
Section 1: *You must answer* ***all*** *of the following questions in* Section 1.
As a guide, you can spend up to 2 hours and 30 minutes on this part of the exam.
Wherever possible ***use diagrams and chemical structures*** *to enhance your answers.*

Marks

8 1. What is an osmolyte? Why is proline a good osmolyte? How does it work?

8 2. With the use of the following table of amino acid masses deduce the sequence of the peptide that generates the following fragment ions in a tandem CID spectrum.

Ala	71	Arg	156	Asn	114
Asp	115	Cys	103	Glu	128
Gln	129	Gly	57	His	137
Ile	113	Leu	113	Lys	128
Met	131	Phe	147	Pro	97
Ser	87	Thr	101	Trp	186
Tyr	163	Val	99		

The mass of the parent ion is 586 Da. The fragment ions have masses of 406 Da, 335 Da and 188 Da. It may be helpful to know the masses of the atoms: H = 1 Da, C = 12 Da, N = 14 Da, O = 16 Da, S = 32 Da.

5 3. What important insight was gained by synthesizing all-*D* and all-*L* versions of the HIV-1 protease?

4 4. Describe 4 advantages of drugs made of *D*-amino acids.

8 5. Outline the determination of protein structures using cryoelectron microscopy.

6 6. What is the hydrophobic effect and what is its importance to protein folding?

4 7. What is the repeat for each of the helices with the following numbers of residues per turn: 3.0, 3.5, 3.6, and 4.0?

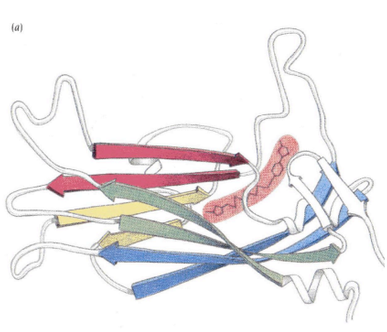
2 8. The Major Histocompatibility complex binds peptides in a binding pocket having walls made of α-helices. Estimate the number residues per α-helix needed to bind a 9-residue peptide in an extended conformation parallel to the α-helix.

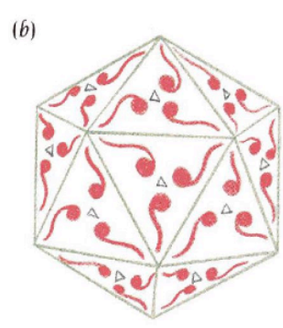
6 9. Where is the polyproline II helix located in Ramachandran space? What are the advantages of polyproline II helices in cellular signal transduction?

10 10. Name and describe two motifs found in all-α-helical proteins. For each motif, give an example of a protein containing the motif and describe how the structure is used to carry out the biological function of the protein.

8 11. Using your own diagrams discuss the packing of β-sheets.

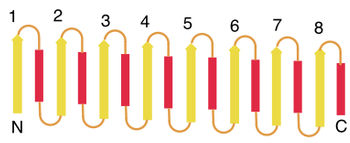
10 12. With the use of the following diagrams comment on the structure and function of the rhinovirus.

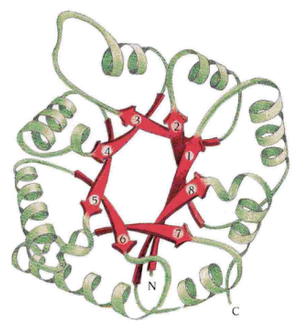




8 13. What is FRET? Explain the principles behind FRET. How could FRET be used to study a protein conformational change?

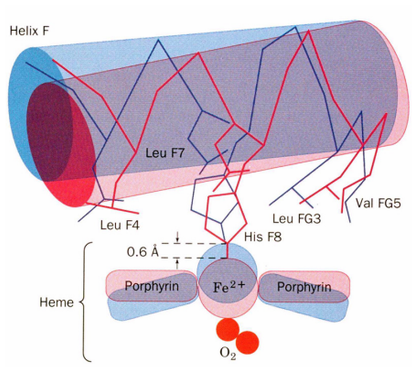
10 14. Describe the structural features and function of one protein with the illustrated motifs, topology and structure:





10 15. With the use of the following diagrams, outline the changes in conformation that occur in hemoglobin upon the binding of O_2.

