



*Rewarding Learning*

**ADVANCED**  
**General Certificate of Education**

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## **Biology**

**Assessment Unit A2 2**

*assessing*

**Biochemistry, Genetics and Evolutionary Trends**

**[ABY21]**

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## **Assessment**

## **MARK SCHEME**

## General Marking Instructions

The main purpose of the mark scheme is to ensure that each question is marked accurately, consistently and fairly.

Mark schemes are not intended to be totally prescriptive. No mark scheme can cover all the responses which students may produce. In the event of unanticipated answers, teachers and lecturers are expected to use their professional judgement to assess the validity of answers.

### Mark Scheme Notation

The use of a solidus (/) denotes alternative answers which can be awarded within the same question (or marking point in a question worth more than one mark).

The use of a semi-colon (;) denotes separate marking points. These are particularly relevant when separating the different marking points in a question worth more than one mark.

Part of an answer within brackets indicates that this part is not essential to gain credit – the bracketed section is usually to set context or for the purpose of completeness.

Some answers are shown as 'Any **two** from' (or any number between two and six). This means that any two (or other specified number) answers from the bullet-pointed list can be credited in this question or question part.

Some answers have 'Other appropriate response' (OAR) as an alternative answer which may be credited. OAR is most likely to appear in an answer where there are a wide range of possible answers worthy of credit and it is unlikely that the mark scheme contains all the possible answers.

### Marking Calculations

Full marks are normally awarded for the correct answer – irrespective of whether working out has been shown (even when asked to show working out.) The principle of 'error carried forward' (ECF) usually applies in that if a student makes a mistake in the first part of a three-mark, three-stage calculation then the final two marks can be awarded if the second and third stage processes are carried out correctly. The same principle applies to a mistake at any stage in a calculation.

### Essays

The mark scheme includes indicative points for essays. Each indicative point is numbered to aid marking. Following the indicative points in the mark scheme, a table is included which shows how many marks should be awarded for an answer that is credited with having a particular number of indicative points.

### Additional Guidance

The Additional Guidance column in the mark scheme provides extra information to aid the marking process. This column includes clarification concerning some marking points: this may include naming key words which may be required in an answer or may provide a range of alternative answers which would be considered creditworthy under OAR, or examples of the ECF principle. It may also include examples of answers which would not be considered creditworthy.

Question	Answer	Additional Guidance	Mark												
1 (a)	<table><tr><td></td><td><b>Phylum</b></td></tr><tr><td><b>A</b></td><td>Platyhelminthes</td></tr><tr><td><b>B</b></td><td>Annelida</td></tr><tr><td><b>C</b></td><td>Chordata</td></tr><tr><td><b>D</b></td><td>Cnidaria</td></tr><tr><td><b>E</b></td><td>Arthropoda</td></tr></table> <p>(All correct = 3; three/four correct = 2; one/two correct = 1;)</p>		<b>Phylum</b>	<b>A</b>	Platyhelminthes	<b>B</b>	Annelida	<b>C</b>	Chordata	<b>D</b>	Cnidaria	<b>E</b>	Arthropoda	Examples/sub-divisions of phyla, e.g. insects (for E) <b>not</b> enough, but credit terms in common usage such as annelids and chordates.	[3]
	<b>Phylum</b>														
<b>A</b>	Platyhelminthes														
<b>B</b>	Annelida														
<b>C</b>	Chordata														
<b>D</b>	Cnidaria														
<b>E</b>	Arthropoda														
(b) (i)	Annelida, Arthropoda and Chordata;	As above re: terms in common usage.	[1]												
(ii)	Any <b>two</b> from: <ul style="list-style-type: none"><li>• allows regional specialisation</li><li>• prevents waste being mixed with incoming food</li><li>• allows continuous feeding</li></ul>	Bullet point (bp) 2 – allow by example, e.g. allows the gut to have a stomach for digesting food and a separate region for absorption.	[2] <b>[6]</b>												

2 (a) (i)	Separates the two DNA strands by breaking hydrogen bonds (holding the complementary bases together);	Needs both separation of strands and breaking hydrogen bonds.	[1]
(ii)	Specify/bracket the section of DNA to be copied/DNA replication can only start within a double stranded region/ stop the DNA strands from rejoining;		[1]
(b) (i)	As speed of copying increases accuracy of copying tends to decrease/negative correlation between speed of copying and accuracy of copying;	<b>Not</b> just negative correlation unqualified.	[1]
(ii)	An enzyme on the graph with very high accuracy;	Any of three examples in top left-hand corner.	[1]
(iii)	(With one error in approximately every 10 000 bases copied) less likely to have errors in shorter sections (with fewer base pairs);	Allow reduces risk of mistakes (in copying).	[1]
(c) (i)	The probe will bind/hybridise with a complementary strand of DNA (through complementary base pairing); as the probe can be labelled (fluorescent or radioactive), the hybridised section can be identified;	Marking point (MP)1 – needs to be complementary rather than identical. Can be by example, e.g. adenine/A pairs with thymine/T. MP2 – if reference to labelling present, identification is implied.	[2]
(ii)	Exposed bases are necessary for binding;	Allow if double stranded then there will be no exposed bases.	[1] [8]

