

THE UNIVERSITY OF MANITOBA

November 1, 2016

Mid-Term EXAMINATION

PAPER NO: 1LOCATION: 173 Robert Schultz TheatrePAGE NO: 1 of 5DEPARTMENT & COURSE NO: CHEM / MBIO 2770TIME: 1 HOUREXAMINATION: Elements of Biochemistry IEXAMINER: 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 and can be removed from the exam.

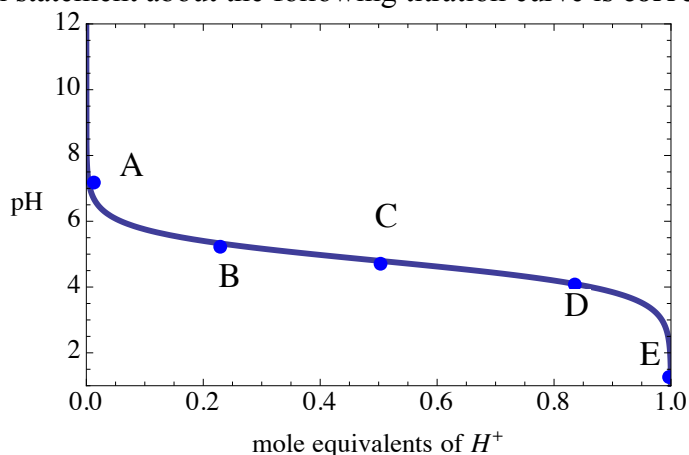
1. All living cells use the same types of biomolecules and all share some common metabolic features. This suggests that _____.
 - A) all cells share a common ancient ancestor.
 - B) the universe is constantly in a state of decay.
 - C) metabolic pathways are linear.
 - D) biomolecules are all derived from water.
 - E) catabolism involves the degradation of nutrient molecules consuming energy.
2. The major essential atoms found in all life forms are:
 - A) Hydrogen, oxygen, sodium and calcium.
 - B) Hydrogen, helium, carbon, oxygen, calcium and iron.
 - C) Beryllium, carbon, nitrogen, oxygen, silicon, and calcium.
 - D) Carbon, nitrogen, oxygen, fluorine, sodium, and iron.
 - E) Hydrogen, carbon, nitrogen, oxygen, phosphorus, and sulphur.
3. In a nucleophilic addition reaction _____.
 - A) an electrophilic oxygen atom will attack a nucleophilic carbon atom.
 - B) a nucleophilic nitrogen atom will attack an electrophilic oxygen atom.
 - C) a nucleophilic oxygen atom will attack an electrophilic carbon atom.
 - D) a nucleophilic carbon atom will attack an electrophilic oxygen
 - E) an electrophilic nitrogen atom will attack a nucleophilic carbon atom.
4. The first law of thermodynamics states:
 - A) The temperature of the universe is constant.
 - B) The energy of the universe is constant.
 - C) The entropy of the universe is constantly decreasing.
 - D) The enthalpy of the universe is constant.
 - E) The enthalpy of the universe is constantly increasing.
5. Potential energy is _____.
 - A) the energy an object has owing to its motion.
 - B) the total energy in the whole system.
 - C) the energy an object has owing to its position in a field.
 - D) a measure of the disorder of a system.
 - E) the heat energy of a material at constant pressure.

6. If the free energy change, ΔG , for a reaction is -23.25 kJ/mol, the reaction _____:
- will proceed spontaneously to form products from reactants.
 - requires the input of 23.25 kJ/mol to form products from reactants.
 - is at equilibrium.
 - is driven by a large entropy decrease.
 - will release 23.25 kJ/mol as reactants form from products.

7. Bile has a pH of 7.8. What is the H^+ concentration of bile?

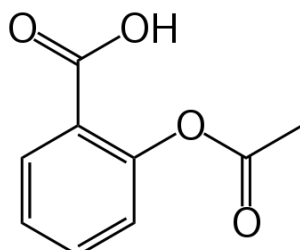
- $10^{-6.2}M$
- $1.6 \times 10^{-8}M$
- $6.3 \times 10^{-7}M$
- $1.6 \times 10^{-8}M$
- $4.1 \times 10^{-4}M$

