

**UNIT 4 – VARIATION, INHERITANCE AND OPTIONS****MARK SCHEME****GENERAL INSTRUCTIONS**Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark.

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct relevant alternative responses which are not recorded in the mark scheme.

Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statement. Award the middle mark in the level if most of the content statements are given and the communication statement is partially met. Award the lower mark if only the content statements are matched.

### Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only

ecf = error carried forward

bod = benefit of doubt

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)		I II III IV	O J P K 4 ✓ = 2; 3 or 2✓ = 1; 1 ✓ = 0		2		2		
	(b)	(i)		(12.07- 7.81)/12.07 x 100 = 35.29% (1) Accept 35.3		1		1	1	
		(ii)		(550/1000) x 200 = 110mg(1)		1		1	1	1
		(iii)		FSH and LH produced by pituitary gland associated with the brain (1) FSH concentration decreased therefore less effect on primary spermatocytes (1) Less LH produced resulting in less testosterone produced (1) Fewer secondary spermatocytes undergo meiosis II (1)			4	4		
		(iv)		Could affect Sertoli cells (1) Less nutrients for / protection of developing sperm cells (1) Could affect interstitial cells / cells of Leydig (1) So less testosterone produced (1)			4	4		
				<b>Question total</b>	<b>0</b>	<b>4</b>	<b>8</b>	<b>12</b>	<b>2</b>	<b>1</b>

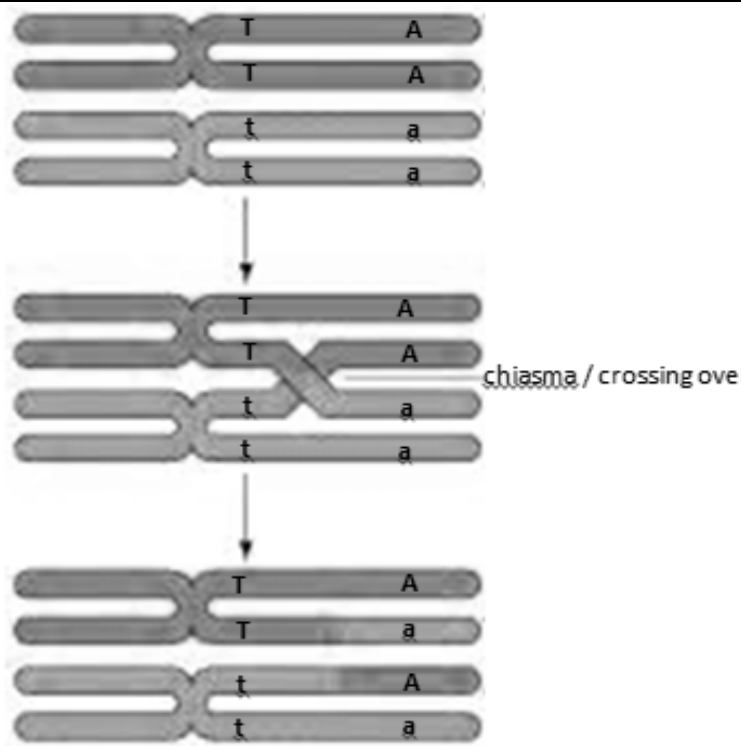
## GCE AS and A LEVEL BIOLOGY Specimen Assessment Materials 176

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)		Pollen tube grows controlled by the pollen tube nucleus(1) Enzymes digest a path through the style to the micropyle(1) One male nucleus enters the embryo sac and fuses with the female gamete to form the zygote(1) Second male nucleus fuses with the two polar nuclei to form the primary endosperm nucleus(1)	4			4		
	(b)		Insect-pollinated (1) Attracts insects: using faecal {odour / smell}/warmer temperature inside spadix (1) Insects prevented from leaving spadix by hairs (1) Cross-pollinated - separate male and female flowers (1) Cannot be self-pollinated as male flowers ripen after fertilisation has occurred(1)			5	5		
	(c)		April, – highest light intensity <b>and</b> increasing temperature so neither limiting rate of photosynthesis (1) July – light intensity lowest while temperature high so light acting as limiting factor (1) November – light intensity increasing but temperature low so temperature acting as limiting factor (1)			3	3		
			<b>Question total</b>	<b>4</b>	<b>0</b>	<b>8</b>	<b>12</b>	<b>0</b>	<b>0</b>

