Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Monohybrid crosses (genetic diagrams)

Time allowed: 1 hour 10 minutes

Subject code **0610**

Biology

Questions from Paper 3 and Paper 4

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 71

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 71 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 Fig. 8.1 shows a cat with an inherited condition that means the cat has extra toes.



Fig. 8.1

The allele that causes this condition is dominant to the allele for the normal condition.

Fig. 8.2 shows the inheritance of this condition in a family of cats.

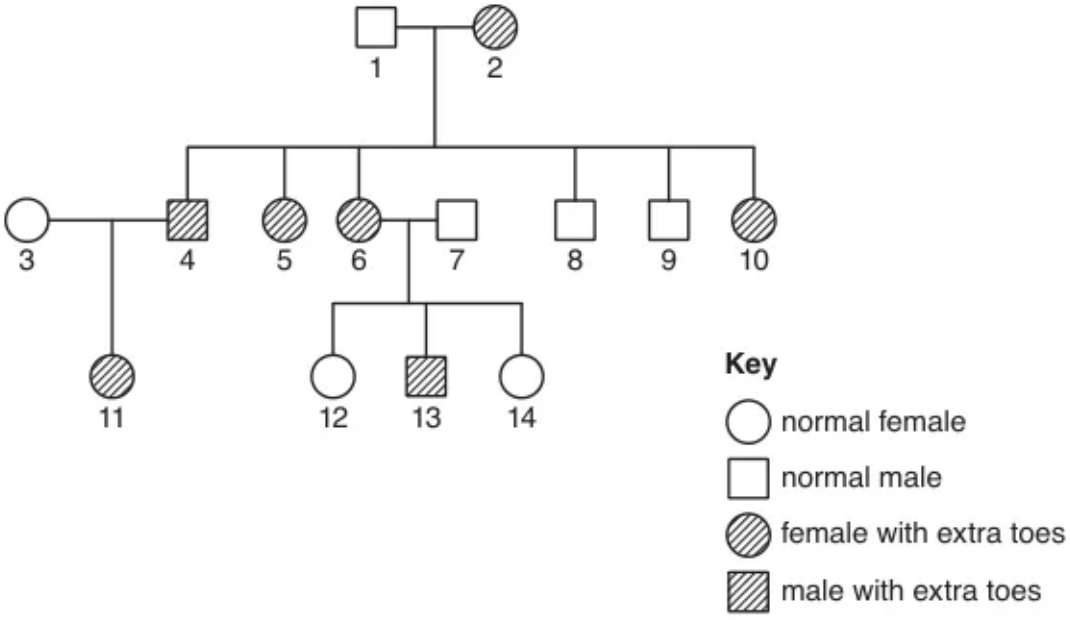


Fig. 8.2

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Complete Table 8.1 by stating the genotypes of the numbered individuals.

Use **B** for the dominant allele and **b** for the recessive allele.

Table 8.1

number of individual in Fig. 8.2	genotype of individual
1	
2	
4	
14	

[4]

Monohybrid inheritance Click for more variations

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1

number	genotype
1	**bb ;**
2	**Bb ;**
4	**Bb ;**
14	**bb ;**

4

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2 Fig. 9.1 shows a genetic cross between a purple flower and a white flower. Components of the cross are labelled with the letters **U–Z**.

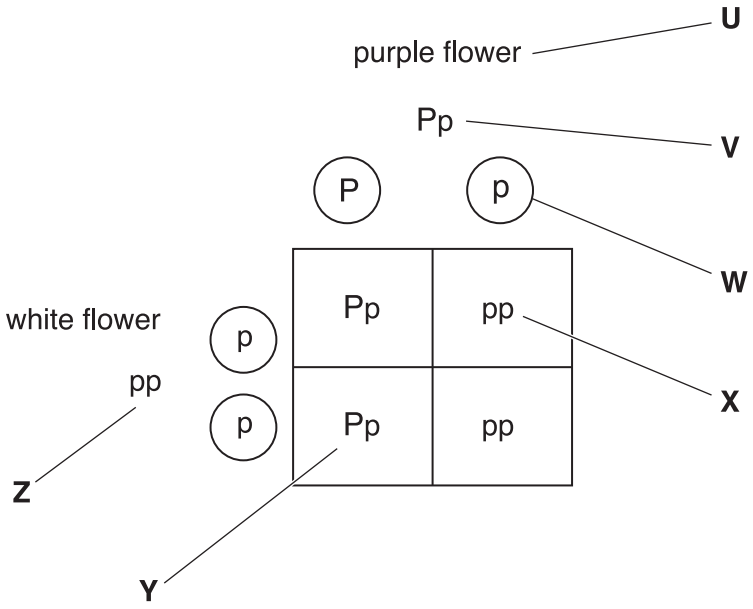


Fig. 9.1

(a) Use the letters **U**, **V**, **W**, **X**, **Y**, or **Z** from Fig. 9.1 to answer the questions.

