

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 8: ORIGINS OF GENETIC VARIATION
GENE POOLS

SCORE

/84

PERCENTAGE

%

STEMUP

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Q1.

The ability to taste phenylthiocarbamide (PTC) depends on a single gene.

This gene has two alleles. One is a dominant, tasting allele (T), and the other is a recessive, non-tasting allele (t).

In a survey, it was found that 64% of people could taste PTC.

(a) The Hardy-Weinberg equation is

$$(p + q)^2 = 1$$

Use this equation to calculate the proportion of the population who would be TT, Tt and tt.

(4)

(b) There is no known selective advantage for being able to taste PTC.

(i) Describe two conditions under which these proportions remain the same over many generations.

(2)

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(ii) In native American populations 98% of individuals can taste PTC.

In native Australian population 58% of individuals can taste PTC.

State why these two populations have different frequencies of the T allele.

(3)

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Q2.

The genetic condition Hers disease is caused by a recessive allele of the glycogen phosphorylase gene.

In an isolated population of 1400 people in the USA, 15 people have Hers disease.

(i) Calculate the number of heterozygous individuals in this population.

Use the Hardy-Weinberg equation

(4)

$$p^2 + 2pq + q^2 = 1$$

Answer

(ii) The frequency of Hers disease in most human populations is 1 in 40 000.

Explain why the frequency of Hers disease is higher in the isolated population.

(2)

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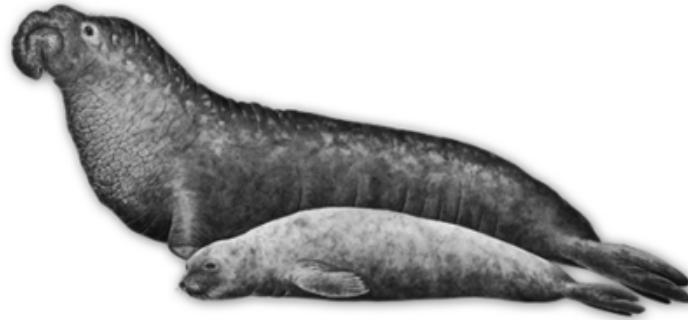
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Q3.

The Northern elephant seal is a mammal found in the Eastern Pacific Ocean.



In the nineteenth century, Northern elephant seals were hunted and this reduced the population to about 20 seals.

The seals were listed as an Appendix II species when CITES was established in the 1970s.

The population has now recovered to over 100 000 individuals.

The seals in this population have developed health problems, including a high mortality rate for newborn pups, deformities and weak immune systems.

(i) Describe the role of treaties such as CITES in maintaining global biodiversity.

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(ii) Explain why, although the population of seals has recovered, many of the seals have health problems.

(2)

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(Total for question = 4 marks)

Q4.

* The photograph shows a tawny owl. These owls live in areas close to the Arctic Circle.



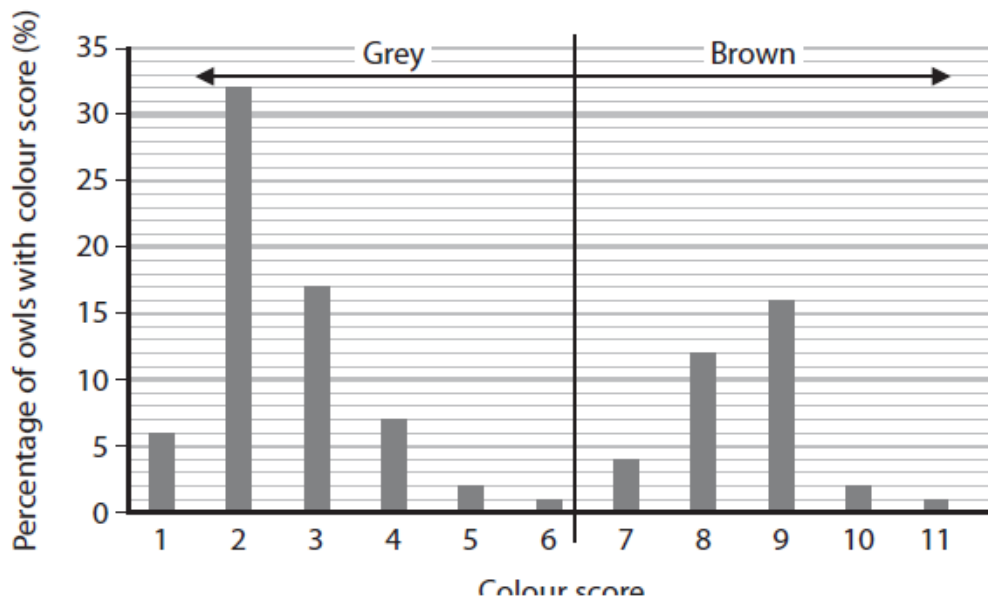
(Source: © LINDA WRIGHT/SCIENCE PHOTO LIBRARY)

