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90715

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Level 3 Biology, 2004

90715 Describe gene expression

Credits: Four
9.30 am Thursday 25 November 2004

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 provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–11 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.

Achievement Criteria	*For Assessor's use only*	
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Describe biological concepts and processes relating to gene expression. ☐	Explain biological concepts and processes relating to gene expression. ☐	Discuss biological concepts and processes relating to gene expression. ☐
Overall Level of Performance ☐		

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

QUESTION ONE: MOLECULAR GENETICS

One form of leukaemia is associated with a recognisable change in the genetic material of the cell where parts of chromosomes 9 and 22 of the person with the disease are exchanged, as shown in the following diagram.

[For copyright reasons, this resource cannot be reproduced here. See below.]

adapted from http://www.hospprac.com/genetics/9909mmc.htm

The break point on each chromosome interrupts an existing gene. Remarkably, the new gene sequence formed on the new chromosome 22 functions to form a protein. This new protein interacts with other cell chemicals, producing more than one effect. It stops normal cell death and activates genes involved with cell reproduction, so that cells do not recognise their surroundings and constantly divide.

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(a) Identify and explain the process where one gene can have more than one effect on an organism.

(b) Explain why the phenotypic effect of mutations such as the one outlined on page 2 are not often seen.

(c) Explain how **transcription factors** might be involved with the formation of the new protein.

(d) Discuss why it is remarkable that the new gene sequence formed on the small chromosome codes for a functional protein.

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The gene that causes the leukaemia formed by the exchange outlined on page 2, was originally the target for genetic drugs. These are short sequences of nucleotides that act by binding to DNA or mRNA molecules by preventing the synthesis of disease-causing proteins. There are two main types of genetic drugs:

- Triplex drugs, which are made from DNA nucleotides and bind to DNA forming a triple helix.
- Antisense drugs that are made of RNA nucleotides and block the function of mRNA that has been made.

(e) Describe a difference between a nucleotide of DNA and RNA.

(f) Describe a function of mRNA that will be inhibited by Antisense drugs.

(g) One of the problems in using Triplex and Antisense drugs has been to stop them being broken down by extracellular nuclease enzymes before they get to their target cell. Scientists can do this by altering the chemical arrangement of the nucleotides. Discuss why the scientists are trying to alter only two of the three chemical groups of the nucleotides of these drugs in order to make them as effective as possible.

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QUESTION TWO: MAMMALIAN COAT COLOURS

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(a) Coat colour in mice is controlled by a single gene with two alleles, one of which is a yellow fur allele and the other a grey fur allele. The gene is not sex linked. A large number of crosses between two yellow mice were carried out, resulting in the following numbers of offspring:

208 yellow mice and 96 grey mice.

Litters were unusually small.

(i) Describe the term 'sex linked'.

(ii) Use the letter **F** for the yellow fur allele and **f** for the grey fur allele to explain the genotypes of the parents and explain the outcome of the cross in terms of dominance and any other factors that have caused the numbers of offspring shown. You may use Punnett square diagrams in your explanation.

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Coat colour in Labrador dogs is controlled by a gene-gene interaction involving a simple metabolic pathway. Labradors are usually black, golden or chocolate brown. The symbols for the genes involved are:

B for one dominant allele and **b** for its recessive allele, and

E for the other dominant allele and **e** for its recessive counterpart.

(b) A cross of two dogs BbEe and bbee gives a phenotypic ratio of:

1 Black :1 Brown : 2 Golden.

Relate the outcome of this cross to the simple metabolic pathway involved with this gene-gene interaction. You may need to use diagrams to help you analyse the cross and to show where in the pathway each of the genes acts to produce these results.

(c) There are three linked genes associated with coat colour in rats. A male rat heterozygous for the three linked genes, genotype AaBbCc, was test crossed with a number of females that were aabbcc. The linkage groups of these mice are:

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Male			**Females**		
A	B	c	a	b	c
a	b	C	a	b	c

1000 offspring were obtained. The number that received each of the gamete types from the heterozygous male are given in the table below (the alphabetical order given is not necessarily the order of the genes on the chromosome).

ABc	305
abC	310
aBC	42
Abc	43
ABC	140
abc	145
aBc	6
AbC	9

Analyse these results to draw a linkage map of the genes, including distance in map units. Justify your map with relevant calculations and discuss any discrepancies within the data.

QUESTION THREE: ENVIRONMENT AND GENE EXPRESSION

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Like many other reptiles, the incubation temperature of tuatara eggs has been found to be quite critical in sex determination. If tuatara eggs are incubated at 21^{o} Celsius or below, they hatch into females. If they are incubated at 22^{o} Celsius or above, they hatch into males.

(a) There is a tendency for tuatara on their island sanctuaries to lay eggs on south facing slopes under a thin covering of soil. Explain why this benefits their conservation.

(b) Describe another example of the effect of the environment on gene expression in a species other than humans.

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

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Question number