BIOL/CHEM 3361 Name_____
Fall 2012

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).
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 properties characterize(s) the side chain of tyrosine?
   a. contains a weak acid group with pKa about 10
   b. is amphiphilic (aka amphipathic)
   c. absorbs UV light at 280 nm
   d. a & b
   e. all of the above

2. Which of the following will contribute to driving a reaction in the forward direction?
   a. $T\Delta S$ is 0
   b. ΔG is positive
   c. ΔS is negative
   d. ΔS is positive
   e. ΔH is positive

3. 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. H_2O forms a clathrate-like structure around the non-polar molecules
   c. The entropy of the system increases
   d. H-bonds form between the non-polar molecules and water
   e. Charge-dipole interactions hold the molecules in solution

4. Defining r as the distance of separation of centers of charge, the energy of dipole-dipole interactions is a function of
   a. r^{-1}
   b. r^{-2}
   c. r^{-3}
   d. r
   e. r^2

5. Which of the following amino acids would be the most conservative replacement for an Asp residue in a protein, and thus least likely to change the protein's structure and activity?
   a. Glu
   b. Cys
   c. Arg
   d. Gly
   e. Tyr

6. The pKa of the side-chain carboxylic group of glutamic acid residue will rise as a result of
   a. increasing dielectric constant of the solution
   b. decreasing dielectric constant of the solution
   c. the presence of a of a neighboring glutamate residue
   d. a and c
   e. b and c

7. Which of the following amino acids has a side chain that cannot participate in charge-charge interactions?
   a. arginine
   b. aspartic acid
   c. glutamine
   d. histidine
   e. lysine

8. Which of the following amino acids has an α-N that is covalently linked to the R group?
   a. P
   b. W
   c. L
   d. F
   e. G

9. Which of the following amino acids has a side chain that can participate in H-bonding?
   a. Leu
   b. Phe
   c. Gly
   d. Ser
   e. Ala

10. The regularly recurring arrangement of the polypeptide chain to form α helices represents which level of protein structure?
   a. primary
   b. secondary
   c. supersecondary
   d. tertiary
   e. quaternary

11. Which amino acid has a side chain that can be post-translationally phosphorylated?
   a. I
   b. K
   c. M
   d. R
   e. T

12. Which of the following weak acids would serve as the best buffer for a reaction at pH = 6.1?

	Ka
a. acetic acid	1.74×10^{-5} M
b. MES	7.94×10^{-7} M
c. $H_2PO_4^-$	6.17×10^{-8} M
d. HEPES	2.82×10^{-8} M
e. TRIS	8.32×10^{-9} M

13. If the pKa of a histidine residue in the active site of an enzyme has been shifted to 5.1 and the pH of the organelle containing the enzyme is 5.5, what fraction of this residue will be + charged?
    a. 28%
    b. 40%
    c. 55%
    d. 67%
    e. 75%

14. If 20 mM H^+ is produced during an enzyme-catalyzed reaction where the starting buffer is 50 mM Tris-HCl), pH 8.1, what will be the pH at the end of the reaction? (For Tris, pKa = 8.1)
    a. 5.90
    b. 6.10
    c. 6.65
    d. 7.10
    e. 8.10

15. How many fragments will result from complete V8 protease cleavage of the following peptide: BREAKTHISPEPTIDE?
    a. 1 peptide and 2 amino acids
    b. 1 peptide and 3 amino acids
    c. 2 peptides and 1 amino acid
    d. 2 peptides and 2 amino acids
    e. three peptides and no amino acids

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

17. Which of the following amino acid residues can be post-translationally acetylated on the side chain?
    a. Lys
    b. Met
    c. Cys
    d. a and c
    e. all of the above

18. The most abundant divalent cations in biological systems are
    a. Na^+ and K^+
    b. Ca^{2+} and Mg^{2+}
    c. Ca^{2+} and Mn^{2+}
    d. Cu^{2+} and Mg^{2+}
    e. Cu^{2+} and Zn^{2+}

19. Hydrophobic chromatography
    a. is also known as reverse phase chromatography
    b. uses an increasing salt gradient to elute proteins
    c. uses a polar mobile phase
    d. a and c
    e. all of the above

20. The H^+ concentration in a pH 7.4 solution is
    a. 1.0×10^{-4} M
    b. 4.0×10^{-6} M
    c. 1.0×10^{-6} M
    d. 6.0×10^{-7} M
    e. 4.0×10^{-8} M

21. CM-cellulose would be used for what type of chromatography?
    a. anion exchange
    b. cation exchange
    c. hydrophobic
    d. affinity
    e. molecular sieve (aka gel filtration)

22. In MALDI TOF mass spectrometry of peptides, the first to reach the detector will be those with the
    a. lowest m/z ratio
    b. highest m/z ratio
    c. smallest size
    d. highest plus charge
    e. lowest pI

