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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

For Supervisor's use only

Level 3 Biology, 2009

90715 Describe the role of DNA in relation to gene expression

Credits: Four
2.00 pm Thursday 19 November 2009

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 2–8 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 45 minutes answering the questions in this booklet.

Assessor's use only

QUESTION ONE

The NF1 gene contains 8 454 base pairs and codes for a protein called neurofibromin. Neurofibromin regulates the action of the Ras protein, which **promotes cell division**. Mutant forms of NF1 produce a protein that cannot regulate Ras properly.

(a) When DNA is replicated, it is important that cells make exact copies of genes such as NF1.

Explain why replication of a gene needs to be exact, with reference to the role of the NF1 gene.

(b) Describe the role of transcription in the formation of a protein such as neurofibromin.

(c) Explain how mRNA is processed once it has been transcribed.

(d) People with mutations in the NF1 gene develop neurofibromatosis type 1, a disease of the nervous system that affects 1 in 3 500 people worldwide. Several different mutations result in neurofibromatosis. Some of these mutations involve the RNA transcript.

Assessor's use only

Discuss how TWO types of mutation may arise in the NF1 gene, **and** the effect these mutations could have on the control of cell division.

In your answer you should:

- describe each type of mutation
- explain the relationship between the size of the NF1 gene and the occurrence of mutations
- explain the effect each mutation may have on the control of cell division.

QUESTION TWO

Assessor's use only

There are three coat colours in Labrador retriever dogs: black, brown and yellow.
Black coat and brown coat colours are due to the interaction between two separate genes.
Black coat and brown coat colours are determined at the B locus, and black is dominant. Yellow coat colour is determined at the E locus, and is recessive (ee).

(a) Describe the gene interaction controlling coat colour in Labrador retrievers.

_____

_____

_____

(b) A black male Labrador (genotype EEBB) was mated with a yellow female Labrador (genotype eebb). All eight puppies (F_1 generation) were black.

Determine the possible F_2 phenotype ratios expected in the offspring when two of these F_1 black puppies are mated. Use a Punnett square in your answer.

F_2 phenotype ratios: _____

(c) Labrador coat colours are due to the presence of different forms of melanin. Melanin is produced from the amino acid tyrosine. There are two forms of melanin. Pheomelanin gives a yellow pigment and eumelanin produces black or brown pigment. Labradors that have the dominant E allele are able to produce eumelanin, so the dog will appear black or brown. Labradors that are homozygous recessive for this gene will produce only pheomelanin and will have yellow coats.

Assessor's use only

Discuss the gene interactions and the metabolic pathways involved in producing yellow Labradors and brown Labradors.

In your discussion you should focus on:

- describing the genotypes that will produce both brown Labradors and yellow Labradors;
- explaining how the genes interact to control the production of each coat colour;
- discussing the metabolic pathways involved in production of yellow coat `and brown coat colours.

QUESTION THREE

Assessor's use only

Down syndrome, or trisomy 21, is due to the presence of all or part of an extra 21st chromosome. People with trisomy 21 have impaired cognitive ability, impaired physical growth and a characteristic appearance.

Nearly all cases of Down syndrome result from non-disjunction of chromosome 21 during meiosis. However, a few cases can arise from a translocation mutation. In this situation, part or all of chromosome 21 is fused to another chromosome, usually chromosome 14.

Karyotype of trisomy 21

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www.genetics.com.au/images/factsheets/fs28-2.gif

Karyotype of a carrier with translocation of 14-21

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www.gla.ac.uk/medicalgenetics/guimages/Kar1421.JPG

An individual with a translocation 14-21 can be phenotypically normal, and is called a *carrier*.

(a) Explain why a carrier can be phenotypically normal.

(b) Discuss the genetic differences between individuals with Down syndrome due to trisomy 21, and individuals with Down syndrome due to a translocation mutation.

In your answer consider:

- the chromosome complement of individuals affected by each type of mutation
- the process of meiosis
- the genotypes of parents with affected children.

Assessor's use only

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

Assessor's use only

Question number	