Chem 204

Mid-Term Exam I

July 21, 2009

Name: **Answer Key**

Student ID: _____

There are 3 sections to this exam:
Answer ALL questions

Section I: Multiple-Choice – 20 questions, 2 pts each
Section II: Fill-in-the-Blank – 10 questions, 3 pts each
Section III: Short Answer – 4 questions, 30 pts total

Please make sure your exam paper is complete.

Do not start writing exam until indicated.

Section I : Multiple Choice (2 pts each)

1. The pH of a sample of blood is 7.4, while gastric juice is pH 1.4. The blood sample has: 1. E

A) 0.189 times the $[H^+]$ as the gastric juice.
B) 5.29 times lower $[H^+]$ than the gastric juice.
C) 6 times lower $[H^+]$ than the gastric juice.
D) 6,000 times lower $[H^+]$ than the gastric juice.
E) a million times lower $[H^+]$ than the gastric juice.

2. The three-dimensional structure of a protein is determined primarily by: 2. B

A) electrostatic guidance from nucleic acid structure.
B) the sequence of amino acids in the protein.
C) how many amino acids are in the protein.
D) hydrophobic interaction with lipids that provide a folding framework.
E) modification during interactions with ribosomes.

3. All of the amino acids that are found in proteins, except for proline, contain a(n): 3. A

A) amino group.
B) carbonyl group.
C) carboxyl group.
D) ester group.
E) thiol group.

4. During muscle contraction, hydrolysis of ATP results in a change in the: 4. B

A) conformation of actin.
B) conformation of myosin.
C) structure of the myofibrils.
D) structure of the sarcoplasmic reticulum.
A) structure of the Z disk.

5. A compound has a pK_a of 7.4. To 100 mL of a 1.0 M solution of this compound at pH 8.0 is added 30 mL of 1.0 M hydrochloric acid. The resulting solution is pH: 5. D

A) 6.5
B) 6.8
C) 7.2
D) 7.4
E) 7.5

6. The peptide alanylglutamylglycylalanylleucine has: 6. C

A) a disulfide bridge.
B) five peptide bonds.
C) four peptide bonds**.**
D) no free carboxyl group.
E) two free amino groups.

7. Enzymes are biological catalysts that enhance the rate of a reaction by: 7. B

A) decreasing the amount of free energy released.
B) decreasing the activation energy.
C) increasing the activation energy.
D) increasing the amount of free energy released.
E) increasing the energy of the transition state.

8. Which of the following refers to particularly stable arrangements of amino acid residues in a protein that give rise to recurring patterns? 8. B

A) Primary structure
B) Secondary structure
C) Tertiary structure
D) Quaternary structure
E) None of the above

9. The steady state assumption, as applied to deriving the Michaelis-Menten 9. D

A) Km=[S].
B) The enzyme is regulated.
C) The rate of ES breakdown to EP is k_2.
D) The ES complex is formed and broken down at equivalent rates.
E) The maximum velocity occurs when the enzyme is saturated.

10. 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 the: 10. D

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

11. An enzyme, aldolase, requires Zn^{2+} for catalysis. Under conditions of zinc deficiency, when the enzyme lacks zinc, it would be referred to as the: 11. A

A) apoenzyme.
B) coenzyme.
C) holoenzyme.
D) prosthetic group.
E) heteroenzyme.

12. Which of the following statements about protein-ligand binding is correct? 12. E

A) The K_a is equal to the concentration of ligand when all of the binding sites are occupied.
B) The K_a is independent of such conditions as salt concentration and pH.
C) The larger the K_a (association constant), the weaker the affinity.
D) The larger the K_a, the faster the binding.
E) The larger the K_a, the smaller the K_d (dissociation constant).

13. When the linear form of glucose cyclizes, the product is a(n): 13. C

A) anhydride.
B) glycoside.
C) hemiacetal.
D) lactone.
E) oligosaccharide.

14. In the α helix the hydrogen bonds: 14. A

A) are roughly parallel to the axis of the helix.
B) are roughly perpendicular to the axis of the helix.
C) occur mainly between electronegative atoms of the R groups.
D) occur only between some of the amino acids of the helix.
E) occur only near the amino and carboxyl termini of the helix.

15. Which of the following statements about buffers is true? 15. D

A) A buffer composed of a weak acid of $pK_a = 5$ is stronger at pH 4 than at pH 6.
B) At pH values lower than the pK_a, the salt concentration is higher than that of the acid.
C) The pH of a buffered solution remains constant no matter how much acid or base is added to the solution.
D) When $pH = pK_a$, the weak acid and salt concentrations in a buffer are equal.
E) The strongest buffers are those composed of strong acids and strong bases.

16. Which of these statements about enzyme-catalyzed reactions is *false*? 16. D

A) At saturating levels of substrate, the rate of an enzyme-catalyzed reaction is proportional to the enzyme concentration.
B) If enough substrate is added, the normal V_{max} of a reaction can be attained even in the presence of a competitive inhibitor.
C) The rate of a reaction decreases steadily with time as substrate is depleted.
D) The activation energy for the catalyzed reaction is the same as for the uncatalyzed reaction.
E) The Michaelis-Menten constant K_m equals the [S] at which $V = 1/2\ V_{max}$.

