Evolution and Speciation: AQA A Level Biology Exam Questions by Topi

15 questions · 49 marks · about 64 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · A level Paper 2 · June 2024 · Q10.1 · 2 marks

1 0 Read the following passage.

The wall gecko is a medium-sized lizard. In an isolated habitat of southern Italy, the wall gecko shows phenotypic diversity. Scientists investigated whether disruptive selection was leading to sympatric speciation in the wall gecko.

Pale geckos live only on walls and are nocturnal (active at night). Dark geckos live mainly on the dark trunks of olive trees and are diurnal (active during the day). These diurnal geckos can change skin colour when occupying different surfaces during the day.

Comparison of mitochondrial genes indicated that the diurnal geckos formed a distinct genetic group. This comparison also confirmed that all the geckos in the habitat were of the same species.

The scientists used the mark-release-recapture method to estimate the size of the population of geckos in the habitat.

Use the information in the passage and your own knowledge to answer the following questions.

1 0 . 1 The wall gecko shows phenotypic diversity (lines 1–2).

Suggest **two** factors that have resulted in this phenotypic diversity.

[2 marks]

1 _____

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2 _____

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Question 2 · A level Paper 2 · June 2024 · Q10.2 · 2 marks

10.2 The ability of diurnal geckos to change skin colour (lines 7–8) is advantageous.

Explain why.

[2 marks]

Question 3 · information from earlier in the question

10 Read the following passage.

North American black bears can hibernate for up to 7 months without food or water. The bears survive using the fat stores in their bodies. The bears build up the fat stores during the summer. During hibernation, the heart rate of black bears decreases from a summer mean of 55 beats per minute to 14 beats per minute. Their metabolic rate falls by 75%.

In many mammals, 'uncoupling proteins' help to maintain a constant body temperature during hibernation. Uncoupling proteins are found in the inner mitochondrial membrane and act as proton channels during chemiosmosis. However, these proton channels do not generate ATP.

In the mountains of North America, when winter changes into spring, the coat colour of snowshoe hares changes from white to brown. Climatic changes have caused the snow to melt earlier. This has reduced the survival rate of snowshoe hares in these habitats. The change in coat colour occurs when new fur replaces old fur. This is called moulting. Recent research has shown that snowshoe hares within a population moult at different times. Moulting at different times could be a major factor in ensuring the survival of snowshoe hare populations.

Use the information in the passage and your own knowledge to answer the following questions.

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Question 3 · A level Paper 2 · November 2020 · Q10.4 · 2 marks

1 0 . 4 Climatic change has reduced the survival rate of snowshoe hares in mountain habitats (lines 11–13).

Suggest and explain how.

[2 marks]

Question 4 · A level Paper 2 · November 2020 · Q10.5 · 4 marks

1 0 . 5 Snowshoe hares within a population moult at different times (line 15).

Explain how this could ensure the survival of snowshoe hare populations in these mountain habitats.

[4 marks]

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Question 5 · information from earlier in the question

1 0 Alzheimer's disease (AD) is a non-reversible brain disorder that develops over a number of years. At the start of 2014 the number of Americans with AD was estimated to be 5.4 million. Every 30 seconds another person in America develops AD.

In the brain of a person with AD there is a lower concentration of acetylcholine. This affects communication between nerve cells and initially results in memory loss and confusion. Some of the symptoms of AD that are associated with communication between nerve cells are reduced by taking the drug donepezil. Donepezil inhibits the enzyme acetylcholinesterase.

A gene mutation called E280A found on chromosome 14 causes early-onset AD at a mean age of 49 years. The age at which the E280A mutation is expressed to cause AD varies.

Yaramul is a town in a historically isolated region of the Andes Mountains. The population of this town has the highest frequency of the E280A mutation in the world. The origin of the E280A mutation in this population has been traced back to a common ancestor in the 17th century. Natural selection has not reduced the frequency of the E280A mutation in the population.

This autosomal dominant mutation involves a change in triplet 280 from GAA to GCA. Scientists analysed chromosome 14 from 102 individuals from Yaramul. They recorded a sample size of 204 and detected 75 E280A mutations but only 74 potential AD cases. The scientists identified individuals with the mutation by whole genome sequencing. They had decided that a DNA probe would not be a suitable method to detect the E280A mutation.

