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91159

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NZQA

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.

Achievement

TOTAL 07

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QUESTION ONE: PROTEIN SYNTHESIS

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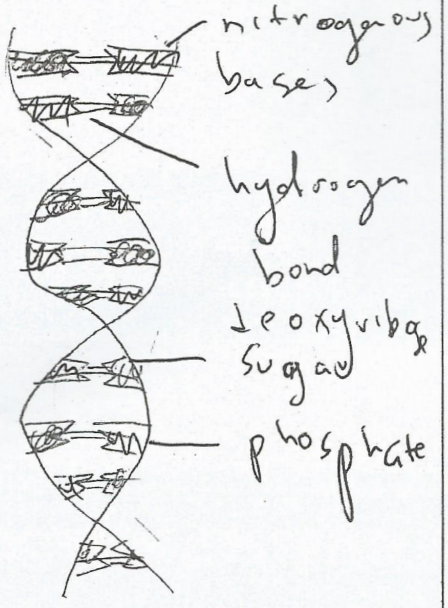
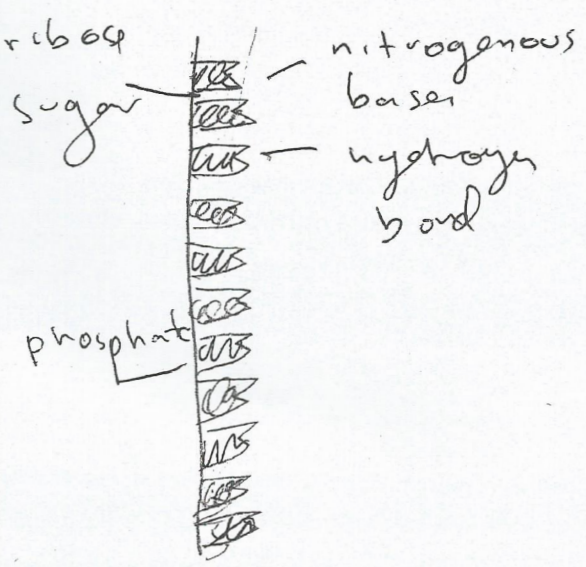
(a) In the table below, draw a DNA and an RNA molecule, each composed of the FOUR different nucleotides that are specific to each molecule.

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.

During Protein Synthesis there are two main stages transcription and translation.

Transcription occurs when DNA helix is unwound and bases are exposed. Using the template

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Strand the triplets on DNA is used to find complimentary codons for transcribed onto mRNA (Uracil replaces Thymine) the single stranded mRNA leaves nucleus and enters cytoplasm where translation occurs. Ribosome reads the mRNA in codons. The tRNA with the complimentary anticodon matches with the codon and the amino acid attached to the end of tRNA is released, making a polypeptide chain which results in a protein.

tRNA is shorter than mRNA because it only carries 3 bases which are the anticodon to match a complimentary codon on the mRNA. mRNA is longer because it consists more than a codon, it is the same length as the DNA so is longer.

DNA is not directly translated into a polypeptide chain because it is double stranded

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

so the tRNA cannot perform their function.
Another reason why DNA is not used directly is because if it is used only one polypeptide chain will be formed from it. A cell must have its genetic material for cell division so all cells have genetic information so cannot be directly used for making proteins.

QUESTION TWO: GENETIC CODE

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mRNA (codon) : Amino Acid Table

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 CAC AAC
mRNA strand	CUG ACU CCU GAG UUG	CUG ACU CCU GUG UUG
amino acid sequence	Leu Thr Pro Glu Phe	Leu Thr Pro Val Phe

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

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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.

substitution lead to sickle cell disease The Thymine was replaced with an Adenine, this resulted in a different amino acid.

Originally the amino acid was Glu and become Val.

This changed the structure of final protein because ca different amino acids.

Sometimes when codons are affected by substitution the amino acid produced is the same as before a mutation this is due to the degenerate nature of DNA. But in this case the amino acid differed.

Degeneracy and Redundancy can be achieved when only the last base of the codon is changed but the middle base was changed so amino acid

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A mutation can negatively affect an organism because a different amino acid was formed and can harm the organism.
The redundancy can help an organism survive because protein will be the same and unchanged.

