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 18 August 2016

Duration of examination: 3 hours

10.00 – 13.00

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) Show how the CORN law demonstrates the difference between the L- and D-forms of alanine. [2 Marks]

   b) Draw a *cis* and *trans* peptide? [2 Marks]

   c) What is a key function of cysteine amino acids in the tertiary structure of the hormone insulin? [2 Marks]

   d) Draw the side chains for Phe, Tyr and Trp. Which feature in Tyr makes it more likely to be found close to the surface of a water soluble protein? [4 Marks]

2. Answer all parts;

   a) Draw the covalent structure of the hexapeptide;

      Ala-Phe-Asn-Ser Met-Glu [3 Marks]

   b) Indicate the positions of the three possible torsion angles in a peptide backbone. [2 marks]

   c) Draw a Ramachandran plot. Indicate the location of the secondary structure regions. [5 Marks]

3. Answer all parts;

   a) How do parallel and anti-antiparallel beta sheets differ? [2.5 Marks]

   b) How is an alpha helix stabilised internally? [2.5 Marks]

   c) Indicate simply the side view for a four-stranded, parallel beta-sheet. [2.5 Marks]

   d) Draw an up-down-up-down, four helix bundle. Indicate how it is stabilised between the helices [2.5 Marks]

4. Answer all parts;

   a) Illustrate a beta-alpha beta motif indicating clearly the correct hand. [2.5 Marks]

   b) Indicate how this beta-alpha-beta motif features in a topology diagram for Triose phosphate isomerase and show how these elements combine to form into a TIM barrel structure. [5 Marks]

   c) What is a Rossmann Fold? [2.5 Marks]

5. Describe briefly the six common types of post-translational modifications that may occur in proteins. [10 Marks]

6. Give eight headings and some factors to consider for each one, which could assist you in judging the standard of a research journal article. [10 Marks]

7. Answer all parts;

   a) Name one amino acid that is rarely found in alpha helices, and briefly explain this preference based on the chemical structure of that amino acid's side chain [3 Marks]

   b) Explain briefly what insights can be gained from a protein sequence analysed using the technique of secondary structure prediction. What are the limits of understanding using this technique alone? [3 Marks]

   c) Name one program for secondary structure prediction and explain very briefly how it works. [4 Marks]

8. Answer all parts;

   a) Describe briefly the heat shock response that arises when cells are stressed. Explain how cell stress affects protein synthesis and folding, and explain in general terms the roles of heat shock

proteins (molecular chaperones) in protecting cells from stress. [4 Marks]

b) Draw a schematic or describe the structure of **both** of the following heat shock proteins, making reference to the tertiary and quaternary structure. Explain the specific function of each protein in one or two sentences;

i) Small heat shock protein. [3 Marks]

ii) Hsp60 (GroEL). [3 Marks]

9. Answer both parts;

a) Define the term force field. What types of molecular modelling program make use of force fields? [3 Marks]

b) Write down a simple schematic equation for a force field that can be used to calculate the total energy of a protein and explain briefly what each term in that equation means. N.B. mathematical equations for the individual terms are not necessary to gain full marks. [7 Marks]

10. Answer all parts;

a) Give one example of a protein that must bind each of the following types of molecule in order to function biologically. Describe the structure and function of each briefly;

i) A haem group. [2 Marks]

ii) A monosaccharide. [2 Marks]

iii) The major groove of a DNA double helix. [2 Marks]

iv. A protein (or a peptide) of your choice. [2 Marks]

b) List some of the general principles that are involved in protein-ligand binding. [2 Marks]

11. Answer both parts;

a) Draw the schematic structure of a G-protein coupled receptor, and mark on your structure the locations of the N- and C-termini, the cell membrane and the binding sites for two other molecules. [5 Marks]

b) Making reference to your structure, describe the mechanism through which ligand binding to a GPCR causes a signal to be transmitted into a cell. [5 Marks]

12. Answer both parts;

a) Draw or describe in detail the complex formed between a class II 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 its structure and function briefly. [3 Marks]