23. The $\Delta G^{o\prime}$ for the reaction below is -14 kJ/mol at 25° C. What is the Gibbs free energy change for the reaction if A and B are 1 mM and C is 10 mM? R is 8.31 J/°K·mol

$$A + B \leftrightarrows C$$

    a. +2.0 kJ/mol
    b. +8.8 kJ/mol
    c -8.3 kJ/mol
    d. -13.5 kJ/mol
    e. -36.8 kJ/mol

24. The $\Delta G^{o\prime}$ for the hydrolysis of ATP to ADP + P_i is -31 kJ/mol at 25° C. What is the Keq′ for this reaction? R is 8.31 J/°K·mol
    a. 3.60×10^{-6} M
    b. 3.60×10^{-5} M l
    c. 7.55×10^{4} M
    d. 2.75×10^{5} M
    e. 2.75×10^{6} M

25. For a weak acid, over the pH range pKa ± 3, the ratio of [conjugate base]/[acid] will vary from
    a. 1/5 to 5/1
    b. 1/10 to 10/1
    c. 1/100 to 100/1
    d. 1/500 to 500/1
    e. 1/1000 to 1000/1

26. ΔS is responsible for
    a. hydrophobic interactions
    b. osmotic pressure
    c. diffusion of solutes
    d. a and b
    e. all of the above

27. A homotrimeric protein of M_r 36,000 will be comprised of 3 polypeptides, each of which will contain approximately
    a. 50 amino acid residues
    b. 75 amino acid residues
    c. 100 amino acid residues
    d. 300 amino acid residues
    e. 600 amino acid residues

28. In what order will the following proteins be expected to band in an SDS PAGE gel starting with the slowest migrating and ending with the fastest?
    Protein A, M_r 88,000, pI 7.1; protein B, M_r 11,000, pI 7.8; protein C, M_r 21,000, pI 6.6
    a. A, B, C
    b. A, C, B
    c. C, A, B
    d. C, B, A
    e. B, A, C

Bonus question

29. In isoelectric focusing, which of the proteins in the preceding problem will be closest to the cathode?
    a. A
    b. B
    c. C

30. At physiological pH the negatively and positively charged amino acid residues comprise about what percent of all residues in a protein?
    a. 5 %
    b. 12%
    c. 25%
    d. 45%
    e. 55%

31. What is the pI value for Cys-Asp, which has pKa values of 2.7, 4.7, 8.3, and 10.8?
    a. 3.7
    b. 6.5
    c. 6.6
    d. 8.5
    e. 9.6

32. If ΔH = -25 kJ/mol and ΔG = -15 kJ/mol for a reaction at 25°C, what is the change in entropy for the reaction?
    a. -33.6 J/K mol
    b. -25.5 J/K mol
    c. -22.5 J/K mol
    d. +10.0 J/K mol
    e. +40.0 J/K mol

Answer the following 4 questions on the back of your Scantron sheet.

34. 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. cysteine See text

b. histidine Since the pKa for the R group of His is 6.0, the principal form will not have a + charge on the side chain.

35. Paraphrase the 1st Law of Thermodynamics and state the thermodynamic term that arises from it which is useful in considering biochemical systems. Also, state its standard abbreviation and explain what it comprises, i.e., what it represents.
Energy in the universe, or an isolated system, is conserved; it is neither gained or lost but can change in form. Biosystems, which are open systems, can exchange energy and materials with the surroundings. For biosystems, the term that arises from the 1st Law is ENTHALPY. The change in enthalpy during a reaction comprises the change in bond energy between reactants and produces and takes the form of heat and work exchanged with the surroundings at constant temperature and pressure.

36. Do humans have more genes and a more complicated biochemistry than any other organism? Explain citing examples.
All free-living organisms have similar biochemistries. Flowering plants and some fish have more genes than humans.

37. What are the two principal buffer systems in animals and where are they found?
Bicarbonate system in the blood and interstitial fluid.
Phosphate (organic and inorganic) inside cells.

BIOL 6352 Name_____
Fall 2012

EXAM I

Answer the following questions on this sheet and turn in with your Scantron form.

1. a. State the 2 equations that relate $\Delta G°$ 1) to $\Delta H°$ and $\Delta S°$ and 2) to Keq. Then combine these 2 equations and rearrange to derive the van't Hoff equation.

   b. Explain how the van't Hoff equation is used to experimentally determine $\Delta H°$ and $\Delta S°$ values and why the values obtained are approximations.

2. BLAST is the most used program to search for protein homologs in primary sequence data bases and align them. It makes use of a BLOSUM substitution matrix. What is a BLOSUM matrix and what is the physiochemical basis for higher or lower numbers in the matrix?

3. When performing ion exchange chromatography to purify proteins, the pH of the buffer must be between the pI of the proteins and the pKa of the exchanger in order for the proteins to bind to the column? Explain why.

4. Compare the physiochemical changes that occur when lysine residues are methylated versus acetylated.