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Level 2 Biology, 2016

91157 Demonstrate understanding of genetic variation and change

9.30 a.m. Friday 18 November 2016
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 2–11 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.

Achievement

TOTAL 10

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QUESTION ONE: INHERITANCE AND MEIOSIS

Roses display complete dominance in both their flower colour and in their susceptibility to some diseases. The allele for red petals (R) is dominant to the allele for white petals (r). In addition, the allele for healthy leaves (H) is dominant to the allele for being susceptible to leaf lesions (h). Leaf lesions are spots on the leaf that are very prone to disease and injury. The genes for petal colour and healthy leaves are located on different chromosomes.

Leaf with lesions.
https://edis.ifas.ufl.edu/pp267

http://www.tophdwallpaersland.com/red-white-rose-wallpaper.htm

A rose that was homozygous for both red petals and healthy leaves was crossed with a white rose that was susceptible to leaf lesions.

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

RrHh

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

F_1 gametes	RH	Rh	rH	rh
RH	RRHH	RRHh	RrHH	RrHh
Rh	RRHh	RRhh	RrHh	Rrhh
rH	RrHH	RrHh	rrHH	rrHh
rh	RrHh	Rrhh	rrHh	rrhh

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

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The predicted phenotype ratios produced by this cross is ~~9 red petals with~~ 9 red petals and healthy leaves : 3 red petals ~~with~~ that ~~was~~ susceptible to leaf lesions : 3 white rose with healthy leaves ~~and~~ 1 white rose that was susceptible to leaf lesions.

Genotype ratio is 9 : 3 : 3 : 1

	RH	RH	RH	RH
rh	RrHh	RrHh	RrHh	RrHh
rh	RrHh	RrHh	RrHh	RrHh
rh	RrHh	RrHh	RrHh	RrHh
rh	RrHh	RrHh	RrHh	RrHh

All red petals and healthy leaves.

(d) Discuss the processes that produce genetic variation during meiosis, and how gametes differ from parent cells.

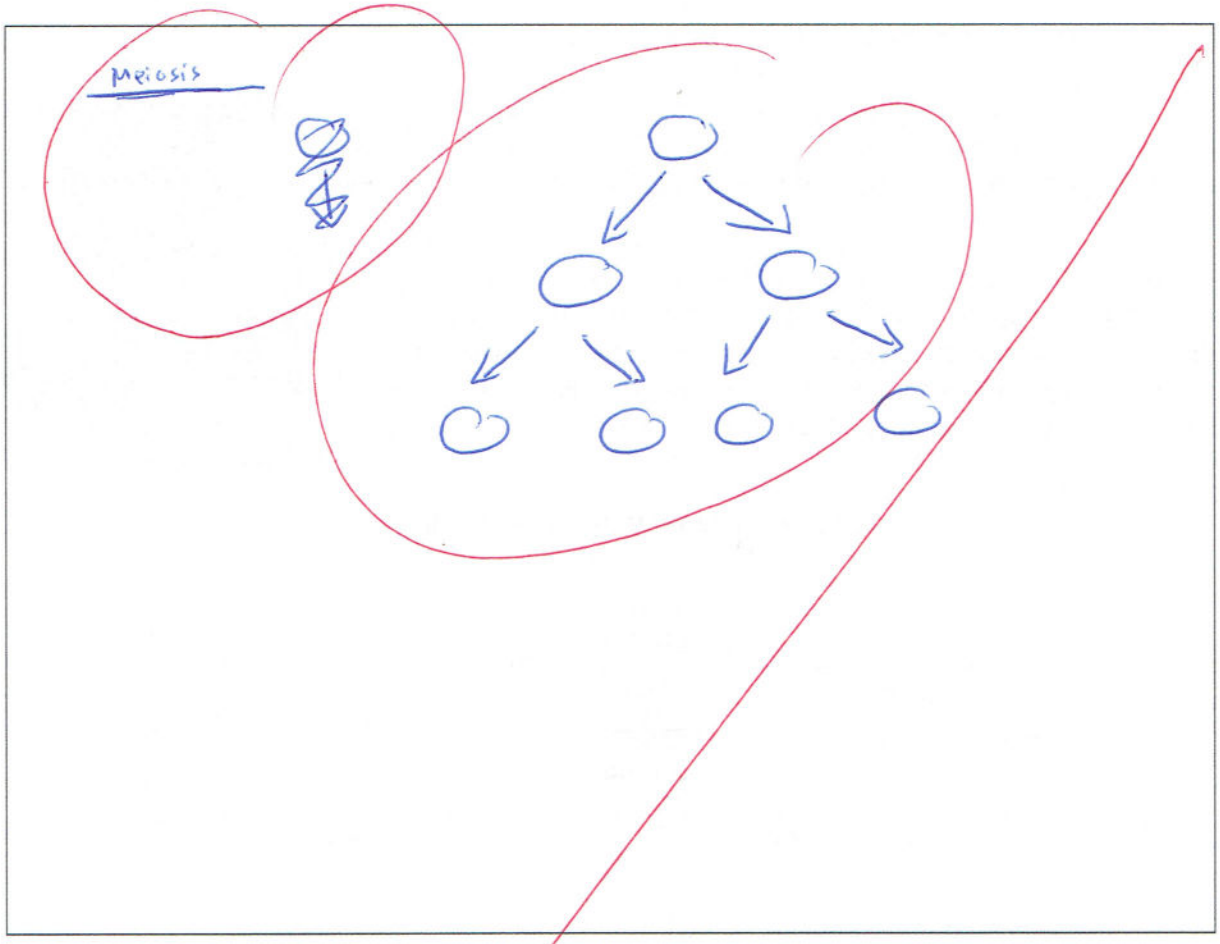
Your answer should include:

- a description of meiosis and the type of cells produced by meiosis
- an explanation of the processes of independent assortment, segregation, and crossing over
- a discussion of how each process contributes to the genetic variation of cells produced.

You may use diagrams in your answer.

The purpose of meiosis is for sexual reproduction (ie. eggs and sperms). One cell goes to four cells with ½ ~~the~~ number of chromosomes. Independent assortment, crossing over and segregation cause genetic variation.

Independent assortment is the random shuffeling of chromosomes. Crossing over is the ~~segg~~ exchange of segments of ~~chromosom~~ DNA to produce ~~recombination~~ recombination. Segregation is the random exchange of chromatids.



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QUESTION TWO: NATURAL SELECTION IN MOA

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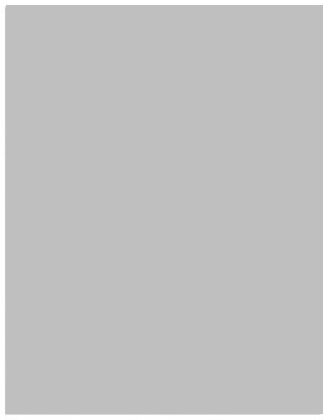
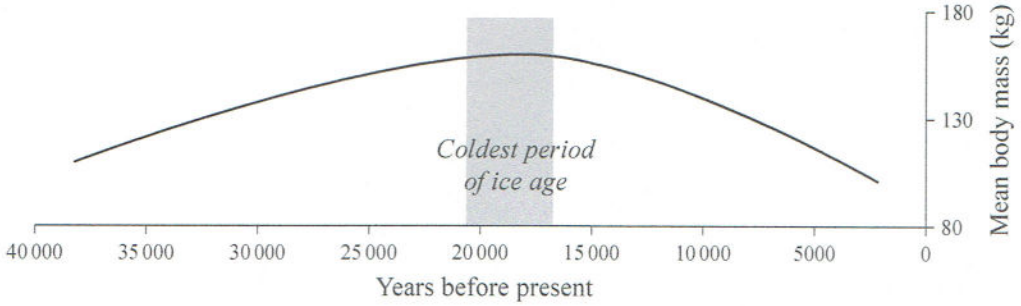
A large body mass is an advantage in cooler climates because its low surface area to volume ratio helps animals to retain heat. Many examples of this, such as polar bears, walrus and large polar sea mammals, are seen today.

Fossil evidence shows that during the last ice age, the population of heavy-footed moa, *Pachyornis elephantopus*, contained much larger individuals than the same species of moa that existed during warmer times. As the ice age ended and temperatures warmed, the fossil evidence shows that the heavy-footed moa's body mass became smaller again.



http://collections.tepapa.govt.nz/search.aspx?term=Heavy-footed moa

Change in moa body mass over time



Moa body mass data calculated from femur bone circumferences.