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

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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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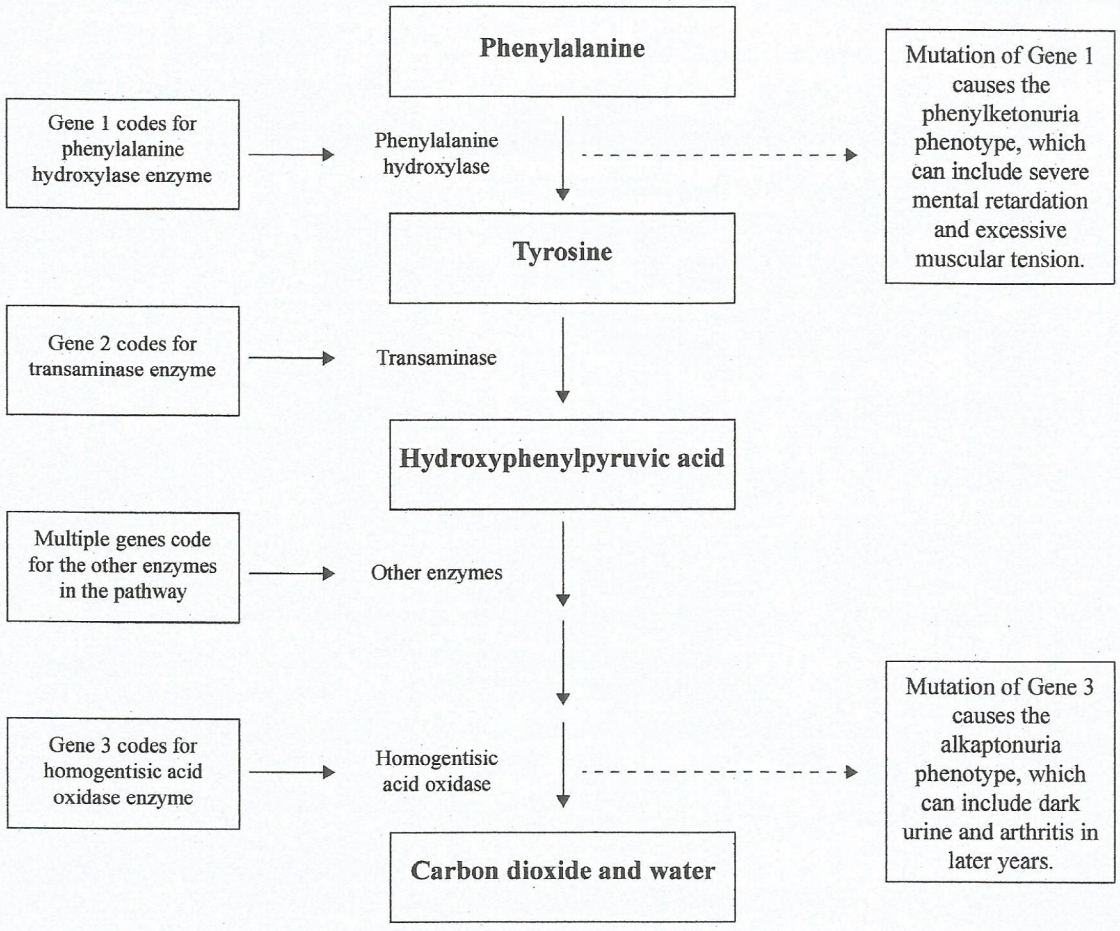
QUESTION THREE: METABOLIC PATHWAYS

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.

enzymes are biological catalysts and help speed up chemical reactions. Without them metabolism will occur too slowly.

Enzymes become enzyme substrate complexes which are used multiple times in a

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metabolic pathway.

genes help code for proteins through protein synthesis. Enzymes help aid with this to form products.

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

Subject:	BIOLOGY	Standard:	91159	Total score:	07

Q	Grade score	Annotation
1	N2	States correctly that DNA is double- stranded but two correct labels needed for N1. Both transcription and translation are poorly expressed. Describes why tRNA is shorter than mRNA. Description of why DNA is not directly translated reflects a low level of literacy rather than a lack of knowledge.
2	A4	Top two sections correct. Identifies mutation as substitution. Describes swapping of bases and that as a consequence a different amino acid is selected so altering the structure of the resulting protein. Describes that Glu becomes Val. Incorrect/incomplete description of degeneracy.
3	N1	States that enzymes speed up reactions.