PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

BIOLOGY



EXAM QUESTION PACK

TOPIC 8: ORIGINS OF GENETIC VARIATION

GENE POOLS

SCORE	PERCENTAGE
/84	%

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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.

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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.

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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.

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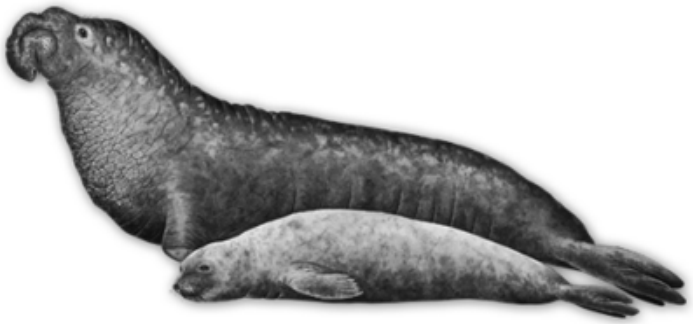
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(Total for question = 6 marks)

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.

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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.



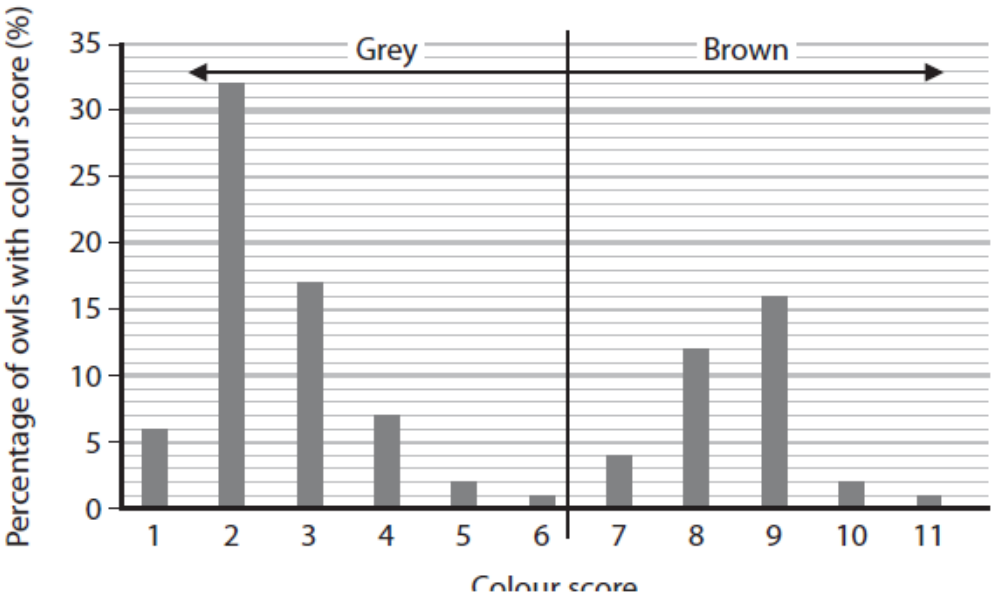
(Source: © LINDA WRIGHT/SCIENCE PHOTO LIBRARY)

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.



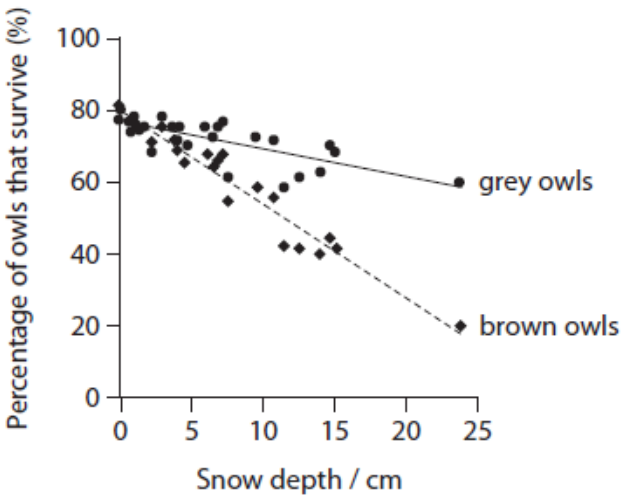
The scientists investigated the effect of climate change on the frequencies of these two alleles for feather colour in populations of tawny owls.

