**genetic variation and change**

1 **Sea lions and tuatara**

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|  | **Expected Coverage** | | | | | | Achieve | Merit | Excellence |
|  | **Population bottleneck:** occurs when there is a significant reduction in the size of a population (due to a catastrophic effect). Hunting of sea lions resulted in a bottleneck with the population being rebuilt from a small population of survivors.  **The founder effect:** occurs when a small group of individuals from a larger population establish a new population (in a different location). The 130 tuatara establishing a new population in Wellington were a subset of a larger population existing on an offshore island. This is an example of the founder effect.  **Genetic drift described:** is the change in the allele frequency due to chance/random events.  Both current populations of sea lions and tuatara were built up from a small population of individuals. Genetic drift has a greater effect on small populations.  **Genetic drift explained:**  If an animal with a rare allele dies for example, that allele may be lost from the gene pool.  Other alleles may increase in frequency, depending on the gene pool of the remaining population. Because both populations have been rebuilt from a small group of individuals, the alleles in the existing population may not be representative of the original population.  **Relating Bottleneck and Fonder effect to genetic drift**  **Small numbers of survivors** make up the population after a bottleneck, whereas in the founder effect the small population is made up of organisms that have moved to a new location (migrants). In both the effect of chance on (the composition of the) gene pool will be great. | | | | | | Describes population bottleneck  Describes founder effect  Genetic drift described | Both bottleneck and founder effects explained using the correct examples  Genetic drift explained | Relating Bottleneck and Fonder effect to genetic drift. All three processes linked in a comprehensive answer |
|  | **Minimising the effect of Genetic drift in the Tuatara example:**  **Methods:**   * Animals chosen for transfer should have as much genetic variation as possible (avoids inbreeding).   This could be established by genetic tests or knowledge of pedigrees so that closely related animals are not chosen.  Animals could also be taken from different islands to give maximum genetic variability.  When these animals breed they will produce more variable offspring, giving a divers gene pool   * Transfers can be made between populations (Karori and islands) once populations have been established and have bred (especially young animals).   This effectively means the smaller populations or gene pools are in fact not isolated. Because animals that were originally produced in different populations can interbreed there is effectively ONE larger population   * **Or similar** | | | | | | One method described  A second method described | One method explained  A second method explained | Both methods evaluated i.e. their effects on the gene pool discussed. |
| **Not Achieved** | | | | **Achievement** | | **Merit** | | **Excellence** | |
| **NØ** | | **N1** | **N2** | **A3** | **A4** | **M5** | **M6** | **E7** | **E8** |
| No response; no relevant evidence. | | Provides any ONE statement from Achievement. | Provides any TWO statements from Achievement. | Provides any 4statements from Achievement. | Provides any 4 statements from Achievement. | Provides any 2 statements from Merit. | Provides 3 statements from Merit. | Provides any ONE statement from Excellence. | Provides TWO statements from Excellence. |

Question 2 **Genetic variation**

Evidence Statement

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| **Q2** | | **Expected Coverage** | | | | | | Achieve | Merit | | Excellence |
| **a** | | **Co-dominance described:**  both alleles in a heterozygous organism contribute to the phenotype or similar  **Co-dominance explained:**  Phenotype of the heterozygous individual shows both alleles, both are (active and are) fully expressed.  IA IB individuals have both Type A and Type B blood (A and B proteins on their rbc’s)  **Contrast with Incomplete dominance**  Incomplete dominance:  only one allele is active in a heterozygous individual and the phenotype is thus not expressed to the same degree.  Co-dominance:  Both alleles are fully expressed and the phenotype shows both traits  **Or similar** | | | | | | Describes co-dominance | Explains co-dominance using AB blood group as example. | | Co-dominance contrasted with incomplete dominance. |
| **b** | | | **Description of woman’s genotype:**  IB i or heterozygous type B  **Explanation of woman’s genotype (must have both parts):**   * she is type B so must have at least one IB allele * her mother is type O (ii genotype) so must have inherited one i allele   **Description of man’s genotype:**  i i  **Punnet square completed correctly**  See right  **Punnet square used correctly to explain offspring phenotypes and ratios**  50% : 50% (or 1 : 1 or 2 : 2) type B : Type O blood |  |  |  |  |  | Determines mother to have genotype BO.  Correct punnet square. | Explains how woman’s blood group determined  Explains how phenotype ratio obtained. |  | |
|  |  | i | i |  |
|  | IB | IB i | IB i |  |
|  | i | i i | i i |  |
|  |  |  |  |  |
| c | **Independent assortment described:**  Each of the homologous chromosomes in a pair separate randomly (at meiosis) into the gametes.  When homologous chromosomes line up on the spindle at meiosis they do so and are separated randomly  or similar  **Effect of Independent assortment explained:**  Each gamete will contain a random assortment or selection of chromosomes (one of each pair)  i.e. a random selection of maternal and paternal chromosomes (those originally inherited from the egg and those originally inherited form the sperm.  **Variation occurs between chromosomes i.e. new combinations of unlinked alleles will be produced.**  or similar  **Crossing over / recombination described:**  is where there is an exchange of genetic material (homologous portions of the chromosomes) between adjacent chromatids of homologous chromosomes.  or similar  **Effect of Crossing over / recombination explained:**  Produces new combinations of alleles within a chromosome.  Alleles that were originally inherited maternally or paternally (on different homologues) are now recombined on the same chromosome.  **Variation occurs within chromosomes i.e. new combinations of linked alleles will be produced.**  or similar  **Random fertilisation described**  Fertilisation between eggs and sperm occurs randomly. Each egg has the same s=chance of being fertilised by any sperm  **Effect of Random fertilisation explained:**  Each sperm is unique as a result of Independent assortment and crossing over.  Similarly each eggs is unique.  Because they can fertilise in any combination the number of possible zygotes produce and the variation they will exhibit is huge. | | | | | | | Describes independent assortment  Describes  crossing over / recombination | Explains the effect of independent assortment  Explains the effect of crossing over / recombination  Explains how random fertilisation | | Independent assortment and crossing over / recombination are contrasted w.r.t. Linked and unlinked alleles. | |

