Questions

Q1.

Gregor Mendel used pea plants in plant breeding experiments. He discovered the basis of genetic inheritance.
Pea plants produce different coloured peas.

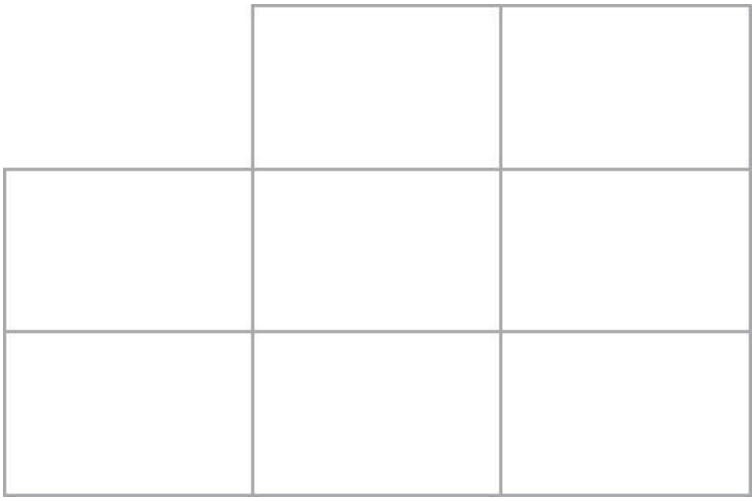
The allele for yellow-coloured peas (A) is dominant to the allele for green-coloured peas (a).

Two heterozygous parent plants were used in a genetic cross.

(i) Predict, using the Punnett square, the percentage probability that this cross will have offspring that produce

green-coloured peas.

(3)



percentage probability of green-coloured peas =.....%

(ii) Explain one advantage to pea plants of using sexual reproduction to produce offspring.

(2)

.....

.....

.....

.....

(Total for question = 5 marks)

Q2.

Gregor Mendel investigated the genetics of peas.

He did not know about genes but showed that inherited characteristics can be dominant or recessive.
Explain how Mendel used homozygous tall and homozygous short pea plants to show that the tall allele is dominant to the short allele.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q3.

Mendel's research on pea plants showed that genetic traits are inherited.

(i) Which term is used to describe the expression of traits in an organism?

(1)

- ☒ A genotype
- ☒ B phenotype
- ☒ C allele
- ☒ D gamete

(ii) Mendel crossed pea plants that produced round seeds with pea plants that produced wrinkled seeds.

All the offspring produced round seeds.

He then crossed these offspring with each other.
Some pea plants in the next generation produced round seeds and the others produced wrinkled seeds.
Explain how this showed that some inherited traits are not expressed in an organism.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 4 marks)

Q4.

(i) Draw a Punnett square to show the offspring from a male homozygous dominant for Huntington's disease and a female homozygous recessive for Huntington's disease.

(2)

(ii) State the probability that the offspring shown in the Punnett square will have Huntington's disease.

(1)

.....

(Total for question = 3 marks)

Q5.

Transcription and translation are stages in the synthesis of proteins.

The inheritance of different alleles affects the phenotype of an individual.

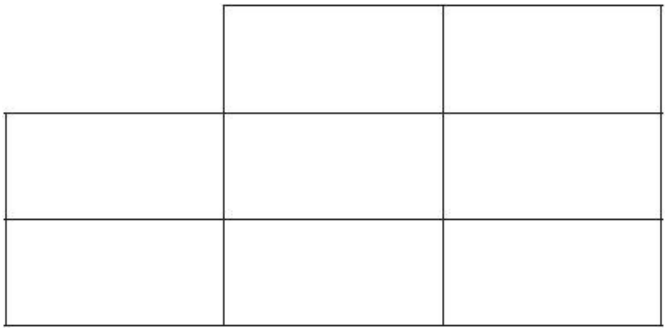
A child is blood group O.

The child's mother is blood group A and the child's father is blood group B.

Explain how this child is blood group O.

Use the Punnett square and probability in your answer.

(6)



.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

Q6.

Explain how two parents with a dominant phenotype can produce offspring expressing a recessive characteristic.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q7.

Explain why sperm determine the sex of offspring at fertilisation.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q8.