You may use any letter once, more than once, or not at all.

State which letter represents:

(i) the genotype of a heterozygous parent ..... [1]

(ii) a gamete ..... [1]

(iii) the phenotype of an individual ..... [1]

(iv) a pure-breeding offspring. ..... [1]

(b) State the ratio of purple flowers to white flowers produced in this cross.

..... [1]

[Total: 5]

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2(a)(i)	**V**;	**1**	
2(a)(ii)	**W**;	**1**	
2(a)(iii)	**U**;	**1**	
2(a)(iv)	**X**;	**1**	
2(b)	1:1;	**1**	**A** 50% / 0.5
		Total: 5	

3 Fig. 9.1 shows a cross between two guinea pigs. The male guinea pig is pure-breeding for black fur colour and the female guinea pig is pure-breeding for white fur colour.

The allele for black fur colour can be represented by **B** and the allele for white fur colour can be represented by **b**.

All four of their offspring had black fur.

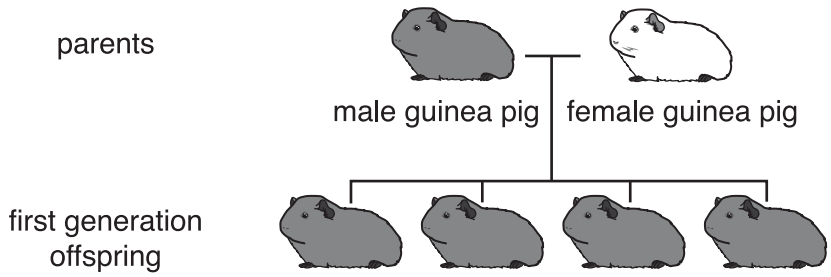


Fig. 9.1

(a) (i) State the phenotypes of each of the parent guinea pigs in Fig. 9.1.

phenotype of the male .....

phenotype of the female .....

[1]

(ii) State the genotype of the female parent guinea pig.

..... [1]

(iii) All of the offspring are heterozygous.

State the genotype of the heterozygous offspring.

..... [1]

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(b) Two of the first generation offspring were crossed.

They produced four second generation offspring.

These are labelled **A**, **B**, **C** and **D** in Fig. 9.2.

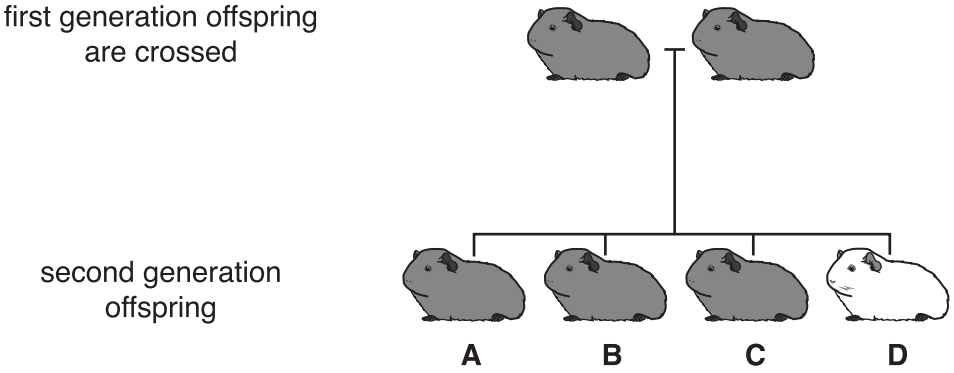


Fig. 9.2

(i) State **all** of the possible genotypes for the three offspring labelled **A**, **B** and **C**.

..... [1]

(ii) State the phenotypic ratio of the second generation of guinea pigs.

..... [1]

[Total: 5]

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3(a)(i)	(male) black (fur) (female) white (fur) ;	1	
3(a)(ii)	**bb** ;	1	
3(a)(iii)	**Bb** ;	1	
3(b)(i)	**BB** and **Bb** ;	1	
9)b)(ii)	3 (black) : 1 (white) ;	1	

4 **(a)** Fig. 10.1 shows the results of crossing a plant with red flowers with a plant with white flowers.