Question	Answer	Additional Guidance	Mark
3 (a)	Thylakoids;	Allow grana.	[1]
(b)	<p>(PSII) Any <b>two</b> from:</p> <ul style="list-style-type: none"> <li>• (accepted by electron acceptor then) pass through series of electron carriers/cytochromes</li> <li>• producing ATP as a consequence of oxidation and reduction reactions/ phosphorylation</li> <li>• joins PSI to replace electrons lost</li> </ul> <p>(PSI) electrons combine with hydrogen ions (from photolysis); to form NADPH (from NADP);</p>	<p>(bp) 2 – two key points are ATP production and either (by) redox reactions or (photo)phosphorylation.</p> <p>(MP2) credit to reduce NADP.</p>	[4]
(c)	<p>As concentration of carbon dioxide increases, rate of photosynthesis increases up to a point before levelling off;</p> <p>(at lower carbon dioxide concentrations) as concentration of carbon dioxide increases more carbon fixation by rubisco;</p> <p>(at higher carbon dioxide concentrations) concentration of rubisco/availability of ATP/NADPH becomes limiting;</p>	<p>(MP1) needs both (initial) increase then levelling off.</p> <p>(MP2) needs reference of both carbon fixation (or by description) and rubisco/RuBP). However, rubisco can be implied in MP2 if referenced in MP3.</p> <p>(MP3) <b>not</b> just another factor such as light becomes limiting.</p>	[3]
(d) (i)	<p>Reduced stomatal pore size will not affect rate of photosynthesis (when higher levels of carbon dioxide present);</p> <p>but will reduce moisture loss (through the stomata);</p>	<p>(MP2) reduced transpiration/reduced evaporation within spongy mesophyll or equivalent implies reduced water loss.</p> <p>'Reduces water loss without affecting rate of photosynthesis' = 2 marks.</p>	[2]
(ii)	<p>Tighter coupling of carbon dioxide levels to site of photosynthesis/ concentration of carbon dioxide at site of photosynthesis is controlled;</p>	<p>Leaf surface is too far away from where photosynthesis takes place ✓.</p>	[1]
(e)	Increased atmospheric carbon dioxide levels;	<b>Not</b> global warming unqualified.	[1] [12]

4 (a) (i)	Presence of a nucleus/nuclear envelope;	Credit contains Golgi body/apparatus (based on answer for (a)(ii)) but <b>not</b> contains organelles unqualified.	[1]
(ii)	<p><b>X</b> – transcription;</p> <p><b>Y</b> – ribosome;</p> <p><b>Z</b> – Golgi apparatus;</p>	Z-allow Golgi/Golgi body.	[3]
(b) (i)	<p>Conversion of DNA bases to mRNA (UAUCCCGUC);</p> <p>tyrosine, proline, valine;</p>	<p>(MP1) evidence for this could be anywhere on the page.</p> <p>Correct answer = 2 marks.</p>	[2]

Question	Answer	Additional Guidance	Mark
(ii)	No change if the substituted base is G/will produce tyrosine as either UAU or UAC codes for tyrosine/code is degenerate; polypeptide extension stops as stop codon produced (by either UAA or UAG/substituted base is T or C);	No error carried forward (ECF) if table treated as DNA (rather than mRNA) in parts (i) or (ii).	[2]
(c)	Therefore DNA read in units of three/ base triplets; one base change causes frameshift mutation; two base changes cause frameshift mutation; three base changes has no effect as no frameshift/one complete amino acid added/removed so others unaffected;	MPs 2 and 3 – <b>not</b> just one or two base changes result in a major way – need why a major change. Credit frameshift by description.  MP4 – <b>not</b> only one amino acid <i>affected</i> .	[4] [12]