Haemochromatosis is a disease that occurs when iron accumulates in the liver.

A person with haemochromatosis is treated by having 0.5 dm3 of their blood removed each week.
This lowers the level of iron in their blood.

(i) Give two safety precautions needed when blood is removed from this person.

(2)

1 .....

.....

2 .....

.....

(ii) Haemochromatosis can be inherited.

Haemochromatosis occurs when a person inherits two copies of a recessive allele.
Figure 9 shows the inheritance of haemochromatosis in a family.

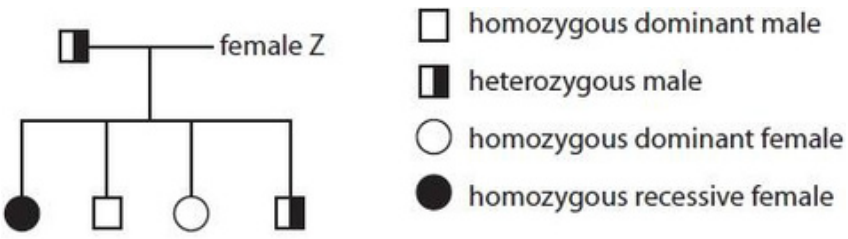


Figure 9

State and explain the genotype of female Z.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 5 marks)

Q9.

The allele for blood group A and the allele for blood group B are codominant.

Gregor Mendel investigated the inheritance of alleles using flowering plants.

He showed that the allele for red flowers (IR) is codominant with the allele for white flowers (IW).

A heterozygous plant produces pink flowers.

(i) Give the genotype for a plant producing white flowers.

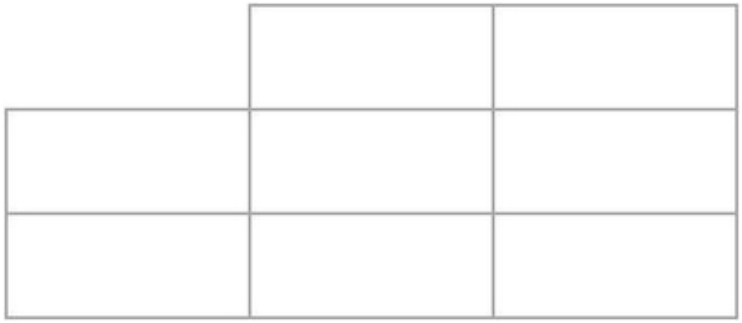
(1)

.....

(ii) Explain the outcome if two plants that produce pink flowers are crossed.

You should complete the Punnett square as part of your answer.

(4)



.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 5 marks)

Q10.

Haemochromatosis is a disease that occurs when iron accumulates in the liver.

A person with haemochromatosis is treated by having 0.5 dm3 of their blood removed each week.
This lowers the level of iron in their blood.

(i) Give two safety precautions needed when blood is removed from this person.

(2)

1 .....

.....

2 .....

.....

(ii) Haemochromatosis can be inherited.

Haemochromatosis occurs when a person inherits two copies of a recessive allele.
Figure 6 shows the inheritance of haemochromatosis in a family.

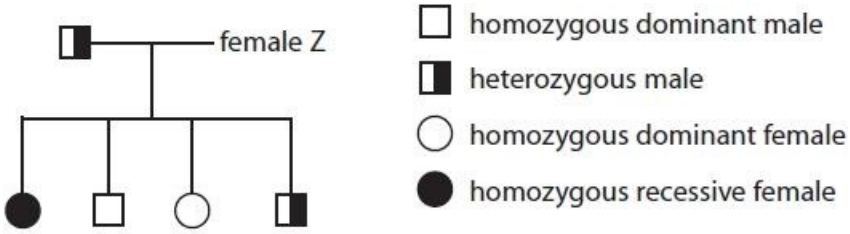


Figure 6

State and explain the genotype of female Z.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 5 marks)

Q11.

Duchenne muscular dystrophy is a recessive sex-linked genetic disorder. This disorder causes muscle weakness.
Figure 14 shows the inheritance of Duchenne muscular dystrophy in a family.

