Helicate

HELICATE · A-LEVEL BIOLOGY · TOPIC BANK

3.7.1 Inheritance

Topic question bank

Version 3 · 15 October 2026

Name

Date

QUESTIONS	TOTAL MARKS	TIME	YOUR SCORE
9	62	No time limit	/ 62

Contents

Subtopic	Questions	Marks
Monohybrid inheritance and multiple alleles Specification 3.7.1	01–04	22
Dihybrid inheritance and epistasis Specification 3.7.1	05	8
Sex-linkage Specification 3.7.1	06	7
Autosomal linkage Specification 3.7.1	07	8
The chi-squared test Specification 3.7.1	08–09	17
Total		**62**

Instructions

- Answer the questions in the spaces provided. Show all your working.
- The marks for each question are shown in brackets. Use them to judge how much detail to give.
- Work through a subtopic at a time, then mark your answers with the matching mark scheme.

Original questions by Helicate for AQA A-level Biology (7402), specification section 3.7.1. Not affiliated with or endorsed by AQA.

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Monohybrid inheritance and multiple alleles 3.7.1

In Shorthorn cattle, one gene controls coat colour. The allele C^R gives red hairs and the allele C^W gives white hairs. Cattle with the genotype C^RC^W have a roan coat, in which red hairs and white hairs are mixed together.

0 1 . 1 Which statement about a roan Shorthorn is correct?
Tick (✓) one box.

[1 mark]

- It is homozygous for coat colour, and both alleles are expressed in its phenotype. ☐
- It is heterozygous for coat colour, and both alleles are expressed in its phenotype. ☐
- It is heterozygous for coat colour, and the C^W allele is recessive. ☐
- It has two different genes for coat colour at the same locus. ☐

0 1 . 2 A roan bull was mated with many red cows.
What percentage of their calves would be expected to be roan?
Tick (✓) one box.

[1 mark]

- 25% ☐
- 50% ☐
- 75% ☐
- 100% ☐

Question 1 continues on the next page

Do not write outside the box

0 1 . 3 A farmer wants every calf born in her herd to be roan.
Explain why she should mate red cattle with white cattle, rather than mating roan cattle with each other.

[3 marks]

0 1 . 4 The red hairs of Shorthorn cattle kept outdoors often become paler during a sunny summer.
Use this example to explain what is meant by the term phenotype.

[2 marks]

7

Turn over for the next question

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In rabbits, one gene controls the coat colour. This gene has four alleles. Table 1 shows the alleles in order of dominance: each allele is dominant to every allele below it in the table.

Table 1

Allele	Coat colour of a rabbit with two copies of this allele
C	Full colour: dark grey-brown all over
c^{ch}	Chinchilla: silver-grey all over
c^{h}	Himalayan: white, with dark ears, nose, feet and tail
c	Albino: white all over, with pink eyes

0 2 . 1 There are four alleles of this gene, but a rabbit can have no more than two of them.
Explain why.

[1 mark]

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Question 2 continues on the next page

Do not write outside the box

0 2 . 2 A chinchilla rabbit was mated with a Himalayan rabbit. Some of their offspring were albino.
Complete the genetic diagram to show the genotypes of the parents, all the possible genotypes of the offspring and the ratio of the offspring phenotypes.
Use the allele symbols in Table 1.

[3 marks]

Parental phenotypes Chinchilla × Himalayan

Parental genotypes .....

Gametes .....

Offspring genotypes .....

.....

Offspring phenotypes .....

.....

Ratio of offspring phenotypes .....

0 2 . 3 The same two rabbits produced another litter.
What is the probability that the first two rabbits born in this litter were both albino?
Tick (✓) one box.

[1 mark]

1/2 ☐

1/4 ☐

1/8 ☐

1/16 ☐

5

Turn over for the next question

Do not write outside the box

In tomato plants, the allele for a purple stem, **A**, is dominant to the allele for a green stem, **a**.
A plant breeder had a tomato plant with a purple stem, but she did not know its genotype. She removed the anthers from its flowers to prevent self-pollination, then pollinated the flowers with pollen from a plant with a green stem.

0 3 . 1 Explain why pollen from a green-stemmed plant was more useful in this cross than pollen from another purple-stemmed plant.

[2 marks]

0 3 . 2 All 12 offspring of the cross had purple stems.
If the purple-stemmed plant had been heterozygous, the probability of any one offspring having a purple stem would have been 0.5.
Calculate the probability that a heterozygous plant would produce 12 offspring that all had purple stems.
Give your answer in standard form.