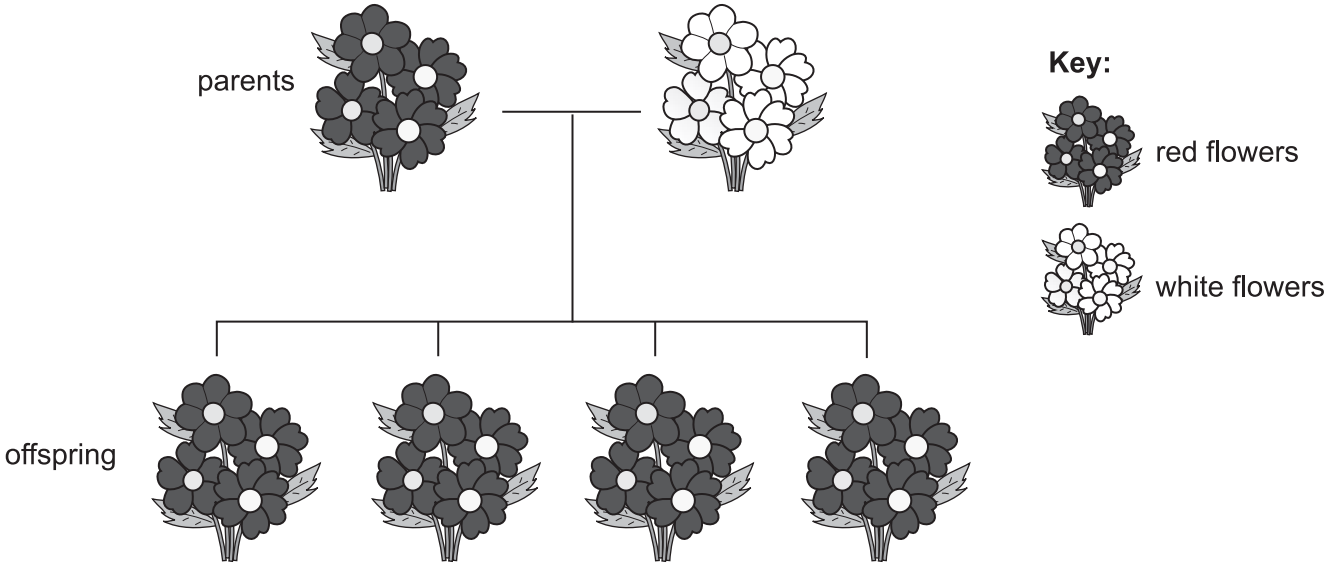


Fig. 10.1

Both of the parent plants were homozygous for flower colour.

All of their offspring had red flowers.

(i) State what is meant by the term homozygous.

.....

.....

..... [1]

(ii) The gene controlling flower colour in this plant species has two alleles:

- **R** is dominant and represents the allele for red flowers
- **r** is recessive and represents the allele for white flowers.

Describe the evidence shown in Fig. 10.1 that supports the fact that **R** is the dominant allele for flower colour in this species of plant.

.....

.....

..... [1]

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(b) Another plant with red flowers was crossed with a plant with white flowers.

Some of the offspring plants from this cross had red flowers and some of the offspring plants had white flowers.

Complete the genetic diagram to show the results of this cross.

	red-flowered plant	X	white-flowered plant
parental genotypes	.....	X	.....

parental gametes ....

offspring genotypes .....

offspring phenotypes .....

[5]

[Total: 7]

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4(a)(i)	has two identical alleles (for a particular gene)**;**	**1**	
4(a)(ii)	(one of the parent plants is white but) all of the offspring have red flowers **;**	**1**	
4(b)	*parental genotypes: (red flower)* **Rr ;** (white flower) **rr ;** *parental gametes:* **R**, **r** and **r**, (**r**) **;** *offspring genotypes:* **Rr** and **rr ;** *offspring phenotypes:* red and white **;**	**5**	

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5 **(a)** A species of pea plant can produce green or yellow peas.

Fig. 3.1 shows a photograph of a green pea and a yellow pea.

