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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Biology 2023

91159 Demonstrate understanding of gene expression

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 room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–16 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (⬚). This area will be cut off when the booklet is marked.

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

QUESTION ONE: MUTATIONS

Table 1. mRNA (codon): Amino Acid

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

(The rightmost column is the **Third Position**.)

Genetic disorders can be caused by point mutations. A point mutation to a gene at any point may disrupt protein folding and structure.

(a) The template DNA sequence for part of a normal gene and two different mutations is shown in Table 2 below. The affected bases are shown in red, bold and underlined.

Complete Table 2.

Table 2

	Normal gene sequence	Point mutation 1	Point mutation 2
DNA template strand (middle section)	TAA TAG ATA CCA CAA	TAA TAG AT**G** CCA CAA	TAA TAG AT**T** CCA CAA
mRNA strand			
Amino acid sequence			

(b) Discuss the effects of these mutations on the amino acid sequence and final protein.

In your answer, include a discussion of:

- a mutation, including a description, and identify the type of point mutations shown in Table 2 on page 2

- how point mutation 1 will affect the amino acid sequence and final protein

- how point mutation 2 will affect the amino acid sequence and final protein

- how the degeneracy of the code and the mutations will affect the final functioning of the protein.

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## QUESTION TWO: GENOTYPE, ENVIRONMENT, AND MUTAGENS

A person's skin colour is a result of both genotype and the environment. Ultraviolet (UV) radiation or light can be a mutagen, and it can also be an environmental factor which is non-mutagenic. Low levels of UV light do not act as a mutagen but instead cause Gene 2, in the simplified metabolic pathway below, to produce more melanin in the skin and to express the full genetic potential of the person. This increased melanin protects the DNA in skin cells from the higher, mutagenic levels of UV light.

However, people with albinism produce very little or no melanin, regardless of how much UV light they are exposed to, and are at much greater risk of skin cancer. Cancer is caused by mutagens.

Watch strap tan line

Simplified metabolic pathway
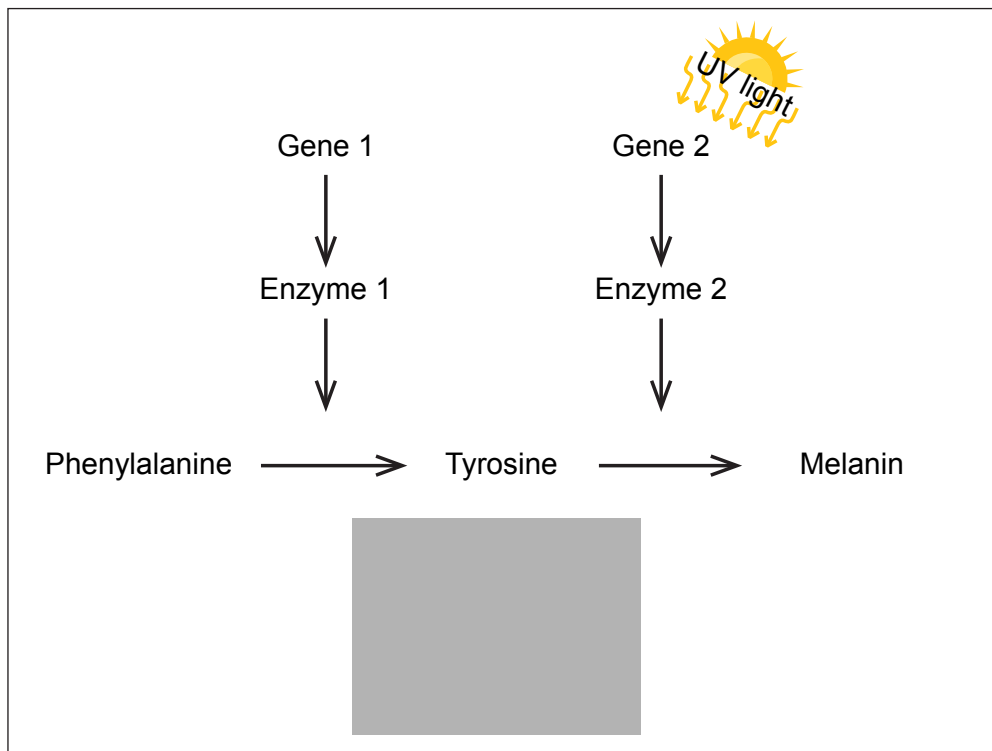
Using the information given and the metabolic pathway above, discuss **how** and **why** UV light can affect **both** phenotype (melanin production) and genotype.