Question 5 · A level Paper 2 · June 2017 · Q10.4 · 2 marks

1 0 . 4 Explain why natural selection has **not** reduced the frequency of the E280A mutation in the population (lines 16–17).

[2 marks]

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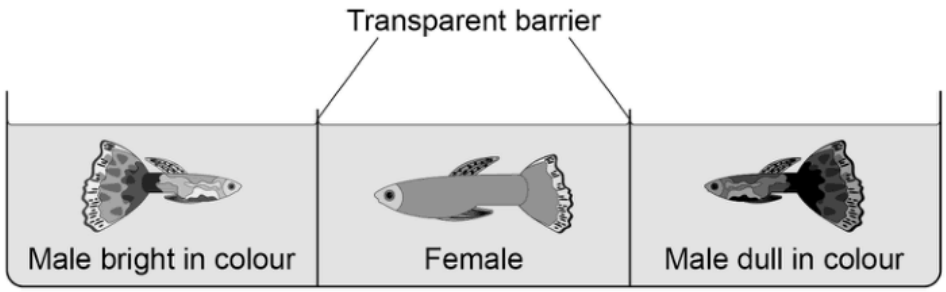
Question 6 · information from earlier in the question

0 1 Guppies are small fish. Female guppies are dull in colour. Male guppies can be bright or dull in colour.

Scientists investigated the effect of female brain size on choosing a mate. They used laboratory-bred female guppies with large brains and with small brains.

They set up a fish tank as shown in **Figure 1**.

Figure 1



They observed each female for 10 minutes and recorded which male they were attracted towards. They repeated this with 45 large-brained females and 45 small-brained females.

Questions, mark schemes and examiners' report extracts © AQA.

Question 6 · A level Paper 3 · November 2020 · Q01.2 · 3 marks

Guppies with large brains are better at identifying predators.

The scientists found that **only** female guppies with large brains were attracted to male guppies bright in colour.

0 1 . 2 Suggest and explain the advantage of this behaviour to the population of guppies.

[3 marks]

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Question 7 · A level Paper 3 · November 2020 · Q01.3 · 3 marks

0 1 . 3 Describe how the behaviour of female guppies could result in sympatric speciation.

[3 marks]

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Question 8 · A level Paper 2 · June 2017 · Q09.2 · 5 marks

0 9 . 2 Lord Howe Island in the Tasman Sea possesses two species of palm tree which have arisen via sympatric speciation. The two species diverged from each other after the island was formed 6.5 million years ago. The flowering times of the two species are different.

Using this information, suggest how these two species of palm tree arose by sympatric speciation.

[5 marks]

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1 0 Read the following passage.

Lake Malawi in East Africa has more species of fish than any other lake in the world. Many of these species have evolved from a common ancestor. Lake Malawi is one of the largest lakes in the world and was formed several million years ago. Since then, the water level has fluctuated greatly. As a result, what is now a large lake was at one time many smaller, separate lakes.

The country of Malawi has a total area of 118 000 km^2. The actual land area is only 94 080 km^2, because approximately one-fifth of the country is Lake Malawi.

In December 1990, forests covered 41.4% of the actual land area of Malawi. In December 2016, forests covered 26.4% of the actual land area of Malawi.

Deforestation and farming along the shores of Lake Malawi have caused increased soil erosion and loss of nutrients into the lake. This has resulted in a decrease in some fish populations. The mark-release-recapture method can be used to estimate the size of a fish population. However, this method can produce unreliable results in very large lakes.

Use the information in the passage and your own knowledge to answer the following questions.

1 0 . 1 Lake Malawi in East Africa has more species of fish than any other lake in the world (line 1).

Suggest and explain how this speciation may have occurred.

