

Unit 4 Biology

Revision Booklet 13

Topics

Evolution & Change over time

Evidence for Evolution

Patterns of Evolution

Determining Evolutionary relationships

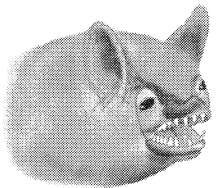
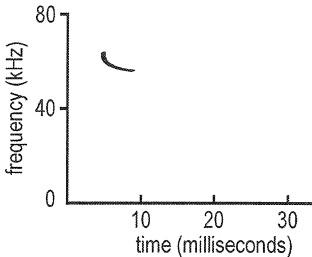
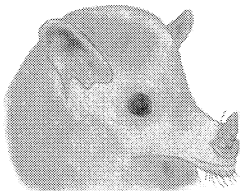
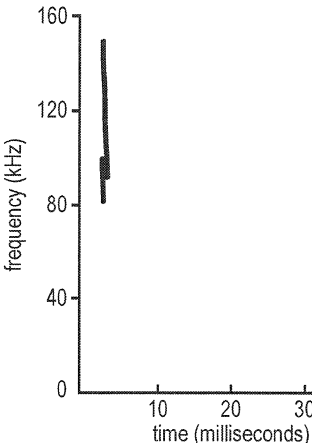
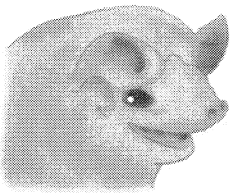
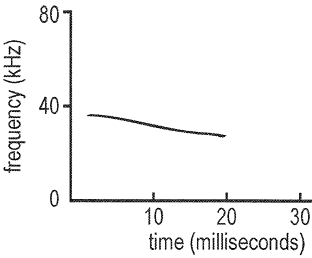
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Question 5

Barro Colorado Island is a small island covered by tropical forest in Central America. Seventy-four different species of bats live in the forest.

Bats are nocturnal, flying mammals. To find their way around in darkness, many bat species emit high-frequency sound pulses that bounce off obstacles and prey. These pulses enable them to judge the distance to an object. This behaviour is called echolocation.

Three of the Barro Colorado Island species are described in the table below.

Species name	Facial appearance of bat	Diet	Feeding location	Echolocation signal
Black myotis bat (<i>Myotis nigricaris</i>)		insects	around trees at forest's edge and in clearings	
Mexican long-tongued bat (<i>Choeronycteris mexicana</i>)		nectar and pollen flowers that open at night, for example cactus, agave	narrow gaps and small spaces	
Velvety free-tailed bat (<i>Molossus molossus</i>)		insects	above trees, in open spaces	

- a. From the information provided, state one selection pressure operating on the bats of Barro Colorado Island.

1 mark

- b. i. In terms of time, which of the three species emits the longest echolocation signal?

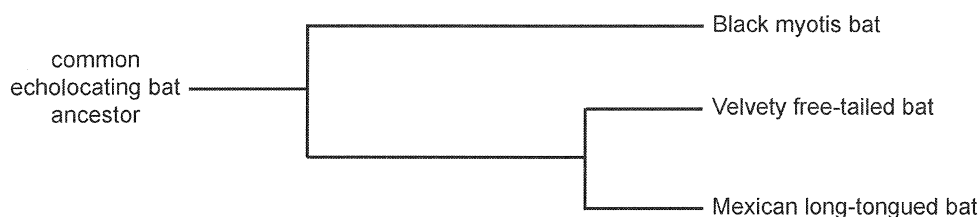
- ii. Explain how this could be a selective advantage for this bat species.

1 + 1 = 2 marks

- c. A biologist suggested that the three species shown evolved from a recent common ancestor. What is this type of evolution called?

1 mark

The biologist wanted to establish the order in which each species had evolved from the common ancestor. DNA hybridisation between the various species was carried out. After analysing the results, the scientist drew the following phylogenetic tree.



- d. What results would have been obtained from the DNA hybridisation that led the biologist to construct this phylogeny?

