Assessment Schedule – 2021

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

Evidence Statement

Q	Expected Coverage	Achievement	Merit	Excellence
ONE	Genetic drift is the change of allele frequency in a gene pool due to chance / Random. Founder effect is when a small group of individuals from an existing population moves to another area and establishes a new population, / are reproductively isolated from the original population. Natural selection is the process where individuals that possess the 'best'phenotype / adaptation / trait / feature / characteristic(specific example-grey / black-accepted) in an environment survive and reproduce, passing their alleles which increases the frequency of this allele in the population / gene pool. Gene pool is all the alleles present in an interbreeding population. The main conditions needed for natural selection are genetic variety and selection pressures. In this case, the genetic variety is the two different alleles for fur colour, and the selection pressure seems to be climatic conditions and habitat. For some reason, the black fur colour offers a survival advantage in rainy forested areas. The possums with this allele produced more offspring in rainy areas, which increased the frequency of black allele in the gene pool. Possums with the grey allele produced less offspring, which decreased the frequency of this allele in the gene pool in rainy areas. The reverse is true in drier areas, where possums with the grey allele reproduced more offspring, therefore increasing the frequency of the grey allele in dry areas while genetic drift being a chance change in allele frequency there is no selection towards a beneficial phenotype. The evidence suggests that natural selection and NOT genetic drift is the main reason for the change in allele frequencies. There is a clear relationship between rainfall and coat colour. Since more black possums were originally released in New Zealand, the founder effect would suggest that the black fur allele would be more common everywhere in New Zealand, since the original population had a higher frequency of black alleles. If the change in allele frequency were only due to chance, you would expect a more random frequency of black and grey alleles in populations in both climates, e.g. some rainy areas would have more grey possums, and some dry areas would have black possums. Since the original 65% black allele and 35% grey allele frequency has changed so dramatically in both dry areas and wet areas, this suggests that there is a selection pressure working and not just chance.	• Describes genetic drift. • Describes founder effect. • Describes gene pool. • Defines allele frequency. • Describes natural selection. • Gives ONE condition needed for natural selection. • Identifies rain / wet vs dry is the selection pressure.	• Explain natural selection • Explains why survival is higher for black individual in rainy OR grey individual in dry, leading to higher reproduction rates • Explains how higher reproduction leads to increase in black / grey **allele frequency** in rainy / dry areas. • Refers to the example to explain change in gene pool in terms of genetic drift / founder effect(explains genetic drift). e.g. genetic drift would indiscriminately affect change in allele frequency with similar effects on both phenotypes in either condition.	• Makes a discussion that includes genetic drift being caused by chance and beneficial alleles could be decreased in frequency / not influenced by selection pressure AND natural selection is influenced by selection pressure; therefore beneficial alleles will increase in frequency / harmful alleles will decrease in frequency, due to uneven reproduction. • Uses evidence to support natural selection such as: Founder effect would predict more black possums all over New Zealand and NOT such a clear distinction with more black / grey alleles in rainy / dry areas. OR It is unlikely that chance results would change the gene pools in dry / rainy areas so consistently to produce such a clear trend in widespread populations. Reference to examples required for both excellence points

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	Describes any ONE statement from Achievement.	Describes any TWO statements from Achievement.	Describes any THREE statements from Achievement.	Describes any FOUR statements from Achievement.	Explains any TWO statements from Merit.	Explains any THREE statements from Merit.	Discusses ONE criterion for Excellence.	Discusses BOTH criteria for Excellence.

