PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

BIOLOGY



MARK SCHEME

TOPIC 8: ORIGINS OF GENETIC VARIATION

GENE POOLS

SCORE	PERCENTAGE
/84	%

STEMUP

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Mark Scheme

Q1.

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)	An answer that makes reference to the following: • calculation of frequency of homozygous recessives *f*(tt) (1) • calculation of q (1) • calculation of p (1) • calculation of *f*(TT) and *f*(Tt) (1)	Example of calculation Allow ECF for incorrect values 100-64% = 36% = **0.36** q $= \sqrt{0.36}$ = **0.6** p =1 – 0.6 = **0.4** $p^2 = 0.4^2$ = **0.16** 2pq = 2 x 0.4 x 0.6 = **0.48**	**(4)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(i)	A description that makes reference to any two of the following: • population is large (1) • mating is random (1)		**(2)**
	• mutation is rare (1) • migration does not alter allele frequency / does not happen / the population is isolated (1)		

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(ii)	An answer that makes reference to the following: • founder effect (1) • population bottleneck (1) • genetic drift / result of chance (1)		**(3)**

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	A calculation that makes reference to three of the following: • calculation of q^2 • calculation of p and q • calculation of 2pq • calculation of the number of heterozygotes in a population of 1400 252 to 260 (4)	<u>Example of calculation</u> 15 ÷ 1400 = 0.0107 p = 0.897 q = 0.103 2pq = 2 x 0.897 x 0.103 = 0.185 0.185 x 1400 = 259 Correct answer with no working gains full marks **ACCEPT** one mark for: q^2 = 0.01 to 0.0107 p = 0.897 to 0.9 **and** q = 0.1 to 0.103 **ACCEPT** 2pq = 0.18 to 0.187 in final answer for **3** marks	**4**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to two of the following: • founder effect (1) • therefore genetic bottleneck / therefore small gene pool (1) • more likely to receive two recessive alleles (from parents) / both parents are more likely to be heterozygous / carriers (1)	**ACCEPT** low genetic diversity / small number of different alleles	**2**

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to two of the following: • CITES prevents {exploitation / hunting / sale / trade / poaching} (1) • by countries that sign up to the treaty (1) • by {protecting / conserving} endangered species (1)		**(2)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to two of the following: • (genetic / population) bottleneck (1) • causing reduced {genetic diversity / gene pool / number of different alleles} (in populations) (1) • therefore the chance of inheriting two harmful recessive alleles increases (1)	**Accept** small / restricted gene pool	**(2)**

Q4.

Question Number	Indicative content
*	Answers will be credited according to candidate's deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • with increasing snow depth, there is higher survival of grey owls / fewer brown owls survive / more grey owls D • snow depth has decreased over time D • the percentage of brown owls has increased over time / percentage of grey owls has decreased D For • with less snow, more ground is visible / uncovered / more twigs and trees visible E • with less snow, grey owls more obvious (to predators / prey) / less camouflaged E • with less snow, natural selection would favour brown owls / more brown (advantageous) alleles passed on / fewer grey alleles passed on / brown owls outcompete grey owls E • enhanced greenhouse effect due to carbon dioxide emissions reflecting radiation back / absorbing radiation (causing melting) E Against • no direct measure of greenhouse gas / temperature / fossil fuel emissions A • graphs show correlations not causal links A • data for owl survival with snow depth is scattered / gaps in data / weak correlation A • data for mean snow depth has many outliers / anomalies / not all points are around line / data is scattered A • other factors (named factors) could be affecting the owl population A • reduced snow may not be due to greenhouse gas release A

	• data for owl survival with snow depth is scattered / gaps in data / weak correlation A • data for mean snow depth has many outliers / anomalies / not all points are around line / data is scattered A • other factors (named factors) could be affecting the owl population A • reduced snow may not be due to greenhouse gas release A

Level 0	Marks	No awardable content
Level 1	1-2 (1-3)	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made . **1 mark : any 1 from D, E, A** **2 marks : any 2 from D, E, A**
Level 2	3-4 (4-6)	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made. **D and, E OR A** **3 marks : at least 3 points. Any combination of D, plus E, or A** **4 marks : at least 4 points. Any combination of D, plus E, or A**
Level 3	5-6 (7-9)	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made. **D, E, AND A** **5 marks : at least 5 points. Must have combination of D, E, and A** **6 marks : at least 6 points. Must have combination of D, E, and A**

Q5.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to three of the following: • both change the frequency of alleles / change genetic diversity (1) • both select against (less well adapted) phenotypes (1) • disruptive selection selects against {middle / mean / median} phenotypes but stabilising selection selects against extreme phenotypes (1) • disruptive selection leads to {two distinct populations / bimodal distribution} but stabilising selection maintains one population (1)	**Accept** change gene pool **Accept** converse **Accept** alleles for phenotypes **Do not accept** genes **Accept** converse **Accept** alleles for phenotypes **Do not accept** genes **Accept** clear labelled diagrams	**(3)**

