Mark scheme – Inheritance (H)

Question			Answer/Indicative content	Marks	Guidance
1			D ✓	1 (AO1.1)	
			Total	**1**	
2			B ✓	1 (AO1.1)	
			Total	**1**	
3			C ✓	1 (AO2.1)	
			Total	**1**	
4			D	1 (AO 1.1)	**Examiner's Comments** Recalling their knowledge in this AO1.1 question was answered well by higher ability candidates, less so by others. Lower ability candidates were frequently distracted by A.
			Total	**1**	
5			D	1 (AO 1.1)	
			Total	**1**	
6			D ✓	**1 (AO1.1)**	
			Total	**1**	
7			D ✓	**1 (AO1.1)**	
			Total	**1**	
8			C ✓	**1 (AO1.2)**	**Examiner's Comments** This question assessed candidates' understanding of how the phenotype and genotype are affected under different conditions. Many candidates' responses were that it was only the genotype that would be affected by the treatment rather than the correct response being only the phenotype.  This may indicate a misconception in candidates thinking that anything that happens within the body has to do with the genotype.

					Key:  **Misconception**
			Total	**1**	
9			C ✓	**1 (AO2.1)**	
			Total	**1**	
10			males do not live as long/**ORA** ✓	**1 (AO3.1b)**	**ALLOW** they (females) live longer **Examiner's Comments** In this AO3 question many candidates tried to explain why it was likely that males die, but few referred to them dying earlier than females, or that females live longer. Higher ability candidates correctly referred to the longer life expectancy of females.
			Total	**1**	
11	a		smallest: nucleotide / allele / chromosome / largest: genome	1 (AO1.1)	
	b		66000000 ÷ 500 = 132 000 ✓	1 (AO2.2)	**ALLOW** 0.132 million or 132 thousand
	c		man: D, d; woman: d, d; Dd, dd, Dd, dd ✓ 0.5 / 50(%)✓	2 (AO2.2) (AO3.1a)	**ALLOW** appropriate use of other lower/upper case letters **ALLOW** ECF **ALLOW** 1 in 2 / ½ / 1:1 ✓ **DO NOT ALLOW** 1:2
			Total	**4**	
12			Gene: a length of DNA that codes for a protein ✓ Allele: an alternative form/version of a gene ✓	**2 (AO 2 × 1.1)**	**IGNORE** section of DNA that codes for a specific characteristic **ALLOW** a particular copy of a gene **Examiner's Comments** This question tested recall knowledge AO1.1 of the definitions of two genetic terms. The most common

					error was to only describe the gene as a section of DNA coding for a characteristic rather than coding for a protein. Candidates had a better knowledge of what an allele was.
			Total	**2**	
13			**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 839 award 2 marks** 2517/3 ✓ = 839 ✓	2 (AO2 x 1.2)	**ALLOW** 840 or 2521/3 ✓
			Total	**2**	
14			sperm/male gametes contain either an X or Y chromosome **and** eggs/female gametes contain an X chromosome ✓ indication that XX is female **and** XY is male ✓	**2 (AO 2 × 1.1)**	**ALLOW** correct Punnett square but unlabelled for gamete mark **ALLOW** correct Punnett square that indicates XY is male **and** XX is female for 2 marks **Examiner's Comments** Most candidates scored well on this AO1 question. Candidates who didn't gain marks either mixed up the genders, saying females were XY, or occasionally they used incorrect nomenclature **m** and **f**, and some had **YY** as a possible genotype.
			Total	**2**	
15			an allele is a form/version of a gene ✓ dominant means that it always expresses itself when present ✓	2 (AO 1.1)	**ALLOW** only needs one allele present to be expressed/shown in the phenotype **ALLOW** allele which is expressed instead of another **Examiner's Comments** This AO1.1 question proved to be very challenging, even for some higher ability candidates. Many candidates did not define the term allele at all, limiting their maximum mark to 1. **AfL** Candidates should be encouraged to learn definitions. Many candidates didn't seem to really understand the term dominant, in a biological context, using words like stronger, override or overpower.

			Total	**2**	
16	a		platelets are needed for blood clotting ✓ the rat would keep bleeding/bleed to death ✓	2 (AO 2.1)	**Examiner's Comments** Many candidates were able to score both marks on this AO2.1 question although some did not mention platelets. A significant number of candidates, however, linked the poison to clotting incorrectly, saying blood would clot too much or in the wrong place. In that type of response, there were references to heart attacks and strokes. Some candidates referred to wounds clotting.
	b		parents are Rr and Rr ✓ offspring are RR, Rr, Rr, rr ✓ rr identified as being non-resistant ✓	3 (AO 2.2)	**ALLOW** all marks from a Punnett square **ALLOW** ECF on offspring **Examiner's Comments** Many candidates scored on this AO2.2 question. The most frequent way candidates did not get maximum marks was by omitting to identify the correct offspring genotype. Candidates needed to annotate rr. A significant number of candidates only identified the non-resistant rate, not noticing that homozygous dominant rats were also present in that ratio; and therefore only stating 25% were homozygous. Candidates should be encouraged to routinely include the phenotypic ratio.  **AfL** Some candidates made errors on the Punnett square diagram. The main error was to cross R with r and derive RR. Candidates should be encouraged to check their answers for this type of error.
	c		Rr/heterozygous rats more likely to survive than RR/homozygous rats as they need less vit K / ORA ✓ therefore, when two Rr rats mate rr rats will be born ✓	2 (AO 2.2)	**ALLOW** rats that need less vit K are more likely to survive **Examiner's Comments** Where candidates successfully answered this AO2.2 question, it was from developing ideas from the previous question and linking the vitamin K survival rate in the heterozygous rat to when two Rr rats mate rr rats will be born. Many responses to this question showed confusion. Candidates referred to a variety of incorrect explanations such as non-resistant alleles becoming dominant and rats finding enough vitamin K to become non-

