THE UNIVERSITY OF MANITOBA

October 22, 2013   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

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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.   Plant cells contain a _____ whereas animal cells do not.
      A)   nucleus and cytosol
      B)   plasma membrane and peroxisome
      C)   cell wall and chloroplasts
      D)   Golgi apparatus and vesicles
   E)   mitochondrion and endoplasmic reticulum

2.   Where will a hydroxyl anion (OH^-) attack the following ester?
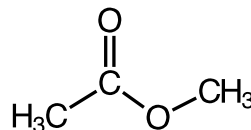
      A)   At the carbonyl oxygen.
      B)   At the carbonyl carbon.
      C)   At one of the methyl carbons.
      D)   At the ester oxygen.
      E)   At one of the methyl hydrogens.

3.   Virtually all life on earth depends on energy ultimately from _____
      A)   hydroelectric power
      B)   activation energy.
      C) CO_2 and global warming.
      D)   the sun.
      E)   enthalpy

4.   In detergent micelles _____
      A)   the hydrocarbon tails are excluded from water and associate with each other.
      B)   the polar head groups form hydrophobic interactions with water.
      C)   the nonpolar tails interact with water through H-bonding.
      D)   the hydrocarbon tails are made from amino acids.
      E)   the polar heads are hydrophobic and the nonpolar tails are hydrophilic.

5.   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)   If the equilibrium constant is 1 then ΔG^o is 0.
      D)   It depends on the pathway that the reaction follows.
      E)   It is unrelated to the equilibrium constant K_{eq}.

6. Identify the **incorrect** statement about work.
   A) Enthalpy released can be used to do work in a system.
   B) A system moving from low entropy to high entropy permits work to be done.
   C) The Gibb's Free Energy is the energy available to do work in a system.
   D) Energy is the capacity of a system to do work or release heat.
   E) Increasing the order of a system allows work to be done.

7. 225 mL of 0.05 M HCl solution is added to 1 L of pure water. What is the pH of the resulting solution?
   A) 1.95
   B) 2.04
   C) 3.65
   D) 5.00
   E) 6.53

8. Lemon juice and vinegar are about 100 times more acidic than tomato juice. If tomato juice has a pH of 4.2 what is the pH of lemon juice?
   A) $1.0 \times 10^{-4.2}$
   B) 1.2
   C) 2.2
   D) 3.2
   E) 5.4

9. Which statement about the following titration curve is **correct**?
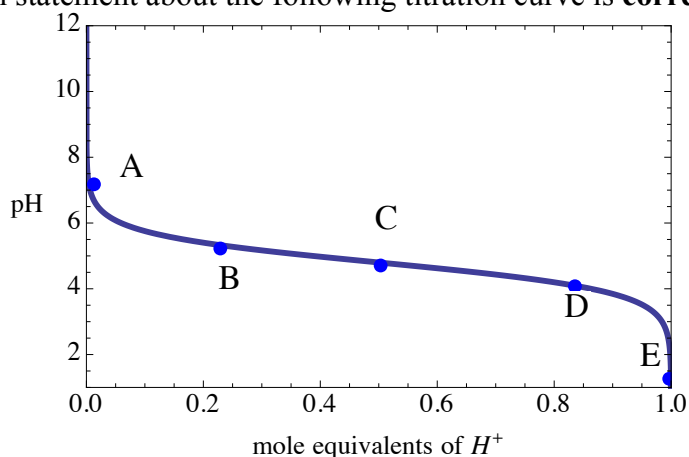
   A) At point "B" there is more of the weak acid form of the buffer than the weak base form.

   B) The pK_a of the compound is about 7.
   C) At point "A" the fraction of conjugate base is low.
   D) At point "E" the compound exists mainly in the weak acid form.
   E) The compound being titrated is an amino acid.

