

**GCE**

**Biology B (Advancing Biology)**

Unit **H422A/01**: Fundamentals of biology

Advanced GCE

**Mark Scheme for June 2017**

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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## Annotations

<b>Annotation</b>	<b>Meaning</b>
<b>DO NOT ALLOW</b>	Answers which are not worthy of credit
<b>IGNORE</b>	Statements which are irrelevant
<b>ALLOW</b>	Answers that can be accepted
( )	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
<b>ECF</b>	Error carried forward
<b>AW</b>	Alternative wording
<b>ORA</b>	Or reverse argument
<b>AVP</b>	Alternative valid points

Question	Answer	Marks	Guidance
1	B	1	
2	A	1	
3	D	1	
4	A	1	
5	A	1	
6	C	1	
7	A	1	
8	D	1	
9	B	1	
10	B	1	
11	A	1	
12	A	1	
13	B	1	
14	C	1	
15	B	1	
16	B	1	
17	D	1	
18	C	1	
19	B	1	
20	B	1	
21	B	1	
22	B	1	
23	A	1	
24	B	1	

<b>25</b>	D	<b>1</b>	
<b>26</b>	C	<b>1</b>	
<b>27</b>	A	<b>1</b>	
<b>28</b>	D	<b>1</b>	
<b>29</b>	B	<b>1</b>	
<b>30</b>	A	<b>1</b>	
	<b>Total</b>	<b>30</b>	

Question		Answer	Mark	Guidance
31	(a)	substitution ✓	1	<b>ALLOW</b> ref to single base replacement. <b>IGNORE</b> point mutation
	(b)	(i)	2	<b>IGNORE</b> ref to genetic testing
		(ii)	max 2	<b>ALLOW</b> increased risk of miscarriage <b>DO NOT ALLOW</b> inaccuracy unqualified <b>IGNORE</b> ref to playing God
	(c)*	<p><b>Summary of instructions to markers:</b>  <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)  Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, <b>Level 1</b>, <b>Level 2</b> or <b>Level 3</b>, best describes the overall quality of the answer.  Then, award the higher or lower mark within the level, according to the <b>Communication Statement</b> (shown in italics):</i></p> <ul style="list-style-type: none"> <li>○ <i>award the higher mark where the Communication Statement has been met.</i></li> <li>○ <i>award the lower mark where aspects of the Communication Statement have been missed.</i></li> </ul> <p>• <b>The science content determines the level.</b>  • <b>The Communication Statement determines the mark within a level.</b></p>		
		<p><b>Level 3 (5 – 6 marks)</b>  A detailed description and explanation of the data, comparing the survival of the <i>HBB</i> genotypes. There are some valid comments relating to data quality.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p><b>Level 2 (3 – 4 marks)</b>  Good description of the data, comparing the survival of the</p>	6	<p><b>Indicative scientific points may include:</b></p> <p><b>H<sup>S</sup>H<sup>S</sup> genotype</b></p> <ul style="list-style-type: none"> <li>• fastest death rate/most deadly genotype</li> <li>• ref to haemoglobin/erythrocyte clumping</li> <li>• ref to consequent capillary-blocking &amp; organ damage</li> </ul> <p><b>H<sup>A</sup>H<sup>S</sup> genotype</b></p> <ul style="list-style-type: none"> <li>• lowest death rate/least deadly genotype</li> </ul>

		<p><i>HBB</i> genotypes. There is some explanation of survival of at least one genotype OR there is some valid comment on data quality.</p> <p><i>There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.</i></p> <p><b>Level 1 (1 – 2 marks)</b>                  Good description of the data, comparing the survival of the <i>HBB</i> genotypes OR limited explanation of the data. There is no comment on data quality.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p><b>0 marks</b>                  No response or no response worthy of credit.</p>			<ul style="list-style-type: none"> <li>• due to lower risk of malaria</li> <li>• least infectivity of/best resistance to malaria parasite (<i>Plasmodium</i>)</li> <li>• ref to sickling of erythrocytes in low oxygen tension and destruction of parasite within by phagocytosis</li> <li>• other detail, e.g. ref to peroxide in sickled cells killing parasite and ref to increase in carbon monoxide production as possible reason for lower risk of malaria</li> </ul> <p><b>H<sup>A</sup>H<sup>A</sup> genotype</b></p> <ul style="list-style-type: none"> <li>• death rate between H<sup>S</sup>H<sup>S</sup> and H<sup>A</sup>H<sup>S</sup></li> <li>• no resistance to malaria parasite (<i>Plasmodium</i>)</li> </ul> <p><b>Data quality</b></p> <ul style="list-style-type: none"> <li>• anomaly in first 60 days due to sample size</li> <li>• relevant comment about small sample size for H<sup>S</sup>H<sup>S</sup></li> <li>• data obtained from health visitors, not doctors</li> <li>• some health visitors / centres may not respond (therefore not representative)                         <ul style="list-style-type: none"> <li>• some health centre data may be estimated / over different timescales / mis-diagnosed</li> </ul> </li> <li>• comment about separation of rural and urban areas</li> <li>• relevant comment about length of study</li> </ul>
		<b>Total</b>	<b>11</b>		

