

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 15 August 2019

Duration of examination: 3 hours

Time

Students will be required to answer 8 out of 12 questions.

All questions carry equal marks.

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) Demonstrate the difference between the L- and D- forms of the amino acids using alanine as an example. [2 marks]
 - b) Which is the only non-chiral amino acid and why is this conformationally important? [2 marks]
 - c) Which two amino acids that have chiral sidechains? [2 marks]
 - d) Show the reaction to produce a peptide bond? [2 marks]
 - e) Compare the *trans* and *cis* arrangements in a peptide bond. [2 marks]

2. Answer all parts;
 - a) Describe the hydrogen bond? [2 marks]
 - b) What are torsion angles and where are they located in a polypeptide. [2 marks]
 - c) Show the key features found in a Ramachandran Plot. [6 marks]

3. Discuss the general structural features of the various forms of beta-sheet structures and alpha helices that occur in proteins. [10 marks]

4. Answer all parts;
 - a) Draw a beta turn. [2.5 marks]
 - b) Draw a beta-alpha-beta motif. [2.5 marks]
 - c) Draw a Four-helix bundle. [2.5 marks]
 - d) Draw a Greek Key motif. [2.5 marks]

5. Discuss the two methods used for modelling alpha helix packing?
[10 Marks]
6. Answer all parts:
- a) What is plagiarism and scientific fraud? [5 Marks]
 - b) Discuss the issues you would consider when publishing a scientific article? [5 Marks]
7. Answer all parts;
- a) Define the terms 'genome' and 'proteome'. [2 Marks]
 - b) Approximately how many genes are there in the genome of the pathogen *Mycobacterium tuberculosis* (to the nearest thousand)? Give one other characteristic feature of this genome. [2 Marks]
 - c) Explain in detail how you can use the program BLAST to find out if there are proteins in the human genome that are significantly similar to a given protein from this pathogen. [6 Marks]
8. Answer all parts;
- a) What is meant by 'redundancy' in the context of the genetic code? [2 Marks]
 - b) Describe or draw the basic structure of a tRNA molecule and explain how this structure enables it to act as an adaptor in protein synthesis. [3 Marks]
 - c) Explain in simple terms the mechanism of protein synthesis by ribosomes. (Note; You do not need to refer to any differences between prokaryotic and eukaryotic ribosomes). [5 Marks]

9. Answer all parts;

- a) Explain how the electron density around polar atoms leads to the formation of the specific electrostatic interactions that are known as hydrogen bonds. [3 Marks]
- b) Draw a schematic diagram of a hydrogen bond between a carbonyl and an amino group. Label the donor and acceptor atoms and mark the approximate length of the bond. [3 Marks]
- c) Name one amino acid with a side chain that includes:
 - i) At least one donor atom, but no acceptors. [1 Mark]
 - ii) At least one acceptor atom, but no donors. [1 Mark]
 - iii) Both donor and acceptor atoms. [1 Mark]
 - iv) Neither donor nor acceptor atoms. [1 Mark]

10. Answer all parts;

- a) Write down the basic molecular formula of a monosaccharide. [1 Mark]
- b) Draw or describe the structure of the 'head' of the monosaccharide-binding protein neuraminidase, which is found on the surface of the influenza virus. What is the quaternary structure of this protein, and what is the name of the monomer fold? [4 Marks]
- c) Explain, with reference to this structure, the mechanism of action of the influenza drug zanamivir. [5 Marks]

11. Answer all parts;

- a) What is the single most distinct difference between the structures of most proteins embedded in the outer membranes of Gram-negative bacteria and other membrane proteins? [1 Mark]
- b) Draw the structure of the porin that is embedded in the outer membrane of bacteria such as *E. coli* and describe its function in one sentence. [3 Marks]
- c) Why is the type IV secretion system found in these bacteria an exception to this rule? Describe the structure and function of this system briefly. [6 Marks]

12. Answer both parts;

- a) Draw or describe in detail the complex formed between a class I MHC protein, a peptide antigen and a T-cell receptor that can lead to an adaptive immune response. Indicate the positions of the cell membranes that bind the proteins and name the cells involved. [7 Marks]
- b) Name the co-receptor that is required for this complex to form and describe briefly its structure and function. [3 Marks]