THE UNIVERSITY OF MANITOBA

April 21, 2008 FINAL EXAMINATION

PAPER NO: 452 LOCATION: E2-229 EIT PAGE NO: 1 of 4

DEPARTMENT & COURSE NO: CHEM 4630 TIME: 3 HOURS

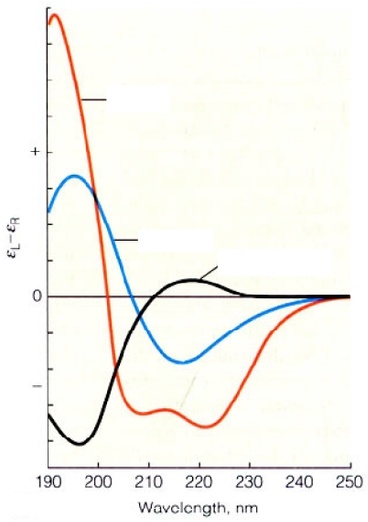
EXAMINATION: Biochemistry of Proteins EXAMINER: J. O'Neil

Section 1: *You must answer all of the following questions in* Section 1. *As a guide you can spend up to 2 hours and 20 minutes on this part of the exam. Wherever possible* ***use diagrams and structures*** *to enhance your answers.*

Marks

6 1. *L*-amino acid oxidase catalyzes the oxidative deamination of a number of *L*-amino acids. It has an absolute specificity for *L*-amino acids and will not recognize *D*-amino acid substrates. Explain what structural features of enzymes make such selectivity possible.

6 2. With the use of the following diagram explain how circular dichroism spectropolarimetry is used in the analysis of protein structure.



8 3. Draw the chemical structure of the tripeptide Gly-Ala-Pro at pH 7 and label all the dihedral angles with Greek letters or names. What conformation do you think the backbone of this peptide prefers? Explain your reasoning.

8 4. What information did V. N. Ramachandran use to construct his Plot? Draw a Ramachandran Plot and label the locations of the right- and left-handed α-helices, parallel and antiparallel β-sheets, the right-hand 3_{10} helix, and the collagen triple helix.

8 5. Name and describe the four levels of protein structure.

6 6. What are Chameleon sequences and what does their existence imply about the predictability of protein secondary structure?

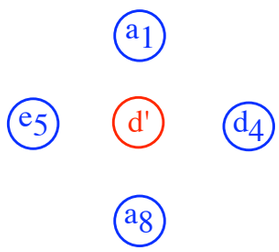
12 7. A π-helix can be designated 4.4_{16}. In words and pictures describe the properties of such a structure. How many turns of helix are there in one repeat of such a helix? How many residues per repeat? If the rise of the helix is 1.2 Å what is the repeat of the helix? What is the pitch?

8 8. Explain the helix propensities of proline and glycine.

Marks

12 9. Identify the following structures. Describe the main features of each using examples wherever possible.

A



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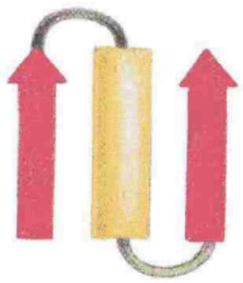

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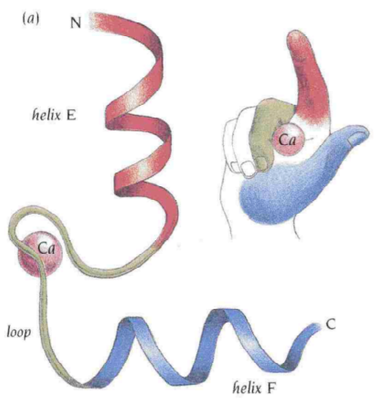

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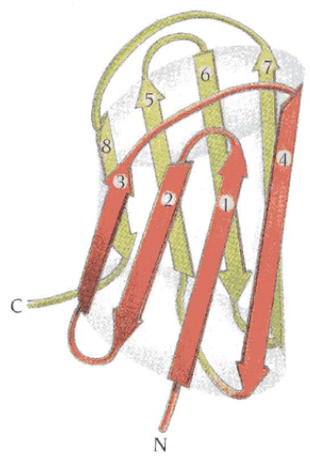
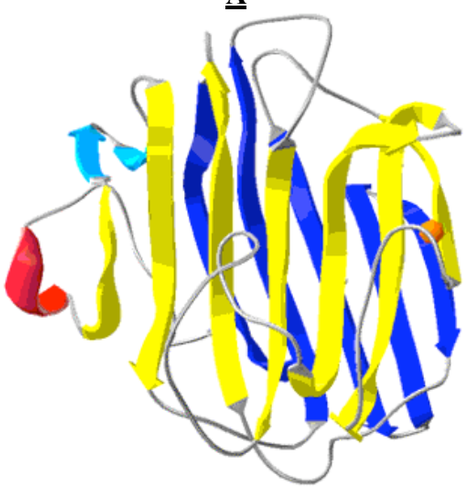


8 10. Figure A shows the structure of an L-type animal lectin involved in protein sorting in the endoplasmic reticulum and golgi apparatus. Figure B shows the structure of a fatty acid binding protein from the heart ventricle of an arctic teleost (having a bony skeleton) fish. Compare and contrast the secondary structures, motifs, and packing of each of these proteins.

