

EXAM I
FORM A

Place your name at the top of this page of the exam. On the F-1712 Scantron form, use a no. 2 pencil to enter your test form designation, i.e., A or B. Also print and encode your name and your UTD ID (starting in the first column on the left and leaving the last spaces blank). If your UTD ID is more than 8 numbers, print only the last 8 numbers. Leave phone number, code and subject score sections blank.

Select the best answer for the following multiple-choice questions and enter the corresponding letter on the Scantron sheet. You may use these test pages to make notes and work problems.

You may use a non-graphing calculator or a graphing calculator you have cleared of all stored data.

When finished, turn in this exam along with your Scantron sheet.

1. Which of the following amino acids would be the most conservative replacement for a val residue in a protein, and thus least likely to change the protein's structure and activity?
 - a. glu
 - b. ile**
 - c. arg
 - d. gly
 - e. his
2. Which of the following amino acids is considered the universal methyl donor?
 - a. dimethylarginine
 - b. selenocysteine
 - c. methionine**
 - d. methyllysine
 - e. hydroxyproline
3. Which of the following serves as the major buffer inside cells?
 - a. phosphate (P_i)**
 - b. sulfate
 - c. CO_2 -bicarbonate system
 - d. histidine
 - e. thiol
4. Which of the following is the major divalent cation inside cells?
 - a. magnesium**
 - b. zinc
 - c. iron
 - d. sodium
 - e. phosphate
5. The energy of individual H-bonds can vary from
 - a. -0.2 to -0.5 kJ/mol
 - b. 5 to 15 kJ/mol
 - c. -250 to -400 kJ/mol
 - d. -12 to -30 kJ/mol**
 - e. 50 to 100 kJ/mol

6. Which of the following amino acid side chains is amphipathic (aka amphiphilic)
- a. proline
 - b. leucine
 - c. valine
 - d. glutamine
 - e. glycine
7. Which of the following amino acids has a side chain that can form hydrogen bonds?
- a. phenylalanine
 - b. glycine
 - c. isoleucine
 - d. valine
 - e. tyrosine
8. Which of the following amino acids has a side chain that can participate in charge-charge interactions?
- a. S
 - b. N
 - c. I
 - d. A
 - e. K
9. The folded 3D structure of an individual polypeptide is its
- a. primary structure
 - b. secondary structure
 - c. tertiary structure
 - d. quaternary structure
 - e. pentanary structure
10. Defining r as the distance of separation of centers of charge, the energy of dipole-charge interactions is a function of
- a. r^{-1}
 - b. r^{-2}
 - c. r^{-3}
 - d. r
 - e. r^2
- 11 Which of the following is one of the three domains of life on earth which share a common biochemistry?
- a. euglena
 - b. archaea
 - c. bacterioids
 - d. prokaryota
 - e. none of the above
12. Selenium is found in what can be called the 21st standard amino acid. This amino acid is
- a. selenocysteine
 - b. selenoserine
 - c. selenothreonine
 - d. selenomethionine
 - e. none of the above

13. Calculate the final pH of a solution made by the addition of 10 ml of 0.25 M NaOH to 20 ml of a 0.25 M solution of acetic acid which has a pKa of 4.8.
- 3.8
 - 4.1
 - 4.8
 - 5.8
 - 6.1
14. Which of the following will contribute to driving a reaction in the forward direction?
- $T\Delta S$ is 0
 - ΔG is positive
 - ΔS is negative
 - ΔS is positive
 - ΔH is positive
15. When non-polar molecules are dissolved in water, which of the following is true?
- The normal clathrate structure of water is broken up
 - H₂O forms a clathrate-like structure around the non-polar molecules
 - The entropy of the system increases
 - H-bonds form between the non-polar molecules and water
 - Charge-dipole interactions hold the molecules in solution
16. Which of the following chemical groups is added to proteins during post-translational modification of amino acid residues?
- hydroxyl
 - imidazole
 - carboxyl
 - a & c
 - all of the above
17. Which of the following cations is not normally found in organisms?
- Na⁺
 - Ca²⁺
 - K⁺
 - Mg²⁺
 - Li⁺
18. Which of the following properties characterize alanine?
- has no D and L stereoisomers.
 - is the smallest amino acid.
 - forms H-bonds with its side chain
 - a & b
 - none of the above
19. If the H⁺ concentration in a solution is 6.0×10^{-4} M, the pH will be
- 2.22
 - 3.22
 - 4.22
 - 4.60
 - 6.04

