Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/41**

Paper 4 A Level Structured Questions **May/June 2023**

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 2023 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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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.

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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.

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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 For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • 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. • 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 marking point
R	reject
A	accept
I	ignore
AVP	any valid point
AW	alternative wording (where responses vary more than usual)
ecf	error carried forward
underline	actual word underlined must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument

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Examples of how to apply the list rule

State **three** reasons…. [3]

A	1	Correct	✓	**2**
	2	Correct	✓	
	3	Wrong	×	

B	1	Correct, Correct	✓, ✓	**3**
(4 responses)	2	Correct	✓	
	3	Wrong	ignore	

C	1	Correct	✓	**2**
(4 responses)	2	Correct, Wrong	✓, ×	
	3	Correct	ignore	

D	1	Correct	✓	**2**
(4 responses)	2	Correct, CON (of 2)	×, (discount 2)	
	3	Correct	✓	

E	1	Correct	✓	**3**
(4 responses)	2	Correct	✓	
	3	Correct, Wrong	✓	

F	1	Correct	✓	**2**
(4 responses)	2	Correct	✓	
	3	Correct CON (of 3)	× (discount 3)	

G	1	Correct	✓	**3**
(5 responses)	2	Correct	✓	
	3	Correct Correct CON (of 4)	✓ ignore ignore	

H	1	Correct	✓	**2**
(4 responses)	2	Correct	×	
	3	CON (of 2) Correct	(discount 2) ✓	

I	1	Correct	✓	**2**
(4 responses)	2	Correct	×	
	3	Correct CON (of 2)	✓ (discount 2)	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><th>description</th><th>letter</th></tr>
<tr><td>accumulates (builds up) a high concentration of protons</td><td>B ;</td></tr>
<tr><td>makes triose phosphate</td><td>A ;</td></tr>
<tr><td>makes some chloroplast proteins</td><td>D ;</td></tr>
<tr><td>pumps protons</td><td>C ;</td></tr>
</table>
</td><td>4</td></tr>
<tr><td>1(b)(i)</td><td>any four from:

1 spot / extract, placed on, pencil line / base line / line of origin ;
2 repeat / concentrate, spot / extract ;
3 end / base, of paper, suspended / placed, in (named) solvent ;
4 mark the solvent front after, some time / paper removed / solvent moves ;
5 R_f value = distance moved by, spot / pigment / component / solute ÷ distance moved by solvent (front) ;
6 compare (R_f) with known R_f values to identify, constituents / pigments ;
7 detail of method ;</td><td>4</td></tr>
<tr><td>1(b)(ii)</td><td>any three from:

1 (pigments / they / to) absorb / capture / harvest, <u>light</u> (energy) ;
2 increase (range of) / more / different, wavelengths / colours of light, can be absorbed ;
3 increase, efficiency / rate, of, photosynthesis / light dependent reaction OR
increase / broader, action spectrum ;
4 ref. two of: chlorophyll a / chlorophyll b / carotene / xanthophyll ;</td><td>3</td></tr>
</table>

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Question	Answer	Marks
2(a)(i)	**1** (self-contained unit containing) community of / all / different, organisms / populations / species, **and** their interactions **;** **2** (with the) biotic and abiotic, environment / factors **OR** with each other and with the physical environment **;**	**2**
2(a)(ii)	role / function, of a species within its, ecosystem / habitat **;**	**1**
2(b)(i)	(interrupted belt) <u>transect</u> **;**	**1**
2(b)(ii)	*were assessed:* **1** abundance / density / (%) frequency / % cover, of (selected) species **;** *not assessed:* **2** number / range, of (different), ecosystems / habitats **;** **3** genetic, variation / diversity (within each species) **;**	**3**
2(c)(i)	*Haematopus* / *Larus* **;**	**1**
2(c)(ii)	*any **two** from:* **1** eukaryotic (cells) **;** **2** autotrophic / photosynthetic **;** **3** cellulose cell wall **;** **4** aquatic **;** **5** not motile / sessile **;** **6** multicellular **;** **7** no, vascular tissue / xylem / phloem **;**	**2**
2(d)	*any **four** from:* **1** rats no longer, prey on / eat, birds / eggs / chicks **;** **2** mussels / sea snails, decrease because there are more (named) birds **;** **3** seaweeds increase because there are fewer, mussels / (sea) snails **;** **4** Hawadax has changed to match a rat-free island **;** **5** rats were an, invasive / alien, species / predator **;** **6** AVP **;**	**4**

