



# Cambridge International AS & A Level

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**BIOLOGY**

**9700/04**

Paper 4 A Level Structured Questions

**For examination from 2022**

MARK SCHEME

Maximum Mark: 100

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**Specimen**

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This document has **20** pages. Blank pages are indicated.

**Generic Marking Principles**

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

**GENERIC MARKING PRINCIPLE 1:**

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

**GENERIC MARKING PRINCIPLE 2:**

Marks awarded are always **whole marks** (not half marks, or other fractions).

**GENERIC MARKING PRINCIPLE 3:**

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

**GENERIC MARKING PRINCIPLE 4:**

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

**GENERIC MARKING PRINCIPLE 5:**

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

**GENERIC MARKING PRINCIPLE 6:**

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

**Science-Specific Marking Principles**

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<p><u>'List rule' guidance</u> (see examples below)</p> <p>For questions that require <b>n</b> responses (e.g. State <b>two</b> reasons ...):</p> <ul style="list-style-type: none"> <li>• The response should be read as continuous prose, even when numbered answer spaces are provided</li> <li>• Any response marked <i>ignore</i> in the mark scheme should not count towards <b>n</b></li> <li>• Incorrect responses should not be awarded credit but will still count towards <b>n</b></li> <li>• Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should <b>not</b> be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response</li> <li>• Non-contradictory responses after the first <b>n</b> responses may be ignored even if they include incorrect science.</li> </ul>

6	<p><u>Calculation specific guidance</u></p> <p>Correct answers to calculations should be given full credit even if there is no working or incorrect working, <b>unless</b> the question states 'show your working'.</p> <p>For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.</p> <p>For answers given in standard form, (e.g. <math>a \times 10^n</math>) in which the convention of restricting the value of the coefficient (<math>a</math>) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.</p> <p>Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.</p>
7	<p><u>Guidance for chemical equations</u></p> <p>Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.</p> <p>State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.</p>

Mark scheme abbreviations:

; separates marking points  
 / separates alternatives within a marking point  
**R** reject  
**I** ignore mark as if this material was not present  
**A** accept (a less than ideal answer which should be marked)  
**COND** indicates mark is conditional on previous marking point  
**OWTTE** or words to that effect (accept other ways of expressing the same idea)  
**AW** alternative wording (where responses vary more than usual)  
**UNDERLINE** actual word given must be used by candidate (grammatical variants accepted)  
**max** indicates the maximum number of marks that can be awarded  
**ECF** credit a correct statement that follows a previous wrong answer  
**MP** marking point (with relevant number)  
**( )** the word / phrase in brackets is not required, but sets the context  
**ORA** or reverse argument

**Examples of how to apply the list rule**

State three reasons ... [3]

