



IB • HL • Biology

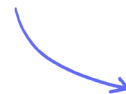
🕒 1 hour ❓ 7 questions

Structured Questions

Natural Selection

Natural Selection & Evolution / Selection Pressures / Selection Pressures: Skills / Gene Pools (HL) / Allele Frequencies: Skills (HL) / Types of Natural Selection (HL) / Hardy-Weinberg Principle (HL) / Artificial Selection (HL)

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Total Marks

/62

1 (a) A group of biologists conducted an investigation on a remote archipelago (a collection of islands) in the Pacific Ocean. A species of mouse lives on these islands without any natural predators. The biologists measured the claw length of a large number of these mice.

On half of the islands a species of snake was accidentally introduced that preys on the mice but that cannot climb trees. Several years after the snakes were introduced the biologists returned and found that on the islands with snakes, the claw length of the mice had changed. Some had shorter claws, enabling them to run faster, while others had longer claws, enabling them to climb trees.

Suggest the benefit to the scientists' investigation of there being islands without any snakes present.

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(2 marks)

(b) The evolution of long claws in the mice in part (a) was made possible by a mutation in the gene controlling claw length.

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

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(3 marks)

(c) When the biologists conducted the investigation in part (a), flooding of the islands was very rare. Now, due to climate change, flooding of the islands occurs more regularly. This flooding can regularly wipe out large numbers of ground-living species.

Using this information and the information from part (a), explain how the claw length of the mice on the islands are likely to be changing now.

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(3 marks)

2 (a) Outline the equivalent features of selective breeding and evolution by natural selection.

(5 marks)

(b) Explain how natural selection can account for the development of antibiotic resistant bacterial strains.

(7 marks)

3 (a) Fur colour in rabbits (*Oryctolagus cuniculus*) is determined by four alleles, each with a varying degree of dominance.

- Allele **C** = brown
- Allele **c^{ch}** = chinchilla
- Allele **c^h** = himalayan
- Allele **c** = white

Scientists investigated the frequency of the different alleles within a population of rabbits. Allele **C** had a frequency of 0.65 while allele **c^{ch}** had a frequency of 0.25. Allele **c^h** had a frequency that was twice that of allele **c**.

Calculate the frequency of allele **c^h**.

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(2 marks)

(b) The habitat of this rabbit population changed:

- Temperatures dropped
- Snowfall became more frequent

Explain the effect that this would have on the allele frequencies in the rabbit population over time.

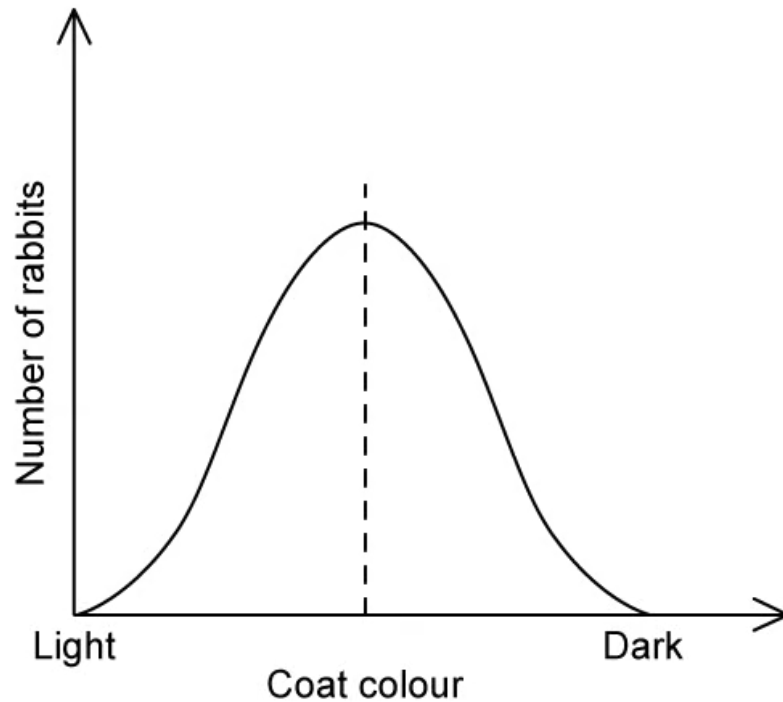
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(3 marks)

(c) The following graph shows the distribution of coat colour within the rabbit population before the environment changed.



