

MBB 694:407, 115:511
First Test Severinov/Deis
Tue. Sep. 30, 2003

Name _____
Index number (not SSN) _____
Row Letter _____ Seat Number _____

This exam consists of two parts. Part I is multiple choice. Each of these 25 questions is worth two points. Answer the Part I questions on this sheet, below. Answer the Part II questions on the question pages.

Please use BLOCK CAPITAL letters like this --- A, B, C, D, E. Not lowercase!

- | | | |
|----------|-----------|-----------|
| 1. _____ | 10. _____ | 18. _____ |
| 2. _____ | 11. _____ | 19. _____ |
| 3. _____ | 12. _____ | 20. _____ |
| 4. _____ | 13. _____ | 21. _____ |
| 5. _____ | 14. _____ | 22. _____ |
| 6. _____ | 15. _____ | 23. _____ |
| 7. _____ | 16. _____ | 24. _____ |
| 8. _____ | 17. _____ | 25. _____ |
| 9. _____ | | |

GRADE:

Part I Total _____

Part II:

II-1 _____

II-2 _____

II-3 _____

II-4 _____

II-5 _____

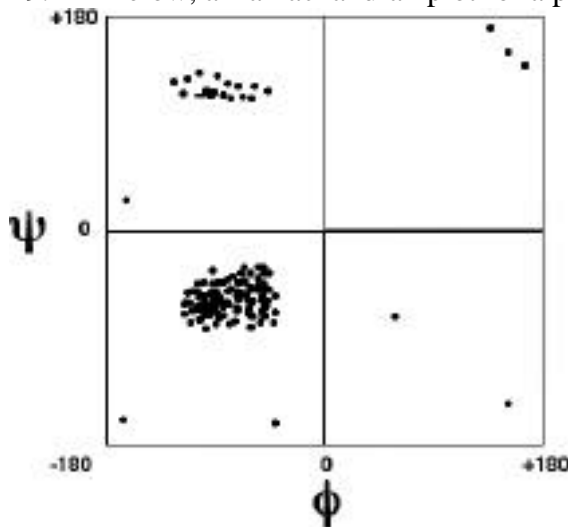
Part II Total _____

Total, I & II _____

1. Which of the following forces would explain a close-range weak attraction between two methyl groups (CH_3)?
A. hydrogen bonding
B. van der Waals forces
C. ionic interactions
D. Hypomethyly
2. Nucleic acid sequences (DNA and RNA) always start with
A. the 5' end
B. the non-reducing end
C. the amino end
D. the carboxy end
3. Which of the following lacks a nucleus and is often found in extreme environments?
A. Eukarya
B. Bacteria
C. Archaea
D. carbon atom
4. A reaction with a positive standard free energy change (ΔG°)...
A. can never go forward
B. will always go forward
C. goes forward if $[\text{R}] \gg [\text{P}]$
D. no way to tell
5. The standard free energy for hydrolysis of ATP to ADP + Pi is about
A. 300 kJ/mol
B. 30 kJ/mol
C. -30 kJ/mol
D. -3 kJ/mol
6. The two major reasons why ATP is a high energy compound are: (pick both)
A. hydrogen bonding
B. charge repulsion
C. anhydride effect
D. phosphates are special
E. resonance stabilization
7. At the scale of 10^8 magnification, used for models (or 2 Å/inch) a typical protein would be roughly the size of
A. an aspirin
B. a baseball
C a football
D. a large pillow
E. a dining room table
F. a campus bus
8. How many different dipeptides can be made from the 20 L-amino acids?
a. 40
b. 400
c. 20!
d. 40!
e. none of the above
9. Of all the possible dipeptides the following have minimal pKa values.
a. KK, KR, RK, RR
b. EE, ED, DE, DD
c. HR, RH, KH, HK
d. EK, ER, DK, DR, KE, KD, RD, RK

10. For the pentapeptide GMRTL, the amino terminal residue is
- Glutamic acid
 - Leucine
 - Glycine
 - Lysine
11. For the same pentapeptide, the net charge at pH 1 is
- +1
 - 1
 - zero
 - +2
12. Terminal residues tend to be on the:
- surface of the protein molecule.
 - inside the molecule.
13. Proline residues are more often found
- inside α -helices
 - at the N-terminal end of α -helices
 - at the C-terminal ends of α -helices
14. If a polypeptide has 400 amino acid residues, what is the approximate mass?
- 11,000 daltons
 - 22,000 daltons
 - 44,000 daltons
 - 88,000 daltons
15. Protein X has 155 amino acids. Protein X contains 10 K residues, 20 A residues, 15 R residues, 10 E residues, 1 D residue, 12 L residues and 5 S residues. You want to purify this protein by binding to an ion exchanger and eluting with a salt gradient. At pH 8.0, which ion exchanger you'd use?
- anion exchanger
 - cation exchanger
16. Proteins are least soluble
- below the pI value
 - at the pI value
 - above the pI value
17. SDS page separates proteins by
- Charge only
 - Size only
 - Both size and charge
18. β -mercaptoethanol helps protein renaturation and assembly by
- Stabilizing the hydrophobic core of the protein
 - Promoting formation of secondary structure
 - Increasing ionic interactions
 - Preventing the formation of incorrect disulphide bonds.

