OCR GCSE 21ST CENTURY BIOLOGY B · J257

BIOLOGY



MARK SCHEME

B1.2 HOW IS GENETIC INFORMATION INHERITED? (HIGHER)

SCORE	PERCENTAGE
/66	%

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Question			Answer/Indicative content	Marks	Guidance
1		i	Correct Punnet square ✓ X^H | X^h X^H | X^HX^H | X^HX^h Y | X^HY | X^hY	2	
		i	Probability 25% / ¼ / 1 in 4 ✓		ECF correct probability if Punnet square incorrect
		ii	X^hX^h ✓	1	
			Total	3	
2	a		40,037 / 40,000 + 37; 0.09;	2	0.09 **must** be expressed to two decimal places. **Examiner's Comments** Given it was a calculation, this was answered relatively poorly with the majority of candidates gaining no marks. Of those who scored, many gave 0.09 as the answer, but with no working or the incorrect working. Many candidates got the answer 0.09 but often by carrying out the calculation (37/40000) × 100, which limited them to one mark. It is important to note that showing working here was essential to gain the second mark, and candidates should always be encouraged to show their working. Some candidates gave the answer to more than two decimal places, or to two significant figures. Many candidates calculated 40000/37.

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Question			Answer/Indicative content	Marks	Guidance
	b		*any one from:* **majority of / most of / 99.91%** of their genes/chromosomes/genetic information/DNA from the mother and father/parents/sperm and egg/fertilised egg (not the donor); only small percentage of their genes/chromosomes/genetic information/DNA inherited from the donor; idea that most characteristics are coded for by DNA/genes/chromosomes/genetic material **found in the nucleus**;	1	**ignore** reference to 50% from mother / 50% from father **Examiner's Comments** This question was answered poorly, with candidates not taking time to understand what was being asked. Many candidates focused on half of genes/23 chromosomes originating from each parent, without credit. Although some candidates had the correct idea that most genes come from the mother and father, they frequently forgot to say 'most', failing to understand what the question was actually asking. Some did say that characteristics are coded for by genes found in the nucleus. Very few made explicit the idea that few genes originated from the donor.
	c		enzymes	1	**ignore** named proteins / enzymes **accept** structural/structure / functional/function (proteins) **Examiner's Comments** Most candidates did not score on this question, with a surprising number of no response answers. Of those who did score, enzymes was frequently given, with some candidates giving functional as a response and very rarely structural. Some did name specific enzymes or proteins, such as e.g. amylase/keratin and some candidates wrote 'hair', but these were not worthy of credit. Many also wrote 'amino acids', but again this was not worthy of credit. Given enzymes are a type of protein, the proportion of wrong answers was surprising.

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Question			Answer/Indicative content	Marks	Guidance
	d		*any three from any category:* *Consideration of consequences. Examples include:* not enough known (about the impact); DNA in the mitochondria may affect the characteristics of the child / cause complications; may be unsafe / harmful / risky; may cause disability; idea of concerns about where it could lead; likely to be costly / could the money be put to better use; problems caused by having three parents; causes problems for DNA testing; psychological problems; consideration of other consequences; *Consideration of ethics. Examples include:* unethical/morally wrong; is it right to select based on disease/to get rid of genetic disease; child unable to give consent/decide; uncertainty over legal parents/ donor may wish to parent the child / donor is not fully the parent of the children; should only have two parents / people may believe that a child should not have three parents; destruction of an egg cell / nucleus / genetic information / DNA which could have created life; other ethical consideration; *Religious argument. Examples include:* religious reasons / against God's will; other religious argument;	3	**accept** alternative ideas to those on left **ignore** mutations **ignore** 'unnatural' **ignore** reference to embryos **ignore** 'playing God' **Examiner's Comments** Most marks were awarded for simple statements of ethical or religious reasons or problems associated with having three parents. Some candidates talked about the nucleus which could become a life being discarded, although some gave this in the context of an embryo, which gained no credit. 'Playing God' and unnatural were very frequent responses which gained no credit. Centres are advised that these responses do not gain credit, and candidates should be advised against them. Only a small number candidates considered costs, or considered consequences. The candidates that did identify consequences tended to be around the ideas of where it may lead. Very few considered the impact on the child themselves.

