A-Level Biology

Protein Synthesis

Question Paper

Time available: 67 minutes
Marks available: 53 marks

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1. The diagram below shows part of a DNA molecule.

(a) Name the type of bond between:

complementary base pairs _____

adjacent nucleotides in a DNA strand _____

(2)

(b) The length of a gene is described as the number of nucleotide base pairs it contains.

Use information in above diagram to calculate the length of a gene containing 4.38×10^3 base pairs.

Answer _____ nm

(2)

(c) Describe **two** differences between the structure of a tRNA molecule and the structure of an mRNA molecule.

1 _____

_____

2 _____

_____

(2)

(d) In a eukaryotic cell, the structure of the mRNA used in translation is different from the structure of the pre-mRNA produced by transcription.

Describe **and** explain a difference in the structure of these mRNA molecules.

_____

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

2. (a) Describe how **one** amino acid is added to a polypeptide that is being formed at a ribosome during translation.

(3)

Table 1 shows:

- mRNA codons and the amino acid coded for by each codon
- the type of bond formed by the R group of some of the amino acids.

Table 1

First base	Second base				Third base
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
					C
	Leu		Stop	Stop	A
				Trp	G
C	Leu	Pro	His	Arg	U
					C
			Gln		A
					G
A	Ile	Thr	Asn	Ser	U
					C
	Met		Lys	Arg	A
					G
G	Val	Ala	Asp	Gly	U
					C
			Glu		A
					G

Key to the type of bond formed by the R group of each amino acid

Hydrogen bonds Ionic bonds Disulfide bridges

(b) Crystallin is a structural protein found in the human eye. An inherited disease that leads to blindness is caused by changes in properties of crystallin. The replacement of the amino acid Arg with the amino acid Gly causes these changes.

Use information in **Table 1** to suggest why this amino acid replacement changes the properties of crystallin.

_____

_____

_____

_____

_____

_____

(2)

(c) The amino acid replacement of Arg with Gly is caused by a single base substitution mutation in the DNA. The non-mutant DNA triplet is TCC.

Complete **Table 2**.

Give:

- the mRNA codon complementary to the non-mutant DNA triplet
- the mutated mRNA codon that could cause the change from Arg to Gly in the crystallin protein
- the DNA triplet complementary to this mutated mRNA codon.

Table 2

mRNA codon for the non-mutant triplet	
Mutated mRNA codon	
Mutated DNA triplet	

(2)

(Total 7 marks)

3. (a) Describe how mRNA is produced from an exposed template strand of DNA.

Do **not** include DNA helicase or splicing in your answer.

(3)

(b) Define the term exon.

_____

_____

_____

(1)

The table below shows **mRNA** codons for some amino acids.

Serine	Proline	Glycine	Threonine	Alanine
UCU	CCU	GGA	ACU	GCA
UCC	CCA	GGG	ACC	GCG

(c) **Figure 1** shows the DNA template nucleotide base sequence that determines the sequence of four amino acids.

Figure 1

AGG CGT CCT GGA

Use information from the table and **Figure 1** to give the amino acid sequence determined by this sequence of nucleotides.

_____

(1)

(d) A mutation in the nucleotide sequence shown in **Figure 1** resulted in the following amino acid sequence.

Figure 2

Serine Glycine Glycine Proline

A student concluded that the mutation involved the addition of one nucleotide within the sequence shown **Figure 1**. Does information in this question support the student's conclusion? Give reasons for your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

4. (a) Describe how mRNA is formed by transcription in eukaryotes.

(5)

(b) Describe how a polypeptide is formed by translation of mRNA.

(6)

(c) Define ‘gene mutation’ and explain how a gene mutation can have:

- no effect on an individual
- a positive effect on an individual.

(4)

(Total 15 marks)

5. (a) What is the proteome of a cell?

(1)

(b) Give **two** structural differences between a molecule of messenger RNA (mRNA) and a molecule of transfer RNA (tRNA).

1. _____

_____

_____

_____

_____

2. _____

_____

_____

_____

_____

(2)

(c) Starting with mRNA in the cytoplasm, describe how translation leads to the production of a polypeptide.

Do **not** include descriptions of transcription and splicing in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

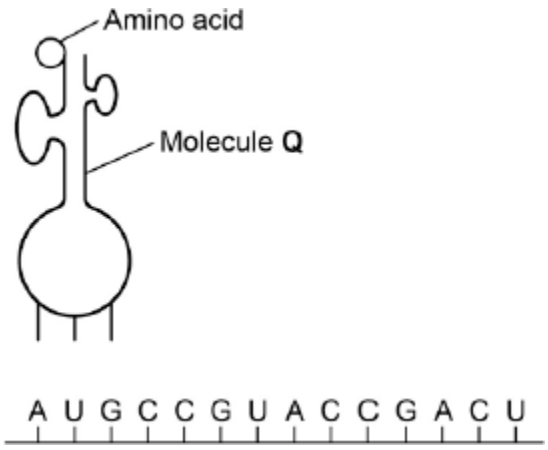
_____

_____

(5)

(Total 8 marks)

6. The diagram below represents one process that occurs during protein synthesis.



(a) Name the process shown.

_____

(1)

(b) Identify the molecule labelled **Q**.

_____

(1)

(c) In the diagram above, the first codon is AUG. Give the base sequence of:

the complementary DNA base sequence _____

the missing anticodon _____

(2)

The table below shows the base triplets that code for two amino acids.

Amino acid	**Encoding base triplet**
Aspartic acid	GAC, GAU
Proline	CCA, CCG, CCC, CCU

(d) Aspartic acid and proline are both amino acids. Describe how two amino acids differ from one another. You may use a diagram to help your description.

(1)

(e) Deletion of the sixth base (G) in the sequence shown in the diagram above would change the nature of the protein produced but substitution of the same base would not. Use the information in the table and your own knowledge to explain why.

(3)

(Total 8 marks)