Questions

Q1.

The diagram shows four varieties of rabbit.

Fur colour in rabbits is controlled by four different alleles:

- the allele for brown fur, C, is dominant to all other alleles
- the allele for chinchilla fur, c^{ch}, is dominant to the alleles for Himalayan and albino
- the allele for Himalayan fur, c^{h}, is dominant to the allele for albino
- the allele for albino fur, c, is recessive to all other alleles

(i) Describe how new combinations of alleles are produced in meiosis.

(2)

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(ii) State all the possible genotypes of a rabbit with brown fur.

(1)

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(iii) Two parent rabbits with brown fur were mated. Two of the F_1 offspring had chinchilla fur.

The F_1 rabbit offspring with chinchilla fur were mated.
The F_2 generation consisted of some rabbits with chinchilla fur and the rest having Himalayan fur.
Use genetic crosses to deduce the genotypes of the two parent rabbits with brown fur.

(3)

Answer .....

(Total for question = 6 marks)

Q2.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

(i) The table shows the chromosome number and chromatid number of some of the cells formed during oogenesis in humans.

Cell type	Chromosome number	Chromatid number
ovum	23	23
primary oocyte	46	92
secondary oocyte	23	46

Which of the cells are haploid?

(1)

- ☒ **A** ovum and primary oocyte
- ☒ **B** ovum and secondary oocyte
- ☒ **C** primary oocyte and secondary oocyte
- ☒ **D** ovum alone

(ii) Explain how meiosis produces new combinations of alleles in gametes.

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(Total for question = 5 marks)

Q3.

Recombination of alleles can be due to the crossing over that occurs during meiosis. This process results in gametes with different combinations of alleles and genetic variation in the offspring.

Crossing over occurs between two genes found on the same chromosome.

The recombination frequency reflects the likelihood of crossing over occurring. It depends on how close the genes are on the chromosome.

Explain why crossing over between two different genes, located on a pair of homologous chromosomes, results in a maximum of 50% of gametes with the recombinant alleles.

(3)

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(Total for question = 3 marks)

Q4.

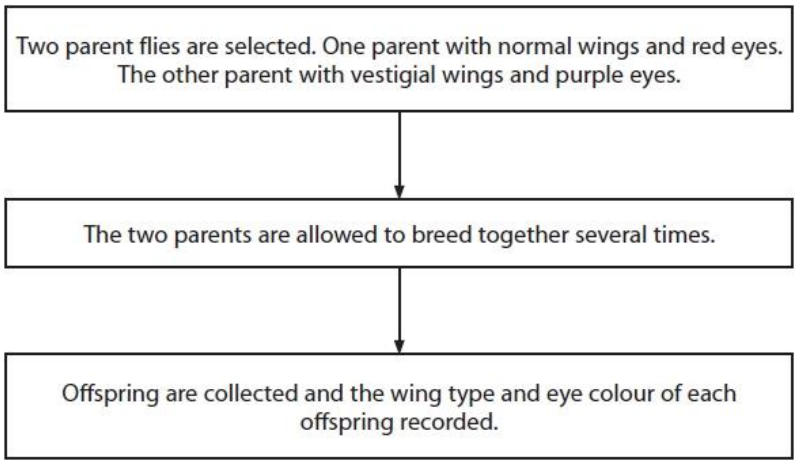
Recombination of alleles can be due to the crossing over that occurs during meiosis. This process results in gametes with different combinations of alleles and genetic variation in the offspring.

Crossing over occurs between two genes found on the same chromosome.

The recombination frequency reflects the likelihood of crossing over occurring. It depends on how close the genes are on the chromosome.

In fruit flies, the gene for wing type is located on the same chromosome as the gene for eye colour.

The flow diagram shows an experiment used to calculate the recombination frequency for these two genes.



The table shows the results of one experiment.

Description of offspring	Number recorded
Normal wings and red eyes	672
Vestigial wings and purple eyes	592
Normal wings and purple eyes	75
Vestigial wings and red eyes	69

The recombinant frequency is the percentage of offspring that have a different combination of characteristics compared with the parents. It is the proportion of the total number of offspring.

Calculate the recombinant frequency for this pair of genes.

Give your answer to three significant figures.

(1)

Answer ..... %

(Total for question = 1 mark)

Q5.

A zygote is formed when gametes fuse at fertilisation.

Explain how meiosis results in genetic variation in the gametes.

(2)

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(Total for question = 2 marks)

Q6.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

(i) Complete the table with a ✓ or ✗ to compare the events during mitosis and meiosis.