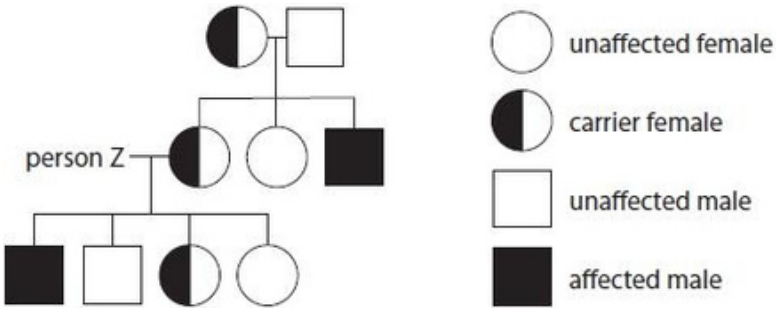


Figure 14

State and explain the phenotype of person Z.

(3)

.....

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q12.

Huntington's disease is a genetic disorder.
Huntington's disease is caused by a dominant allele (H).
Figure 6 shows the inheritance of Huntington's disease in a family.

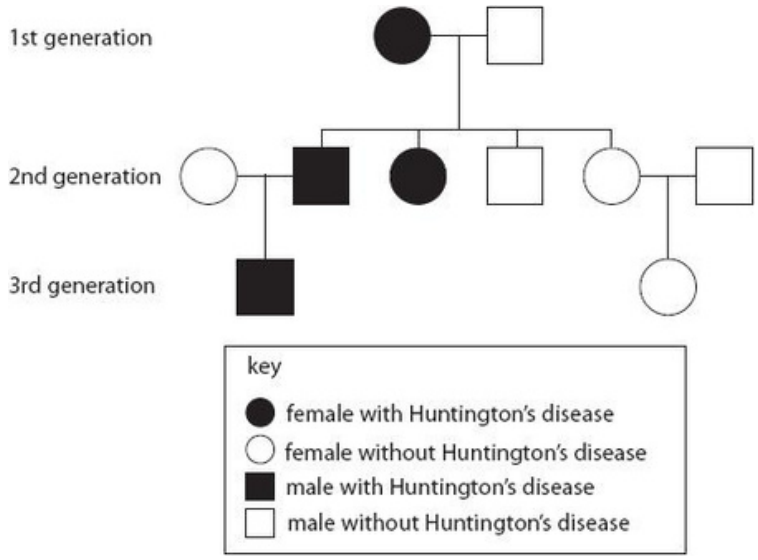


Figure 6

(i) State the genotype of the male in the 1st generation.

(1)

.....

(ii) It is possible for a female with Huntington's disease to have one of two genotypes.
State the two genotypes possible for a female with Huntington's disease.

(2)

.....

.....

(iii) Explain which Huntington's disease genotype the female in the 1st generation must be.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

Q13.

Duchenne muscular dystrophy is a sex-linked recessive genetic disorder caused by a mutation on a single gene on the X-chromosome.
The letter D can be used for the dominant allele and the letter d for the recessive allele.

Figure 5 shows the inheritance of Duchenne muscular dystrophy in a family.

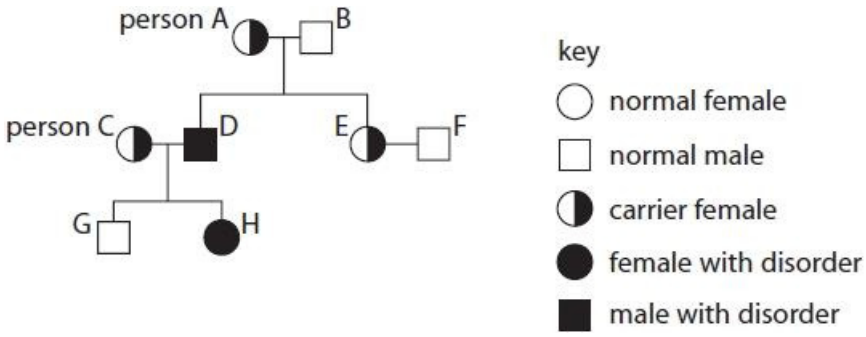


Figure 5

(i) What is the percentage chance of any child from person A inheriting the mutated allele?