Scientists investigated the feather colours of a population of tawny owls. Feather colours of the owls were scored on a scale of 1 to 11, according to how grey or brown they were.

Grey feathered owls were given a score between 6 and 1, with 1 being the most grey.

Brown feathered owls were given a score between 7 and 11, with 11 being the most brown.

The graph shows the percentages of owls in the population with each of the colour scores.



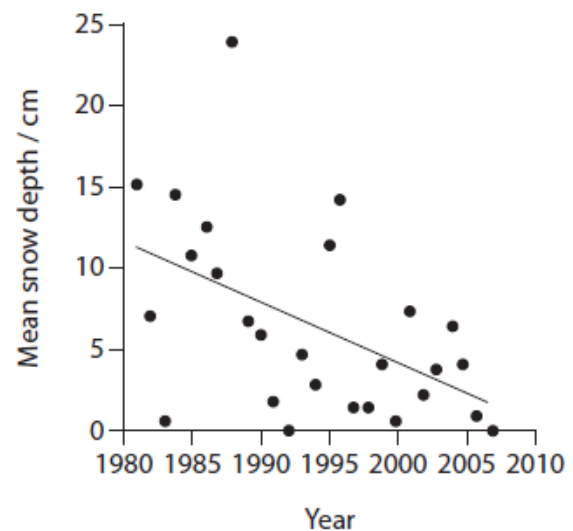
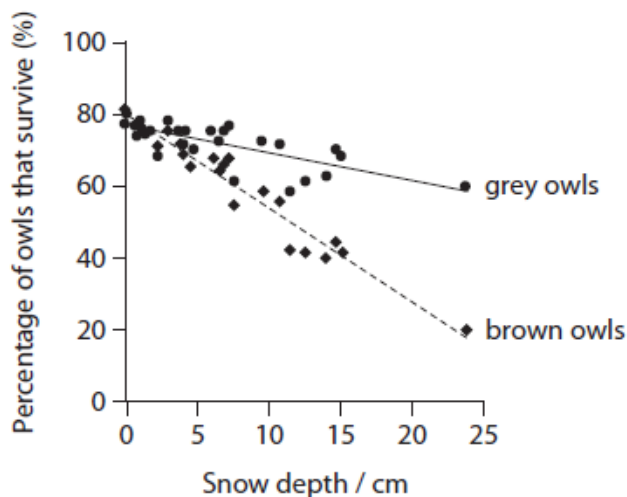
The scientists investigated the effect of climate change on the frequencies of these two alleles for feather colour in populations of tawny owls.

The percentage survival rates of both colours of owl were measured when there were different depths of snow.

The mean depth of snow was recorded each year between 1980 and 2007.

The percentage of owls that were coloured brown between 1960 and 2007 was also recorded.

The graphs show the results.



(Total for question = 6 marks)

Q5.

The diagram shows four varieties of rabbit.