Question		Answer	Mark	Guidance
32	(a)	beta / $\beta$ ✓ islets of Langerhans ✓ (glucose) transport(er) ✓  glycogenesis ✓	4	<b>ALLOW</b> wrong use of upper and lower cases <b>ALLOW</b> GLUT (1-4) <b>OR</b> carrier <b>DO NOT ALLOW</b> receptor / co-transport <b>ALLOW</b> glycogen synthesis
	(b)	(i)	1	<b>ORA</b>  <b>ALLOW</b> any reference to graph showing insulin resistance / insulin not having effect on glucose / blood glucose remaining high
		(ii)	2	<b>ALLOW</b> 71.4 or unrounded answer (71.4285...) for 1 mark
	(c)*	<p><b>Summary of instructions to markers:</b>  <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.) Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, <b>Level 1</b>, <b>Level 2</b> or <b>Level 3</b>, best describes the overall quality of the answer. Then, award the higher or lower mark within the level, according to the <b>Communication Statement</b> (shown in italics):</i></p> <ul style="list-style-type: none"> <li>○ award the higher mark where the Communication Statement has been met.</li> <li>○ award the lower mark where aspects of the Communication Statement have been missed.</li> </ul> <p>• <b>The science content determines the level.</b>          • <b>The Communication Statement determines the mark within a level.</b></p>		
		<p><b>Level 3 (5 – 6 marks)</b>            A detailed outline, including the correct naming of enzymes and a correct description of their roles. Stages of the process are in the correct order, well detailed and with no major stages missing.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is</i></p>	6	<p><b>Indicative scientific points may include:</b></p> <p><b>Gene</b></p> <ul style="list-style-type: none"> <li>• isolate human gene with restriction enzyme</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• reverse transcribe mRNA with reverse transcriptase</li> </ul>

		<p><i>relevant and substantiated.</i></p> <p><b>Level 2 (3 – 4 marks)</b> Outline includes the correct naming of an enzyme and a description of its role. Stages of the process are in the correct order, although some stages may be missing.</p> <p><i>There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.</i></p> <p><b>Level 1 (1 – 2 marks)</b> No enzymes are named but the roles of the enzymes may be described. Stages of the process may not be in the correct order and some may be missing.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p><b>0 marks</b> No response or no response worthy of credit.</p>			<p><b>Vector</b></p> <ul style="list-style-type: none"> <li>• cut open vector / plasmid with (same) restriction enzyme</li> </ul> <p><b>Gene and vector</b></p> <ul style="list-style-type: none"> <li>• joining of gene and vector with DNA ligase</li> <li>• annealing of complementary bases</li> <li>• molecular detail, e.g. ligation of sugar-phosphate backbones / formation of phosphodiester bonds</li> <li>• ref to recombinant vector / plasmid</li> </ul> <p><b>IGNORE</b> reference to DNA polymerase</p> <p><b>Bacteria</b></p> <ul style="list-style-type: none"> <li>• mix plasmid and bacteria</li> <li>• transform bacteria / electroporation</li> </ul> <p><b>Additional detail</b></p> <ul style="list-style-type: none"> <li>• e.g. addition of sticky ends with terminal transferase</li> <li>• reference to identification of transformed bacteria e.g. antibiotic resistance</li> </ul> <p><b>IGNORE</b> ref to protein purification</p>
		<b>Total</b>	<b>13</b>		