[2 marks]

Answer .....

0 3 . 3 Use your answer to 03.2 to suggest what the breeder should conclude about the genotype of her purple-stemmed plant.

[1 mark]

5

Turn over for the next question

Do not write outside the box

In mice, one gene controls whether the coat is yellow or a grey-brown colour called agouti. The allele $\mathbf{A^Y}$ gives a yellow coat and the allele **a** gives an agouti coat. Embryos with the genotype A^YA^Y die early in development, before birth.

Scientists carried out three types of cross between mice. Table 2 shows their results.

Table 2

Phenotypes of parents	Number of litters	Mean number of pups per litter	Number of pups born	
			Yellow	Agouti
Yellow × yellow	53	5.9	209	103
Yellow × agouti	40	8.0	158	162
Agouti × agouti	35	8.1	0	284

0 4 Use Table 2 and the information given to explain the results of all three types of cross.

[5 marks]

5

Turn over for the next question

Do not write outside the box

Dihybrid inheritance and epistasis 3.7.1

In Labrador retriever dogs, coat colour is controlled by two genes on different chromosomes.

- Gene **B**: the allele **B** produces black pigment. The recessive allele **b** produces brown pigment, which gives a chocolate coat.
- Gene **E**: the allele **E** allows pigment to be deposited in the hairs. Dogs with the genotype **ee** cannot deposit pigment in their hairs, so they have a yellow coat, whatever alleles of gene B they have.

0 5 . 1 In a dog with the genotype ee, the alleles of gene B have no effect on coat colour.
What term is used when the alleles at one locus mask the expression of a different gene in this way?

[1 mark]

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0 5 . 2 A dog that is heterozygous for both genes produces four genotypes of gamete in equal numbers.
Explain why.

[2 marks]

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Question 5 continues on the next page

Do not write outside the box

0 5 . 3 A black male dog that is heterozygous for both genes was mated with a chocolate female that is heterozygous for gene E.
Complete the genetic diagram to show the genotypes of the parents, all the possible genotypes of the offspring and the ratio of the offspring phenotypes.

[3 marks]

Parental phenotypes Black male × Chocolate female

Parental genotypes

Gametes

Offspring genotypes

Offspring phenotypes

Ratio of offspring phenotypes

0 5 . 4 A breeder mated two yellow Labradors. All of their puppies were yellow.
Explain why.

[2 marks]

8

Turn over for the next question

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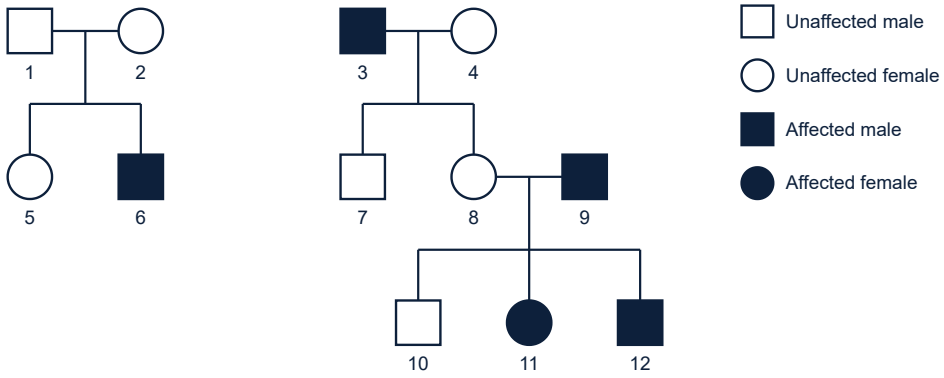
Sex-linkage 3.7.1

One form of red–green colour vision deficiency in humans is controlled by a gene on the non-homologous region of the X chromosome. Females have two X chromosomes; males have one X and one Y.

Figure 1 shows the inheritance of this condition in one family. Individuals shaded in the chart have the condition.

Figure 1



0 6 . 1 A man with this condition cannot pass the allele for it to his sons.
Which statement explains why?
Tick (✓) one box.

[1 mark]

His sons inherit his Y chromosome, not his X chromosome. ☐

The allele is not expressed in males. ☐

The Y chromosome carries no genes. ☐

His sons inherit both of their X chromosomes from their mother. ☐

Question 6 continues on the next page

Do not write outside the box

0 6 . 2 In a large survey of one population, 8% of men but only 0.64% of women had this form of colour vision deficiency.
Use your knowledge of sex-linkage to account for this difference.