Brown



Chinchilla



Himalayan



Albino

Fur colour in rabbits is controlled by four different alleles:

- the allele for brown fur, C , is dominant to all other alleles
- the allele for chinchilla fur, c^{ch} , is dominant to the alleles for Himalayan and albino
- the allele for Himalayan fur, c^h , is dominant to the allele for albino
- the allele for albino fur, c , is recessive to all other alleles

The fur colour of animals can be affected by natural selection.

Compare and contrast stabilising selection with disruptive selection.

(3)

(Total for question = 3 marks)

Q6.

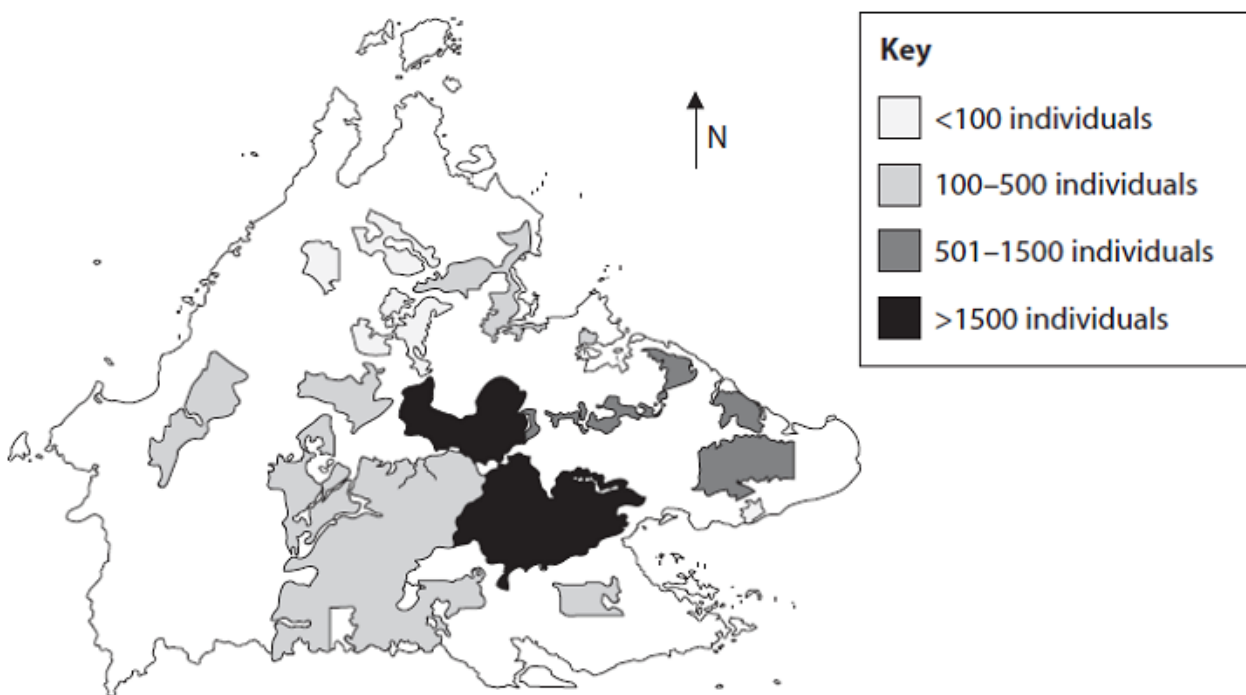
Palm plants and cocoa plants are used to produce lipids for the food industry.

Palm oil is produced from palm plants. Cocoa butter is produced from cocoa plants.

Some forests in Borneo have been cleared to grow these plants.

Orangutans used to live in forests throughout this island but now they are found in small areas of forest.

The map shows the distribution of orangutans in parts of Borneo.



(i) Explain why in areas with low populations of orangutans, many of the orangutans have deformities and health problems.

(2)

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(ii) The Malaysian government is paying local people to create and maintain 'land-bridges' of forest to link areas of forest together.

Explain why these payments will help to develop palm oil production and support conservation of orangutans.

(3)

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(iii) State how treaties such as CITES help conserve orangutans.

(1)

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(Total for question = 6 marks)

Q7.

