BIRKBECK COLLEGE

(University of London)

Advanced Certificate in Principles in Protein Structure

MSc Structural Molecular Biology

Date: Thursday, 23rd August 2012

Time: 3 hours

You will be given a start time with your exam instructions

Students will be required to answer 10 out of 15 questions.
All questions carry 10 marks each.

Each question must start on a new page and the question number written at the top of each sheet.

1. Answer all parts;

   a) Demonstrate the difference between the L- and D- forms for the amino acid alanine. {2 Marks}.

   b) Which two amino acids have chiral side-chains? {2 Marks}.

   c) Which amino acid is non-chiral and why? {1 Mark}.

   d) Which two amino acid side-chains are hydrophobic, bifurcated and non-chiral? {2 Marks}.

   e) Draw the structures of the three key catalytic residues located at the active site of a serine protease and indicate the chemical properties of each of the side chains. {3 Marks}.

2. Answer both parts;

   a) Draw schematically a parallel, antiparallel and mixed beta-sheet indicating the hydrogen bond arrangement. How would a four-stranded, parallel beta-sheet appear from the perpendicular direction? {4 Marks}.

   b) What are the properties of a standard alpha-helix in the Pauling-Corey model? When can distortions to this secondary structure occur in native proteins? {6 Marks}.

3. Answer all parts;

   a) How is a peptide bond formed? What is the difference between a *trans* and *cis* peptide bond {3 Marks}.

   b) Describe the key features of the hydrogen bond. {2 Marks}.

   c) How are torsion angles defined in a polypeptide. What are the main restrictions placed on these torsion angles in a folded protein? {2 Marks}.

   d) Draw a generalised Ramachandran plot indicating the expected locations of secondary structure elements. {3 Marks}.

4. Describe briefly the six common types of post-translational modifications that may occur in proteins. {10 Marks}.

5. Answer both parts;

   a) Outline how you should approach the preparation of a scientific paper for publication.{5 Marks}.

   b) Discuss scientific fraud and plagiarism.{5 Marks}.

6. Answer all parts;

   a) Describe the type of protein fold that is characterized by a GXGXXG sequence motif and name a ligand that it binds.{5 Marks}.

   b) Outline a typical function for this type of protein. {5 Marks}.

7. Outline the kinds of information stored in the following databases:

   a) UniprotKB. {2.5 Marks}.

   b) Protein DataBank. {2.5 Marks}.

   c) CATH. {2.5 Marks}.

   d) The Pawson Lab. {2.5 Marks}.

8. Answer all parts;

   a) What, in general terms, is the program BLAST used for? {1 Mark}.

   b) Explain in detail how BLAST works and how its output is interpreted in biological terms. Your answer must include a definition of the term “E value”. {5 Marks}.

   c) What does it mean in both mathematical and biological terms if the E value for a match between a test protein sequence and a sequence taken from a database is 0.0? {4 Marks}.

9. Answer all parts;

a) Using a simple shape, sketch a diagram of a trimer with cyclic symmetry. {2 Marks}.

b) Describe in words or make a sketch of how this shape can be arranged to form a hexamer with dihedral symmetry. {2 Marks}.

c) Describe the quaternary structure of the heat shock protein GroELS (HSP60) and outline how it works as a molecular chaperone. {6 Marks}.

10. Outline the roles played by RNA polymerase and the ribosome in transferring information from DNA into proteins. {10 Marks}.

11. Describe the structure and one function for TWO of the following protein domains: Zinc finger, Leucine zipper, EF hand. {5 Marks each}.

12. Answer both parts;

a) Name and describe the structures of two proteins from the influenza virus that bind sugar molecules. Explain briefly the role that each plays in the life cycle of the virus? {4 Marks for each protein}.

b) Which of these molecules is the principal target for anti-influenza drugs? Name one such drug in current clinical use. {2 Marks}.

13. Name and describe in detail four types of interaction that the side chain of the amino acid tyrosine can make with neighbouring atoms or groups in a protein. {10 Marks}.

14. Answer both parts;

a) Describe in detail, using diagrams if you would prefer, the structure of an immunoglobulin. Your answer should make reference to all the elements in the hierarchy of protein structure other than primary structure. {8 marks}.

b) How does the structure enable immunoglobulins to recognise and bind selectively to antigens of widely varying sizes and structures? {2 marks}.

15. Describe in detail the mechanism through which Gram negative bacteria synthesise the filamentous pili through which they attach to target eukaryotic cells. Wherever possible, include in your answer descriptions of the three-dimensional structures of the proteins involved. {10 Marks}.