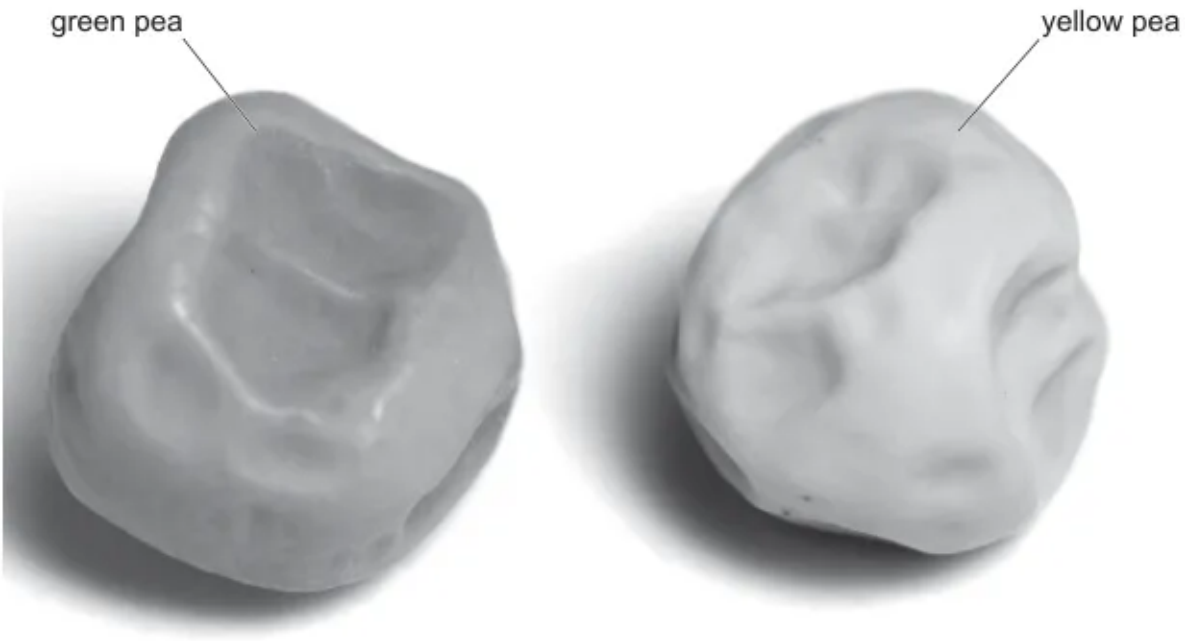


Fig. 3.1

The colour of peas is controlled by a single gene:

- The allele for yellow peas is dominant and is represented by the letter **G**.
- The allele for green peas is recessive and is represented by the letter **g**.

(i) Use your knowledge and this information to complete Table 3.1.

Table 3.1

genotype of pea **A**	
phenotype of pea **B**	
phenotype of a pea with a heterozygous genotype	

[3]

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(ii) Two pea plants were crossed.

Complete the genetic diagram in Fig. 3.2 to show the outcome of the cross.

		parental gametes	
		g	**g**
parental gametes	**G**	.....	.....
	g	.....	.....

ratio of yellow offspring : green offspring ..... : .....

[2]

Fig. 3.2

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(b) Cystic fibrosis is a disease caused by a recessive allele in humans.

Fig. 3.3 is a pedigree diagram showing the inheritance of cystic fibrosis in a family.

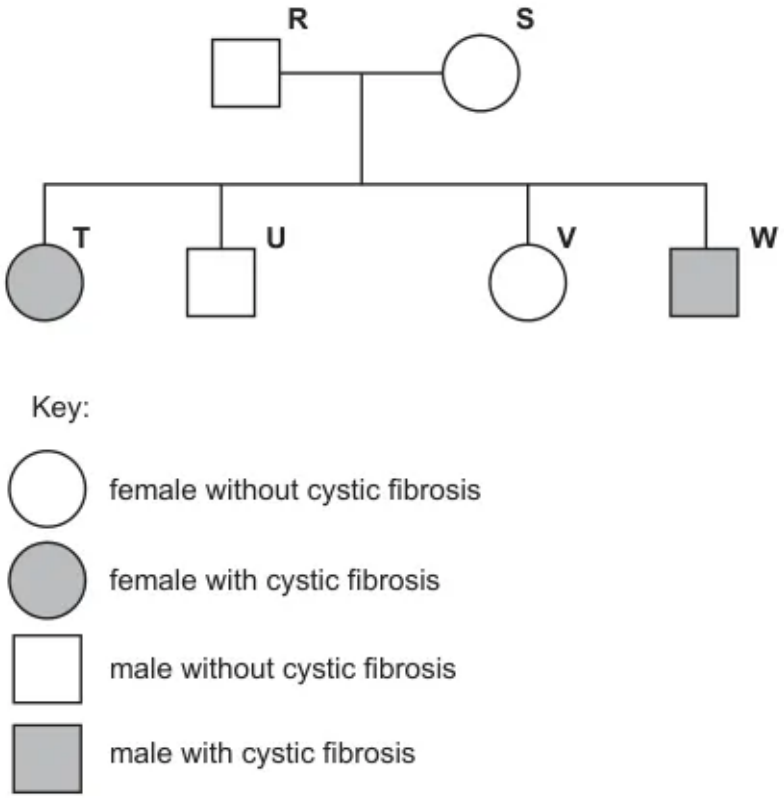


Fig. 3.3

(i) State the number of people that have cystic fibrosis.