Of the five rhino species, Javan rhinos (*Rhinoceros sondaicus*) are the most in threat of extinction, with as few as 35 individuals surviving in Ujung Kulon National Park in Java, Indonesia.

This national park is highly vulnerable to tsunamis and volcanic activity. In Java, large areas have been planted with *Arenga pinnata*, which is a source of palm oil. This plant has now colonised 50% of this national park.



© topimages/shutterstock

(a) Give **one** biotic factor which contributes to *Rhinoceros sondaicus* becoming a critically endangered species.

(1)

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(b) Explain why a species may become endangered when its population falls to a very low number.

(2)

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Conservationists are working with the national park in order to conserve the Javan rhino.

Give **two** methods that could be used to conserve the Javan rhino.

(2)

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Q8.

Sickle cell anaemia is caused by a mutation in the β -globin gene which codes for part of haemoglobin.

The diagram shows the first 10 amino acids in this part of haemoglobin, in a healthy person and in a person with sickle cell anaemia.

Healthy person: val – his – leu – thr – pro – glu – glu – lys – ser – ala

Person with sickle cell anaemia: val – his – leu – thr – pro – val – glu – lys – ser – ala

The allele that leads to sickle cell anaemia is known as HbS.

From 1990 to 1996, all newborn infants in California were screened for the presence of the HbS allele.

The data in the table show the ratio of individuals with and without the HbS allele, in various ethnic groups.

Ethnic group	HbS allele : no HbS allele
African American	1:14
Asian	1:1336
Caucasian	1:625
Hispanic	1:183
Middle Eastern	1:360
Native American	1:176

A chi squared test was used to analyse the raw data.

The null hypothesis was: "There is no difference between the frequency of the HbS allele in African Americans and in all other ethnic groups combined."

The calculated value of chi squared was 450 615.

The table shows some critical values for the chi squared distribution, with one degree of freedom.

probability, p	0.005	0.010	0.025	0.050	0.100
critical value	7.879	6.635	5.024	3.841	2.706

Malaria is a major cause of death in Africa.

Assess the effect that this might have on the frequency of the HbS allele in African populations.

(4)

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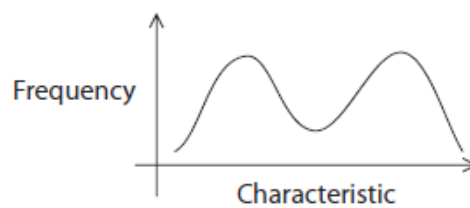
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Q9.

The graph shows the frequency of a characteristic found in a population of animals.



Which type of selection would create this pattern?

(1)

☒ **A** allopatric selection

☐

- ☐ B directional selection
- ☒ C disruptive selection
- ☒ D stabilising selection

(Total for question = 1 mark)

Q10.

Gilbert's potoroo is one of the most critically endangered species in the world.

Gilbert's potoroo was thought to be extinct until one was found in 1994.

It is thought that there are only 70 individuals.

The photograph shows a potoroo and its pouched baby feeding on berries.



The map shows the only part of Australia where Gilbert's potoroo is found.



In 1994, there were only 20 Gilbert's potoroo individuals, 12 of which were in a captive colony.

A captive breeding programme was set up using:

- four adult females and one young female
- one adult male, two young males and one young male still in its mother's pouch.

(i) Explain why allele frequencies may cause problems in this population of potoroos.

(3)

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(ii) Foxes and feral cats, which are predators of potoroos, were introduced into Australia by settlers.

The photograph shows a feral cat with its prey.



The Australian government is using poisoned sausages in an attempt to kill 2 million feral cats by 2020.

The sausages contain chunks of kangaroo meat combined with chicken fat, herbs, spices and a poison.

The content of the sausages was based on flavours irresistible to cats.

The poison used is produced by the Swan River pea plant that is found in Western Australia. Other Australian plants that contain the poison are: *Acacia*, *Wedge Peas* and *Nemcia*.

