BIOL/CHEM 3361   Name_____
Fall 2010
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 last 6 digits of your UTD
ID (starting in the first column on the left and leaving the last spaces blank). 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 will generate the least amount of hydrophobic interactions?
    a. tryptophan
    b. alanine
    c. methionine
    d. valine
    e. phenylalanine

2. Which amino acid has the side chain $(CH_2)_3$ and is really an imino acid?
    a. proline
    b. isoleucine
    c. leucine
    d. valine
    e. alanine

3. The principal intracellular cation and buffer system are:
    a. K^+ and bicarbonate
    b. Mg^{2+} and bicarbonate
    c. K^+ and phosphate
    d. Mg^{2+} and phosphate
    e. Na^+ and bicarbonate

4. The Second Law of Thermodynamics says that
    a. a chemical reaction will occur spontaneously only if it results in a net release of free energy
    b. the total amount of energy in the universe is constant
    c. the total amount of entropy in the universe is always increasing
    d. a chemical reaction will proceed spontaneously only if entropy increases
    e. a chemical reaction will proceed spontaneously only if entropy decreases

5. Compared to C-C single bonds, individual weak interactions are
    a. 5 times or more as strong
    b. equal in strength
    c. 1/10 or less as strong
    d. 1/50 or less as strong
    e. 1/100 or less as strong

6. Arginine is
    a. amphipathic
    b. aromatic
    c. anionic on its side chain
    d. a & b
    e. all of the above

7. Which of the following amino acids occurs in many organisms but in only a few of their proteins??
    a. glycine
    b. lysine
    c. phenylalanine
    d. selenocysteine
    e. isoleucine

8. Calculate the final pH of a solution made by the addition of 5 ml of 50 mM NaOH to 10 ml of
    50 mM weak acid (pKa 6.6).
    a. 7.6
    b. 6.9
    c. 6.6
    d. 4.9
    e. 3.3

9. A reaction is at equilibrium if and only if
    a. ΔG is 0
    b. ΔG is negative
    c. $T\Delta S$ is 0
    d. $T\Delta S$ is negative
    e. ΔH is 0

10. At physiological pH the positively and negatively charged amino acid residues comprise approximately
    what percent of all residues in a protein?
    a.   5 %
    b.   10%
    c.   25%
    d.   45%
    e.   55%

11. Which amino acid can carry a negative charge on its side chain?
    a. Y
    b. D
    c. C
    d. a & b
    e. all of the above

12. When non-polar molecules are dissolved in water, which of the following is true?
    a. The normal clathrate structure of water is broken up
    b. Charge-dipole interactions hold the molecules in solution
    c. The entropy of the system increases
    d. H-bonds form between the non-polar molecules and water
    e. H_2O forms a clathrate-like structure around the non-polar molecules

13. Iodoacetamide reacts specifically with which amino acid?
   a. A
   b. C
   c. I
   d. D
   e. S

14. Disulfide bridges in proteins are the oxidation product of
   a. Tyr
   b. Met
   c. Cys
   d. Thr
   e. Ser

15. Which of the following chemical groups is added to serine during post-translational modification of amino acids?
   a. hydroxyl
   b. thiol
   c. carboxyl
   d. phosphate
   e. methyl

16. Which elements comprise the predominant divalent cations in organisms
   a. Ca^{2+} and Zn^{2+}
   b. Mg^{2+} and Mn^{2+}
   c. Zn^{2+} and Cu^{2+}
   d. Zn^{2+} and Mo^{2+}
   e. Ca^{2+} and Mg^{2+}

17. Which form of chromatography uses a decreasing salt gradient to elute proteins?
   a. hydrophobic chromatography
   b. anion exchange chromatography
   c. cation exchange chromatography
   d. affinity chromatography
   e. gel filtration

18. Calculate the pH of 1.0×10^{-4} M HCl.
   a. 11.0
   b. 4.0
   c. 1.0
   d. 2.0
   e. 2.5

19. Which standard amino acids have peaks in their absorption spectra near 280 nm?
   a. His and Phe
   b. D and E
   c. Trp and Tyr
   d. Se-cys and Cys
   e. H and F

20. The largest and least frequently occurring amino acid among the classic 20 standard amino acids is
    a. G
    b. V
    c. S
    d. Y
    e. W

21. In isoelectric focusing proteins are separated in the basis of their
    a. size
    b. charge at pH 2
    c. m/z ratio
    d. pI
    e. polarity

22. What is the enthalpy change for a solution when a salt such as ammonium sulfate is dissolved in water? Remember, the solvation of ammonium sulfate was endothermic.
    a. no significant change, i.e. about 0 in value
    b. decrease, i.e., negative in value
    c. increase, i.e., positive in value
    d. cannot predict

