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NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Biology 2023

91157 Demonstrate understanding of genetic variation and change

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of genetic variation and change.	Demonstrate in-depth understanding of genetic variation and change.	Demonstrate comprehensive understanding of genetic variation and change.

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 (DO NOT WRITE IN THIS AREA DO NOT WRITE). 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: MEIOSIS

Budgies display a complete dominance pattern. The allele for green (G) feathers is dominant over the allele for blue (g) feathers. The allele for barred (B) wing is dominant to the allele for clear (b) wing. The genes for feather colour and wing pattern are not linked, being found on different chromosomes.

A budgie homozygous for both green feathers and barred wing was crossed with a budgie homozygous for blue feathers and clear wing.

(a) State the genotype of the F1 generation this cross produces.

(b) Use the Punnett square below to show:

- the F1 gametes of this cross
- all the expected genotypes of the F2 generation of budgies.

F1 gametes

F1 gametes

(c) Describe the predicted phenotype ratios produced by this cross.

(d) Meiosis produced the gametes for the F1 and F2 generations on page 2.

Discuss why the parents of F1 individuals produced all the same type of gametes, while the F1 individuals themselves produced four different types of gametes.

In your answer, include a discussion of:

- meiosis, including a description
- homologous chromosomes
- independent assortment, crossing over, and segregation
- how independent assortment, segregation, and crossing over affect genetic variation.

You may use a diagram in your answer.

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

QUESTION TWO: NATURAL SELECTION

Skin colour (melanin pigmentation) is produced by multiple alleles (and genes). Some of these alleles show incomplete dominance.

Melanin is located in the surface cells of the skin (epidermis) and protects cells from ultraviolet (UV) rays that can cause harmful mutations. However, the human body does need to absorb a certain amount of UV light in order to produce vitamin D.

Vitamin D is important in maintaining cellular function and bone health. Vitamin D also improves fertility and increases a woman's chance of surviving child birth.

Average skin pigmentation levels among historical indigenous populations

Using the information given and the map above, discuss how human skin colour is a result of natural selection.

In your answer, include a discussion of:

- multiple alleles and incomplete dominance, including a description of each
- natural selection
- why beneficial mutations are retained in a population and harmful mutations are not
- why people from equatorial regions tend to have darker skin colour, and people from higher latitudes tend to have lighter skin.

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: SMALL POPULATIONS

The tara iti (fairy tern) is one of Aotearoa New Zealand's rarest birds. There are fewer than 40 individuals remaining, including only 8–10 breeding females. The population has decreased to critical levels due to introduced predators, habitat loss, and human activity.

Discuss the factors that affect allele frequencies and genetic variation of the tara iti, and the consequences of having a small population size.

In your answer, include a discussion of:

- allele frequency, genetic variation, and genetic drift, including descriptions of each
- bottleneck effect, including a description, and why tara iti are an example of a population bottleneck
- how the bottleneck effect could affect the genetic variation of the tara iti population
- the different effects genetic drift would have on the gene pool of the tara iti population, compared to a much larger population, and future challenges this creates for the species.

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

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

QUESTION NUMBER	

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QUESTION NUMBER	

Acknowledgements
Material from the following sources has been adapted for use in this assessment:

Page 2
Image: http://mybudgiesinfo.blogspot.com/p/mutation-and-varieties.html

Page 6
Image: https://www.nature.com/articles/ng1440

Page 10
Image: https://www.doc.govt.nz/globalassets/documents/conservation/native-animals/birds/tara-iti-new-zealand-fairy-tern.pdf