



A-Level Biology

DNA Structure

Question Paper

Time available: 65 minutes

Marks available: 55 marks

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1.

(a) Describe how a phosphodiester bond is formed between two nucleotides within a DNA molecule.

(2)

(b) The two DNA strands of a particular gene contain 168 guanine bases between them. The relationship between the numbers of guanine bases (G), adenine bases (A), thymine bases (T) and cytosine bases (C) in these two strands of DNA is shown in the following equation.

$$G = 4(A + T) - C$$

Use this information and your understanding of DNA structure to calculate the maximum number of amino acids coded by this gene.

Show your working.

Answer _____

(2)

(c) Name the protein associated with DNA in a chromosome.

(1)

- (d) In the process of semi-conservative DNA replication, the two strands within a DNA molecule are separated. Each then acts as a template for the formation of a new complementary strand.

Describe how the separation of strands occurs.

(2)

(Total 7 marks)

2.

- (a) The nucleus and a chloroplast of a plant cell both contain DNA.

Give **three** ways in which the DNA in a chloroplast is different from DNA in the nucleus.

1 _____

2 _____

3 _____

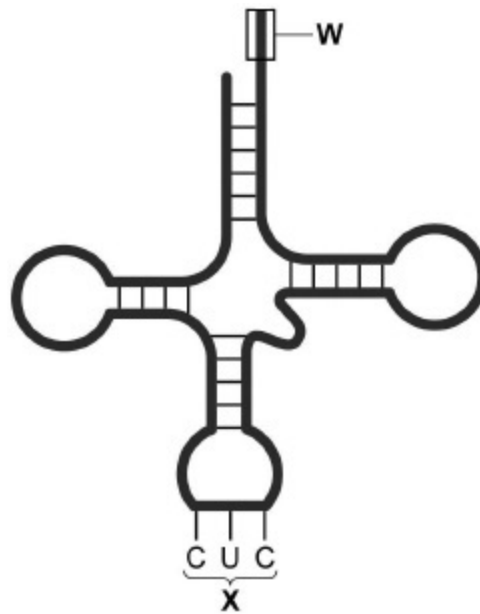
(3)

- (b) Some DNA nucleotides have the organic base thymine, but RNA nucleotides do not have thymine. RNA nucleotides have uracil instead of thymine.

Give **one** other difference between the structure of a DNA nucleotide and the structure of an RNA nucleotide.

(1)

The diagram shows a tRNA molecule.



- (c) Name the structures labelled **W** and **X** in the diagram.

W _____

X _____

(1)

- (d) Not all mutations in the nucleotide sequence of a gene cause a change in the structure of a polypeptide.

Give **two** reasons why.

1 _____

2 _____

(2)

(Total 7 marks)

3.

- (a) DNA is a polymer of nucleotides. Each nucleotide contains an organic base.

Explain how the organic bases help to stabilise the structure of DNA.

(2)

- (b) Triplets of bases in a DNA molecule code for the sequence of amino acids in a polypeptide. The genetic code is frequently written as the three bases on mRNA that are complementary to a triplet on DNA. **Table 1** shows what different combinations of bases on mRNA code for. The names of amino acids are abbreviated. For example, 'Ala' stands for alanine.

Table 1

First base	Second base				Third base
	Guanine (G)	Adenine (A)	Cytosine (C)	Uracil (U)	
G	GGG Ala	GAG Glu	GCG Ala	GUG Val	G
	GGA Gly	GAA Glu	GCA Ala	GUA Val	A
	GGC Gly	GAC Asp	GCC Ala	GUC Val	C
	GGU Gly	GAU Asp	GCU Ala	GUU Val	U
A	AGG Arg	AAG Lys	ACG Thr	AUG Met	G
	AGA Arg	AAA Lys	ACA Thr	AUA Iso	A
	AGC Ser	AAC Asn	ACC Thr	AUC Iso	C
	AGU Ser	AAU Asn	ACU Thr	AUU Iso	U
C	CGG Arg	CAG Gln	CCG Pro	CUG Leu	G
	CGA Arg	CAA Gln	CCA Pro	CUA Leu	A
	CGC Arg	CAC Hist	CCC Pro	CUC Leu	C
	CGU Arg	CAU Hist	CCU Pro	CUU Leu	U
U	UGG Trp	UAG stop	UCG Ser	UUG Leu	G
	UGA stop	UAA stop	UCA Ser	UUA Leu	A
	UGC Cyst	UAC Tyr	UCC Ser	UUC Phe	C
	UGU Cyst	UAU Tyr	UCU Ser	UUU Phe	U

Suggest **one** advantage of showing the genetic code as base sequences on mRNA, rather than triplets on DNA.

(1)

- (c) What name is given to a group of three bases on mRNA that codes for an amino acid?

(1)

(d) Use information from **Table 1** to explain why the genetic code is described as degenerate.

(2)

(e) Suggest the role of the mRNA base triplets UGA, UAG and UAA.

(2)

(f) **Table 2** shows the sequence of mRNA bases forming part of a single gene.

Table 2

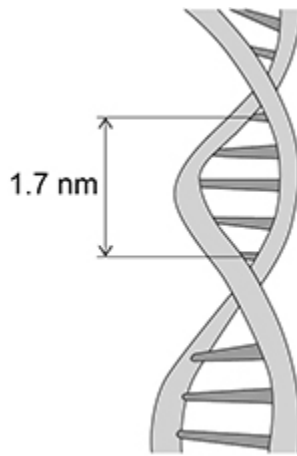
Base on DNA template									
Base on mRNA	G	U	G	U	A	C	U	G	G
Encoded amino acid									

Complete **Table 2** to show the base sequence of the DNA template from which this mRNA was transcribed and the encoded amino acid sequence.