State, with a reason, the type of selection that would be observed **after** the environment changed.

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(2 marks)

(d) After several generations the rabbit population accumulated several phenotypic differences to other rabbit populations in nearby habitats.

Explain how scientists could determine whether rabbits from these populations still belong to the same species.

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(2 marks)

4 (a) Renosterveld is a type of vegetation that is part of South Africa's fynbos biome and is found within the Cape Floristic Region. Renosterveld is characterised by a variety of species of shrubs and grasses that grow in relatively fertile soil, which make the areas where they grow popular for cultivating crops, such as wheat. Renosterveld is home to the endangered geometric tortoise (*Psammobates geometricus*), which survives in pockets of natural vegetation.

Wheat crops are cultivated in fields which are securely fenced, preventing the movement of some animals between the natural vegetation and crop fields.

Explain how the cultivation of crops in this region could result in speciation in geometric tortoises over time.

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(4 marks)

(b) Scientists investigated one of these tortoise populations and discovered that most individuals were either very large or very small. Very small individuals have the advantage of being able to hide under shrubs from aerial predators, while large individuals have larger shells that make it difficult for aerial predators to get a secure grip on them.

State, with a reason, the type of selection that will be occurring in this population.

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(2 marks)

- (c) A fire swept through the habitat of the tortoise population, destroying all the vegetation. Only ten tortoises near the edge of the vegetation managed to escape the blaze; all of these individuals had the small phenotype.

The surviving tortoises were rescued by volunteers at a reptile sanctuary and released into a small nature reserve where no other geometric tortoises occurred.

Explain the effect that this event would have on the new tortoise population in the nature reserve.

(2 marks)

5 (a) Mining for gold produces waste rocks and mine tailings, which contain sulfur-bearing minerals. When surface water and shallow groundwater come into contact with these minerals, a chemical reaction occurs which produces sulfuric acid. This process is known as acid mine drainage and it can lower the soil pH to a level where very few plants can survive.

Environmentalists studied the area around an abandoned gold mine and discovered a few specimens of earleaf acacia (*Acacia auriculiformis*) surviving in the acidic soil. This species typically occurs in more neutral or alkaline soils.

Explain how natural selection could produce a population of *Acacia auriculiformis* that would be tolerant of the acidic soil found around the mine shaft.

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(4 marks)

(b) The scientists found that individuals from the population of *Acacia auriculiformis* that are tolerant to low soil pH flowered at a different time to individuals from the population of *Acacia auriculiformis* growing in the surrounding habitat, which were not tolerant to low soil pH.

Identify, with a reason, the type of speciation that could occur between the two populations of *Acacia auriculiformis*.

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(2 marks)