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)	Change to the base sequence of a single gene (1)	1			1		
		(ii)	Change to mRNA base sequence/ codons of mRNA are changed / different (1) Different tRNA / brings different amino acid (1) Primary structure / amino acid sequence different (1) Different variable groups on amino acids cause polypeptide to fold differently / form different tertiary structure / bonds formed between different amino acids (1)	4			4		
		(iii)	NAD (accept FAD) (1)	1			1		
		(iv)	Reduced NAD / FAD can act a hydrogen donor to the electron transport chain (1) 2 carbon molecule / acetate can enter the Krebs cycle (1)		1		1		
	(b)	(i)	restriction endonuclease (1)	1			1		1
		(ii)	Alu1 TaqI HaeIII all 3 ✓ = 2; 2 ✓ = 1; 1 or 0 ✓ = 0		2		2		
		(iii)	lines at 17,38,40 and 55 (2) all 4 ✓ = 2; 3 or 2 ✓ = 1; 1 ✓ = 0		2		2		2
		(iv)	DNA fragments attracted to positive electrode due to negative charge on phosphate groups(1) Smaller fragments travel further as its easier to pass through pores in the gel(1)	2			2	0	2
			<b>Question total</b>	<b>9</b>	<b>5</b>	<b>0</b>	<b>14</b>	<b>0</b>	<b>5</b>

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Question			Marking details			Marks available																							
						AO1	AO2	AO3	Total	Maths	Prac																		
4	(a)		<p><b>Parent genotypes + gametes:</b> TTAA x ttaa + TA x ta (1)</p> <p><b>F1 genotype + gametes:</b> TtAa x TtAa + TA, Ta, tA, TA X TA, Ta, tA, TA (1)</p> <p><b>F2 phenotypes:</b> long style long style short style short style (1) low anther high anther low anther high anther</p> <p><b>F2 genotypes:</b> TTAA TTaa ttAA ttaa (1) TtAA Ttaa ttAa TTAa TtAa</p> <p><b>F2 ratio:</b> 9 : 3 : 3 : 1 (1)</p>				5		5																				
	(b)	(i)	<table border="1"> <thead> <tr> <th>Phenotype</th> <th>Expected Numbers (E)</th> <th><math>\frac{(O-E)^2}{E}</math></th> </tr> </thead> <tbody> <tr> <td>Low anther, long style</td> <td>18</td> <td>2.000</td> </tr> <tr> <td>Low anther, short style</td> <td>18</td> <td>3.556</td> </tr> <tr> <td>High anther, long style</td> <td>18</td> <td>1.389</td> </tr> <tr> <td>High anther, short style</td> <td>18</td> <td>2.722</td> </tr> <tr> <td></td> <td>(1)</td> <td>(1)</td> </tr> </tbody> </table> <p><math>\chi^2 = 9.67</math> (accept 9.7) (1)</p>			Phenotype	Expected Numbers (E)	$\frac{(O-E)^2}{E}$	Low anther, long style	18	2.000	Low anther, short style	18	3.556	High anther, long style	18	1.389	High anther, short style	18	2.722		(1)	(1)		3		3	3	
Phenotype	Expected Numbers (E)	$\frac{(O-E)^2}{E}$																											
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	(1)	(1)																											
		(ii)	<p>Critical value from table = 7.82(1) reject null hypothesis (1) Because <math>\chi^2</math> value &gt; than critical value of 7.82 so there is a significant difference at 0.05% probability(1) Deviation is not due to chance(1)</p>				2	2	4	2																			

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	(c)		 <p>showing crossing over (1)  showing alleles correctly labelled (accept either order of T and A – must be either side of chiasma) (1)  showing <b>TA</b>, <b>Ta</b>, <b>tA</b> and <b>ta</b> on chromatids following crossing over (1)</p>		3		3		
<b>Question total</b>				<b>0</b>	<b>13</b>	<b>2</b>	<b>15</b>	<b>5</b>	<b>0</b>

## GCE AS and A LEVEL BIOLOGY Specimen Assessment Materials 180

Question				Marking details	Marks available						
					AO1	AO2	AO3	Total	Maths	Prac	
5	(a)	(i)		A = progesterone (1) B = human chorionic gonadotrophin / HCG (1) HCG/ hormone B is not produced until after ovulation / {progesterone/ hormone A} present before ovulation (1)	2			1	3		
		(ii)	I	<b>A</b> (progesterone): maintains the endometrium / lining of the uterus / prepares the endometrium for implantation (1)	1				1		
			II	<b>B</b> (HCG): maintains the corpus luteum (in early stages of pregnancy) (1) so that progesterone levels are maintained (1)	2				2		
	(b)	(i)		all women in the sample were proven to be pregnant at the time of testing (1)			1		1		1
		(ii)		(0.8+1+3+10.2)/100x 1200 = 180 (1)  OR (100-85)/100 x 1200 = 180(1)			1		1	1	
<b>Question total</b>					<b>5</b>	<b>2</b>	<b>1</b>		<b>8</b>	<b>1</b>	<b>1</b>