..... [1]

(ii) Identify the letter of a person that **must** have a heterozygous genotype.

..... [1]

(iii) Person **U** has a homozygous dominant genotype.

Circle the probability of person **U** having a child with cystic fibrosis.

0% **25%** **50%** **75%** **100%** [1]

[Total: 8]

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5(a)(i)	gg ; yellow ; yellow ;	3	
5(a)(ii)	top row both offspring Gg, bottom row both offspring gg ; 1:1 ;	2	
5(b)(i)	2 ;	1	
5(b)(ii)	**R** / **S** ;	1	
5(b)(iii)	0% circled ;	1	

6 Pea plants produce seeds in pods.

The colour of pea pods is controlled by a single gene.

Some pea pods are green and some are yellow.

The allele for green is dominant and is represented by the letter **G**.

The allele for yellow is recessive and is represented by the letter **g**.

(a) Describe what is meant by the term allele.

.....

..... [2]

(b) Fig. 5.1 is a pedigree diagram for the inheritance of pod colour in some pea plants.

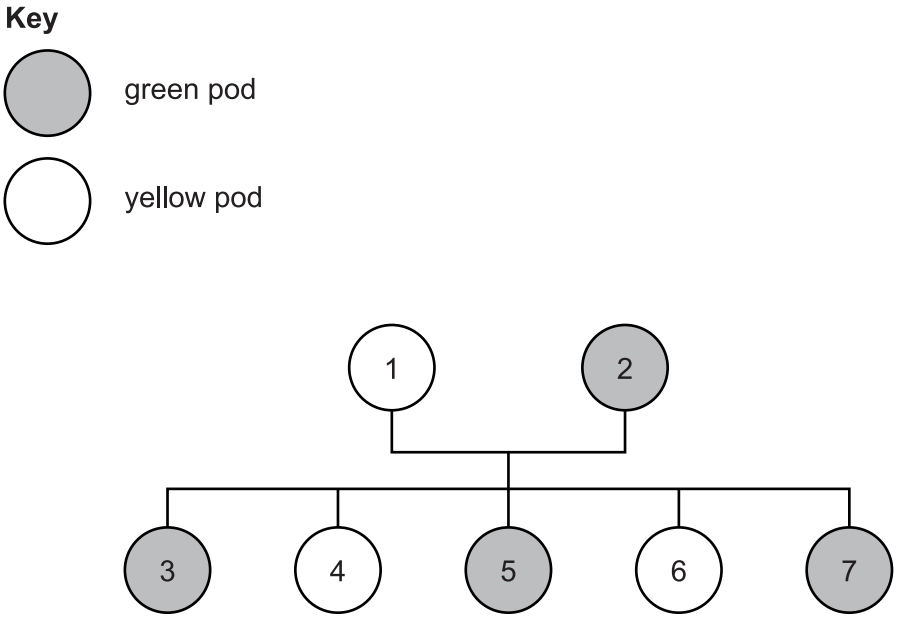


Fig. 5.1

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The possible genotypes for pea pod colour are **GG**, **Gg** and **gg**.

Determine the genotypes of individual 1 and individual 2 in Fig. 5.1.

Explain how you determined your answer for each individual.

individual 1 genotype .....

explanation .....

.....

.....

individual 2 genotype .....

explanation .....

.....

.....

[4]

(c) Two pea plants with the genotype **Gg** for pod colour are bred together.

Complete the Punnett square to determine the possible genotypes of the offspring and calculate the expected phenotypic ratio.

	.....	.....
.....	.....	.....
.....	.....	.....

The expected phenotypic ratio of the offspring is ..... green pods : ..... yellow pods.