19. Below, a Ramachandran plot for a protein is presented.



This protein is mostly:

- a. α -helical
- b. β -sheet
- c. 50% α -helical and 50% β -sheet

20. The protein from question 19 contains

- a. At least 8 G residues
- b. Does not contain any G residues
- c. Contains no more than 8 G residues

21. Mass-spectrometry determines, with very high precision

- a. The sequence of DNA that codes for protein under study
- b. Proportion of different amino acids in the protein.
- c. The molecular mass of the protein
- d. pI of the protein

22. The phi and psi dihedral angles define the conformation of polypeptide backbone in space because:

- a. There are only 20 amino acids
- b. Because all amino acids are found in L configuration
- c. Because the peptide bond is planar
- d. Because there is steric hindrance between the side chains

23. Lower K_m means that the enzyme has

- a. Better affinity for the substrate
- b. Lowers the activation energy for reaction to a larger extent
- c. The enzyme performs more acts of catalysis at a fixed time interval

24. A competitive inhibitor
- a. Lowers the K_m
 - b. Binds in the substrate center
 - c. Inactivates the enzyme
 - d. Makes a good drug
25. In the cell, for most enzymes the following is true
- a. Enzymes are saturated with substrates
 - b. Enzymes are inactive
 - c. Substrates are present at a concentration that equals K_m
 - d. Enzymes are only partially saturated with their substrates

PART II Answer these questions here on the question pages.

1. a. One mole of Alanine is dissolved in one liter of water, at its isoelectric point. 0.3 moles of NaOH is added to the solution. If the pKa of the carboxyl group is 2.4 and the pKa of the amino group is 9.4, calculate 1) the Isoelectric point, i.e. the pH before Sodium Hydroxide was added and 2) the pH after the addition. State equations, show work, and circle both answers.

(4)

b. The standard free energy change for the reaction $[A] \rightarrow [B] + [C]$ is -16 kJ/mol. If the concentrations observed are $[A] = 1$ M, $[B] = 2$ M, and $[C] = 3$ M, calculate 1) the equilibrium constant for this reaction and 2) the actual free energy change. State equations, show work, circle both answers. $R = 8.3$ J/mol deg, and $T = 300$ K.

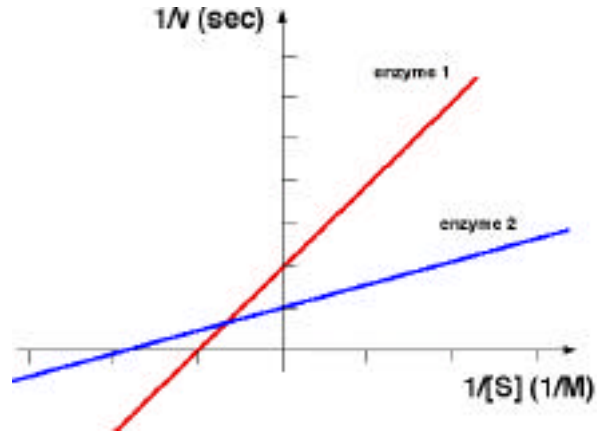
(4)

c. In class, life was called an "emergent property of biomolecules." What does "emergent property" mean? Give a different example.

(2)

2. **10 points.** Using structural formulae, schematically draw the reaction of the DP dipeptide formation from D and P substrates. Draw the reaction product in a *cis* conformation.

3. **10 points.** The graph below shows the enzymatic activity of two enzymes that perform the same enzymatic reaction. Which of the two enzymes has a higher affinity for the substrate? Which of the two enzymes has higher turnover number? Replot the enzymatic activity data in direct coordinates $[v([s])]$.



4. **10 points.** Protein Y has a pI value of 5.3. 50% of this protein is phosphorylated at a Serine residue. Another 20% have a Lysine residue methylated. A sample of protein Y was resolved by isoelectrofocusing and revealed by staining. Schematically draw the expected pattern; indicate which bands will contain unmodified and modified forms of the protein; indicate the polarity of the electric field used to separate the protein by labeling the electrodes as – and +.

5. **10 points.** An SDS gel schematically presented below shows the results of separation of protein mixture containing four polypeptides of 100, 60, 40 and 20 kDa on a gel filtration column (numbers at the top refer to fraction numbers; a smaller number indicates that a corresponding fraction eluted earlier from the column). Identify bands on the gel and provide a plausible explanation for the result of chromatographic separation.

