BIRKBECK COLLEGE
(University of London)

MSc EXAMINATION FOR INTERNAL STUDENTS
DEPARTMENT OF BIOLOGICAL SCIENCES

PRINCIPLES OF PROTEIN STRUCTURE
CRYS024D7

Thursday 17 August 2017
10.00 – 13.00
Duration of examination: 3 hours

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.

©Birkbeck College 2017

1. Answer all parts;

a) What does the CORN law demonstrate? Show both chiral forms possible for an amino acid in a simple diagram. [2 Marks]

b) (i) Draw the backbone structure and all the amino acid side chains for cyclic peptide oxytocin.
[2 Marks for the main chain backbone, 5 Marks for correct sidechains];

Gly-Leu-Pro-Cys-Asn-Gln-Ile-Tyr-Cys

(ii) Indicate the location of the single disulphide bond within this small polypeptide structure. [1 Mark]

2. Answer all parts;

a) Show the resulting structure from the post-translational modification of Ser in a protein utilising P? What other two amino acids can be similarly modified in this way? [3 Marks]

b) Discuss briefly four other types of post-translational changes, including the addition of ubiquitin. [4 marks]

c) Explain the simple Prosite pattern representation shown for a modification to Asn;

N-{P}-[ST]-{P}

[3 Marks]

3. Answer all parts;

a) The C-N bond length in a peptide group is 10% shorter than that found in usual C-N amine bonds. Draw a peptide unit and indicate why this occurs. What is the impact on polypeptide backbone conformation? [2 Marks]

b) Draw a Ramachandran plot with the location of the alpha helix and beta sheet regions clearly marked. [4 Marks]

c) Beta sheets and alpha helices are stabilised by hydrogen bonds. Indicate how these important secondary element arrangements differ to each other. [4 Marks]

©Birkbeck College 2017

4. Answer all parts, draw schematic diagrams for the following;

a) The Greek Key motifs in a single gamma crystalline domain. [2.5 Marks]

b) A beta hairpin. [2.5 Marks]

c) A beta-alpha-beta motif. [2.5 Marks]

d) A TIM barrel. [2.5 Marks]

5. How can you model alpha helix packing? [10 Marks]

6. Answer all parts:

a) Discuss the issues you would consider when publishing a scientific article? [5 Marks]

b) What is plagiarism and scientific fraud? [5 Marks]

7. Answer all parts;

a) What is meant by the statement that two proteins are homologs? [2 Marks]

b) Explain briefly how local and global alignments of protein sequence pairs are carried out. To what extent is it possible to tell whether two proteins are homologs from these alignments? [6 Marks]

c) From these listed pairs of amino acids;

Lys and Glu
Cys and Cys
Ala and Ala
Phe and Tyr
Asp and Phe

(i) Which pair above would have the highest (most positive) score in the BLOSUM matrices used in protein sequence alignments? [1 Mark]

(ii) Which pair above would have the lowest (most negative) score. [1 Mark]

8. Answer all parts;

a) Draw the general features of the DNA structure and highlight the location of the major and minor grooves on that structure. What are the main structural and chemical difference between the grooves? [4 Marks]

b) Name one prokaryotic and one eukaryotic protein that bind into the major groove of DNA using an alpha-helical motif, and describe the structure and function of each very briefly. [6 Marks]

9. Answer all parts;

a) Define the term 'hydrophobicity effect' and explain in one or two sentences the role that this effect plays in driving the folding of a globular protein. [3 Marks]

b) What is a hydrophobicity scale? Name one amino acid that you would expect to find on each end of such a scale, and one that you would find in the centre. Give reasons for your choices based on the chemical structures of the amino acid side chains. [7 Marks]

10. Describe in detail the structure of the active haemoglobin molecule.
Name the prosthetic group and describe its structure briefly. How do these features assist Hb to function as an oxygen carrier?

[10 Marks]

11. Answer both parts;

a) Describe the function and mechanism of an ion channel in general terms, making use of the terms 'sensor region' and 'gating mechanism' as they are applied to ion channel proteins. [4 Marks]

b) Making use of these terms, describe in detail the structure of the potassium leak channel and explain how this structure enables the channel to select for potassium ions over sodium ions. [6 Marks]

©Birkbeck College 2017

12. Answer both parts;

a) Describe the structure, function and mechanism of action of the CD4 T-cell co-receptor [6 Marks]

b) Explain how CD4 enables the virus HIV to enter cells. What is the physiological response to HIV infection that is directly related to this protein's function? [2 Marks]

c) Name two proteins involved in different parts of the immune system that contain the same 'super-fold' as CD4 [2 Marks]

©Birkbeck College 2017