Birkbeck College

University of London

School of Crystallography

Advanced Certificate in Principles of Protein Structure

Date: Friday 21st September 2001

Time: 14.30 - 17.30

Answer five questions, including at least two from section B.

Section A

1. Give structural formulae for the 20 amino acid residues that occur in protein molecules. Classify these according to their physical properties. How does this classification affect

a) their position in protein structures

b) their possible interaction with neighbouring residues.

2. Turns serve to reverse the direction of the polypeptide chain. How are turns usually classified into three types? Note any particular amino acid residues that are favoured at any turn positions and explain why. Illustrate your answer by plotting relevant torsion angles on a Ramachandran plot.

3. How is gene transcription regulated in bacteria? What molecules are involved? Illustrate your answer by discussing the regulation of a particular operon.

4. What chemical reaction is catalysed by a protease? Indicate with a diagram the bond that is cleaved during this reaction. Give examples of three types of proteinase, indicating in each case the critical residues required for catalytic activity. A detailed description of the catalytic mechanisms is not required. For one protease, give an example of a protease inhibitor.

5. With the aid of diagrams, give one example each of inner and outer membrane proteins in a Gram-negative bacterium such as E. coli. What algorithm is available for the prediction an integral inner membrane protein, given the amino acid residue sequence?

6. Describe how some commonly used databases of protein structural classification are organised. Give examples of proteins in each of the classes that you discuss, briefly referring to their function.

7. What is a G-protein coupled receptor and how does it function? Illustrate your answer with a schematic diagram. Give examples of some physiological processes that are mediated by these

proteins.

8. What is meant by the term "the twilight zone" in protein bioinformatics? Briefly describe three approaches to investigating the function of a novel protein sequence, and indicate which, if any, of these would be applicable to sequences that lie within the twilight zone.

Section B

9. Describe two proteins in the HIV virus that are the target of drugs against AIDS. You should cover, briefly, the structure of each; its function; its place within the HIV virus life cycle and the mechanism of action of the drugs that target it.

10. What is allostery? Give an account of the structure and mechanism of haemoglobin, explaining carefully the importance of allosteric mechanisms in this protein's function. How do allosteric modulators work?

11. Explain the following interactions in protein structure. For each, give an example with a diagram showing the atom types involved. Sketch a graph showing the strength and direction (attractive/repulsive) of each interaction as a function of the separation distance of the atoms involved.

a) Van der Waals

b) Aromatic-aromatic

c) Salt bridges

d) Hydrogen bonds

12. With the aid of diagrams, give a description of the domain structure of the key molecules of the human immune system and describe the role that they play in conferring protection. Describe how the enormous sequence diversity that is necessary for the immune system to function is generated.

13. Define the terms

a) orthologous

b) paralogous

c) analogous

Give examples of one pair of proteins that are orthologues, one pair that are paralogues and one pair that are analogues. For each pair, give an indication of the differences (if any) between the two proteins in terms of both structure and function.

14. Describe with the aid of diagrams the structure of two multienzyme complexes and the biological functions that they perform. What advantages do such complexes offer over a number of independent enzymes performing the same functions?

(Birkbeck College 2001)