[3]

[Total: 9]

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6(a)	alternative form / different versions ; of a gene ;	**2**	
6(b)	*individual 1*: **gg** / homozygous recessive ; it is yellow / it is **not** green ; *individual 2:* **Gg** / heterozygous ; there are yellow offspring ;	**4**	**A** if **G** was present, it would be green **A** individuals **4** and **6** could not be produced (if **GG**) / both pod colours can only be produced if **Gg**
6(c)	both parental gametes are **G** and **g** ; offspring are **GG Gg Gg gg** ; 3 (green pod :) 1 (yellow pod) ;	**3**	**ecf** for incorrect previous step

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7 In tulip plants, the petals can have markings called flecks.
There are two alleles for flecks in tulip plants: with flecks **F**; and without flecks **f**.

(a) Explain the meaning of the term *dominant* allele.

.....

..... [1]

(b) A tulip grower crosses two tulip plants.

He finds that 76 of the offspring have petals with flecks and 23 of the offspring have petals without flecks.

(i) Complete the genetic diagram to explain this result.

parental genotypes ..... X .....

parental phenotypes ..... X .....

gametes (....) (....) X (....) (....)

offspring genotypes ....

offspring phenotypes petals with flecks present petals without flecks

[5]

(ii) The tulip grower wants to produce a pure-breeding variety of tulips with petals without flecks.

State the genotypes of the parent plants he should use to produce tulip plants without flecks. Explain your answer.

parental genotypes ..... X .....

explanation .....

.....

..... [2]

[Total: 8]

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7 **(a)**	the allele that is expressed (if it is present) / AW; always seen in the phenotype; masks (effect of) recessive allele;	**max 1**	**I** 'powerful' defines the phenotype defines characteristic(s)
(b) (i)	*Parent genotype*: Ff , Ff; *Parent phenotype*: (with) flecks × (with) flecks; *Gametes*: F , f, F , f; Working shown to derive genotype; *Offspring genotype*: FF , Ff , ff; linked to correct phenotype	**5**	**ECF** on incorrect key usage **ECF** from each line **A** Punnett square / criss-cross lines
(ii)	ff × ff; parents may be implied as first part of the question asks for parental genotype both parents must have a recessive <u>allele</u> / (if ff × ff) no dominant or F <u>allele</u>, in either parent / (if ff × ff) both parents must be homozygous, recessive / without flecks no parent must be homozygous dominant / presence of (even) one dominant allele in parents could result in flecks;	**2**	**A** Ff × Ff and Ff × ff **ECF** on incorrect key usage from **(i)** **A** gene for allele
		[Total: 8]	

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8 The gene for red-green colour vision is on the **X** chromosome.

There are two alleles for this gene:

- The allele for normal colour vision is represented by the letter **B**.
- The allele for red-green colour blindness is represented by the letter **b**.

Fig. 5.1 shows a pedigree chart for a family in which some of the members are red-green colour-blind.

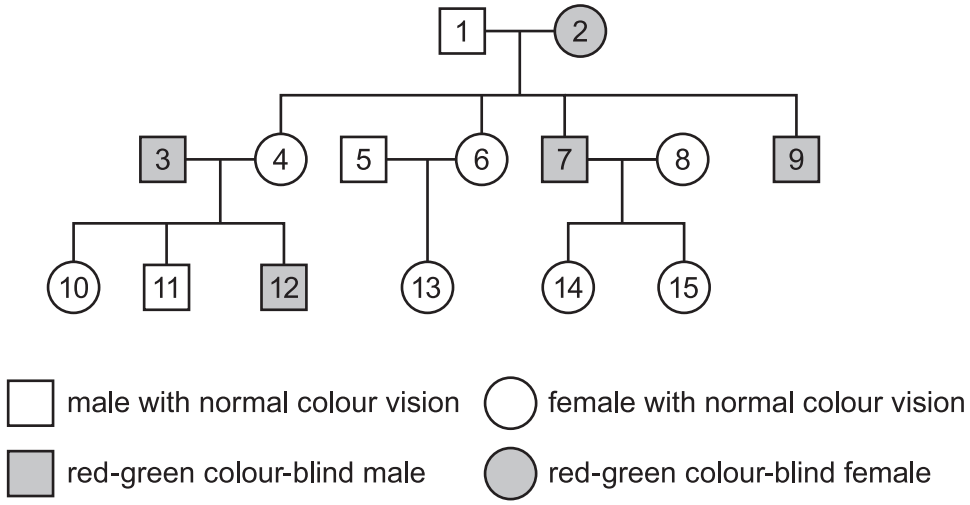


Fig. 5.1

(a) Explain why all of the male children of parent **1** and parent **2** are red-green colour-blind.

.....

.....

.....

.....

..... [2]

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(b) Parent **4** is a female who has normal colour vision and is heterozygous for red-green colour blindness.