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Question			Answer/Indicative content	Marks	Guidance
	e		**any two from** (1 in 200 is a) **high** number of children affected; (so) less money will be spent treating children with diseases; (so) prevents faulty mitochondria being passed on to offspring/children; (but) **low number** (seriously) affected / **only** 1 in 6,500 / small chance of being (seriously) affected (so it may be) cheaper to treat those affected (than to develop the new technique); (however) idea that money used for the treatment only benefits few people / one disease / could benefit more patients/other diseases; it is worth it even to save one life / improve the quality of life / health;	2	**ignore** reference to religious and ethical arguments **accept** alternative idea that this is a high number in a whole population **Examiner's Comments** This question frequently scored 1 out of the 2 marks, with a significant number of candidates failing to use the information provided in the question. Many candidates gained credit for stating that the technique would improve quality of life, or save lives. Many candidates identified 1 in 6500 being a low number. Very few candidates discussed the idea of preventing faulty mitochondria being passed on. Some candidates did use both the 1 in 200 and the 1 in 6,500 figures thoughtfully in their answers to score 2 marks. Few candidates referred to it being cheaper to treat those affected than to develop the new technique.

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Question			Answer/Indicative content	Marks	Guidance
3	f		any two from amino acid **sequence** will be different/ the amino acids coded for will be different; no/different/incorrect protein/enzyme produced; protein/enzyme may not function; **Total**	2 11	**ignore** changes to the production/formation of amino acids **Examiner's Comments** Generally the idea that a different or wrong protein would be produced was scored by many candidates. The concept of amino acid sequence being changed seemed not to be so well understood, and rarely scored. There were quite a few references to amino acid *production*, which on its own did not gain credit. Quite a lot of candidates seized on the mutation idea and described how a mutation could affect an individual ranging from various disabilities to cancer, occasionally also talking about incorrect base pairing. The link between a protein being different and a protein not functioning was not often seen, so relatively few candidates scored the final marking point.
			One egg cell and one sperm cell. ✓	1	two or more ticks = 0 marks **Examiner's Comments** This question was well answered. The majority of candidates knew the process of fertilisation to produce identical twins.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
4	a		proteins; DNA; genotype; phenotype	2	four correct = 2 marks two or three correct = 1 mark one correct = 0 marks **accept** enzymes **Examiner's Comments** Many candidates were able to provide at least 2 correct responses for 1 mark.
	b		sex (chromosomes) / XX / XY / X AND Y	1	**do not credit** 'sex cells / gametes' / genes **do not credit** 'X' alone or 'Y' alone **Examiner's Comments** The majority of candidates were able to produce the correct response.
			Total	3	

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Question	Answer/Indicative content	Marks	Guidance
5	[Level 3] Explanation of how A & B are produced AND explains why C is different to the other two using some level 3 responses. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) [Level 2] Explanation of how A & B are produced AND recognises that C must be from a different sperm / egg (combination). Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) [Level 1] Explanation of how A & B are produced OR recognises that C must be from different sperm / egg (combination). Quality of written communication impedes communication of the science at this level. (1 – 2 marks) [Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	• formed from one sperm and one egg / from the same fertilised egg • embryo / zygote / fertilised egg splits / cells separate • same genes / genetic information This question is targeted at grades up to A* Level 3 responses Indicative scientific points may include: A and B • identical DNA / chromosomes / alleles / genotypes Level 1/2 responses • cell division / mitosis • creates identical twins / natural clones C Level 1/2 responses • formed from different sperm / egg / embryo • genes from both parents come together Level 3 responses • variation in offspring • inherit different combinations of alleles • some genes / DNA / chromosomes will be the same / some different ignore reference to egg or sperm splitting Examiner's Comments Many excellent responses contained detailed descriptions on the origins of the identical twins A and B and the non-identical twin C. Others needed to discuss the differences between C and the identical twins in terms of alleles to gain the higher

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>marks.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>6</td><td></td></tr>
<tr><td>6</td><td></td><td>i</td><td>Harold: ff Hilda: Ff</td><td>1</td><td>need both for the mark
allow fF for Hilda
do not credit if the distinction between the capital letter and the small letter is not clear

Examiner's Comments

Many candidates were able to provide the two correct genotypes. The distinction between the capital letter and the small letter had to be unambiguous to gain the mark.</td></tr>
<tr><td></td><td></td><td>ii</td><td><table><tr><th>Harold</th><th>Hilda</th><th></th></tr><tr><td>heterozygous</td><td>homozygous dominant</td><td></td></tr><tr><td>heterozygous</td><td>homozygous recessive</td><td></td></tr><tr><td>homozygous dominant</td><td>heterozygous</td><td></td></tr><tr><td>homozygous dominant</td><td>homozygous recessive</td><td></td></tr><tr><td>homozygous recessive</td><td>homozygous dominant</td><td></td></tr><tr><td>homozygous recessive</td><td>heterozygous</td><td>✓</td></tr></table></td><td>1</td><td>no ecf from ai