Question		Answer	Mark	Guidance	
33	(a)	(i)	any 1 from: cut shoot under water ✓ connect shoot to rubber tubing under water ✓ ensure tight fit between shoot and rubber tubing ✓ seal with Vaseline ✓ set up the potometer under water ✓	max 1	
		(ii)	0.12 ✓ ✓	2	<b>ALLOW</b> unrounded answer (0.115758...) for 1 mark
		(iii)	<i>Description:</i> faster the wind speed, faster the (rate of) water uptake ✓  <i>Explanation:</i> wind <u>increases</u> water (vapour) potential gradient (between airspaces in leaf and air in environment) ✓ faster diffusion of water <u>vapour</u> / increased transpiration rate ✓	3	<b>ORA</b>  <b>ALLOW</b> wind <u>increases</u> concentration/diffusion gradient
		(iv)	humidity ✓ light intensity ✓ temperature ✓	max 2	
		(v)	water used in photosynthesis / hydrolysis ✓ water produced in respiration / condensation reactions ✓ water used to maintain turgor pressure ✓	max 2	
	(b)		<i>Mechanism</i> <b>ANY TWO FROM</b> <i>(Apoplast):</i> through, cell walls / extracellular spaces ✓ stopped by, suberin / Casparian strip ✓  <i>(Symplast):</i> through cytoplasm ✓	max 3	

			(from cell-to-cell) via <u>plasmodesmata</u> ✓ By osmosis from a high to low water potential / along a water potential gradient ✓  <b>PLUS</b> Correctly identifies apoplast and symplast pathways ✓		<b>DO NOT ALLOW</b> concentration gradient
			<b>Total</b>	<b>13</b>	

Question			Answer	Mark	Guidance
34	(a)	(i)	F C A D B E ✓✓	2	2 correct = 1 mark
		(ii)	kill / destroy, infected (host) cells ✓	1	
	(b)	(i)	<b>3 FROM</b>  <i>Idea that:</i> for HPV 16, no significant difference between the 2 dose and the 3 dose regime ✓ for HPV18, two-dose less effective than three-dose ✓  for both HPV16 and HPV18, both regimes produce similar antibody levels at 1 month / 3 years (3 dose) – equally effective ✓ comparison of median or range values in support of one of the above statements ✓ <b>1 FROM EITHER:</b> top of range for HPV18 antibody levels at 3 years in two-dose schedule does not overlap with ranges in other datasets ✓ <b>OR</b> very large range for HPV18 antibody levels at 3 years in two-dose schedule ✓	4	

		(ii)	<p><b>first exposure</b> no <u>memory</u> B cells prior to first dose ✓</p> <p><i>idea that:</i> it takes time for clonal selection / clonal expansion / small number of plasma cells to produce antibodies ✓</p> <p><b>second / third exposure</b> memory cells stimulated to divide rapidly / clonal selection faster / clonal expansion faster ✓ memory cells <u>differentiate</u> into (many) <u>plasma</u> cells ✓ <u>plasma</u> cells produce antibodies faster and in greater numbers ✓</p>	Max3	<b>ALLOW</b> small number of B cells produce antibodies
			<b>Total</b>	<b>10</b>	

Question			Answer	Mark	Guidance										
35	(a)	(i)	number of species in habitat / species richness ✓ relative abundance of each species / species evenness ✓	2											
		(ii)	<b>any 2 from:</b> equal size of, field / sampled area ✓ same soil, quality / type / hydration ✓ same season for observations ✓ same time of day for observations ✓ same method of sampling ✓ same climate ✓ same time period for observations ✓	max 2											
	(b)	(i)	<p><math>N = 100</math> <b>AND</b></p> <table border="1" style="margin-left: 20px;"> <tr><td style="text-align: center;"><math>n/N</math></td></tr> <tr><td style="text-align: center;">0.12</td></tr> <tr><td style="text-align: center;">0.04</td></tr> <tr><td style="text-align: center;">0.18</td></tr> </table> <p>✓</p> <table border="1" style="margin-left: 20px;"> <tr><td style="text-align: center;"><math>(n/N)^2</math></td></tr> <tr><td style="text-align: center;">0.0144</td></tr> <tr><td style="text-align: center;">0.0016</td></tr> <tr><td style="text-align: center;">0.0324</td></tr> </table> <p>✓</p> <table border="1" style="margin-left: 20px;"> <tr><td style="text-align: center;"><math>\Sigma(n/N)^2 = 0.2622</math></td></tr> <tr><td style="text-align: center;"><math>1 - (\Sigma(n/N)^2) = 0.7378</math></td></tr> </table> <p>✓</p>	$n/N$	0.12	0.04	0.18	$(n/N)^2$	0.0144	0.0016	0.0324	$\Sigma(n/N)^2 = 0.2622$	$1 - (\Sigma(n/N)^2) = 0.7378$	3	<p>ECF</p> <p>ECF</p> <p><b>ALLOW</b> 0.26 or 0.262 <b>ALLOW</b> 0.74 or 0.738</p>
$n/N$															
0.12															
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$\Sigma(n/N)^2 = 0.2622$															
$1 - (\Sigma(n/N)^2) = 0.7378$															

