2

91159

911590

NZQA
NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

SUPERVISOR'S USE ONLY

Tick this box if you have NOT written in this booklet

Level 2 Biology 2022

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.

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

Merit

TOTAL 15

QUESTION ONE: PROTEIN SYNTHESIS

Translation is an important step in protein synthesis.

Source: https://www.thinglink.com/scene/750792545688092673

Discuss the importance of translation, and why the DNA strand is not directly translated into a polypeptide chain.

In your answer:

- describe protein synthesis
- explain translation
- discuss the relationship between codons, anticodons, tRNA, mRNA, and amino acids
- justify with TWO reasons why DNA is not directly translated into a polypeptide chain.

P — start
A — exposed
E — exit
-attaches ribosomal subunit
3 mRNA
3 tRNA
no u/nast + cant leave too large

Protein synthesis is the process consisting of transcription and translation which results in the formation of a protein. Translation occurs after transcription has formed the mRNA (messenger strand). It is transported from the nucleus into the cytoplasm where it attaches itself to a ribosomal subunit. The process of translations occurs when the start codon, 3 consecutive bases on mRNA, are read (this is often, but not always MET). When the start codon enters the P site* it meets

it complementary anti codon (3 consecutive bases on tRNA). This forms the amino acid using the instructions from the mRNA. Once the amino acid has been formed it is pulled through by exactly three bases. These bases now enter the exposed A site and the process continues. The end of translation is initiated by release factors which fit into the P site. They cause a water molecule to be formed instead of a peptide bond. Once this occurs the now formed polypeptide chain is released through the E (exit) site* to form a protein. There is a clear relationship between codons and mRNA and one between anti-codons and tRNA. A codon is three consecutive bases found on mRNA while an anti codon is three consecutive bases on tRNA. tRNA is what brings the complementary / matching amino acids to the mRNA codes in order to form a fully functional protein. There are two reasons why DNA can not be directly translated. The first probelem faced is its bases, in the RNA, used for translation, uracil (u base) is required since it is the base amino acids code from. The t base (thymine) that is found on DNA is unable to be used for translation since thymine does not translate into amino acids (in RNA u pairs with C instead of U). A second reason

* it is pulled through to the exposed A site where
** from the ribosomal subunit

QUESTION TWO: THE GENETIC CODE

A mutation in the gene coding for the enzyme tyrosine causes albinism, a condition that results in a decrease in the production of the pigment melanin. These individuals have albino phenotypes, because melanin gives pigment to their skin, hair, and eyes.

Source: https://www.quora.com/Can-animals-have-albinism

(a) Describe what a mutation is.

A mutation is a permanent change in the DNA base sequence which can results in formation of new alleles

(b) Different point mutations can cause albinism.

Discuss the effect of point mutations on final proteins.

In your answer:

- describe an insertion, deletion, and substitution mutation (same sense e.g substitution)
- name the type of point mutation that is unlikely to change the protein, and explain why (missense nonsense)
- name the type of point mutation that would change the protein the most, and explain why
- discuss how these mutations affect the length and expression of the DNA base sequence (deletion → short, insertion → long)
- discuss the degeneracy in the genetic code.

Different point mutations have different impacts on the final protein formed, some minor

of mutations

and some major. The different types are:

1. Insertion which occurs when a base/s are added into the coding for the protein
2. Deletion which occurs when a base/s have been removed from the coding for the protein

and lastly 3. substitution which causes a base/s to be replaced by another in the protein coding. Out of the 3 substitution mutation is the least likely to change the protein, this is a samesense point mutation. This is due to it not changing the length of the coding strand since it is simply replacing one of the bases present. On the other hand, a point mutation of missense and nonsense, have the most impact in changing a protein. These include a deletion mutation which shortens the base sequence, therefore, the protein, and insertion which increases the base sequence and therefore the proteins produced. A substitution mutation, as stated before will have no effect on the length or expression of the DNA base sequence. A deletion or insertion mutation will however. This is because they remove (delete) or add (insert) extra bases into the DNA length. when this occurs the

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

way the DNA base sequence is expressed will chang since the base sequence itself has changed. When the base sequence is expressed it forms a functional protein. However, when it has been changed by a mutation-(deleted/inserted) the protein created may be longer/shorter and result in a non-functional protein which impacts the entire organism*. The reasons substitution wont have this major effect on the protein formed is due to the idea of degeneracy. There are 20 20 amino acids able to be formed, however, there are 64 possible combinations. This causes redundancy where multiple base combinations (codons) can form the the same amino acid. When substitution occurs there is a likely chance that the replaced base still ~~codes fo~~ ends up coding for the same amino acid. This means if a substitution ~~that~~ mutation occurs the ~~ge~~ DNA sequence will often be read the same and end up producing the same functional protein.

