

BC 367, Exam 1
October 9, 2008

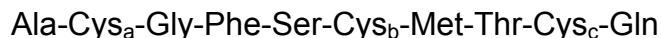
Multiple Choice (3 pts each)- Please circle the single best answer.

1. Given only the information shown here, which of the following statements is true?



- a) Reaction i) is faster than reaction ii).
 - b) Reaction ii) is faster than reaction i).
 - c) Neither reaction is spontaneous.
 - d) At equilibrium, reaction i) will have more products than reaction ii).
 - e) At equilibrium, reaction ii) will have more products than reaction i).
2. Uncontrolled diabetes can lead to acidosis. Which component of the blood buffering system could be administered as treatment for acidosis?
- a) HCO₃⁻
 - b) CO₂
 - c) H₂CO₃
 - d) OH⁻
 - e) Tris buffer

3. Sequencing of a novel peptide reveals the following:



The peptide contains one disulfide bond and one free Cys residue. Treatment of the intact peptide (containing its disulfide bond) by either cyanogen bromide or chymotrypsin does not break the peptide into two fragments. Where is the disulfide linkage?

- a) between Cys_a and Cys_b
- b) between Cys_a and Cys_c
- c) between Cys_b and Cys_c
- d) Between Cys_a and Met
- e) It is impossible to tell from this information

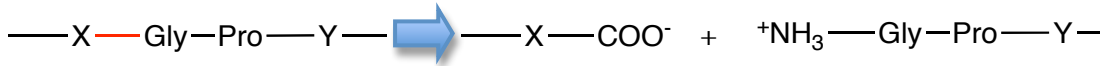
4. Which of the following is *true* with respect to the amino acid composition of proteins?
- a) Homologous proteins have the same amino acid composition.
 - b) All proteins contain at least one each of the twenty different standard amino acids.
 - c) Larger proteins have a more uniform distribution of amino acids than smaller proteins.
 - d) Fibrous proteins often differ significantly in their amino acid compositions from globular proteins.
 - e) The average molecular weight of an amino acid in a protein increases with the size of the protein.
5. Which of the following is *false* regarding the peptide bond?
- a) Peptide bonds in proteins are always in the *trans* configuration.
 - b) Its components have excellent hydrogen bond forming capacity.
 - c) It is essentially planar with no free rotation about the C-N axis.
 - d) Its free energy of formation is thermodynamically unfavorable.
 - e) Peptidyl prolyl isomerases catalyze isomerization of X-Pro peptide bonds, thereby assisting with protein folding.
6. Determination of the precise spacing of atoms within a large protein is possible only through the use of:
- a) a Ramachandran diagram
 - b) molecular model building
 - c) X-ray diffraction
 - d) electron microscopy
 - e) SDS-polyacrylamide gel electrophoresis
7. For the characterization of a novel protein in detail, the first step is usually to
- a) determine its T_M
 - b) determine its amino acid composition
 - c) determine its molecular weight
 - d) determine its amino acid sequence
 - e) purify the protein

8. A sequence of amino acids in a certain protein is found to be –Ser–Gly–Pro–Gly–. The sequence is most probably part of a(n):
- a) β turn
 - b) parallel β sheet
 - c) anti-parallel β sheet
 - d) α helix
 - e) transmembrane protein
9. Which of the following statements concerning protein folding is *false*?
- a) It may involve intermediates with incorrect disulfide linkages.
 - b) It may involve formation of local secondary structures to “seed” further folding.
 - c) It may involve initial formation of a highly compact molten globule.
 - d) It may be an essentially random process.
 - e) It may be defective in some human diseases.
10. Which of these statements about hydrogen bonds is *false*?
- a) Individual hydrogen bonds are quite weak, but multiple hydrogen bonds can lead to strong materials such as Kevlar.
 - b) Hydrogen bonds account for many of water’s unique properties, such as high boiling point and high specific heat.
 - c) Hydrogen bonds stabilize the native structure relative to the unfolded chain.
 - d) Water has more entropy hydrogen bonded to other water molecules than to solute molecules.
 - e) Stronger hydrogen bonds are the reason that anti-parallel β sheets are more favorable than parallel ones.