Complete the genetic diagram to determine the probability that the offspring of parent **3** and parent **4** would be red-green colour-blind.

parents	**3**	x	**4**
parental phenotypes	red-green colour-blind male	x	female with normal colour vision
parental genotypes	.....	x	.....
gametes	..... , ...	x	..... , ...

offspring genotypes				
offspring phenotypes				

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probability of offspring having red-green colour blindness .....

[5]

[Total: 7]

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8(a)	*any two from:* parent 2, is homozygous recessive / has two alleles (for red-green colour blindness) **;** only parent 2 can provide the X chromosome for male children **;** males only have one X chromosome and they only need one recessive allele (to be red-green colour blind) **;** red-green colour blindness is a sex-linked characteristic **;**	**2**	

8(b)

parental genotypes: parent 3 X^bY **and** parent 4 X^BX^b **;**

gametes: X^b , **Y/0/-** **and** X^B, X^b **;**

offspring genotypes	X^BX^b,	X^BY	X^bX^b	X^bY	**;**
offspring phenotypes	normal (colour vision) female	normal (colour vision) male	colour-blind female	colour-blind male	**;**

probability: 0.5 / 50% **;**

5

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9 Catalase is an enzyme that breaks down hydrogen peroxide inside cells. Red blood cells contain catalase.

Some dogs have an inherited condition in which catalase is not produced. This condition is known as acatalasia and it is caused by a mutation in the gene for catalase.

(a) Define the terms *gene* and *gene mutation*.

gene.....

.....

gene mutation.....

.....

[2]

(b) A geneticist was asked to investigate the inheritance of acatalasia in dogs.

The normal allele is represented by **B** and the mutant allele is represented by **b**.

The geneticist made the diagram in Fig. 3.1 to show the inheritance of acatalasia in a family of dogs. The shaded symbols indicate the dogs with acatalasia.

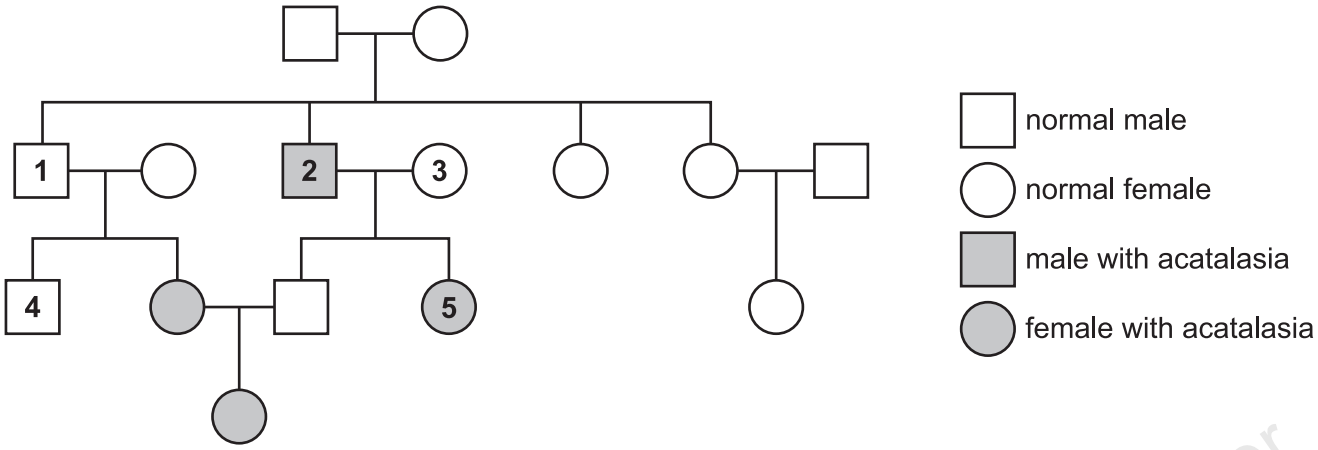


Fig. 3.1

(i) State the genotypes of the dogs identified as **1**, **2** and **3** in Fig. 3.1.

1 .....

2 .....

3 ..... [3]

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(ii) The geneticist crossed dog **4** with dog **5**. Approximately half of the offspring had acatalasia and half the offspring did not have acatalasia.

Complete the genetic diagram to show how this is possible.

	dog **4**	dog **5**
parental phenotypes	normal	has acatalasia
parental genotypes	.....	.....
gametes	..... , ...	+ .....