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| **Not Achieved** | | | **Achievement** | | **Merit** | | **Excellence** | |
| **NØ** | **N1** | **N2** | **A3** | **A4** | **M5** | **M6** | **E7** | **E8** |
| No response; no relevant evidence. | Provides any ONE statement from Achievement. | Provides any TWO statements from Achievement. | Provides any THREE statements from Achievement. | Provides any FOUR statements from Achievement. | Provides any TWO statements from Merit. | Provides THREE statements from Merit. | Provides any ONE statement from Excellence. | Provides TWO statements from Excellence. |

Question 3 **Tail-less felines**

Evidence Statement

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| **Q1** | **Expected Coverage** | Achieve | Merit | Excellence |
| **a.** | Mutation defined as a permanent change in the nucleotide sequence / DNA in a gene or a chromosome or similar | Defines mutation |  |  |
| **b.** | Phenotype ratio = 2 Manx cats: 1 normal tailed cat  This is an example of a lethal allele. Manx cats are heterozygous for a dominant allele that is lethal when homozygous. In a cross between two Manx cats, we expect 1/4 to be normal (tt), 1/2 to be Manx (Tt), and 1/4 to die (TT).  Normal 1 : 2 : 1 ratio becomes 1 : 2. | Correct phenotype ratio | Correct ratio AND explains lethal alleles |  |
| **c.** | **Somatic mutations described:**  mutations occur in somatic / body cells  **Gametic mutations described:**  Mutations that only occur in gametes, eg, sperm / eggs/pollen  These mutations occur during meiosis or in any cells from which sex glands are derived i.e. during embryological development of ovaries or testes (the mutation is present in the cells from which sperms and eggs are derived).  **Significance:**  **Somatic mutations** affect parts of the body only.   * Somatic mutations can be passed on by mitosis when a cell divides * They can result in different cell lines within an organism eg one blue and one brown eye, Some cancers are known to result from somatic mutations.   In plants somatic mutations can be passed on by asexual reproduction eg Royal Gala apples, navel oranges etc.   * Somatic mutations are not inheritable and only affect the individual organism in their lifetime.   **Gametic mutations**   * can be passed on to offspring / are heritable * Gametic mutations are passed on by meiosis and fertilisation * If the mutation is survivable and the individual reproduces, the mutation can lead to a new allele in the gene pool.   If a gametic mutation id=s advantageous it will become more common in the gene pool as a result of natural selection (and vice versa) | Describes somatic mutations  Describes gametic mutations | Explains the significance of somatic mutations  Explains the significance of somatic mutations | Comparison of the significance of somatic and gametic mutations involves at least two comparisons |

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|  | **Significance of mutations described:**  NB. mutations have been defines in part a.  Mutations create new alleles  **Independent / random assortment**  Independent / random assortment results in different combinations of chromosomes in gametes.  or similar  **Crossing over**  Crossing over leads to variation of alleles on homologous (the same) chromosomes, resulting in unique chromosomes. It operates on linked alleles (or groups of alleles that are on the portions of the chromosome that is recombined.  or similar  **Limitations of both of these processes explained**  Produce variation by reshuffle **pre-existing genetic material**  i.e. the amount of variation that can be produced by these processes is limited by the alleles already available  **Importance of mutations as the ultimate source of variations explained**  eg. mutations are not reshuffling, but are the only way (besides immigration) that new alleles can be added to a gene pool.  Mutations result in new alleles being added to a population. Mutations are not reshuffling of genetic material, they introduce new genetic material to a gene pool. Because new alleles are produced, mutations are considered the ultimate source of variation.  **Comprehensive discussion:**  Comprehensive discussion explaining how mutations are inherited and how mutations result in new alleles being added to a population whereas crossing over is a way of reshuffling existing genetic combinations. Mutation, Independent assortment and crossing over discussed. | | | | | | Significance of mutations described:  Effect of independent assortment  described  Effect of Crossing over described | Limitations of both of these processes explained  Importance of mutations explained | Comprehensive discussion |
| **Not Achieved** | | | | **Achievement** | | **Merit** | | **Excellence** | |
| **NØ** | | **N1** | **N2** | **A3** | **A4** | **M5** | **M6** | **E7** | **E8** |
| No response; no relevant evidence. | | Provides any ONE or TWO statement from Achievement. | Provides any THREE statements from Achievement. | Provides any FOUR or FIVE statements from Achievement. | Provides any SIX statements from Achievement. | Provides any THREE statements from Merit. | Provides FOUR statements from Merit. | Provides any ONE statement from Excellence. | Provides TWO statements from Excellence. |

