CAMBRIDGE
International Education

# Cambridge International AS & A Level

**BIOLOGY** **9700/41**

Paper 4 A Level Structured Questions **May/June 2024**

MARK SCHEME

Maximum Mark: 100

**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.



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**PUBLISHED**

## 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 descriptions 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.

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| |
|---|
| GENERIC MARKING PRINCIPLE 5:<br><br>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:<br><br>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 | ‘List rule’ guidance<br><br>For questions that require ***n*** responses (e.g. State **two** reasons …):<br><br>• The response should be read as continuous prose, even when numbered answer spaces are provided.<br>• Any response marked *ignore* in the mark scheme should not count towards ***n***.<br>• Incorrect responses should not be awarded credit but will still count towards ***n***.<br>• Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** 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.<br>• Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science. |

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

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.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient ($a$) 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.

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.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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**Mark scheme abbreviations**

| | |
|---|---|
| **;** | separates marking points |
| **/** | alternative answers for the same point |
| **A** | accept (for answers correctly cued by the question, or by extra guidance) |
| **R** | reject |
| **I** | ignore |
| **( )** | the word / phrase in brackets is not required, but sets the context |
| **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 given |
| **ora** | or reverse argument |
| **mp** | marking point (with relevant number) |
| **ecf** | error carried forward |
| **AVP** | alternative valid point |

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><th>stage of respiration</th><th>letter</th></tr>
<tr><td>glycolysis</td><td>B</td></tr>
<tr><td>link reaction</td><td>D</td></tr>
<tr><td>Krebs cycle</td><td>D</td></tr>
<tr><td>oxidative phosphorylation</td><td>C</td></tr>
</table>
;;;<br>3 marks if all four letters are correct<br>2 marks if three letters are correct<br>1 mark if one or two letters are correct
</td><td>3</td></tr>
<tr><td>1(b)</td><td>any four from:<br>1 oxygen is the, <u>final / last / terminal</u>, electron acceptor ;<br>2 electron transport chain / ETC, stops ;<br><br>3 less / no, protons / $H^+$ / hydrogen ions, move,<br>into intermembrane space / across inner mitochondrial membrane ;<br>4 less / no, proton / electrochemical, gradient ;<br>5 less / no, protons move through ATP synthase ;<br>6 less / no, recycling / regeneration, of, NAD / FAD ;</td><td>4</td></tr>
<tr><td>1(c)</td><td>any three from:<br>1 <u>lactate</u> dehydrogenase ;<br>2 less / no, pyruvate → lactate ;<br>3 (so) less / no, NAD, regenerated / recycled ;<br>4 (so) less / no, triose phoshate / TP, → pyruvate ;<br>5 (so) less / no, ATP from substrate, linked / level, reactions / phosphorylation (in glycolysis) ;</td><td>3</td></tr>
</table>

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| Question | Answer | Marks |
|---|---|---|
| 2(a)(i) | **1** *similarity:* both involve a (signalling), chemical / ligand / molecule **;**<br>**2** *difference:* endocrine chemical / hormone, travels in <u>blood / circulatory system</u> (but paracrine chemical travels by diffusion) **;** | **2** |
| 2(a)(ii) | **1** (ACh) travels a short distance by <u>diffusion</u> **;**<br>**2** across, synapse / synaptic cleft / neuromuscular junction **;** | **2** |
| 2(b) | *any **three** conclusions from:*<br>**1** palmitate-exposed cells, release / secrete, molecule / chemical / substance **;**<br>**2** (this) molecule switches on stress genes in, new / other, muscle cells **;**<br>**3** molecule is not, destroyed / denatured, by, boiling / high temperature **;**<br>**4** (so) molecule is not a protein **;**<br>**5** molecule is, lipid / lipid-soluble / hydrophobic / non-polar **;**<br>**6** AVP **;** | **3** |
| 2(c) | *any **three** from:*<br>**1** less actin **;**<br>**2** less myosin **;**<br>**3** less troponin **;**<br>**4** less tropomyosin **;**<br>**5** fewer / smaller, sarcomeres / myofibrils / myofilaments / mitochondria / ribosomes **;**<br>**6** less of other named protein **;** | **3** |

