

Birkbeck College

University of London

School of Crystallography

Advanced Certificate in Principles of Protein Structure

Friday 22nd September 2000

Answer 5 questions. If more than 5 questions are attempted, only the answers for the 5 highest scoring questions will contribute to the final mark.

1.
  - a) Which amino acid can form disulphide bonds? Draw the chemical structure of a disulphide bond and indicate the approximate length of the sulphur-sulphur bond.
  - b) What type of chemical reaction leads to the formation of disulphide bonds?
  - c) What is the principal structural role of disulphide bonds in proteins? Write brief notes about the structure and function of one protein in which these bonds are important.
2. You have been given a DNA sequence that is believed to code for a protein. Describe the steps that you would take to determine whether it is, in fact, a protein coding sequence. Assuming that it is, what bioinformatics programs and databases could you use to find out as much as possible about the protein's function?
3. Describe, with the aid of diagrams, the structure of one protein that has a beta barrel fold and one that has a non-barrel beta fold. Write brief notes about the function of each.
4.
  - a) What is a lectin? Name three proteins that have been classified as lectins.
  - b) What are the principal non-covalent interactions used in the interaction between lectins and their ligands, and how do these interactions allow lectins to distinguish between different ligands?

5.
  - a) Draw a diagram of a short segment of a polypeptide chain labelling the main chain torsion angles with the appropriate Greek letters. Which of the torsion angles has the least variation and why?
  - b) Draw a Ramachandran plot, labelling the axes and marking the low energy areas associated with alpha-helix and beta-sheet conformations. Where is the region associated with a left-handed alpha helix? Why is this generally less stable than the right-handed helix?
6. What is understood by the quaternary structure of a protein? Illustrate your answer with examples of four proteins that each exhibits a different point group symmetry. State how the oligomeric structure is relevant to the biological function.
7. What are the three types of RNA usually found in living organisms? Write notes on the biological role of each type.
8. Describe the DNA binding helix-loop-helix motif? Discuss examples of one prokaryotic and one eukaryotic protein that have this feature.
9. Discuss how the following properties of the twenty L-amino acids are important in the context of protein structure.
  - a) size
  - b) charge
  - c) polarity
  - d) hydrophobicity
  - e) aromaticity
  - f) conformationally unusual side chains.
10. What is understood by super secondary structure? Write notes and draw diagrams of the following super secondary structure elements.
  - a) beta hairpin
  - b) beta-alpha-beta
  - c) E-F hand
  - d) Greek key
11. Write a comparative account of commonly available software for displaying and manipulating and modelling protein structures.
12. Illustrate with a schematic diagram the structure of an antibody. What has protein crystallography taught us about the way antibodies bind antigens and why is there structural diversity important in the immune system?