

AICE Biology: Evolution Problem Set

Answer the following AICE practice questions in complete sentences. All attached questions come from AICE Paper 4 (A2 Level topics) and are all essay. **In addition to these questions, please complete the end of chapter questions #1-11 on pages 420-422 in your book.** For all multiple choice questions, please justify your answers in addition to including your letter response. This problem set is worth 30 points and is due the day of the test, Friday, December 8.

1

From 1975 to 1977 one of the Galapagos Islands, Daphne Major, experienced a severe drought. A ground finch, *Geospiza fortis*, feeds on seeds on Daphne Major.

Fig. 6.1 shows the ground finch, *G. fortis*.



Fig. 6.1

- One of the few plants that survived the drought produced large seeds inside tough fruits.
 - Many *G. fortis* died during the drought and the population declined from 1400 in 1975 to 190 in 1977.
 - The mean beak depth of those *G. fortis* that died was 10.68 mm and the mean beak depth of those that survived was 11.07 mm.
 - The mean beak depth of *G. fortis* before the drought was 10.86 mm.
- (a) Calculate the percentage decrease in population size between the years 1975 and 1977.

Show all the steps in your calculation and give your answer to the nearest whole number.

Answer % [2]

1 continued...

(b) Suggest why some *G. fortis* were able to survive the drought while others died.

.....
.....
.....
.....
.....
..... [3]

(c) Natural selection was taking place on Daphne Major.

State the type of natural selection operating on *G. fortis* during the drought and explain your answer.

type of natural selection
explanation
..... [2]

2

The following passage is a summary of the main principles of artificial selection.

Some of the words have been omitted.

Write the most appropriate term in each space.

When humans purposefully apply selection to members of a population, the process is known as artificial selection. For example, people have tried to 'improve' their cattle for thousands of years. It is desirable for a dairy farmer to have cows with a high milk yield. The farmer will select cows with high milk yields and mate them with bulls whose have high milk yields. Some of the conferring high milk yield are passed onto their female offspring who are then chosen for breeding. This will continue for many Artificial selection can have disadvantages such as depression which can lead to infertility. [5]

3

(a) *Asellus aquaticus* is a small freshwater crustacean.

200 *A. aquaticus* were released into a pond where there had previously been none. The pond was favourable for their growth and reproduction.

Describe **and** explain the expected changes in the population size of *A. aquaticus* over the following few months.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(b) In order for natural selection to occur a population must show phenotypic variation.

Explain why variation is important in natural selection.

.....

.....

..... [2]

5

In Central America the Isthmus of Panama closed about 3 million years ago creating a land bridge between North and South America. Snapping shrimps on the Caribbean side of the isthmus appear almost identical to those on the Pacific side, having once been members of the same population. When males and females from different sides of the isthmus were put together they snapped aggressively instead of courting. They had become separate species.

An outline of the region is shown in Fig.4.1.



Fig.4.1

- (a) The term species is often used in the context of evolution of new species. Explain the meaning of the term species.

.....
.....
.....
.....[2]

- (b) State the likely isolating mechanism and type of speciation taking place.

Isolating mechanism
Type of speciation [2]

- (c) Explain how the process of speciation occurred in the snapping shrimp population.

.....
.....
.....
.....
.....
.....
.....[4]

6

There are over 40 Galapagos Islands including the small and isolated island named Daphne Major.

- Only two species of Darwin finches are found on this island.
- Studies were made every year from 1970 to 1989 on the beak size of the island's population of ground finch, *Geospiza fortis*, by measuring the beak length of every bird (Fig. 2.1).
- Larger finches with larger beaks are better at opening large seeds.
- From 1976 to 1978 there was a drought and only 15% of the ground finches survived and these did not breed during drought years.



Fig. 2.1

- All finches were reduced in number. The most conspicuous feature of the survivors of the drought years was their large beak size.
- The main environmental consequences of drought is the decline in food supply, mainly seeds.
- During normal years, many grasses and herbs produce an abundance of small seeds. A few other plants produce a much smaller number of large seeds which are not normally eaten.

(a) Describe how environmental factors appear to have acted, during drought years, on the beak size of finches as an evolutionary force of natural selection.

.....

 [3]

Finches with small beaks were found to be smaller than finches with larger beaks.

(b) Explain the stabilizing force of natural selection on the beak size and size of birds in normal years.

.....

 [3]

(c) Outline the mechanisms that may have let natural selection lead to the evolution of the thirteen species of Darwin finches now found on the Galapagos Islands.

.....