| Question | Answer | Marks |
|---|---|---|
| 3(a) | *any **four** from*:<br>**1** protons / $H^+$ ions, pumped, from <u>guard cells</u> / into <u>guard cell</u> wall **;**<br>**2** *ref. to* negative potential (inside cell) **or** $Cl^-$ ions enter (cell) **;**<br>**3** (voltage-gated) $K^+$ channels open **or** $K^+$ ions enter (guard) cells **;**<br>**4** water enters cell, by osmosis / down water potential gradient **;**<br>**5** (guard) cells, become turgid / swell / increase in volume **;** | **4** |

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| Question | Answer | Marks |
|---|---|---|
| 3(b)(i) | *any **two** from*:<br>**1** as abscisic acid concentration increases stomatal conductance decreases **or** negative correlation / inverse correlation / inversely proportional **;**<br>**2** two sets of *x y* figures to support mp 1 with units (at least once) **;**<br>**3** steep decrease in conductance to 100–150 ABA **;**<br>**4** no / little, effect on conductance above 250–425 ABA **;** | **2** |
| 3(b)(ii) | *any **four** from*:<br>**1** ABA causes stomata to close **;**<br>**2** ABA binds to receptor on guard cell **;**<br>**3** $Ca^{2+}$ ions, enter (guard) cells / act as 2nd messenger **;**<br>**4** $K^{+}$ ions leave (guard) cells **;**<br>**5** water leaves so cells become, flaccid / less turgid **;**<br>**6** AVP **;** | **4** |
| 3(c) | DNA / promoter **;** | **1** |

| Question | Answer | Marks |
|---|---|---|
| 4(a) | *any **four** from:*<br>**1** (random / spontaneous) mutation gave resistance **;**<br>**2** pathogen / disease / plague, was selection pressure **;**<br>**3** mutation, gave selective advantage / was selected for / allowed crayfish to survive (plague) **;**<br>**4** survivors / resistant crayfish, bred / reproduced / passed on mutation **;**<br>**5** frequency of, allele / mutation, (for resistance) increased **;**<br>**6** natural / directional, selection **;**<br>**7** AVP **;** | **4** |
| 4(b)(i) | **1** (heat to) 90–98 °C so DNA, denatures / strands separate **;**<br>**2** (cool to) 50–65 °C so primers, bind / base pair / anneal (to DNA) **;**<br>**3** (heat to) 68–75 °C so, *Taq* / DNA, polymerase, makes DNA / (new) strand **;**<br>**4** repeat cycles to amplify DNA **;** | **4** |
| 4(b)(ii) | used, a (named) database / bioinformatics **;** | **1** |

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| Question | Answer | Marks |
|---|---|---|
| 4(c)(i) | **A ;** | **1** |
| 4(c)(ii) | $(2^3) = 8$ **;** | **1** |
| 4(d)(i) | (named) plasmid / vector (used) **;**<br>(containing) gene / DNA, for (green) fluorescent protein **;**<br>(containing) a (prokaryotic) promoter **;** | **3** |
| 4(d)(ii) | to act as a, marker / reporter, gene<br>**or**<br>to identify, recombinant / GM / transgenic, bacteria / organisms<br>**or**<br>to show expression of another transferred gene **;** | **1** |

| Question | Answer | Marks |
|---|---|---|
| 5(a)(i) | **A** = stroma **;**<br>**B** = thylakoid, lumen / space **;** | **2** |
| 5(a)(ii) | **1** cyclic photophosphorylation **;**<br>**2** ATP synth(et)ase **;** | **2** |
| 5(a)(iii) | **1** **D** = reduced NADP **;**<br>**2** reduces / gives hydrogen to, glycerate (3) phosphate / GP **;**<br>**3** forming, triose phosphate / TP **;** | **3** |
| 5(b)(i) | *any **three** from:*<br>**D1** rate of energy transfer, higher / highest, for tropical<br>**or**<br>rate of energy transfer, lower / lowest, for snow forest **;**<br>**D2** paired data quote with units (at least once) **;**<br>**S3** tropical forest has, high(er/est) temperature / hot(ter) **;**<br>**S4** tropical forest has high(er/est) light, intensity / duration **;**<br>**S5** temperature / light intensity, is a limiting factor (on photosynthesis) **;** | **3** |