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Question	Answer	Marks
3(a)(i)	*any **two** from*: **1** oxygen / gas, supply / diffusion / transfer **;** **2** to, submerged / underwater, cells / tissues / roots **;** **3** for <u>aerobic respiration</u> **;**	**2**
3(a)(ii)	*any **one** from:* **1** anaerobic respiration / ethanol fermentation **;** **2** high tolerance to, alcohol / ethanol **OR** high / more, alcohol / ethanol, dehydrogenase **;**	**1**
3(a)(iii)	*any **three** from*: **1** cross / breed, rice / plants / individuals, with fast-growing stems **;** **2** select / choose, and breed offspring with fast-growing stems **;** **3** repeat (crossing **and** selection) over generations **;** **4** hybridise / outbreed / out-cross **OR** avoid / reduce, inbreeding depression / background selection **;**	**3**
3(a)(iv)	*any **three** from*: **1** auxin increases <u>stem,</u> growth / length / height **;** **2** protons / hydrogen ions / H^+, move / pumped, into cell wall(s) **;** **3** (expansins) break, links / (H) bonds, between <u>cellulose</u>, molecules / microfibrils **;** **4** water enters cell(s) by osmosis **;** **5** <u>cells</u>, elongate / expand / increase in volume / swell **;**	**3**
3(b)	*any **three** from*: **1** *O. nivara*, adapted to / selected for, dry / drier, conditions / habitats **;** **2** different habitats / ecological isolation **;** **3** prevent interbreeding / no gene flow / reproductive isolation **;** **4** polyploidy / auto(poly)ploidy **;** **5** AVP **;**	**3**

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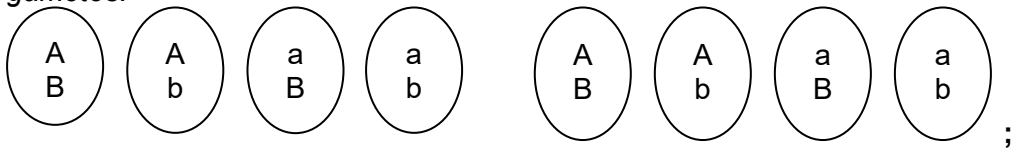
Question	Answer	Marks
4(a)(i)	DNA, combined / joined, from, two / different, organisms / sources ;	1
4(a)(ii)	*any **three** from:* *(protein made in, bacteria / yeast, so)* **1** can be made in, large / unlimited, quantities ; **2** cheap to make / low cost / cost-efficient ; **3** does not, harm / involve, animals / pigs / cows ; **4** no risk of (named) disease, transfer / infection ; *(sequence identical to human sequence so)* **5** does not cause, allergy / inflammatory response / immune response / antibody production ; **6** acts more rapidly ; **7** do not, develop tolerance to it / need larger doses ;	3
4(b)(i)	cow ;	1
4(b)(ii)	*any **three** from:* **1** obtain (normal human), gene / DNA, from (m)RNA by reverse transcriptase / using restriction enzyme ; **2** use gene editing (to alter human gene) ; **3** obtain (nucleotide) sequence for (normal human) insulin gene ; **4** synthesise, new / analogue, gene / nucleotide sequence ; **5** put, new / analogue, gene in, bacteria / yeast ; **6** add <u>promoter</u> for, gene expression / protein synthesis ; **7** AVP ;	3
4(c)	*any **three** from:* **1** can, share / search / access, data(base) / information / sequences ; **2** from anywhere / online ; **3** can, compare / align / analyse, (multiple) sequence<u>s</u> ; **4** rapid / fast(er) (process) ; **5** can, quantify / count, nucleotide differences ; **6** closely-related species have few, differences / mutations ;	3