**A**

1. Correct	✓	<b>2</b>
2. Correct	✓	
3. Wrong	✗	

**B (4 responses)**

1. Correct, Correct	✓, ✓	<b>3</b>
2. Correct	✓	
3. Wrong	ignore	

**C (4 responses)**

1. Correct	✓	<b>2</b>
2. Correct, Wrong	✓, ✗	
3. Correct	ignore	

**D (4 responses)**

1. Correct	✓	<b>2</b>
2. Correct, CON (of 2.)	✗, (discount 2)	
3. Correct	✓	

**E (4 responses)**

1. Correct	✓	<b>3</b>
2. Correct	✓	
3. Correct, Wrong	✓	

**F (4 responses)**

1. Correct	✓	<b>2</b>
2. Correct	✓	
3. Correct CON (of 3.)	✗ (discount 3)	

**G (5 responses)**

1. Correct	✓	<b>3</b>
2. Correct	✓	
3. Correct Correct CON (of 4.)	✓ ignore ignore	

**H (4 responses)**

1. Correct	✓	<b>2</b>
2. Correct	✗	
3. CON (of 2.) Correct	(discount 2) ✓	

**I (4 responses)**

1. Correct	✓	<b>2</b>
2. Correct	✗	
3. Correct CON (of 2.)	✓ (discount 2)	

Question	Answer	Marks
1(a)(i)	<u>Eukarya</u> ;	1
1(a)(ii)	<p><i>any one from:</i></p> <ol style="list-style-type: none"> <li>1 habitat destruction / habitat fragmentation / deforestation / logging ;</li> <li>2 disease ;</li> <li>3 hunting ;</li> <li>4 AVP ; e.g. low genetic diversity / large range and low population density</li> </ol>	1
1(a)(iii)	<p><i>any three from:</i></p> <ol style="list-style-type: none"> <li>1 captive breeding / AW ;</li> <li>2 release into the wild ;</li> <li>3 conservation projects (in Madagascar) / establish reserves ;</li> <li>4 education / raise awareness ;</li> <li>5 research ;</li> <li>6 veterinary care ;</li> <li>7 AVP ; e.g. further qualification of marking point raise funds</li> </ol>	3

Question	Answer	Marks
1(b)(i)	<p>any <b>five</b> from:</p> <ol style="list-style-type: none"> <li>1 geographical, isolation / barrier ;</li> <li>2 (due to) named barrier ; e.g. rivers / mountains</li> <li>3 (west and east populations) unable to interbreed / no gene flow / AW ;</li> <li>4 different, selection pressures / environmental conditions, (acting on west and east populations) ;</li> <li>5 different mutations (in west and east populations) / AW ;</li> <li>6 so different alleles selected for (in west and east populations) ;</li> <li>7 ref. to genetic drift ;</li> <li>8 (west and east populations) separated for a long time ;</li> <li>9 ref. to change in gene pool ;</li> <li>10 AVP ;</li> </ol> <p><u>allopatric</u> ;</p>	5
1(b)(ii)		1
Question	Answer	Marks
2(a)	<p><b>A</b> – node of Ranvier ;</p> <p><b>B</b> – axon ;</p> <p><b>C</b> – cell body ; <b>accept</b> soma</p>	3
2(b)	<p>transmit, impulses / action potentials, from, CNS / sensory neurones / relay neurones / intermediate neurones ;</p> <p>to, effectors / muscle / glands ;</p>	2

Question	Answer	Marks
2(c)	<p>any <b>four</b> from:</p> <ol style="list-style-type: none"> <li>1 Schwann cells wrap around, the axon / <b>B</b> ;</li> <li>2 (to form) myelin sheath ; <b>accept</b> axon myelinated</li> <li>3 insulate the axon / ref. to lack of movement of ions ;</li> <li>4 depolarisation / action potentials, can only occur at, nodes (of Ranvier) / <b>A</b> ;</li> <li>5 ref. to local circuits ;</li> <li>6 action potentials jump from node to node / saltatory conduction ;</li> <li>7 AVP ;</li> </ol>	4



Question	Answer	Marks
3(a)	<p><b>either</b> <b>any three from:</b></p> <ol style="list-style-type: none"> <li>1 carbon dioxide concentration, higher / increased ;</li> <li>2 (carbon dioxide concentration) no longer limiting factor ;</li> <li>3 (carbon dioxide from) coral / polyp, respiration ;</li> <li>4 (increased CO<sub>2</sub>) for, Calvin cycle / light independent reactions, in algae ;</li> <li>5 further detail of effect of CO<sub>2</sub> concentration on binding of CO<sub>2</sub> to rubisco ;</li> </ol> <p><b>or</b> <b>any three from:</b></p> <ol style="list-style-type: none"> <li>6 temperature, higher / increased ;</li> <li>7 (temperature) no longer limiting factor ;</li> <li>8 (increased temperature due to) coral / polyp, respiration ;</li> <li>9 (increased temperature) for, Calvin cycle / light independent reactions, in algae ;</li> <li>10 further detail of effect of temperature on enzyme-catalysed reactions ;</li> </ol>	3