Short Answer. Please use only the allotted space.

11. (5 pts) Whereas most bacteria are killed by temperatures above 50°C, some thermophilic species thrive at 70-80°C. Briefly describe one way in which proteins of thermophilic bacteria are likely to differ from the analogous proteins of ordinary bacteria.

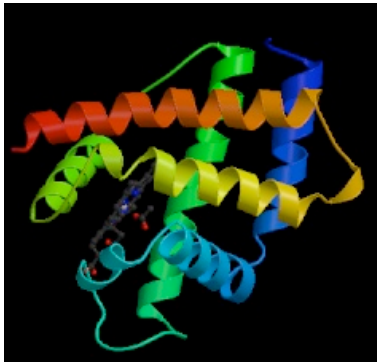
12. (10 pts) The deadly bacterium *Clostridium perfringens* causes gas gangrene. These environmental bacteria enter the host through a wound and secrete enzymes that destroy nearby tissue. The enzymes catalyze hydrolysis of the peptide bond shown in red, where X and Y are any amino acid.



a) How does secretion of this enzyme contribute to the invasiveness of this bacterium in human tissues? (Be as specific as possible.)

b) Why doesn't this enzyme harm the bacterium itself?

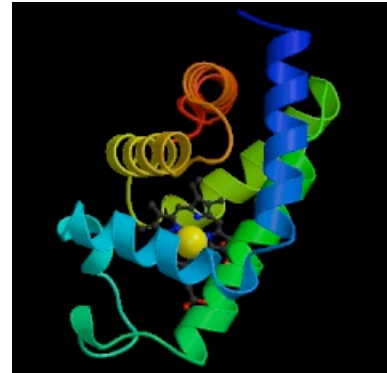
13. (6 pts) The structures shown here were obtained from the protein data bank.



Protein A: leghemoglobin, a heme-containing O₂-binding protein found in nitrogen-fixing bacteria.



Protein B: human myoglobin.



Protein C: the α chain of human hemoglobin.

a) What is the relationship between protein A and protein B?

b) What is the relationship between protein B and protein C?

c) The heme in these proteins is an example of what kind of group?

14. (6 pts) A gel filtration column was calibrated with two known proteins:

- catalase, 232 kDa, elution volume 31.0 mL
- lactate dehydrogenase, 144 kDa, elution volume 48.5 mL

Calculate the molecular weight of an unknown protein with elution volume 36.6 mL.

15. (20 pts) You are trying to separate the components of the mixtures given below.

a) Match each mixture to the number corresponding to its best separation method from this list of possible separation methods:

- | | | |
|----------------------------------|---|-------------|
| 1. Gel filtration chromatography | 2. Ultracentrifugation | 3. Dialysis |
| 4. Ion exchange chromatography | 5. SDS-Polyacrylamide gel electrophoresis | |

Mixtures:

_____ The peptides Val-Leu-Phe and Lys-Asn-Arg

_____ Two proteins of 20 kDa but with different ratios of (Asp + Glu) to (Lys + Arg)

_____ A protein of 100 kDa that exists both as a simple monomer and as a multimer with quaternary structure of > 2000 kDa.

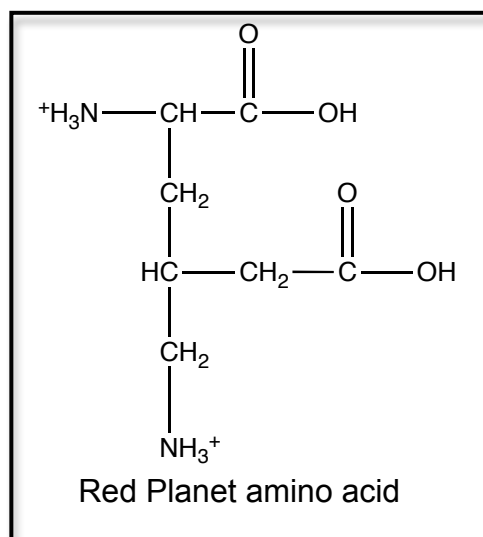
_____ A complex mixture of many globular proteins of varied sizes and charges

_____ A homogenized liver from which you wish to purify mitochondria

b) In one sentence written below each mixture, justify your choices.