<table>
<tr><th>Q</th><th>Expected Coverage</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr><td>TWO
(a)</td><td>Large Black = BBLL
Small Grey = bbll
F1= BbLl
<table><tr><td></td><td>BL</td><td>Bl</td><td>bL</td><td>bl</td></tr><tr><td>BL</td><td>BBLL</td><td>BBLl</td><td>BbLL</td><td>BbLl</td></tr><tr><td>Bl</td><td>BBLl</td><td>BBll</td><td>BbLl</td><td>Bbll</td></tr><tr><td>bL</td><td>BbLL</td><td>BbLl</td><td>bbLL</td><td>bbLl</td></tr><tr><td>bl</td><td>BbLl</td><td>Bbll</td><td>bbLl</td><td>bbll</td></tr></table></td><td>• Genotypes of BOTH parents correct.
• Punnett square completed with correct gametes and F2.</td><td></td><td></td></tr>
<tr><td>(b)</td><td>9 Black Large: 3 Black small: 3 grey Large: 1 small grey</td><td>• Ratio is correct.</td><td></td><td></td></tr>
<tr><td>(c)</td><td>Linked genes are on the same chromosome, and therefore are inherited together. In the case of possums, this would mean that the black allele and the large body allele would always be inherited together. Therefore linked genes would reduce genetic diversity and produce less-diverse phenotypes than unlinked genes.
The process of independent assortment is where the homologous pairs line up randomly during meiosis.
Crossing over is the exchange of alleles segments of chromosomes segments of DNA between homologous pairs chromosomes accept annotated diagram.
Linked genes reduce diversity of genotypes / genetic diversity because linked genes cannot independently assort and segregate, which will produce less genetic variety in the gametes. For example, a heterozygous animal BbLl with unlinked genes could produce 4 different gametes, BL, Bl, bL, and bl. But if the genes are linked, a heterozygous animal could only produce two different types of gametes BL and bl. With fewer types of gametes, there would be less genetic diversity in the offspring, unless crossing over occurred. For example, BBLL, BbLl, and bbll would be the only genotypes of the offspring. The only way that an offspring could be bbLl or BBll would be if crossing over occurred to produce a chromosome that was Bl or bL.
Since linked genes are on the same chromosome, they are not affected by independent assortment and will be inherited together. In this example, there are rarely large grey or small black possums produced. This indicates that the genes are very close together on the same chromosome, and therefore, it is unlikely that they will be separated by crossing over.</td><td>• Defines linked genes.
• Describes Crossing-Over
• Describes Independent Assortment
• Identifies that linked genes produce fewer types of / unique gametes than unlinked genes.
• Identifies that linked genes reduce genetic variety.
• Identifies that linked genes reduce the variety of phenotypes.
• Identifies that linked genes reduce the variety of genotypes, e.g. BL / bl not Bl / bL</td><td>• Explains that since linked genes are inherited together, they will produce fewer types of / unique gametes.
• Explains why linked genes can’t independently assort / segregate and therefore are inherited together.
• Explains how reduced variety in gametes reduces the phenotypes produced.
• Explains how crossing over can affect linked genes.(either unlinks or remains linked due to proximity).</td><td>• A comprehensive discussion, supported by examples, that explains that since linked genes can’t independently assort / segregate, they produce only two types of gametes and therefore, less genetic diversity and phenotype diversity.
• The effect of BOTH independent assortment and crossing over is discussed. A comprehensive discussion that links that since few small black or large grey possums are produced, these genes must be close together on the chromosome, and they are not being separated by crossing over. Being on the same chromosome, they are not separated by independent assortment either.</td></tr>
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<tr><th>Q</th><th>Expected Coverage</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr><td>THREE
(a)</td><td>Black possum = $F^B F^g$
Grey possum = $F^G F^g$
<table><tr><td></td><td>F^B</td><td>F^g</td></tr><tr><td>F^G</td><td>$F^B F^G$</td><td>$F^G F^g$</td></tr><tr><td>F^g</td><td>$F^B F^g$</td><td>$F^g F^g$</td></tr></table>Genotype ratio: $1F^B F^G : 1F^G F^g : 1 F^B F^g : 1 F^g F^g$
Phenotype ratio of offspring 2 Black: 1 Grey : 1 Golden</td><td>• ONE parent genotype correct.
• Punnett square / or genotype ratio correct / phenotype ratio correct.</td><td>• Both parent’s genotype and phenotype correct.
• Punnet square and offspring genotype AND phenotype ratio correct.</td><td></td></tr>
<tr><td>(b)</td><td>$F^GF^g \times F^BF^g$ is the only combination of alleles becaused to express the recessive phenotype of golden, a (recessive) allele from each parent must be inherited.
Each parent must have F^G or F^B to express those phenotypes in the offspring.
The only combinations that could produce a grey offspring are $F^G F^G$ or $F^G F^g$. So the grey parent must be $F^G F^g$.
This means to make black offspring, the other parent must have the black allele, and have the genotype $F^B F^g$.</td><td>• States that F^gF^g is needed to produce golden fur.</td><td>• Explanation that includes all three alleles and reasoning for the phenotype and genotype of each offspring and parent.</td><td></td></tr>
<tr><td>(c)</td><td>A mutation is a (permanent) change in the (base sequence of) DNA / RNA / gene.
A gametic mutation forms a new allele in sperm / eggs / ovum / pollen that can be passed onto the offspring, whereas somatic mutation forms a new allele in a body cell, which may affect the individual, but cannot be passed on to the offspring.
Gametic mutations affect both the individual and the gene pool. This is because they are inherited and passed to the next generation. In this case, the golden allele affects the individual by giving it golden fur / changing its phenotype. The golden allele also increases genetic variation in the gene pool because a new allele is created; there are three fur colour alleles now, not just two.
Somatic mutations affect the individual possums but not the gene pool. In this case, the mutated skin cells give the individual cancer, but this cancer and mutation are not passed to the next generation. Therefore, the gene pool remains unchanged.</td><td>• Describes mutation.
• Describes somatic mutation as occurring in body cell OR is not inherited.
• Describes gametic mutation as occurring in sex cells OR is inherited.</td><td>• Explains location of somatic mutation AND is not inherited.
• Explains gametic mutation as occurring in gametes AND is inherited.</td><td>• Discussion which includes effect of gametic mutation on gene pool and individual (within the context of golden fur).
• Discussion which includes effect of somatic mutation on gene pool and individual (within the context of cancer cells).</td></tr>
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Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 7	8 – 12	13 – 18	19– 24