17.2 Natural & Artificial Selection

Question Paper

Course	CIE A Level Biology
Section	17. Selection & Evolution
Topic	17.2 Natural & Artificial Selection
Difficulty	Medium

Time allowed: 70

Score: /52

Percentage: /100

Question 1a

A group of biologists conducted an investigation on a remote archipelago (a collection of islands) in the Atlantic Ocean. They measured the claw length of a large number of mice of a single species living on the islands. The mouse species had no natural predators.

After the biologists' visit to the islands, a species of snake that preyed on the mice was accidentally introduced on half of the islands. These snakes were not able to climb trees but they could move very fast over open ground. Several years after the snakes were introduced the biologists returned and found that the claw length of the mice on the snake infested islands had increased while the claw length of the mice on the islands without snakes remained unchanged. The longer claws enabled the mice to climb trees, while shorter claws enabled them to run faster.

State the purpose of including the islands where no snakes were present in the biologists' investigation.

[2 marks]

Question 1b

A mutation in the gene controlling claw length in mice was responsible for the development of longer claws in the mice in part a).

Explain how a mutation could lead to a change in claw length in mice.

[3 marks]

Question 1c

(i)
Identify the type of selection that occurred on the snake infested islands.

[1]

(ii)
Give a reason for your answer to part i).

[1]

Question 1d

The species of snake that was introduced onto some of the islands made its way onto one of the islands that had no trees growing on it.

Explain the effect this may have on the claw length of the mice living on this island over time.

[3 marks]

Question 2a

The mango tilapia (*Sarotherodon galilaeus*) is a species of fish found in rivers and lakes across Africa and Eurasia. Scientists monitored the numbers of mango tilapia in a lake over a period of 10 years. Fig. 1 shows the results of this study.
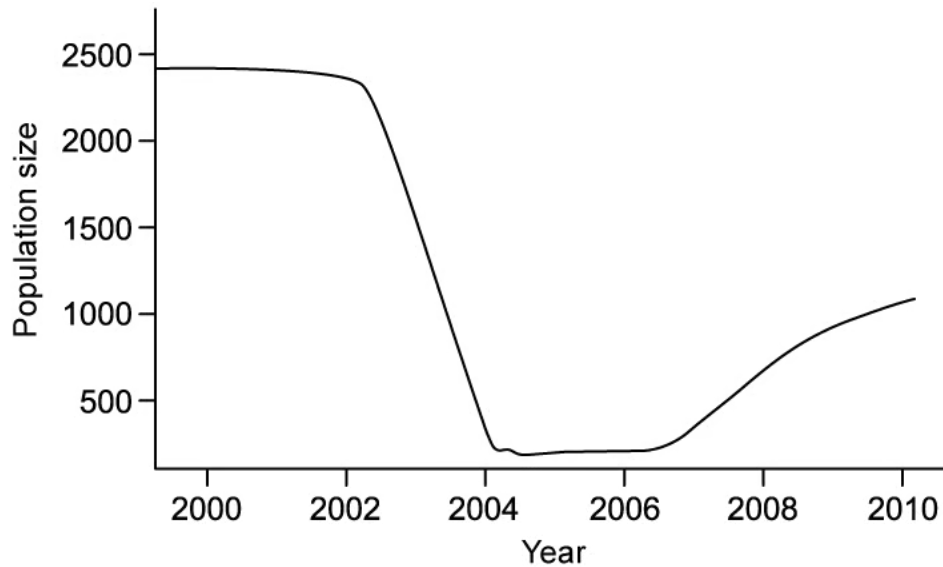

Fig. 1

The number of different alleles present in the mango tilapia population shown in Fig. 1 changed between 2000 and 2004.

Name the precise biological process or event that has affected the number of alleles in the population of mango tilapia represented in Fig. 1

[1 mark]

Question 2b

Explain the effect that the process identified in part a) would have on the tilapia population.

[2 marks]

Question 2c

The population of tilapia decreased from 2400 individuals in 2003 to 52 individuals in 2005.

Calculate the percentage decrease in the tilapia population over this time period.

[2 marks]

Question 2d

A new species of predatory fish is introduced into the lake which preys on mango tilapia. The biologists monitoring the tilapia population noticed that the predatory fish mainly catches tilapia of medium body size.

