Evolution (17.3): Cambridge (CIE) A Level Biology 9700 Exam Questions by Topic

21 questions · 69 marks · about 83 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · Paper 4 · February/March 2021 (42) · Q1(b) · 2 marks

(b) Explain what is meant by the general theory of evolution.

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(c) The generation time of a species is the mean (average) time from one generation (parents) to the next generation (offspring). For example, the generation time of humans is about 25 years.

Fig. 1.1 shows a graph of the relationship between the rate of evolution and the generation time for a wide range of different species.

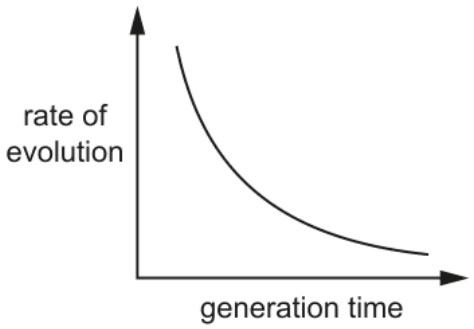


Fig. 1.1

Describe **and** explain the relationship shown in Fig. 1.1.

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5 Complete the following paragraphs using the most appropriate word or words.

The theory of evolution describes a process that can lead to the formation of new species from pre-existing species over ..... .

DNA sequence data of different species can be compared to show evolutionary relationships. Two species that have a more recent common ancestor share more ..... in the DNA nucleotide sequences of their genomes than two species that are more distantly related.

Mitochondrial DNA can also be used in the study of evolutionary relationships. Mitochondrial DNA is inherited only from the female gamete, and its nucleotide sequence is unaffected by ..... during the production of gametes.

DNA sequence data can be stored in large biological ..... , allowing faster comparison of the nucleotide sequences of genomes using computer software. DNA sequence data can also be used to predict the ..... sequences of proteins produced by a species.

A ..... can be used to detect many different mRNA molecules at the same time in studies that compare gene expression between different species.

[6]

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Question 4 · Paper 4 · October/November 2022 (41) · Q5(a) · 5 marks

5 A large number of alpine plant species grow in the mountains of New Zealand's South Island. Alpine plants are defined as plants that live above the treeline, which is the height above which trees cannot grow. The current treeline for most of South Island is 1200 m.

(a) The alpine areas nearest to South Island are 1500–2000 km away across the sea. Many of South Island's alpine species live nowhere else in the world.

Explain how a large number of alpine plant species developed on South Island.

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Question 5 · information from earlier in the question

2 Variation exists in populations of a species and this may provide the opportunity for evolution to occur.

Question 5 · Paper 4 · May/June 2024 (42) · Q2(b)(i) · 3 marks

(b) (i) Outline the theory of evolution.

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Question 6 · Paper 4 · May/June 2024 (42) · Q2(b)(ii) · 3 marks

(ii) The theory of evolution is supported by DNA sequence data.

Explain how DNA sequences are used to show evolutionary relationships between species.

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Question 7 · information from earlier in the question

5 Bison are a type of large wild cattle. Ancestors of modern bison appeared in Asia 2.5 million years ago. This ancestral bison species increased its range into Europe and North America.

While the ancestral species is now extinct, its descendants include *Bison bonasus*, the European bison, and *Bison bison*, the American bison.

Fig. 5.1 shows an American bison.



Fig. 5.1

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Question 7 · Paper 4 · May/June 2022 (42) · Q5(c) · 3 marks

(c) The European bison has a nuclear genome that is very similar to that of the American bison. The European bison has a mitochondrial genome that is more similar to that of wild cattle of the genus *Bos* than to the American bison.

Discuss what this implies about the evolutionary history of the European bison.

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Question 8 · Paper 4 · May/June 2022 (42) · Q5(d) · 4 marks

(d) Outline how practical techniques could be used to test the hypothesis that farmed cattle are closely related to European bison.

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Question 9 · Paper 4 · May/June 2019 (42) · Q6(d)(i) · 1 mark

(d) Molecular evidence is used to investigate evolution. One study involved a marine worm, *Platynereis dumerilii*, that still has characteristics similar to its ancestors from 600 million years ago.

Researchers sequenced all the proteins in light receptor cells of *P. dumerilii* and humans. The results showed that there are many similarities between the protein sequences of *P. dumerilii* and humans, particularly in the light-detecting protein opsin.

(i) State what this molecular evidence indicates about the evolutionary origins of *P. dumerilii* and humans.

