen bonds.
    E) Van der Waals forces.

20. Which amino acid acts as a helix breaker due to steric interactions between its side-chain and the carbonyl of the preceding amino acid?
    A) Glycine
    B) Tyrosine
    C) Arginine
    D) Serine
    E) Proline

21. Which statement about fibrous proteins is INCORRECT:
    A) They are globular containing hydrophobic groups on their interiors and hydrophilic groups on their exteriors.
    B) They contain a quaternary arrangement of polypeptides.
    C) The sequence Gly-Xxx-Pro is repeated over and over in collagen fibres.
    D) Fibroin is a soft material made of stacked β-sheets.
    E) α-keratin is a tough insoluble fibre made of two right-handed α-helices.

22. AMP is an activator of allosteric Phosphofructokinase. It:
    A) Increases the number of T conformations.
    B) Causes a shift to the right in the sigmoid V_o *vs.* [S] curve.
    C) Stabilizes the T-state, increasing $S_{0.5}$, and making the curve less sigmoid.
    D) Decreases the cooperativity of the substrate.
    E) Stabilizes the R-state, decreasing $S_{0.5}$, and making the curve more sigmoid.

23. Which of the following are correct regarding enzymes that follow Michaelis-Menten kinetics.
    A) The Michaelis constant, K_M, is the substrate concentration at which the enzyme initial velocity is equal to its maximum velocity.
    B) The enzymes are consumed during the reaction.
    C) The affinity of the enzyme for substrate increases as the K_M increases.
    D) The graph of substrate concentration *vs*. initial velocity is sigmoid.
    E) None of the above are correct.

24. Zymogens are:
    A) Organic co-enzymes.
    B) Allosteric enzyme activators.
    C) Enzymes activated by proteolytic cleavage.
    D) Non-competitive enzyme inhibitors.
    E) Metallic co-enzymes.

25. For an enzyme that follows simple Michaelis-Menten kinetics what is the initial velocity of the reaction at a substrate concentration of $7x10^{-3}$ M, if the K_M of the enzyme is $3x10^{-4}$ M and its V_{max} is 22 μmoles/litre/min?

    A) 1 μmoles/litre/min.
    B) 2.6 μmoles/litre/min.
    C) 3.1 μmoles/litre/min.
    D) 14 μmoles/litre/min.
    E) 21 μmoles/litre/min.