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Level 2 Biology 2021

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 – 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.

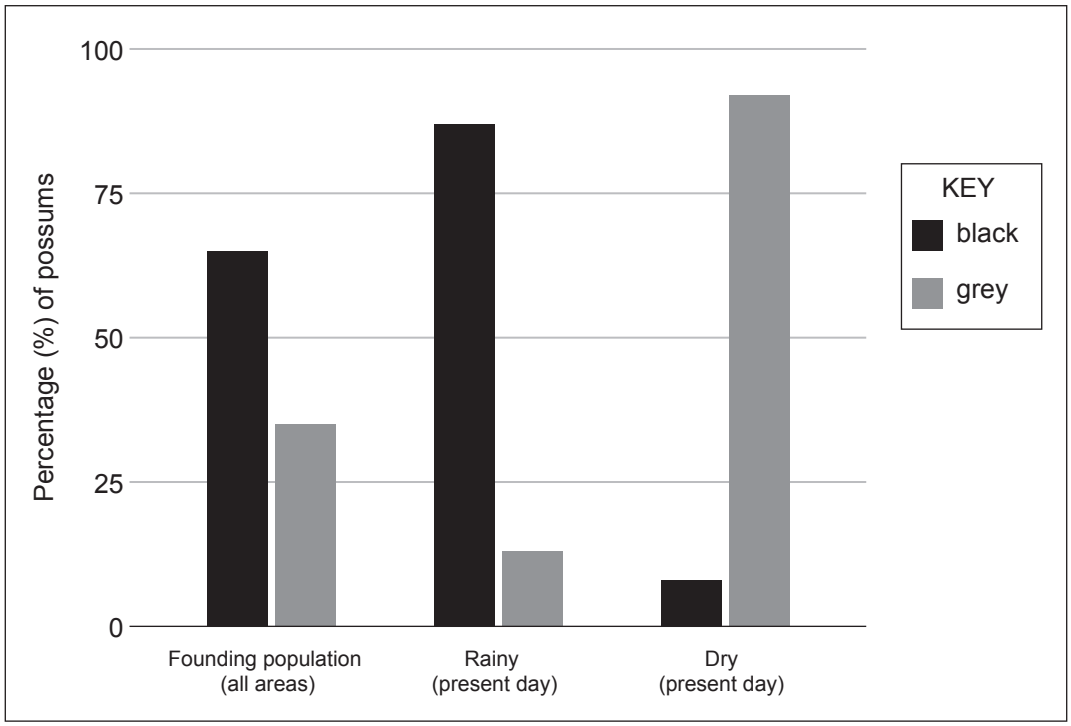
YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

QUESTION ONE: GENETIC DRIFT VS NATURAL SELECTION

Brushtail possums, *Trichosurus vulpecula*, were introduced into New Zealand between 1837 and 1924. Although there is variation, possum fur colour can be classified into two basic types: black or grey. Both black and grey possums were introduced in all areas of New Zealand.

Today's possum populations do not, however, reflect the colour distribution of the founding possum populations. Black possums are more frequent in areas of high rainfall and grey possums are more frequent in areas with less rainfall. This suggests that the change in black and grey allele frequency in different populations is not due to chance.

Percentage of black and grey possums in different areas



Adapted from Triggs, S.J. and W.Q Green. 1989, *New Zealand Journal of Ecology*, Vol 12.

Some biologists hypothesise that the dark coloured fur has a higher rate of water evaporation than the grey fur and therefore could help regulate body heat in wet conditions. High water evaporation rates could be a disadvantage in a dry climate.

Discuss the effects of genetic drift AND natural selection on the gene pools of the possums in BOTH the rainy habitat and the drier habitat.

In your answer, refer to the possum fur colour example and:

- describe genetic drift and founder effect
- explain the conditions needed for natural selection to take place, and how this applies to change in fur colour allele frequency in possum gene pools
- discuss which factor – natural selection or genetic drift as a result of the founder effect – has had the greatest effect on the gene pool of possums in the different habitats.

Use evidence from the graph and reading to support your discussion.

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

QUESTION TWO: DIHYBRID CROSS

Grey possum
www.smh.com.au/technology/new-zealand-vows-to-eradicate-the-feral-aussie-possum-by-2050-20160726-gqdwpb.html

Black possum
https://dpipwe.tas.gov.au/wildlife-management/living-with-wildlife/living-with-brush-tailed-possums

Although still the same species, black possums are usually larger than grey possums. Assume the alleles for black fur and large size both show complete dominance. Black (B) is dominant to grey (b) and large size (L) is dominant to small size (l).