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to two from the following: • a genetic bottleneck has occurred (1) • resulting in a smaller gene pool (1) • so the probability of receiving two recessive alleles is higher (1)	**Accept** lower genetic diversity **Accept** inbreeding / higher chance of two organisms have similar alleles	2

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three from the following: • therefore animals from different populations can move across territories / forest to forest (1) • therefore increasing genetic diversity / widens gene pool / increased allele number (1) • and balances the needs of local people with conservation / retains jobs for local people (1) • local people are more likely to maintain the bridges (1)	**Accept** animals from different forests can move in / more outbreeding	3

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to one from the following: • {banning export / import trade of species} preventing {poaching / illegal trapping} (1)	**Accept** {countries} sign treaty / agree preventing {poaching / trapping / exports / imports / trade}	1

Q7.

Question Number	Correct Answer	Additional guidance	Mark
(a)	An answer that makes reference to one of the following: • poached by humans for their horn (1) • *Arenga pinnata* outcompetes the food source/less food for rhino (1) • disease (1)		**(1)**

Question Number	Correct Answer	Additional guidance	Mark
(b)	An explanation that makes reference to two of the following: • difficulty in finding mates (1) • so population growth is affected (1) **or** • loss of genetic diversity / small gene pool (1) • so less resistance to environmental change (1)		**(2)**

Question Number	Correct Answer	Additional guidance	Mark
(c)	An answer that makes a reference to two of the following: • habitat maintenance / restoration / clearing *Arenga pinnata* (1) • locate breeding sites for reproduction (1) • protect the rhinos from poachers (1) • ensuring that the food source is maintained/plant more food source (1) • breeding programme outside of national park (1)		**(2)**

Q8.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An answer that makes reference to the following: • { selective pressure against / loss of } sickle cell alleles due to effects of sickle cell anaemia (1) • heterozygote advantage due to protection against malaria increases { HbS frequency / number of heterozygotes } (1) • heterozygote advantage increases with increased prevalence of malaria (1) • HbS frequency depends on whether malaria or sickle cell disease represents a greater risk to survival (1)		**(4)**

Q9.

Question Number	Answer	Mark
	The only correct answer is C ***A*** *is not correct because allopatric selection is an incorrect term* ***B*** *is not correct because directional selection would move the curve in one direction* ***D*** *is not correct because stabilising selection would result in one peak*	**(1)**

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to three of the following: • the numbers are very small causing a genetic bottle neck (1) • so that variation in the gene pool may have been reduced (1) • causing increased likelihood of inbreeding effects (1) • such as accumulation of disadvantageous mutations (1)	Allow reference to founder effect Allow small gene pool Allow inbreeding depression, Allow early offspring may have comefrom only one male Allow greater chance of receiving tworecessive alleles	(3)

(ii)

Level	Marks	
0	0	No awardable content
1	1-3	Demonstrates isolated elements of biological knowledge and understanding to the given context withgeneralised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas,processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge andunderstanding to the given context.
2	4-6	Demonstrates adequate knowledge and understanding by selecting and applying some relevantbiological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientificideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.
3	7-9	Demonstrates comprehensive knowledge and understanding by selecting and applying relevantknowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range ofscientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear andlogically structured.

ii **Applying marking points** These are indicative marking pointsand other relevant information should be credited **Level 1** 1 mark: any point 2 marks: any two points3 marks: any 3 points **Level 2** 4 marks: 4 points, must have +and - 5 marks: 5 points, must have +and - 6 marks: 6 points, must have +and - **Level 3** Points must come	**Justification for using poison to kill feral cats** 1. less potoroos killed (+) 2. potoroos less likely to become extinct (+) 3. feral cats are an introduced species (+) 4. there are very large numbers of feral cats (+) 5. increased fungal spread in ecosystem (by potoroos) (+) 6. introduced species will be killed but native species unharmed (+) 7. biodiversity remains higher if native species not killed (+) 8. sausages are designed to target cats (+) 9. native species less likely to become extinct (+)10.poison is biodegradable (+)
	Reasons not to kill feral cats with poison 1. pets may be killed (-) 2. other animals may be killed (-) 3. lots of people object to this (petition) (-) 4. sausages could be attractive to wild species as well (-) 5. government could use other methods to reduce population of feral cats (-) 6. suggested other methods eg spaying, shooting (-) 7. killing cats does not deal with threat from foxes (-) 8. plants / kangaroos are killed to make the poison (-) 9. feral cats are behaving naturally and should not be punished for this (-)
from all threesections 7 marks: 7 points, must have +and - 8 marks: 8 points, must have +and – 9 marks: 9 points, must have +and -	**Wider points** 1. poison made from native plants so less likely to kill native animals (+) 2. biodegradable poison so action now will not affect animals in the future (+) 3. potoroos require special protection as there are such small numbers /endangered (+) 4. idea of balance needed in ecosystem (+) 5. cats have no natural predators in Australia, so it is justified to kill them (+) 6. ethics of government choosing which species to kill (-) 7. government could continue the breeding programme for potoroos (-) 8. effect on food chain of killing 2m feral cats (positive or negative) 9. feral cats may develop resistance to the poison (-) 10. government could try a small-scale trial to find effects of cull (-)