5 (a) (i)	Cellulose cell wall;		[1]
(ii)	Any <b>two</b> from: <ul style="list-style-type: none"> <li>it is difficult to obtain accurate data</li> <li>estimation avoids removing plants/ trees/damaging habitat</li> <li>if removed would affect habitat and subsequent results</li> </ul>		[2]
(iii)	• 32;		[1]
(iv)	The percentage of total biomass that is fern decreases with time;  Any <b>three</b> from: <ul style="list-style-type: none"> <li>some fern (and moss and angiosperm) plants remain after the woodland is cleared</li> <li>fern percentage decreases over time due to competition</li> <li>from (larger) trees</li> <li>competitive effect increases with time as trees increase in size</li> <li>fern maximum biomass much lower than that of trees</li> </ul>	(MP1) allow <i>percentage</i> fern biomass decreases (as over time implied in the question) but <b>not</b> just fern biomass decreases. Allow as alternative for MP1 fern biomass relative to trees decreases over time. (Ignore reference to being similar to moss biomass.)  (bp1) allow fern establishes/grows quickly so relatively high initial/early biomass.	[4]
(b) (i)	Possess true roots/stomata/ cuticles/ vascular tissue; explanation of adaptation (e.g. control over stomata/presence of cuticle allows reduction of water loss);	(MP2) credit true roots/vascular tissue allows for more effective absorption/transport of water or vascular tissue provides support, so ferns are not reliant on turgor alone.	[2]

Question	Answer	Additional Guidance	Mark
(ii)	Possess wood/disperse seeds rather than spores; explanation of adaptation (e.g. wood allows greater size to be reached/ less reliant on water for support/seeds more resistant to desiccation/contain more food reserves (than spores));	Allow trees being larger than ferns (MP1) have longer/larger roots so can penetrate deep into ground to reach water (MP2).	[2] [12]

6 (a) (i)	A nucleotide/base that can vary between individuals;		[1]
(ii)	Substitution;	Point/base mutation <b>not</b> enough.	[1]
(iii)	Individuals with smaller numbers/less than 34 CAG repeat sequences have not developed Huntington's disease; (in those individuals with Huntington's) there is a negative correlation (or by description) between number of CAG repeats and age at diagnosis; onset does not occur in children (under 18)/in older people (over 42);	(MP1) allow increased number of CAG repeats increases the risk of Huntington's.	[3]
(iv)	Unable to understand information provided/other appropriate response;	Other appropriate response (OAR) – credit interpreting risk may be difficult/may increase anxiety about future health.	[1]
(b) (i)	More effective treatment/fewer side effects;	Greater efficacy ✓	[1]
(ii)	In many medical conditions many genes involved/costs involved/other appropriate response;	<b>Not</b> just doctors would need to be trained in personalised medicine unless linked to costs/time needed.	[1]
(c)	DNA degraded over time/contamination (as skeletons in ground/exposed to decomposers)/other appropriate response;	(OAR) – allow DNA more brittle (and more easily damaged)/genome is incomplete.	[1] [9]

7 (a)	The two alleles of each gene separate during meiosis with only one entering each gamete;	Allow only one (of the two) allele(s) of a gene can enter a gamete.	[1]
(b)	22 autosomes and one X chromosome;	Not just 22 autosomes and one sex chromosomes.	[1]
(c) (i)	4 – Tt; 5 – TT;		[2]
(ii)	3 in 8 chance;	Allow 0.38 or 38% chance.	[1]

Question	Answer	Additional Guidance	Mark
(iii)	(Sex linked) allele is on X chromosome; fathers do not pass on X chromosomes to sons/only pass Y chromosomes to sons/sons get their X chromosome from their mother;	(MP2) allow fathers <i>only</i> pass X chromosomes to daughters (but <b>not</b> just fathers pass X chromosomes to daughters).	[2]
(iv)	Sex-linked dominant;		[1]
(v)	Caused by spontaneous mutation;		[1]
(d)	$q^2 = 1 \div 17\,000 = 0.00006$ ; $q = 0.008$ and $p = 0.992$ ; $(2pq = 0.0159) = 1.59\%$ ;	If $q$ or $p$ not rounded during calculation, allow percentage of people heterozygous ( $2pq$ ) as 1.52% (or any answer between 1.52-1.59%).  Correct answer without working out = 3 marks.	[3] [12]

8 (a) (i)	How well an organism is adapted for its environment;		[1]
(ii)	The albatrosses do not have a high level of 'fitness'; as they have no defences against the mice; and breed at low rates; therefore population is selected against;	(MP1) allow albatrosses poorly adapted/have low level of fitness.  (MP4) allow as alternative: rate of losses (due to mice) not compensated for by (infrequent) breeding (so numbers decline).	[4]
(iii)	Preferred food sources (e.g. seeds, grain) of the mice are unavailable;	Allow other food options in short supply.	[1]
(iv)	Large amounts of food/few or no competitors/predators/high protein food source;		[1]
(b) (i)	Both standard deviation and range give an indication of the variability of the data; standard deviation indicates the spread either side of the mean/ traps 68% of the values either side of the mean; range is the difference between the lowest and highest value;		[3]
(ii)	Range values only give highest and lowest value and no information about the data between/overall variability not known/other appropriate response;	Allow range can be affected more by an anomalous outlier.	[1] [11]
		<b>Section A</b>	<b>[82]</b>

