AQA – Genetic information, variation and relationships between organisms – A2 Biology P3

1. June/2021/Paper_3/No.1

   | 0 | 1 |

   In one species of squirrel, *Sciurus carolinensis*, fur colour is controlled by one gene, with two codominant alleles. C^G represents the allele for grey fur colour, and C^B represents the allele for black fur colour.

   Table 1 shows the three possible phenotypes.

   ### Table 1

Genotype	Phenotype
$C^G C^G$	Grey fur
$C^G C^B$	Brown-black fur
$C^B C^B$	Black fur

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   In a population of 34 *S. carolinensis*, 2 had black fur.

   Use the Hardy–Weinberg equation to estimate how many squirrels in this population had brown-black fur. Show your working.

   [2 marks]

   Answer _____

0 1 . 2 The actual number of squirrels in this population that had brown-black fur was 16.

Use all of the information to calculate the **actual** frequency of the C^G allele.

Do **not** use the Hardy–Weinberg equation in your calculation.

Give your answer to 2 decimal places.

[1 mark]

Answer _____

0 1 . 3 *S. carolinensis* were first introduced to the UK from North America in the 1870s. They are now widely distributed across the UK.

S. carolinensis from both North America and the UK show exactly the same genotypic and phenotypic variation. An identical mutation causing black fur has also been found in several other species closely related to *S. carolinensis*.

Use this information to deduce which **one** of the following conclusions is most likely true.

Tick (✓) **one** box.

[1 mark]

A	The mutation that caused black fur happened after *S. carolinensis* was introduced to the UK from North America.	☐
B	The mutation that caused black fur happened in a common ancestor of *S. carolinensis* and other closely related species.	☐
C	The mutation that caused black fur happened independently in *S. carolinensis* and all other closely related species.	☐
D	The phenotypic variation shown in *S. carolinensis* and other closely related species is caused by genetic drift.	☐

The mutation that caused the C^B allele was due to a 24 base-pair deletion from the C^G allele.

0 1 . 4   The protein coded for by the C^B allele is 306 amino acids long.

Calculate the percentage reduction in size of the protein coded for by the C^B allele compared with the protein coded for by the C^G allele.
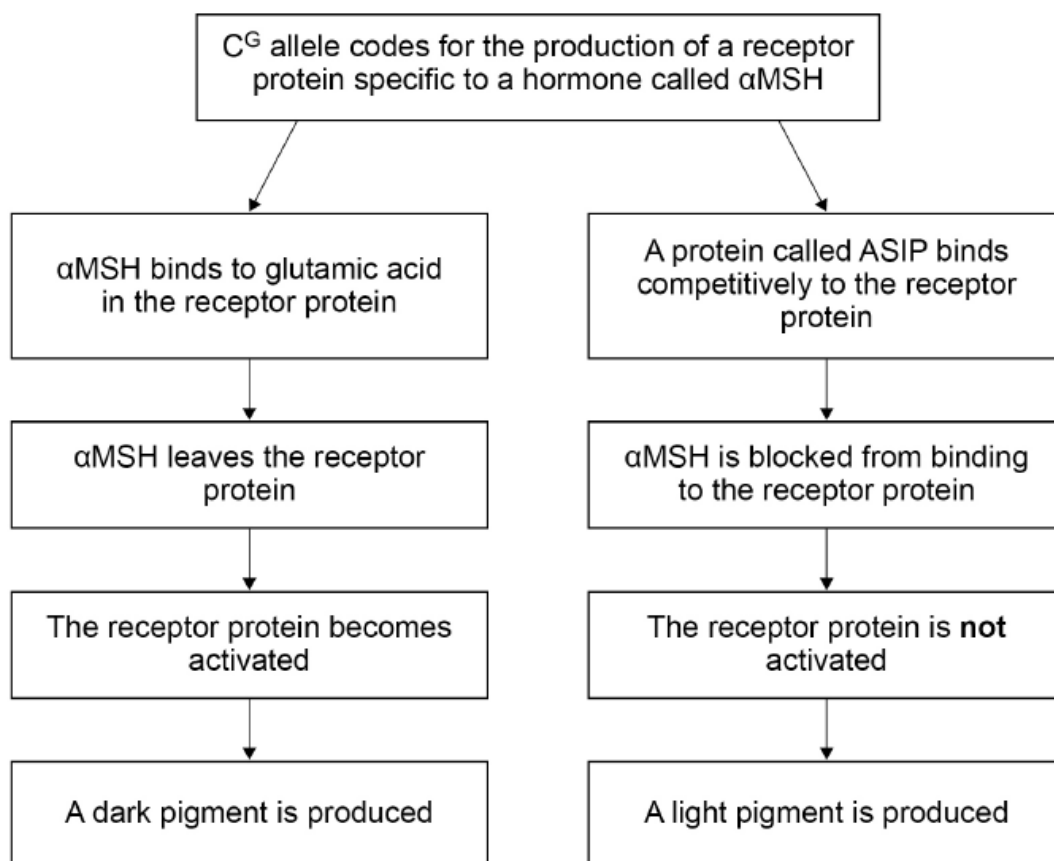
Give your answer to 3 significant figures and show your working.

[2 marks]

Answer _____

In *S. carolinensis*, fur colour depends on the distribution and relative amounts of light pigments and dark pigments in the hairs of the fur. **Figure 1** shows how the protein produced from the C^G allele can result in the production of a light pigment or a dark pigment.

Figure 1

The deletion mutation in the C^B allele results in the production of a receptor protein that does not have glutamic acid. The lack of glutamic acid in the receptor protein has the same effect as αMSH leaving the receptor protein.

0 1 . 5   Use **Figure 1** and this information to suggest why *S. carolinensis* with the genotype $C^B C^B$ have black fur rather than grey fur.

[3 marks]

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2. June/2021/Paper_3/No.4

| 0 | 4 |

Freshwater marshes have one of the highest rates of gross primary production (*GPP*) and net primary production (*NPP*) of all ecosystems.

Carbon use efficiency (*CUE*) is the ratio of *NPP:GPP*. Freshwater marshes have a high *CUE*.

| 0 | 4 |.| 1 |

Use your knowledge of *NPP* to explain why freshwater marshes have a high *CUE* and the advantage of this.

Do **not** refer to abiotic factors in your answer.

[2 marks]

Explanation _____

Advantage _____

| 0 | 4 |.| 2 |

Freshwater marsh soils are normally waterlogged. This creates anaerobic conditions.

Use your knowledge of the nitrogen cycle to suggest why these soils contain relatively high concentrations of ammonium compounds and low concentrations of nitrite ions and nitrate ions.

[2 marks]

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A student investigated the growth rate of a freshwater marsh plant.

The growth rate (R) of a plant can be determined using this equation.

$$R = \frac{(\ln W_2 - \ln W_1)}{t}$$

Where
ln = natural logarithm
t = duration of the investigation in days
W_1 = plant biomass at the start of the investigation
W_2 = plant biomass at the end of the investigation

The student used the equation above; however, she substituted height for biomass. This was because she did not want to destroy the plants to measure their biomass.

0 4 . 3 State the assumption the student has made **and** suggest why this assumption might **not** be valid.

[2 marks]

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0 4 . 4 At the end of the investigation, the student noted the freshwater marsh plant had grown 268 mm in height, and now measured 387 mm. She calculated the rate of growth (R) to be 0.097 mm m^{-1} day^{-1}

Use this information and, **substituting height for biomass**, use the equation to calculate the duration of the student's investigation.

Give your answer to the nearest full day. Show your working.

[2 marks]

_____ days