10. In the brain, dopamine is a neurotransmitter derived from the amino acid tyrosine that is involved in reward-motivated behaviour. Many addictive drugs act by intensifying the effects of dopamine. What is the pH of a solution of dopamine in which the amino group having a pK_a of 8.9 is 40% dissociated?
    A) 8.20
    B) 8.50
    C) 8.68
    D) 8.72
    E) 9.08

11. Cinnamic acid is obtained from oil of cinnamon. 125 millimoles of HCl were added to a solution containing 0.2 moles of a cinnamic acid and 0.3 moles of its conjugate base. After mixing, the pH of the solution was found to be 4.17. What is the pK_a of cinnamic acid?
    A) 4.44
    B) 4.17
    C) 3.90
    D) 4.93
    E) 4.66

12. The digestive enzyme *pepsin* is secreted by stomach cells into an environment with a pH of 1.5 – 2. It has as a pH optimum of about 2.0 and is inactive at pH 6.5. What would be the buffer of choice to study this enzyme?

    A)   carbonic acid ($K_{a1} = 4.5$ x 10^{-7}; $K_{a2} = 4.7$ x 10^{-11})

    B)   lactic acid ($K_a = 1.38 \times 10^{-4}$)

    C)   tris-hydroxymethyl aminomethane ($K_a = 8.32 \times 10^{-9}$)

    D)   phosphoric acid ($K_{a1} = 7.1$ x 10^{-3}; $K_{a2} = 6.3$ x 10^{-8}; $K_{a3} = 4.5$ x 10^{-13})

    E)   boric acid ($K_a = 5.75 \times 10^{-10}$)

13. Which amino acid below is aromatic?
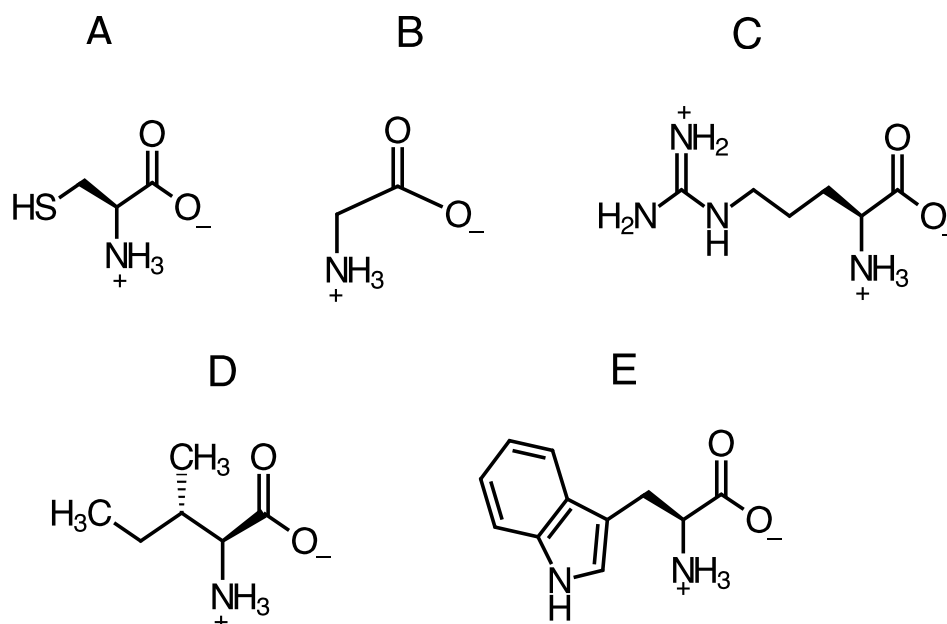
14. Identify the **incorrect** statement:
    A)   Leucine and valine are aliphatic, non-polar amino acids.
    B)   Serine and glutamine are polar, uncharged amino acids.
    C)   Glutamic acid and aspartic acid are acidic amino acids.
    D)   Lysine and arginine are basic amino acids.
    E)   Glutamine and glutamic acid are isomers.