A



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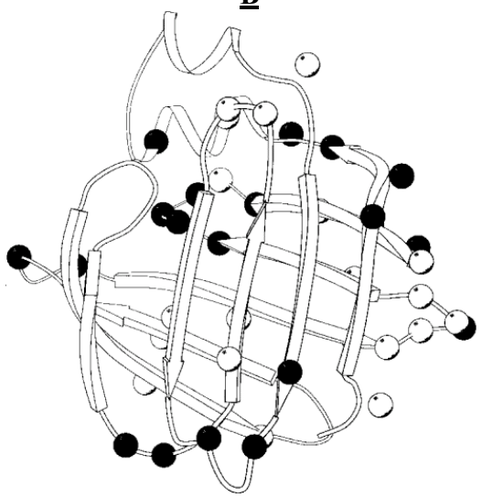

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4 11. What is the timescale for the calculation of 1 step in a molecular dynamics calculation? The amount of time it takes a computer to calculate 1 step of dynamics will depend on the size of the protein and the number of solvent molecules in the simulation. For a small protein 1 molecular dynamics step might take 0.026 seconds. How long would it take to calculate a protein folding trajectory if the protein in question requires 2 seconds to fold.

2 12. How many different conformations can a 10 amino acid peptide form if each amino acid can adopt 3 different conformations?

6 13. What two key discoveries about the folding of proteins were made by the research group of Christian Anfinsen?

10 14. Explain the role of Peptidyl-Prolyl *cis-trans* Isomerase in the folding of proteins. Be sure to show the structure of proline and explain how the isomerase carries out its function.

8 15. Explain the cellular mechanisms that control the formation of disulphide bonds in the endoplasmic reticulum.

8 16. Draw and label a 3-dimensional folding funnel. Outline the main features of protein folding that are illustrated in folding funnels. What feature of the folding funnel illustrates the cooperativity of protein folding?

Section 2: *Answer **1** of the following questions in* Section 2. *You can spend about 15 min. on this question.*

10 17. Using examples, discuss the potential value of high-resolution protein structures to the pharmaceutical industry.

OR

10 18. Explain the concept of fluorescence and how fluorescence spectra are acquired. How can fluorescence be used to monitor protein folding, protein conformational changes, and protein-protein interactions?

Section 3: *Answer **1 part*** of question 19. *You can spend about 25 min. on this question.*

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20 19. With the use of the appropriate diagrams discuss the structure and function of the enzyme cycloxygenase (also known as prostaglandin synthase) ***OR*** the *E. coli* OmpF porin.

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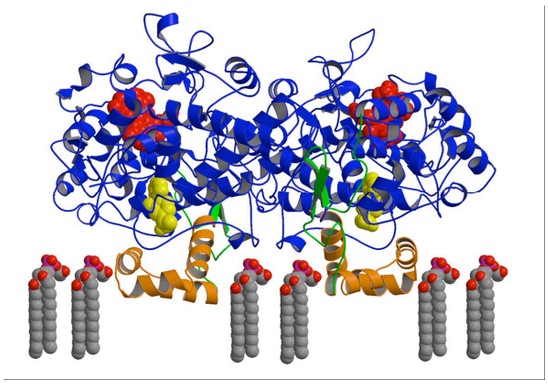

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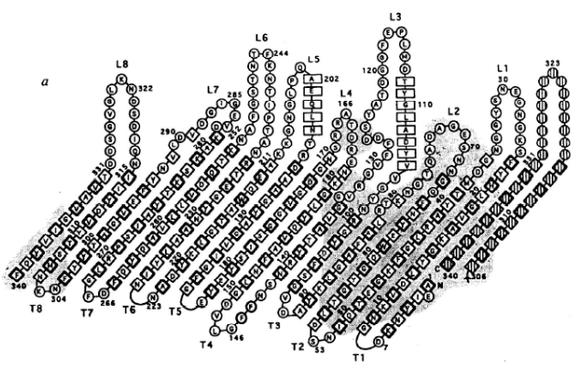

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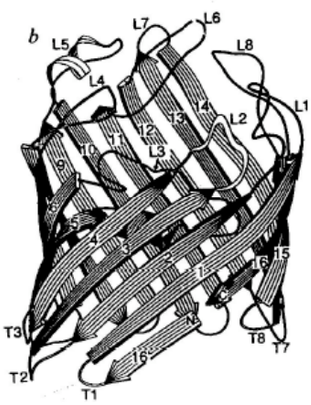

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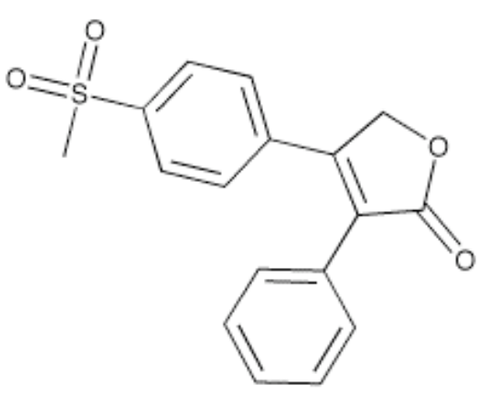

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