23. The $\Delta G^{o'}$ for the reaction below is -30 kJ/mol at 25° C. What is the Gibbs free energy change for the reaction if all species are 10 mM in concentration? R is 8.31 J/°K·mol
$$A + B \leftrightarrow C$$
    a. -18.6 kJ/mol
    b. -24.3 kJ/mol
    c. -30.0 kJ/mol
    d. -37.7 kJ/mol
    e. -40.3 kJ/mol

24. The energy of which of the following non-covalent interactions depends on r^{-1}?
    a. dipole-dipole
    b. charge-charge
    c. charge-dipole
    d. dipole-induced dipole
    e. hydrogen bonding

25. The buffer range for a weak acid is
    a. $pI \pm 1$
    b. $pKa \pm 2$
    c. $K_A \pm 1$
    d. $pI \pm 2$
    e. $pKa \pm 1$

26. The number of amino acid residues in a protein with molecular weight of 120,000 is about
    a. 1100
    b. 1000
    c. 220
    d. 200
    e. none of the above

27. Which of the following would serve as the best buffer for a reaction at pH = 5.1?

		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. What is the pI value for cysteine, which has pKa values of 1.7, 8.3, and 10.7?
    a. 5.0
    b. 6.9
    c. 8.3
    d. 8.5
    e. none of the above

30. The binding of an enzyme to its substrate has a $\Delta G°´ = -28.5$ kJ/mol at 25°C. Calculate the equilibrium constant for this substrate-protein interaction. R = 8.31 J/°K·mol
    a. 10^{10}
    b. 10^{12}
    c. 10^{6}
    d. 10^{8}
    e. 10^{5}

31. What is the ratio of the concentration of a weak acid to its conjugate base when the pH of a solution is 1 unit above the pKa of the weak acid?
    a. 1:2
    b. 1:10
    c. 10:1
    d. 2:1
    e. 1:1

32. The central set of biochemical reactions is common to all three domains of life on earth. These domains have been named
    a. protists, fungi, bacteria
    b. animals, plants, fungi
    c. bacteria, fungi, higher eukaryotes
    d. archaea, bacteria, eukaryotes
    e. dogs, cats, parrots

33. Calculate the pH of a 0.1 M solution of a weak acid with a pKa of 5.0.
    a. 7.00
    b. 6.10
    c. 5.09
    d. 4.50
    e. 3.00

34. CM-cellulose is used for
    a. anion exchange chromatography
    b. cation exchange chromatography
    c. gel filtration
    d. affinity chromatography
    e. hydrophobic chromatography

35. What amino acid has the one letter symbol D?
    a. glutamine
    b. lysine
    c. phenylalanine
    d. histidine
    e. aspartic acid

36. In ESI-TOF MS, peptides are separated based on
    a. mass
    b. charge
    c. density
    d. a and b
    e. all of the above

37. The Edman reagent phenyl isothiocyanate reacts with
    a. C-terminus of a protein
    b. N-terminus of a protein
    c. R-group of tryptophan
    d. R-group of lysine
    e. disulfide bridges

38. Which peptidase or chemical could you use to cleave the oligopeptide: THEANSWERIS?
    a. trypsin
    b. V8 protease
    c. cyanogen bromide
    d. a & b
    e. all of the above

39. $\Delta G°'$ 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

40. 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

41. The folded 3-D structure of a protein represents what level of its structural organization?
   a. primary
   b. secondary
   c. supersecondary
   d. tertiary
   e. quaternary

42. At pH 7 what charge is carried by the peptide: THEANSWERIS ?
   a. +3
   b. +2
   c. +1
   d. 0
   e. -1

43. After phosphorylation of the <u>internal</u> serine in the 11-mer in the preceding question and digestion with chymotrypsin, the products will be
   a. two peptides that can be separated by anion exchange chromotography at pH 6
   b. two peptides that cannot be separated by anion exchange chromotography at pH 6
   c. three peptides that can be separated by anion exchange chromotography at pH 6
   d. three peptides that cannot be separated by anion exchange chromotography at pH 6

44. 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 hydroxylaton
   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

45. A van't Hoff plot of lnKeq vs. 1/T can be used to determine
   a. Ka
   b. $\Delta H°$
   c. $\Delta S°$
   d. a and b
   e. b and c

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

46. Draw the complete structure of the predominant form of the following tetrapeptide at pH 7, showing all charges.

   Cys-Asp-Leu-His

Bonus question:
47. What are the two ways most often used today to volatilize and charge polypeptides for sequencing by mass spectrometry?

EXAM I

Additional Questions for BIOL 6352 grad students (Answer on this page, sign above, and turn in with your
    Scantron sheet):

1. Gel filtration chromatography separates proteins on the basis of size and shape. Assuming all proteins in
    a mixture are globular, which will elute from the column first, and which last? Explain why.

2. How can the equilibrium between bicarbonate and carbonic acid be involved in extracellular buffering
    when the pKa for this reaction is 3.57 at 37° C?

3. For reactions involving weak interactions in water, explain why an increase in entropy during the
    reaction is usually accompanied by an increase in enthalpy.