If more than 1 box is ticked, no mark awarded

Examiner's Comments

The majority of candidates were able to identify the correct response.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>2</td><td></td></tr>
<tr><td>7</td><td></td><td></td><td>(look at the sex) chromosomes / Karyotype (1)
males: XY and females: XX (1)</td><td>2</td><td>Males have XY chromosomes and females XX chromosomes = 2 marks

Examiner's Comments

Good responses linked chromosomes to the correct gender. Answers using genes or DNA did not get the mark.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>2</td><td></td></tr>
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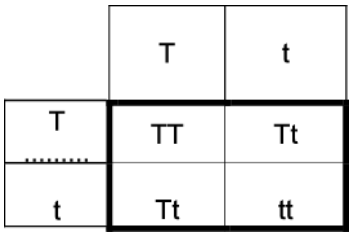
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Question			Answer/Indicative content	Marks	Guidance
8			Any two from idea of F / dominant allele being inherited from Hilda / Harold will only pass on one f allele (1) so child might be heterozygous / carrier / Ff (1) there is a 50% chance (1) need 2 recessive alleles to have cystic fibrosis / homozygous recessive / ff (1)	2	Ignore Hilda is a carrier Points could be awarded from a correctly annotated diagram. Do not credit gene instead of allele Examiner's Comments Examiners commented that candidates demonstrated clear understanding of how cystic fibrosis is inherited and were able to prove why the statement was incorrect.
			Total	2	
9			gene on Y chromosome / SRY gene (1) leads to formation of testes / testosterone / androgen (1) absent leads to formation of ovaries / female reproductive system (1)	3	'hormone' alone is insufficient Examiner's Comments This was a challenging question. Candidates needed to know about the sexdetermining gene on the Y chromosome and how it has its effect on gender.
			Total	3	

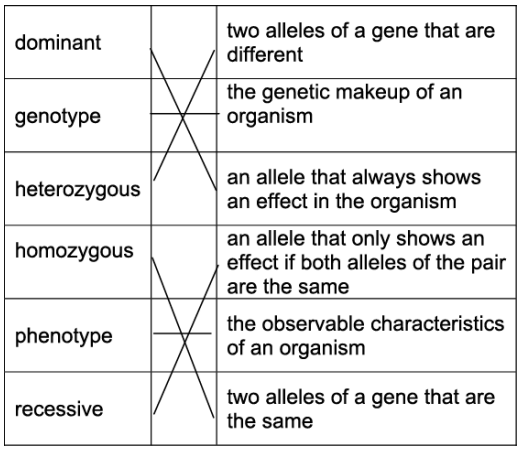
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Question			Answer/Indicative content	Marks	Guidance
10			 Probability = 0.25	3	one mark for **correct** parent genotypes (both Tt / tT) incorrect genotypes do not credit for ecf marks one mark for correct completion of Punnett Square. Allow correct alternative genetic diagram. one mark for correct probability Use of alternative symbols (as long as upper and lower case of same letter is clear). Max 2 marks. allow 1 / 4 or 25% or 1 in 4 or 1:3 ignore 1 in 3 Examiner's Comments This was a well answered question. Many candidates were able to produce a correct genetic diagram and probability. Some candidates limited their mark by not using the letters provided.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
11	a			3	all correct = 3 marks 4 or 5 correct = 2 marks 3 correct = 1 mark Examiner's Comments The majority of candidates scored well on this question, when marks were lost is was generally because of confusion between the definitions of dominant and recessive
	b	i	gg Gg; gg gg Gg gg; Gg gg;	3	1 mark for each correct row if no fully correct rows allow 1 mark for all homozygous recessives (gg) correct accept alternative letters if clearly upper and lower case used correctly Examiner's Comments This proved to be a difficult question, with only the strongest candidates gaining all three marks; as similar questions where punnet squares have to be completed generally score well perhaps candidates have less experience of unpicking family trees. A large number of candidates only wrote one allele in the spaces provided, others correctly identified the double recessive individuals but then lost marks for not realising all the individuals with Marfan syndrome were heterozygous.

