

2.3 Proteins

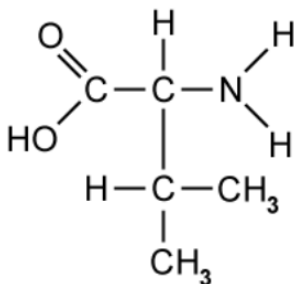
Question Paper

Course	DP IB Biology
Section	2. Molecular Biology
Topic	2.3 Proteins
Difficulty	Medium

Time allowed: 70
Score: /52
Percentage: /100

Question 1a

- a) The diagram below shows the structure of a commonly-occurring amino acid in nature.



Identify the word that best describes the chemical nature of this amino acid's R group from the following list: *saturated*; *hydrophobic*; *acidic*; *aromatic*. Give a reason for your answer.

[2 marks]

Question 1b

- b) Nine of the twenty amino acids are described as 'essential amino acids' for humans.

Define and explain the term, 'essential' in this context.

[2 marks]

Question 1c

- c) The amino acid alanine has a single methyl group ($-\text{CH}_3$) as its R group.

Draw the dipeptide formed when two alanine molecules join together.

[3 marks]

Question 1d

- d) Calculate the number of combinations of the 20 commonly-occurring amino acids that can be joined together in a short polypeptide chain of 8 amino acids in length, in which each amino acid is different to the other seven.

Give your answer to 1 significant figure.

[2 marks]

Question 2a

- a) Explain how the amino acid sequence determines the three-dimensional conformation of a polypeptide.

[3 marks]

Question 2b

- b) Calculate, in pairs of nucleotides, the total length of a gene that codes for a polypeptide of 351 amino acids in length. In this gene, 40% of its DNA is non-coding.

[2 marks]

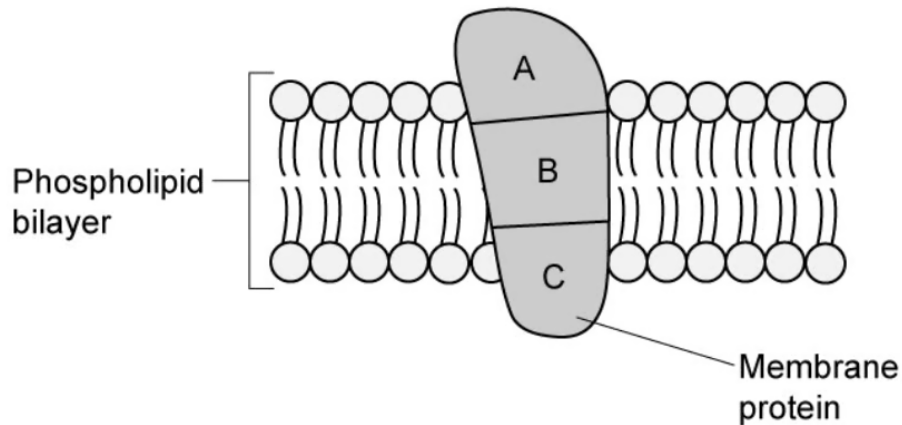
Question 2c

- c) Distinguish between the structures and properties of collagen and haemoglobin.

[3 marks]

Question 2d

- d) In cell membranes, proteins can be positioned within the phospholipid bilayer, in order to perform various functions. Some membrane proteins can span the entire bilayer as shown in the diagram below.

