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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 2 Biology, 2014

91159 Demonstrate understanding of gene expression

9.30 am Monday 17 November 2014
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: MAKING PROTEINS

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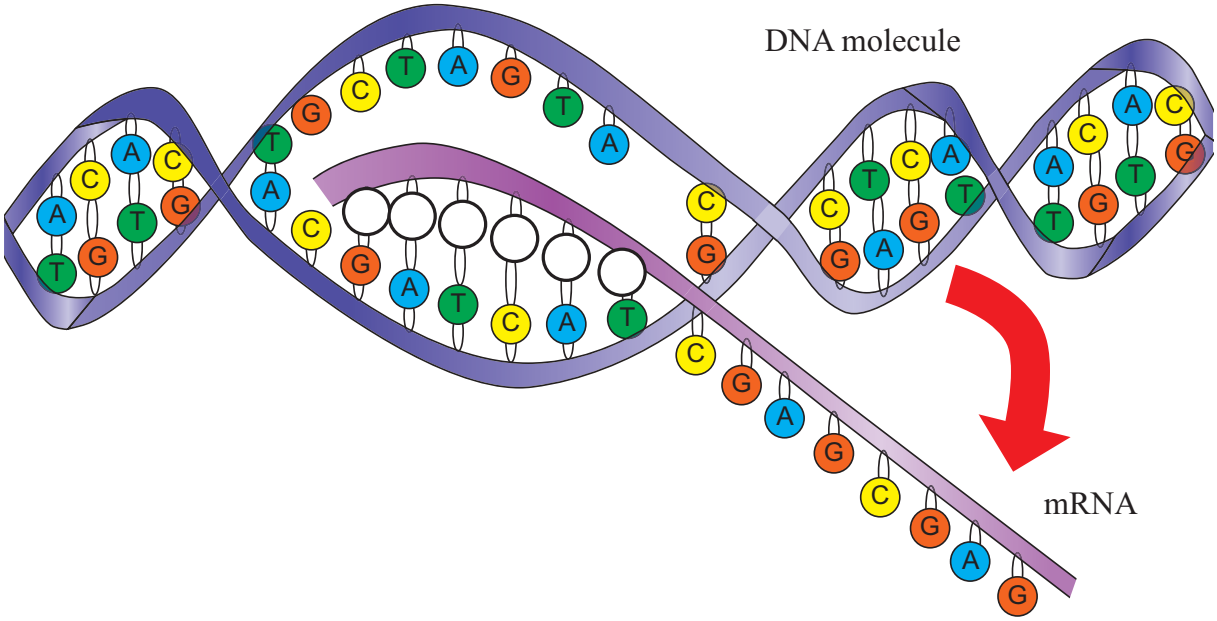
(a) The diagram below shows the cell process, transcription.

On the diagram, fill in the missing bases on the mRNA strand.



Adapted from http://www.scientificpsychic.com/fitness/aminoacids1.html

(b) Protein synthesis involves two stages: transcription and translation.

Compare and contrast these two cell processes and their role in protein synthesis.

In your answer:

- explain the purpose and processes of transcription AND translation
- discuss the similarities and differences between transcription and translation.

You may use diagrams to support your answer.

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

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The examination continues on the following page.

QUESTION TWO: COAT COLOUR

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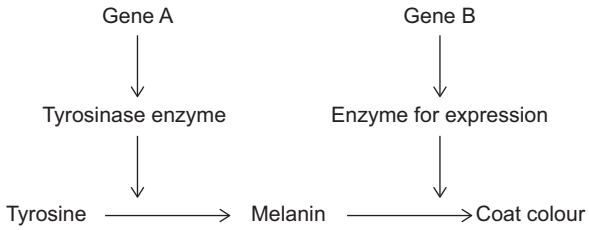
http://en.wikipedia.org/wiki/Siamese_(cat)

Tyrosine Metabolic Pathway



Skin and hair colouring are influenced by the pigment melanin. Melanin is a protein that is made via the tyrosine pathway, and there are two genes involved in the pathway, which lead to its expression.

Albino animals lack the pigment melanin, and so have no colouring of their skin, hair, and eyes. Siamese cats, like the one in the picture above, show a form of albinism. However, Siamese cats possess a mutated gene that codes for the enzyme tyrosinase, which is an enzyme in the melanin expression pathway. This enzyme is temperature sensitive, and so Siamese cats can produce the pigment melanin in body extremities, such as the feet, tail, and face, which gives them darker colouring.

Discuss how the metabolic pathway for melanin and the environment interact to influence the coat colour in Siamese cats.

In your answer:

- describe what a metabolic pathway is
- explain why Siamese cats have darker colouration around their body extremities such as the nose, feet and tail, and **not** around their chest area
- using the diagram above, discuss how genes and enzymes control the metabolic pathway for melanin, and how this causes Siamese cats to be albino.

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QUESTION THREE: THE 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) The mRNA codon sequence for part of a normal haemoglobin protein is shown in the table below.

- Complete the normal template DNA sequence in the table below.
- Complete the normal amino acid sequence using the mRNA : Amino Acid table above

Normal template DNA								
Normal mRNA	AUG	GUG	CAC	CUG	ACU	CCU	GAG	UUG
Normal amino acid								

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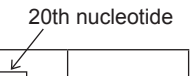
Sickle cell disease (previously known as sickle cell anaemia) is an inherited disorder caused by a mutation on the haemoglobin (red blood cell) gene. The 20th nucleotide in the DNA sequence, has a T nucleotide substituted with an A nucleotide base on the DNA strand.

(b) Using the table below, describe the mutated amino acid sequence resulting from T being replaced at the 20th nucleotide position.



Mutated DNA	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _
Mutated mRNA								
Mutated amino acid								

(c) Discuss what happens to the final protein as a result of this mutation.

In your answer:

- explain how the substitution mutation affects the sequence of bases and the final protein
- discuss what would happen to the DNA base sequence and final protein if an additional nucleotide was inserted into the sequence as an extra, rather than being substituted for another, and
- link this to the degeneracy of the genetic code.

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

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

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