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NZQA
NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

For Supervisor's use only

Level 3 Biology, 2007

90715 Describe the role of DNA in relation to gene expression

Credits: Four
9.30 am Tuesday 27 November 2007

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should answer ALL the questions in this booklet.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–10 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

For Assessor's use only	**Achievement Criteria**				
Achievement		**Achievement with Merit**		**Achievement with Excellence**	
Describe the role of DNA in relation to gene expression.		Explain the role of DNA in relation to gene expression.		Discuss the role of DNA in relation to gene expression.	
Overall Level of Performance					

You are advised to spend 40 minutes answering the questions in this booklet.

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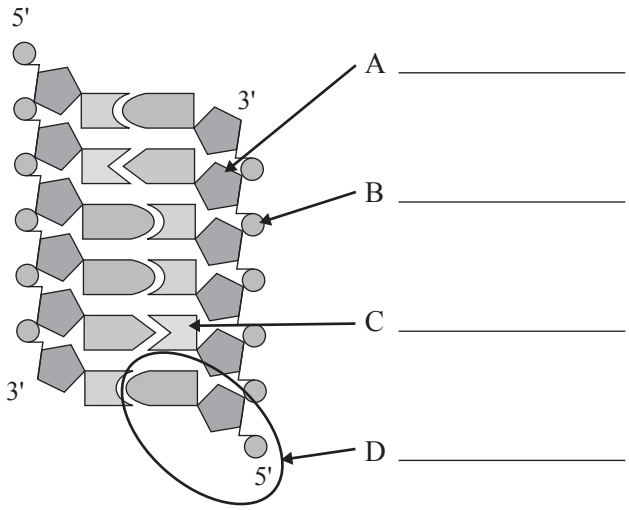
QUESTION ONE

The following diagram shows part of a DNA molecule.

(a) Identify the structures labelled A, B, C and D in the diagram, by writing their names in the spaces provided.



(b) DNA is able to make copies of itself. This process is controlled by several enzymes.

Describe the role of each of the following enzymes in DNA replication:

(i) DNA polymerase

(ii) DNA helicase

(iii) DNA ligase

The information carried by DNA controls protein synthesis. Protein synthesis includes transcription and translation.

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(c) Discuss the reasons why **both** transcription and translation are necessary for protein synthesis.

QUESTION TWO

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Human haemoglobin is formed from two polypeptides, the α-globin and β-globin chains. Glutamic acid is normally the sixth amino acid in the β-globin chain.

The first part of the DNA template sequence, for amino acids one to eight, of the normal β-globin chain is:

CAC GTG GAC TGA GGA CTC CTC TTC

(a) In the space below, give the **sequence** of the corresponding **mRNA** strand, that will code for these amino acids.

People with sickle-cell anaemia have a different base sequence that codes for valine instead of glutamic acid as the sixth amino acid.

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http://www.valleyhealth.com/images/image_popup/r7_sicklecells.jpg

The mRNA codons for glutamic acid are GAA and GAG, and the codons for valine are GUU, GUC, GUA and GUG.

(b) Describe the changes to **both** the mRNA codon and the DNA base sequence as a result of this mutation.

(c) Discuss the **effect** of this mutation on the **red blood cell**, through the mutation's effect on:

- mRNA
- the amino acid sequence
- the general structure of the protein
- the function of the protein
- the shape of the red blood cell.

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The allele coding for normal β-globin is called Hb^A, and the allele coding for mutant β-globin is Hb^S. People who are homozygous for the mutant allele ($Hb^S\ Hb^S$) suffer from sickle-cell anaemia. A person who is heterozygous ($Hb^A\ Hb^S$) has a mixture of normal red cells and sickle-shaped cells.

(d) Explain why this pattern of gene expression is an example of co-dominance, **and not** incomplete dominance.

A man is homozygous for the sickle cell allele, and a woman is heterozygous.

(e) Complete a Punnett square to show the possible genotypes for their children.

		Parent 1 gametes	
Parent 2 gametes			

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(f) (i) What proportion of the children in (e) are likely to have sickle cell anaemia?

_____

(ii) What proportion of the children in (e) are likely to be homozygous for normal haemoglobin?

_____

(g) The mutation that causes sickle cell anaemia is described as **pleiotropic**.

Describe what is meant by **pleiotropy**.

_____

_____

QUESTION THREE

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Coat colour in poodles (black or white) is controlled by two genes.

A white female poodle (with the genotype AAbb) was mated with a white male poodle (aaBB). This mating produced six puppies (the F_1 generation), which were all black.

(a) State the possible F_2 phenotypic ratio expected in the offspring if two of these F_1 black puppies are mated with each other. You may use a Punnett square in your answer.

F_2 phenotypic ratio: _____

		Parent 2 gametes			
Parent 1 gametes					

(b) Name **and** describe the gene interaction that produces this phenotypic ratio.

_____

_____

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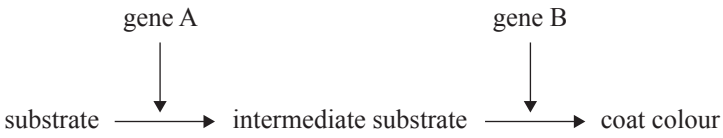
(c) In poodles, white and black coat colours are controlled by a metabolic pathway.

This pathway is controlled by two genes, as shown below:



Discuss how the **two** genes **control** this pathway to produce both black, **and** white poodles.

Extra paper for continuation of answers if required.
Clearly number the question.

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