(1)

☒ A 0%

☒ B 25%

☒ C 50%

☒ D 75%

(ii) Explain the conclusion that can be made about the genotype of person C.

(2)

.....

.....

.....

.....

(Total for question = 3 marks)

Q14.

The DNA of an organism determines its phenotype.

White tigers are produced because of a mutation of a single allele which usually produces the normal orange and yellow fur pigmentation.
The mutated allele is recessive.

Samba, a male white tiger, was bred with Rani. They had three offspring; two offspring have white fur and one has a normal fur pigmentation.

(i) State the genotype of Rani.

(1)

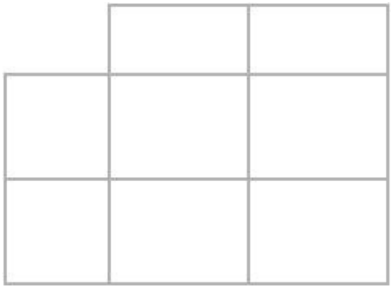
.....

.....

(ii) The offspring with normal fur pigmentation was bred with a tiger that was heterozygous.

Use A/a to represent the alleles for fur pigmentation.
Predict, using the Punnett square, the percentage probability of the offspring from this cross having normal fur pigmentation.

(2)



percentage probability = ... %

(Total for question = 3 marks)

Q15.

Sickle cell disease is a recessive genetic disorder in humans.

(i) Two parents are heterozygous for sickle cell disease.

Complete the Punnett square to show the possible genotypes of their children.

(1)

	D	d
D		
d		

(ii) State the percentage probability that their children could have sickle cell disease.

(1)

percentage probability = ... %

(iii) A father with the genotype dd and a mother with the genotype DD plan to have several children.

Explain why none of their children will have sickle cell disease.

(2)

.....

.....

.....

.....

.....

.....

(Total for question = 4 marks)

Q16.

Eye colour is controlled by genes.

The allele for brown eyes, B, is dominant to the allele for blue eyes, b.

(a) A female with blue eyes and a male with brown eyes are about to have a child.
Complete the Punnett square to determine the phenotype of the child.

(2)

		man	
		B	B
woman	b		
	b		

Phenotype of child

.....

(b) A scientist recorded the eye colour of 30 people.
The results are shown in Figure 1.

blue	green	blue	brown	brown	brown	hazel	blue	
brown	hazel	blue	blue	hazel	green	brown	brown	
blue	green	brown	brown	blue	hazel	blue	brown	brown
brown	blue	brown	brown	brown				

Figure 1

(i) Complete the tally chart, in Figure 2, for this data.

(2)

eye colour			
blue	brown	green	hazel
total.....	total.....	total.....	total.....

Figure 2

(ii) Give another appropriate method of displaying this information.

(1)

.....

.....

(Total for question = 5 marks)

Q17.

Figure 1 shows a pea plant with flowers.

Figure 1

The seeds produced by this pea plant can be round or wrinkled.

The allele for round seeds (R) is dominant to the allele for wrinkled seeds (r).

(i) A homozygous dominant round seeded plant was crossed with a homozygous recessive wrinkled seeded plant.

Complete the Punnett square to show the genotypes of the offspring.

(1)

	r	r
R		
R		

(ii) State the percentage of the offspring that will produce round seeds.

(1)

percentage = ... %

(iii) Which scientist discovered the basis of genetic inheritance by crossing pea plants?

(1)

- ☒ A Charles Darwin
- ☒ B Alfred Wallace
- ☒ C Louis Leakey
- ☒ D Gregor Mendel

(Total for question = 3 marks)

Q18.

Sickle cell anaemia is a recessive genetic condition that affects the shape of a person's red blood cells.
A child inherits either a dominant or a recessive allele from each parent.
A child must inherit two recessive alleles to be affected by the condition.
(i) Figure 2 shows a Punnett square with the parental genotypes completed.

The letter B has been used for the dominant allele and the letter b for the recessive allele.
Complete the Punnett square to show the genotypes of the offspring.