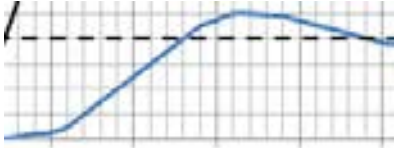
Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6			<p><b>Indicative Content</b></p> <p>Prior to 1959 cod did not reproduce on average until they were about six years old. As cod grow at an even rate this meant that cod of reproductive age were also usually the largest.</p> <p>During the period of heavy fishing, smaller cod would have had a selective advantage as they would have been able to escape being caught in the nets.</p> <p>This meant that only the smaller cod survived. Due to mutation there was some variation in the age at which they reproduced, so some of these would have been able to reproduce at a younger age.</p> <p>Consequently, the alleles that resulted in cod only becoming able to reproduce when older would have largely disappeared from the gene pool. The alleles that enable cod to reproduce when younger were then present in the gene pool at a higher frequency. Therefore these were more likely to be passed onto the next generation.</p> <p>Alleles for a slower rate of growth would also have been advantageous as these cod would have been less likely to grow to a size that would not be able to escape the nets.</p> <p>In addition, because only 1% of the population remained, reproductive isolation occurred. This made it unlikely that cod would be able to meet and reproduce with the very small number of cod remaining that reproduced at older ages.</p> <p>This has resulted in genetic drift and could lead to allopatric speciation.</p>		7	2	9		

			<p><b>7-9 marks</b></p> <p>The candidate clearly explains the link between age of cod, reproductive age and length and the competitive advantage of smaller cod when being fished. In addition, the consequence of mutation on variation in reproductive age and hence size is clearly made and there is a clear understanding of the impact of this on allele frequency in the gene pool. The advantage of the alleles for reproducing when smaller being more likely to be inherited is explained. The effect of genetic drift and the reasons for the lack of recovery of the population to larger, older cod reproducing is described and the link to possible allopatric speciation is made. All explanations are supported by reference to information provided.</p> <p><i>The candidate constructs an articulate, integrated account, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses scientific conventions and vocabulary appropriately and accurately.</i></p> <p><b>4-6 marks</b></p> <p>The candidate makes a link between age of cod, reproductive age and length and the competitive advantage of smaller cod when being fished. In addition, the consequence of mutation on variation in reproductive age and hence size is explained and there is some understanding of the impact of this on allele frequency in the gene pool. The advantage of reproducing when smaller being more likely to be inherited is explained. Some attempt is made to describe the effect of genetic drift and the reasons for the lack of recovery of the population to larger, older cod reproducing is described but the link to possible allopatric speciation may not be clear. Some reference is made to the information provided to support some explanations.</p> <p><i>The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions</i></p>						
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			<p><i>The candidate usually uses scientific conventions and vocabulary appropriately and accurately.</i></p> <p><b>1-3 marks</b> The candidate does not communicate a clear understanding of the link between age of cod, reproductive age and length and the competitive advantage of smaller cod when being fished. The consequence of mutation on variation in reproductive age and hence size is made but there is only limited understanding of the impact of this on allele frequency in the gene pool. Some attempt is made to describe the effect of genetic drift but does not give acceptable reasons for the lack of recovery of the population to cod reproducing when larger and older. Limited reference is made to the information provided.</p> <p><i>The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate has limited use of scientific conventions and vocabulary.</i></p> <p><b>0 marks</b> The candidate does not make any attempt or give a relevant answer worthy of credit.</p>						
			<b>Question 6 total</b>	<b>0</b>	<b>7</b>	<b>2</b>	<b>9</b>	<b>0</b>	<b>0</b>

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Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)	A disease regularly found at low levels in a local population(1)	1			1		
		(ii)	Pandemic (1)	1			1		
	(b)	(i)	Biuret test(1) Pale blue to purple/lilac(1)	2			2		2
		(ii)	Haemagglutinin needed for virus to bind to cells + neuraminidase needed for virus to enter cells (1) If either of these proteins can be inactivated the virus could not infect cells (1)			2	2		
		(iii)	(Neuraminidase) shows lower mutation rate / is common to more strains of the virus (1) Memory cells would continue to recognise the antigen (1) However, it does not stimulate as strong an immune response so would need more {booster shots / exposure to antigen} / protection may not be as effective (1)			3	3		
	(c)	(i)	12.5 days		1		1		
		(ii)	Any <b>2</b> from Memory cells already present (1) Less antigen needed to stimulate immune response (1) More plasma cells produced in a shorter period of time (1)	2			2		

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	(d)	(i)	<p>Approximately same shape as primary immune response:</p>  <p>Start at 0 at 40 days followed by a slow increase (1)</p> <p>Reaches a peak similar to primary response after 13 / 15 days then decreases (1)</p>		2		2		
		(ii)	<p>No prior exposure to the measles antigen (1)</p> <p>Produces a primary immune response / no memory cells for measles (1)</p> <p>{Has to go through a latent period/ needs time}{ to recognise measles antigen / for clonal expansion / clonal selection / development of humoral response} (1)</p>		3		3		
	(e)		<p>0.24 absorbance = 8 ng cm<sup>-3</sup> (1)</p> <p>Conc = 8 x 1000 x 1/0.4 (1)</p> <p>= 20 000ng = 20mg cm<sup>-3</sup> (1)</p>		3		3	3	
<b>Question total</b>				<b>6</b>	<b>9</b>	<b>5</b>	<b>20</b>	<b>3</b>	<b>2</b>