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Question 10 · Paper 4 · May/June 2019 (42) · Q6(d)(ii) · 2 marks

(ii) Explain how amino acid sequences indicate how close the relationship is between two species.

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Question 11 · information from earlier in the question

3 Fig. 3.1 shows a male red deer, *Cervus elaphus*. Red deer are herbivores, browsing on low vegetation in forests and on waste land.



Fig. 3.1

A history of wild red deer on the western European island of Ireland includes these facts:

- Red deer have lived in Ireland for at least 12 000 years.
- Originally red deer could cross from the neighbouring island of Great Britain to Ireland over a land connection.
- A rise in sea levels at the end of the last Ice Age removed this land connection, separating the red deer on the two islands.

- In the 1800s the number of red deer in Ireland decreased sharply after the main food crop for the human population failed for several consecutive years.
- In the 1900s this decrease in the number of red deer continued as large areas of waste land were drained for agriculture.

- By 1960 red deer were nearly extinct in Ireland, restricted to one population, **A**, of 60 individuals.
- Since then protection has allowed population **A** to increase to over 600 red deer.
- Several new red deer populations, **B**, **C** and **D**, have also been established in different parts of Ireland from individuals brought from Great Britain.

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Question 11 · Paper 4 · October/November 2017 (42) · Q3(b) · 3 marks

(b) Describe how the level of molecular similarity between the red deer in population **A** and population **B** can be investigated.

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Question 12 · information from earlier in the question

7 *Spea multiplicata* is one of several species of American spadefoot toad.

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Question 12 · Paper 4 · October/November 2024 (41) · Q7(b) · 3 marks

(b) Fig. 7.3 shows the evolutionary relationships between three species of American spadefoot toad.

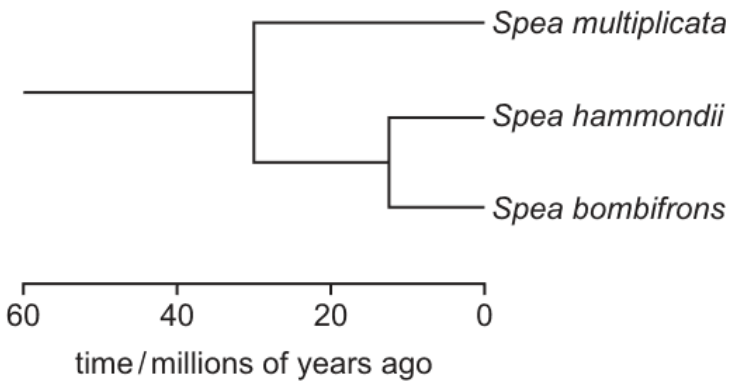


Fig. 7.3

Explain how analysis of DNA allowed the evolutionary relationships shown in Fig. 7.3 to be determined.

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Question 13 · information from earlier in the question

5 *Myosotis* is a genus of small flowering plants. Many different *Myosotis* species grow on the islands of New Zealand, which are an important site of *Myosotis* evolution. Lowland *Myosotis* species grow at low altitude while alpine *Myosotis* species grow at high altitude at the tops of mountains.

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(b) Fig. 5.1 shows the three largest New Zealand islands.

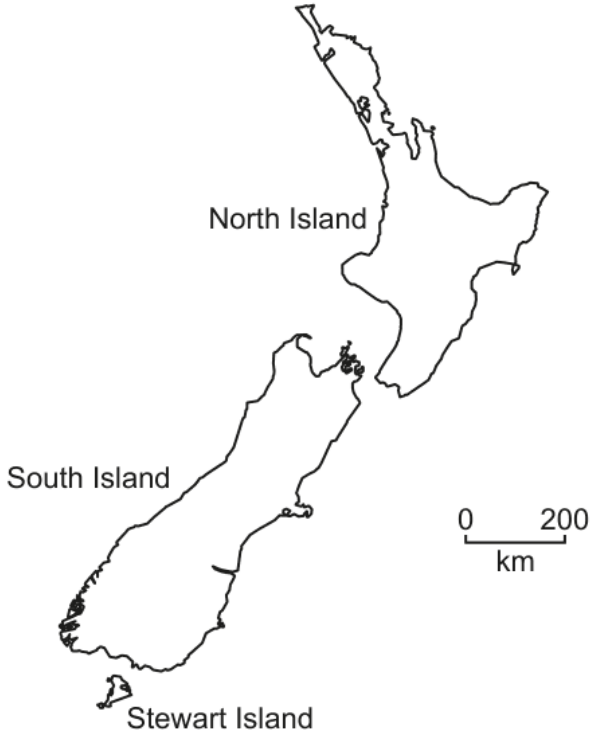


Fig. 5.1

North Island has mostly lowland habitat. South Island and Stewart Island have mountains with alpine habitats that are above the tree line.

