

CHEM 237 Midterm Spring 2013

Name:

Student ID number

INSTRUCTIONS:

There are 11 pages including the cover sheet. Make sure you have all 11 pages

There are 30 questions. Make sure you read all the way to the end of the test

Look at the scantron form. Please fill in your ID number and please make sure you fill in the ovals below the written numbers.

Copy your answers to the scantron card. Please leave yourself enough time to copy your answers to the card.

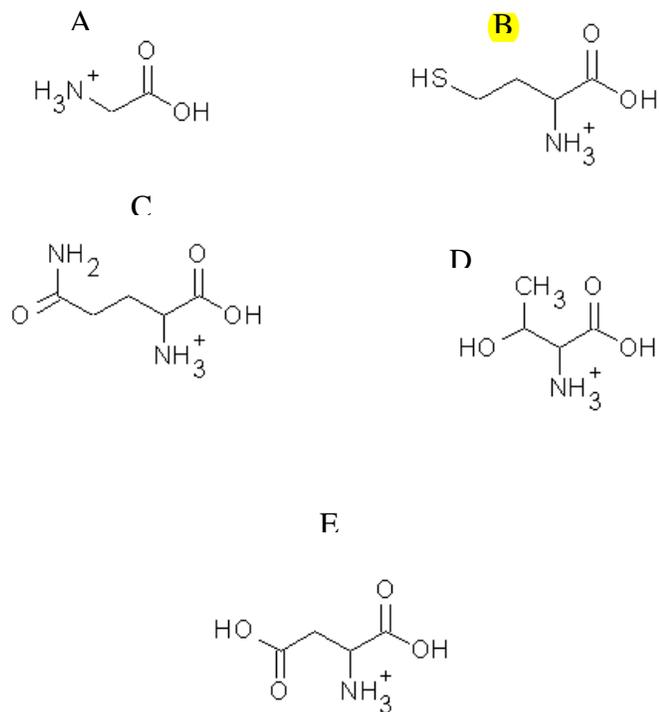
Read through the entire test and answer the easy questions first.

You have 80 minutes to complete the test

1. The three-dimensional structure of macromolecules is formed and maintained primarily through noncovalent interactions. Which one of the following is *not* a noncovalent interaction?
A) disulfide bonds
B) hydrogen bonds
C) hydrophobic interactions
D) ionic interactions
E) van der Waals interactions
2. The four covalent bonds in methane (CH₄) are arranged around carbon to give which one of the following geometries?
A) linear
B) tetrahedral
C) trigonal bipyramidal
D) trigonal planar
E) trigonal pyramidal
3. The standard free energy change ΔG° for a reaction is -46.11 kJ/mol. Which of the following statements is always true?
A) The value of the equilibrium constant is less than one.
B) The reaction is always spontaneous as written
C) The value of K at 25°C is 1.19×10^8
D) The value of K at 25°C is 8.4×10^{-7}
E) The reaction is exothermic.
4. The phosphorylation of glucose, the first step in its metabolism is energetically unfavorable. How, then, do all cells accomplish this process?
A) Cells make sure the concentrations are such that the reaction is favorable.
B) The reaction is coupled to an energetically favorable reaction.
C) The cells use energy from the light it absorbs and couples that to the unfavorable reaction.
D) All cells use more than 1 method to accomplish this process.
E) None of the above

5. Which of the following best completes this statement? Nonpolar solutes aggregate in aqueous solution ...
- A) because of the strong attractions between nonpolar molecules.
 - B) due to the electrostatic repulsion between water and nonpolar molecules.
 - C) to increase the entropy of the water.
 - D) to increase the entropy of the nonpolar solute.
 - E) due to the strong ionic interactions between nonpolar molecules.
6. Which of the following best completes this statement? Hydrophobic interactions make important energetic contributions to:
- A) binding of a hormone to its receptor protein.
 - B) enzyme-substrate interactions.
 - C) membrane structure.
 - D) three-dimensional folding of a polypeptide chain.
 - E) all of the above are true.
7. Phosphoric acid is triprotic, with pK_a 's of 2.14, 6.86, and 12.4. Which of the following most closely describes the composition of a phosphate buffer at pH= 6?
- A) 85 % H_3PO_4 15% $H_2PO_4^-$
 - B) 50% $H_2PO_4^-$ 50% HPO_4^{2-}
 - C) 34% $H_2PO_4^-$ 66% HPO_4^{2-} .
 - D) 88% $H_2PO_4^-$ 12 % HPO_4^{2-} .
 - E) 12 % HPO_4^{2-} 88% PO_4^{3-}
8. The Bohr effect refers to
- A) the decrease in affinity of Hb for O_2 when the pH goes down
 - B) the decrease in affinity of Hb for O_2 when the pH goes up
 - C) the increase in the affinity of Hb for O_2 when the O_2 concentration goes up
 - D) the decrease in affinity of Hb for O_2 when the BPG concentration goes up
 - E) the decrease in affinity of Hb for O_2 when the BPG concentration goes down