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| Question | Answer | Marks |
|---|---|---|
| 5(b)(ii) | *any **three** from:*<br>**1** more, transpiration / water loss (from leaves) **;**<br>**2** stomata shut reducing, carbon dioxide (entry) / gas exchange **;**<br>**3** (so) carbon dioxide (concentration) is a limiting factor **;**<br>**4** (grassland / desert) fewer plants / less plant cover / smaller plants **;**<br>**5** (so smaller surface area) less light absorbed **;**<br>**6** AVP **;** | **3** |

| Question | Answer | Marks |
|---|---|---|
| 6(a)(i) | *any **one** from:*<br>**1** same / equal, size / length **;**<br>**2** same, shape / position of centromere **;**<br>**3** same banding pattern **;** | **1** |
| 6(a)(ii) | *any **three** from*:<br>**1** recessive / mutation = faulty / inactive / no, tyrosinase **;**<br>**2** (melanocytes) do not produce, melanin / pigment **;**<br>**3** *ref. to* skin / hair / iris **;**<br>**4** AVP **;** | **3** |

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>6(b)</td><td>
gametes (on Punnett square)<br>
1 BF Bf bF bf ;<br><br>
Punnett square
<table>
<tr><td></td><td>BF</td><td>Bf</td><td>bF</td><td>bf</td></tr>
<tr><td>BF</td><td>BBFF<br>black</td><td>BBFf<br>black</td><td>BbFF<br>black</td><td>BbFf<br>black</td></tr>
<tr><td>Bf</td><td>BBFf<br>black</td><td>BBff<br>white</td><td>BbFf<br>black</td><td>Bbff<br>white</td></tr>
<tr><td>bF</td><td>BbFF<br>black</td><td>BbFf<br>black</td><td>bbFF<br>brown</td><td>bbFf<br>brown</td></tr>
<tr><td>bf</td><td>BbFf<br>black</td><td>Bbff<br>white</td><td>bbFf<br>brown</td><td>bbff<br>white</td></tr>
</table>
2 correct offspring genotypes on Punnett square ;<br>
3 phenotypes matching genotypes ;<br><br>
offspring phenotype ratio<br>
4 9 black : 3 brown : 4 white ;
</td><td>4</td></tr>
</table>

| Question | Answer | Marks |
|---|---|---|
| 7(a)(i) | as mutation rate increases lifespan decreases **;** | **1** |
| 7(a)(ii) | *any **three** from:*<br>**1** high(er) mutation rate gives more, genetic diversity / genetic variation / alleles / chance of beneficial allele **;**<br>**2** short(er) lifespan gives more generations (per year / per unit time) **;**<br>**3** with, high(er) mutation rate / short(er) lifespan, they, adapt / evolve, better / more easily / faster **;**<br>**4** mouse (and ferret) may, adapt / evolve, faster **;**<br>**5** AVP **;** | **3** |

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| Question | Answer | Marks |
|---|---|---|
| 7(b)(i) | *comparison:*<br>**C1** genetic engineering faster / selective breeding slower **;**<br><br>*any **one** reason from:*<br>**R2** selective breeding occurs over (many) generations **;**<br>**R3** all cows could be surrogate mothers for engineered embryos (giving large increase in allele frequency in one generation) **;**<br>**R4** AVP **;** | **2** |
| 7(b)(ii) | *any **two** from:*<br>**1** (improve named) quality of, animal / milk **;**<br>**2** (improve) quantity / yield, of milk **;**<br>**3** AVP **;** | **2** |

| Question | Answer | Marks |
|---|---|---|
| 8(a) | *any **three** from:*<br>**1** assess / categorise / rank, species, threat level / conservation status **;**<br>**2** *ref. to* Red List (of Threatened Species)<br>**3** influence / advise, countries / governments / policy makers **;**<br>**4** educate / raise awareness **;**<br>**5** promote sustainable, use / management, of (natural) resources **;** | **3** |