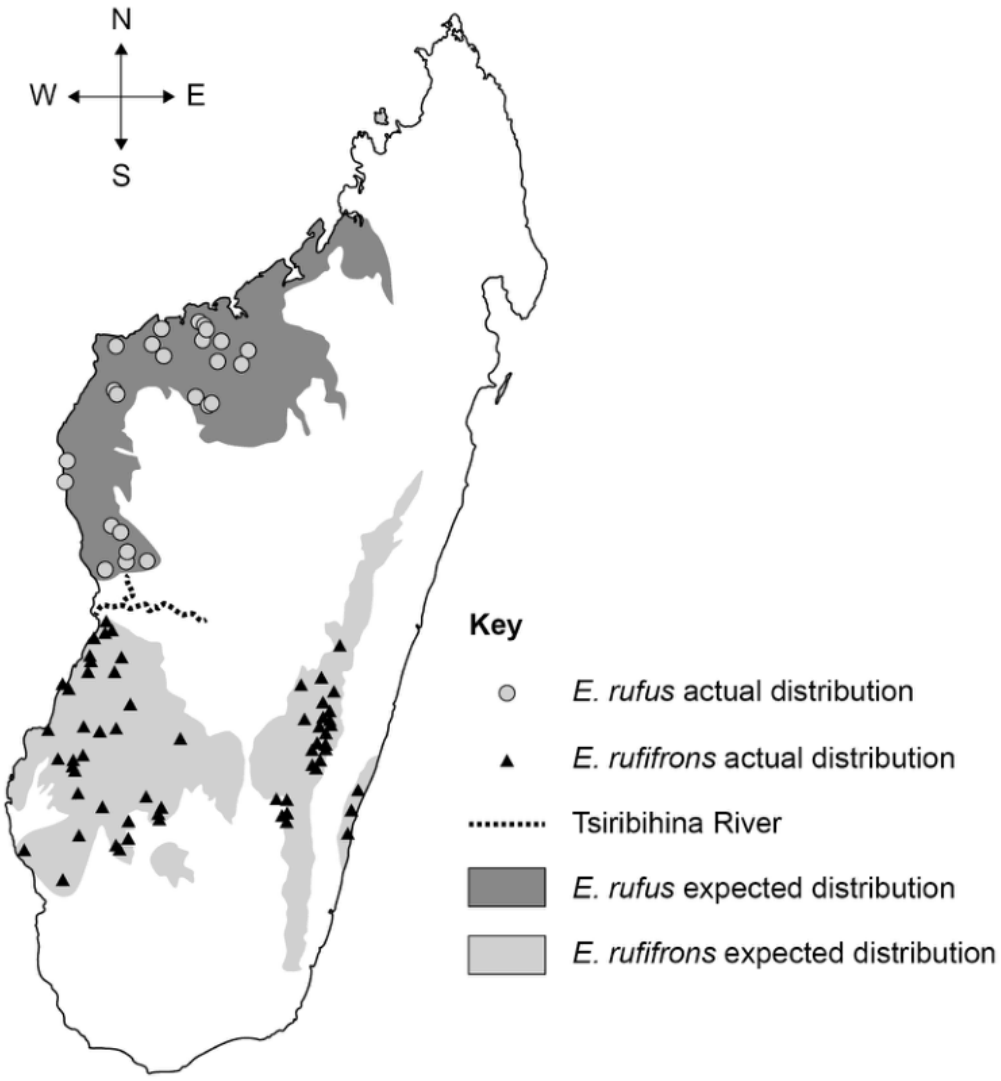
[4 marks]

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0 5 Lemurs are small mammals. Lemurs live in trees and feed on leaves and fruit. Scientists used a computer program to predict the expected distribution of two species of lemur, *Eulemur rufus* and *Eulemur rufifrons,* on the island of Madagascar. These predictions were based on the environmental needs of each species.
Then, the scientists determined the actual distribution of these two species of lemur on the island of Madagascar.

Figure 2 shows the scientists' results.

Figure 2



0 5 . 1 Using **Figure 2**, give **three** conclusions you can make about the distribution of these lemur species.

[3 marks]

1 _____

2 _____

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Question 11 · A level Paper 2 · June 2022 · Q05.2 · 5 marks

0 5 . 2 Using all the information, suggest how speciation happened to produce two species of lemur.

[5 marks]

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0 5 . 3 Variation in flower colour is considered one of the factors involved in the evolution of the following two species of monkeyflower.