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Question	Answer	Marks
5(a)(i)	**A** = glomerulus **;** **B** = Bowman's capsule **;**	**2**
5(a)(ii)	*any **four** from:* **1** ultrafiltration **;** **2** high(er) pressure due to afferent arteriole wider than efferent arteriole **;** **3** capillary endothelium has, fenestrations / gaps / holes / pores **;** **4** small molecules / (named) ions / glucose / amino acids / urea / water, **and** **EITHER** leave, blood / plasma / capillary / glomerulus **OR** enter, capsule / filtrate / tubule **;** **5** basement membrane forms, (main) filtration / selective, barrier **;** **6** (R)MM / M_r, limit of, 68 000 to 70 000 (Da) / 68–70 kDa **;** **7** podocytes, form slit pores / support basement membrane **;**	**4**
5(b)(i)	**C** adenyl(yl) cyclase **;** **D** c(yclic) AMP **;**	**2**
5(b)(ii)	*any **four** from*: **1** in both as Na^+ concentration increases ADH concentration increases (after a, certain / stated, point) **;** **2** in, type C / SIAD, ADH rise occurs at a lower Na^+ concentration **;** **3** comparative figures **;** **4** (ADH →) more aquaporins / greater permeability to water, in collecting duct / DCT **;** **5** (C / SIAD / ADH →) more water reabsorbed, at collecting duct / at DCT / into blood **;** **6** (C / SIAD / ADH →) small(er) volume of / (more) concentrated, urine **;** **7** type C / SIAD, causes, high blood water potential / low blood Na^+ concentration **;**	**4**

Question	Answer	Marks
6(a)(i)	**AAb^hb^h** **Aab^hb^h** **AAb^hb** **Aab^hb ; ;**	**2**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>6(a)(ii)</td><td>long, white / albino ;</td><td>1</td></tr>
<tr><td>6(b)</td><td>
1 F1 parent genotypes: AaBb x AaBb ;

2 gametes:


;

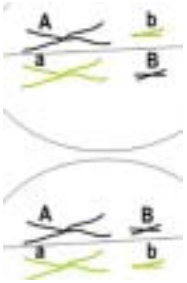
3 F2 offspring genotypes:

<table>
<tr><th></th><th>AB</th><th>Ab</th><th>aB</th><th>ab</th></tr>
<tr><td>AB</td><td>AABB</td><td>AABb</td><td>AaBB</td><td>AaBb</td></tr>
<tr><td>Ab</td><td>AABb</td><td>AAbb</td><td>AaBb</td><td>Aabb</td></tr>
<tr><td>aB</td><td>AaBB</td><td>AaBb</td><td>aaBB</td><td>aaBb</td></tr>
<tr><td>ab</td><td>AaBb</td><td>Aabb</td><td>aaBb</td><td>aabb ;</td></tr>
</table>
4 evidence of deduction of phenotypes from (min 9 different) genotypes ;

5 F2 offspring phenotype ratio:
9 : 3 : 3 : 1
black short | white short | black long | white long ;
</td><td>5</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>6(c)(i)</td><td>any three from:

1 because they are, on separate chromosomes / not linked ;
2 each, bivalent / <u>pair</u> of homologous chromosomes, orients itself separately ;
3 (at equator) in metaphase I of meiosis ;
4 gives, four / different / new, combinations of alleles / gametes ;
5 parental allele combinations are not, preserved / fixed ;
6 AVP ;

