THE UNIVERSITY OF MANITOBA

October 23, 2012 Mid-Term EXAMINATION

PAPER NO: _1_ LOCATION: 224 / 290 Education PAGE NO: 1 of 5

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 THE QUESTIONS CAREFULLY!*
- *The last page is scratch paper.*

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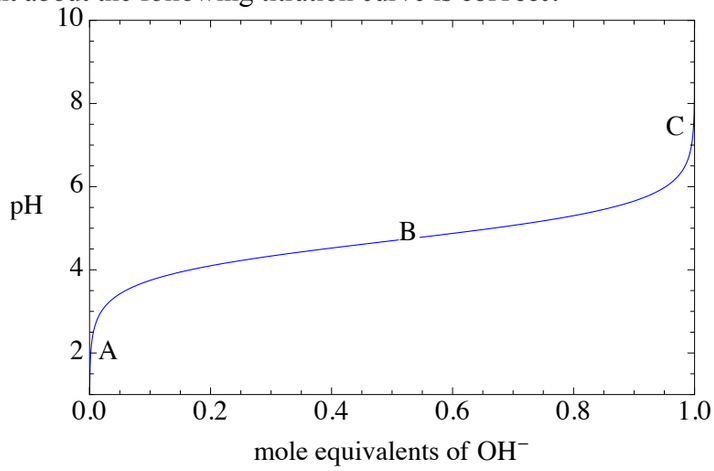
1. The Second Law of thermodynamics states:
   - A) the energy of the universe becomes more concentrated over time.
   - B) the entropy of the universe increases.
   - C) like dissolves like.
   - D) heat naturally flows from a cold body to a hot body.
   - E) the energy of the universe is constant.

2. If the enthalpy and entropy of a reaction are positive
   - A) the reaction is at equilibrium.
   - B) the reaction will proceed from reactants to products.
   - C) the reaction will proceed from products to reactants.
   - D) the direction of the reaction cannot be predicted.
   - E) the reaction is exergonic.

3. Which statement about covalent bonds is **incorrect**:
   - A) The single covalent bond between C and O is longer that the double covalent bond between C and O.
   - B) Covalent bonds are stronger than H-bonds.
   - C) Covalent bonds usually require hundreds of kJ to break.
   - D) Covalent bonds involve the sharing of a H atom between electronegative atoms.
   - E) Covalent bonds are stronger than van der Waal's attractions.

4. Identify the **correct** statement about the van der Waal's interaction.
   - A) It is an induced dipole attraction.
   - B) It is a covalent attraction between polarized molecules containing O-H, N-H, or F-H.
   - C) It is formed between oppositely-charge ions.
   - D) It is the same as a hydrophobic interaction.
   - E) It explains why ice is less dense than liquid water.

5. Which statement about the following titration curve is **correct**?



A) The compound being titrated is an amino acid.
B) Point "B" is the good buffering region.
C) The pK_a of the compound is about 2.
D) At point "C" the fraction of conjugate base is low.
E) At point "B" the compound exists mainly in the weak acid form.

6. The pH of milk is about 6.6. What is the hydroxide ion concentration?
A) 2.51×10^{-7} M
B) 3.98×10^{6} M
C) 3.98×10^{-8} M
D) 2.51×10^{7} M
E) $1.0 \times 10^{-6.6}$ M