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



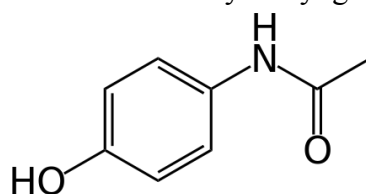
- The compound being titrated is a strong acid.
 - At point "B" there is more of the weak acid form of the buffer than the conjugate base form.
 - The pK_a of the compound is about 3.
 - At point "A" the fraction of conjugate base is high.
 - At point "E" the compound exists mainly in the conjugate base form.
9. Titration of alanine by a strong acid, for example HCl, reveals two pK_a 's. The titration reaction occurring at pK_1 ($pK_1 = 2.1$) is:
- $-\text{NH}_3^+ + \text{H}^+ \rightarrow -\text{NH}_4^+$
 - $-\text{COOH} + \text{OH}^- \rightarrow -\text{COO}^- + \text{H}_2\text{O}$
 - $-\text{COO}^- + -\text{NH}_2^+ \rightarrow -\text{COOH} + -\text{NH}_2$
 - $-\text{NH}_3^+ + \text{H}^+ \rightarrow -\text{NH}_4^+$
 - $-\text{COO}^- + \text{H}^+ \rightarrow -\text{COOH}$

10. The structure of aspirin (acetyl salicylic acid) is shown below. The pK_a of the carboxyl group is 3.5. In order to be absorbed into cells the drug must cross a cellular membrane. Neutral molecules cross easily whereas charged molecules pass only with difficulty. Identify the correct statement below:



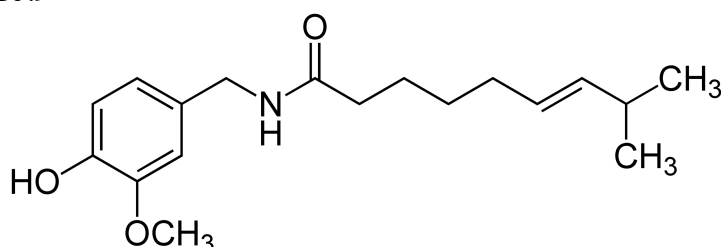
- Aspirin will easily pass into cells from the blood where the pH is 7.35.
- Aspirin will easily pass into cells from cerebrospinal fluid with a pH of 7.33.
- Aspirin will easily pass out of lysosomes where the pH is 5.
- Aspirin will easily pass into cells from saliva with a pH of 7.4.
- Aspirin will easily pass into gastric cells from the stomach with a pH of 1.

11. Acetaminophen is a drug with anti-pyretic and analgesic activities that contains a hydroxyl group with a pK_a of 9.8. Its structure is shown below. What is the pH of a solution of acetaminophen in which the hydroxyl group is 33% dissociated?

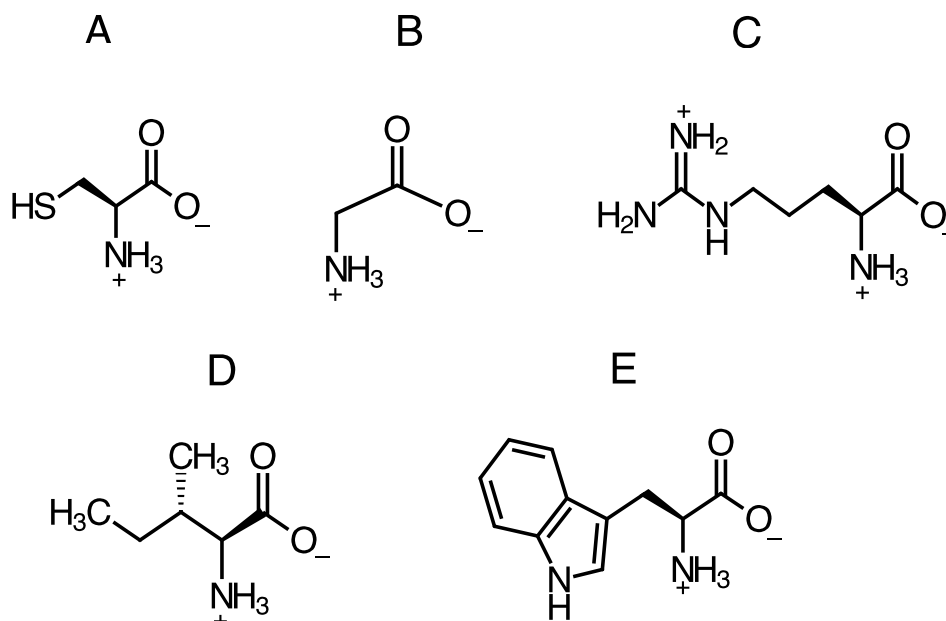


- A) 9.1
 B) 9.3
 C) 9.5
 D) 9.6
 E) 10.1
12. Capsaicin is the pungent spice present in hot chili peppers. It's structure is shown below. 1 micromole of HCl was added to a solution containing 3 micromoles of a capsaicin and 3 micromoles of its conjugate base. The pK_a of Capsaicin is 10.1. What was the new pH after adding the strong acid?