(1)

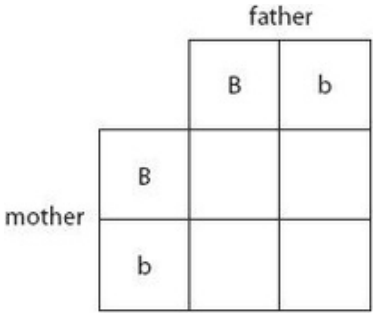


Figure 2

(ii) Calculate the percentage chance of a child being born with sickle cell anaemia.

(1)

..... %

(iii) Give the reason why the parents' genotype is described as heterozygous.

(1)

.....

.....

(Total for question = 3 marks)

Q19.

Gregor Mendel investigated the genetics of peas.

He did not know about genes but showed that inherited characteristics can be dominant or recessive.

(a) Explain how Mendel used homozygous tall and homozygous short pea plants to show that the tall allele is dominant to the short allele.

(2)

.....

.....

.....

*(b) Figure 16 shows a drosophila fruit fly.

(Source: Science Photo Library)

Figure 16

The brown body colour of a drosophila fruit fly is dominant to black body colour and is not sex-linked.

Explain how Gregor Mendel could have used a brown drosophila fruit fly and a black drosophila fruit fly to show that brown body colour is dominant to black body colour.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 8 marks)

Q20.

Cystic fibrosis is a genetic condition that can also cause liver disease.

(i) State where genes are found in cells.

(1)

.....

(ii) Figure 6 shows the inheritance of cystic fibrosis in a family.

F represents the dominant allele that does not cause cystic fibrosis.
f represents the recessive allele that causes cystic fibrosis.

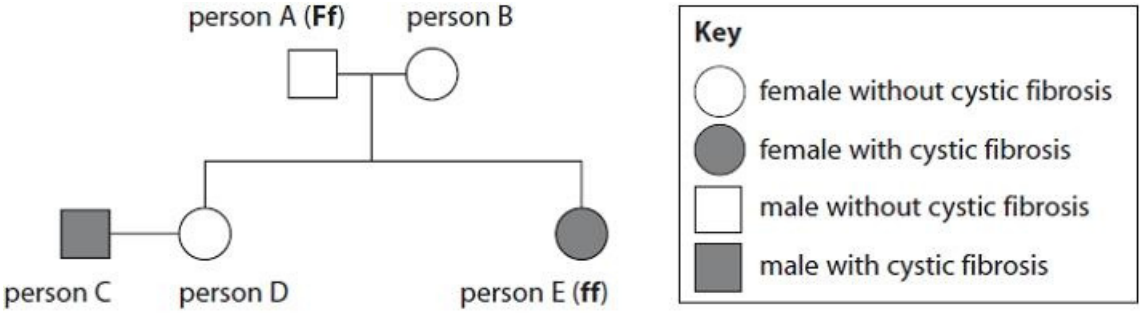


Figure 6

A scientist states that the genotype of person B is Ff.
Explain why the scientist is correct.

(2)

.....

.....

.....

.....

(iii) State the genotype of person C.

(1)

.....

(Total for question = 4 marks)

Q21.

Gregor Mendel investigated genetic inheritance using pea plants.

Figure 3 shows some of the equipment used in this investigation.

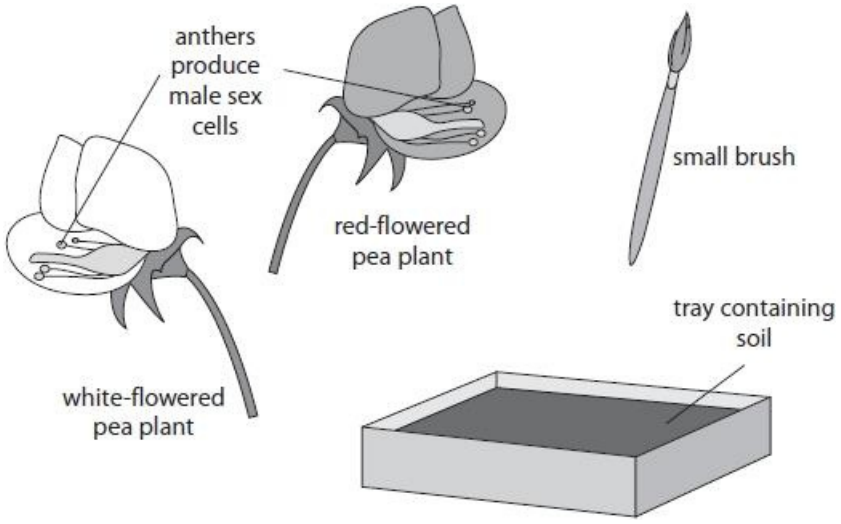


Figure 3

In an investigation, Mendel crossed pea plants that produced yellow seeds (AA) with pea plants that produced green seeds (aa).