DNA sequence data for three *Myosotis* species were compared. The results are described in the bullet points.

- In the alpine species *M. pygmaea*, individuals on South Island showed genetic differences from individuals of *M. pygmaea* on Stewart Island.
- In the alpine species *M. pulvinaris*, individuals from different mountains on South Island showed genetic differences.
- In the lowland species *M. pottsiana*, individuals from different areas of North Island showed overall genetic similarity.

Discuss reasons for the results in the three species.

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8 Twenty million years ago, an ocean covered the area where the country of Panama is now located. There was a gap between the continents of North America and South America through which the waters of the Atlantic and Pacific Oceans flowed freely.

The porkfish, *Anisotremus sp*, lived in this area between North America and South America.

Fig. 8.1 shows a porkfish.



Fig. 8.1

About 3 million years ago, volcanic activity and sedimentation formed a narrow strip of land, Panama, joining North America and South America.

Fig. 8.2 shows the area 20 million years ago and now.

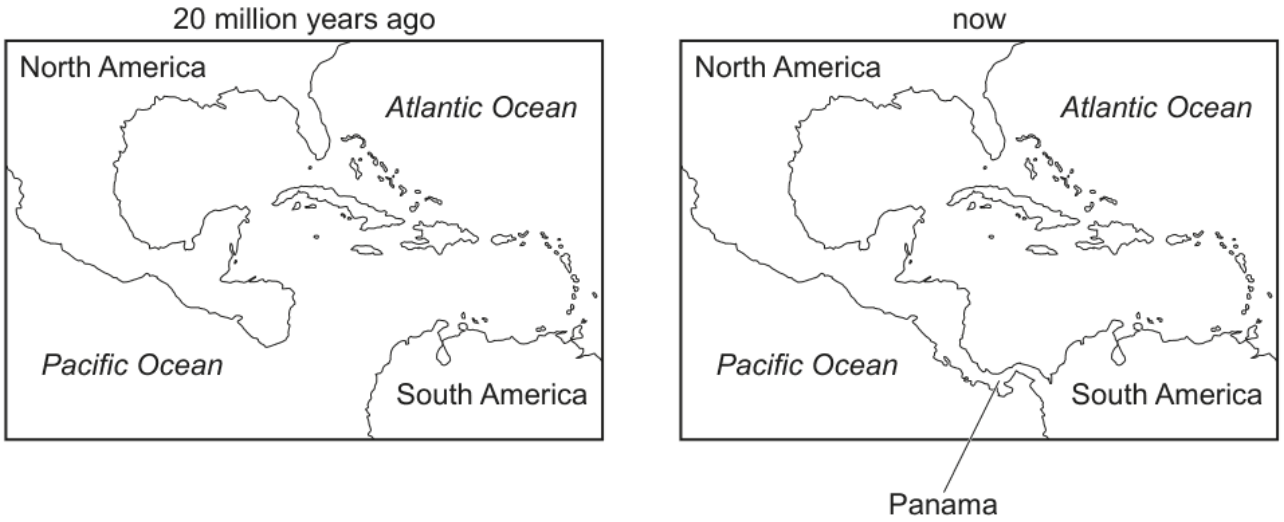


Fig. 8.2

Twenty million years ago, porkfish in the Atlantic and Pacific Oceans were able to breed successfully and produce fertile offspring.

Explain why Atlantic porkfish and Pacific porkfish are now **not** able to breed successfully to produce fertile offspring.

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Question 15 · Paper 4 · October/November 2020 (42) · Q3(a) · 4 marks

3 A subspecies is a genetically distinct population of a species that has some phenotypic differences but is not yet reproductively isolated.

500 000 years ago, the European house mouse, *Mus musculus*, evolved into two subspecies, *Mus musculus domesticus* and *Mus musculus musculus*.

(a) Suggest **and** explain how the two subspecies *M. m. domesticus* and *M. m. musculus* could have evolved from the original *M. musculus* population.

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4 The Grand Canyon is located in Arizona, USA. It is estimated to have formed over five million years ago as the Colorado River began to create a deep channel (canyon) in the surrounding rocks.

