Chemistry and Biochemistry 153A
Spring 2011

Exam 1

Instructions:

- You will have 1 hour 45 minutes to complete the exam.
- You may use a pencil (recommended) or blue or black ink pen to write your answers. Other color inks will not be graded. Your choice of writing utensil will not affect your ability to request a regrade.
- Only answers on the separate answer sheet, in the indicated space, will be graded; writing anywhere else will be ignored. Be sure to write your name on the answer sheet.
- Do not write in the score boxes on your answer sheet; you will be docked points if you do.
- For answers with a word or sentence limit, words beyond this limit will not be read or graded.
- For short- or multi-answer questions, including irrelevant or wrong information or selections in your answer will cause you to lose points.
- Write legibly. If the grader cannot read your answer, you won't get credit.
- Items you may have on your desk:
  - non-programmable scientific calculator, *without its case or cover*
  - writing utensil(s)
  - student ID

  ALL other items must be placed into a bag, which must be zipped up or closed and pushed *completely* under your chair.
- No hats, hoods, earphones, or cellphones are allowed.
- If you continue to write after 'time' is called, your exam will be taken and docked 10 points.
- **Questions are printed on both sides, as is the colored answer sheet. Be sure you've answered all of the questions!**

1. (3) True or False?
   a. (1) Water is a polar solvent.
   b. (1) Liquid water is more extensively H-bonded than ammonia.
   c. (1) Liquid water is more extensively H-bonded than ice.

2. (8) Complete the following sentences:
   a. (1) The dielectric constant reflects the _____ of a solvent.
   b. (3) A glycogen-like polysaccharide with 10 branch points has ___ reducing end(s) and ___ non-reducing end(s).
   c. (3) _____ are covalent bonds that stabilize the tertiary structure of some proteins. They are formed through the _(choose one: oxidation or reduction)_ of two _____ amino acids.
   d. (1) _____ are the energy-storage lipids of animals.

3. (2) Briefly define the hydrophobic effect (in 12 words or fewer).

4. (3) Briefly describe the role of water in the hydrophobic effect (in 30 words or fewer).

5. (3) How does the hydrophobic effect contribute to protein folding? Briefly explain in 20 words or fewer.

6. (3) The following sentence is famous for containing all of the letters of the English alphabet:

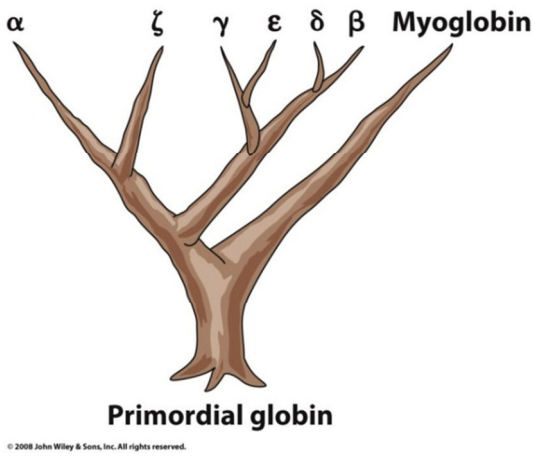
   The quick brown fox jumps over the lazy dog.

   Which of the words of this sentence can be 'written' as a peptide (using 1-letter abbreviations)? Choose all that apply:

   a. the
   b. quick
   c. brown
   d. fox
   e. jumps
   f. over
   g. lazy
   h. dog

7. (3) Which carbon of D-glyceraldehyde is the most reduced? Show your reasoning.