20. Which of the following amino acids has a side chain that absorbs light in the 260-280 nm range?
- a. Trp
 - b. Arg
 - c. His
 - d. a & c
 - e. all of the above
21. The ΔG° for the reaction below is -24 kJ/mol at 25° C. What is the Gibbs free energy change for the reaction if [A] and [B] are each 0.01 M in concentration and [C] is 0.10 M? R is 8.31 J/°K·mol
- $$A \leftrightarrow B + C$$
- a. -20 kJ/mol
 - b. -23 kJ/mol
 - c. -30 kJ/mol
 - d. -35 kJ/mol
 - e. -40 kJ/mol
22. The ΔG° for binding a substrate to an enzyme is -5.9 kJ/mol at 37° C. What is the Keq for the reaction? R is 8.31 J/°K·mol
- a. 1
 - b. 10
 - c. 100
 - d. 1000⁵
 - e. 10000
23. An amino acid with N in its side chain is
- a. Ala
 - b. Trp
 - c. Tyr
 - d. a & b
 - e. all of the above
24. The buffer range for a weak acid is
- a. pI \pm 1
 - b. pKa \pm 1
 - c. pOH \pm 1
 - d. pI \pm 2
 - e. pKa \pm 2
25. The molecular weight of a protein containing 600 residues is about
- a. 32000
 - b. 36000
 - c. 50000
 - d. 72000
 - e. none of the above
26. In TOF mass spectrometry of proteins the first to reach the detector will have the
- a. largest size
 - b. lowest m/z ratio
 - c. highest charge at pH 2
 - d. lowest pI
 - e. greatest polarity

27. Which of the following would serve as the best buffer for a reaction at pH = 7.9?

| | Ka |
|--|------------------------|
| a. acetic acid | 1.74×10^{-5} |
| b. pyridine | 5.90×10^{-6} |
| c. H_2PO_4^- | 1.38×10^{-7} |
| d. tris-hydroxymethylaminomethane (TRIS) | 8.32×10^{-9} |
| e. ethylamine | 1.78×10^{-11} |

28. Hydrophobic interactions are

- a. entropy driven
- b. electrostatic in nature
- c. due to van der Waals attractive forces
- d. the strongest of weak interactions
- e. enthalpy driven

29. At physiological pH the charged amino acid residues comprise approximately what percent of all residues in a protein?

- a. 5 %
- b. 12%
- c. 25%
- d. 45%
- e. 55%

30. Which of the following amino acids would be the most conservative replacement for M in a protein, and thus most likely to maintain the protein's structure and activity?

- a. E
- b. C
- c. R
- d. L
- e. A

31. Which amino acid can be phosphorylated post-translationally?

- a. Y
- b. C
- c. I
- d. a & b
- e. all of the above

32. What is the ratio of the concentration of a weak acid to its conjugate base when the pH of a solution is one unit above the pKa of the weak acid?