15. Identify the correct statement regarding an electrophoretic separation of Ala (pI = 6.15), Lys (pI = 9.8) and Glu (pI = 3.1) where the pH of the buffer was 3.1.
    A)   All amino acids move toward the cationic electrode.
    B)   Ala remains stationary and Lys moves toward the negative electrode.
    C)   Glu remains stationary, Ala moves toward the positive electrode and Lys moves toward the negative electrode.
    D)   Lys remains stationary and both Glu and Ala move toward the positive electrode.
    E)   Ala and Lys move toward the negative electrode and Glu remains stationary.

16. Identify the correct statement about affinty chromatography:
    A)   Proteins are separated on the basis of size.
    B)   Ligands are separated on the basis of charge.
    C)   When proteins dissociate from immobilized ligand in the presence of free ligand they can be eluted from the column.
    D)   Protein separation is based on the covalent attachment of proteins to immobilized ligand.
    E)   Binding of SDS to proteins causes them to become negatively charged and elute from the column.

17. Which of the following best represents the backbone structure of a protein?

    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_α—C—N—C_α—C

    E) N—C_α—C—N—C_α—C—N

18. α-helix and β-strand are components of _____ structure.
    A) only primary
    B) only secondary
    C) secondary, tertiary and quaternary
    D) only quaternary
    E) only quinary

19. By adding SDS (sodium dodecyl sulfate) during the electrophoresis of proteins, it is possible to _____
    A) determine the amino acid composition of the protein.
    B) determine a protein's isoelectric point.
    C) determine an enzyme's specific activity.
    D) separate proteins exclusively on the basis of molecular weight.
    E) preserve a protein's native structure and biological activity.

20. Reaction of the peptide Arg-Pro-Val-Tyr, with phenylisothiocyanate (PITC) at pH 8.0 followed by mild acidification (first cycle of the Edman method) would release:
    A) The peptide Pro-Val-Tyr and PTH-Arg.
    B) The dipeptides Arg-Pro and Val-Tyr.
    C) PTH-Tyr and the peptide Arg-Pro-Val
    D) The peptide Arg-Pro-Val-Tyr.
    E) PTH-Arg, PTH-Pro, PTH-Val and PTH-Tyr.

21. Zinc is an essential trace element for most organisms. In the enzyme carbonic anhydrase the zinc ion _____.
    A) is a competitive inhibitor of water.
    B) is an allosteric activator of the enzyme.
    C) poisons the enzyme.
    D) aids in abstraction of a proton from water and binds and orients the substrates.
    E) donates an electron pair to CO_2.

22. Which equation best describes the initial rate of the following reaction?

$$A + B \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} C + D$$

    A) $V_0 = k_1[A][B] - k_{-1}[C][D]$
    B) $V_0 = k_1[A][B]$
    C) $V_0 = k_1[A][B] - k_{-1}[C]$
    D) $V_0 = k_1[A][B]k_{-1}[C][D]$
    E) $V_0 = k_1[A][B] / k_{-1}[C][D]$

23. An enzyme has a V_{max} = 10 micromoles/s and a K_m of 5 micromolar. For a substrate concentration of 50 micromolar which of the following are likely to cause the largest increase in the rate of the reaction?
    A) Doubling the activation energy.
    B) Reducing the temperature of the reaction by $10^\circ C$.
    C) Doubling the substrate concentration.
    D) Doubling the enzyme concentration.
    E) Doubling the substrate concentration and halving the enzyme concentration.

24. When you have a severe fever what may happen to the enzymes in your body?

A)   They will begin to catalyze reactions at a much faster rate.
B)   They may unfold, losing their catalytic activity.
C)   Their active sites may heat up causing active site side chains to become protonated.
D)   They may rigidify.
E)   They may begin catalyzing incorrect reactions.

25.   In the absence of a catalyst at $25^{\circ}C$ 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 in the presence of the enzyme carbonic anhydrase?

$$H_2O + CO_2 \rightarrow HCO_3^- + H^+$$

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

SCRATCH