1 In 2014 at Longleat Safari Park, a decision was made to humanely kill a female lion and four of her cubs. These lions showed violent and aggressive behaviour to other lions.

These lions had serious genetic defects caused by inbreeding.

(a) (i) Suggest how inbreeding could have led to genetic defects in these lions.

(2)

(ii) Describe how breeding programmes at zoos are designed to reduce the risk of inbreeding.

(4)

(b) When the female lion was first brought to Longleat Safari Park, the zookeepers noted symptoms including tremors, uncoordinated movements and aggressive behaviour.

It was thought that these problems were due to a poor diet when she was younger.

Her cubs were given a better diet at Longleat but they had the same symptoms as their mother.

Suggest what could have been the main cause of the problems in these lions.
Give a reason for your answer.

(2)

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(Total for Question 1 = 8 marks)

2 Genetic diversity is important for the long term survival, adaptation and evolution of organisms. Genetic diversity can be considered as the number of different alleles found at each gene locus in a population of organisms.

(a) Explain what is meant by the term **gene locus**.

(2)

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(b) The genetic diversity of two breeds of dog, P and Q, was investigated.
The total number of different alleles found at 31 gene loci was recorded for each breed.

The results are shown in the table below.

Breed of dog	Total number of different alleles at 31 gene loci
P	239
Q	144

(i) The mean number of different alleles per gene locus for both breeds was calculated.
Place a cross ☒ in the box next to the mean for breed P.

(1)

☒ **A** 5.7

☒ **B** 7.2

☒ **C** 7.7

☒ **D** 31.0

(ii) Breed Q has a mean of 4.6 different alleles per gene locus.
If their environment changed, breed P would be more likely to survive and evolve than breed Q.

Using information on mean number of different alleles per gene locus and your own knowledge, explain why breed P is more likely to survive and evolve than breed Q.

(5)

(c) Two groups of dogs, of breed P, were taken from the same population.
The total number of different alleles at the same 31 gene loci was recorded for each of these two groups.

The results are shown in the table below.

Group	Number of dogs of breed P	Total number of different alleles at 31 gene loci
1	40	239
2	20	215

Suggest why the total number of different alleles in group 1 was greater than in group 2.

(2)

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(d) Adaptation can be behavioural, physiological or anatomical.
Place a cross ☒ in the box that correctly identifies a **behavioural adaptation** in humans.

(1)

☒ **A** Long necks are more common in people living in hot dry conditions

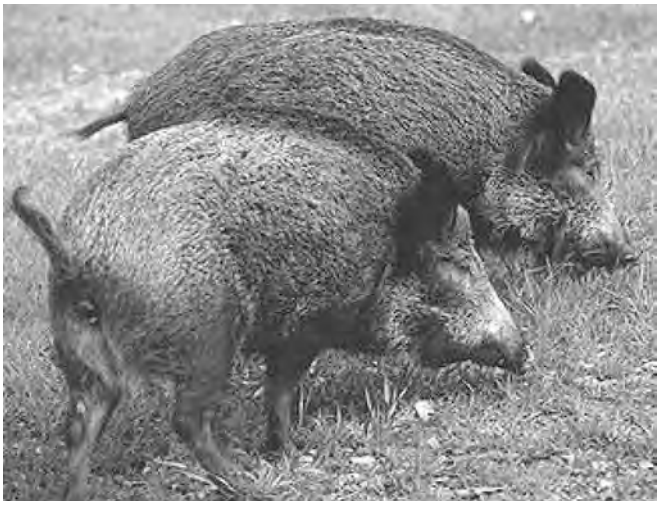
☒ **B** More red blood cells in people living high up a mountain

☒ **C** More white blood cells in people with an infection

☒ **D** Taking a rest in the heat of the day

(Total for Question 2 = 11 marks)

3 Sardinia is an island in the Mediterranean Sea. Many of the plants and animals on islands, such as Sardinia, show distinct physical and behavioural features that are different from those found in closely-related mainland populations.
The Sardinian wild boar is an example of this, shown in the photograph below.



Magnification ×0.1

(a) Explain what is meant by each of the following terms.

(i) Gene pool

(1)

(ii) Allele frequency

(1)

(b) The population of wild boar in mainland Italy and the population in Sardinia both belong to the species, *Sus scrofa*. The mainland population is placed in the sub-species, *Sus scrofa scrofa*, whilst the Sardinian population is placed in the sub-species, *Sus scrofa meridionalis*.

(i) Suggest why scientists classify the mainland and Sardinian wild boar as two sub-species rather than as two separate species.

(2)

*(ii) Suggest how the two sub-species, *Sus scrofa meridionalis* and *Sus scrofa scrofa*, have developed from a single ancestral population.

(5)

(iii) Explain how the results of DNA profiling of tissue samples from the two sub-species could be used to provide evidence that they share common ancestry.

(3)

(Total for Question 3 = 12 marks)

4 The photograph below shows Ethiopian wolves (*Canis simensis*). They live on isolated mountains at altitudes above 3000 metres. They are one of 19 endemic animal species living in the mountains of Ethiopia.

Magnification ×0.01

(a) Explain what is meant by the term **endemic species**.

(1)

(b) There are estimated to be only 500 Ethiopian wolves left in the wild, living in six separate populations. There are high levels of genetic diversity between these six populations.

The separate populations are geographically isolated. This prevents interbreeding between populations.

Suggest how this may affect the genetic diversity of each individual population.

(2)

(c) Ethiopian wolves are endangered in the wild.

Some scientists have suggested that moving male wolves from one population to another may help the species survive.

Suggest how this strategy of transferring individuals from one population to another could help the species survive.

(2)

(d) (i) The table below shows adaptations of the Ethiopian wolf that enable it to survive in its mountain habitat. Place a cross (✘) in the table that correctly describes whether the adaptation is behavioural, anatomical or physiological.

(3)

Adaptation	Behavioural	Anatomical	Physiological
Small sharp teeth widely-spaced to cope with small prey			
Narrow snout to fit into small gaps when hunting small prey			
Hunting alone, as prey are too small to share with other wolves			

*(ii) Suggest how natural selection has led to the evolution of this species of wolf, adapted for life in the mountains of Ethiopia.

(4)

(Total for Question 4 = 12 marks)