Punnett square

offspring genotypes.....

offspring phenotypes..... [3]

(iii) State the name given to the type of cross that you have completed in **(b)(ii)**.

..... [1]

[Total: 9]

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9 (a)	*gene* a length of DNA that codes for a protein **;** *gene mutation* a change in <u>base</u> sequence of DNA **;**	[2]	**R** chromosome / molecule of / genome
(b) (i)	1 **Bb ;** 2 **bb ;** 3 **Bb ;**	[3]	
(ii)	(Bb x bb) **B** , **b** + **b** , (**b**) **;** *offspring genotypes* **Bb** and **bb ;** **A** heterozygous and homozygous recessive *offspring phenotypes* normal / carrier and acatalasia **;**	[3]	<table><tr><td colspan="2"></td><td>male gametes</td><td></td></tr><tr><td colspan="2"></td><td>**B**</td><td>**b**</td></tr><tr><td rowspan="2">female gametes</td><td>**b**</td><td>**Bb**</td><td>**bb**</td></tr><tr><td>(**b**)</td><td>(**Bb**)</td><td>(**bb**)</td></tr></table>
(iii)	test (cross) **;**	[1]	
		[Total: 9]	

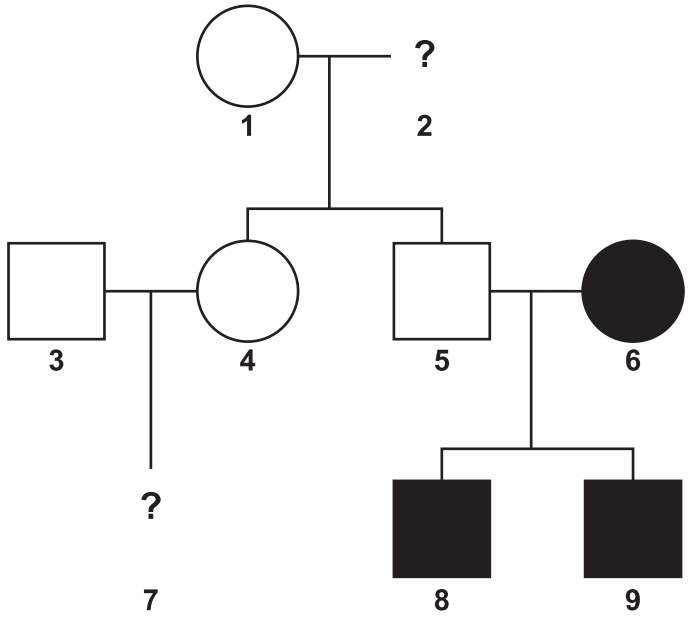
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10 Feather colour in some breeds of chicken is an example of codominance in birds.

In this example, a chicken with white feathers and a chicken with black feathers can breed to produce offspring that have white feathers and black feathers.

The allele for black feathers is F^B and the allele for white feathers is F^W.

Fig. 5.1 is a pedigree diagram of a family of chickens.



Key

Circles represent females and squares represent males.

chickens with black feathers only

chickens with white feathers only

chickens with both black feathers and white feathers

Fig. 5.1

(a) State the type of variation that is caused by genes only.

..... [1]

(b) State **all** the possible genotypes of chicken **2** and chicken **7** in Fig. 5.1.

chicken **2** .....

chicken **7** .....

[2]

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(c) Complete the genetic diagram to show the results of a cross between chicken **5** and chicken **6** in Fig. 5.1.

	chicken **5**		chicken **6**
parental phenotypes	.....	×	.....
parental genotypes	.....	×	.....
gametes	..... , ...		..... , ...

offspring genotypes .....

expected offspring phenotype percentage .....

[5]

(d) State **one** example of codominance in humans.

..... [1]

[Total: 9]

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Reduced to 78% to fit the page (wider than A4).

10(a)	discontinuous **;**	**1**	
10(b)	*chicken 2* – F^BF^B and F^BF^W **;** *chicken 7* – F^WF^W and F^BF^W and F^BF^B **;**	**2**	
10(c)	*phenotypes: (**5**)*(male) black and white (feathers) × *(**6**)(*female) black (feathers) **;** *parental genotypes:* F^BF^W × F^BF^B **;** *gametes:* F^B , F^W F^B , F^B **;** *offspring genotypes:* F^BF^W, (F^BF^W) and F^BF^B, (F^BF^B) **;** *offspring phenotype percentage:* 50(%) black and white and 50(%) black **;**	**5**	ecf from previous step
10(d)	(ABO) blood group / AVP **;**	**1**	

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