Question 4 **Poultry problems**

Evidence Statement

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| **Q1** | **Expected Coverage** | | | | | | | | | | Achieve | | Merit | Excellence |
| **a.** | **Incomplete dominance recognised and described:**  a form of inheritance in which one allele for a specific trait is not completely dominant over the other allele.  **Description of heterozygote phenotype**  Blue  **Explanation:**  Because both alleles have partial influence, an intermediate/blended phenotype is observed in the heterozygous offspring. The blue chickens are the result of the influence of the black and white alleles. | | | |  | | | | | | Describes incomplete dominance  Description of heterozygotes  Correct punnet square. | | Explanation of heterozygote phenotype |  |
|  |  | A | | a |  |
| A | AA | | Aa |
| a | Aa | | aa |
| AA= White chickens  aa = Black chickens  Aa = Blue chickens | | | | | |
| **b.** | **Possible genotypes described:**  The genotype of the farmer’s bronze, normal feathered turkey could be:  RRHH, RrHh,RRHh or RrHH.  The farmer needs to determine whether the turkey he bought is heterozygous or homozygous for both traits.  **Test cross described:**  i.e. mate the turkey with a homozygous recessive turkey (red and hairy feathered, rrhh).  **Results of test cross explained**   1. If any of the offspring in the next generation show any recessive traits (are either red or hairy feathered) the original turkey he bought was heterozygous for those traits. 2. If ALL the offspring in the next generation are bronze and normal feathered, the breeder can identify this turkey as probably being homozygous for the two characteristics and thus a possible parent turkey to mate with the turkey he bought to establish his pure-breeding population.   **Establishing a population of pure-breeding bronze, normal-feathered turkeys.**   * recognition that this involves breeding Homozygous dominant individuals but some of these may be heterozygous for one or both traits * test crosses explained:   identifies heterozygous turkeys from homozygous, can be used to establish which individuals the farmer should use a breeding stock.   * Recognition that in order to establish a purebreeding Bronze, normal-feathered (i.e. homozygous dominant) population recessive traits must be eliminated from the population * If any animals exhibit recessive traits they should be eliminated from the population * If any animals exhibit recessive traits their parents should be eliminated from the population because these individuals must have inherited recessive alleles from both parents. * Even an established population will have some recessive alleles in the gene pool (hidden) in the heterozygous individuals * When these (increasingly rare) heterozygous individuals reproduce, there is a ¼ chance that the offspring will have recessive phenotypes.   **Evaluation of the long term success of the farmer’s objective etc.**   * Populations with established dominant traits are harder to establish than populations with established recessive traits. When a recessive trait is desired the dominant trait can be eliminated in one generation because any individual with one or two dominant alleles will exhibit that trait and can be eliminated leaving only homozygous recessive individuals to breed. * Even if a totally homozygous population could be established recessive traits can sometime appear as the result of mutations although this is rare * or similar | | | | | | | | | | Possible genotypes described:  Test cross described  Describes the need to find homozygous individuals to breed from | | 1st possible result of test cross explained  2nd possible result of test cross explained  Use of test crosses explained  Explains the need to eliminate any individual with recessive traits | Comprehensive discussion of the methods by which a pure breeding population can be established  Evaluation of the long term success of the farmers objective |
| **Not Achieved** | | | | **Achievement** | | | | **Merit** | | | | | **Excellence** | |
| **NØ** | | **N1** | **N2** | **A3** | **A4** | | | **M5** | | | | **M6** | **E7** | **E8** |
| No response; no relevant evidence. | | Provides any ONE statement from Achievement. | Provides any TWO or THREE statements from Achievement. | Provides any FOUR statements from Achievement. | Provides any FIVE or SIX statements from Achievement. | | | Provides any TWO or THREE statements from Merit. | | | | Provides FOUR or more statements from Merit. | Provides any ONE statement from Excellence. | Provides TWO statements from Excellence. |

grade boundaries.

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|  | **Judgement Statement if using FOUR questions** | | | |  |
|  | **NA** | **A** | **M** | **E** |  |
| **Score range** | **0 – 10** | **11 – 18** | **19– 25** | **26 - 32** |  |