

Question number	Answer	Mark
1(a)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): <ul style="list-style-type: none"> • 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	Answer	Mark
1(b)(i)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): <ul style="list-style-type: none"> • asexual reproduction is a rapid reproduction technique allowing the production of more plants • as there is no requirement for cross pollination/higher crop yield/increased profit 	(2)

Question number	Answer	Mark
1(b)(ii)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): <ul style="list-style-type: none"> • introduces variation into the population • which allows for natural selection of fitter plants/increased chance of the population surviving 	(2)

Question number	Answer	Mark
1(c)(i)	C	(1)

Question number	Answer	Mark
1(c)(ii)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): <ul style="list-style-type: none"> • genotype is $X^D X^d$/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)

Question number	Answer	Mark
2(a)(i)	B	(1)

Question number	Answer	Mark
2(a)(ii)	TACGTACATGGC	(1)

Question number	Answer	Additional guidance	Mark
2(a)(iii)	<ul style="list-style-type: none"> 3.33×10^{-10} equals 0.33 nm (1) $0.33 \times 250 = 82.5$ (nm) (1) 	<p>maximum one mark if no conversion to nm</p> <p>award full marks for correct numerical answer without working</p>	(2)

Question number	Answer	Additional guidance	Mark
2(b)(i)	<ul style="list-style-type: none"> heterozygous 	accept alleles showing heterozygous genotype	(1)

Question number	Answer	Mark									
2(b)(ii)	<ul style="list-style-type: none"> correct Punnett square (1) <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>A</td> <td>a</td> </tr> <tr> <td>A</td> <td>AA</td> <td>Aa</td> </tr> <tr> <td>a</td> <td>Aa</td> <td>aa</td> </tr> </table> <ul style="list-style-type: none"> 75% normal fur pigmentation (1) 		A	a	A	AA	Aa	a	Aa	aa	(2)
	A	a									
A	AA	Aa									
a	Aa	aa									

Question number	Answer	Mark
2(c)	<p>An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark):</p> <ul style="list-style-type: none"> both parents must be heterozygous for the recessive allele (1) so the offspring must inherit the recessive allele from each parent (1) 	(2)

Question Number	Answer	Acceptable answers	Mark
3(a)(i)	D ☒ homozygous recessive		(1)

Question Number	Answer	Acceptable answers	Mark
3(a)(ii)	<p>A description to include three of the following points:</p> <p>tired / lethargic (1)</p> <p>short of breath / reduced oxygen carrying capacity / problems exercising (1)</p> <p>swelling of hands and feet (1)</p> <p>painful / weak joints (1)</p> <p>blocked blood vessels / blood clots(1)</p>	<p>Accept weak/fatigued/</p> <p>Accept difficulty breathing</p> <p>Accept reference to pain or painful episodes/sickle cell crisis</p> <p>Ignore references to the shape of the red blood cell</p> <p>Ignore references to mucus</p>	(3)

Question Number	Answer	Acceptable answers	Mark									
3(b)(i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>D</td> <td>d</td> </tr> <tr> <td>D</td> <td>DD</td> <td>Dd</td> </tr> <tr> <td>D</td> <td>DD</td> <td>Dd</td> </tr> </table> <p>correct gametes (1)</p> <p>correct offspring genotypes (1)</p>		D	d	D	DD	Dd	D	DD	Dd	<p>Allow ECF for incorrect gametes</p>	(2)
	D	d										
D	DD	Dd										
D	DD	Dd										

Question Number	Answer	Acceptable answers	Mark
3(b)(ii)	50(%) (1) 0(%) (1)	Answers must be in this order Possible ecf from the candidates Punnett square Clip together with 1bi	(2)

Total for Question 3 = 8 marks

Question Number	Answer	Acceptable answers	Mark
4(a)(i)	75%		(1)

Question Number	Answer	Acceptable answers	Mark
4(a)(ii)	<p>An explanation linking two of the following:</p> <ul style="list-style-type: none"> • Punnett square would predict 50% normal 50% carrier (1) • actual offspring are not 50% carrier (1) • the probability is applied to each child not the overall offspring (1) 	<p>accept ratios or probabilities instead of percentages</p> <p>actual offspring are 75%</p> <p>accept references to random assortment</p>	(2)

Question Number	Answer	Acceptable answers	Mark									
4(a)(iii)	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>b</td> <td>b</td> </tr> <tr> <td>B</td> <td>b</td> <td>Bb</td> </tr> <tr> <td>b</td> <td>bb</td> <td>bb</td> </tr> </table> <p>Probability = 50%</p> <p>Ratio 2/4, 2:2, can be given for probability</p> <p>1 mark for correct gametes</p> <p>1 mark for completed Punnett square with correct probability</p>		b	b	B	b	Bb	b	bb	bb	<p>Accept reverse order for gametes</p> <p>Accept letters other than B/b (but alleles must be the same letter)</p> <p>50% mark can only be given if 50% of the offspring are homozygous recessive</p>	(2)
	b	b										
B	b	Bb										
b	bb	bb										