Explain the effect that this would have on the body size of mango tilapia over time.

[4 marks]

Question 3a

Klebsiella pneumonia are bacteria that commonly occur in the intestines of humans. In the intestines, *K. pneumonia* cause no harm but once they spread to other parts of the body, such as the lungs and brain, they can cause serious bacterial infections.

Carbapenems are a class of powerful antibiotic that are often prescribed to treat serious bacterial infections, such as those caused by *K. pneumonia*. In recent years there have been an increase in cases of *K. pneumonia* infections where the bacteria are resistant to carbapenems.

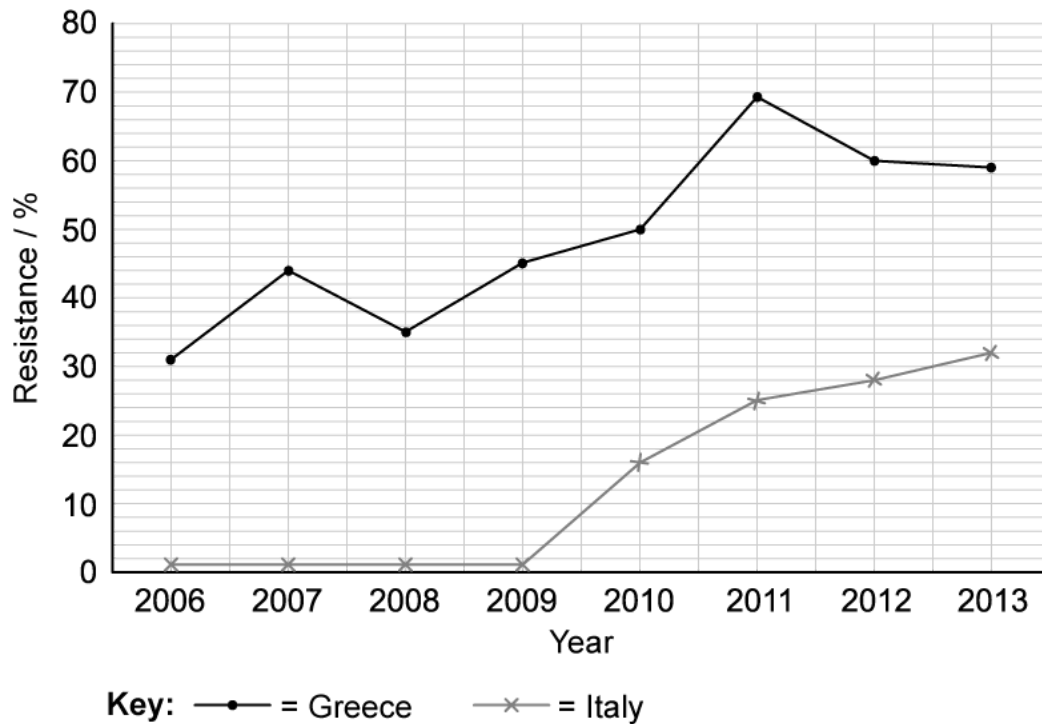Fig. 1 shows the increase in antibiotic resistance shown by *K. pneumonia* in two European countries.

Key: ——●—— = Greece   ——✕—— = Italy

Fig. 1

Describe the trend in antibiotic resistance observed in Fig. 1 for both countries.

[4 marks]

Question 3b

Greece has one of the highest uses of antibiotics outside of hospitals in Europe.

Explain how such widespread use of antibiotics can lead to the development of antibiotic resistance in bacteria such as *K. pneumonia*.

[3 marks]

Question 3c

K. pneumonia are resistant to several different types of antibiotics and they are able to pass this resistance on to other species of bacteria.

Outline the mechanism by which *K. pneumonia* would be able to transfer antibiotic resistance to other species of bacteria.

[2 marks]

Question 4a

In tomato plants, the gene that codes for stem colour has two alleles. Allele **B** codes for a purple stem, while allele **b** codes for a green stem. A farmer growing tomatoes in a greenhouse noticed that about 20 % of the tomatoes had green stems.