Worthy, Trevor H. and Richard N. Holdaway, 2002. *The Lost World of the Moa, Prehistoric life in New Zealand* (Indiana University Press, Bloomington), Table 5.6, p. 20.

The large body mass allele may have entered the population via a mutation.

Discuss how the allele for large body mass became established in the heavy-footed moa gene pool during the last ice age.

Your answer should include:

- a description of what a gene pool is
- a description of what a mutation is and an explanation of how it affects genetic variation in a species
- a discussion of the process of natural selection and how it affected both the body mass and the gene pool of the heavy-footed moa
- a discussion, with justified reasons, why the body mass of the heavy-footed moa returned to a smaller mass once the climate warmed again.

A gene pool is all the alleles that are presented in a population. A mutation is a permanent change in the base sequence of DNA. Mutation affects genetic variation by changing the DNA of an organism therefore resulting in new alleles.

Natural selection is the process whereby an organism that are better suited for the environment tend to survive and produce offspring. It affected both the body mass and gene pool of heavy-footed moa because the ~~best~~ alleles that are better suited

for the environment tend to survive and produce offspring and therefore the alleles ~~that~~ are presented in the gene pool and the body mas of the moa is ~~heavy~~ different, ~~as the~~ As the temperature increases, the body mass of the moa increase. The ~~moa~~ body mass of the heavy-footed moa returned to a smaller mass once the climate warmed again because the alleles which is not suited for the ~~the~~ warm environment will die out and the ~~moa~~ moa that has the smaller mass allele tend to survive. ~~Big~~ Moa with big ~~moas~~ body mass is only suited to live in cold conditions while Moa with smaller body mass is only suited to live in warm conditions.

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for the environment tend to survive and produce offspring and therefore the alleles ~~that~~ are presented in the gene ~~pool~~ pool and the body mas of the moa is ~~heavy~~ different, ~~in the~~

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~~Big~~ Moa with big ~~body~~ body mass is only suited to live in cold conditions while Moa with smaller body mass is only suited to live in warm conditions.

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QUESTION THREE: GENETIC DRIFT AND MIGRATION

Many of New Zealand's native species have suffered population bottlenecks due to hunting, introduced predators, and habitat destruction. The Department of Conservation has successfully saved some of these species from extinction by moving several breeding pairs from mainland populations to predator-free islands. However, maintaining genetic diversity on island populations can be difficult for many species of flightless birds, such as the takahe, *Porphyrio hochstetteri*.

www.nzbirdsonline.org.nz/species/south-island-takahe

Discuss the issues of maintaining genetic diversity in small island populations of flightless birds, such as the takahe.

Your answer should use the takahe and include:

- a description of what genetic diversity is
- an explanation of how allele frequency in a population is affected by genetic drift and migration
- a discussion of how migration and genetic drift affect genetic diversity of flightless birds on small island populations compared to larger mainland populations.

Allele frequency in a population is affected by genetic drift and migration because a genetic drift is the random change in allele frequency due to chance over time in a population. Migration is the allele that flows from one population to another for the purpose of genetic variation.

Genetic diversity is the different alleles that are presented in a population.

Migration and genetic drift affect genetic diversity of flightless birds on small island populations compared to larger mainland populations.

If the flightless birds migrate to somewhere else, or genetic drift occur, the alleles presented population in the small island will decrease and the alleles presented in the population will be very low. On the other hand, the flightless birds migrate to somewhere else or genetic drift occur, the allele frequency presented in the mainland will decrease but it doesn't has much difference as the mainland has a larger populations. So the flightless birds on the mainland will still have the alleles that are gone as some other flightless bird might be carrying the same alleles as the migrated flightless birds.

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Achieved exemplar for 91157 year 2016		Total Score	10
Q		Annotation	
1	A4	Correct responses provided for (a) (b) and (c). Answer to (d) is at a minimal level. Brief descriptions to the purpose of meiosis, Independent Assortment, Crossing over and Segregation have been provided.	
2	A4	Has provided correct descriptions / definitions for gene pool, mutation and Natural Selection. The answer reuses words from the resource material without providing any explanation.	
3	N2	There is no evidence to explain how two different populations (island and mainland) are affected in different ways. Basic definitions/descriptions have been provided towards the 2 grade score.	