- a. 1:2
- b. 1:10
- c. 10:1
- d. 2:1
- e. 1:1

33. Which amino acid has a side chain that is linked to both the α -C and the α -N?
- alanine
 - isoleucine
 - leucine
 - valine
 - proline
34. Which amino acid reacts with aldehydes to form Schiff bases?
- C
 - D
 - N
 - K
 - T
35. What is the pI value for histidine, which has pKa values of 2.1, 6.0, and 9.8?
- 2.1
 - 4.05
 - 5.96
 - 7.9
 - none of the above
36. Which peptidase or chemical could you use to cleave the oligopeptide: ITSAMYSTERY?
- trypsin
 - V8 protease
 - cyanogen bromide
 - a & b
 - all of the above
37. Which of the following amino acids has a hydroxyl in its R group?
- tyrosine
 - asparagine
 - cysteine
 - a & b
 - a & c
38. What is the enthalpy change for a solution when a salt such as LiCl is dissolved in water? Remember, the solvation of lithium chloride is exothermic.
- no significant change in H, i.e. ΔH is about 0 in value
 - decrease in H, i.e., ΔH is negative in value
 - increase in H, i.e., ΔH is positive in value
 - cannot predict
39. If the quaternary structure of a protein is comprised of two alpha and two beta polypeptides, the protein will be a
- homodimer
 - heterodimer
 - homotetramer
 - heterotetramer
 - alphabetamer

40. At pH 2 what charge is carried by the peptide: ITSAMYSTERY?
- a. +4
 - b. +3
 - c. +2 (Correct based on the typical C-terminal pKa of 4-5)
 - d. +1 (Acceptable, since free amino acid pKa1 is 2)
 - e. 0
41. The fluorescence of Green Fluorescent Protein (GFP) is due to
- a. oxidation of an amino acid sequence in the protein to create a prosthetic group
 - b. post-translational modification of lysine by hydroxylation
 - c. post-translational modification of three tyrosine residues by phosphorylation
 - d. attachment of a fluorescent prosthetic group to the protein
 - e. binding to a modified small RNA
42. If $\Delta H = 100 \text{ kJ/mol}$ and $\Delta S = 0.25 \text{ kJ/}^\circ\text{mol}$, for a reaction at 25°C , what is the change in free energy for the reaction?
- a. 36.3 kJ/mol
 - b. 25.5 kJ/mol
 - c. 22.5 kJ/mol
 - d. 14.4 kJ/mol
 - e. 93.8 kJ/mol
43. ΔG° represents
- a. the Gibbs free energy for a reaction
 - b. the Gibbs free energy difference where all reactants and products are 1M or 1 atmosphere
 - c. the Gibbs free energy difference at equilibrium
 - d. the standard state Gibbs free energy change with pH set at 1.0
 - e. the standard state Gibbs free energy change with pH set at 7.0
44. The pKa value for an acidic group can sometimes depend on the solution conditions or the immediate environment of the group. If glutamic acid is dissolved in a dioxane/water mixture rather than water, how will the pKa value of its side chain be affected? Hint: dioxane has a lower dielectric constant than water.
- a. it will increase
 - b. it will decrease
 - c. it will be essentially unchanged
 - d. cannot predict
45. Given 0.1 M solutions of K_2HPO_4 and KH_2PO_4 , in what ratio should they be mixed to yield a solution of pH 7.51? (For H_3PO_4 , $\text{pK}_{a1} = 2.12$, $\text{pK}_{a2} = 7.21$, $\text{pK}_{a3} = 12.32$)
- a. 1:1
 - b. 2:1
 - c. 2.5:1
 - d. 3:1
 - e. 4:1

Bonus question

46. The transition point for heat denaturation of a protein is called the melting temperature. At this point

- a. $\Delta H = T\Delta S$
- b. $\Delta H < T\Delta S$
- c. $\Delta G = T\Delta S$
- d. $\Delta G = -T\Delta S$
- e. $\Delta G = \Delta H$

Answer the following questions on the back of your Scantron sheet.

47. Give the single letter abbreviations for the following amino acids and draw their complete chemical structures at pH 7, showing all charges present on the majority of the molecules at this pH

- a. asparagine
- b. histidine

48. Paraphrase the 2nd Law of Thermodynamics and give the thermodynamic term and abbreviation that arises from it.

49. A van't Hoff plot of $\ln K_{eq}$ vs. $1/T$ can be used to determine what 2 thermodynamic parameters?