This poison is a natural toxin that biodegrades rapidly and the native wildlife in Australia has evolved natural resistance to it.

A group of 160 000 people in Australia have signed a petition against the plan to poison feral cats.

Discuss whether the plan to poison feral cats is justified.

(9)

(Total for question = 12 marks)

Q11.

The photograph shows an insect fossilised in amber resin.



(Source: Bjoern Wylezich. 123rf.com/PAL)

Scientists have classified another fossilised insect found in amber resin as a new species of mosquito, *Priscoculex burmanicus*.

This mosquito is anatomically very similar to modern species of mosquito.

Mosquito populations are often controlled using pesticides that inhibit the enzyme acetylcholinesterase.

Long-term use of pesticides often leads to the development of resistance in these mosquitoes.

The ace-1 gene codes for the enzyme acetylcholinesterase.

The ace-1^r allele is a recessive form of this gene that gives resistance to pesticides.

The changes in the numbers of resistant and non-resistant mosquitoes in an area of farmland where pesticides were used in 2007 was investigated.

The use of the pesticides was stopped in 2016.

The table shows the results of this investigation.

Mosquito type	Number of mosquitoes		
	2005	2015	2018
resistant	125	5250	4120
non-resistant	8755	1250	3950

(i) Calculate the number of heterozygous mosquitoes in 2015.

Use the Hardy-Weinberg equation

$$p^2 + 2pq + q^2 = 1$$

(3)

Answer

(ii) Explain why the changes in the numbers of the resistant and non-resistant mosquitoes, from 2005 to 2018, are related to the function of the ace-1 gene.

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(Total for question = 7 marks)

Q12.

The Eurasian lynx is the largest native European cat species.

It was once widespread across Europe but is now restricted to small areas of national parks.



Ex-situ and *in-situ* conservation measures were used in the 1970s to increase biodiversity.

- Lynx were bred in zoos and 10 were reintroduced into an area of protected forest where

the lynx had become extinct.

- Existing wild lynx were protected in an area of forest where they had not become extinct.

In 2016 scientists estimated the population sizes and genetic biodiversity of the lynx in these two areas of forest.

They found that the population and genetic biodiversity of the lynx in the area where they had been reintroduced were much lower than in the protected area.

(i) State what is meant by the term **biodiversity**.

(1)

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(ii) Explain why, in 2016, the genetic biodiversity of the lynx population in the area where they had been reintroduced was much lower than in the protected area.

(2)

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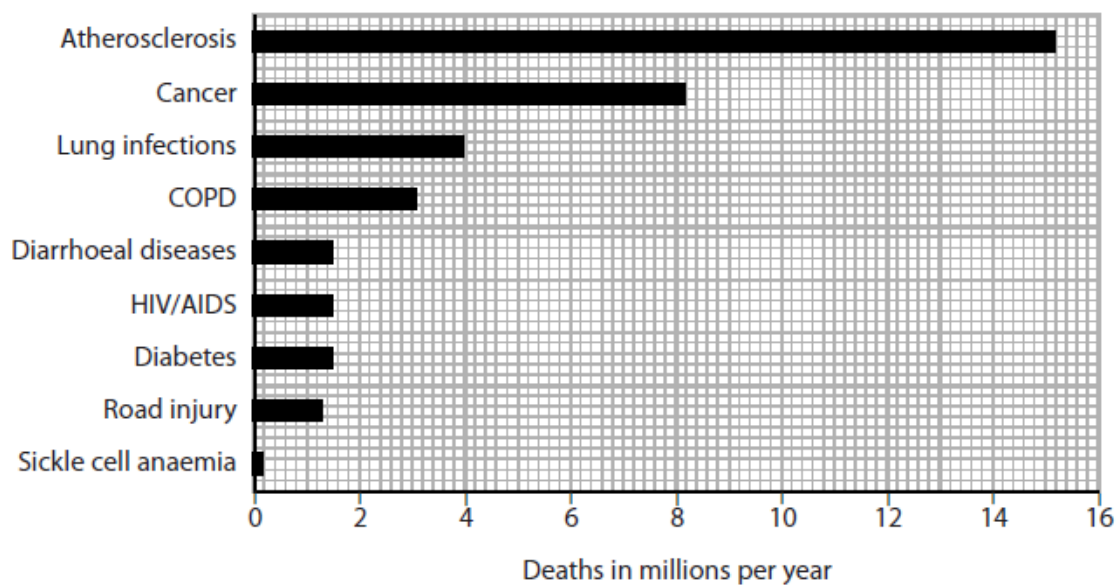
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(Total for question = 3 marks)

Q13.