Question	Answer	Additional Guidance	Mark
9 (a)	<p><b>Indicative content:</b></p> <ol style="list-style-type: none"> <li>1. cylindrical/bean shaped organelle (in the cytoplasm)</li> <li>2. mitochondrion enclosed within a double membrane</li> <li>3. inner membrane infolded to form cristae</li> <li>4. that extend into the matrix</li> <li>5. pyruvate (from glycolysis) enters mitochondrial matrix</li> <li>6. during link reaction pyruvate is converted into acetyl Co A</li> <li>7. during this stage NAD is reduced to NADH and carbon dioxide evolved</li> <li>8. acetyl Co A enters Krebs cycle</li> <li>9. (during this stage) 6-carbon compound is decarboxylated / converted to form a 4-carbon compound</li> <li>10. with two molecules of carbon dioxide given off (for each turn of the cycle)</li> <li>11. three molecules of NAD reduced to NADH and one molecule of FAD to FADH<sub>2</sub></li> <li>12. and one ATP produced (for each turn of cycle)</li> <li>13. reduced NAD (and FADH<sub>2</sub>) enters electron transport chain</li> <li>14. takes place on inner mitochondrial membrane/cristae</li> <li>15. electrons (hydrogens) pass through a series of carriers at progressively lower energy levels</li> <li>16. involving redox reactions</li> <li>17. producing ATP</li> <li>18. final electron acceptor is oxygen</li> <li>19. with water produced as a waste product</li> <li>20. in total 36 ATP produced in mitochondrion (from one molecule of glucose)</li> </ol>	<p>(bp3) need reference to <i>cristae</i> by name: needs reference to <i>matrix</i> for bp4 (as innermost part of organelle).</p> <p>Inner membrane folded to create more surface area for enzymes of the electron transport chain – allow bps 2 and 14 (but not 3).</p> <p>(bp5) allow either pyruvate enters matrix or pyruvate from glycolysis enters the mitochondrion.</p> <p>(bp11) allow during Krebs cycle 3 molecules of NADH or reduced NAD and one molecule of FADH<sub>2</sub> or reduced FAD produced.</p> <p>(bp13) allow reference to either reduced FAD or reduced NAD.</p> <p>(bp17) oxidative phosphorylation implies that ATP is produced.</p> <p>(In the ETC) after passing through the cytochromes the electrons (and hydrogen ions)* combine with oxygen to form water = bps15, 18 and 19. *allow hydrogen as an alternative for electrons (and hydrogen ions).</p>	



Question	Answer	Additional Guidance	Mark																										
9 (a) (contd.)	<table><tr><th>Indicative points</th><th>Marks</th></tr><tr><td>15+</td><td>12</td></tr><tr><td>14</td><td>11</td></tr><tr><td>13</td><td>10</td></tr><tr><td>12</td><td>9</td></tr><tr><td>10–11</td><td>8</td></tr><tr><td>8–9</td><td>7</td></tr><tr><td>7</td><td>6</td></tr><tr><td>6</td><td>5</td></tr><tr><td>5</td><td>4</td></tr><tr><td>4</td><td>3</td></tr><tr><td>1–2</td><td>1</td></tr><tr><td>0</td><td>0</td></tr></table>	Indicative points	Marks	15+	12	14	11	13	10	12	9	10–11	8	8–9	7	7	6	6	5	5	4	4	3	1–2	1	0	0	bps 9–12 likely to be dispersed through an account of the Krebs cycle and bps 13–19 through an account of the electron transport chain.	[12]
Indicative points	Marks																												
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5	4																												
4	3																												
1–2	1																												
0	0																												
9 (b)	<p><b>Indicative content:</b></p> <ol style="list-style-type: none"><li>1. glucose converted to pyruvate in glycolysis</li><li>2. pyruvate converted to ethanol</li><li>3. during which reduced NAD oxidised to NAD</li><li>4. carbon dioxide produced as a waste product</li><li>5. when rainfall high, soil is waterlogged leading to reduced oxygen levels</li><li>6. preventing aerobic respiration/ leading to anaerobic respiration</li><li>7. causing RQ values to rise above 1</li></ol> <table><tr><th>Indicative points</th><th>Marks</th></tr><tr><td>6+</td><td>6</td></tr><tr><td>5</td><td>5</td></tr><tr><td>4</td><td>4</td></tr><tr><td>3</td><td>3</td></tr><tr><td>2</td><td>2</td></tr><tr><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td></tr></table>	Indicative points	Marks	6+	6	5	5	4	4	3	3	2	2	1	1	0	0	<p>In the final stage of anaerobic respiration in plants NADH is converted to NAD and carbon dioxide produced = bps 3 and 4.</p> <p>(bp5) need reference to either high levels of rainfall or waterlogged soil.</p>	[6] [18]										
Indicative points	Marks																												
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		Section B	[18]																										
		Total	[100]																										