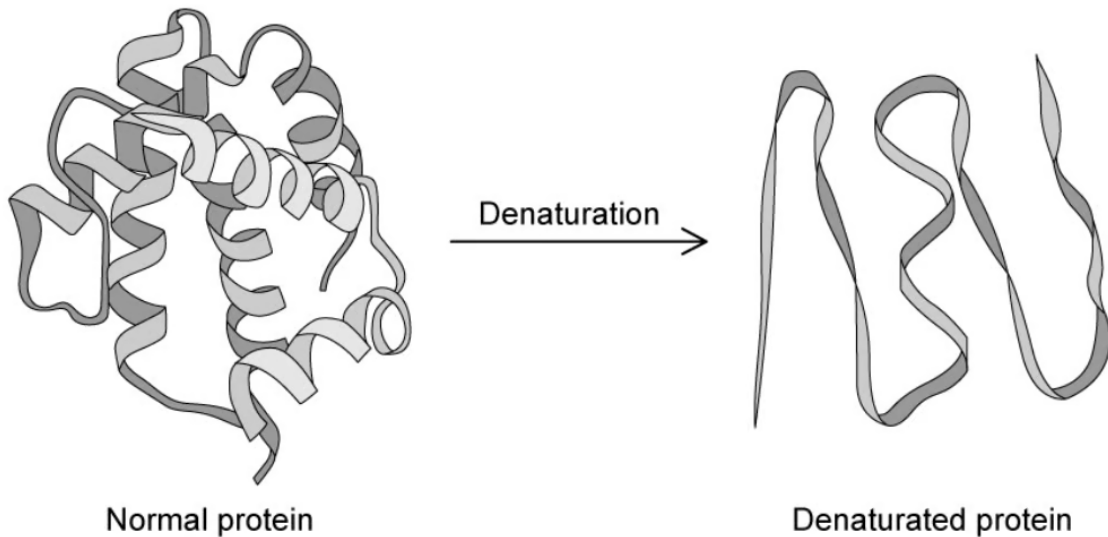


Explain why the amino acids in region B of the membrane protein tend to have hydrophobic R groups towards the surface, whilst those in regions A and C tend to have hydrophilic R groups towards their surfaces.

[2 marks]

Question 3a

- a) The image below shows the process of denaturation of a polypeptide.



Describe **one** change of conditions that can lead to such a denaturation and the effect this change has on the polypeptide's structure.

[2 marks]

Question 3b

- b) Use your knowledge of the denaturation of proteins to explain the nutritional benefits of **cooking** protein-rich food like eggs before eating them.

[4 marks]

Question 3c

- c) The proteins of many different extremophile prokaryotes have been studied extensively. A common feature among these proteins is a more tightly-packed hydrophobic core that prevents denaturation at high temperature or extremes of pH.

Suggest one benefit of humans developing detailed knowledge of these proteins and their structures.

[1 mark]

Question 3d

- d) State the source and the property of the enzyme *Taq* polymerase that allows it to be used in the Polymerase Chain Reaction when amplifying small amounts of genetic material.

[2 marks]

Question 4a

- a) Following partial hydrolysis of a naturally-occurring protein, samples of the polypeptides that were produced were identified.

Select from the table below the **two** molecular formulas that could be one of the naturally-occurring polypeptides.

Give reasons for your answer.

Polypeptide Number	Number of amino acids long	Molecular formula
I.	12	$C_{30}H_{54}N_{10}O_{33}S_4$
II.	44	$C_{66}H_{86}O_{78}N_{59}S_3$
III.	6	$C_{18}H_{26}O_{18}N_{12}$
IV.	37	$C_{60}H_{102}O_{75}N_{42}S_{15}$

[3 marks]

Question 4b

- b) Identify the role that proteins play in the central dogma of gene expression.

[1 mark]

Question 4c

- c) A protein found in leaves is thought to be the most abundant protein in nature.

State its name and describe its basic function.

[2 marks]

Question 4d

- d) Explain why the genome of an organism is fixed, whereas the organism's proteome can vary.

[3 marks]

Question 5a

One mark is available for clarity of communication throughout this question.

- a) Use your knowledge of protein structure to explain the term, 'specificity' in the context of immunoglobulins and their mode of action.

[3 marks]

Question 5b

b) Outline, with examples, the main roles that proteins play in organisms.

[4 marks]

Question 5c

c)

For each of the proteins listed **A – D** below, state one aspect of its structure and one function that is enabled by the structural feature that you have stated.

- A. Ribulose Bisphosphate Carboxylase (RuBisCo)
- B. Spider silk
- C. Immunoglobulins
- D. Rhodopsin

[8 marks]