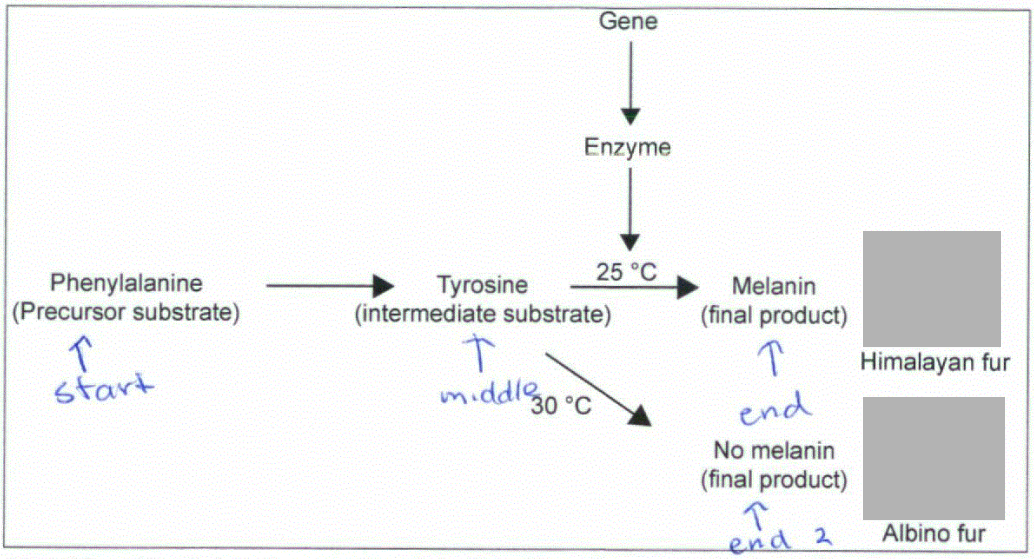
* what can also happen when a deletion or insertion mutation occurs is a frame shift. When this occurs it means the the DNA sequence will not be read as intended causing the incorrect or a non-functional protein to be produced.

QUESTION THREE: GENE EXPRESSION AND ENVIRONMENT

Himalayan rabbits show a mutant form of albinism that is temperature sensitive.

At lower temperatures (below 25 °C), the gene produces melanin (black) in fur. The enzyme is inactive at higher temperatures (above 30 °C) and produces no melanin (white) in fur. The average body temperature of a Himalayan rabbit is 37 °C.

Simplified metabolic pathway



Adapted from: https://arba.net/recognized-breeds/ and https://animalcorner.org/rabbit-breeds/himalayan-rabbit-breed/

Discuss how genes, enzymes, and the environment control the expression of melanin in Himalayan rabbits.

In your answer:

- describe what a metabolic pathway is
- explain a metabolic pathway using the terms precursor, substrate, intermediate, enzyme, gene, and final product
- discuss why Himalayan rabbits have dark melanin expression in their body extremities such as nose, ears, feet, and tail, and not in their core body
- discuss the environmental conditions necessary for Himalayan rabbits to express melanin (all black) AND no melanin (all white) fur colour for their entire life span.

A metabolic pathway is a series of enzyme controlled reactions where the product of one is the substrate of the next. The metabolic pathway are controlled by enzymes which are coded for by genes. In order for the metabolic pathway to be ~~functio~~ successful the gene must code correctly for a functional enzyme. If the enzyme

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

is non-functional the metabolic pathway is unable to carry on and form the final product. The precusor, in this case is Phenylalanine, is the first ~~product~~ substrate and is used to complete the initial part of the pathway, producing the first product, this is tyrosine. The product of tyrosine is ~~two~~ now used as intermediate substrate needed to reach the final stage in the metabolic pathway, forming the final product of Melanin. The dark melanin colour is expressed when temperatures are below 25°C and only on their nose, ears, feet and tail. A Himilayans rabbits average body temp is 37°C, far larger than these temps. The areas of ~~fur~~ the rabbits fur that turns black is their body extremities, therefore, the body parts with the most exposure to the cold weather. In order to keep the rabbits temperature at the average amount a focus of protection must be put on the exposed part. For example a rabbits feet come into direct contact with the cold ground as the rabbit moves arounds. Because of this this area is greatly exposed to the cold so the melanin is directed to this area. Though the core body of the rabbit will experience the cold it is not in direct contact with it like the foot is, as it is somewhat lifted off the ground. Because of this it is not an

area of the rabbits body which requires the most protection from the ~~snow~~ cold and is therefore ~~not~~ does not have the dark melanin. In order for a rabbit to experience either all black or all white it requires to be continuesly exposed to extreme weather conditions, extreme hed or cold. When the weather the rabbit is exposed to decreases, ~~to~~ eg causes snow, more of the rabbits body will directly exposed to the snow and will therefore need more melanin present on its body to keep the rabbits average body temperature at 37°C in order for it to survive successfully*. On the other hand if the weather increases, eg. a heat wave, the rabbit no longer needs help staying warm, its worry is instead staying cool, therefore, the rabbits fur in warm conditions will remain to help the rabbits body temperature down at 37°C which it requires to survive successfully.

* if the temp gets low enough the whole body fur will be required to be black

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

QUESTION NUMBER

Q 1) is due to DNA size. To exit the nucleus mRNA uses the small nuclear pores which are far too small for DNA to leave through. However, transcription must occur in the cytoplasm so it can attach to the ribosomal subunit where tRNA is present. DNA is unable to do that due to its size-

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

QUESTION NUMBER

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

QUESTION NUMBER

Standard	91159	Display ID	681462	**Total score**	15
		NSN			

Q	**Grade score**	**Annotation**
1	M6	Describes translation including the idea of a start/stop codon. Explains how mRNA/tRNA have specific amino acids by mentioning the complementary nature. Explains why DNA is not directly translated into a polypeptide chain.
2	M5	Explains a substitution mutation has the least effect on the final protein because, it may code for the same amino acid/doesn't cause a frameshift. Explains an insertion has a major effect on the final protein by changing the amino acid/shape/function of the protein. Explains a deletion mutation has a major effect on the final protein by changing the amino acid/shape/function of the protein.
3	A4	Describes a metabolic pathway; genes code for proteins; a precursor substrate; enzymes work at low temperatures to produce black.