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NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Biology 2025

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 the margins (////). 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: Snake genetics

Corn snakes (*Pantherophis guttatus*) are considered helpful to humans and are found in different parts of the eastern United States. This species lives in a wide variety of habitats including wooded areas, rocky hillsides, barns, and abandoned buildings.

They have a complete dominance inheritance pattern for body colour and scale pattern. The orange body-colour allele (G) is dominant to the white body-colour allele (g).The allele for striped scale pattern (B) is dominant to the allele for blotched scale pattern (b). The genes for body colour and scale pattern are not genetically linked.

Corn snake.

Anerythristic Hurricane Motley corn snake.

(a) Conservationists crossed a corn snake homozygous for the orange body-colour allele and the striped pattern allele, with a corn snake homozygous for white body colour and blotched scale pattern.

State the genotype of the gametes produced by each parent:

Parent 1: _____ Parent 2: _____

State the genotype of the F1 generation:

_____

(b) Use the Punnett square below to show the gametes of the F1 generation, and all of the possible genotypes of the F2 generation.

F1 gametes

F1 gametes				

(c) Describe the predicted phenotype (F2) ratio produced by the cross.

(d) The garter snake (*Thamnophis sirtalis*) is another species of snake and has often been bred in captivity. When snakes are crossed that are heterozygous for a striped pattern and rough scale texture, striped (E) is dominant over unstriped (e), and smooth texture (R) is dominant over rough texture (r).

With this cross, the observed ratio is frequently found to be:

7 striped smooth : 1 striped rough :
1 unstriped smooth : 7 unstriped rough

Common garter snake.

Discuss how genes located on the same chromosome can show both linked and unlinked characteristics, using the information provided for BOTH species of snake.

In your answer, include discussion of:

- how the processes of crossing over and segregation can influence the inheritance patterns of both linked and unlinked genes
- the effect of gene location on the observed phenotype ratios
- why the dihybrid heterozygous crosses for these identified traits are so different in these two species of snake.

QUESTION TWO: The New Zealand giraffe weevil / pepeke nguturoa

The New Zealand giraffe weevil / pepeke nguturoa (*Lasiorhynchus barbicornis*) is an insect endemic to New Zealand. The most notable phenotypic variation in this species is observed in males, particularly in the length of their snout, known as a rostrum, and overall larger body size. These phenotypes are influenced by genetic and environmental factors and are subject to strong sexual selection (mate selection) where females are choosing the males based on their phenotypes.

New Zealand giraffe weevil.

The table below shows the common distribution of these phenotypes:

	North Island	**South Island**	**Smaller offshore islands** (limited food and habitat resources, smaller populations)
Long-rostrum males	Dense native forests (e.g. Waipoua Forest, Tongariro National Park).	Dense native forests (e.g. Fiordland National Park, Westland Tai Poutini National Park).	Phenotype distribution is far more random and shows less relationship to the dominant type of vegetation.
Short-rostrum males	More open or smaller patches of native forests.	Drier or more open habitats (e.g. Canterbury Plains).	

Discuss what factors may cause allele frequencies in a gene pool to change, using the information provided above.

In your answer, include discussion of:

- how the gene pool of the New Zealand giraffe weevil could be affected by their migration between habitats AND by genetic drift
- how sexual selection (mate selection) and natural selection may have influenced these two distinct phenotypes of long-rostrum and short-rostrum males.

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The assessment continues on the following page.

QUESTION THREE: Blood types

If a patient needs a blood transfusion during surgery, it is essential to match their blood type correctly. Receiving the wrong blood type can cause serious, potentially life-threatening reactions.

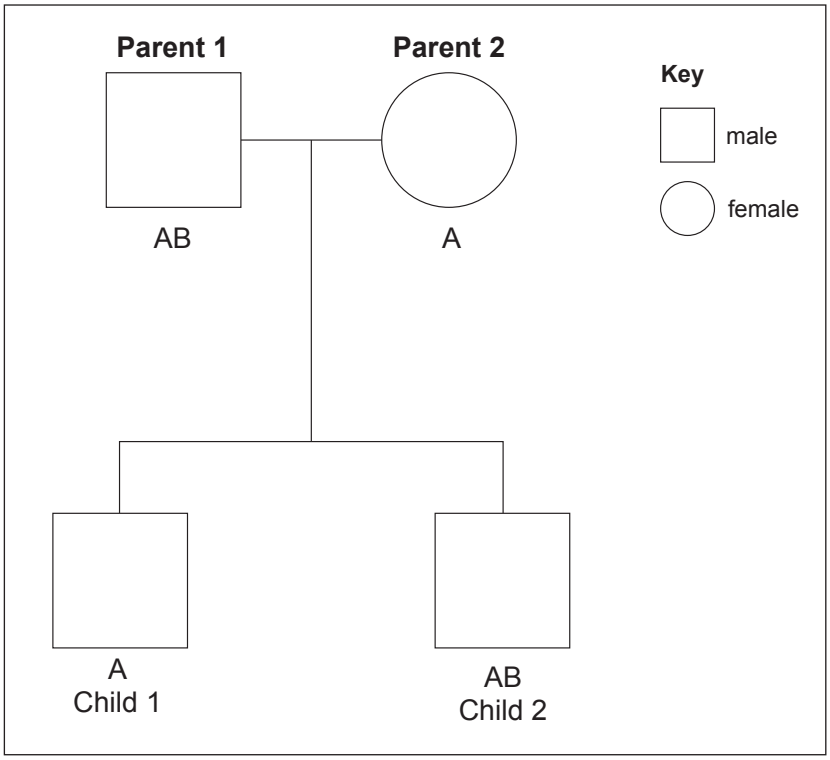
Blood type in humans is controlled by multiple alleles. The alleles I^A and I^B are dominant over i^O. I^A and I^B are examples of alleles that show co-dominance.

The pedigree chart below shows the blood types / phenotypes of two children and their parents.

Blood types

Phenotype	Genotype
A	$I^A I^A$, $I^A i^O$
B	$I^B I^B$, $I^B i^O$
AB	$I^A I^B$
O	$i^O i^O$

Pedigree chart



Discuss the inheritance of these blood types, using the information provided above. You may include a Punnett square to support your answer (optional).

In your answer, include discussion of:

- what is meant by the term multiple alleles
- the possible genotypes of Child 1
- the difference between dominant alleles and co-dominant alleles
- how to determine the genotype of Child 1 using the blood types of **his** children, if his partner is a blood type O female
- why the determination of Child 1's genotype may **not** be guaranteed as correct if determined using his children's blood types.

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

Page 2
https://www.thesprucepets.com/corn-snakes-1236771
https://cornsnake.net/pages/corn-snake-morph-photos

Page 3
https://www.britannica.com/animal/garter-snake

Page 6
https://www.landcareresearch.co.nz/tools-and-resources/identification/what-is-this-bug/giraffe-weevil/