Assessment Schedule – 2017

Biology: Demonstrate understanding of genetic variation and change (91157)

Evidence Statement

<table>
<tr><th>Q1</th><th>Expected coverage</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr><td>ONE
(a)

(b)

(c)</td><td>F1 genotype: BbFf
F1 phenotype : Bar wing and feather legs

<table><tr><td></td><td>BF</td><td>Bf</td><td>bF</td><td>bf</td></tr><tr><td>BF</td><td>BBFF</td><td>BBFf</td><td>BbFF</td><td>BbFf</td></tr><tr><td>Bf</td><td>BBFf</td><td>BBff</td><td>BbFf</td><td>Bbff</td></tr><tr><td>bF</td><td>BbFF</td><td>BbFf</td><td>bbFF</td><td>bbFf</td></tr><tr><td>bf</td><td>BbFf</td><td>Bbff</td><td>bbFf</td><td>bbff</td></tr></table>
9 bar wings + feather legs
3 bar wings + not feather legs
3 barless wings + feather legs
1 barless wings + not feather legs</td><td>• Genotype.
• Phenotype of F1 correct.

• Punnett square gametes correct and offspring genotypes correct.

• Phenotype ratios correct.</td><td></td><td></td></tr>
<tr><td>(d)</td><td>Linked genes are found on the same chromosome and are inherited together. Since they don’t independently assort, the gametes produced show less genetic variation than unlinked genes.
Independent assortment is when homologous chromosomes line up in a random manner along the equator of the cell during meiosis.
Unlinked genes can independently assort, therefore produce more genetic variation in the gametes. From the Punnett square, it can be seen that unlinked genes can produce 4 different types of gametes.
Since there is less genetic variation in the gametes for linked genes, they produce less genetic variation in the offspring than unlinked genes.
From the Punnett square, it can be seen that unlinked genes produce 9 / many different genetic combinations of the wing and leg alleles in the offspring.
We can tell that the genes are unlinked since the heterozygous cross of the F1 produced 4 different phenotypes instead of just 2. The unlinked genes could produce the phenotype of barless + feathered or bar + not feathered offspring / more offspring phenotypes that are NOT like the parents. Linked genes produce a higher percentage of phenotypes like the parents / bar + feathered than unlinked genes.</td><td>• Linked genes defined as on the same chromosome.
• Independent assortment described with specific reference to homologous chromosomes.
• Linked genes described as producing less genetic variation in offspring / gametes (only give one Achievement credit if they mention both without links).
• Linked genes produce fewer phenotypes in offspring than unlinked genes.</td><td>• Linked genes described as on the same chromosome AND inherited together OR not independently assorted.
• Explains that unlinked genes independently assort.
• Explains that linked genes have higher percentage of phenotypes like parents / bar + feathered than unlinked genes.
• Explains that unlinked genes can result in offspring not like their parents / different combination of alleles to their parents / bar wings + not feather legs, barless wings + feather legs.</td><td>Discussion comprehensively contrasts the effect of linked and unlinked genes on both gametes and offspring which could include:
• For LINKED genes – lack of genetic variation in gametes is linked to no independent assortment AND for UNLINKED genes – more genetic variation in gametes is linked to independent assortment.
• For LINKED Genes – lack of genetic diversity in offspring is clearly associated with lack of genetic diversity of the gametes / linked genes being inherited together.
• Uses phenotype ratios of One (c) and those given to discuss that linked genes have a more limited range of phenotypes possible than unlinked genes.</td></tr>
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NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	Provides ONE correct statement from Achievement.	Provides TWO correct statements from Achievement.	Provides THREE correct statements from Achievement.	Provides FOUR correct statements from Achievement.	Provides TWO correct statements from Merit.	Provides THREE correct statements from Merit.	Clearly linked discussion that provides ONE bullet point from Excellence.	Provides TWO bullet points from Excellence.

