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NZQA

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Level 2 Biology 2020

91157 Demonstrate understanding of genetic variation and change

9.30 a.m. Wednesday 2 December 2020
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 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: PEA PEDIGREE

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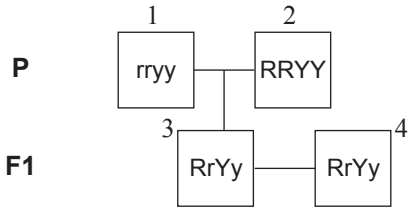
Gregor Mendel carried out a dihybrid cross for the pea plant (*Pisum sativum*). Pea plants display a complete dominance inheritance pattern. The allele for round (R) is dominant to the allele for wrinkled (r) seeds. The allele for yellow (Y) seeds is dominant to the allele for green (y) seeds.

Source: https://plantscientist.wordpress.com/2013/08/15/why-plants-can-be-great-models-for-studying-genetics/

The genes for seed shape and colour are found on different chromosomes.

Use the pedigree chart below to answer the following questions:



(a) Explain why the offspring in the F1 generation will always have the genotype of RrYy.

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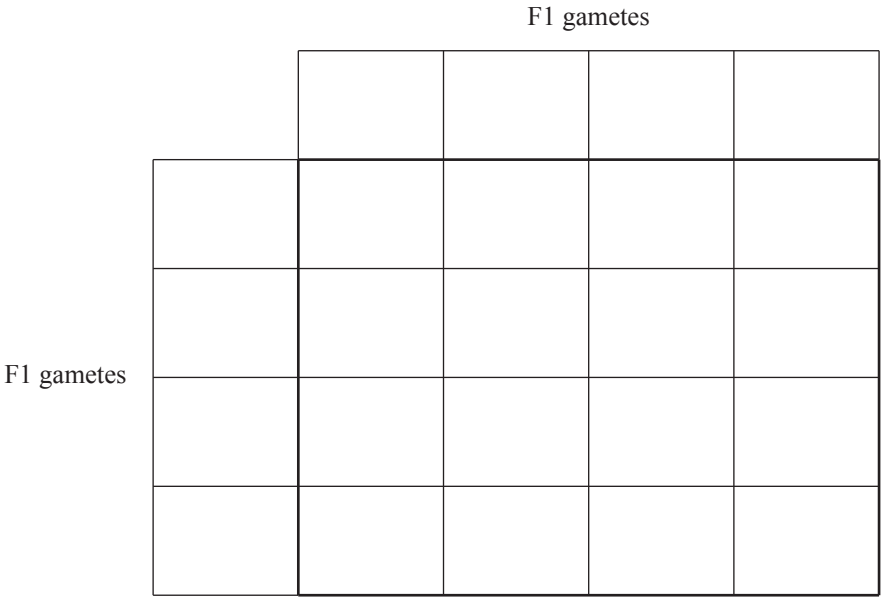
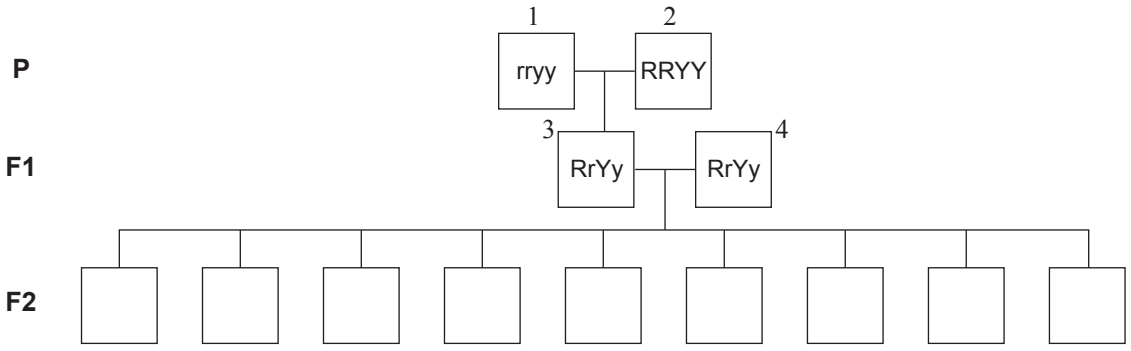
(b) There are nine possible genotypes (F2) from this cross between the gametes of the F1 generation (RrYy).

(i) Using the working space below, determine the nine possible genotypes and determine the phenotype ratio.