17. Phosphoric acid is tribasic, with pK_a's of 2.14, 6.86, and 12.4. The ionic form that predominates at pH 9.2 is: 17. C

A) H_3PO_4.
B) $H_2PO_4^-$.
C) HPO_4^{2-}.
D) PO_4^{3-}.
E) none of the above.

18. V_{max} for an enzyme-catalyzed reaction: 18. D

A) generally increases when pH increases.
B) increases in the presence of a competitive inhibitor.
C) is limited only by the amount of substrate supplied.
D) is twice the rate observed when the concentration of substrate is equal to the K_m.
E) is unchanged in the presence of a uncompetitive inhibitor.

19. Which of the following generalizations concerning motor proteins is correct? 19. A

A) They convert chemical energy into kinetic energy.
B) They convert chemical energy into potential energy.
C) They convert kinetic energy into chemical energy.
D) They convert kinetic energy into rotational energy.
E) They convert potential energy into chemical energy.

20. From the abbreviated name of the compound Gal(β1 → 4)Glc, we know that: 20. A

A) C-4 of glucose is joined to C-1 of galactose by a glycosidic bond.
B) the compound is a D-enantiomer.
C) the galactose residue is at the reducing end.
D) the glucose is in its pyranose form.
E) the glucose residue is the β anomer.

Section II – Fill in the Blank
(3 pts each)

21. Define, with one to two sentences, each of the following terms:
   A) Amphoteric – acid/base same molecule

   B) Hydrogen bond – special type of dipole-dipole force that exists between an electronegative atom and a hydrogen atom bonded to another electronegative atom

   C) Zwitterion – electrically neutral molecule, but carries formal positive and negative charges

   D) anomeric carbon - The anomeric carbon is the newly formed chiral center upon ring formation of the ring structure of a monosaccharide (the carbonyl carbon atom of a sugar)

   E) Denaturation – loss of secondary or tertiar structure (of protein or nucleic acid)

22. The common amino acids are classified at pH 7.0 based upon their

chemical nature of the R group.

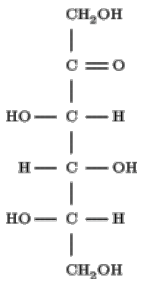
23. The basic unit of the muscle which spans from Z-disc (Z-line) to Z-disc is the

Sarcomere

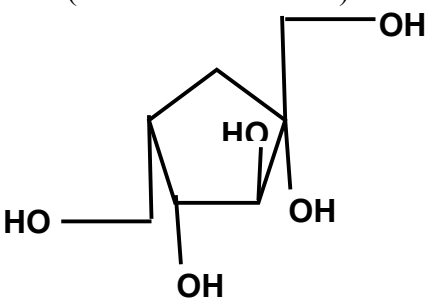
24. The double-recriprocal equation of the Michaelis-Menten equation is known as the

Lineweaver-Burke equation

Using the space below, draw the following two structures
25. Draw the sugar to the right in a Haworth projection:
26. Draw the structure of any polar, uncharged amino acid at pH 7.0.



25. (the beta form shown)



26. Any of the set allowed.

Part III - Short Answer

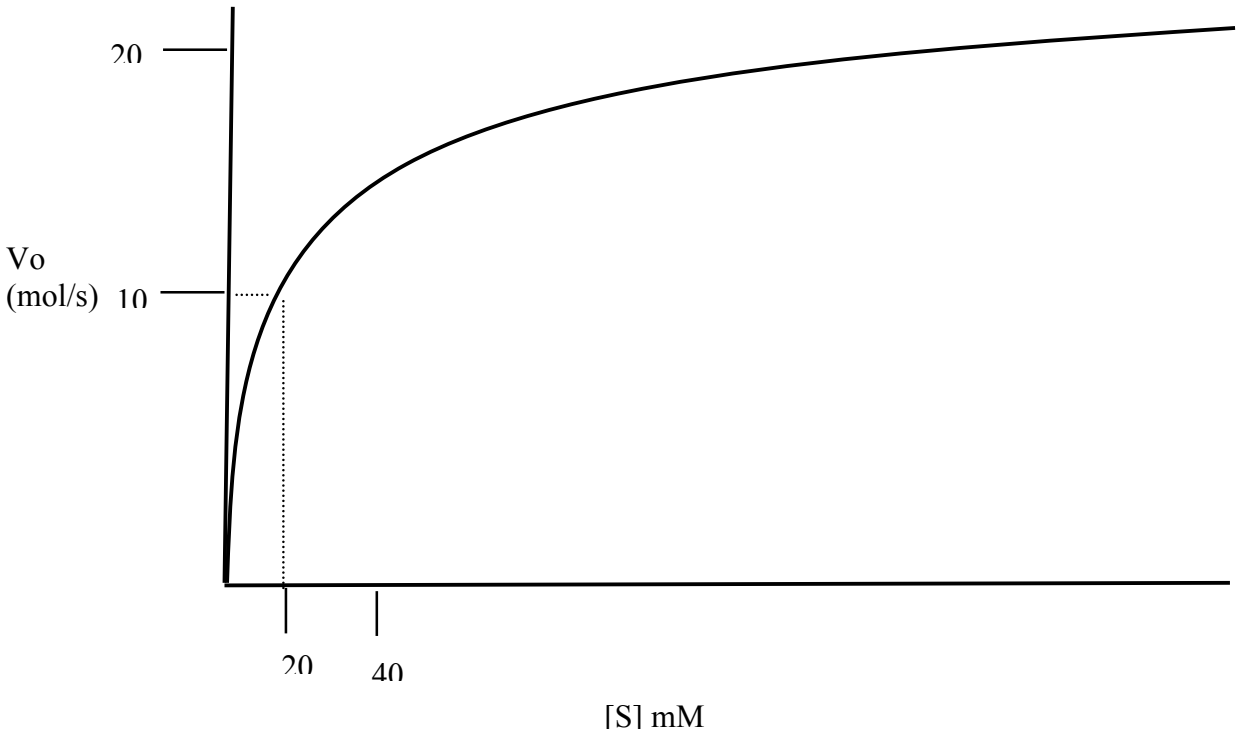
Point totals as given in each question – Show your work where required