Q2	Evidence	Achievement	Merit	Excellence
TWO	Gene pool is the total alleles available to a (breeding) **population**. **The founder effect describes the gene pool of a population that was established from a (subset) of a larger population.** The allele frequency of the founder population may not be representative / reflect the allele frequency of the original population. Therefore, there could be less genetic diversity in founder effect populations. In the case of the South Island saddleback, the Big South Cape Island population's low genetic diversity in the 1800s was most likely caused by the founder effect, since there were other populations on the mainland still in existence at the time. It is likely this population was established by a few from the mainland, who did not carry all the alleles available to the population. Therefore, its relative genetic diversity is only just over 20%, which is low compared to the South Island population. **The bottleneck effect is where a species is reduced to a few individuals and then recovers with low genetic diversity. (Populations may be suddenly reduced due to catastrophic events / any example given – to very small numbers.)** Many alleles will be lost or fixed forever. The current gene pool of the South Island saddleback will have very low genetic diversity due to the bottleneck effect, since the species was entirely wiped out except for those on Big South Cape Island. In the case of the South Island Saddleback, since the current population arose from a population on Big South Cape Island that already had low genetic diversity due to the founder effect, its current genetic diversity would be extremely low. From the graph, it can be seen that the current population has a much lower genetic diversity (less than 20%) than the 1800s mainland population (about 95%) and slightly less than the 1800s Big South Cape Island (just over 20%). Additional alleles would have been lost through genetic drift as the current population re-establishes itself, further reducing genetic diversity.	• Gene pool is described. • Founder effect is described. • Bottleneck effect is described. • States that **current** saddleback population will have low genetic diversity. • Identifies **the1800s Big South Cape Island** population as founder effect. • Identifies the **Kaimohu** Island population as a bottleneck / founder effect. • Identifies that Inbreeding / reproduction among close relatives / breeding between small number of individuals occurs in **either** Big South Cape Island 1800s **or** Kaimohu Island can lead to low genetic diversity (must mention at least one location).	• Explains that founder population alleles are non representative of the parent population resulting in less genetic variation. • Explains that in the bottleneck effect alleles are permanently lost / fixed. • Explains that historic Big South Cape Island population is an example of founder effect **because** other saddleback populations exist. • Explains that current saddleback population is an example of bottleneck / founder effect.	• Compares the genetic diversity of 1800s South Island saddleback populations **using explicit numbers / references** from the graph and links the lower genetic diversity of Big South Cape Island population to the **founding** saddlebacks not carrying all the possible alleles available to South Island mainland population. • **Uses specific references to the graph** to discuss that the current genetic diversity of the South Island saddleback has lower diversity than 1800s mainland population due to **bottleneck.** • **Links to Genetic drift or infers Genetic Drift and s**tates that the current South Island saddleback population will have unusually low (20%) genetic diversity since it was produced from a population that already had low genetic diversity.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	ONE Achievement statement.	TWO Achievement statements.	THREE Achievement statements.	FOUR Achievement statements.	TWO correct Merit statements.	THREE correct Merit statements.	ONE Excellence bullet point.	TWO Excellence bullet points.

Q3	Evidence	Achievement	Merit	Excellence
THREE	**Natural selection** is the process where individuals that are best adapted to the environment survive and reproduce, therefore passing favourable / desirable / good alleles onto offspring / into gene pool. **Migration** is the movement of individuals into / out of a population. **Mutation** is the (permanent) change in the gene sequence / nucleotide / gene / DNA. The mutated allele became established in gene pools A and B because those with the allele had access to an extra food source. Individuals who possessed the mutation could use milk as a food source. Therefore, they survived and produced more offspring that also had this allele and higher survival due to better nutrition. Over time, those without the mutated allele reproduced less successfully and the mutation / new allele / mutated allele increased in frequency until the entire population possessed it. The reason the mutated allele has a higher frequency in population B is because that is where it originated, and due to natural selection, it increased in frequency. The mutated allele could have passed to population C through migration. C has a lower frequency of the mutated allele because the mutation didn't arise here and has had less time to become established. Individuals from population B could have moved to population C and through interbreeding passed the mutated allele to that population. If population C also had cattle and access to milk, the mutated allele would give them a survival / reproductive advantage, and it would begin to become more frequent. There are low frequencies of mutated allele in population D because D / Australia is a long way from population B, and passing the allele on through migration is less likely. In addition, if population D did not use cattle and milk as a food source, there would be no advantage to having this allele, so any mutations that arose would not increase due to natural selection. **Note**: accept use of "gene" if "allele" has been used most of the time and the candidate shows clear understanding of the difference.	• Describes natural selection. • Describes migration. • Describes a mutation. • Identifies that the mutation must be in the gametes / or is a gametic mutation for the allele to enter / establish / increase in frequency in the gene pool. • Identifies mutation to digest milk / lactose. • Identifies migration less likely between A / B / C and D. • Identifies migration more likely between B and C.	• Explains that those with mutated allele in populations A and B had a **survival advantage due to better nutrition** / milk (food) **and** therefore a higher reproductive success / more offspring. • Explains that those with mutated allele in populations A and B had a survival advantage and then passed the allele to offspring thus **increasing frequency of the mutated allele** in the population. • Explains that A and B have the **highest frequency of mutated allele because that is where it originated (arose)** / the survival advantage it offered. • Explains that migration increases frequency of mutated allele through **interbreeding** / **gene flow**.	• Discussion links lower frequency of mutated allele in population C than B due to less time for it to become established after migration **and** interbreeding / **gene flow** introduced it. • Discusses that Population C has a higher frequency than D because **migration is more possible** between B and C due to **shorter distances** therefore **more chances of gene flow.** • Discusses that after mutated allele introduced through migration, natural selection could be working to increase frequency in population C **if C also uses milk as a food source** • Discussion links lowest frequency of mutated allele in population D due to **large distances** making **migration** less likely thus **reducing gene flow**. • Discussion links fact that milk not used as a food source in population D so there is no survival advantage / selection pressure for natural selection to work to increase the mutated allele frequency.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	Provides ONE correct statement from Achievement.	Provides TWO correct statements from Achievement.	Provides any THREE statements from Achievement.	Provides any FOUR statements from Achieved column.	Provides any TWO statements from Merit column.	Provides any THREE statements from Merit column.	Provides ONE Bullet Point from Excellence.	Provides TWO Bullet Points from Excellence;

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 12	13 – 18	19 – 24