The dominant allele is shown as A.

The Punnett square shows the genotypes of the offspring from this cross.

	A	A
a	Aa	Aa
a	Aa	Aa

Explain a conclusion that can be made from the results of this cross.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
(i)	One mark for gametes One mark for the offspring 25 (%) (1)	accept aA accept ecf from the Punnett square	(3) AO3 2a+2b Exp

	A	a
A	AA	Aa
a	Aa	aa

Question number	Answer	Additional guidance	Mark
(ii)	An answer linking the following: • genetic variation increase / (offspring) show variation (1) • more likely to survive {a disease / environmental change / selection pressure} / allows evolution/survival of the fittest (1)	 accept different combination of alleles accept allows dispersal of offspring through seeds accept other examples of a survival reason e.g natural disaster	(2) AO2 1

Q2.

Question number	Answer	Mark
	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • Mendel crossed homozygous tall and homozygous short pea plants and produced all tall offspring (1) • therefore all the offspring had a heterozygous genotype with one tall and one short allele showing that the tall allele is dominant (1)	(2)

Q3.

Question Number	Answer	Mark
(i)	B phenotype **1. The only correct answer is B** ***A** is not correct because genotype is the combination of alleles* ***C** is not correct because an allele is an alternative version of a gene* ***D** is not correct because gametes are sex cells*	**(1)** AO 1 1

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation linking three of the following: • the first generation were heterozygous (1) • offspring {needed two wrinkled alleles/are homozygous} to have wrinkled seeds (1) • 25% offspring have wrinkled seeds (1) • wrinkled is recessive / round is dominant (1)	accept first generation are carriers accept traits for alleles accept 1 in 4 wrinkled seeds are homozygous recessive = 2 marks accept annotated Punnett squares/ genetic diagrams	**(3)** AO 2 1

Q4.

Question number	Answer	Additional guidance	Mark
(i)	<table><tr><td></td><td>H</td><td>H</td></tr><tr><td>h</td><td>Hh</td><td>Hh</td></tr><tr><td>h</td><td>Hh</td><td>Hh</td></tr></table> accept male and female genotypes reversed Correct gametes (1) Correct offspring (1)	accept other letters accept correct offspring genotypes for incorrect gametes as error carried forward accept alternative correct genetic diagrams instead of Punnett square	(2)

Question number	Answer	Additional guidance	Mark
(ii)	100% / 1	accept 4 out of 4/ all offspring ecf for their offspring in the Punnett square Ignore ratios	(1)

Q5.

Question number	Indicative content	Mark
	AO2 I^B | I^o I^A | $I^A I^B$ | $I^A I^o$ I^o | $I^o I^B$ | $I^o I^o$ Indicative content • I^o is recessive to I^A or I^B • mothers genotype must be $I^A I^o$ • fathers genotype must be $I^B I^o$ • child must inherit two recessive I^o alleles • child genotype of $I^o I^o$ • offspring have 25% chance of being blood group O	**(6)** AO2(1)

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1-2	• The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3-4	• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5-6	• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Q6.

Question number	Answer	Mark
	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • both parents must be heterozygous for the recessive allele (1) • so the offspring must inherit the recessive allele from each parent (1)	**(2)**

Q7.

Question number	Answer	Mark
	An explanation that combines identification of knowledge (1 mark) and reasoning / justification –understanding (1 mark): • sperm can either carry an X or a Y (chromosome) / egg cells carry only X (chromosomes) (1) • XX results in female and XY in a male (1)	**(2)**

Q8.