Before the canyon formed, an ancestral species of antelope squirrel lived in the area. An antelope squirrel is a type of rodent and member of the squirrel family, Sciuridae.

It is estimated that around 3.6 million years ago, an ancestral species diverged into the two species that are present today.

- Harris's antelope squirrel, *Ammospermophilus harrisii*, has its habitat range extending from the south rim of the canyon.
- The white-tailed antelope squirrel, *Ammospermophilus leucurus*, has its habitat range extending from the north rim of the canyon.

Fig. 4.1 shows the location of the Colorado River in the Grand Canyon and the location of these species of antelope squirrel.

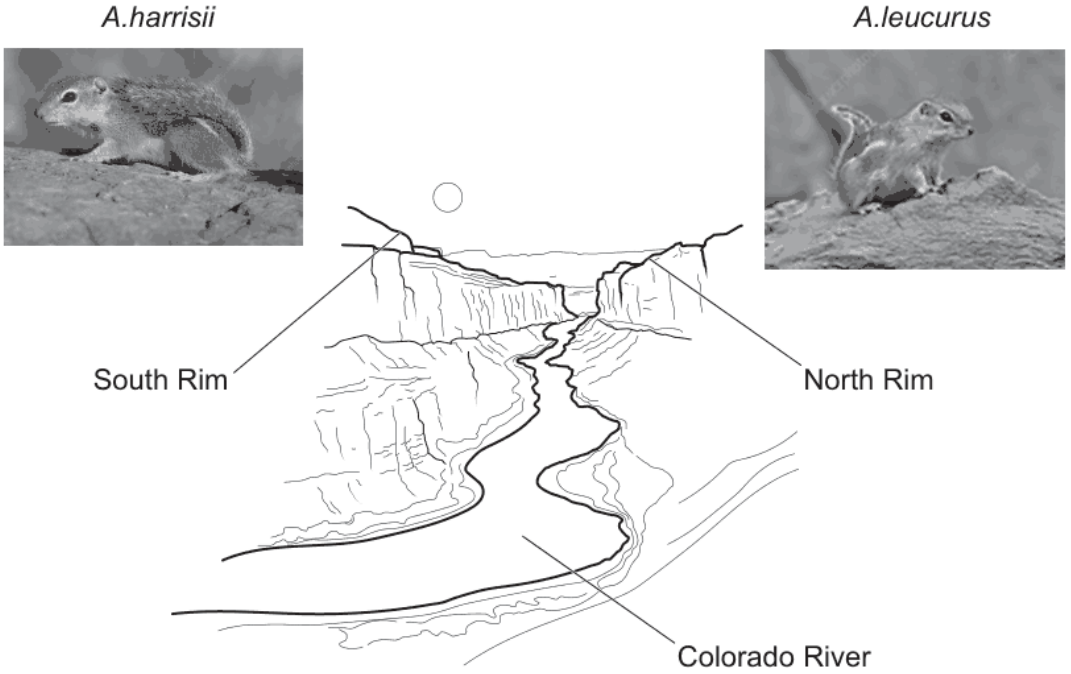


Fig. 4.1

(a) Suggest **and** explain how *A. harrisii* and *A. leucurus* evolved from an ancestral species.

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2 The orca, *Orcinus orca*, has the largest distribution of all aquatic mammals and is found in nearly all seas and oceans. Orca are social mammals that usually live in groups. These groups can vary in size.

Fig. 2.1 shows an orca.



Fig. 2.1

There are a number of distinct types of orca. These distinct types of orca are classified as members of the same species. However, there is evidence that sympatric speciation is occurring.

(a) (i) There are two distinct types of orca in the Northeast Atlantic Ocean: Type **1** and Type **2**. Type **1** orca feed mainly on fish. Type **2** orca feed mainly on aquatic mammals, such as seals.

Fig. 2.2 shows the locations in the Northeast Atlantic Ocean where Type **1** orca and Type **2** orca have been observed. Orca do **not** occur only in these areas and some groups of orca travel great distances.