2 marks

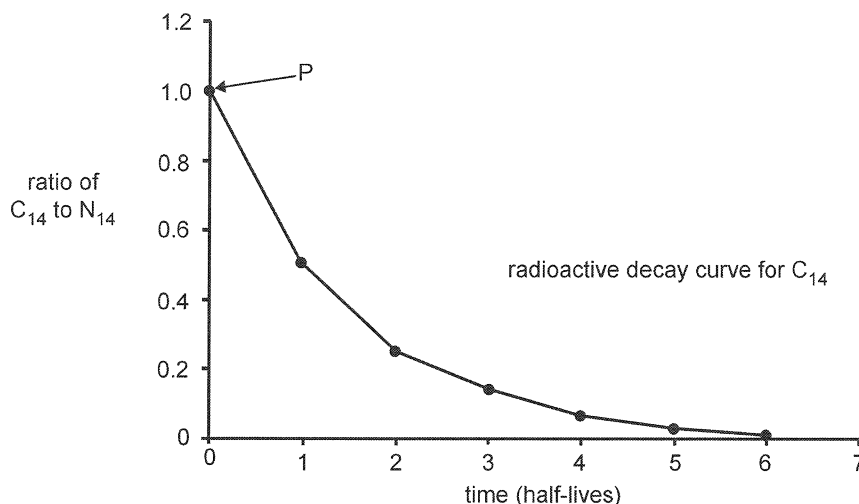
- e. A student suggested that the evolution of the three species was an example of allopatric speciation. Explain why you agree or disagree with the student.

2 marks

Question 6

One form of dating the age of a fossil is by radioactive carbon dating. The ratio of carbon-14 to nitrogen-14 ($C_{14} : N_{14}$) in the fossil is analysed and compared with the ratio of these elements in an organism living today.

The graph below shows the rate of decay for carbon-14.



Key Point P on the graph represents the ratio of C_{14} to N_{14} found in present-day organisms.

A fossil kangaroo skull was found in a limestone cave. The skull's $C_{14} : N_{14}$ ratio was analysed and found to contain one-quarter ($\frac{1}{4}$) of the carbon-14 of a kangaroo that died in 2012.

- a.
 - i. Place an X on the curve to show the fossil's $C_{14} : N_{14}$ ratio.
 - ii. Given the half-life of carbon is approximately 6000 years, what is the approximate age, in years, of the kangaroo skull?

1 + 1 = 2 marks

Carbon-dating analysis is not always possible and the age of the fossil can be estimated by dating the rock in which it is found.

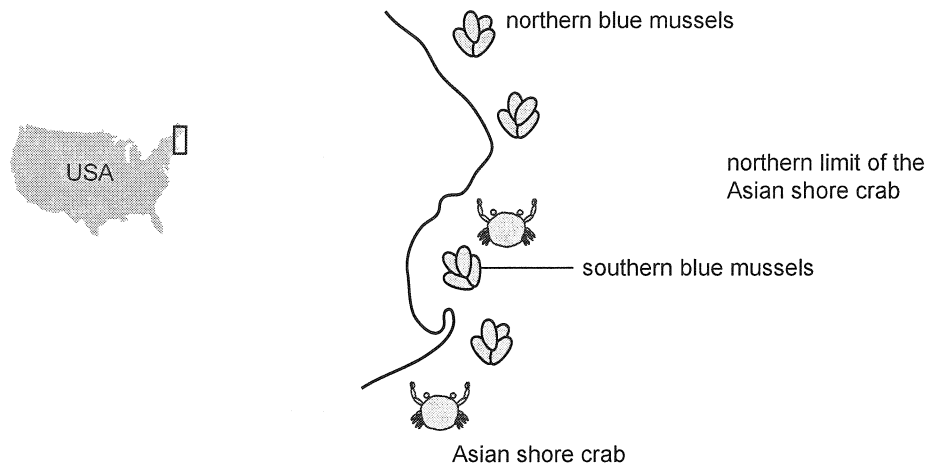
- b.
 - i. Why is carbon-dating analysis not always possible?