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| Question | Answer | Marks |
|---|---|---|
| 8(b) | *any **six** from*:<br><br>*biological species (concept)*<br>**1** no / not separate species / same species **;**<br>**2** as can, interbreed / breed together, to produce, fertile offspring / pizzly bears<br>**or**<br>they are not reproductively isolated **;**<br><br>*morphological species (concept)*<br>**3** yes / separate species / different species **;**<br>**4** as have different, colours / mass / size / hump size **;**<br><br>*ecological species (concept)*<br>**5** yes / separate species / different species **;**<br>**6** as have different, niches / diets / habitats **;**<br><br>*genetic / phylogenetic, species (concept)*<br>**7** unsure / don't know **;**<br>**8** as no information about genetic similarity **;**<br>**9** AVP **;** | **6** |
| 8(c)(i) | *G. hapalotricha* $\frac{n}{N} = 0.194$ **and** $\left(\frac{n}{N}\right)^2 = 0.037$ **;**<br><br>$\left(\frac{n}{N}\right)^2$ total = 0.272 **;**<br><br>$D = 0.728$ **;** | **3** |
| 8(c)(ii) | undisturbed / higher D, has, larger / higher / more, (food), diversity / variation **;** | **1** |

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>9(a)</td><td>any two from:<br><br>
<table>
<tr><th>discontinuous</th><th>continuous</th></tr>
<tr><td>(forms / phenotypes / categories)<br>distinct / discrete / categoric / do not overlap / do not form a (gradual) range / no intermediates / two or few different forms</td><td>(forms / phenotypes / categories) not distinct / not discrete / overlap / form a (gradual) range / include intermediates / many different forms / many values on a spectrum ;</td></tr>
<tr><td>not a normal distribution / few bars (on bar chart)</td><td>normal distribution or normal / bell-shaped curve (on graph) ;</td></tr>
<tr><td>no / little, effect from environment<br>A genes only</td><td>some / large, effect from environment ;</td></tr>
</table></td><td>2</td></tr>
<tr><td>9(b)</td><td>any two from:<br>1 one / two, genes (control colour pattern) ;<br>2 different alleles of a gene have a large effect ;<br>3 multiple / three, alleles ;<br>4 gene interaction / epistasis ;<br>5 AVP ;</td><td>2</td></tr>
<tr><td>9(c)</td><td>any two from:<br>1 temperature / food (supply) ;<br>2 of larva / during larval development ;<br>3 egg size / diet of mother / size of mother ;</td><td>2</td></tr>
</table>

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| Question | Answer | Marks |
|---|---|---|
| 10 | *any **six** from:*<br>**1** sucrose binds to, receptor <u>protein</u> / (chemoreceptor) cell surface receptor **;**<br>**2** *ref. to* second messenger **;**<br>**3** (chemoreceptor cell) $Na^+$ entry / membrane depolarises **;**<br>**4** receptor / generator, potential **;**<br>**5** $Ca^{2+}$ ions enter (chemoreceptor cell) **;**<br>**6** (named) neurotransmitter vesicles, move towards / fuse with, (presynaptic) membrane **;**<br>**7** (named) neurotransmitter, release / exocytosis, into (synaptic) cleft **;**<br>**8** (named) neurotransmitter binds to receptor on, sensory neurone / postsynaptic membrane **;**<br>**9** $Na^+$ enters (through ligand-gated channel) → depolarisation **;**<br>**10** *ref. to* threshold for action potential **;**<br>**11** AVP **;** | **6** |

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