 [2]

Resistance to the widely used poison warfarin is now extremely common in rats. Warfarin interacts with vitamin K to prevent its normal functions in the blood clotting mechanism. Normal rats fed on warfarin suffer a fatal haemorrhage. Resistant rats apparently do not use vitamin K in the same way and maintain normal blood clotting times, even when they have eaten large amounts of warfarin. Warfarin resistance in rats is determined by a single dominant allele. Animals carrying the allele for resistance need large quantities of vitamin K.

genotype	resistance to warfarin	quantities of vitamin K required
homozygous recessive	not resistant (susceptible)	normal
heterozygous	resistant	slightly higher
homozygous dominant	resistant	extremely large

When warfarin is used continually the percentage of resistant rats remains at about 50% of the total rat population.

- (a) Using the symbols R for the allele that confers warfarin resistance and r for the allele that produces no resistance, draw a genetic diagram to explain how resistant rats can produce warfarin susceptible offspring.
- (b) Suggest why homozygous dominant rats are unlikely to survive in the wild.

[1]
- (b) Suggest why homozygous dominant rats are unlikely to survive in the wild.

[1]
- (c) Describe how natural selection operates to maintain the proportion of resistant rats at about 50% of the total population.

[3]
- (d) Explain, with an example, how a mutation that results in the substitution of a single base may affect the phenotype of an organism.

[3]

- (c) Scientists synthesised woolly mammoth haemoglobin in order to investigate whether or not the different haemoglobin was part of the mammoth's adaptation to a cold climate.

The affinity of haemoglobin for oxygen is affected by the changes in temperature that can occur in mammals, for example in active muscle tissue or close to the skin surface.

It is advantageous for Arctic mammals to have haemoglobin whose affinity for oxygen is only slightly affected by changes in temperature. This is often achieved by using substances called 'red cell effectors', which bind to haemoglobin.

Fig. 2.1 compares the effect of temperature on the affinity for oxygen of woolly mammoth and Asian elephant haemoglobin, with and without red cell effectors.

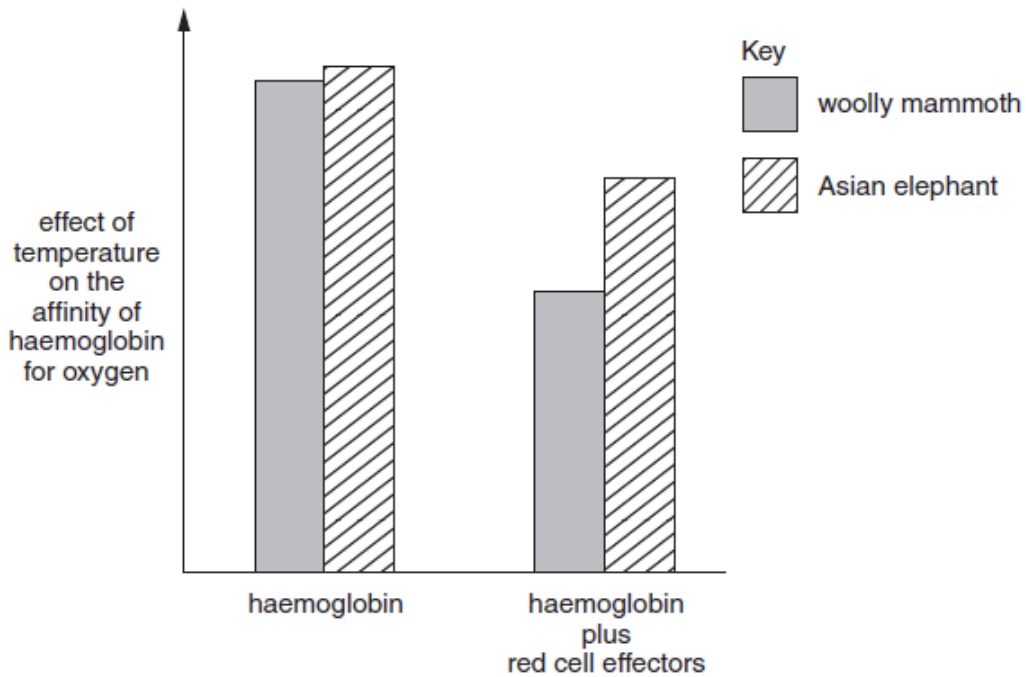


Fig. 2.1

- (i) Suggest why it is advantageous for Arctic mammals to have haemoglobin whose affinity for oxygen is only slightly affected by changes in temperature.

.....

.....

.....

..... [2]

8 continued...

Explain whether or not Fig. 2.1 provides evidence that woolly mammoth haemoglobin is better adapted for a cold climate than Asian elephant haemoglobin.

For
Examiner's
Use

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 14]

Answer the following extended essay questions on your own paper (can be the same paper as the chapter questions) and attach:

9 (a) Explain the role of isolating mechanisms in the evolution of new species. [8]

(b) Describe and explain, using an example, the process of artificial selection. [7]

[Total: 15]

10 (a) Describe how crossing over **and** independent assortment can lead to genetic variation. [9]

(b) Outline how artificial selection differs from natural selection. [6]

[Total: 15]