

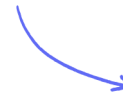
Structured Questions

Proteins

Formation of Proteins / The Variety of Proteins / Protein Structure: Effect of pH & Temperature

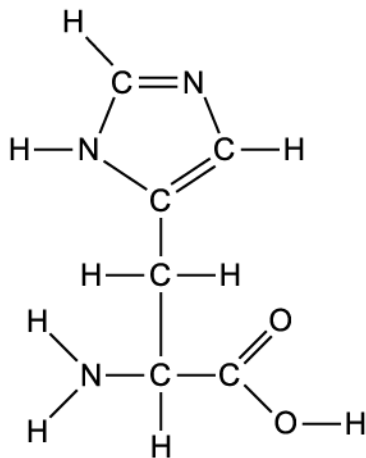
Easy (2 questions)	/8
Medium (6 questions)	/27
Hard (6 questions)	/41
Total Marks	/76

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Easy Questions

1 (a) The image below shows the amino acid histidine.



Circle the section of the amino acid that is unique to histidine.

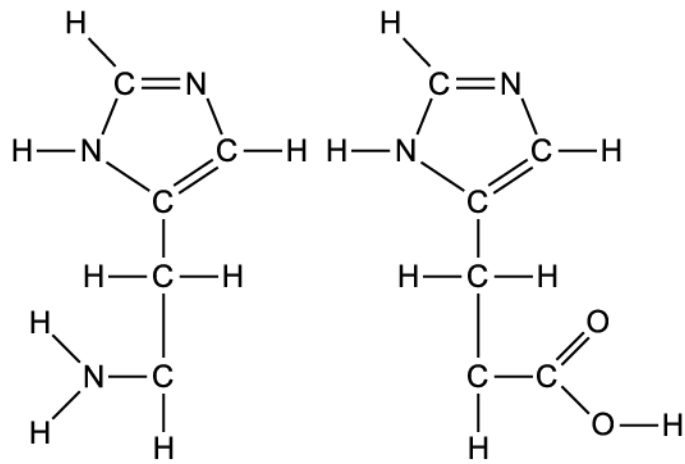
(1 mark)

(b) State the type of reaction that occurs when two amino acids bond with each other.

(1 mark)

(c) The image shows two histidine amino acids with the diagrams not fully complete.

Complete the image to include the structure of a peptide bond joining the two amino acids together into a dipeptide.



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(1 mark)

(d) In a polypeptide with 100 amino acids, how many peptide bonds exist within the chain?

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(1 mark)

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

Describe the process of protein denaturing.

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(4 marks)

Medium Questions

- 1 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)

- 2 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)

3 (a) 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)

(b) 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)

(c) 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)

4 (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	$C_{60}H_{102}O_{75}N_{42}S_{15}$

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(3 marks)

(b) A protein found in leaves is thought to be the most abundant protein in nature.

State its name and describe its basic function.

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(2 marks)

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

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(3 marks)

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

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(4 marks)

6 The table below shows some of the events which take place in protein synthesis.

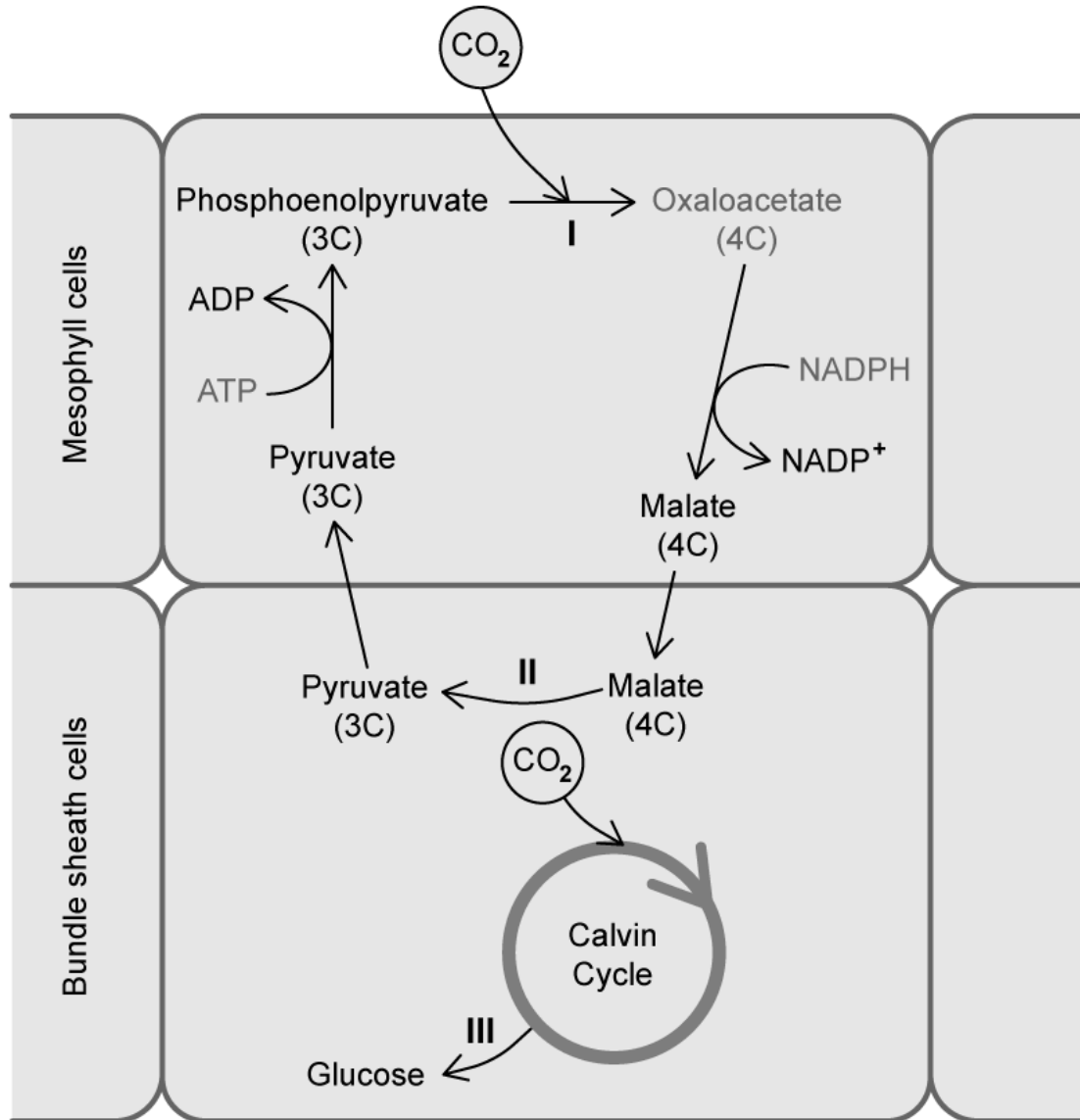
A	mRNA nucleotides join with exposed DNA bases and form a molecule of mRNA
B	Peptide bonds form between the amino acids
C	tRNA molecules bring specific amino acids to the mRNA molecule
D	The introns are spliced from the pre-mRNA to produce mRNA
E	A ribosome attaches to the mRNA molecule
F	The two strands of a DNA molecule separate
G	The mRNA molecule leaves the nucleus