The first row in the table has been completed for you.

(3)

Event	Mitosis	Meiosis I	Meiosis II
chromosomes shorten and thicken	✓	✓	✗
homologous chromosomes pair together			
crossing over can cause genetic variation			
homologous chromosomes separate			
sister chromatids separate			

(ii) Which of the following increases the number of different alleles in a population?

(1)

- ☒ **A** crossing over
- ☒ **B** gene mutation
- ☒ **C** independent assortment of chromosomes during nuclear division
- ☒ **D** random fusion of gametes

(Total for question = 4 marks)

Q7.

Recombination of alleles can be due to the crossing over that occurs during meiosis. This process results in gametes with different combinations of alleles and genetic variation in the offspring.

When does crossing over first take place?

(1)

- ☒ **A** metaphase I
- ☒ **B** metaphase II
- ☒ **C** prophase I
- ☒ **D** prophase II

(Total for question = 1 mark)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to the following: • {independent / random} assortment of chromosomes (1) • {crossing over / recombination / chiasmata formation} between homologous chromosomes (1)	**Accept** correct descriptions of crossing over between homologous chromosomes	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: • CC, Cc^{ch}, Cc^{h}, Cc (1)	**Accept** alleles in different order e.g. $c^{h}C$	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to the following: • parents identified as Cc^{h}, Cc^{ch} (1) • F_1 that are crossed identified as $c^{ch}c^{h} \times c^{ch}c^{h}$ (1) • F_2 identified as $c^{ch}c^{ch}$, $c^{ch}c^{h}$, ($c^{ch}c^{h}$), $c^{h}c^{h}$ (1)	**Accept** all mps from Punnett squares **Accept** any clear indication that $c^{ch}c^{h} \times c^{ch}c^{h}$ are crossed	(3)

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	B ovum and secondary oocyte A is incorrect because secondary oocyte is diploid C is incorrect because the secondary oocyte is diploidD is incorrect because the primary oocyte is diploid		1
(ii)	*An explanation that makes reference to:* • crossing over (1) • which swaps {alleles / DNA / genes} between {homologous chromosomes} (1) • independent / random assortment (1) • because it is random movement of homologous chromosomes to poles (1)	**Allow** random movement of paternaland maternal chromosomes / random combinations of paternal and maternal chromosomes	4

Q3.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: • crossing over occurs between chromatids (between the same homologous chromosomes) (1) • therefore (only) half the chromosomes (produced by anaphase II) will be recombinant chromosomes (so maximum of 50%) (1) • crossing over does not always take place (so can be less than 50%) (1)	**ACCEPT** will have recombinant {genes / alleles}	(3) Exp

Q4.

Question Number	Answer	Additional Guidance	Mark
	• 10.2		(1) CLER

Q5.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: • meiosis results in recombination of alleles (1) • due to {independent / random} assortment (of chromosomes) (1) • (and) due to crossing over between chromatids (between the same homologous chromosomes) (1)	**IGNORE** references to maternal and paternal chromosomes throughout **ACCEPT** description e.g. pairs of homologous chromosomes line up (on the equator) randomly **ACCEPT** description e.g. genetic material is swapped between chromatids (between the same homologous chromosomes) **DO NOT ACCEPT** wrong description/ wrong stage **IGNORE** mutations	(2) Exp

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	<table><tr><th>Feature</th><th>Mitosis</th><th>Meiosis I</th><th>Meiosis II</th></tr><tr><td>homologous chromosomes pair together</td><td>×</td><td>✓</td><td>×</td></tr><tr><td>crossing over can cause genetic variation</td><td>×</td><td>✓</td><td>×</td></tr><tr><td>homologous chromosomes separate</td><td>×</td><td>✓</td><td>×</td></tr><tr><td>sister chromatids separate</td><td>✓</td><td>×</td><td>✓</td></tr><tr><td></td><td>(1)</td><td>(1)</td><td>(1)</td></tr></table>		(3)

Question Number	Answer	Mark
(ii)	**The only correct answer is B** ***A*** *is not correct because crossing over does not alter the DNA sequence of a gene to produce new alleles* ***C*** *is not correct because independent assortment does not alter the DNA sequence* ***D*** *is not correct because random fusion of gametes does not alter the DNA sequence*	(1)

Q7.

Question Number	Answer	Additional Guidance	Mark
	The only correct answer is C **A** *is incorrect because crossing over has taken place by metaphase I* **B** *is incorrect because crossing over takes place in meiosis I* **D** *is incorrect because crossing over takes place in meiosis I*		(1) COMP