THE UNIVERSITY OF MANITOBA

October 24, 2006 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. An organized network of reactions that degrade molecules and release free energy is best described by the word:

   A) metabolism
   B) condensation
   C) catabolism
   D) anabolism
   E) canabolism

2. Which statement about the hydrophobic effect is NOT correct?

   A) It is a major driving force in the folding of proteins.
   B) An organized water cage forms around non-polar hydrocarbons.
   C) It is explained primarily in terms of hydrocarbon enthalpy.
   D) It is explained primarily in terms of water entropy.
   E) It is a major driving force in the formation of detergent micelles.

3. A definition of pH is:

   A) The power of H.
   B) $pH = -\ln_e[H^+]$.
   C) $pK_A = -\log_{10}[K_A]$
   D) H is enthalpy, the heat energy at constant temperature, pressure, and volume.
   E) $pH = -\log_{10}[H^+]$

4. A plasma pH of 6.8 doesn't seem too far away from a normal pH of 7.4, but at pH 6.8 the H^+ concentration is ___ times greater than at pH 7.4, and results in severe acidosis.

   A) 0.1
   B) 0.6
   C) 4
   D) 10.0
   E) 20

5. A buffer solution is prepared by mixing 100 mL of 0.6 M sodium acetate and 200 mL of 0.2 M acetic acid. What is the pH of the buffer solution prepared? (pK_a for acetic acid = 4.76

   A) 4.94
   B) 4.76
   C) 4.58
   D) 5.23
   E) 4.28

6. Titration of asparagine by a strong base, for example NaOH, reveals two *pK's*. The titration reaction occurring at pK_2 (pK_2 = 8.8) is:

A) $—NH_2 + OH^- \rightarrow —NH^- + H_2O$
B) $—COOH + —NH_2 \rightarrow —COO^- + —NH_2^+$
C) $—COO^- + —NH_2^+ \rightarrow —COOH + —NH_2$
D) $—NH_3^+ + OH^- \rightarrow —NH_2 + H_2O$
E) $—COOH + OH^- \rightarrow —COO^- + H_2O$

7. What is the pH of a serine solution in which the α-NH_3^+ group (pKa 9.2) is one-third dissociated?

A) 8.7
B) 8.9
C) 9.0
D) 9.5
E) The problem cannot be solved without knowing the pK_a value of the carboxyl group.

8. 75 mL of 0.2 M NaOH were added to 100 mL of 0.1M aspartate solution, *pH=pI*. What is the new pH? pK_a values for aspartate are 1.88, 3.65 (R-group) and 9.60.

A) 1.40
B) 4.13
C) 6.62
D) 2.76
E) 9.60

9. The amino acid that contains a sulfur atom in its side chain and can form disulphide bonds is:

A) cysteine
B) methionine
C) serine
D) histidine
E) proline

10. 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) cysteine
B) methionine
C) serine
D) histidine
E) proline

11. Which of the peptides would absorb light at 280 nm?

A) ala-lys-his
B) ala-ala-trp
C) ser-gly-asn
D) val-pro-leu
E) ser-val-ile

12. Reaction of the peptide, ala-met-lys-ser, with phenylisothiocyanate (PITC) at pH 8.0 followed by mild acidification (first cycle of Edman method) would release:

A) The labeled peptide ala-met-lys-ser-PTH.
B) PTH-ala, PTH-ser, PTH-lys and PTH-met.
C) PTH-ser and the peptide ala-met-lys.
D) PTH-ala and the peptide met-lys-ser.
E) The amino acid ser and the peptide ala-met-lys.

13. In an aqueous solution, protein conformation is determined by two major factors. One is the formation of the maximum number of hydrogen bonds. The other is:

A) Maximization of ionic interactions.
B) Minimization of entropy by the formation of a water solvent shell around the protein.
C) Formation of the maximum number of hydrophilic interactions.
D) Placement of polar amino acid residues around the exterior of the protein.
E) Placement of hydrophobic amino acid residues within the interior of the protein.