- ii. Name another absolute dating technique that can determine the age of the rock surrounding a fossil.

1 + 1 = 2 marks

Question 4

The blue mussel, *Mytilus edulis*, lives along the northeastern coastline of the USA. A species of Asian shore crab, *Hemigrapsus sanguineus*, was accidentally introduced into the area about 15 years ago. As shown below, the Asian shore crab has only migrated to the southern half of the total area inhabited by the blue mussel.



The Asian shore crab feeds off the blue mussels. The thinner the mussel shell, the easier it is for the crab to crush and eat the mussel.

In recent times, scientists have observed that the overall population of the southern blue mussel has a thicker shell than that of the northern blue mussel. This contrasts with 15 years earlier when there was no difference in the range of shell thickness in northern and southern blue mussel populations.

- a. Explain the process of natural selection that has occurred in the population of southern blue mussels over the last 15 years that has resulted in thicker shells.

3 marks

Assume that the Asian shore crab is unable to migrate past the northern limit line into the northern blue mussel area.

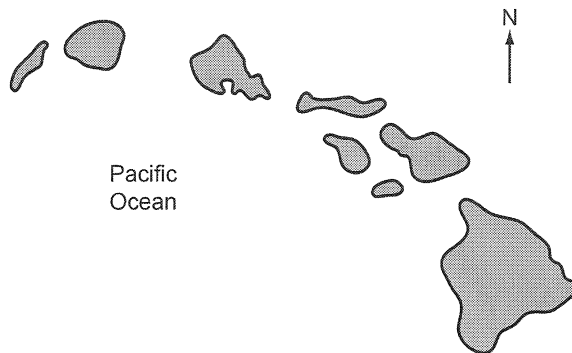
- b. What would you expect to happen to the shell thickness of the northern blue mussels over time? Explain your reasoning.

2 marks

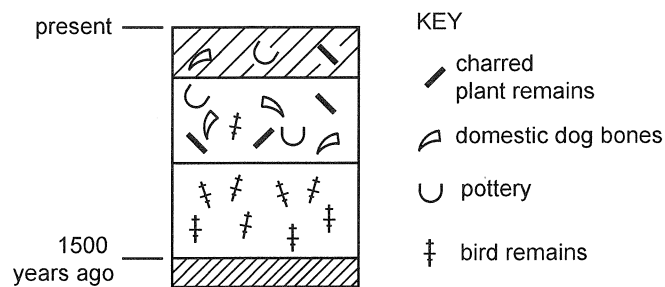
Total 5 marks

Question 7

The islands of Hawaii in the Pacific Ocean were formed as a result of volcanic action in which small land masses were thrown up by submarine volcanoes. The youngest of the islands lies to the east of the oldest.



A similar pattern of deposition has been found across all islands, shown by the profile below.



- a. What assumption is made about the formation of strata when interpreting profiles such as this?

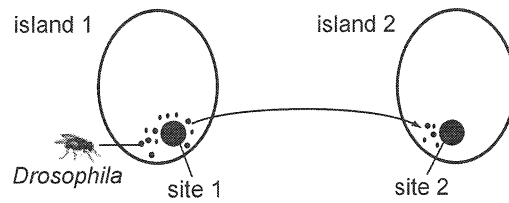
1 mark

- b. i. State a hypothesis to account for the disappearance of many of the bird species from the groups of islands.

- ii. Provide evidence to support your hypothesis.

1 + 1 = 2 marks

Biologists studied many species of the fruit fly, *Drosophila*, living on the Hawaiian islands. The species vary widely in appearance, behaviour and habitat. The diversity of *Drosophila* can be explained by the successive colonisation of newly formed islands by a small number of individuals ‘island-hopping’ from the neighbouring westerly island. This is represented in the diagram below.



- c. i. What name is given to this small group of colonising individuals?

- ii. Explain how the new and old colonies became separate species.

1 + 3 = 4 marks

Total 7 marks

Question 4

In 1877, German workers found a slab of stone containing the fossil of an ancient bird form.