Question Number	Answer	Additional Guidance	Mark
(i)	Any **two** from: • wear gloves (1) • clean the area of skin where blood being removed (1) • cover the wound after (1) • use a sterile needle (1)	 accept wash hands / wear a mask accept disinfect / clean the wound ignore clean accept sit the person down (1) ignore references to removing the correct volume of blood	**(2)** **AO2 2**

Question Number	Answer	Additional Guidance	Mark
(ii)	• heterozygous An explanation linking: • affected offspring must have inherited the recessive allele (1) • unaffected offspring must have inherited dominant allele (1)	accept carrier / dominant and recessive allele / Hh accept one offspring is homozygous recessive accept one / two offspring are homozygous dominant accept a **labelled** Punnett square for any mark point	**(3)** **AO3**

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	I^WI^W / homozygous I^W	accept WW ignore homozygous dominant	(1) AO2 1

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation linking the following: • correct gametes / parental genotype (1) • correct completion of the Punnett square (1) I^W / I^R / I^W / I^WI^W / I^WI^R / I^R / I^RI^W / I^RI^R • 50% offspring will produce pink flowers (1) • 25% will produce white flowers and 25% will produce red flowers (1)		(4) AO3

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	Any **two** from: • wear gloves (1) • clean the area of skin where blood being removed (1) • cover the wound after (1) • use a sterile needle (1)	 accept wash hands / wear a mask accept disinfect / clean the wound ignore clean accept sit the person down (1) ignore references to removing the correct volume of blood	**(2)** **AO2 2**

Question Number	Answer	Additional Guidance	Mark
(ii)	• heterozygous An explanation linking: • affected offspring must have inherited the recessive allele (1) • unaffected offspring must have inherited dominant allele (1)	accept carrier / dominant and recessive allele / Hh accept one offspring is homozygous recessive accept one / two offspring are homozygous dominant accept a **labelled** Punnett square for any mark point	**(3)** **AO3**

Q11.

Question Number	Answer		Mark
	Phenotype: • must be unaffected male (1) Explanation including the following: • he has the dominant allele / males have one copy of the allele as is on the X chromosome (1) • (needs a dominant allele) in order to have an unaffected daughter (1)	accept X^DY (accept any other capital letter) for 1 mark accept a Punnett square to show marking points if annotated.	**(3)** AO 3 1b AO 3 2a AO 3 2b

Q12.

Question number	Answer	Additional guidance	Mark
(i)	Homozygous recessive / 2 lower case letters e.g. hh	accept any recognisable upper/lower case letters as appropriate	**(1)**

Question number	Answer	Additional guidance	Mark
(ii)	• Homozygous dominant / HH(1) • Heterozygous / Hh (1)	accept any recognisable upper/lower case letters as appropriate	**(2)**

Question number	Answer	Additional guidance	Mark
(iii)	An explanation that combines identification via a judgment (1 mark) to reach a conclusion via justification/reasoning (2 marks): • the female in the 1st generation is heterozygous / Hh (1) • because some of her children had Huntington's / some of her children did not have Huntington's (1) • to have the disease they must inherit a dominant allele / to not have the disease they must inherit (two) recessive alleles (1)	accept if she was HH all her children would have Huntington's accept correct Punnett square with identification for 2 marks	(3)

Q13.

Question number	Answer	Mark
(i)	C	(1)

Question number	Answer	Mark
(ii)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • genotype is X^DX^d/she must have one dominant and one recessive allele (1) • because her daughter must have received the recessive allele and her son has inherited a dominant allele (1)	(2)

Q14.

Question number	Answer	Additional guidance	Mark
(i)	• heterozygous	accept alleles showing heterozygous genotype	(1)

Question number	Answer	Mark
(ii)	• correct Punnett square (1) • 75% normal fur pigmentation (1)	(2)

	A	a
A	AA	Aa
a	Aa	aa

Q15.