Question	Answer	Marks
3(b)	<p>any <b>three</b> from:</p> <ol style="list-style-type: none"> <li>1 pigments absorb, violet-blue / 400–490 nm / lamp colours, well / best / most / at 8 (out of 10) peaks ;</li> <li>2 rate of photosynthesis of <b>algae</b> increases with more light absorbed ;</li> <li>3 ref. to transfer of, organic nutrients / oxygen, to polyps from algae ;</li> <li>4 <b>coral</b> growth (increases) with more (algal) photosynthesis ; R products respired to give growth</li> <li>5 AVP ; e.g. violet / blue / 400–490 nm, light is the same as where corals live</li> </ol>	3
3(c)	<p>any <b>four</b> from:</p> <ol style="list-style-type: none"> <li>1 only involves photosystem I ;</li> <li>2 <u>light energy</u> absorbed (by accessory pigments) ;</li> <li>3 passed on to, chlorophyll <i>a</i> / primary pigment / reaction centre ;</li> <li>4 electron, excited to higher energy level / emitted from chlorophyll ;</li> <li>5 collected by electron acceptor ;</li> <li>6 passed along electron transport chain ;</li> <li>7 ATP produced by chemiosmosis ;</li> <li>8 electron returns to chlorophyll ;</li> </ol>	4

Question	Answer	Marks
4(a)(i)	<p><i>any two from:</i></p> <ol style="list-style-type: none"> <li>1 to, separate the two strands / denature DNA ; <b>A</b> make ssDNA</li> <li>2 by breaking <u>hydrogen</u> bonds (between bases) ;</li> <li>3 so that bases are exposed ;</li> <li>4 to produce template strands for (complementary) copying ;</li> </ol>	2
4(a)(ii)	<p><i>any two from:</i></p> <ol style="list-style-type: none"> <li>1 (primer) binds / anneals, to DNA by complementary base pairing ;</li> <li>2 <i>idea of</i> attaching close to the specific section of DNA ;</li> <li>3 (DNA) polymerase attaches to, dsDNA / primer ;</li> <li>4 AVP ; e.g. ref. to forward and reverse primers / AW</li> </ol>	2
4(a)(iii)	<p><i>any two from:</i></p> <ol style="list-style-type: none"> <li>1 (<i>Taq</i> polymerase), is heat stable / works at high temperature ; <b>or</b> other polymerases are not heat stable ;</li> <li>2 (so) does not need to be added again for each cycle / needs replacing only after a number of cycles <b>or</b> other polymerases need replacing regularly ;</li> <li>3 process is, more efficient / faster (than normal DNA polymerase) ;</li> </ol>	2
4(b)(i)	<p>all the, DNA / genetic material (in a person's cell) <b>or</b> combined nuclear and mitochondrial DNA ;</p>	1
4(b)(ii)	<p><i>type of cell:</i> (named) white blood cell / leucocyte <b>and</b> <i>reason:</i> it contains, a nucleus / DNA ;</p>	1

Question	Answer	Marks
4(b)(iii)	<p><i>any four from:</i></p> <ol style="list-style-type: none"> <li>1 ref. to, probes / reporters, are (short) lengths of ssDNA ;</li> <li>2 complementary to the faulty, alleles / DNA, being tested for ;</li> <li>3 many copies of <b>one</b> type of probe placed in <b>each</b> cell (of the microarray) ;</li> <li>4 sample DNA made single stranded ;</li> <li>5 sample DNA labelled (with fluorescent 'tags') ;</li> <li>6 faulty DNA, hybridises / binds, with, probes / ssDNA ;</li> <li>7 unbound sample DNA washed off <b>or</b> bound sample DNA will not be washed off ;</li> <li>8 laser / UV light, used to detect presence of, fluorescence / hybridised probes / alleles / DNA ;</li> </ol>	4
4(b)(iv)	<p><i>any four from:</i></p> <ol style="list-style-type: none"> <li>1 informed choice about making lifestyle change ;</li> <li>2 informed choice about whether preventative treatment needed ;</li> <li>3 if not present removes worry ;</li> <li>4 allows preventative treatment that may be cheaper than treating disease itself ;</li> <li>5 allows informed choice about having children ;</li> <li>6 positive implications for life insurance ;</li> </ol>	4

Question	Answer	Marks
5(a)(i)	sarcomere shortens / Z lines move closer together <b>or</b> ref. rowing motion of the head / power stroke ;	1
5(a)(ii)	<b>any three from:</b> 1 (ATP) binds to myosin head ; 2 hydrolyse by, ATPase / myosin head ; 3 head detaches from actin ; 4 head tilts back to original position ;	3
5(b)(i)	afferent arteriole is wider than efferent arteriole / ORA ;	1
5(b)(ii)	<u>basement membrane</u> ;	1
5(c)(i)	1 the higher the creatinine concentration the lower the GFR ; ORA 2 further qualification of relationship ; e.g. exponential curve inversely proportional data quote for two points  Note: creatinine concentration is inversely proportional to the GFR = 2 marks	2
5(c)(ii)	0.013 ; g dm <sup>-3</sup> ;	2