</td><td>3</td></tr>
<tr><td>6(c)(ii)</td><td><table>
<tr><th>phenotype</th><th>observed number (O)</th><th>expected number (E)</th><th>$(O - E)^2$</th><th>$\frac{(O - E)^2}{E}$</th></tr>
<tr><td>short, black fur</td><td>25</td><td>27</td><td>4</td><td>0.148</td></tr>
<tr><td>long, black fur</td><td>11</td><td>9</td><td>4</td><td>0.444</td></tr>
<tr><td>short, white fur</td><td>8</td><td>9</td><td>1</td><td>0.111</td></tr>
<tr><td>long, white long</td><td>4</td><td>3 ;</td><td>1</td><td>0.333</td></tr>
</table></td><td>1</td></tr>
<tr><td>6(c)(iii)</td><td>1.036 ;</td><td>1</td></tr>
</table>

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Question	Answer	Marks
7(a)	(pyruvate) – serine **;** (oxaloacetate) – asparagine **;**	**2**
7(b)(i)	**1** chloride (ions) / Cl^-, not, sodium ions / Na^+ (enter post-synaptic neurone) **;** **2** glycine not choline (re-enters / recycled to, pre-synaptic neurone) **OR** glycine not, broken down / hydrolysed, but acetylcholine is (in synaptic cleft) **;**	**2**
7(b)(ii)	*any **two** from*: **1** Cl^- decreases, membrane / resting, potential (difference) / voltage **;** **2** harder / need more depolarisation, to reach threshold **;** **3** glycine is inhibitory **;**	**2**
7(b)(iii)	*any **four** from*: **1** sodium-potassium pump / active transport **;** **2** Na^+, out / leaves **and** K^+, in / enters **;** **3** three Na^+ for two K^+ **;** **4** some K^+ can diffuse out of neurone **OR** ($\times$20) more K^+ diffuses out than Na^+ diffuses in **OR** membrane is ($\times$20) more permeable to K^+ (than Na^+) **;** **5** inside of, axon / neurone, is more negative (than outside) **OR** outside of, axon / neurone, is more positive (than inside) **;**	**4**

Question	Answer	Marks
8	*any **four** from:* **1** DNA / chromatin / chromosomes / chromatids, condense **;** **2** homologous chromosomes, pair up / undergo synapsis / form bivalents / form tetrads **;** **3** crossing-over **;** **4** between non-sister chromatids **;** **5** detail of crossing over **;** **6** chromosomes (stay) joined at, cross-over points / chiasmata **;**	**4**

Question	Answer	Marks
9(a)	**1** environmental **;** **2** discontinuous **;**	**2**
9(b)	*any **five** from*: *coenzyme A:* **1** accepts / binds to / transfers, acetyl (group) **;** **2** acetyl / 2C fragment, + oxaloacetate → citrate **;** **3** (joins) link reaction **and** Krebs cycle **;** *NAD / FAD:* **4** transfer / transport / carry / accept / reduced by, H^+ and e^- / H (atoms) / hydrogen (atoms) **;** **5** *ref.* dehydrogenation (reactions) / dehydrogenase (enzymes) **;** **6** transport, to cristae / to inner mitochondrial membrane / to ETC / for oxidative phosphorylation **;** **7** NAD (accepts H) in glycolysis **and** link reaction **and** Krebs cycle **;**	**5**

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Question	Answer	Marks
10	*any **six** from:* **1** *Ie* allele codes for a, non / less, functional enzyme **;** **2** 3 beta-hydroxylase **;** **3** alanine replaced with threonine at active site **;** **4** inactive gibberellin / GA20, not converted to, active gibberellin / GA1 **;** **5** no / less, gibberellin to bind to, (intracellular) receptor / GID1 **;** **6** no / less, gibberellin-receptor-DELLA complexes formed **;** **7** DELLA not broken down **;** **8** DELLA (stays) bound to, transcription factors / PIF **;** **9** transcription factor / PIF / RNA polymerase, cannot, bind to promoter **;** **10** growth genes / XET gene, (stay) switched off / not transcribed / not expressed **;** **11** stem does not elongate **/** internode length is small **OR** no / less, cell division in stem **;**	**6**