Identify the correct order of letters to show the sequence of events during protein synthesis, starting with the earliest.

(3 marks)

Hard Questions

1 (a) Suggest, with a reason, which label (I, II, or III) indicates a catabolic reaction.



(2 marks)

(b) Fats and cholesterol are essential to structures and functions in the bodies of animals and therefore need to be transported in blood.

Discuss how these molecules are transported.

(3 marks)

(c) Draw a labelled diagram of a generalised amino acid.

(4 marks)

2 (a) Albumin is a protein that can be found in a range of vertebrate species.

Different species have slight variations in the structure of the protein. For example, bovine (cow) albumin has 583 amino acids.

Cows and humans share a common ancestor.

Suggest why it is the case that the two types of albumin are similar, but not completely the same as each other.

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(3 marks)

(b) Egg whites are mostly made of albumin.

When the albumin in egg white becomes denatured it causes the 'white' to change from being colourless to being opaque white.

A student wanted to investigate how temperature affects the denaturing of albumin.

Outline a method that the student could use in order to carry out this investigation.

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(4 marks)

(c) When the albumin in the egg white is not denatured it is soluble in the liquid, however, when it denatures it becomes insoluble. This is the mechanism that causes the colour change.

Explain how the protein can have different properties before and after denaturing.

(2 marks)

- 3** Some amino acids exist that have been man-made in a lab and have never been used naturally in the proteins of living organisms.

Describe the features that must exist in these molecules in order for them to be classified as amino acids.

(3 marks)

- 4 (a)** Insulin is a protein that is produced naturally by most people, however, people with insulin-dependent diabetes rely on injecting insulin to replace the protein that they cannot produce for themselves.

Explain why the insulin must be injected into the blood instead of taken orally.

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(2 marks)

- (b)** Many years ago, insulin used to be taken from cows and pigs to treat people with diabetes.

Using your knowledge of protein structure, suggest why pig and cow insulin was less effective at regulating blood glucose levels than human insulin.

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(2 marks)

- (c)** In modern medicine, human insulin is secreted from genetically modified bacteria into large industrial vats called fermenters. This allows the insulin to be extracted and purified for human use.

Outline why the insulin produced by the genetically modified bacteria is identical to insulin produced by a human.

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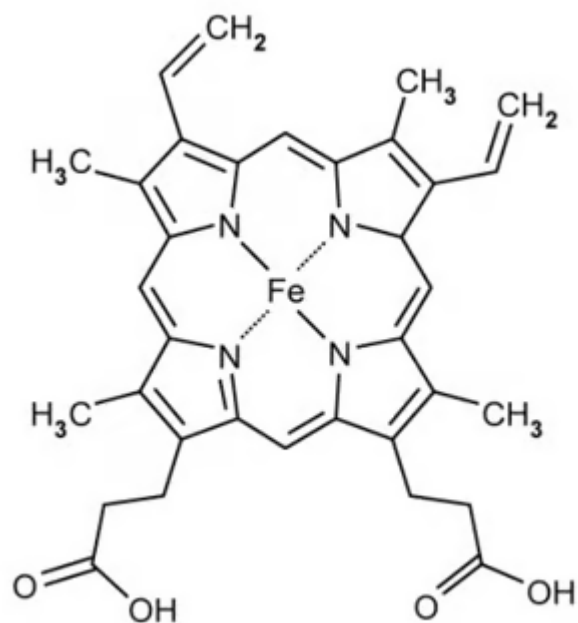
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(3 marks)

- 5** The image below shows the part of haemoglobin that binds to oxygen to deliver it around the body.

Is this an amino acid? Explain your reasoning.



(3 marks)

6 (a) *One mark is available for clarity of communication throughout this question.*

State the essential properties of membrane-bound proteins.

(3 marks)

(b) If a person has been infected with the influenza virus in the past they possess the necessary immunoglobulins to provide immunity to that virus again in the future.

Influenza viruses contain RNA as their genetic information.

State, with reference to RNA and protein structure, why it is possible for people to get the flu several times in their life.

(7 marks)