Question	Answer	Marks
5(c)(iii)	<p>any <b>two</b> from:</p> <ol style="list-style-type: none"> <li>1 kidney, disease / damage ;</li> <li>2 cancer ;</li> <li>3 dehydration ;</li> <li>4 low blood pressure ; <b>A</b> loss of blood</li> </ol>	2
6(a)	<p>any <b>three</b> from:</p> <ol style="list-style-type: none"> <li>1 the greater the concentration of extract the lower the activity of tyrosinase ; <b>A</b> inversely proportional</li> <li>2 extract acts as an inhibitor / enzyme inhibited ;</li> <li>3 binds to, active site / allosteric site, (of tyrosinase) ;</li> <li>4 ref. to alters pH ;</li> <li>5 ref. to extract changes active site ; <b>A</b> ref. to denatures</li> </ol>	3
6(b)(i)	<p><i>recessive</i> only expressed, when a dominant allele not present / in a homozygote <b>or</b> not expressed in a heterozygote ; <i>allele</i> different, form / variety, of a gene ;</p>	2

Question	Answer	Marks
6(b)(ii)	<p>symbols explained e.g. <b>A</b> = <u>allele</u> for, melanin production / normal pigment <b>a</b> = <u>allele</u> for, no melanin production / albinism ;</p> <p>parental genotypes <b>and</b> gametes ; e.g. <b>Aa</b> (and <b>Aa</b>) and <b>A a</b> (and <b>A a</b>)</p> <p>offspring genotypes identifying child with albinism as <b>aa</b> e.g. (<b>AA Aa Aa</b>) <b>aa</b> ;</p>	3

Question	Answer	Marks
7(a)	<p>any <b>three</b> from:</p> <ol style="list-style-type: none"> <li>1 predation ;</li> <li>2 competition for food / decrease in food available / limited amount of food ;</li> <li>3 disease ;</li> <li>4 loss of, habitat / breeding sites ; <b>A</b> size of habitat limited</li> <li>5 pesticides / herbicides ;</li> <li>6 ref. to change in climate ;</li> </ol>	3
7(b)(i)	same shape but to the right ;	1
7(b)(ii)	<u>directional</u> (selection) ;	1
7(c)(i)	same position but two peaks ;	1
7(c)(ii)	<u>disruptive</u> (selection) ;	1

Question	Answer	Marks
8(a)	7 ; 4 ; 9 / 4 ; 2 ; 10 ; 3 ;	<b>6</b>
8(b)	<p><i>any five from:</i></p> <ol style="list-style-type: none"> <li>1 only, glycolysis / conversion of glucose into pyruvate, occurs ;</li> <li>2 (only) produces 2 molecules of ATP (net per molecule of glucose) ;</li> <li>3 (only) substrate-linked phosphorylation (occurs) ;</li> <li>4 pyruvate converted to lactate ;</li> <li>5 lactate is energy-rich / AW ;</li> <li>6 oxygen not available as final electron acceptor ;</li> <li>7 electron transport chain / chemiosmosis / oxidative phosphorylation, does not occur ;</li> <li>8 most ATP is produced (in aerobic conditions) in, electron transport chain / chemiosmosis / oxidative phosphorylation ;</li> <li>9 no additional substrate-linked phosphorylation from Krebs cycle ;</li> </ol>	<b>5</b>