16. (10 pts) You wish to prepare a 0.1 M phosphate buffer at pH 7.24 and have available in the lab 1.0 M stock solutions of phosphoric acid (H_3PO_4), HCl, and NaOH. For phosphoric acid, $\text{pK}_{\text{a}1} = 2.1$; $\text{pK}_{\text{a}2} = 6.8$; $\text{pK}_{\text{a}3} = 12.3$. Describe exactly how you will make 1.0 L of this buffer.

17. (8 pts) During the Mars Sample Return mission, NASA plans to use robotic systems to collect samples of martian rocks, soils, and atmosphere for detailed chemical and physical analysis back on Earth. Assume that this mission finds evidence of the amino acid shown here. Sketch the titration curve for this amino acid, labeling the axes and the region(s) of maximum buffering.



18. (20 pts) During physiological research on a mouse system, peptide Z was isolated with hormone activity. Deduce the amino acid sequence of peptide Z from the following information:

A) Acid hydrolysis of peptide Z yielded equimolar Arg, Glu, Val, Gly, Lys, Phe, Thr, Met, and NH_3 .

B) Treatment with dansyl chloride followed by acid hydrolysis gave dansyl-Gly, whereas Thr was released first by carboxypeptidase.

C) Cleavage of peptide Z with trypsin gave three peptides: T-1, T-2, and T-3.

- T-1 was a tripeptide; T-2 a dipeptide; T-3 a tetrapeptide.
- T-1 had amino acid composition = Arg, Phe, Gly.
- The N-terminal of T-2 was Val.
- T-3 tested positive for sulfur, had an absorbance peak near 275 nm, and produced ammonia upon acid hydrolysis. Its C-terminal was Thr.

D) Cleavage of peptide Z with chymotrypsin gave three peptides: C-1, C-2, and C-3.

- C-1 was a tripeptide; C-2 a dipeptide; C-3 a tetrapeptide.
- The N-terminal of C-1 was Met, while its C-terminal was Thr.
- The amino acid composition of C-2 was Phe, Gly.
- The N-terminal of C-3 was Arg.

a) What is the complete sequence of peptide Z?

b) Draw the structure of peptide T-1 at pH 7.0.

c) What is the net charge of peptide Z at pH 7.0?

d) What is the pI of peptide Z?

19. (15 pts) Match each of the following descriptions to a single amino acid from this list:

Met Val Asp Pro Cys Ser Ala

_____ Most likely to be found on the outer surface of a globular protein

_____ Most likely to prefer β sheet over α helix

_____ Donates H-bonds from its side chain at physiological pH

_____ Least likely to be found in an α helix

_____ Chiefly responsible for keratin's strength in materials such as horn

20. (12 pts) The quaternary structure of a multimeric protein in a dilute aqueous solution is thought to be stabilized almost exclusively by hydrophobic associations between its subunits. Which of the following observations would support this conclusion? Explain briefly.

The protein is dissociated into subunits under the following conditions:

a) in solutions of high salt (circle one) supports doesn't support

Explanation:

b) when a water-miscible organic solvent is added to the solution (circle one)

Explanation: supports doesn't support

c) at high concentrations of urea supports doesn't support

Explanation:

total points of 142	_____
final %	_____

Discussion Section and Participation Assessment as of October 3, 2008 (We will fill this in for you.)

Below Average
infrequently contributes in a positive and meaningful way

Average
sometimes contributes in a positive and meaningful way

Above Average
always contributes in a positive and meaningful way