In your answer, include a discussion of:

*   an environmental factor (non-mutagen) AND a mutagen, including descriptions of each

*   how melanin is produced in the metabolic pathway AND how UV light affects genetic potential

*   how melanin is not produced in people with albinism AND why these people are more likely to get skin cancer.

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

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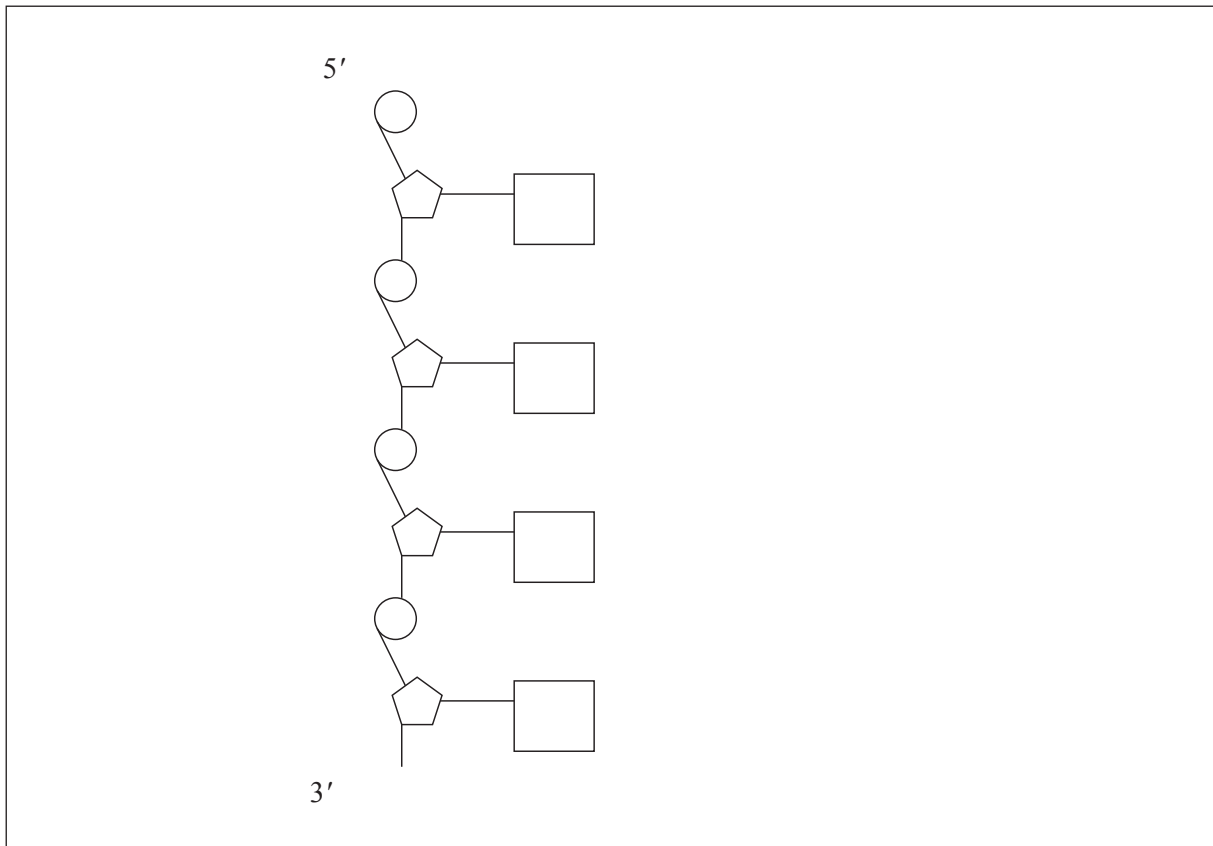**The assessment continues on the following page.**

QUESTION THREE: PROTEIN SYNTHESIS

DNA is made up of phosphates, deoxyribose sugar, and nitrogenous bases.

(a)   Complete the diagram of DNA in the box below.

In your answer:

- fill in the template strand containing bases thymine (T), adenine (A), guanine (G), and cytosine (C)

- draw the corresponding **anti-parallel** complementary strand

- draw and label the sugars

- draw and label the phosphates.

DNA base-pairing rule

(b)   Name the TWO stages in protein synthesis and the order in which they occur.

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(c)   Discuss how the complementary base-pairing rule ensures accurate protein synthesis, referring to the figure above.

A detailed description of the steps in protein synthesis is **not** required.

In your answer, include a discussion of:

*   how triplets, codons, and anticodons (including descriptions of each) are used to transfer the genetic code on DNA to the sequence of amino acids in the protein

*   why accuracy of the two processes named in your answer to (b) above is so important for protein synthesis.

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