- *Erythranthe lewisii* (Great Purple Monkeyflower), which has pink flowers, is mostly found at higher altitudes (1600 to 3000 metres) and attracts bumblebees.
- *Erythranthe cardinalis* (Scarlet Monkeyflower), which has red flowers, is mostly found at lower altitudes (up to 2000 metres) and attracts hummingbirds.

Bumblebees and hummingbirds are important in the pollination of flowers. Pollination involves the transfer of male gametes to female gametes.

Explain the different processes that may have been involved in the evolution of these two species of monkeyflower. Use the information provided to justify your answer.

[5 marks]

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Question 13 · information from earlier in the question

1 0 Read the following passage.

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Comparison of mitochondrial genes indicated that the diurnal geckos formed a distinct genetic group. This comparison also confirmed that all the geckos in the habitat were of the same species.

The scientists used the mark-release-recapture method to estimate the size of the population of geckos in the habitat.

Use the information in the passage and your own knowledge to answer the following questions.

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Question 13 · A level Paper 2 · June 2024 · Q10.3 · 5 marks

1 0 . 3 The scientists concluded that it was probable that disruptive selection was leading to sympatric speciation in the wall gecko.

Use the information in the passage to evaluate this conclusion.

[5 marks]

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Question 14 · information from earlier in the question

1 0 Alzheimer's disease (AD) is a non-reversible brain disorder that develops over a number of years. At the start of 2014 the number of Americans with AD was estimated to be 5.4 million. Every 30 seconds another person in America develops AD.

In the brain of a person with AD there is a lower concentration of acetylcholine. This affects communication between nerve cells and initially results in memory loss and confusion. Some of the symptoms of AD that are associated with communication between nerve cells are reduced by taking the drug donepezil. Donepezil inhibits the enzyme acetylcholinesterase.

A gene mutation called E280A found on chromosome 14 causes early-onset AD at a mean age of 49 years. The age at which the E280A mutation is expressed to cause AD varies.

Yaramul is a town in a historically isolated region of the Andes Mountains. The population of this town has the highest frequency of the E280A mutation in the world. The origin of the E280A mutation in this population has been traced back to a common ancestor in the 17th century. Natural selection has not reduced the frequency of the E280A mutation in the population.

This autosomal dominant mutation involves a change in triplet 280 from GAA to GCA. Scientists analysed chromosome 14 from 102 individuals from Yaramul. They recorded a sample size of 204 and detected 75 E280A mutations but only 74 potential AD cases. The scientists identified individuals with the mutation by whole genome sequencing. They had decided that a DNA probe would not be a suitable method to detect the E280A mutation.

Question 14 · A level Paper 2 · June 2017 · Q10.3 · 2 marks

1 0 . 3 Suggest and explain **two** reasons why there is a high frequency of the E280A mutation in Yaramul (lines 13–15).

[2 marks]

1 _____

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_____

2 _____

_____

_____

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Question 15 · information from earlier in the question

0 5 Leigh syndrome (LS) is a rare, recessive, inherited condition.

LS is caused by a mutation in any one of more than 75 different genes coding for proteins involved in oxidative phosphorylation.

In 80% of people with LS, these mutations occur in nuclear DNA. In 20% of people with LS, these mutations occur in mitochondrial DNA (mtDNA).

15% of the nuclear DNA mutations that cause LS occur in the *SURF1* gene. A mutated *SURF1* gene codes for a shorter polypeptide than a non-mutated *SURF1* gene.

Question 15 · A level Paper 3 · June 2024 · Q05.3 · 2 marks

0 5 . 3 The frequency of LS is higher in the Faroe Islands than globally.

Suggest and explain **one** reason why.

[2 marks]

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Mark schemes

Question 1 · A level Paper 2 · June 2024 · Q10.1 · 2 marks

10.1	1. Mutations/genotype/alleles; 2. Environment/habitat **OR** (Natural) selection; 3. Epigenetics; 4. Crossing over; 5. Independent segregation/assortment (of homologous chromosomes); 6. Random fusion of gametes **OR** Random fertilisation;	2 max (2 x AO2)	2. Accept named different habitats, e.g. 'walls' and 'trees/trunks. 2. Accept selection pressure e.g. predation. 4. Accept recombination. 5. Accept 'Random assortment'.