Phenotype ratio: _____

(ii) Fill in all the possible genotypes for the F2 generation on the pedigree chart below.



(c) Use the simplified diagram below to discuss the processes that occur during meiosis that increase genetic variation in gametes.

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Adapted from: Campbell, N. A., Mitchell, L. G., & Reece, J. B. (2000). *Biology*. Benjamin/Cummings.

In your answer include:

- a description of meiosis
- an explanation of independent assortment, and label when it occurs on the diagram
- an explanation of segregation, and label when it occurs on the diagram
- a discussion of how these processes increase genetic variation of gametes.

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QUESTION TWO: POPULATION GENETICS

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Since the arrival of humans (700 years ago) and other mammalian predators, the population numbers of most native species found in Aotearoa, New Zealand have decreased significantly.

In 1977 the last wild population of kākāpō was discovered on Stewart Island / Rakiura. The birds' main predators there were thought to have been feral cats.

Species	Total population number in Aotearoa	Genetic diversity
Kākāpō (native)  Source: http://nzbirdsonline.org.nz/species/kakapo	~ 211	low
Domestic cat (introduced)  Source: https://now.tufts.edu/articles/cat-eat-bird-world	~ 1.419 million	high

Using the information above, discuss why the genetic diversity of kākāpō is low AND justify why cat predation has resulted in genetic drift.

In your answer include:

- a description of genetic diversity and allele frequency
- an explanation of a population bottleneck, and why small populations (most likely) have low genetic diversity
- an explanation of why this is an example of bottleneck effect and not founder effect
- a discussion of why kākāpō predation by cats has resulted in genetic drift.

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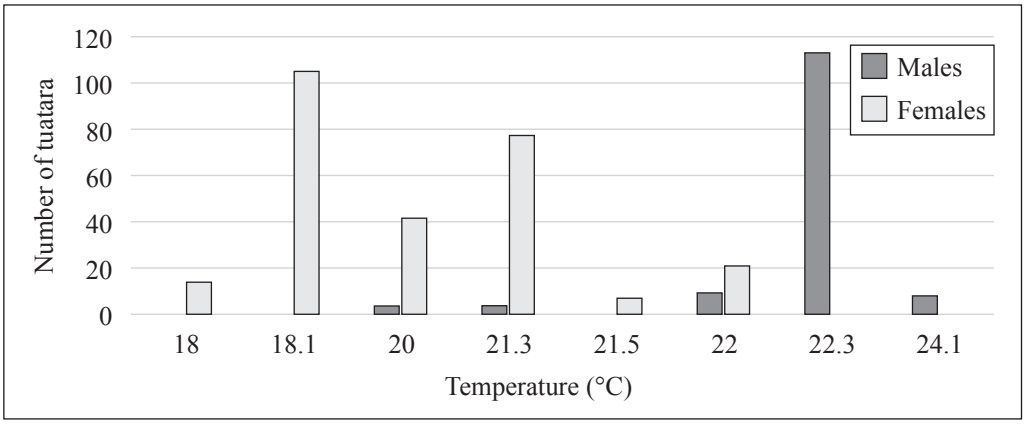
QUESTION THREE: NATURAL SELECTION

Source: https://www.stuff.co.nz/environment/climate-news/109319809/tuatara-kea-and-pua-are-among-kiwi-creatures-threatened-by-climate-change

Tuatara produce offspring through sexual reproduction. Population numbers and genetic diversity are low. The temperature at which tuatara eggs are incubated determines the sex of offspring. In general, temperatures over 22 °C produce males while temperatures under 21 °C produce females. This is a narrow temperature range.

However, some individuals in the population do not fit this trend, with some males developing at 20 °C and 21 °C and some females developing at 22 °C. See graph below.

Number of tuatara that develop into males and females at different temperatures



Adapted from Mitchell, N. J., Nelson, N. J., Cree, A., Pledger, S., Keall, S. N., & Daugherty, C. H. (2006). Support for a rare pattern of temperature-dependent sex determination in archaic reptiles: evidence from two species of tuatara (Sphenodon). Frontiers in Zoology, 3(1), 9.

Consider how the process of natural selection can be used to predict what could happen to the species in the following circumstances:

- if temperatures rise rapidly over a short period of time
- if temperatures rise slowly over a very long period of time.

In your answer:

- name and describe how totally new alleles enter a population
- explain natural selection
- explain, including a reason, why some males and females do not fit the trend
- predict what could happen to the species when temperatures rise quickly over a short period of time, compared with when they rise slowly over a long period of time.

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

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

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