27. Suppose you have just added 100 mL of a solution containing 0.5 mol of acetic acid per liter to 100 mL of 0.45 M NaOH. A) What is the final pH? (3 pts) B) What is the concentration of acetic acid in the final solution? (The pK_a of acetic acid is 4.7.)

Ans: Addition of 45 mmol of NaOH (100 mL × 0.45 M) to 50 mmol of acetic acid (100 mL × 0.5 mM) titrates the acid until 5 mmol of acetic acid is left, and 45 mmol of acetate is present
pH = 4.7 + log(A-/HA) = 4.7 + log (45/5)= 4.7 + 0.95=5.65

B) From above, have 5 mmol acetic acid, total V is 200mL, so
5 mmol/200 mL = 0.025 M acetic acid

28. Sketch a Michaelis-Menten plot for an enzyme with V_{max} = 20 mol/s and K_m= 20 mM. Label axes appropriately (6 pts).



29. Two different enzymes are able to catalyze the same reaction, A → B. They both have the same V_{max}, but differ their K_m the substrate A. For enzyme 1, the K_m is 1.0 mM; for enzyme 2, the K_m is 10 mM. When enzyme 1 was incubated with 0.1 mM A, it was observed that B was produced at a rate of 0.0020 mmoles/minute.

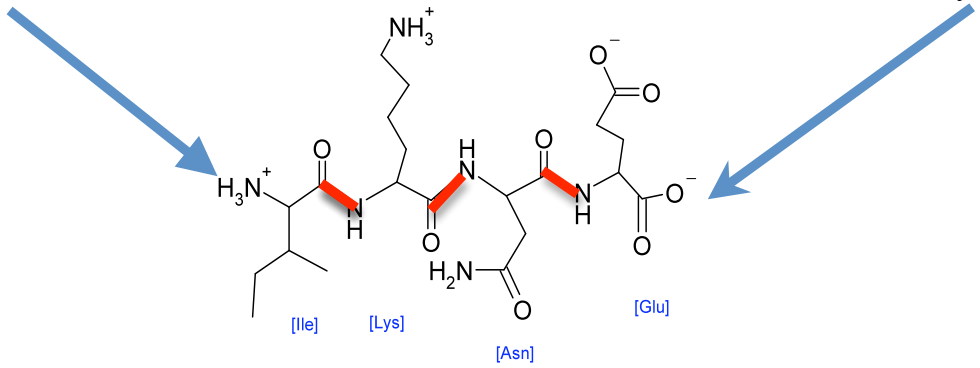
a) What is the value of the V_{max} of the enzymes? (4 pts)
b) What will be the rate of production of B when enzyme 2 is incubated with 0.1 mM A? (2 pt)
c) What will be the rate of production of B when enzyme 1 is incubated with 1 M A? (2 pts)

use MM - $V_0 = V_{max}$ [S]/(K_m + [S])
a) 0.022 mmol/min; b) 0.0022 mmol/min; c) 0.022 mmol/min

30. A)In the structure of the peptide below, at pH 7.0, indicate the amino and the carboxyl termini, where all peptide bonds are, and indicate to which group each amino acid belongs. B) Explain why there is no rotation around the peptide bond. (A- 5 pts B - 3 pts)

Amino Terminus

Carboxy Terminus



.Amnio acid types:
(aminoterm) nonpolar(aliphatic)-basic-polar-acidic (C-term) 3 peptide bonds indicated in red

B) explain why there is no rotation around this bond. (3 pts):

- e^--pair shared by interaction with the carbonyl group
- sets up a dipole
- Planar

See Fig. 4-2(a) from Text.

Section	Possible	Received
I	40	
II	30	
III	30	
Total:	100	