9. Which of the following is not one of the 20 amino acids most common in proteins?



10. The value of n , the Hill constant (coefficient), for hemoglobin is about _____ as great as the value for myoglobin.

- A) half
- B) twice
- C) three times**
- D) five times
- E) ten times

11. Which of the following amino acids has more than one chiral carbon?

- A) Ala
- B) Ser
- C) Thr**
- D) Leu
- E) Val

12. In a highly basic solution, pH = 13, what is the predominant form of glycine?

- A) $\text{NH}_2\text{—CH}_2\text{—COOH}$.
- B) $\text{NH}_2\text{—CH}_2\text{—COO}^-$.**
- C) $\text{NH}_2\text{—CH}_3^+\text{—COO}^-$.
- D) $\text{NH}_3^+\text{—CH}_2\text{—COOH}$.
- E) $\text{NH}_3^+\text{—CH}^-\text{—COO}^-$

13. Which of the following pairs of bonds within a peptide backbone shows free rotation around both bonds?

- A) $\text{C}_\alpha\text{—C}$ and N—C_α**
- B) C=O and N—C
- C) C=O and N—C_α
- D) N—C and $\text{C}_\alpha\text{—C}$
- E) N—C_α and N—C

14. Roughly how many amino acids are there in one turn of an α -helix?

- A) 1
- B) 2.8
- C) 3.6**
- D) 4.2
- E) 10

15. Which of the following statements about beta sheets is False?

- A) In a β sheet, the R groups on the amino acid residues alternate between the top and the bottom of the sheet.
- B) The amino acids with larger side chains are more easily accommodated in the beta sheet structure.
- C) The beta strands are held together by hydrophobic interactions between Ala residues on the same side of the sheet**
- D) The characteristic hydrogen bonds in anti-parallel β -sheets are perpendicular to the peptide backbone axis
- E) The sidechains are perpendicular to the plain of the sheet

16. What is the average overall charge on the free amino acid histidine at pH = 5.5?

- A) +2
- B) +0.5
- C) -.75
- D) +.78
- E) 0

Questions 17-19 refer to the following information. You are given a mixture of 3 proteins with the following properties.

Protein A has a pI of 5.3

Protein B has a pI of 9.5

Protein C has a pI of 4.5

17. How can you separate all three of these proteins at pH =7?

- A) Cation exchange chromatography
- B) Anion exchange chromatography
- C) Hydrophobic interaction chromatography

~~18. Which protein(s) would NOT bind to a cation exchange column run at pH=4?~~

- ~~A) B~~
- ~~B) C and B~~
- ~~C) A and B~~
- ~~D) A and C~~
- E) All of them

Question had no clear answer. Counted as 1 bonus point for everyone.

19. What amino acids would you expect to be prevalent in protein C.

- A) Lys and Arg
- B) His and Arg
- C) Asp and Lys
- D) Asp and Glu
- E) Ala and Ile

20. How would you elute proteins bound to an anion exchange column?

- A) Gradually raise the pH of the elution buffer
- B) Gradually lower the pH of the elution buffer
- C) Gradually raise the salt concentration
- D) A and C
- E) B and C