a



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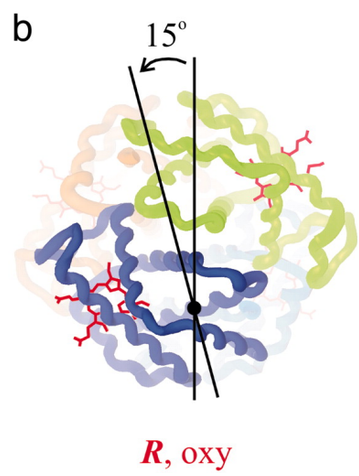
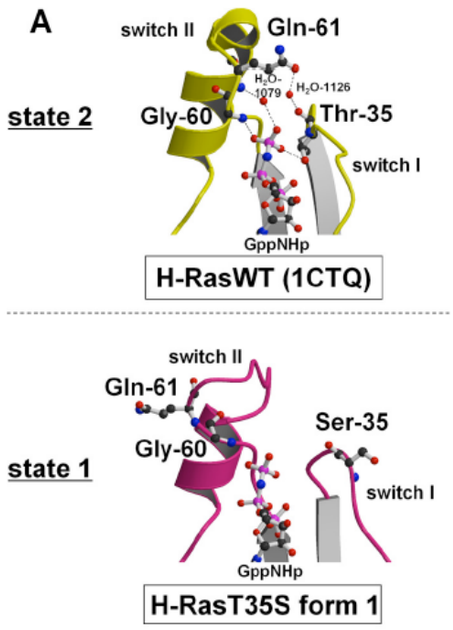


10 16. With the use of the following diagrams, outline the major changes in conformation that occur during hydrolysis of GTP by the Ras GTPases.

A



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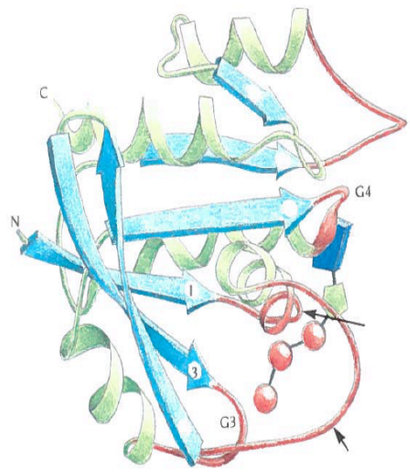

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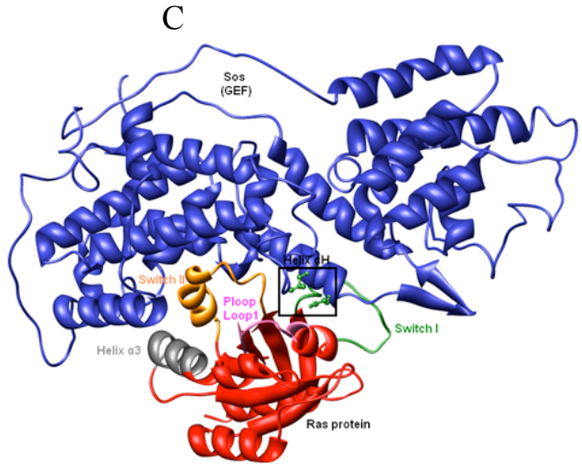
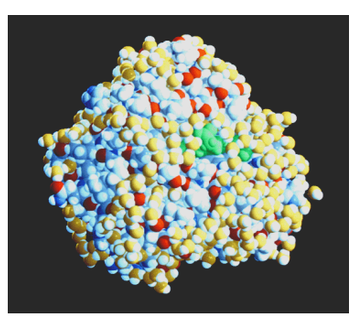


4 17. Name the two proteins involved in regulating muscle contraction and briefly describe the regulatory mechanism.

6 18. Referring to the following diagram, how does Myoglobin carry out its biological function? How was this proven?



7 19. What are the meanings of the symbols in the following equation? What is the equation used for?

$$E = \sum_{bonds} \frac{a_i}{2}(l_i - l_{i0})^2 + \sum_{angles} \frac{b_i}{2}(\theta_i - \theta_{i0})^2 + \sum_{torsions} \frac{Vn}{2}(1+\cos(n\omega - \gamma)) + \sum_{i=1}^{N}\sum_{i\neq j}^{N} 4\varepsilon_{ij}[(\frac{\sigma_{ij}}{r_{ij}})^{12} - (\frac{\sigma_{ij}}{r_{ij}})^{6}] + \frac{1}{2}\sum_{i=1}^{N}\sum_{i\neq j}^{N}\frac{q_i q_j}{r_{ij}}$$

5 20. Briefly describe the function and mechanism of the protein disulfide isomerase **OR** the peptidyl-prolyl *cis-trans* isomerase.