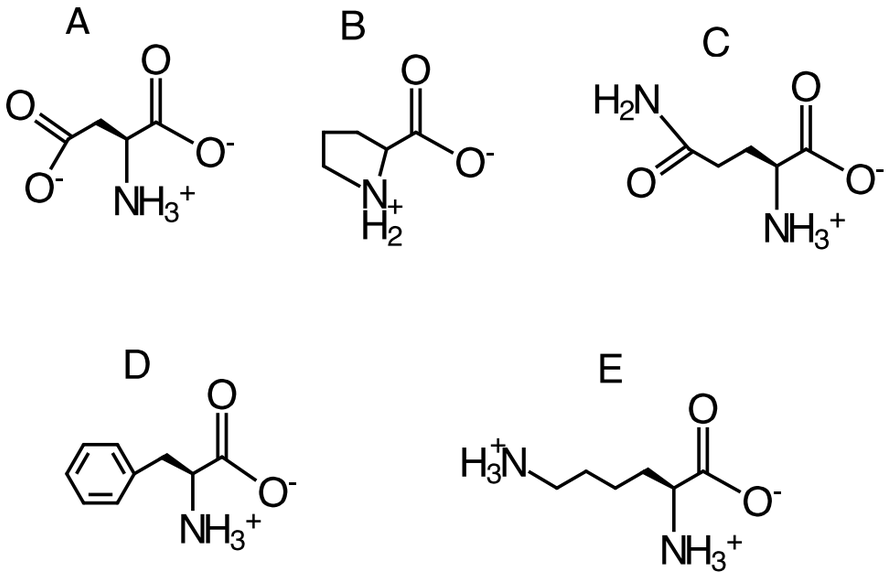
7. 0.2 moles of NaOH were added to a solution containing 0.4 moles of a weak acid and 0.4 moles of its conjugate base. After mixing, the pH of the solution was found to be 5.24. What is the pK_a of the weak acid?
A) 4.76
B) 4.94
C) 5.72
D) 5.76
E) 5.24

8. Proteins, DNA, RNA, polysaccharides, and lipids are degraded in organelles called *lysosomes* that contain about 50 different enzymes. The pH of the lysosome is about 5. How much more acid is present in a cell lysosome compared to the cytoplasm where the pH is 7.2?
A) 6.3×10^{-3}
B) 2.2
C) 0.45
D) 50
E) 158

9. Histamine, synthesized by basophils and mast cells, is involved in regulating the immune response and inflammation. What is the pH of a solution of histamine in which the imidazole group, having a pK_a of 5.80, is 85% dissociated?
A) 5.05
B) 6.55
C) 5.73
D) 5.87
E) 5.80

10. The pancreatic enzyme *lipase* has a pH optimum of about 8.0. What would be the buffer of choice to study this enzyme?
A) succinate ($K_a = 2.34 \times 10^{-6}$)
B) lactic acid ($K_a = 1.38 \times 10^{-4}$)
C) tris-hydroxymethyl aminomethane ($K_a = 8.32 \times 10^{-9}$)
D) bicarbonate ($K_a = 6.3 \times 10^{-11}$)
E) boric acid ($K_a = 5.75 \times 10^{-10}$)

11. Which amino acid below has a side-chain pK_a above 10?



12. Identify the **correct** statement:
    - A) Aspartame is a sugar.
    - B) Aspartic acid is 150x sweeter than sugar.
    - C) Aspartame contains a basic side-chain.
    - D) Aspartame is a dipeptide.
    - E) Aspartame contains 3 chiral carbons.

13. Identify the **incorrect** statement regarding ion exchange chromatography of amino acids:
    - A) Sulfonic acid is a strong acid and is anionic at pH 2 whereas all amino acids are cationic.
    - B) A mixture of AA is applied in a buffer at pH 2 and bind to the sulfonic acid.
    - C) The AA are removed by washing the beads with buffers at higher pH.
    - D) When the pH reaches the pI of an AA it unbinds from the beads and washes out of the column.
    - E) The basic amino acids elute from the column first.

14. In a mixture of the five proteins listed below, which should elute first in gel-sieving (size-exclusion) chromatography?

A)	cytochrome *c*	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

15. Reaction of the peptide, Val-Lys-Leu-Met, with phenylisothiocyanate (PITC) at pH 8.0 followed by mild acidification (first cycle of Edman method) would release:

    - A) The dipeptides Val-Lys and Leu-Met.
    - B) PTH-Val, PTH-Lys, PTH-Leu and PTH-Met.
    - C) PTH-Met and the peptide Val-Lys-Leu.
    - D) The peptide Val-Lys-Leu-Met -PTH.
    - E) PTH-Val and the peptide Lys-Leu-Met.