- A) 9.8
 B) 10.4
 C) 10.7
 D) 10.8
 E) 10.9



13. Which amino acid below has the highest pK_a and is thus the most basic?

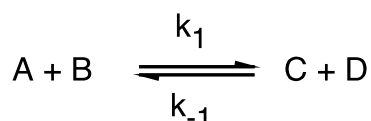


14. Which of the following amino acids will interact through their side-chains through a hydrophobic interaction?

- i. Lysine and aspartic acid.
- ii. Isoleucine and phenylalanine.
- iii. Glycine and asparagine.
- iv. Valine and leucine.
- v. Glycine and glutamine.

- A) v only.
 B) ii and iv only.
 C) i and iv only.
 D) iii only.

- E) None of the above are incorrect.
15. All of the following are considered “weak” interactions in proteins, *except*:
- Electrostatic repulsions.
 - Electrostatic attractions.
 - Hydrogen bonds.
 - Triple covalent bonds.
 - Van der Waals interactions.
16. In a mixture of the five proteins listed below, which should elute fourth in size-exclusion (gel-filtration) chromatography?
- cytochrome *c* $M_r = 13,000$
 - immunoglobulin G $M_r = 145,000$
 - ribonuclease A $M_r = 13,700$
 - RNA polymerase $M_r = 450,000$
 - serum albumin $M_r = 68,500$
17. Which of the following is *least* likely to result in protein denaturation?
- Disruption of weak interactions by heating the protein.
 - Changing the concentration of sodium chloride in the protein solution.
 - Altering net protein charge by changing *pH*.
 - Adding the detergent Sodium Dodecyl Sulphate to the protein.
 - Mixing the protein with organic solvents such as acetone.
18. Which of the following peptides could be cleaved by both CNBr and Trypsin?
- Glu-Gln-Gly-Glc.
 - Trp-Tyr-Phe-Met.
 - Arg-His-Lys-Phe.
 - Leu-Ile-Val-Arg.
 - Pro-Met-Lys-Ala.
19. When a globular protein folds in water it does all of the following EXCEPT:
- Minimizes water entropy.
 - Maximizes the H-bonding potential of the backbone through the formation of α -helices and / or β -strands.
 - Places hydrophobic side-chains on the inside of the protein away from water.
 - Places hydrophilic side-chains on the outside of the protein in contact with water.
 - Transforms an inactive polymer into a biologically active molecule.
20. Soft and flexible silk fibroin is composed of:
- coiled coils.
 - a double helix.
 - a triple helix.
 - β -pleated sheets.
 - a helix-turn-helix motif.
21. Which statement correctly describes the hydrolysis of a peptide bond by chymotrypsin?
- Water is not a reactant.
 - A covalent intermediate forms between the N-terminus of the substrate and the His in the catalytic triad.
 - The enzyme behaves as an acid-catalyst only.
 - Electrons flow out of the substrate and into the enzyme, and then back again.
 - The negative charge on the transition state is neutralized by groups in the protein.
22. Which equation best describes the initial rate of the following reaction?



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

- D) $V_0 = k_1[A][B]k_{-1}[C][D]$
 E) $V_0 = k_1[A][B] / k_{-1}[C][D]$
23. For any enzyme that follows simple Michaelis-Menten kinetics, when the initial Velocity of the reaction is $1/3$ of V_{max} what is the Substrate concentration?
- A) $[S] \ll K_m$
 B) $[S] = 0.33K_m$
 C) $[S] = \frac{1}{2}K_m$
 D) $[S] = 0.66K_m$
 E) $[S] = K_m$
24. Identify the correct statement:
- A) Michaelis-Menten enzymes exhibit sigmoidal initial velocity vs. substrate concentration plots.
 B) Allosteric enzymes exhibit hyperbolic initial velocity vs. substrate concentration plots.
 C) A first-order reaction depends on the concentration of 1 reactant and has a rate constant with units s^{-1} .
 D) In the presence of a competitive inhibitor the V_{max} of an enzyme will be depressed.
 E) Michaelis-Menten enzymes exhibit cooperativity among the substrate molecules.
25. The following data were obtained in a study of an enzyme known to follow Michaelis-Menten kinetics:

V_0 ($\mu\text{mol/s}$)	Substrate added (mM)
0.2	1
0.7	4
1.8	10
13.2	100
22.8	250
30.0	500
35.6	1000
41.6	4000

The V_{max} and K_m for this enzyme are approximately:

- A) 0.2 $\mu\text{mol/s}$ and 100 mM.
 B) 1.8 $\mu\text{mol/s}$ and 10 mM.
 C) 13 $\mu\text{mol/s}$ and 100 mM.
 D) 45 $\mu\text{mol/s}$ and 250 mM.
 E) 41.6 $\mu\text{mol/s}$ and 4000 mM.

SCRATCH

SCRATCH

SCRATCH