The Hardy-Weinberg equation can be used to determine the allele frequency in a population

p + *q* = 1

In this equation, *p* represents the frequency of the dominant allele and *q* represents the frequency of the recessive allele.

Calculate the allele frequencies in this population.

[3 marks]

Question 4b

The farmer decided to only allow the green stemmed tomato plants to reproduce with one another.

Explain why the Hardy-Weinberg principle would not apply to the population that results from the farmer's intervention.

[2 marks]

Question 4c

Explain why the homozygous recessive individuals in the tomato population are the only individuals for whom genotype can be accurately identified from observation alone.

[2 marks]

Question 4d

Use the following Hardy-Weinberg equation to calculate the proportion of heterozygous tomato plants that were present in the original population in part a).

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

Show your working and give your answer to one decimal place.

[2 marks]

Question 5a

Artificial selection has been carried out for thousands of years. An example of this is the Dorper breed of sheep; a fast-growing sheep with a high fertility rate that is well adapted to survive in the arid regions of South Africa. The Dorper was developed from the following two breeds:

- Dorset Horn sheep; a British breed with up to two lambing seasons per year, but not very tolerant of heat or arid conditions
- Blackhead Persian sheep; a Somalian breed with a fast growth rate and high tolerance to heat

Explain how artificial selection resulted in the development of Dorper sheep.

[4 marks]

Question 5b

Suggest **two other** characteristics that breeders may select for when carrying out an artificial selection in sheep.

[2 marks]

Question 5c

Artificial selection can result in inbreeding which can have a negative impact on a species.

Describe the negative impact that inbreeding can have on a species.

[2 marks]

Question 6a

Fig. 1 shows a red deer, *Cervus elaphus*. Red deer feed on a wide range of plants.

Fig. 1

The number of red deer in the UK increased from 135 000 in 1960 to 360 000 in 2010.
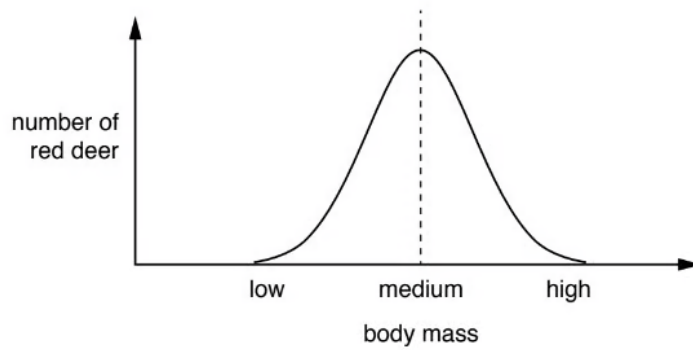
Environmental factors affect the population size of red deer so that numbers do not continue to increase.

Suggest environmental factors that may prevent further increases in the size of red deer populations.

[3 marks]

Question 6b

The body mass of red deer shows wide variation within a population. This is shown in Fig. 2.

Fig. 2

A selection pressure acted consistently over many years against red deer of **low** body mass in a population.

(i)
Sketch a curve on Fig. 3 to show the pattern of variation of body mass in this red deer population after this time.

Fig. 3

[1]

(ii)
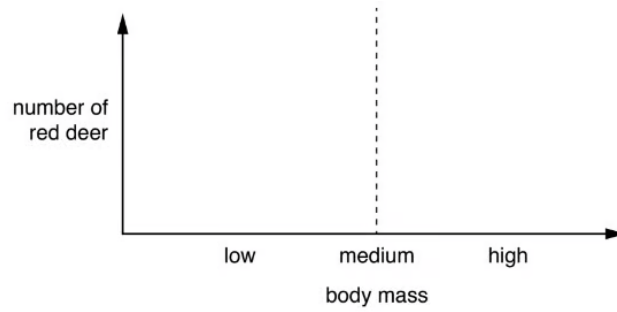Name the type of force of natural selection that is acting on this population.

[1]

[2 marks]

Question 6c

A selection pressure acted consistently over many years against red deer of **medium** body mass in a population.

(i)
Sketch a curve on Fig. 7.4 to show the pattern of variation of body mass in this red deer population after this time.

Fig. 4

[1]

(ii)
Name the type of force of natural selection that is acting on this population.

[1]

[2 marks]