Fossil

The fossil bird was called *Archaeopteryx*.

- a. i. Describe how this fossil could have been formed.

- ii. Scientists use information gained from sedimentary rock to arrange animal and plant fossils into some kind of evolutionary sequence over time.
Explain how such sequencing is possible.

1 + 2 = 3 marks

- b. i.** Name one isolation barrier involved in allopatric speciation.

- ii.** Explain how isolation may result in speciation.

1 + 3 = 4 marks

Total 7 marks

Question 5

Three different kinds of plants, a cactus, euphorbia and milkweed, have similar adaptations for growing in desert environments. They all have long, fleshy stems for water storage, protective spines and reduced leaves. Both the euphorbia and milkweed plants are believed to have evolved from leafy plants adapted to more temperate climates. They share a more recent ancestor than either one does to a cactus.

- a. Draw an evolutionary tree (also called phylogenetic tree or cladogram) to demonstrate this relationship.

1 mark

- b. Name the process by which the ancestral leafy euphorbia plant could have given rise to the desert-adapted species described above.

1 mark

- c. What is a possible explanation for there being so few cactus fossils?

1 mark

Total 3 marks

Question 7

The relatively abundant Green-eyed Tree Frog (*Litoria genimaculata*) inhabits tropical rainforest in Far North Queensland. There are two main populations, a north and a south population.

L. genimaculata has a green crescent across its upper eye and a ridge along the back of its limbs. It has mottled colouring and can vary from light brown and green, to grey with reddish blotches.

- a. State a phenotypic characteristic of *L. genimaculata* and suggest a possible selection pressure acting on this characteristic.