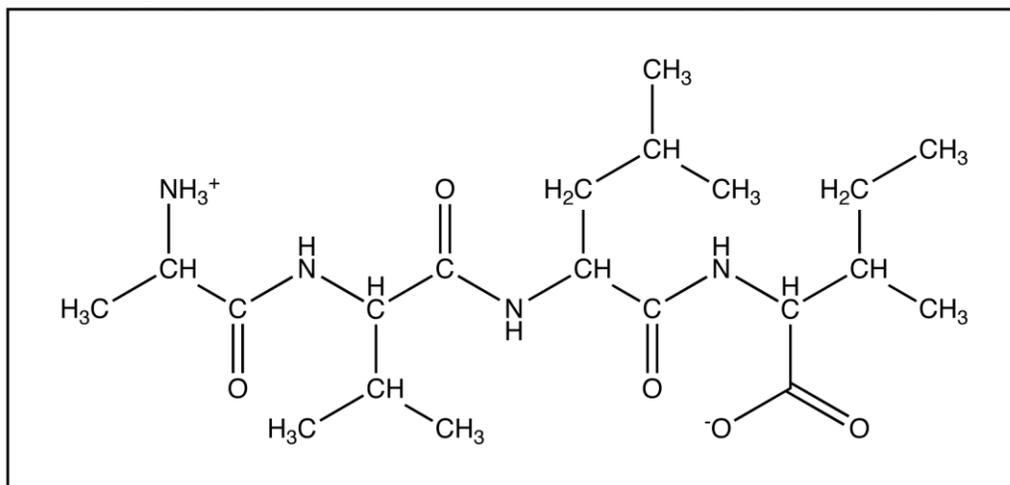
21. Which amino acid does not have a primary α -amino group?

- A) glutamine
- B) arginine
- C) lysine
- D) proline**
- E) glutamate

22. Zwitterions are

- A) amino acids.
- B) ionic molecules that are racemic.
- C) ions that bear both negatively and positively charged groups.**
- D) side chain carboxylate anions.
- E) delocalized ions.

23. The diagram below shows



- A) an amino acid.
- B) a dipeptide.
- C) a tripeptide.
- D) a tetrapeptide.**
- E) a pentapeptide.

24. In a Ramachandran diagram, a larger area represents sterically allowed torsion angles of ϕ and ψ that are allowed in _____ rather than in _____ because there is greater opportunity for separation of amino acid side chains.

- A) secondary structure...tertiary structure
- B) α helix... β sheet
- C) β sheet... α helix
- D) tertiary structure...secondary structure
- E) none of the above

25. Which one of these characteristics is not true for the α helix?

- A) There are 3.6 amino acids per turn.
- B) There is a requirement for glycine every third amino acid residue.
- C) A hydrogen bond forms between the carbonyl oxygen of the n th amino acid residue and the -NH group of the $(n + 4)$ th amino acid residue.
- D) Proline is typically not found in the α helix.
- E) It is right-handed.

26. Which of these characteristics does not describe the β sheet?

- A) Amino acid side chains are located both above and below the sheet.
- B) β sheets have a pleated edge-on appearance.
- C) They can exist in either parallel or antiparallel configurations.
- D) The sheets contain as few as two and as many as 22 polypeptide chains.
- E) Parallel β sheets containing fewer than five chains are the most common.

27. The pH of coffee is 5.6. The pH of grapefruit juice is 2.6. This means that the proton concentration in coffee is

- A) a thousand times higher than in grapefruit juice.
- B) a thousand times lower than in grapefruit juice.
- C) 3000 times lower than in grapefruit juice.
- D) 3 times the proton concentration of grapefruit juice.
- E) 3000 times higher than in grapefruit juice.

28. While the binding of O_2 to myoglobin as a function of pO_2 is described by a simple _____ curve, the binding to hemoglobin is described by a more complex _____ curve.

- A) sigmoidal; hyperbolic
- B) hyperbolic; sigmoidal**
- C) exponential; hyperbolic
- D) sigmoidal; bell-shaped
- E) hyperbolic; concave

This is not the End! Two more questions to go...

Useful(?) Equations:

$$pH = pK_a + \log \left(\frac{[A^-]}{[HA]} \right)$$

$$\Delta G = \Delta G^0 + RT \ln Q$$

$$\Delta G = \Delta H - T\Delta S$$

29. (10 points) Draw the most common structure of the following tri-peptide at pH 7 and pH 14. Include all atoms and charges in your structures.

Pro – Arg – His

30. (10 points) Draw the structure of a parallel β -sheet. Use six amino acids for each strand, include all atoms of the peptide backbone. Represent the sidechains by the letter R. Show all hydrogen bonds.