Question 2 · A level Paper 2 · June 2024 · Q10.2 · 2 marks

10.2	1. Provides camouflage; 2. (So) not seen by predators/prey **OR** Less predation **OR** Obtain/catch (more) prey;	2 (2 x AO2)	1. Accept description of camouflage. 2. Accept 'stops predation'. 2. Accept descriptions of reduced predation e.g. 'fewer are eaten'.

Question 3 · A level Paper 2 · November 2020 · Q10.4 · 2 marks

10.4	1. Less snow **so** less camouflage; 2. More hares seen/eaten/killed by predators;	2	1. Accept 'snow melts' 1. Accept description of less camouflage, e.g. more hares seen. 2. Accept description of predation.

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Question 4 · A level Paper 2 · November 2020 · Q10.5 · 4 marks

10.5	1. Hares which moult earlier (more likely to) survive; 2. Hares which moult earlier (more likely to) reproduce; 3. Pass on (advantageous) <u>allele</u>; 4. Frequency of <u>allele</u> increases (in future populations);	4	1. Accept less likely to be killed for 'survive'. 1. Accept description of survival e.g. not killed/eaten. 1. Accept moult quicker/faster for earlier. 1 and 2. Answers must be in the context of moulting earlier/quicker/faster. Accept rabbits for hares. 2 and 3. Accept 'pass on allele to offspring' or 'to next generation' = 2 marks. 4. 'More alleles' is not enough for a mark.

Question 5 · A level Paper 2 · June 2017 · Q10.4 · 2 marks

10.4	1. AD/symptoms develops late/at 49; 2. Have already reproduced;	2	Note: 'It' is not equivalent to AD/symptom as the question stem relates to the mutation.

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Question 6 · A level Paper 3 · November 2020 · Q01.2 · 3 marks

01.2	1. (Females with large brains) will mate with males bright in colour; 2. Their (male) offspring would be (more likely to be) bright in colour; 3. (Bright in colour male) offspring could attract larger brained females; 4. The population/offspring could (evolve to) have larger brains; 5. The population/offspring are better at identifying/avoiding predators;	3 max

Accept answers that include references to alleles

4. and 5. Ignore answers relating to females only

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Question 7 · A level Paper 3 · November 2020 · Q01.3 · 3 marks

01.3	1. **Not** geographically isolated; 2. (Leading to) reproductive isolation **OR** Gene pools kept separate; 3. Changes in allele <u>frequencies</u>; 4. Cannot breed/mate to produce fertile offspring;	3 max

1. Accept are in the same area
2. Accept large brained females will only mate with males bright in colour <u>and</u> small brained females will only mate with males dull in colour
3. Reject gene frequencies
4. Reject inbreeding

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Question 8 · A level Paper 2 · June 2017 · Q09.2 · 5 marks

09.2	1. Occurs in the same habitat/environment/population; 2. Mutation/s cause different flowering times; 3. Reproductive separation/isolation OR No gene flow OR Gene pools remain separate; 4. Different allele/s passed on/selected OR Change in frequency of allele/s; 5. Disruptive (natural) selection; 6. Eventually different species cannot (inter)breed to produce fertile offspring;	5 max

1. Accept: are **not** geographically isolated /separated.

1. Accept: same place

3. Accept: no interbreeding but must be a separate idea from mark point 6 which relates to definition of a species.

Note: Answers relating only to allopatric speciation = 3 max, mark points 3, 4 and 6.

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Question 9 · A level Paper 2 · November 2021 · Q10.1 · 4 marks

10.1	1. Variation/differences due to mutation/s; 2. (Reference to) allopatric (speciation); 3. Smaller/different lakes have different environmental conditions **OR** Smaller/different lakes have different selection pressures; 4. Reproductive separation/isolation **OR** No gene flow **OR** Gene pools remain separate; 5. Different alleles passed on/selected **OR** Change in frequency of allele/s; 6. Eventually different species/populations cannot breed to produce fertile offspring;	4 max	2. Ignore sympatric speciation. 3. Accept different populations for different lakes.