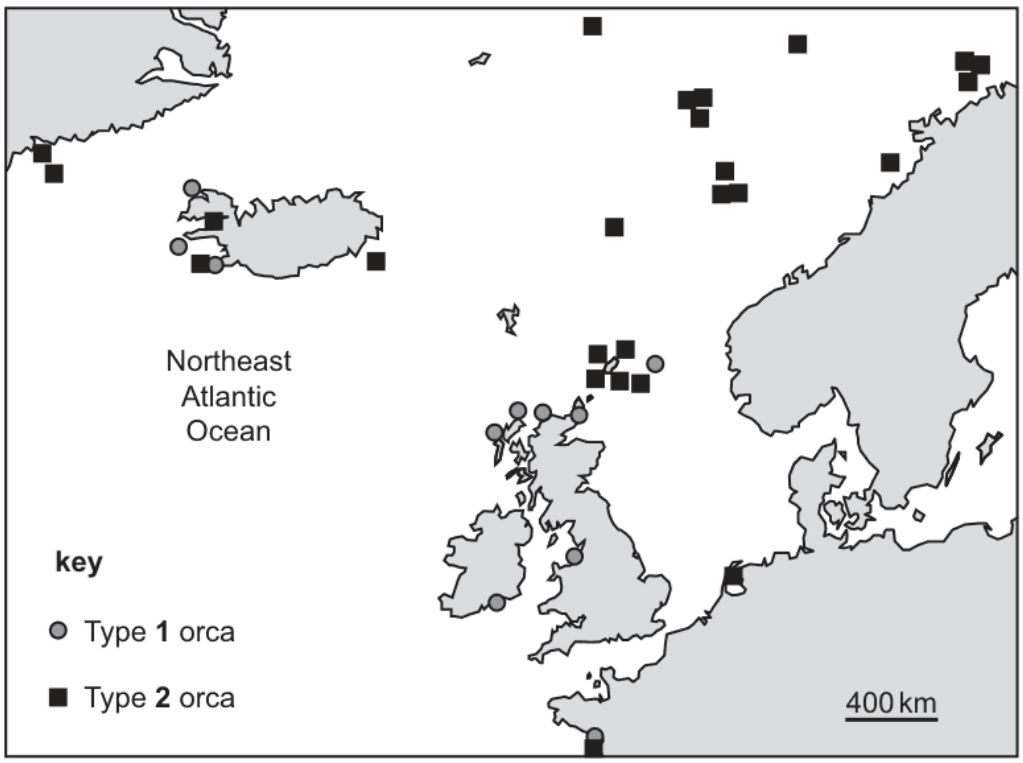


Fig. 2.2

With reference to Fig. 2.2, explain why the type of speciation that is occurring in the orca is described as sympatric speciation.

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Question 18 · Paper 4 · February/March 2025 (42) · Q2(a)(ii) · 3 marks

(ii) Suggest examples of behavioural separation that would contribute to sympatric speciation of Type **1** orca and Type **2** orca.

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Question 19 · Paper 4 · February/March 2022 (42) · Q8(a) · 3 marks

8 Natural selection and artificial selection (selective breeding) both have important roles in evolutionary change.

(a) Seahorses are fish with an unusual appearance and many specialised features.

Fig. 8.1 shows a seahorse.



Fig. 8.1

Two species of seahorse, *Hippocampus erectus* and *H. zosterae*, are found in the coastal waters of the Gulf of Mexico and the Caribbean Sea.

- It is thought that these two species of seahorse have a common ancestor.
- The ranges of the two species overlap in many areas.
- Male and female seahorses stay together for the whole of the breeding season.
- *H. erectus* is much larger than *H. zosterae*.
- Few seahorses occur that are intermediate in size between the two species.

Use this information to name **and** explain the type of speciation that may have occurred in the evolution of these two species.

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Question 20 · information from earlier in the question

3 *Oryza* is a genus of grass plants that includes the rice, *Oryza sativa*, a food crop.

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Question 20 · Paper 4 · May/June 2023 (41) · Q3(b) · 3 marks

(b) *O. rufipogon* and *O. nivara* are two species of wild rice.

- *O. rufipogon* grows in places where water is always available.
- *O. nivara* grows within the same geographical range as *O. rufipogon*.
- The habitat of *O. nivara* can lack water for part of the year.
- The two species flower at different times of the year.

These two rice species may have evolved by sympatric speciation.

Explain how *O. rufipogon* and *O. nivara* may have evolved through sympatric speciation.

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Question 21 · information from earlier in the question

9 Green lacewings are a family of insects with more than 1300 species.

The common green lacewing, *Chrysoperla carnea*, is shown in Fig. 9.1.