8. (13) Recall the hemoglobin and myoglobin evolutionary tree we discussed in lecture (shown at right):



   a. (2) α, ζ, γ, ε, δ, β, and myoglobin belong to what group of biomolecules?
      A. proteins
      B. carbohydrates
      C. lipids
      D. intermediates

   b. (3) Regarding the relationship between α, ζ, γ, ε, δ, β, and myoglobin, they are (choose all that apply):
      A. homologs
      B. heterologs
      C. orthologs
      D. metalogs
      E. paralogs

   c. (2) What do the branch points in the tree represent? Briefly explain in 5 words or fewer.

   d. (2) What do the lengths of the branches represent? Briefly explain in 20 words or fewer.

   e. (2) Which of the following, if any, is most closely related to α?
      A. ζ
      B. γ
      C. ε
      D. δ
      E. β
      F. Myoglobin
      G. None of these

   f. (2) Which of the following, if any, is most closely related to myoglobin?
      A. α
      B. ζ
      C. γ
      D. ε
      E. δ
      F. β
      G. None of these

9. (35) Consider a peptide whose sequence spells the word TIE.

    a. (2) Write the sequence of this peptide using 3-letter abbreviations.

    b. (4) Complete the provided backbone to show the peptide in its predominant form at pH 7, with the correct alpha-carbon stereochemistry.

    c. (2) To your drawing, add boxes that enclose the atoms that make up each peptide plane.

    d. (3) To your drawing, add labels to indicate the bonds about which the phi and psi dihedral angles are measured.

    e. (4) What ionizable group(s) does the peptide have? List each group and its approximate pKa.

    f. (2) Over what pH range(s) does the peptide act as a buffer?

    g. (3) What is the pI of the peptide? Show your reasoning.

    h. (1) What is the predominant charge state of the peptide at pH 7?

    Consider the titration of TIE with a strong acid, and answer the following questions:

    i. (1) How many H^+ equivalents would be required to fully titrate the peptide?

    j. (1) Which group would be the first to be titrated?

    k. (3) What is the pH of the solution after you've added 0.75 equivalents? Show your reasoning.

    l. (3) What is the average charge of the peptide after you've added 0.75 equivalents? Show your reasoning. (Answer to the nearest tenth, or 0.1, of a charge.)

    True or False? Assess the following statements about the TIE peptide:

    m. (2) The peptide is amphipathic.

    n. (2) The peptide can adopt an α-helical conformation.

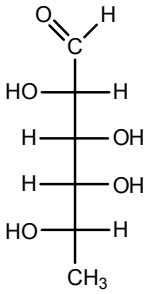
    o. (2) The peptide can form an α-helix (with hydrogen bonds).

Recall our discussion of blood group carbohydrates:

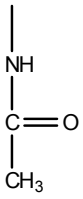
Table 8-1 Structures of the A, B, and H Antigenic Determinants in Erythrocytes

Type	Antigen[a]
H	Gal β(1→4)GlcN Ac ··· ↑1,2 L-Fucα
A	GalN Ac α(1→3)Gal β(1→4)GlcN Ac ··· ↑1,2 L-Fucα
B	Gal α(1→3)Gal β(1→4)GlcN Ac ··· ↑1,2 L-Fucα

[a]Gal, Galactose; GalNAc, *N*-acetylgalactosamine; GlcNAc, *N*-acetylglucosamine; L-Fuc, L-fucose.



L-Fucose



N-acetyl amino modification (on carbon 2)

10. (12) Based on the information provided, complete the provided structure to represent the carbohydrate found in people with type A blood.
11. (4) True or False? Assess the following statements as they apply to your drawn structure:
    a. (1) This is a reducing sugar.
    b. (1) This is a mutarotatory sugar.
    c. (1) This sugar contains a hemiacetal.
    d. (1) This sugar contains a hemiketal.
12. (2) L-Fucose is the 6-deoxy form of what sugar?
13. (2) L-Fucose and D-fucose are:
    a. Hexamers
    b. Epimers
    c. Anomers
    d. Enantiomers

These carbohydrates are attached to lipids in the cell membrane.

14. (3) What is the nature of the attachment of these carbohydrates to the lipids?
    a. Amide linkage
    b. N-glycosidic linkage
    c. O-glycosidic linkage
    d. Ester linkage
    e. Non-covalent interaction
15. (4) The resulting membrane lipids belong to which of the following classes? Choose all that apply:
    a. Gangliosides
    b. Globosides
    c. Phospholipids
    d. Glycolipids
    e. Sphingolipids
    f. Sphingomyelins
    g. Phosphatidylcholines
    h. Sterols