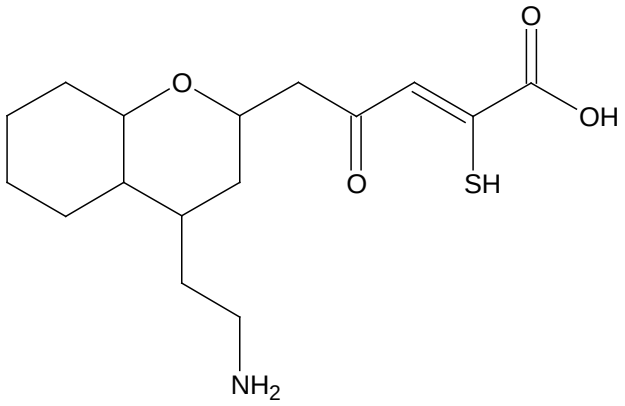
Exam-like questions - October 2000 - Chemistry 341

This are questions similar in format and complexity to the 5 or so that you will have in the exam next Friday

1) What is the approx. energy (in kcal/mole) of a hydrogen bond? And of a salt-bridge? And of a dipole-dipole interaction?

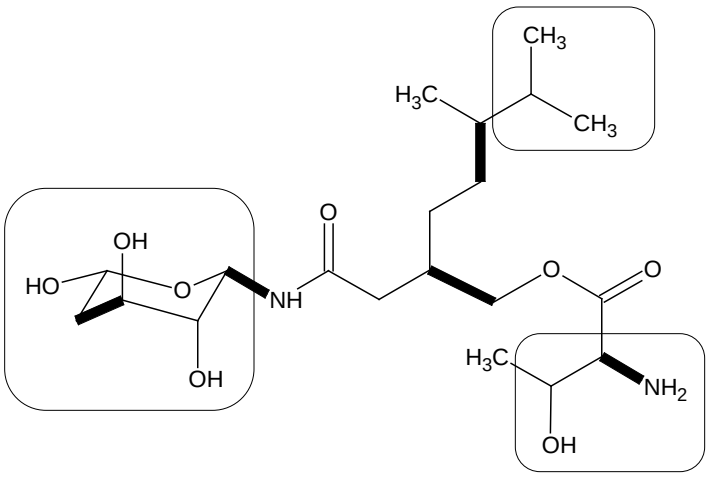
2) In the following molecule, indicate which carbon centers are chiral (i.e., they have four different subsutituents), and which bonds are rotatable.



Remember that we do not draw all the hydrogen atoms in carbons, so to figure out if something is chiral or not, you will first have to mentally include hydrogens.

Is this molecule flexible? If you think some parts are and some aren't indicate it clearly.

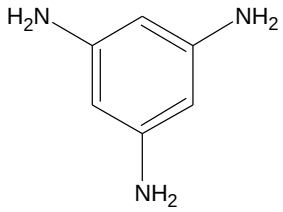
3) In the following molecule, indicate the polarity of the highlighted bonds. For each region of the molecule enclosed in a box, indicate if they are polar or non-polar, and what type of interactions they can form part of (H-bonds, electrostatic, hydrophobic).



4) Which amino acids have side chains that can participate in hydrogen bonds? Draw their structures, three-, and one-letter codes.

5) Which amino acids have side chains that can participate in salt bridges? Draw their structures, three-, and one-letter codes.

6) The following molecule will be likely to participate in non-bonded interactions with which amino acids? What type of interactions will these be? Explain briefly.



7) The two cysteines in the following polypeptide can form a cysteine bridge when oxidized with O_2:

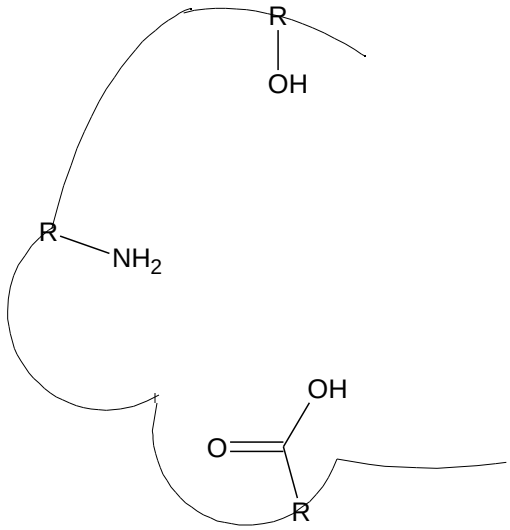
Ala-Cys-Met-Thr-Phe-Gly-Pro-Ala-Leu-Cys-Gly

On the open, reduced polypeptide, the pK_a of the C-terminal carboxylate is 3.5 When the cysteines form the disulfide bridge, the pK_a of the C-terminal carboxylate drops to 2.1. Why?

8) For the following polypeptides: a) Write them with their three-letter codes. b) calculate the isoelectric points (pI), and c) calculate their charges at pH 1, 7, and 14. Use the pK_R of the parent amino acids in your calculations.

   i) G-G-N-T-Q-W-P
   ii) G-G-R-T-E-W-Y
   iii) F-F-G-R-A-K-E-G-G
   iv) A-A-W-N-Q-D-R-K-H-G

9) Design a molecule that will bind tightly with the following 'receptor'. Remember to use the concepts of non-covalent interactions you learned in class.



10) Is the hydrophobic effect better described as a property of the molecule or of the sol0vent it is disolved in? Explain briefly.

11) Draw the full structures of the following polypeptides. In a separate diagram, indicate which atoms form part of the peptide backbone, which atoms form peptide groups, and which atoms form part of the side chains:

i) R-T-W-E
ii) A-L-I-N-M
iii) E-D-C-V-S
iv) A-K-L-I-Y

12) You want to maintain the pH of 1 liter of solution around 4.7 during certain experiment, and you are trying to figure out the concentrations of acetic acid and sodium acetate you will need to prepare your buffer. A friend of yours did the same thing using only dilute HCl, and after the reaction was complete he found that the pH of the solution had climbed all the way to 10. How many moles of acetic acid and acetate you will need to maintain the pH below 5.5 if you are interested in the same reaction your friend performed?

13) To the same solution you prepared above you add 10 g of pure HCl (FW = 36). Considering the change in volume insignificant, what will your final pH be? Is the buffer a good buffer for this addition of strong acid?

14) You have an aqueous solution that contains proline as its sole component.

a) Which forms of proline will you have at pH 2.2? What will be the ratios between these two forms?
b) Same as above, but at pH 11.2.
c) Will proline be an effective buffer near these pH values? Explain briefly.

15) You have a mixture of two peptides with the following primary structures:

Tito: AFDLIGRP
Pepe: MLWQREG

a) For each peptide:

i) Write them using the three-letter code and draw clearly their full chemical structures.
ii) Calculate their isoelectric points.
iii) Calculate their approximate charges at pH 1, 7, and 14

b) What will be the optimal pH to separate Tito and Pepe using ion exchange chormatography if you have a cationic exchange column.

16) Design a polyeptide with 5 residues with general structure Ala-Xaa-Xaa-Xaa-Gly (Xaa can be any amino acid) with an isoelectric point (pI) of 10.11.