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Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)	(i)		Osteoblasts secrete matrix <b>and</b> Osteoclasts break matrix down. (1)	1			1		
		(ii)		<b>Any</b> two for one mark Artery, vein, lymph vessel (1)	1			1		
		(iii)		Cervical vertebra = B (1) vertebrarterial canals to protect blood vessels going to the brain {reduced / small} {neural spine / transverse processes} because of reduced muscle attachment / increase range of neck movement (1)	2			2		
	(b)			Rickets caused by a lack of vitamin D/ calcium(1) Reduced dairy intake means less calcium in diet(1) Less outdoor play means less exposure to UV(1) Therefore less vitamin D synthesised(1) Vitamin D needed for calcium absorption(1)			5	5		
	(c)	(i)		A = Myosin B = Actin	2			2		
(ii)			transverse section (1)		1		1		1	
(iii)			only small circles drawn <b>and</b> labelled actin/A (1)		1		1		1	
	(d)			length of myosin = $1.85 - 0.25 = 1.65\mu\text{m}$ (1) convert to nanometres = $1.65 \times 1000 = 1600\text{nm}$ (1) calculate number of myosin heads = $1600/40 \times 6 = 240$ (1)		3		3	3	
	(e)			(Low calcium) so fewer presynaptic vesicles fuse with presynaptic membrane(1) Less neurotransmitter secreted into synaptic cleft(1) Less troponin activated(1) Less tropomyosin changes shape(1) So fewer myosin-actin cross bridges form(1)		4		4		
				<b>Question total</b>	<b>6</b>	<b>9</b>	<b>5</b>	<b>20</b>	<b>3</b>	<b>2</b>

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
9	(a)	(i)	A Broca's area B Motor area C Wernicke's area D Visual Sensory Area 4 ✓ = 3; 3 ✓ = 2; 2 ✓ = 1; 1 ✓ or 0 = 0	3			3		
		(ii)	Wernicke's area is responsible for interpreting both written and spoken language(1) Broca's area coordinates muscular responses that produce speech(1)	2			2		
	(b)	The person would be reading and understanding text and speaking as in addition to the visual sensory area and Wernicke's area being active, Broca's area and the motor areas are also active.(1)			1	1			
	(c)	(i)	Nerve impulses sent along the external intercostal nerve and phrenic nerve(1) Causing the (external) intercostal muscles and diaphragm (muscles) to contract(1)		2		2		

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Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
9	(c)	(ii)	During exercise there is an increased rate of respiration(1) This causes the {pCO <sub>2</sub> of the blood to increase/pH of the blood to fall}(1) This is detected by the chemoreceptors in the carotid bodies/aortic bodies(1) More nerve impulses are sent to the inspiratory centre in the medulla(1) More nerve impulses sent along the (external )intercostal nerve and phrenic nerve(1)		4		4		
	(d)	(i)	Spray water/ use no insect repellent(1)			1	1		1
		(ii)	Negative chemotaxis(1)	1			1		
		(iii)	$\sum (x - \bar{x})^2 = 69.2(1)$ 69.2/5 = 13.84(1) Standard deviation = $\sqrt{13.84} = 3.72 (1)$		3		3	3	
		(iv)	Brand B is the most effective as it had the highest mean and the lowest standard deviation(1) However the results for brand C have a large standard deviation and so there is less confidence in these results(1) The results for the control, brand A and B are random but there is a trend seen in the results for brand C(1)				3	3	1
			<b>Question 9 total</b>	<b>6</b>	<b>9</b>	<b>5</b>	<b>20</b>	<b>3</b>	<b>2</b>



**COMPONENT 4: Reproduction and Inheritance - SUMMARY OF ASSESSMENT OBJECTIVES**

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
Section A						
1	0	4	8	12	2	1
2	4	0	8	12	0	0
3	9	5	0	14	0	5
4	0	13	2	15	5	0
5	5	2	1	8	1	1
6	0	7	2	9	0	0
<b>Section A – totals</b>	<b>18</b>	<b>31</b>	<b>21</b>	<b>70</b>	<b>8</b>	<b>7</b>
7	6	9	5	20	3	2
8	6	9	5	20	3	2
9	6	9	5	20	3	2
<b>TOTAL</b>	<b>24</b>	<b>40</b>	<b>26</b>	<b>90</b>	<b>11</b>	<b>9</b>