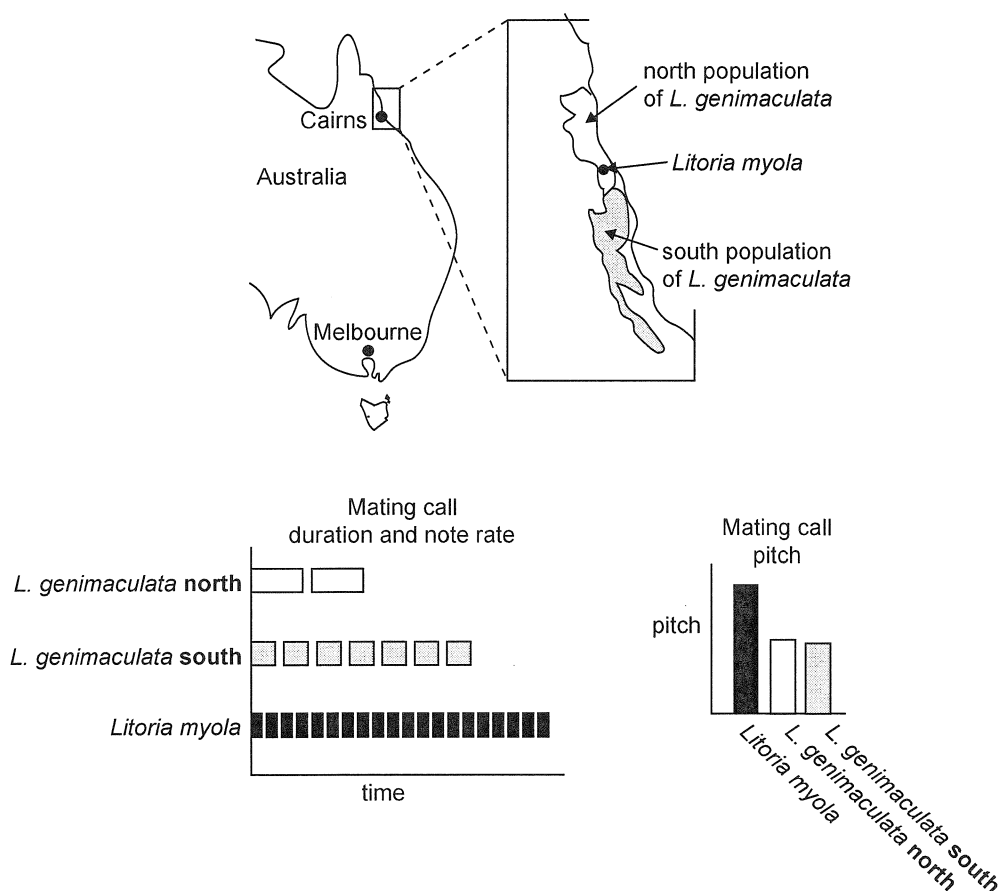
Phenotypic characteristic _____

Selection pressure _____

1 mark

The critically endangered Kuranda Tree Frog, *Litoria myola*, is found in very small populations in isolated fragments of wet tropical rainforest near Cairns in Queensland. The two species, *L. myola* and *L. genimaculata*, are very similar in appearance, although the male *L. genimaculata* is larger than the male *L. myola*. Biologists have also found that their mating calls differ markedly. There is some overlap between the ranges of these three frog groups.

The following diagrams show the distribution of the frogs, and the characteristics of their calls.



- b. Examine the data in the graphs and describe **two** differences between the mating calls of *L. myola* and *L. genimaculata*.

2 marks

Scientists now believe that *L. myola* evolved from the *L. genimaculata* about 8000 years ago. It is proposed that a population of Green-eyed Tree Frogs became isolated due to changing climate conditions.

- c. Suggest how changing climate conditions could have isolated small populations of rainforest frogs.

1 mark

- d. What is one type of evidence that biologists could use to estimate an approximate date of divergence of these two species?

1 mark

- e. Describe how *L. myola* could have evolved from *L. genimaculata*. (Use the terms 'allele frequency' and 'gene flow' in your answer.)

3 marks

In northern areas, where the distributions of the two species overlap, a few hybrid offspring (1.4% of the population) have been observed, resulting from matings between the two species. Biologists wish to establish whether or not the Green-eyed and Kuranda Tree Frogs are, in fact, distinct species.

- f. How could biologists determine this experimentally?

1 mark

Total 9 marks

SECTION B – continued
TURN OVER

Question 5

Eastern tiger snakes (*Notechi scutatus*) living on desolate islands off mainland Australia have longer jaws than the mainland populations of snakes. The diet of island snakes includes large prey, such as seagull chicks, while the diet of the mainland snakes consists of small prey, such as frogs and mice.

Researchers set up experiments using baby snakes from both locations. Snakes were fed either large or small mice over several months, until they reached maturity. The method and results are indicated in the table below.

	experiment 1		experiment 2	
	group A island snakes	group B island snakes	group C mainland snakes	group D mainland snakes
Length of eastern tiger snakes' jaws at birth	long	long	normal	normal
Type of prey given over several months	small mice	large mice	small mice	large mice
Length of eastern tiger snakes' jaws at maturity	normal	long	normal	normal

- a. What were the researchers investigating in these experiments?

1 mark

- b. What was the independent variable in experiment 1?

1 mark

- c. What evidence from the results suggests that the size of eastern tiger snakes' jaws is

- i. a genetically inherited trait

- ii. affected by environmental factors?

1 + 1 = 2 marks

At present the island and mainland populations are both classified as the same species.

It has been proposed that the two populations of snakes may eventually evolve into two separate species.

- d.** Outline the steps involved in the process of speciation, with particular reference to the snakes in the two populations. You may use a labelled diagram or flow chart to illustrate your answer.