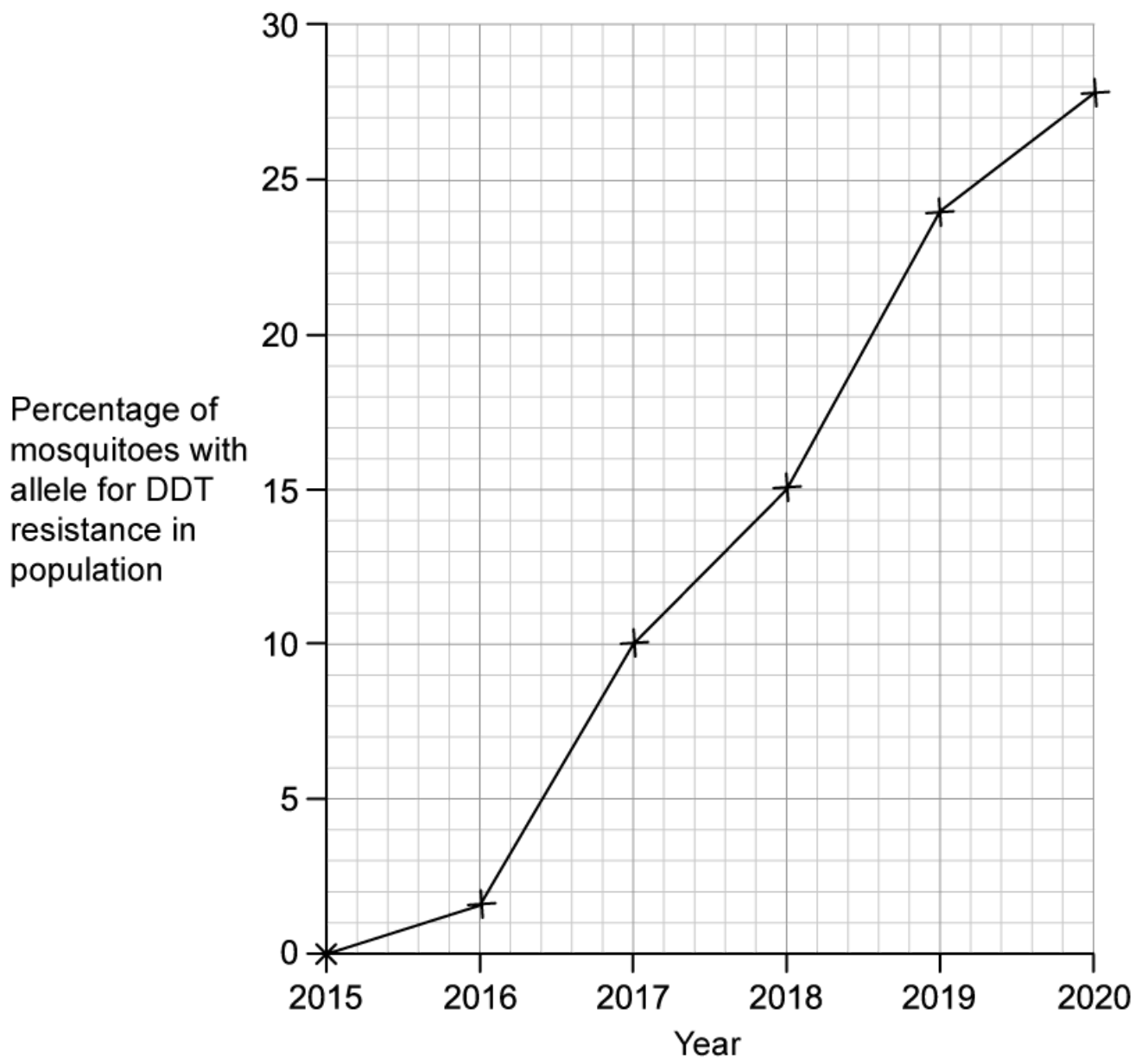
- (c) State, with a reason, whether the population of *Acacia auriculiformis* that are tolerant to low soil pH could be considered a stable gene pool.

(2 marks)

6 (a) Mosquitoes spread a disease called malaria. DDT is a pesticide used to kill mosquitoes; it is used in many countries in Africa to control the spread of malaria.

Some mosquitoes have an allele that gives them resistance to DDT. A group of biologists studied how frequently this allele occurred in a population of mosquitoes in Uganda over 5 years.

The graph below shows the biologists' results.



Explain the results shown in the graph.

(3 marks)

- (b)** Calculate the percentage increase in the percentage of mosquitoes that have the allele for DDT resistance from 2017 to 2020.

(2 marks)

- (c)** Due to the increase in DDT resistance in mosquitoes, many African countries now use alternative pesticides such as pyrethroids, instead of DDT, to control the spread of malaria.

Explain the effect this may have on the frequency of the allele for DDT resistance over time.

(2 marks)

- (d)** Describe the effect of stabilising selection on a population.

(2 marks)

7 (a) Describe the process of evolution by natural selection.

(6 marks)

(b) Outline why some areas of the human genome are more susceptible to detrimental mutations than others.

(2 marks)