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Question 10 · A level Paper 2 · June 2022 · Q05.1 · 3 marks

05.1	1. *E. rufus* in north (west) **OR** *E. rufus* in the west **OR** *E. rufus* above river; 2. *E. rufifrons* in south **OR** *E. rufifrons* in west **and** east **OR** *E. rufifrons* below river; 3. (Actual) distribution similar to expected (distribution) **OR** (Actual) distribution similar to environmental needs **OR** (Actual) distribution (slightly) less than expected distribution;	3 (3 x AO3)

1 and 2. Accept equivalent valid statements e.g., for 1, no *E. rufus* in south.

1 and 2. If neither mark is awarded, accept, for one mark, 'they are separated by the river' **OR** 'there is no overlap in their distribution/ranges'.

1 and 2. Accept converse.

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Question 11 · A level Paper 2 · June 2022 · Q05.2 · 5 marks

05.2	1. Geographical isolation **OR** Allopatric speciation; 2. Reproductive separation/isolation **OR** No gene flow **OR** Gene pools separate; 3. Different selection pressures **OR** Different environmental/abiotic conditions/factors; 4. (Variation due to) mutation(s) (in different populations); 5. (Different/advantageous) <u>allele/s</u> passed on/selected **OR** Change in frequency of <u>allele/s</u>; 6. (Eventually different species) cannot (inter)breed to produce fertile offspring;	5 max (3 x AO1, 2 x AO2)

1.Ignore descriptions of geographical isolation.

1. Reject sympatric.

Ignore reference to two species at start.

2. Reproductive isolation must be at

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05.3	1. Geographical isolation/separation due to elevation/altitude; 2. Allopatric speciation due to isolation/separation; 3. Different selection pressures **OR** Different environment(s); 4. (However) some overlap in distribution **OR** (Both) plants found in same area/habitat/altitude; 5. So (possibly) sympatric speciation; 6. (Variation due to) mutation(s); 7. Reproductive isolation/separation due to different pollinators/distributions/altitudes **OR** Separate gene pools due to different pollinators/distributions/altitudes; 8. Change in allele frequency (in each population) **OR** Different allele frequency (in each population); 9. Different species) can no longer (interbreed to) produce fertile offspring;	5 max (5 x AO3)

3. Accept selection (due to) flower colour.

3. Accept different 'abiotic conditions/factors' for 'different environment(s)' or different named factor e.g. temperature, humidity but 'different altitudes' on its own is

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10.3	**Mark point 1 required for max marks** 1. (Geckos in) same habitat/environment/area **OR** No geographical isolation/separation (between geckos); 2. (Possibly) allopatric speciation as different (areas of same) habitat(s)/environment/area **OR** (Possibly) geographical isolation/separation as different (areas of same) habitat(s); 3. (Could lead to) separate gene pools **OR** Reproductive isolation; 4. Mutation(s); 5. Selection for (both) extremes/colours **OR** Disruptive selection (occurs) as two extremes/ colours; 6. (Analysis shows that) diurnal geckos are a distinct (genetic) group; 7. (Genomes/DNA indicates geckos are) same species;	5 max (5 x AO3)

2. Accept 'walls' and 'trees/trunks' as different habitats.

3. Accept 'can't interbreed' in correct context, i.e., not when describing a species.

3. Accept 'no gene flow'.

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Question 14 · A level Paper 2 · June 2017 · Q10.3 · 2 marks

10.3	1. Isolated **so** inbreeding/low genetic diversity/small gene pool; 2. Allele inherited (through generations) from (common) ancestor;	2	1. Ignore: Founder effect. 1. Accept: no interbreeding with other populations. 1. Reject: interbreeding within the population.

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05.3	**Mark as pairs: 1 and 2 OR 3 and 4** 1. Genetic drift; 2. Frequency is higher by chance **OR** High frequency is not due to natural selection; 3. (Only) inbreeding/interbreeding (within a population) **OR** No (inter)breeding with other populations **OR** (Inherited from) common ancestor; 4. Low genetic diversity **OR** Small gene pool **OR** Little gene flow **OR** Higher chance of inheriting <u>allele</u> **OR** Frequency of <u>allele</u> higher (in offspring);	2 max (2 x AO2)

3. Accept descriptions of inbreeding **OR** no interbreeding
3. Accept reproductively isolated
3. Accept genetic bottleneck **OR**

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