3 marks

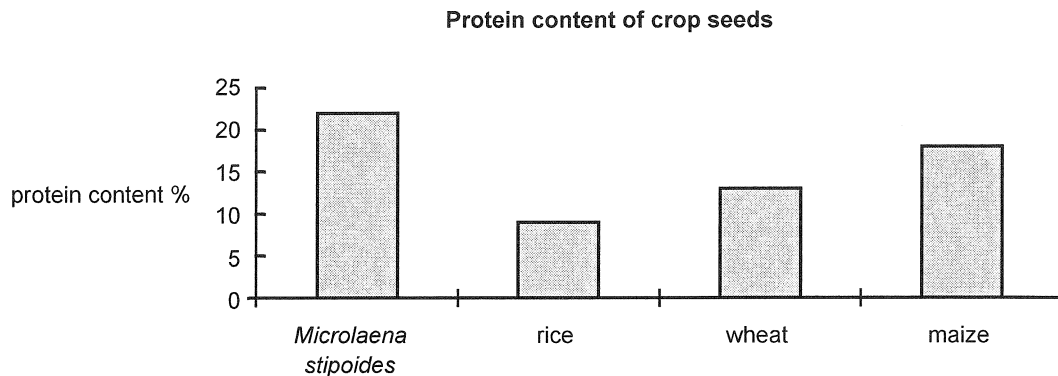
Total 7 marks

Question 6

Australian agricultural biologists are currently researching weeping rice grass (*Microlaena stipoides*), a deep-rooted native relative of rice. Their aim is to produce drought-tolerant grain crops, pasture grass for livestock and domestic lawns.

M. stipoides thrives in a variety of soil types from coastal to mountain habitats. It does not spread in an uncontrolled way as many introduced grasses do. It requires less fertiliser and liming of soil than introduced crop species.

At present *M. stipoides*' seed is only half the size of domestic rice.



- a. The seed size trait is most likely to be polygenic. What is a polygenic trait?

1 mark

A researcher stated that weeping rice grass has not undergone selection or breeding for larger seed size.

- b. What might be the advantage of breeding this species for larger seed size?

1 mark

- c. If you were a farmer involved in a systematic breeding program, outline the steps you should take to develop a variety of weeping rice grass with large seeds.

2 marks

Total 4 marks

Question 7

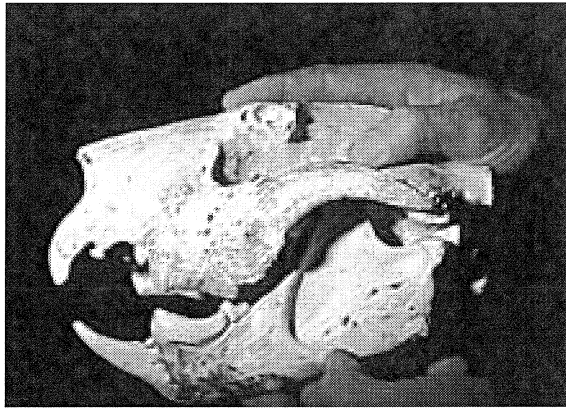
A complete skeleton of *Thylacoleo carnifex*, a huge marsupial ‘lion’, was found in a cave in the Nullarbor Plain. Further exploration uncovered more specimens of *Thylacoleo* as well as other extinct mammals, some previously unknown to science.

The specimens of *Thylacoleo* were dated to be between 100 000 and 200 000 years old.

In attempting to date the other mammal specimens, scientists had a range of methods available.

- a. Describe a relative dating technique which could be used to date the extinct mammals.

1 mark



Thylacoleo skull

Thylacoleo had powerful jaws with only two types of teeth—one type for killing and one type for slicing meat. It had short, strong limbs and opposable thumbs with prominent claws. It has been compared with large placental carnivores such as lions.

- b. What kind of evolution has produced similar characteristics in *Thylacoleo* and lions?

1 mark

- c. Describe two methods by which *Thylacoleo* is likely to have obtained its food, and state the evidence that supports your answers.

	method	evidence
i.		
ii.		