Q11.

Question Number	Answer	Additional Guidance	Mark
(i)	A calculation that makes reference to: • correct calculation to find q (1) • correct calculation to find p (1) • correct calculation to find 2pq and number of mosquitoes (1)	q = 0.899... **Allow** any dpp = 0.101... **Allow** any dp **Allow** ecf for mp2 and mp3 1183 = three marks Correct answer with no working gainsfull marks	**3**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to four of thefollowing: • The frequency of the resistance allele increased in 2015 (1) • because the (resistant) acetylcholinesterase enzyme is not affected by the pesticide / enzymestill works (1) • acetylcholine is still broken down in synapses (1) • the mosquitoes survive and breed (1) • the resistance allele carries a cost as it is reducedwhen no pesticide is used / after 2015 (1)	**Allow** Number of resistant mosquitoesincreases in 2015 **Allow** converse **Allow** converse **Allow** converse **Allow** resistant mosquitoes are at a selective advantage **Allow** lost by genetic drift / non- resistant mosquitoes out compete resistant ones after pesticide use stops **Allow** no selective pressure to retain the resistant allele	4

Q12.

Question Number	Answer	Additional Guidance	Mark
(i)	different {alleles} in a gene pool / species / population OR different {species} in an {area / habitat / environment / ecosystem / community}	**ACCEPT** genetic variation within a species	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • only small number / 10 introduced / {founder effect / genetic bottleneck} has occurred / (1) • (resulting in a) limited gene pool / few different alleles / inbreeding in zoos / no other lynx present to provide new alleles (1)	**ACCEPT** converse for lynx in protected area **ACCEPT** converse for lynx in protected area **DO NOT ACCEPT** diversity of alleles	**(2)**

Q13.

Question Number	Indicative content
*	Answers will be credited according to candidate's deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Candidates are expected to reach a decision/conclusion on whether the Hardy Weinberg equation could be used to predict the number of people in the future who would need treatment in the UK for health disorders. **Lifestyle (L)** • HW only predicts genetic disorders • many health disorders are not genetic / caused by lifestyle • example of a lifestyle disease **Formula and Assumptions (A)** • assumes frequency of alleles remains constant / $p + q = 1$ refers to allele frequency • assumes frequency of genotypes remains constant / $p^2 + 2pq + q^2 = 1$ refers to genotype frequency • p^2 = homozygous dominant / $2pq$ = heterozygotes / q^2 = homozygous recessive • assumes no selection / random mating • assumes no mutation • assumes no migration • assumes large population / no genetic drift

	Problems (P) • recognises assumptions invalid • explain why assumptions are invalid • understands that countries have different population sizes • people unwilling to have a genetic test / risks with genetic tests / tests need to be done • genetic testing is expensive • cannot test for all alleles • understands that environment can affect gene expression

Level	Marks	
0	0	No awardable content
1	1-3	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context. **1 to 3 from L A or P (only one of L A or P)**
2	4-6	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure. **4 to 6 from L A or P (from at least two of L A or P)**
3	7-9	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. **7 plus from L and A and P**

Q14.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: • calculation of q^2 (1) • calculation of p and q (1) • calculation of 2pq (1) • calculation of percentage of carriers (1)	Example of calculation: $q^2 = 0.0004 / 4x10^{-4}$ q = 0.02 and p = 0.98 2pq = 0.0392 percentage of population who are carriers is 3.92% Correct answer with no working gains full marks	**(4)**

Q15.

Question Number	Answer	Additional Guidance	Mark
(i)	• calculation of q (1) • calculation of p (1) • calculation of number of heterozygotes (1)	Correct answer: 516 **Accept** answers with range of 517 and 528 with incorrect rounding for two marks Correct answer gains full marks **Accept** ECF for mp3 for 2pq x 2500	**3**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • only Tibetans and Denisovans have the allele (1) • so (the presence of the allele) suggests that Denisovans and Tibetans must have interbred (1) • and produced fertile offspring (1)	**Accept** Allele is present in Tibetans and Denisovans	**2**