					resistant but immune to warfarin. Other incorrect responses included non-resistant rats surviving because they don't need much vitamin K and rats in some areas not getting access to warfarin.
			Total	**7**	
17			**First check answer on answer line** **If answer = 357512 award 2 marks** $\frac{105}{205}$ x 698000 ✓ = 357512 ✓	**2 (AO 2 × 2.2)**	**ALLOW** answer given to several dps **Examiner's Comments** This question assessed candidates' mathematical skills in AO2.2. In the main, many candidates got maximum marks. Common incorrect responses were due to rounding errors, including rounding before multiplying. Lower ability candidates simply halved 689000. Some candidates made rounding errors but only wrote the final answer and had not shown any working. They were not able to gain the mark for correct working out even though they had most likely done this. Improved examination technique and practice would overcome this. Examination technique needs candidates to focus on candidates showing their working out on calculations.
			Total	**2**	
18	a		**Any two from:** anaemia / tiredness / lack of energy due to lack of red blood cells ✓ inability to fight off infections / prone to infections due to lack of white blood cells/WBC ✓ slow blood clotting due to lack of platelets ✓	2 (AO2 x 1.1)	**DO NOT ALLOW** incorrectly matched symptom to blood cell type **ALLOW** less immunity / reduced immune response / weakened immune system due to lack of white blood cells/WBC **ALLOW** (recurring) nosebleeds / bruise easily due to lack of platelets
	b	i	people may be ill with infection / have a pathogen / just recovering from infection ✓ therefore have produced more white blood cells to destroy the pathogen/produce antibodies ✓ **OR** weakened immune system/cancer/cancer treatment reducing white blood cell	2 (AO2 x 2.1)	**IGNORE** fighting(off) pathogens

			number so less white blood cells to defend against pathogens/produce antibodies		
		ii	Area = 10 × 10 = 100(mm^2) Volume = 100 × 0.001 = 0.1 (mm^3) ✓	1 (AO2.2)	
		iii	No (no mark) 1000 ÷ 0.1 OR 1000 x 10 ✓ number of white blood cells/mm^3 is 10 x 10^3 / 1.0 x 10^4 / 10000 ✓ within the range of 6.0 – 16.0 x 10^3 ✓	3 (AO2 x 2.2) (AO3.2b)	**ALLOW** ECF from (ii) **ALLOW** number of white blood cells /mm^3 = 10 000 **ALLOW** within the normal white blood cell range/ 6000 – 16000
	c		(Fanconi anaemia) (no mark) (3 x 10^6 is a) low red blood cell count ✓ must be Fanconi anaemia because: caused by recessive allele ✓ obtained from heterozygous/carrier parents who don't have a blood disorder ✓ **OR** cannot be D-B anaemia because: neither parents have a blood disorder ✓ it is caused by a dominant allele ✓	3 (AO3x3.2b)	**if incorrect disorder then no marks** **IGNORE** low numbers of all cells
			Total	**11**	

19		i		**4**	**ALLOW** other forms of diagrams other than Punnett square

			<table><tr><td></td><td>R</td><td>r</td></tr><tr><td>R</td><td>RR</td><td>Rr</td></tr><tr><td>r</td><td>Rr</td><td>rr</td></tr></table> correct gametes ✓ correct genotypes of offspring ✓ probability = 0.25 / ¼ / 25% / 1 in 4 / 1:3	**(AO 2.2)** **(AO 2.2)** **(AO 3.2b)**	**Examiner's Comments** This question assessed AO2.2 with the application of practical techniques in completing a genetic cross. This was particularly well done by most candidates, except some candidates did not choose the symbols recommended in the question and this caused them confusion in interpretation. The question also included an AO3 mark for interpreting and drawing a conclusion from the Punnett square. The most common error was to give 75% as the response. Some candidates also made an error by describing the ratio as 1 in 3 when they should have written 1 in 4 or 1:3. These errors could be minimised by improving examination technique, where candidates are made aware of common errors in interpreting genetic diagrams.
		ii	rod cells are do not work / damaged ✓ rod cells can work in dim light ✓ but cannot detect colour ✓	**3** **(AO 2.1)** **(AO 2.1)** **(AO 1.1)**	**ALLOW** rods cells broken down / cones are not broken down **IGNORE**rod cells broken down (as in stem of question) **ALLOW** converse for cones **ALLOW** converse for cones **ALLOW** rods only see in black and white **Examiner's Comments** This question covered AO1.1 and AO2.1. Candidates often did not identify that rod cells were damaged. They frequently just put rod cells break down, missing out it was 'only' the rod cells, and hence were just repeating what was in the stem of the question. Good responses also discussed cones cells so got the reverse argument.
			Total	**6**	