2 marks

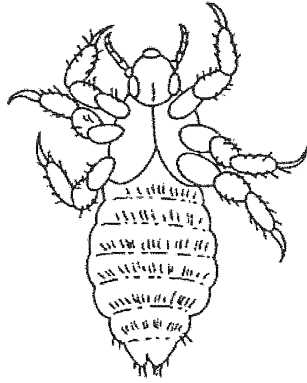
Total 4 marks

SECTION B – continued
TURN OVER

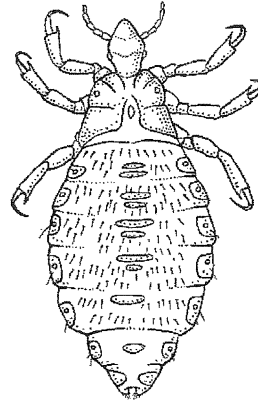
Question 9

There are two varieties of lice which live on humans: body lice which only live in clothing but feed on the body, and head lice which only live in hair and feed on the scalp.

It is not known when humans began wearing clothes. It is difficult to find evidence of cultural evolution in early humans as changes in behaviour are rarely reflected in physical changes visible in fossils. However, indirect evidence can be found.



head louse *Pediculus humanus capitis*



body louse *Pediculus humanus corporis*

A scientist used DNA hybridisation to measure differences between the DNA of head lice and body lice. He estimated that the two groups diverged about 72 000 years ago.

- a. Explain how DNA hybridisation can be used to determine evolutionary relationships.

2 marks

- b. A scientist claimed to have found other evidence showing the time at which humans began wearing clothes. What might this evidence have been?

1 mark

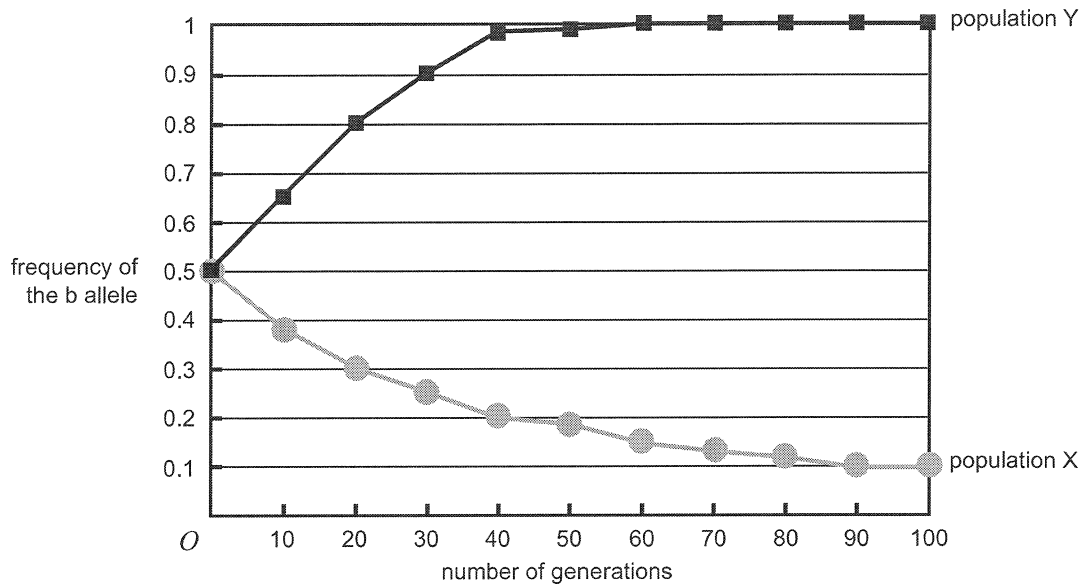
- c. Explain a possible advantage for lice of living in clothing.

1 mark

Total 4 marks

Question 7

The graph below shows changes in allele frequencies at a single locus with two alleles **B** and **b** in two very large populations. The phenotype resulting from allele **B** is the dominant phenotype. In one population there is selection against the homozygous recessive phenotype, and in the other population there is selection against the homozygous dominant and heterozygous phenotypes.



- a. In which population, X or Y, is selection occurring against the homozygous recessive phenotype?
Explain your response.

1 mark

- b. Describe what has occurred in population Y by the 60th generation.

1 mark

- c. Given the results in population Y, why has a similar pattern of events not occurred in population X?

1 mark

Total 3 marks

SECTION B – continued