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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 2 Biology, 2017

91159 Demonstrate understanding of gene expression

2.00 p.m. Wednesday 22 November 2017
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of gene expression.	Demonstrate in-depth understanding of gene expression.	Demonstrate comprehensive understanding of gene expression.

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 attempt 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 2–12 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.

TOTAL

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QUESTION ONE: PROTEIN SYNTHESIS

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(a) In the table below, draw a DNA and an RNA molecule, each composed of the FOUR different nucleotides that are specific to each molecule.

In your answer you **must** include and label where appropriate:

- phosphate
- sugar (deoxyribose or ribose)
- nitrogenous bases (adenine, cytosine, guanine, thymine, and uracil)
- hydrogen bond.

DNA	RNA

(b) Discuss the relationship between DNA, mRNA, and tRNA in protein synthesis.

In your answer include:

- an explanation of the key stages of protein synthesis
- an explanation of why tRNA is shorter than mRNA, when considering their function
- a discussion, with two justified reasons, why DNA is not directly translated into a polypeptide chain.

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There is more space for your answer to this question on the following page.

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QUESTION TWO: GENETIC CODE

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mRNA (codon) : Amino Acid Table

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

Tracey Greenwood, Richard Allan, *Year 12 Biology 2003*, (Hamilton: Biozone, 2003), p 287.

(a) A point mutation on the haemoglobin β gene can cause sickle cell disease. The template DNA sequence for part of the normal and mutated haemoglobin protein is shown in the table below. The affected base is shown in red, and indicated with an arrow.

Complete the normal and mutated amino acid sequence using the mRNA : Amino Acid table above.

	Normal	**Mutation causing sickle cell disease**
DNA template strand	GAC TGA GGA CTC AAC	GAC TGA GGA C↙A C AAC
mRNA strand		
amino acid sequence		

(b) Discuss the effects of point mutations on final protein structure.

In your answer include:

- identification and a description of the type of mutation leading to sickle cell disease
- an explanation of how this mutation affects the amino acid sequence and final protein structure
- a discussion of how the degeneracy of the code can reduce the impact of point mutations on final protein structure, and on an organism's survival.

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QUESTION THREE: METABOLIC PATHWAYS

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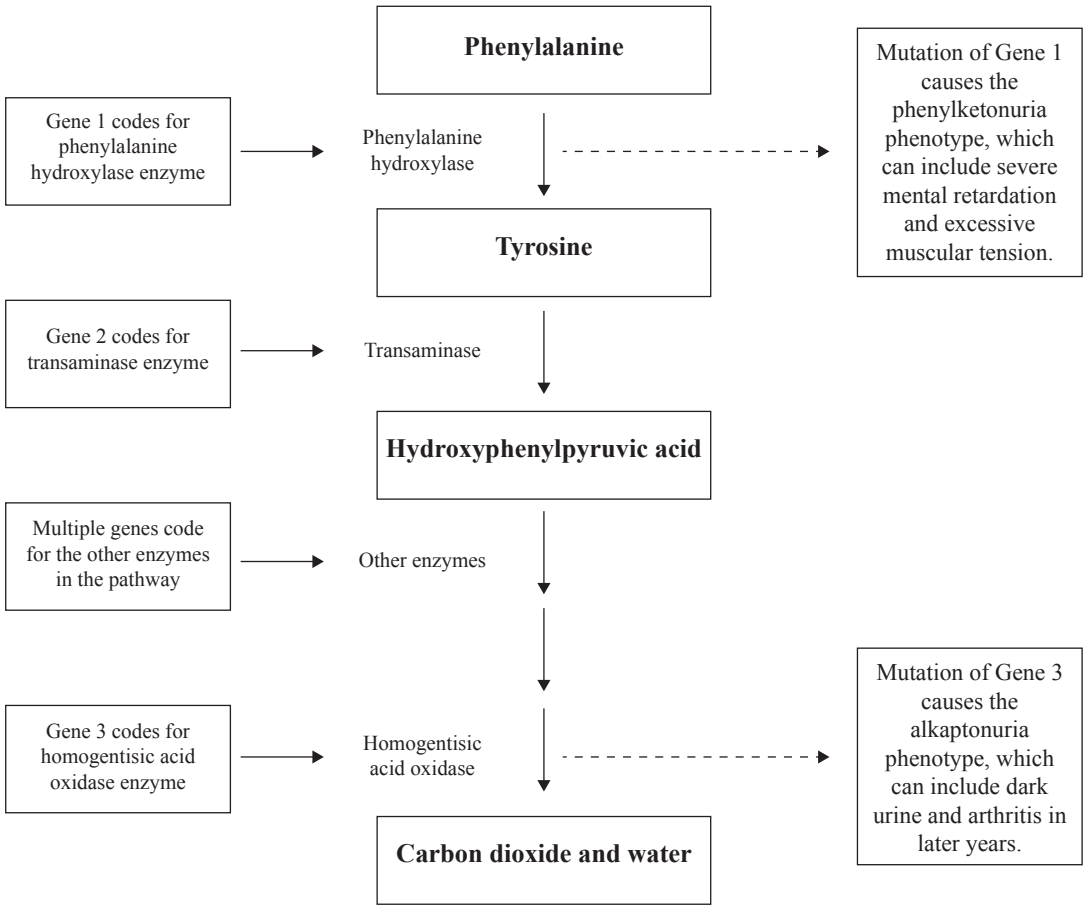
A simplified section of the phenylalanine metabolic pathway is shown below.



Using the simplified section of the phenylalanine metabolic pathway, discuss how the presence or amount of a product affects the phenotype.

In your answer:

- describe how enzymes control metabolic pathways
- explain the relationship between genes, enzymes, and products
- identify which mutation causes the more severe phenotype AND discuss how mutations affect the presence or amount of products in the phenylalanine metabolic pathway.

You may draw on the diagram above.

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There is more space for your answer to this question on the following pages.

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Extra paper if required.
Write the question number(s) if applicable.

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