Question Number	Answer	Acceptable answers	Mark
1(a)(i)	XX	ignore any superscript or subscript letters/symbols reject XY	**(1)**

Question Number	Answer	Acceptable answers	Mark
1(a)(ii)	An explanation linking two of the following they did not inherit the (haemophilia) allele (1) (allele is) located on X chromosome (1) males receive X chromosome from their mother/Y chromosome from father (1) B is homozygous dominant/ neither X chromosome from B has the allele for haemophilia (1)	ignore gene throughout accept have the dominant/normal allele accept disorder is located on the X chromosome ignore mother is unaffected accept mother neither affected **nor** a carrier accept mother for B and father for A	**(2)**

Question Number	Answer	Acceptable answers	Mark
1(a)(iii)	<table><tr><td></td><td>X^H</td><td>Y</td></tr><tr><td>X^H</td><td>X^HX^H</td><td>X^HY</td></tr><tr><td>X^h</td><td>X^HX^h</td><td>X^hY</td></tr></table> a Punnett square showing the gametes of individuals C and D (1) a Punnett square showing the genotypes of the offspring (1) 25% / 0.25 / 1 in 4 probability of a child having haemophilia (1)	<table><tr><td></td><td>X^H</td><td>X^h</td></tr><tr><td>X^H</td><td>X^HX^H</td><td>X^HX^h</td></tr><tr><td>Y</td><td>X^HY</td><td>X^hY</td></tr></table> reject if allele shown on Y chromosome 50% of males have haemophilia Punnett square must be interpreted correctly	**(3)**

Question Number	Answer	Acceptable answers	Mark
1(b)	An explanation linking the following aseptic conditions (1) prevent growth of **unwanted** organisms/prevent contamination (1) OR temperature /pH (1) provide optimal conditions for growth /prevent enzymes denaturing (1) OR nutrient levels (1) provide optimal conditions for growth (1) OR aeration/oxygen (1) for <u>aerobic</u> respiration/ provide optimal conditions for growth / prevent <u>anaerobic</u> respiration (1)	ignore sterile provide optimal conditions for enzymes/prevent micro-organisms being killed	**(2)**

(Total for question 2 = 8 marks)

Question Number	Answer	Acceptable answers	Mark
2a(i)	homozygous recessive	Accept in any order: homozygous recessive (alleles)	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(ii)	female gametes male gametes |	**e**	**e**
E	Ee	Ee
e	ee	ee | correct gametes in male/female gametes headings (1) correct offspring genotypes (1)	**(2)**

Question Number	Answer	Acceptable answers	Mark
2a(iii)	Any **one** of the following • 1/2 • 0.50 • 2/4 • 50 % • 1:1 / 2:2	Accept if 2 correct answers are given e.g. ½, 50% evens chance	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(iv)	A 0%		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(b)	A description including the following points • reference to mucus (1) • location described e.g. lungs / pancreas / reproductive system (1) • consequence described e.g. breathing difficulty / infection / weight loss due to blocking of enzymes / difficulty with digestion or absorption / infertility (1)	**Accept** three symptoms described (3) Ignore: references to symptoms of sickle cell Accept – airways for lungs Accept fertility problems for infertility Symptoms may include diabetes (1) malnutrition (1) incontinence in females (1) sinusitis (1) nasal polyps (1) arthritis (1)	**(3)**

Question Number	Answer	Acceptable answers	Mark
3(a)(i)	D		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(a)(ii)	substitution (1) 27 ÷ 40 evaluation (1) 0.675 x 100 67.5 (%)	e.c.f from 3(a)(i) accept 68(%) for 2 marks give full marks for correct answer, no working	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(b)(i)	gametes / Female / Male gametes |	**b**	**b**
B	Bb	Bb
b	bb	bb | gametes in male/female gametes headings (1) offspring genotypes (1)		**(2)**

Question Number	Answer	Acceptable answers	Mark
3(b)(ii)	0.5 / 50% / 50/50 / ½ / 2/4 / 2:2 /even chance	evens	**(1)**

Question Number	Answer	Acceptable answers	Mark
3(b)(iii)	homozygous recessive homozygous recessive	Accept any reasonable spelling of the term Reject heterozygous	**(1)**

Question Number	Answer	Acceptable answers	Mark
3 (c)	an explanation linking **three** of the following • speciation (1) • different geographical area may have different selection pressures / environmental conditions (1) • those individuals of a species suited /adapted / to this environment will survive and **breed** (1) • adaptations/genes passed down to the offspring • new species unable to breed with original (1)	named environmental conditions e.g. clima Accept survival of the fittest	**(3)**

Question Number	Answer	Acceptable answers	Mark
4(a)(i)	2 / two	(offspring) 2 and 3	**(1)**

Question Number	Answer	Acceptable answers	Mark
4(a)(ii)	D		**(1)**

Question Number	Answer	Acceptable answers	Mark
4(a)(iii)	An explanation linking **two** of the following points: • two of the offspring from generation II had CF (1) • the children with cystic fibrosis must have inherited 1 recessive allele from each parent / children must have 2 recessive alleles (1) • both parents must have 1 recessive allele / be carriers of the CF **allele** (1)	ORA if homozygous dominant then no CF offspring Ignore: references to genes ORA if homozygous recessive offspring would have CF	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b)	correct gametes (1) correct offspring (1) B b B BB Bb b Bb bb	Accept bB instead of Bb	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(c)	An explanation linking **two** of the following: • pedigree analysis will determine the likelihood that their offspring could inherit the CF allele(1) • if heterozygous there is a 50% chance (that the CF allele) will be passed on / if 2 heterozygous parents 25% chance the offspring will have CF(1) • if either parent is homozygous dominant there is 0% chance that their offspring could have the disease(1)	Accept to see if they are a carrier of the CF allele **Accept** ratios rather than percentages 2 in 4 chance	**(2)**

Question Number	Answer	Acceptable answers	Mark
5a(i)	answers must be in this order. dominant HH		**(2)**

Question Number	Answer	Acceptable answers	Mark
5a(ii)	<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>	1 mark for correct gametes 1 mark for correct offspring If incorrect gametes allow 1 mark for correct Punnett square based on selected gametes	**(2)**

Question Number	Answer	Acceptable answers	Mark
5a(iii)	75% / ¾ / 0.75	accept error carried forward from their Punnett square **accept:** 3 : 1	**(1)**

Question Number	Answer	Acceptable answers	Mark
5b(i)	An explanation linking **two** of the following: Huntington's disease is caused by a dominant allele / CF is caused by a recessive allele (1) only one allele for Huntington's disease needs to be inherited to have the disease / would have the disease if heterozygous (or homozygous dominant)(1) two alleles (recessive) need to be inherited to have CF / be homozygous recessive for CF (1)	Ignore refs to gene for allele against this marking point Ignore refs to gene for allele against this marking point	**(2)**

Question Number	Answer	Acceptable answers	Mark
5b(ii)	**A** ☒ mucus		**(1)**

Question Number	Answer	Acceptable answers	Mark
5b(iii)	An explanation linking **two** of the following: (thick / sticky / more) mucus (1) builds up in the tubes (of the reproductive system) (1) (the mucus) blocks the flow of sperm (1)	**Reject: mucus in lungs/intestine** accept sperm duct / vas deferens	**(2)**

Total for question 1 = 10 marks