A pure-breeding large black possum was crossed with a pure-breeding small grey possum.

(a) Complete a Punnet square to show the genotype and phenotype ratios of the F2 generation of possums.

Genotype of pure-breeding large black possum: _____

Genotype of pure-breeding small grey possum: _____

Genotype of F1 offspring: _____

F1 gametes

F1 gametes				

(b) Expected phenotype ratio of F2:

_____

(c) Crosses between large black possums that are heterozygous for both fur colour and size usually produce the following phenotype ratio:

3 black large : 1 grey small

These crosses rarely produce any black small possums or grey large possums. This indicates that the genes for fur colour and size are linked, with the dominant alleles (black and large size) being linked, and the recessive alleles (grey and small size) being linked.

Discuss linked genes and how they affect the diversity of both phenotypes and genotypes of the offspring produced by this dihybrid cross.

Support your answer with examples, and include:

- a description of linked genes
- an explanation of how linked genes affect the diversity of the gametes produced by the heterozygous parents
- a discussion of how the processes of independent assortment and crossing over affect the linked genes in this example.

You may include a diagram to help your discussion.

QUESTION THREE: NEW ALLELES

Golden possum
www.zooborns.com/zooborns/2012/09/
brushtail-baileys-baby-pics-emerge-a-zooborns-first.html

In its native Australia, a mutation that produces golden-furred brushtail possums has been seen in the wild. Golden possums can produce golden-furred offspring. This indicates that in Australia there are at least three alleles for fur colour. It appears that golden fur allele is recessive to both the black and grey alleles. The dominance order of the black allele (F^B), grey allele (F^G), and golden allele (F^g) is:

$$F^B > F^G > F^g$$

(a) Describe why there is only one combination of parental genotypes that could produce offspring with all three phenotypes (black, grey and golden fur).

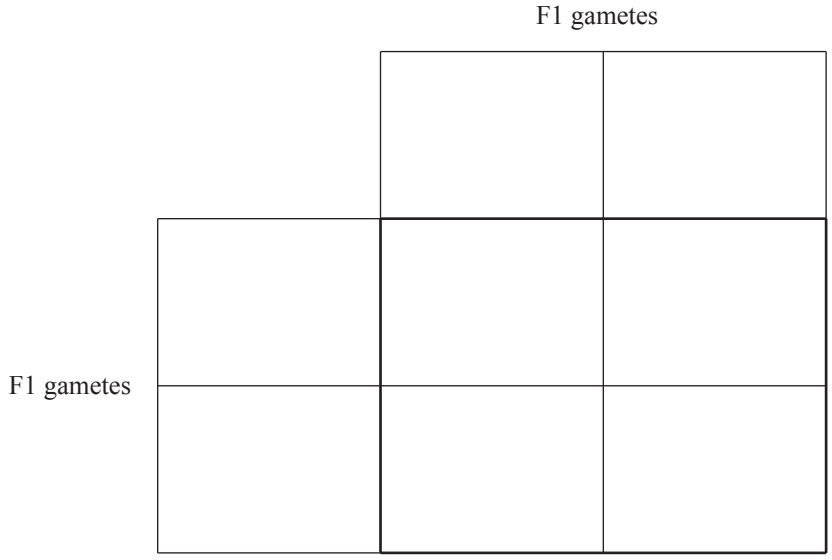
Support your discussion with a Punnet square, and state the genotype and phenotype ratios of the offspring.

Genotype of parent #1: _____

Phenotype of parent #1: _____

Genotype of parent #2: _____

Phenotype of parent #2: _____



Genotype ratio of offspring: _____

Phenotype ratio of offspring: _____

(b) Explain why this is the only combination of parents that can produce offspring with all three phenotypes.

Question Three continues on the next page.

(c) Many animals can develop skin cancer on exposed areas after too much sunlight. These cancers are due to mutations in the exposed cells of their nose and ears.

Compare and contrast the mutations in the exposed skin cells, and the golden-fur mutation, and how they affect individual possums and the possum gene pool.

In your discussion include:

- a description of mutation
- an explanation of the difference between a gametic and a somatic mutation
- a discussion of how gametic mutations and somatic mutations affect both individual possums and the possum gene pool.

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

QUESTION NUMBER