[2 marks]

0 6 . 3 A student suggested that the allele for colour vision deficiency could be dominant.
Name **one** child in Figure 1 whose phenotype shows that the student is wrong, and explain how it does.

[2 marks]

Question 6 continues on the next page

Do not write outside the box

The allele for normal colour vision, $\mathbf{X^D}$, is dominant to the allele for colour vision deficiency, $\mathbf{X^d}$.

0 6 . 4 Individuals 8 and 9 plan to have another child.
Calculate the probability that this child will be a daughter with colour vision deficiency.
Show your working.

[2 marks]

Probability .....

7

Turn over for the next question

Do not write outside the box

Autosomal linkage 3.7.1

Maize plants produce seeds called kernels. The allele for coloured kernels, **C**, is dominant to the allele for colourless kernels, **c**. The allele for full kernels, **S**, is dominant to the allele for shrunken kernels, **s**.

A scientist crossed plants homozygous for coloured, full kernels with plants homozygous for colourless, shrunken kernels. All the offspring had coloured, full kernels. She then crossed these offspring with plants that had colourless, shrunken kernels. Table 3 shows the kernels produced by this second cross.

Table 3

Kernels of offspring	Number of offspring
Coloured and full	1820
Coloured and shrunken	92
Colourless and full	84
Colourless and shrunken	1796

0 7 . 1 A 1 : 1 : 1 : 1 ratio of the four types of kernel would be expected if gene C and gene S were on different chromosomes.
The numbers in Table 3 are very far from this ratio. Explain why.

[4 marks]

Question 7 continues on the next page

Do not write outside the box

0 7 . 2 Calculate the percentage of the offspring in Table 3 that had a combination of kernel characteristics not found in either of the original homozygous parents.
Give your answer to **three** significant figures.

[2 marks]

Answer _____ **%**

0 7 . 3 The scientist did a similar cross for gene C and a third gene, W, which is on the same chromosome. This time, 22% of the offspring had new combinations of characteristics.
Suggest an explanation for the difference between this result and your answer to 07.2.

[2 marks]

8

Turn over for the next question

Do not write outside the box

The chi-squared test 3.7.1

Wisconsin Fast Plants are small plants that complete their life cycle in about five weeks. Students investigated the inheritance of two genes in these plants.

- The allele for a purple stem, **A**, is dominant to the allele for a non-purple stem, **a**.
- The allele for green leaves, **Y**, is dominant to the allele for yellow-green leaves, **y**.

The students crossed plants homozygous for purple stems and green leaves with plants homozygous for non-purple stems and yellow-green leaves. They then pollinated the flowers of the offspring with pollen from other offspring of this cross. They grew 448 of the seeds produced and recorded the phenotype of each seedling. Table 4 shows their results.

Table 4

Phenotype of seedlings	Number of seedlings
Purple stem, green leaves	254
Purple stem, yellow-green leaves	98
Non-purple stem, green leaves	77
Non-purple stem, yellow-green leaves	19

The students expected the two genes to be on different chromosomes. They used a chi-squared test to compare their results with a 9 : 3 : 3 : 1 ratio.

0 8 . 1 Give the null hypothesis for this test.

[1 mark]

Question 8 continues on the next page

Do not write outside the box

0 8 . 2 Give **two** reasons why the chi-squared test is a suitable statistical test for these data.

[2 marks]

1 .....

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2 .....

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0 8 . 3 The formula for the chi-squared test is

$$\chi^2 = \Sigma (O - E)^2 \div E$$

where O is the observed number and E is the expected number.
Calculate the value of chi-squared for the results in Table 4.

[3 marks]

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Answer .....

Question 8 continues on the next page

Do not write outside the box

Table 5 shows critical values of chi-squared.

Table 5

Degrees of freedom	1	2	3	4	5
Critical value of chi-squared at $P = 0.05$	3.84	5.99	7.82	9.49	11.07

0 8 . 4 Use your answer to 08.3 and Table 5 to give the conclusion of the students' test. Explain your answer.

[3 marks]

0 8 . 5 Suggest why it was important that the students grew all the seedlings in the same conditions, such as at the same light intensity.

[2 marks]

11

Turn over for the next question

Do not write outside the box

Fast Plants also have a gene for stem hairs and a gene for plant height.
A student had true-breeding plants with hairy stems and normal height, and true-breeding plants with hairless stems and a dwarf form called rosette. Hairy stems and normal height are both dominant.

0 9 Describe how the student could use these plants to find out whether the gene for stem hairs and the gene for plant height are linked. Include how the student should analyse the results.

[6 marks]

6

END OF QUESTIONS

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