Question	Answer					Marks																				
9(a)(i)	<table border="1"> <thead> <tr> <th data-bbox="201 1727 320 1935">dung beetle species</th> <th data-bbox="320 1727 373 1935">number on grassland not grazed</th> <th data-bbox="373 1727 426 1935"><math>\frac{n}{N}</math></th> <th data-bbox="426 1727 478 1935"><math>\left(\frac{n}{N}\right)^2</math></th> </tr> </thead> <tbody> <tr> <td data-bbox="320 1469 373 1715"><b>A</b></td> <td data-bbox="373 1469 426 1715">6641</td> <td data-bbox="426 1469 478 1715">0.873</td> <td data-bbox="478 1469 531 1715">0.762</td> </tr> <tr> <td data-bbox="373 1211 426 1458"><b>B</b></td> <td data-bbox="426 1211 478 1458">774</td> <td data-bbox="478 1211 531 1458">0.102</td> <td data-bbox="531 1211 584 1458">0.010</td> </tr> <tr> <td data-bbox="426 954 478 1200"><b>C</b></td> <td data-bbox="478 954 531 1200">108</td> <td data-bbox="531 954 584 1200">0.014</td> <td data-bbox="584 954 636 1200">0.000</td> </tr> <tr> <td data-bbox="478 696 531 943"><b>D</b></td> <td data-bbox="531 696 584 943">85</td> <td data-bbox="584 696 636 943">0.011</td> <td data-bbox="636 696 689 943">0.000</td> </tr> <tr> <td data-bbox="531 439 584 685">total</td> <td data-bbox="584 439 636 685">7608</td> <td data-bbox="636 439 689 685"></td> <td data-bbox="689 439 742 685">0.772</td> </tr> </tbody> </table>	dung beetle species	number on grassland not grazed	$\frac{n}{N}$	$\left(\frac{n}{N}\right)^2$	<b>A</b>	6641	0.873	0.762	<b>B</b>	774	0.102	0.010	<b>C</b>	108	0.014	0.000	<b>D</b>	85	0.011	0.000	total	7608		0.772	3
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9(a)(ii)	<p data-bbox="619 1693 667 1935"><math>\frac{n}{N}</math> figures correct ;</p> <p data-bbox="715 1532 788 1935"><math>\left(\frac{n}{N}\right)^2</math> calculated and added up ;</p> <p data-bbox="831 1252 863 1935"><math>D = 0.228 / 0.227</math> ; ECF total figure subtracted from 1</p> <p data-bbox="900 1570 932 1935">apply ECF for mp2 and mp3</p> <p data-bbox="954 1240 1018 1935">greater species evenness on grazed grassland ; ORA <b>accept</b> mostly, one species / <b>A</b>, on not grazed</p> <p data-bbox="1054 1155 1086 1935">grazing increases (dung beetle species) (bio)diversity ; ORA</p>	2																								

Question	Answer	Marks
9(b)	<ol style="list-style-type: none"> <li>1 mark-release-recapture / AW ;</li> <li><i>description (max 3)</i></li> <li>2 detail of trapping ; e.g. pitfall trap</li> <li>3 detail of marking ; e.g. felt tip pen / not to have adverse effects</li> <li>4 release of marked beetles ;</li> <li>5 time of second trapping detail ; e.g. not too soon or mixing won't occur / not too long after as migration may occur</li> <li>6 correct formula for Lincoln index ;</li> </ol>	<b>4</b>

Question	Answer	Marks
10	<p>any <b>seven</b> from:</p> <ol style="list-style-type: none"> <li>1 ref. to regulatory gene ;</li> <li>2 codes for repressor protein ;</li> <li>3 (repressor protein) binds to operator ;</li> </ol> <p><i>in presence of (allo)lactose:</i></p> <ol style="list-style-type: none"> <li>4 (allo)lactose binds to repressor protein ;</li> <li>5 which changes shape ;</li> <li>6 moves away from operator / AW ;</li> </ol> <p><i>in absence of (allo)lactose:</i></p> <ol style="list-style-type: none"> <li>7 covers part of promoter</li> <li>8 RNA polymerase cannot bind to promoter</li> <li>9 structural genes cannot be transcribed / mRNA not synthesised</li> <li>10 enzymes / named enzyme, cannot be synthesised</li> </ol> <p><i>in presence of (allo)lactose:</i></p> <p><b>or</b> promoter region now unblocked ;</p> <p><b>or</b> RNA polymerase can now bind to polymerase ;</p> <p><b>or</b> structural genes now, transcribed / 'switched on' / mRNA synthesised ;</p> <p><b>or</b> enzymes / named enzyme, can now be synthesised ;</p>	7

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