There are many disorders that affect the health of people.

The graph shows the number of people in the world who die each year from different health disorders.



* Some health disorders, such as sickle cell anaemia, have a genetic basis.

People who are at risk of these disorders can be identified using genetic tests.

Hospital managers need to predict the future cost of treating people with health disorders.

It has been claimed that the Hardy-Weinberg equation ($p + q = 1$ or $p^2 + 2pq + q^2 = 1$) could be used to predict the number of people who would need treatment for health disorders.

Discuss the validity of this claim.

(9)

[illegible]

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(Total for question = 9 marks)

Q14.

Cystic fibrosis is a recessive inherited condition where the cells in the lungs produce sticky mucus. This mucus builds up in the airways, causing breathlessness and chest infections.

People with cystic fibrosis often need treatments such as physiotherapy and antibiotics.

The incidence of babies born with cystic fibrosis in Australia is 1 in 2500.

Use the Hardy Weinberg equation, $p^2 + 2pq + q^2 = 1$, to calculate the percentage of Australians who are carriers of cystic fibrosis.

(4)

Answer %

(Total for question = 4 marks)

Q15.

Tibetan populations have a recessive allele that helps them to survive at high altitude.

In a village in Tibet, 1950 people out of a population of 2500 people carry two copies of this allele.

(i) Calculate the number of heterozygous people in the village.

Use the Hardy-Weinberg equation

$$p^2 + 2pq + q^2 = 1$$

(3)

Answer

(ii) This allele is currently found only in human populations in Tibet.

The allele has also been found in the fossil bones of an extinct form of modern humans called the Denisovans.

Fossils of Denisovans have been found in Tibet.

Explain why scientists think that the Denisovans belonged to the same species as modern humans.

(2)

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(Total for question = 5 marks)

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)	<u>Example of calculation</u> Allow ECF for incorrect values $100 - 64\% = 36\% = \mathbf{0.36}$ $q = \sqrt{0.36} = \mathbf{0.6}$ $p = 1 - 0.6 = \mathbf{0.4}$ $p^2 = 0.4^2 = \mathbf{0.16}$ $2pq = 2 \times 0.4 \times 0.6 = \mathbf{0.48}$	(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> $15 \div 1400 = 0.0107$ $p = 0.897 \quad q = 0.103$ $2pq = 2 \times 0.897 \times 0.103 = 0.185$ $0.185 \times 1400 = 259$ 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
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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) <i>Arenga pinnata</i> 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 <i>Arenga pinnata</i> (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 <i>allopatric selection is an incorrect term</i> B is not correct because <i>directional selection would move the curve in one direction</i> D is not correct because <i>stabilising selection would result in one peak</i>	(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 come from only one male Allow greater chance of receiving two recessive 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 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.
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.
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.

ii Applying marking points These are indicative marking points and other relevant information should be credited Level 1 1 mark: any point 2 marks: any two points 3 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 (-)
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from all three sections 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 (-)
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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 gains full marks	3

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to four of the following: - The frequency of the resistance allele increased in 2015 (1) - because the (resistant) acetylcholinesterase enzyme is not affected by the pesticide / enzyme still 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 reduced when no pesticide is used / after 2015 (1)	Allow Number of resistant mosquitoes increases 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
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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

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)	<u>Example of calculation:</u> $q^2 = 0.0004 / 4 \times 10^{-4}$ $q = 0.02$ 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 $2pq \times 2500$	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

