

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 21 August 2014

Duration of examination: 3 hours

10.00 – 13.00

Students will be required to answer 8 out of 12 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) Describe the CORN law using alanine as an example. [2 Marks]
 - b) Which amino acids contain a sulphur atom and indicate how one can form a cross-link in a protein? [2 Marks]
 - c) Draw and name the three aromatic amino acids. Which of these is most suited to be located on a proteins outer surface? [4 Marks]
 - d) Indicate the difference between the *cis* and *trans* peptide bond. [2 Marks]

2. Answer both parts;
 - a) Draw a Ramachandran plot. Indicate the location of the secondary structure regions. [5 Marks]
 - b) Use this Ramachandran plot to explain why glycine and proline are structurally important in globular proteins. Indicate a possible location for a Gly and Pro residue in a polypeptide chain. [5 Marks]

3. Answer both parts;
 - a) Illustrate schematically the hydrogen bond arrangement found in a parallel, antiparallel and mixed beta-sheet. Indicate the side view for a four- stranded, parallel beta-sheet. [4 Marks]
 - b) Contrast in detail a standard alpha-helix with the solvent distorted alpha-helix? [6 Marks]

4. Answer all parts;
 - a) Illustrate a beta-alpha-beta motif [2 Marks]
 - b) Describe how this beta-alpha-beta motif features in TIM. [4 Marks]

- c) Illustrate a four-helix bundle and indicate how this structure is stabilised [4 Marks]
5. While undertaking a critical reading of a research paper, which eight headings may help you in your consideration of the work. [10 Marks]
6. Answer all parts;
- a) Explain how the similarity scores for amino acids in the BLOSUM matrices are used in calculating the best alignment of a pair of protein sequences. [4 Marks]
- b) Give one reason why you would expect:
- i. A much higher score in any given BLOSUM matrix for matching a pair of Cys residues than for matching a pair of Ala residues. [2 Marks]
 - ii. A high score for matching Phe with Tyr in the same matrix. [2 Marks]
 - iii. A negative score for matching Phe with Asp in the same matrix. [2 Marks]
7. Answer all parts;
- a) Draw a schematic diagram of the double helical structure of DNA, and mark the positions of the major and minor grooves. [3 marks]
- b) Name and describe three different structural motifs found in eukaryotic proteins that enable these proteins to bind to the major groove of DNA. [6 marks]
- c) Name the secondary structure element that binds to the DNA in each of these cases. [1 mark]

8. Answer both parts;
- a) Define the terms “hydrophobicity” and “hydrophobicity scale”; name two amino acids that are classed as hydrophobic. [4 marks]
 - b) Name and describe fully in chemical terms two types of interatomic interaction that hydrophobic amino acid side chains often make with neighbouring atoms or groups in a protein. [6 marks]

9. Answer both parts;
- a) Describe in detail the structure of haemoglobin, making reference in your answer to at least four different levels in the hierarchy of protein structure. [5 marks]
 - b) Explain the mechanism through which haemoglobin in the blood binds to oxygen when its concentration is high and releases it when it is needed, relating this to the structure wherever possible. [5 marks]

10. Answer Two parts;

Describe in detail, or draw, the structures of any two of the three membrane proteins listed below and include a brief description of the function of each selected proteins. [5 Marks each part].

- i. Rhodopsin
- ii. Respiratory complex I
- iii. The potassium leak channel (a voltage-gated potassium channel).

11. Answer all parts;
- a) Describe or draw the structure of a MHC Class I protein, highlighting its domain structure and how it binds to the cell membrane. [4 marks]

- b) How does this structure enable the MHC to bind to a wide variety of peptide antigens? [3 marks]
 - c) Explain how this protein differs in structure from the MHC Class II protein. [3 marks]
12. The amino acid tyrosine can undertake four types of interaction with neighbouring atoms or groups within a protein molecule. Describe these interactions in detail. [10 Marks]