(2)

(Total 10 marks)

4. 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)

5.

- (a) (i) Why is the genetic code described as being universal?

(1)

- (ii) The genetic code uses four different DNA bases. What is the maximum number of different DNA triplets that can be made using these four bases?

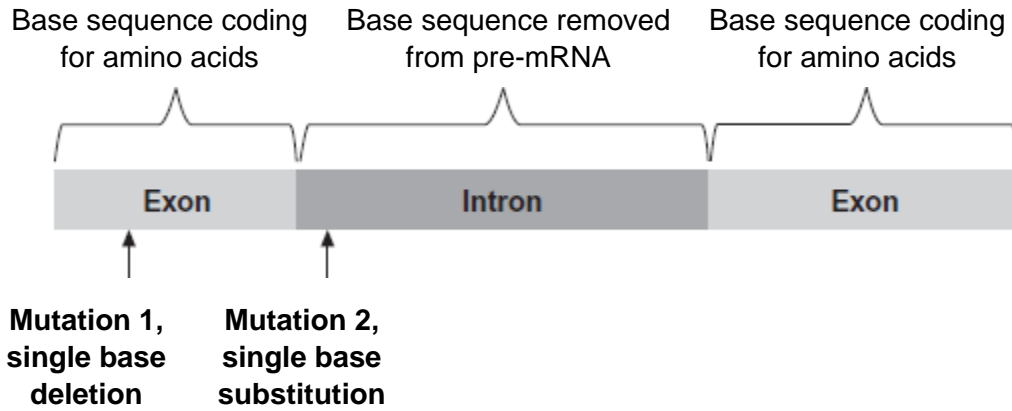
(1)

Transcription of a gene produces pre-mRNA.

- (b) Name the process that removes base sequences from pre-mRNA to form mRNA.

(1)

- (c) The figure below shows part of a pre-mRNA molecule. Geneticists identified two mutations that can affect this pre-mRNA, as shown in the figure.



- (i) **Mutation 1** leads to the production of a non-functional protein.

Explain why.

(3)

- (ii) What effect might **mutation 2** have on the protein produced?

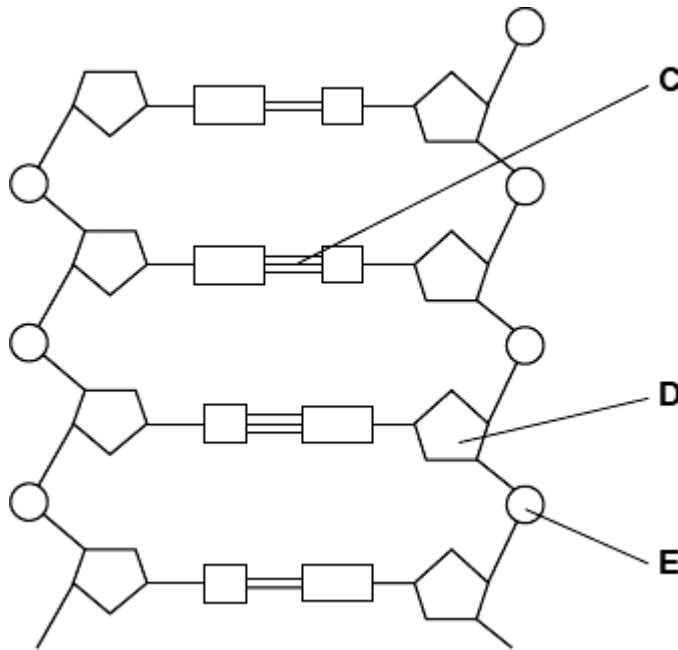
Explain your answer.

(2)

(Total 8 marks)

6.

The diagram shows part of a DNA molecule.



(a) (i) DNA is a polymer. What is the evidence from the diagram that DNA is a polymer?

(1)

(ii) Name the parts of the diagram labelled **C**, **D** and **E**.

Part **C** _____

Part **D** _____

Part **E** _____

(3)

(iii) In a piece of DNA, 34% of the bases were thymine.

Complete the table to show the names and percentages of the other bases.

Name of base	Percentage
Thymine	34
	34

(2)

(b) A polypeptide has 51 amino acids in its primary structure.

(i) What is the minimum number of DNA bases required to code for the amino acids in this polypeptide?

(1)

(ii) The gene for this polypeptide contains more than this number of bases.

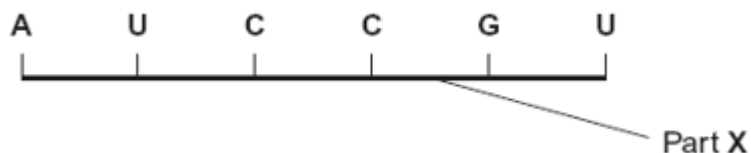
Explain why

(1)

(Total 8 marks)

7.

The diagram shows part of a pre-mRNA molecule.



(a) (i) Name the **two** substances that make up part **X**.

_____ and _____

(1)

(ii) Give the sequence of bases on the DNA strand from which this pre-mRNA has been transcribed.

(1)

(b) (i) Give one way in which the structure of an mRNA molecule is different from the structure of a tRNA molecule.

(1)

(ii) Explain the difference between pre-mRNA and mRNA.

(1)

(c) The table shows the percentage of different bases in two pre-mRNA molecules. The molecules were transcribed from the DNA in different parts of a chromosome.

Part of chromosome	Percentage of base			
	A	G	C	U
Middle	38	20	24	
End	31	22	26	

(i) Complete the table by writing the percentage of uracil (U) in the appropriate boxes.

(1)

(ii) Explain why the percentages of bases from the middle part of the chromosome and the end part are different.

(2)

(Total 7 marks)