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Level 2 Biology 2021

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 2–12 in the correct order and that none of these pages is blank.

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

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QUESTION ONE: NUCLEIC ACIDS

There are two types of nucleic acids: deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

(a) Use the table to explain the similarities AND differences between DNA and RNA.

In your answer include the following:

- phosphate
- sugar
- hydrogen bonds
- bases: adenine, thymine, guanine, cytosine, and uracil
- nucleotide.

	DNA	**RNA**
Diagram:		
Differences:		
Similarities:		

(b) DNA is made up of two strands, the coding strand and the template strand, while mRNA is made of one strand.

Discuss how the structure and function of these strands are involved in making proteins.

In your answer include:

- an explanation of the function of DNA coding and template strands
- an explanation of the mRNA strand, including where and how it is made
- a discussion of how accurate transcription of DNA is achieved.

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

QUESTION TWO: MUTATIONS

Table 1: mRNA (codon) : Amino Acid

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

Adapted from: Tracey Greenwood and Richard Allan. 2003, *Year 12 Biology 2003*, Biozone, p. 287.

A mutation in the gene coding for the enzyme phenylalanine hydroxylase (PAH) causes the disease phenylketonuria.

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

Complete Table 2.

Table 2

	Normal PAH gene sequence	**Point mutation 1**	**Point mutation 2**
DNA template strand	TAT GGA GCC GGG	TAT GGA ACC GGG	TAT GGA TCC GGG
mRNA strand			
Amino acid sequence			

(b) Discuss the effect of these mutations on the amino acid sequence and the functioning of the final enzyme.

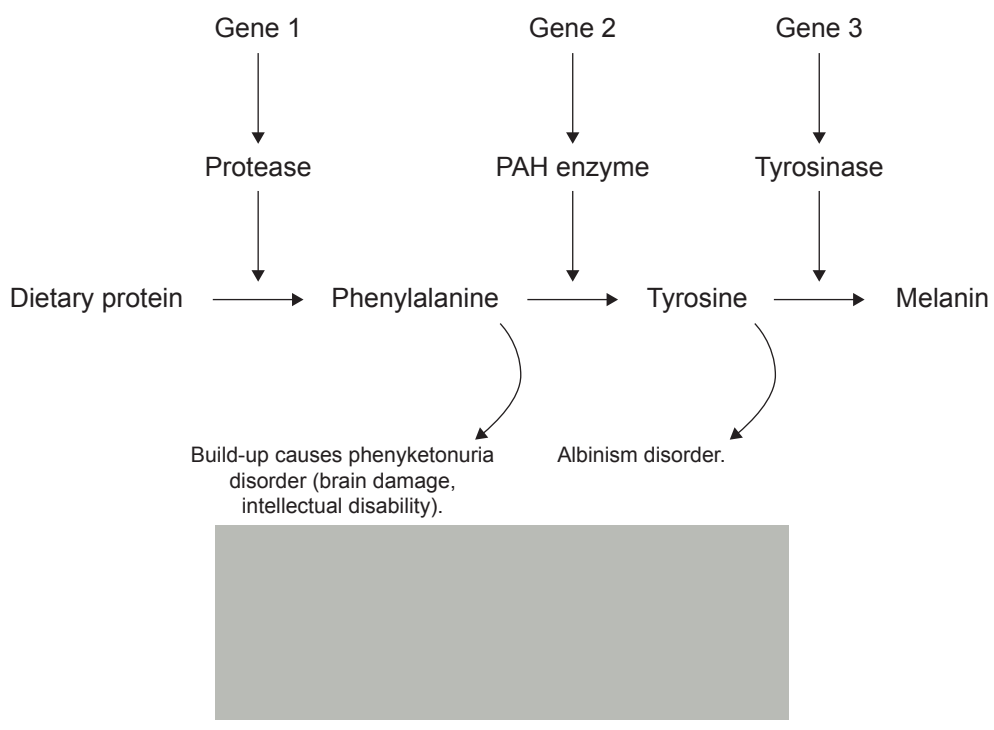
In your answer include:

- a description of the causes of mutations
- an explanation of the point mutations 1 and 2
- an explanation outlining if these mutations affect the start and stop codons
- a discussion of how these two mutations affect the final functioning of the enzyme.

QUESTION THREE: ENVIRONMENT AND GENE EXPRESSION

Phenylketonuria (PKU) disorder causes high levels of the amino acid phenylalanine in the blood. High levels of phenylalanine can cause brain damage and intellectual disabilities. At birth, babies are tested for the PKU disorder. Babies who are diagnosed with PKU do not develop the symptoms of the disorder and can have a normal healthy life if they stick to a strict diet of low protein intake their entire life and consume a tyrosine supplement.

Albinism is caused when melanin (pigment) is not produced. People with albinism lack pigment in their skin, hair, and eyes.



Sources: www.independent.co.uk/news/long_reads/synthetic-biology-microbes-dna-bacteria-phenylketonuria-pku-science-a8530741.html
https://www.boredpanda.com/albino-twins-models/

Using the simplified metabolic pathway above, discuss why the environment can prevent a person from developing PKU disorder, but not from developing albinism.

In your answer include:

- an explanation of a metabolic pathway
- an explanation of why a person with PKU must stick to a low protein diet for their entire life
- a discussion of how a person develops both PKU AND albinism.

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

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

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