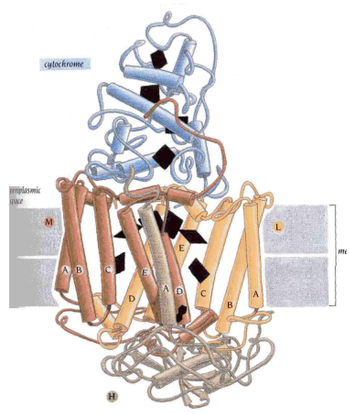
Section 2:

Answer Question 21. You can spend about 20 min. on this question.

Marks

15 21. With the use of the appropriate diagrams discuss the structure and function of the OmpF porin ***OR*** the photosynthetic reaction centre from *Rhodopseudomonas viridis*.

A



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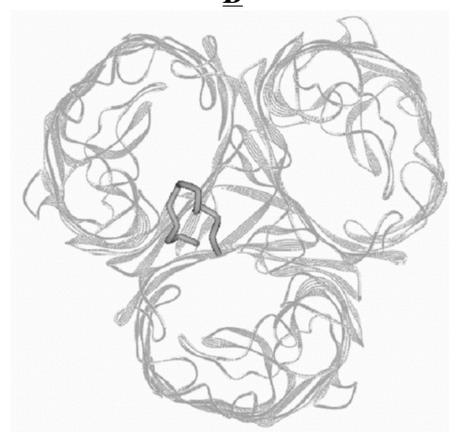

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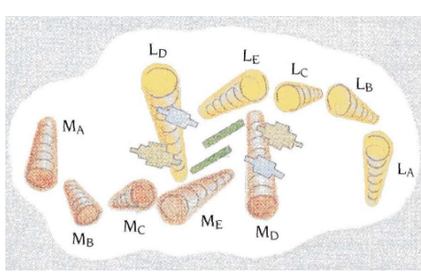

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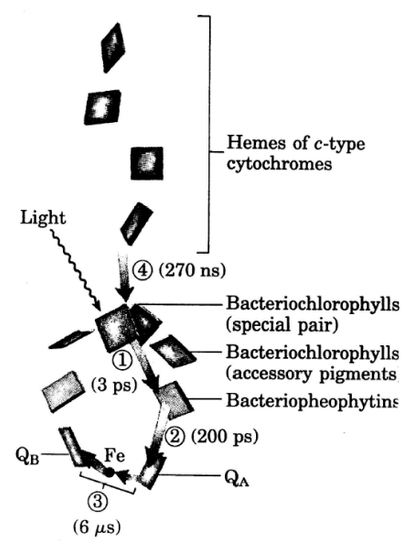

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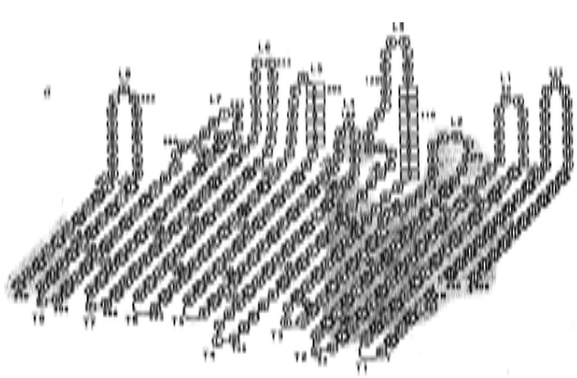

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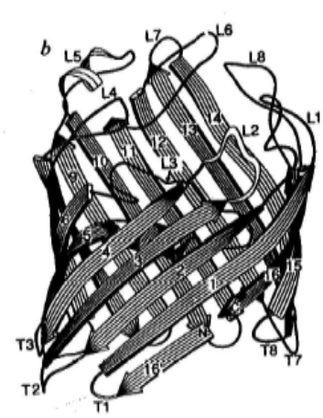

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