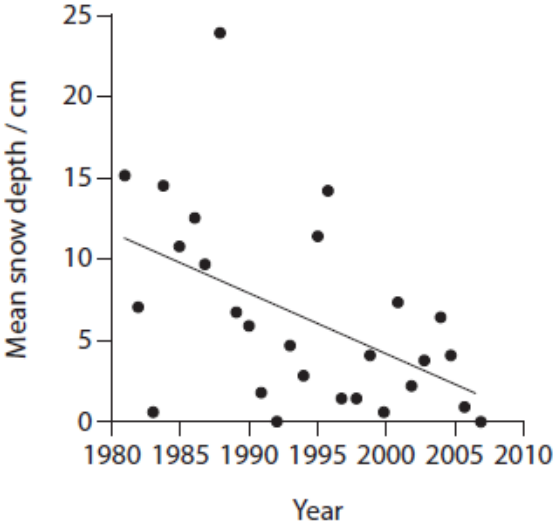
The percentage survival rates of both colours of owl were measured when there were different depths of snow.

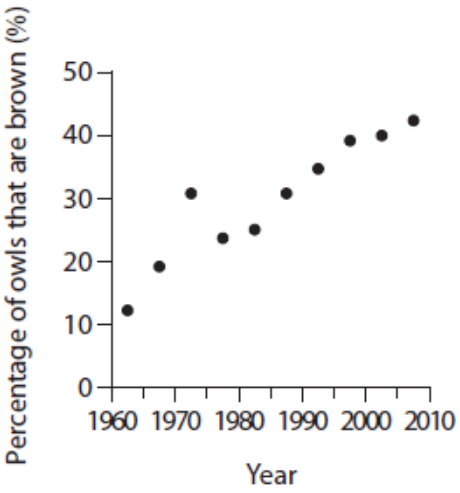
The mean depth of snow was recorded each year between 1980 and 2007.

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

The graphs show the results.







The scientists concluded that increased greenhouse gases from human activity are resulting in an increase in the frequency of the brown allele.

Analyse the data to evaluate this conclusion.

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(Total for question = 6 marks)

Q5.

The diagram shows four varieties of rabbit.



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.

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(Total for question = 3 marks)

Q6.

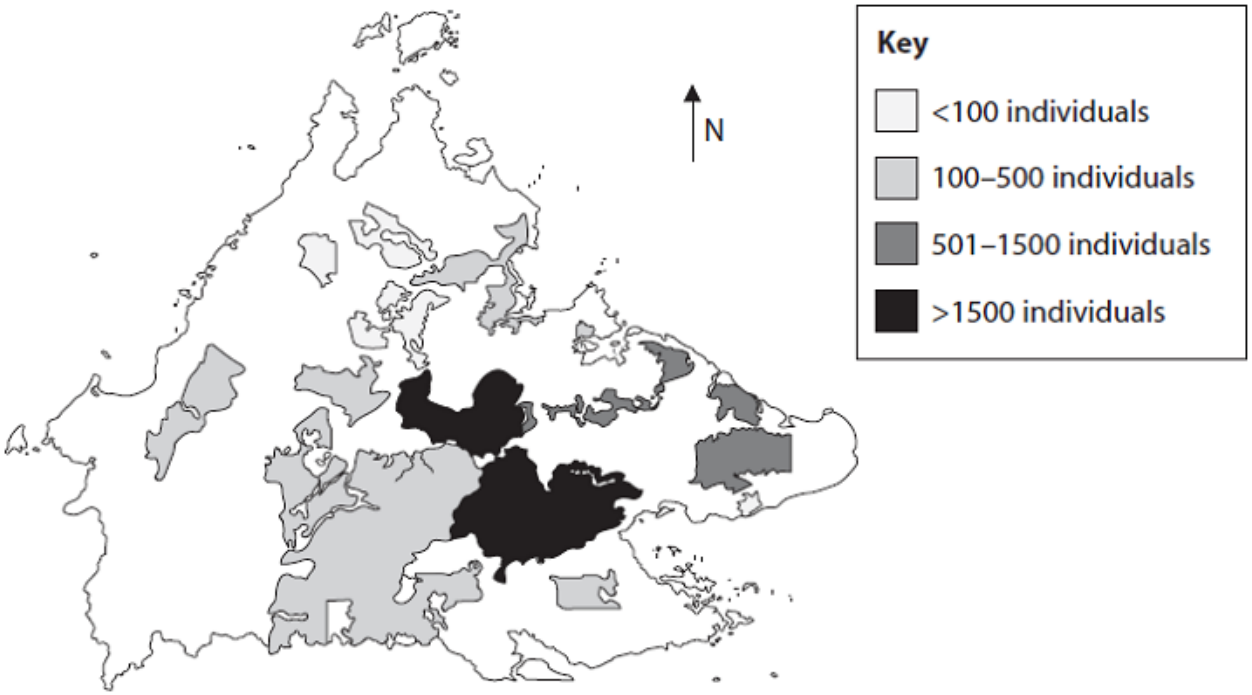
Palm plants and cocoa plants are used to produce lipids for the food industry.