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Question			Answer/Indicative content	Marks	Guidance
		ii	gg X gg Gg X Gg Gg X gg OR gg X Gg	2	combinations can be in any order **accept** Gg either way round (Gg or gG) all correct = 2 marks 2 correct = 1 mark **Examiner's Comments** The majority of candidates wrote the parental genotypes as one allele/letter only so gained no marks. Even those candidates who correctly wrote genotypes often lost a mark for not realising that “gg and Gg” is the same as “Gg and gg”. Some wrote numbers from the genetic diagram suggesting they had misread the question.
	c		risk of test eg risk of miscarriage / risk of infection / harm to fetus / risk to mother; will they terminate / abort; false negatives and positive results / test is not 100% accurate;	3	must have the idea of harm to mother or fetus do not allow “affect” fetus **accept** idea of not keeping the fetus do not credit references to ethical or financial considerations **Examiner's Comments** Many candidates were aware that the test carried a risk and the result would require a decision about termination, although answers here were often too vague to score e.g. “what will they do with the baby”. Fewer candidates recognised that the tests could produce false results. A significant number of candidates discussed ethics, job prospects, insurance premiums which were not appropriate answers to this specific question.
			Total	11	

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Question			Answer/Indicative content	Marks	Guidance
12			(both Ali and Mary) they are carriers / it is recessive / have faulty gene or allele;	1	**accept** heterozygous **reject** Ali OR Mary **Examiner's Comments** Most candidates scored this mark for correctly stating that both Ali and Mary were carriers. The most common errors were stating that either Ali or Mary was a carrier or providing an incorrect genotype.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
13		i	cross Betty with other tolerant/resistance trees / breed two tolerant or resistant trees ✓ test/identify the offspring for tolerance/resistance to ash dieback ✓ select/breed the (most) tolerant/resistance offspring (and repeat) ✓	3 (AO 2.1 × 3)	<u>Examiner's Comments</u> In the slightly unfamiliar scenario of plants rather than the animals, candidates did not explain the process of selective breeding and gave responses involving taking cuttings, cloning or genetic engineering. The key words 'selective breeding' appear to have been ignored.
		ii	the cuttings will be genetically identical to Betty / will have no genetic variation ✓ could all have (a variant/allele that codes for) susceptibility to a different disease/pathogen ✓	2 (AO 2.1) (AO 1.1)	ALLOW will be clones of Betty but DO NOT ALLOW will be similar to Betty /have the same genes as Betty <u>Examiner's Comments</u> Many candidates were able to recognise the fact that clones were genetically identical and a number then went on to explain that they would be susceptible to another disease (rather than the same one). Additionally there was some confusion between resistance of the tree and of the pathogen. A common misconception was the use of the term immunity in relation to the tree.

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Question			Answer/Indicative content	Marks	Guidance
		iii	sequence the genomes of Betty / other tolerant trees ✓ look for variants/alleles/sequences they have in common ✓ isolate/replicate variants/alleles/sequences associated with tolerance/resistance ✓ use genetic engineering to introduce tolerance/resistance (variants/alleles/sequences) into new ash trees ✓	4 (AO 2.1 × 4)	ALLOW use of (restriction) enzymes for this process ALLOW description of a method of genetic engineering Examiner's Comments This longer response question was designed to assess candidates' knowledge of the whole process of genetic engineering, set in a slightly different scenario. Higher ability candidates produced responses which included sequencing of genomes and the use of genetic engineering.
			Total	9	
14		i	There are differences between fossils and living examples of similar organisms✓ Isolated populations of the same species living in different places have different characteristics ✓	2 (AO 1.1 x 2)	
		ii	natural selection ✓	2 (AO 1.1)	ALLOW survival of the fittest Examiner's Comments Question (a) (i) and (a) (ii) tested candidate knowledge of the work carried out by Darwin in the development of his theory of evolution by natural selection. A common error in (a) (i) was the selection of the statement 'There is usually extensive variation within a population of a species'. In (a) (ii) candidates often only used the stem of the question to state the theory was evolution, rather than natural selection.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
15	a	i	Jack genotype Dd ✓ Nina genotype Dd ✓ Mia genotype dd ✓	3 (AO 2.1 x 3)	ALLOW other letters in place of D, allow correct descriptions of genotype – heterozygous and homozygous recessive
		ii	<table><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> ✓ Probability = 0.75 ✓	2 (AO 2.1) (AO 3.2b)	ALLOW ECF All four genotypes must be correct for first mark ALLOW 3 in 4, $^{3}/_{4}$, 75% Examiner's Comments On the whole this question was answered very well. With a large proportion of candidates gaining 5 or 6 marks for the entire question. The most common errors observed in 7(a) (ii) saw candidates stating the probability as 25% rather than 75%.
	b		Any one from: **both** parents are heterozygotes ✓ other genes/ mutations ✓	1 (AO 2.1)	Examiner's Comments On the whole this question was answered very well. With a large proportion of candidates gaining 5 or 6 marks for the entire question. 7 (b) was the question that proved more difficult, a common mistake was to state a parent, rather than both parents would be heterozygous
			Total	6	

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