Question Number	Answer	Mark
(i)		(1) AO3 2a

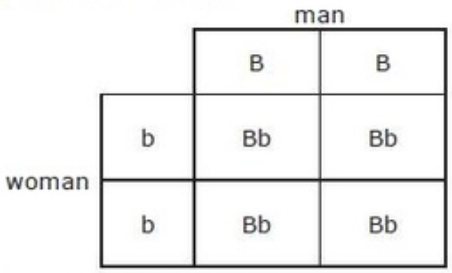
	D	d
D	DD	Dd
d	Dd	dd

Accept dD for Dd

Question Number	Answer	Mark
(ii)	25 (%)	(1) AO3 2b

Question Number	Answer	Additional guidance	Mark
(iii)	An explanation including: • all the children will have the genotype Dd / will be heterozygous (1) • but to have sickle cell disease the children must have {the genotype dd / two recessive alleles} (1)	accept children will always inherit a dominant allele / D from their mother accept a correctly completed Punnett square for this marking point	**(2)** **AO2 1**

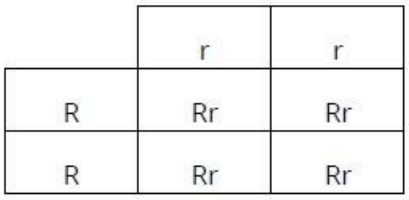
Q16.

Question number	Answer	Mark
(a)	A completed Punnett square, including: • offspring alleles correct (1)  • phenotype of child: brown eyes (1)	**(2)**

Question number	Answer	Additional guidance	Mark
(b)(i)	• All four columns correct (tally and total) (2) • One or two correct columns (1)	blue: 9 brown: 14 green: 3 hazel: 4	**(2)**

Question number	Answer	Mark
(b)(ii)	Could be displayed as a bar chart/pie chart	**(1)**

Q17.

Question number	Answer		Mark
(i)	 Correct offspring (1)	Accept rR	**(1)** AO2

Question number	Answer	Additional guidance	Mark
(ii)	100% (1)	accept correct percentage from incorrect Punnett square in i.	**(1)** AO2

Question number	Answer	Mark
(iii)	D Gregor Mendel **iii The only correct answer is D** ***A*** *is not correct because Charles Darwin did not discover the basis of genetic inheritance* ***B*** *is not correct because Alfred Wallace did not discover the basis of genetic inheritance* ***C*** *is not correct because Louis Leakey did not discover the basis of genetic inheritance*	**(1)** AO1

Q18.

Question number	Answer	Additional guidance	Mark
(i)	correct offspring (1) B B B b B B B B b b B b b b	accept bB for Bb	(1)

Question number	Answer	Additional guidance	Mark
(ii)	25(%)	ecf for incorrect Punnett square in 1bi	(1)

Question number	Answer	Additional guidance	Mark
(iii)	two different **alleles**/a dominant and recessive allele	accept they are carriers ignore they are not affected	(1)

Q19.

Question number	Answer	Mark
(a)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • Mendel crossed homozygous tall and homozygous short pea plants and produced all tall offspring (1) • therefore all the offspring had a heterozygous genotype, with one tall and one short allele showing that the tall allele is dominant (1)	(2)

Question number	Indicative content	Mark
*(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO2 (6 marks)** • cross the brown fruit fly and black fruit fly • identify the phenotype of the offspring • all the phenotype will be brown body • remove the parent flies • cross brown offspring • identify the phenotypes of the 2nd generation offspring • $\frac{1}{4}$ will be black body and $\frac{3}{4}$ will be brown body • the results would show the same ratio as Mendel's pea plant crosses	(6)

Level	Mark	Descriptor
	0	No awardable content
Level 1	1–2	• The explanation attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. (AO2) • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3–4	• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. (AO2) • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5–6	• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. (AO2) • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Q20.

Question number	Answer	Additional guidance	Mark
(i)	in the nucleus / on a chromosome	accept on DNA / it is part of DNA accept in mitochondria	**(1)** **AO1 1**

Question number	Answer	Additional guidance	Mark
(ii)	An explanation including: • person B must have an F allele because she does not have cystic fibrosis (1) • person B must have an f allele because person E must have inherited an f allele from her (1)	accept because person E is ff / homozygous recessive	(2) AO2 2

Question number	Answer	Additional guidance	Mark
(iii)	ff (both letters must be lower case)	accept: homozygous recessive accept: double recessive accept: 'two small fs'	(1) AO2 1

Q21.

Question Number	Answer	Mark
	Any two from: • **all** offspring are the same/Aa / produced yellow seeds/have same genotype (1) • as dominant allele (A) present in genotype of offspring)/ are heterozygous (1) • proves that both parents are homozygous (1)	(2) AO 3 2a AO 3 2b