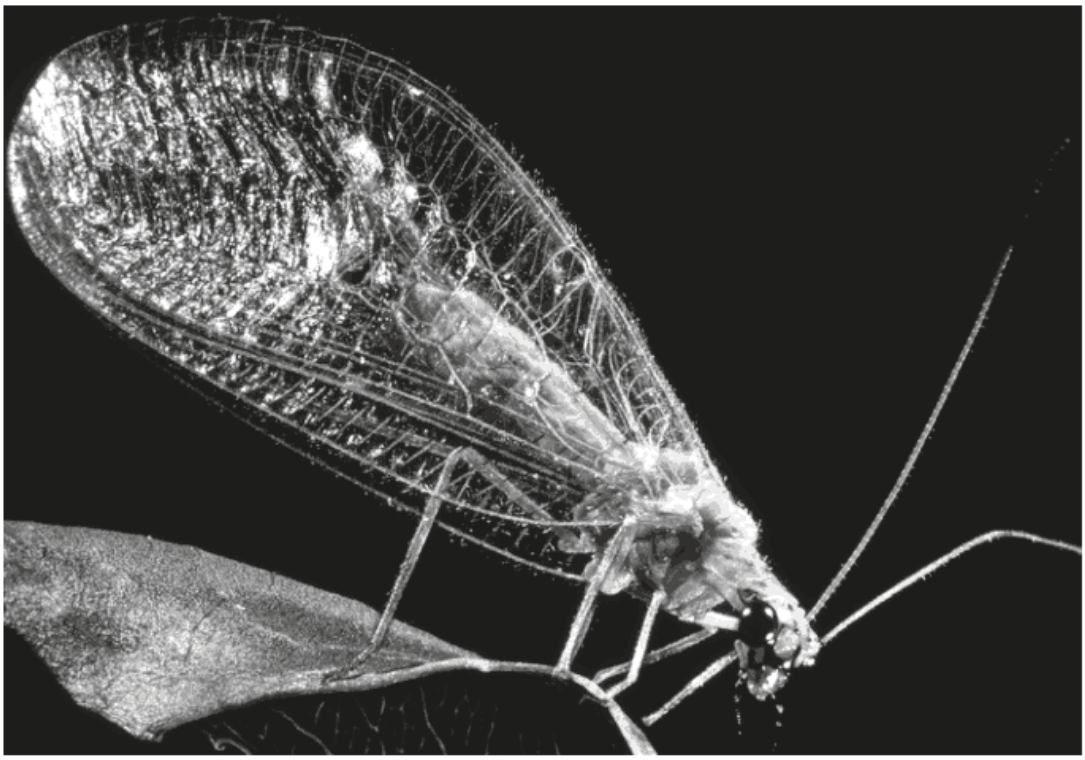


Fig. 9.1

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(b) Two species of green lacewing, *C. carnea* and *C. downesi*, evolved from a common ancestor.

The two species have populations with overlapping distributions in parts of North America.

Table 9.1 shows a comparison of the characteristics of overlapping populations of the two species.

Table 9.1

characteristic	*C. carnea*	*C. downesi*
breeding months	June to September	April to May
courtship song	song with a regular rhythm	song with no regular rhythm
colour	light green	dark green

Suggest how speciation occurred to produce the two different species of green lacewing.

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Mark schemes

Question 1 · Paper 4 · February/March 2021 (42) · Q1(b) · 2 marks

1(b)	1 organisms have changed over time ;	**2**
	*any **one** from:*	
	2 ref. to natural selection / selective advantage for survival / survival of the fittest ;	
	3 ref. to long period of time ;	
	4 ref. to variation ;	

Question 2 · Paper 4 · February/March 2021 (42) · Q1(c) · 3 marks

1(c)	*any **three** from:*	**3**
	1 as the generation time increases, the rate of evolution decreases / relationship is inversely proportional / AW ; **ora**	
	2 not linear / exponential / decreasing gradient ;	
	3 (longer generation time) so less, reproduction / DNA replication ; **ora**	
	4 ref. to fewer mutations ; **ora**	
	5 *idea of* (so) less chance of evolution ; **ora** *mp5 must be linked to mp3 or mp4*	

Question 3 · Paper 4 · February/March 2024 (42) · Q5 · 6 marks

5	(many) generations / (many) years / (a long) time / AW ; mutations / similarities ; meiosis / crossing over / recombination ; databases ; amino acid ; microarray ;	**6**

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Question 4 · Paper 4 · October/November 2022 (41) · Q5(a) · 5 marks