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.

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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.

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

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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.

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

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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.

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(Total for question = 5 marks)

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.

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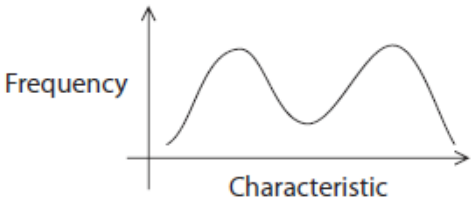
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Q9.

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.

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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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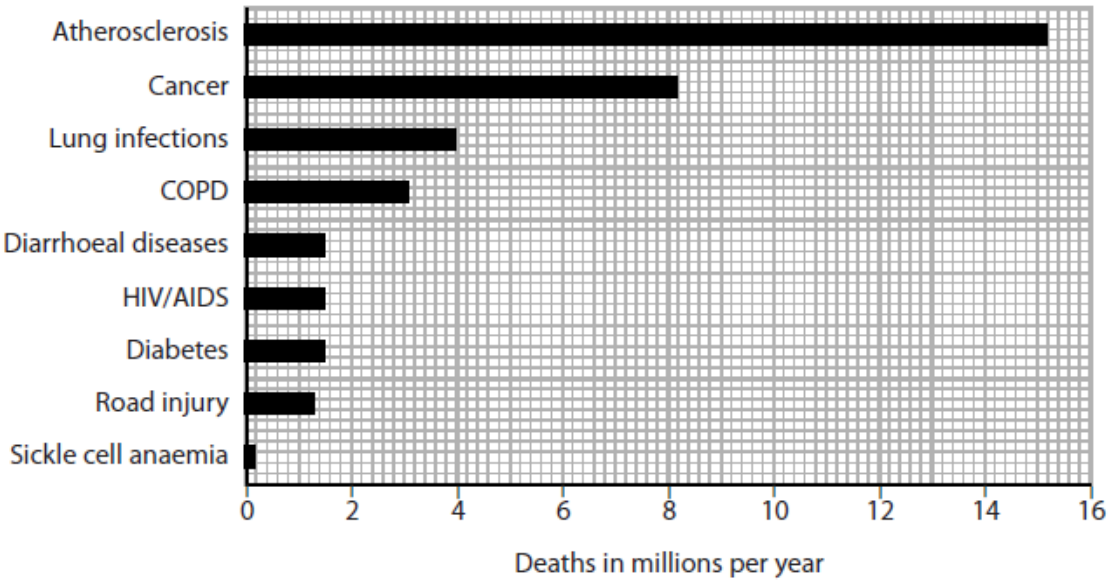
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(Total for question = 3 marks)

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.

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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.

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(Total for question = 5 marks)