16. In a Ramachandran diagram _____
    - A) ψ–angles are plotted along the vertical axis and ω–angles are plotted along the horizontal axis.
    - B) α-helices are located in the lower right quadrant.
    - C) β-strands are located in the upper right quadrant.
    - D) quaternary structures are indicated by Greek letters.
    - E) many combinations of ϕ and ψ angles are not allowed because of steric interactions.

17. In an α helix, the side-chains on the amino acid residues _____
    A) alternate between the outside and the inside of the helix.
    B) stack within the interior of the helix.
    C) are found on the outside of the helix spiral.
    D) cause only right-handed helices to form.
    E) generate the hydrogen bonds that form the helix.

18. Collagen _____
    A) is found in hair, feathers, and nails, and is formed by 2 right-handed α-helices that form a left-handed supercoil.
    B) is made from stacked antiparallel β-sheets rich in Gly and Ala that permit close packing of the sheets.
    C) contains Gly-Xxx-Pro repeated over and over.
    D) is strengthened by covalent cross-links between cysteines.
    E) is a globular enzyme containing a metal cofactor.

19. Which statement correctly describes the flow of electrons during the hydrolysis of a peptide bond by chymotrypsin?
    A) Electrons do not flow during enzyme-catalyzed reactions.
    B) Electrons flow from the catalytic triad into the amide nitrogen of the substrate.
    C) The enzyme behaves as a base-catalyst only.
    D) Electrons flow out of the catalytic triad and into the substrate, and then back again.
    E) Electrons flow out of the substrate and into the enzyme, and then back again.

20. The binding site on an enzyme where _____ binds and catalysis occurs is called the _____ site.
    A) Substrate; active
    B) Coenzyme; substrate
    C) Coenzyme; regulatory
    D) Regulatory; active
    E) None of the above

21. What factor does **not** explain how allosteric enzymes work?
    A) Often they are oligomeric proteins.
    B) The subunits can exist in different conformations with low and high affinity for the substrate.
    C) Activators stabilize the low-affinity conformation making the velocity vs substrate concentration curves more sigmoidal.
    D) They exhibit cooperativity in the binding of substrate.
    E) Their initial velocity vs substrate concentration curves are sigmoidal.

22. Which version of the Michaelis-Menton equation is **incorrect**?
    A) $V_0 = \frac{k_{cat}[E_{tot}][S]}{[S] + K_M}$
    B) $V_0 = \frac{V_{\max}[S]}{[S] + k_{cat}}$
    C) $V_0 = \frac{k_2[ES][S]}{[S] + \frac{k_{-1} + k_2}{k_1}}$
    D) $V_0 = \frac{V_{\max}[S]}{[S] + K_M}$
    E) $\frac{1}{V_0} = \frac{K_M}{V_{\max}} * \frac{1}{[S]} + \frac{1}{V_{\max}}$

23. In the absence of a catalyst at 25°C the forward rate constant for the hydration of carbon dioxide is 0.039 $M^{-1}s^{-1}$ and the reverse rate constant is 23 $M^{-1}s^{-1}$. What is the equilibrium constant for this reaction? $H_2O + CO_2 \rightarrow HCO_3^- + H^+$

A) 8.97×10^{-1}.
B) 5.89×10^{2}.
C) 1.69×10^{-3}.
D) 0.897 M.
E) 0.062.

24. An enzyme catalyzes a reaction with an initial velocity of 50 micromoles/litre-seconds when the substrate concentration is 5 micromolar and 80 micromoles/litre-seconds when the substrate concentration is 10 micromolar. The V_{max} and K_m of this enzyme are:

A) 50 micromoles/litre-seconds; 5 micromolar
B) 80 micromoles/litre-seconds; 10 micromolar.
C) 200 micromoles/litre-seconds; 15 micromolar
D) 100 micromoles/litre-seconds; 12.5 micromolar
E) 10 micromoles/litre-seconds; 1 micromolar

25. In the presence of an inhibitor the V_{max} for the enzyme-catalyzed reaction in question 24 remained unchanged but the K_m increased. What type of inhibition was occurring?

A) Competitive.
B) Non-competitive.
C) Uncompetitive.
D) Anticompetitive.
E) Allosteric.

SCRATCH