5(a)	*any **five** from:* 1 evolution / speciation / natural selection ; 2 random / spontaneous ; 3 mutations (occurred) ; 4 adapting some plants to, alpine habitat / high altitude / mountains ; 5 (in this habitat) these plants, survived / were selected for ; 6 (selection pressure is / must resist) cold / strong winds / thin soil ; 7 alleles for alpine features passed to offspring ; 8 change in, allele frequency / gene pool (of population) ; 9 population become, morphologically / physiologically / biochemically, different ; 10 less, herbivores / competition, in new <u>niche</u> ; 11 AVP ;	**5**

Question 5 · Paper 4 · May/June 2024 (42) · Q2(b)(i) · 3 marks

2(b)(i)	*any **three** from:* 1 formation of new species from, pre-existing species / common ancestor ; 2 change in, characteristics / phenotypes ; 3 over, time / generations ; 4 <u>natural selection</u> ; 5 changes in, gene pools / allele frequencies **or** genetic drift ;	**3**

Question 6 · Paper 4 · May/June 2024 (42) · Q2(b)(ii) · 3 marks

2(b)(ii)	*any **three** from:* 1 compare sequences (of DNA) ; 2 the more similar the sequences the more, closely related the species / recent the common ancestor ; **ora** 3 over time mutations accumulate **or** less time fewer mutations occurred ; 4 *ref. to* bioinformatics / software / database ; 5 AVP ; e.g. molecular clock / constant rate of mutation e.g. mtDNA has no crossing over e.g. the percentage similarity can be used to build a phylogenetic tree	**3**

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Question 7 · Paper 4 · May/June 2022 (42) · Q5(c) · 3 marks

5(c)	1 European bison has a, close / recent / common, ancestor with that of, cattle / *Bos* **or** European bison is more closely related to, cattle / *Bos*, (than to American bison) ; 2 European bison may have interbred with, cattle / *Bos* ; 3 mitochondria are inherited from, mother / female ;	**3**

Question 8 · Paper 4 · May/June 2022 (42) · Q5(d) · 4 marks

5(d)	*any **four** from:* 1 obtain / use, blood / cells / tissue / DNA ; 2 from, both species / cattle and European bison ; 3 use PCR to, replicate / amplify, DNA ; 4 use, electrophoresis (described) / DNA profiling / DNA fingerprinting, to see genetic differences / compare the banding (patterns) ; 5 sequence DNA and, count / identify, (percentage) difference / similarity **or** sequence DNA and compare the, nucleotide / base, sequence ; 6 use, genome / DNA, microarray ; **R** for gene expression 7 *ref. to* bioinformatics / database / (computer) software ; 8 similarity indicates, close relationship / more recent split ; 9 if they can breed to produce (viable) offspring (they are closely related) ;	**4**

Question 9 · Paper 4 · May/June 2019 (42) · Q6(d)(i) · 1 mark

6(d)(i)	shared origin / common ancestor / same ancestor ;	**1**

Question 10 · Paper 4 · May/June 2019 (42) · Q6(d)(ii) · 2 marks

6(d)(ii)	*any **two** from:* 1 compare (amino acid sequences of two species) ; 2 more similar (amino acid sequence) more closely related the species are ; **ora** 3 more similar (amino acid sequence) more recent common ancestor / less time has elapsed (since a common ancestor); **ora** 4 *ref. to* molecular clock ;	**2**

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Question 11 · Paper 4 · October/November 2017 (42) · Q3(b) · 3 marks

3(b)	*three from:* 1 DNA / nucleotide, sequencing ; 2 *ref. to* mitochondrial DNA ; 3 protein / amino acid, sequencing ; 4 *idea of* comparing sequences (from **A** and **B**) ; 5 AVP ; e.g. sequencing method such as Sanger / dideoxynucleotides / chain termination / automated / next generation **or** *ref. to* bioinformatics / genome analysis / microarray analysis	**3**

Question 12 · Paper 4 · October/November 2024 (41) · Q7(b) · 3 marks

7(b)	*any **three** from*: **1** *ref. to* DNA sequence (for all / three species) ; **2** find / count, nucleotide / base, differences / similarities ; **3** fewer differences means, more closely related / less time since divergence / less time to common ancestor ; **4** bioinformatics / database / software / BLAST ; **5** *S. hammondii* and *S. bombifrons,* have the fewest genetic differences / are the most genetically similar ;	**3**