Question Number	Answer	Acceptable answers	Mark
4(a)(iv)	A <input checked="" type="checkbox"/> homozygous dominant (BB)		(1)

Question Number	Indicative Content	Mark									
QWC	<p>*4(b) A explanation to include some of the following points:</p> <p>Pedigree analysis would show the likelihood of their offspring inheriting the disorder Pedigree analysis should also be carried out on the partners of the third generation.</p> <ul style="list-style-type: none"> • X is not a carrier • X is homozygous dominant • and does not have sickle cell disease • The parents of X are heterozygous / his sister has sickle cell • so will not pass on the allele for the disease to offspring • if his partner is a carrier • there will be a 50% chance of the child being a carrier • Y and Z are carriers of the sickle cell allele • Y and Z are heterozygous • The mother of Y has sickle cell / Y will inherit the sickle cell allele • The parents of Z do not have sickle cell / mother is a carrier/heterozygous • They have a 50% chance of passing the sickle cell allele onto their potential offspring • If their partners were also carriers • There would be a 25% chance that the offspring will have the sickle cell disease • There would be a 50% chance that the offspring would also carry the allele for sickle cell disease <p>Example Punnett square:</p> <table border="1" data-bbox="628 1316 1129 1428" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>B</td> <td>b</td> </tr> <tr> <td>B</td> <td>BB</td> <td>Bb</td> </tr> <tr> <td>b</td> <td>Bb</td> <td>bb</td> </tr> </table>		B	b	B	BB	Bb	b	Bb	bb	(6)
	B	b									
B	BB	Bb									
b	Bb	bb									
Level	0	No rewardable content									
1	1 - 2	<ul style="list-style-type: none"> • a limited explanation the genetic profile of X,Y and Z or an explanation of the use of pedigree analysis • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy 									
2	3 - 4	<ul style="list-style-type: none"> • A simple explanation of the genetic profile of X, Y and Z and an explanation of the use of pedigree analysis • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy 									
3	5 - 6	<ul style="list-style-type: none"> • a detailed explanation of the genetic profile of X, Y and Z and explanation of the use of pedigree analysis plus either an explanation of one genotype or a prediction of one of the offspring outcomes • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors 									

Question Number	Answer	Acceptable answers	Mark
5a (i)	D - ff		(1)

Question Number	Answer	Acceptable answers	Mark
5a (ii)	<p>An explanation linking two of the following:</p> <ul style="list-style-type: none"> • mucus blocks (pancreatic) duct /small intestine wall / digestive system(1) • preventing enzymes/named enzyme being released (into small intestine) (1) • less digestion of food (1) • less absorption (1) 		(2)

Question Number	Answer	Acceptable answers	Mark
5b (i)	an individual who has one recessive allele and one dominant allele (1)	2 different alleles	(1)

Question Number	Answer	Acceptable answers	Mark
5b (ii)	<p>An explanation to include two of the following:</p> <ul style="list-style-type: none"> • Rebecca is homozygous dominant(for CF)(1) • Rebecca has (inherited) one dominant allele from each parent(1) • cystic fibrosis involves the inheritance of two recessive alleles (1) 	Rebecca has (inherited) 2 dominant alleles	(2)

Question Number	Indicative Content	Mark									
QWC *5(c)	<p>An explanation including the following points:</p> <ul style="list-style-type: none"> A Punnett square or genetic diagram showing the following gametes and offspring <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>D</td> <td>d</td> </tr> <tr> <td>d</td> <td>Dd</td> <td>dd</td> </tr> <tr> <td>d</td> <td>Dd</td> <td>dd</td> </tr> </table> <ul style="list-style-type: none"> mother gametes = d, d father gametes = D, d offspring = 50% Dd, 50% dd probability of offspring with sickle cell disease = 50% probability of carrier / heterozygous = 50% both parents will give one allele to the possible offspring the father can give either the dominant or recessive allele the mother can only give a recessive allele a dominant and recessive allele will result in heterozygous offspring 		D	d	d	Dd	dd	d	Dd	dd	(6)
	D	d									
d	Dd	dd									
d	Dd	dd									

Level	0	No rewardable content
1	1 - 2	<ul style="list-style-type: none"> Limited written explanation is provided by the candidate of the inheritance and / or a genetic diagram/ Punnett square with only correct gametes or offspring the answer communicates ideas using simple language and uses limited scientific terminology spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	<ul style="list-style-type: none"> The genetic diagram/ Punnett square is correct for both gametes and offspring with a simple explanation the answer communicates ideas showing some evidence of clarity and organisation and mostly uses scientific terminology appropriately spelling, punctuation and grammar are used with some accuracy
3	5 - 6	<ul style="list-style-type: none"> The Punnett Square/genetic diagram is complete and accurate for both gametes and offspring plus percentage outcomes and a detailed explanation of inheritance of CF the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately spelling, punctuation and grammar are used with few errors