

BIRKBECK COLLEGE
(University of London)

SCHOOL OF BIOLOGICAL SCIENCES

M.Sc. EXAMINATION FOR INTERNAL STUDENTS ON:

**Postgraduate Certificate in Principles of Protein Structure
MSc Structural Molecular Biology**

CRYS024D7

PRINCIPLES OF PROTEIN STRUCTURE

Thursday 22 August 2013

Duration of examination: 3 hours

10.00 – 13.00

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.

The exam papers have not been prior-disclosed.

1. Answer all parts;
 - a) Illustrate the CORN law. Which amino acid is exempted from this law? {3 Marks}
 - b) Draw the structures for the side-chains of Tyr, Phe and Trp. Which one is entirely non-polar and what features make the other two polar? {3 Marks}
 - c) What feature of proline causes it to act as an alpha helix breaker? {2 Marks}
 - d) How can serine be modified after initial translation into protein? {2 Marks}

2. Answer both parts;
 - a) Draw a Ramachandran plot and indicate the locations occupied by the right-handed alpha helix and beta sheets. {5 Marks}
 - b) How is a peptide bond formed? Indicate where the torsion angles phi, psi and omega are located along the polypeptide backbone? {5 Marks}

3. Answer both parts;
 - a) Show schematically the features of an alpha helix. {2 Marks}. How can water distort this structure? {2 Marks}
 - b) What distinguishes a parallel from an anti-parallel beta-sheet? {4 Marks}
 - c) Show schematically how the four-strands in a parallel beta-sheet form a twist. {2 Marks}

4. Explain the ridges and grooves model of helix packing. {10 Marks}

5. Answer both parts;
- a) What is meant by scientific fraud and plagiarism? {5 Marks}
 - b) What points should you consider if you wish to publish a scientific paper. {5 Marks}
6. Answer all parts;
- a) Define the term protein superfold and name three examples. {2 Marks}
 - b) Describe or draw the topology of one type of superfold. {2 Marks}
 - c) Name a specific example of a cytoplasmic protein that is classified as a superfold and give its function. {3 Marks}
 - d) What are the common themes used in the construction of extracellular proteins, and why? {3 Marks}
7. Explain the role of gene duplication in the evolution of protein structure. {10 Marks}
8. Answer both parts;
- You are given a protein sequence and told that it comes from the bacterium *Mycobacterium tuberculosis*. Explain how you could use databases and bioinformatics tools to investigate the following;
- a) The three-dimensional structure or fold of the protein {4 Marks}
 - b) Whether the protein is likely to be a good target for the design of drugs against tuberculosis. {6 Marks}
9. Discuss how helical and icosahedral symmetries have been used to construct viruses. {10 Marks}

10. Describe the distinctive roles of transcription factors and heat shock proteins in the regulation of the protein life cycle. {10 Marks}
11. Answer all parts;
- a) Define a hydrogen bond {2 Marks}
 - b) Name one amino acid with a side chain that can act as a hydrogen bond donor; one with a side chain that can act as an acceptor; and one with a side chain that can act as either or both. {3 Marks}
 - c) Explain briefly how changes in hydrogen bonding patterns when hydrophobic molecules are dissolved in water can cause linear protein chains to fold into compact structures. {5 Marks}
12. Answer all parts;
- a) Name the six types of reaction used to classify enzymes. {1.5 Marks}
 - b) Describe how a coenzyme can contribute to a reaction mechanism. {2.5 Marks}
 - c) Name and describe the active site of a type of protease. {3 Marks}
 - d) Give an example of how protease inhibitor has been used to design a drug. {3 Marks}
13. Answer both parts;
- a) Explain what is meant by the term “molecular machine” and describe some of the particular challenges in determining the structures of molecular machines. {3 Marks}
 - b) Using diagrams if you prefer, describe in detail the structure of the enzyme ATP synthase, which has been described as a molecular machine. Give the function of this enzyme and explain its mechanism of action starting from its structure. {7 Marks}

14. Answer all parts;

- a) Draw a schematic diagram of the structure of a G-protein coupled receptor (GPCR) and indicate;
 - i. The number and nature of the membrane-spanning regions. {2 Marks}
 - ii. The positions of the N and C termini. {2 Marks}
 - iii. The location of the binding sites for the ligand and G protein. {2 Marks}
- b) Describe the mechanism through which a photon of light will activate the GPCR visual rhodopsin. {4 Marks}

15. Answer both parts;

- a) Describe in detail the structure of a T-cell receptor. How does its structure differ from that of an immunoglobulin? {4 Marks}
- b) Name the other molecules that are involved in the complex formed by this T-cell receptor that leads to the activation of the T cells. Describe or draw the structure of this complex. {6 Marks}