Question 13 · Paper 4 · October/November 2022 (42) · Q5(b) · 5 marks

5(b)	*any **four** from 1–7:* 1 *M. pygmaea* (populations) geographically isolated / separated by sea or water ; 2 *M. pulvinaris* (populations) geographically isolated / mountain tops separated ; *M. pygmea* or *M. pulvinaris / South Island or Stewart Island species:* 3 no / little, interbreeding / gene flow, between populations ; 4 different, selection pressures / environment ; 5 different / random, mutations ; 6 different changes in allele frequencies / different gene pools ; 7 (so) allopatric speciation could be occurring (within either species) / AW ; *M. pottsiana / North Island species:* 8 no geographical isolation ; 9 (so) interbreeding / gene flow, occurs, within / between, population(s) ; 10 similar, selection pressures / environment ;	**5**

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Question 14 · Paper 4 · October/November 2021 (42) · Q8 · 5 marks

8	*any **five** from:* 1 geographical, isolation / separation **or** *ref. to* Panama / land, separating populations ; 2 no, gene flow / interbreeding, between both populations ; 3 different, environmental conditions / selection pressures ; 4 random / different, mutations ; 5 (different), alleles selected for / gene pool / changes in allele frequency ; 6 over time populations have different, morphological / physiological / behavioural, features ; 7 eventually reproductive isolation occurs ; 8 allopatric speciation ;	**5**

Question 15 · Paper 4 · October/November 2020 (42) · Q3(a) · 4 marks

3(a)	*any **four** from:* **1** *ref. to* geographic isolation / geographic barrier / named barrier / populations are separate; **2** no, breeding / gene flow, between **populations** ; **3** different, selection pressures / environmental conditions ; **4** different mutations occur ; **5** *ref. to* some individuals, better adapted / have selective advantage ; **ora** **6** natural selection ; **7** allopatric (speciation) ; *ignore sympatric speciation*	**4**

Question 16 · Paper 4 · May/June 2025 (43) · Q4(a) · 4 marks

4(a)	*any **four** from:* 1 geographical, isolation / barrier (caused by the, river / canyon walls) ; 2 no gene flow between (isolated ancestral) populations ; 3 different, selection pressures / environment ; 4 different / random / independent, mutations (in each population) ; 5 different changes in allele frequencies / different gene pools / different alleles selected for ; 6 populations have different, morphological / physiological / behavioral, features ; 7 leads to, reproductive isolation / inability to interbreed (to produce fertile offspring) ; 8 allopatric speciation ;	**4**

Question 17 · Paper 4 · February/March 2025 (42) · Q2(a)(i) · 1 mark

2(a)(i)	no geographical separation / AW ;	**1**

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Question 18 · Paper 4 · February/March 2025 (42) · Q2(a)(ii) · 3 marks

2(a)(ii)	*any **three** from:* 1 do not, interbreed / interact / recognise each other ; 2 due to differences in, courtship / mating ; e.g. mating calls / time of year 3 different group sizes ; **A** description (e.g. groups vs solitary) 4 different, hunting / feeding / diets ;	**3**

Question 19 · Paper 4 · February/March 2022 (42) · Q8(a) · 3 marks

8(a)	1 sympatric ; *any **two** from:* 2 no geographical barrier / not geographically isolated ; 3 ref. to behavioural isolation / described ; 4 ref. to reproductive isolation / described ;	**3**

Question 20 · Paper 4 · May/June 2023 (41) · Q3(b) · 3 marks

3(b)	*any **three** from*: **1** *O. nivara*, adapted to / selected for, dry / drier, conditions / habitats ; **2** different habitats / ecological isolation ; **3** prevent interbreeding / no gene flow / reproductive isolation ; **4** polyploidy / auto(poly)ploidy ; **5** AVP ;	**3**

Question 21 · Paper 4 · October/November 2023 (41) · Q9(b) · 3 marks

9(b)	*any **three** from:* S1 sympatric (speciation) ; S2 different mutations ; S3 gave, (named) phenotypic / behavioural, differences ; S4 which gave behavioural, isolation / separation ; S5 (leading to) inability to reproduce together / reproductive isolation / genetic isolation / no gene flow between them ; **or** *any **three** from:* A1 allopatric (speciation) ; A2 geographical, separation / barrier, in the past ; A3 different, mutations / selection pressures ; A4 gave, (named) phenotypic / behavioural, differences ; A5 inability to reproduce together / reproductive isolation / genetic isolation / no gene flow between them, after populations re-join ;	**3**

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