14. All of the following are considered "weak" interactions in proteins, except:

A) ionic bonds
B) peptide bonds
C) hydrophobic interactions
D) hydrogen bonds
E) van der Waals forces

15. Which of the following correctly depicts intrachain H-bonding in the alpha helix?

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

16. In the beta pleated-sheet, the R-groups of the amino acids ___?

A) Cause only anti-parallel sheets to form.
B) Lie in the plane of the sheet.
C) Generate H-bonds to stabilize the sheet.
D) Are found above and below the plane of the sheet.
E) Stack within the interior of the helix.

17. By adding SDS (sodium dodecyl sulfate) during the electrophoresis of proteins, it is possible to:

A) Determine a protein's isoelectric point.
B) Determine an enzyme's specific activity.
C) Determine the amino acid composition of the protein.
D) Preserve a protein's native structure and biological activity.
E) Separate proteins exclusively on the basis of molecular weight.

18. Which of the following is *least* likely to result in protein denaturation?

A) Changing the salt concentration.
B) Altering net charge by changing *pH*.
C) Disruption of weak interactions by boiling.
D) Exposure to detergents.
E) Mixing with organic solvents such as acetone.

19. The protein fibroin is composed of:

A) β-pleated sheet
B) triple helix
C) helix-turn-helix motif
D) coiled coils
E) double helix

20. Which of the following is a correct statement about K_m for an enzyme-catalyzed reaction showing a hyperbolic V_0 versus *[S]* curve?

A) The rate of reaction is equal to K_m multiplied by V_{max}.
B) K_m for the substrate is decreased in the presence of a competitive inhibitor.
C) The enzyme's active site is saturated with substrate when $[S] = K_m$.
D) The larger the K_m the more strongly the substrate binds to the enzyme.
E) If two different substrates can bind to the same active site, the substrate with the smaller K_m will bind more strongly.

21. For the following irreversible reaction, the relationship between activation energy and the rate constant of the reaction can be found by using which of the following equations.

$$A \rightarrow P$$

A) $k = \frac{k_B \bullet T}{h} \bullet e^{(-\Delta G^{\dagger}/R \bullet T)}$
B) $\Delta G^o = -RT \bullet \ln_e(K_{eq})$
C) $K_m = \frac{k_{-1} + k_2}{k_1}$
D) $V = \frac{d[P]}{dt} = -\frac{d[S]}{dt}$
E) $V_0 = \frac{V_{\max}[S]}{[S] + K_m}$

22. Enzymes are biological catalysts that enhance the rate of a reaction by:

A) Binding tightly to the substrate transition state.
B) Decreasing the amount of free energy released.
C) Releasing the product as quickly as possible.
D) Altering the reaction equilibrium.
E) Increasing the energy of the transition state.

23. Which statement correctly describes the flow of electrons during the hydrolysis of a peptide bond by chymotrypsin?

A) Electrons flow from the catalytic triad into the amide nitrogen of the substrate.
B) The enzyme behaves as both an acid- and base-catalyst.
C) Electrons do not flow during enzyme catalyzed reactions.
D) Electrons flow out of the substrate and into the enzyme, and then back again.
E) The enzyme behaves as a base-catalyst only.

24. For an enzyme which follows simple Michaelis-Menten kinetics, what is the V_{max} if V_0 = 15 micromol/s when $[S] = K_m$.

A) 1.5 s
B) 15 s
C) 30 s
D) 150 s
E) 15 min

25. An enzyme has a K_m for its substrate of 1×10^{-6} M. In one experiment, the initial velocity of the reaction catalyzed by the enzyme was measured at a substrate concentration of 1×10^{-3} M and was found to be 3.5×10^{-5} moles per litre per second. What would the rate of reaction have been if the substrate concentration had been 1×10^{-6} M?

A) 3.5×10^{-5} moles per litre per second
B) 35×10^{-5} moles per litre per second
C) 1.75×10^{-5} moles per litre per second
D) 1×10^{-6} moles per litre per second
E) 1×10^{-3} moles per litre per second