		(ii)	M <b>AND</b> greater value of, $D$ / Simpson's Index of Diversity ✓	1	<b>ECF</b> (i.e. R <b>AND</b> lower value of, $D$ / Simpson's Index of Diversity, if $D$ calculated as $< 0.54$ )  <b>ALLOW M AND 0.738</b> is greater than 0.54
	(c)		fertiliser moves (from soil) into lake / stream / aquatic ecosystem ✓ algae bloom / rapid growth of algae ✓ plants (underneath), cannot photosynthesise / die ✓ bacteria / microorganisms, break down / decompose, dead matter ✓ bacteria / microorganisms consume all oxygen / decrease in oxygen concentration ✓ <b>at least 1 from:</b> (adult) dragonflies may not be able to lay eggs (because of lack of plants) ✓ eggs / nymph die from lack of oxygen ✓	max 3	Must link idea of eutrophication to interruption of dragonfly life cycle for 3 marks
			<b>Total</b>		

Question			Answer	Mark	Guidance
36	(a)	(i)	frequency of exercise ✓ time / duration, of exercise ✓ type of exercise ✓	max 2	
		(ii)	(check for) asthma / heart condition / pregnancy / high blood pressure ✓ equipment training ✓	1	
	(b)	(i)	(Student's) t-test ✓ paired / measurements from same people (before and after) ✓	2	
		(ii)	improvement in recovery time (at all intensities / wattages of exercise) ✓ improvement falls as intensity / wattage rises ✓ uncertainty in making conclusion because standard deviations / error bars (for before-and-after) overlap ✓	2	ORA
		(iii)	higher intensity / wattage exercises such as weightlifting show less improvement in recovery time ✓ weightlifting is not an aerobic exercise ✓ weightlifting occurs over a short duration/in short bursts ✓	2	ORA ALLOW if not awarded in 36(b)(ii) uncertainty in making conclusion (about weightlifting) because standard deviations / error bars (for before-and-after) overlap
<b>Total</b>				<b>9</b>	

Question			Answer	Mark	Guidance
37	(a)	(i)	<b>any 2 from:</b> decrease in urea concentration (in blood) ✓ glucose concentration (of blood) remains unchanged ✓ protein, composition / concentration, (of blood) remains unchanged ✓	max 2	<b>IGNORE</b> reference to glucose increasing or decreasing
		(ii)	passage of molecules through partially permeable membrane via (passive) <u>diffusion</u> ✓ urea (diffuses) from a high concentration to a low concentration /down concentration gradient ✓ glucose (stays the same) because of, equilibration of molecules either side of membrane / no net diffusion ✓ protein too large to pass through membrane / tubing ✓	max 3	<b>ALLOW</b> 'semi-permeable membrane'  <b>DO NOT ALLOW</b> ECF from 37 (a)(i)
	(b)		<i>Advantage:</i> <b>1 from:</b> no need for specialist equipment ✓ can be done, at home / by patient ✓ patient can be mobile during treatment ✓  <i>Disadvantage:</i> <b>1 from:</b> risk of infection ✓ required more frequently than haemodialysis ✓	2	<b>AW</b>
	(c)	(i)	packed, red (blood) cells / erythrocytes ✓	1	<b>ALLOW</b> red (blood) cell / erythrocyte, concentrate
		(ii)	B ✓  B <b>AND</b> O ✓	2	<b>ALLOW</b> ECF

	<b>(d)</b>	<p>surgery would carry risk due to, high BMI / weight / obesity ✓</p> <p>hypertension / type 2 diabetes would damage transplanted kidney ✓</p> <p>patient does not pose risk to other dialysis patients (due to HIV status) ✓</p> <p>sister ageing, so risks from surgery ✓</p> <p><i>idea of</i></p> <p>blood vessels not being suitable for haemodialysis due to drug use ✓</p>	<b>max 3</b>	<p><b>ACCEPT</b> ref to 'existing conditions'</p> <p><b>IGNORE</b> unqualified statements relating to the best treatment option</p>
			<b>Total</b>	<b>13</b>

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