Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/42**

Paper 4 A Level Structured Questions **May/June 2022**

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 2022 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 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.

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.

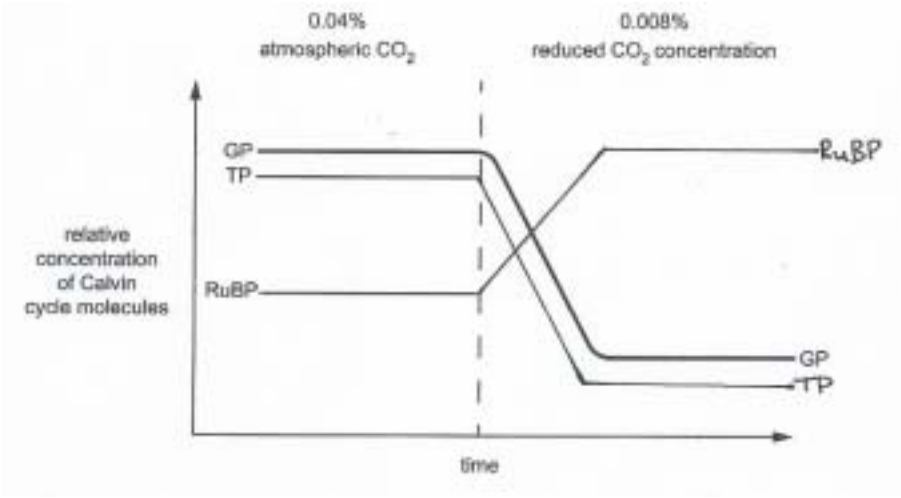
State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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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Question	Answer	Marks
1(a)(i)	DOPA / dopaquinone / melanin **;**	**1**
1(a)(ii)	cyclic AMP / cAMP **; A** calcium ions	**1**
1(a)(iii)	*any **two** from:* 1 albino / albinism **;** 2 no pigment or melanin in skin / pale skin **or** white hair **;** **Ignore** fair, skin / hair 3 red / pink, eyes / irises **; A** blue 4 poor vision / described **or** eyes sensitive to light **or** jerky eye movements **; Ignore** blindness	**2**
1(b)	symbols **;** e.g. **B** allele for black fur **b** allele for (light) brown fur parental genotypes **Bb x Bb** gametes **B b B b** ; offspring genotypes **BB Bb (Bb) bb ;** offspring phenotypes black black (black) (light) brown **;** *accept gametes mark from a Punnett square*	**4**

Question	Answer	Marks
2(a)(i)	*any **two** from:* 1 *ref. to* light energy / photons **;** 2 for, light-dependent stage / photophosphorylation / photolysis / photoexcitation / photoactivation **;** 3 to make, reduced NADP / ATP **;** 4 to open stomata (for CO_2 to enter) **;**	**2**
2(a)(ii)	*correctly showing that TP reduces to a plateau below GP* **;** *correctly showing that RuBP increases to a plateau* **;** 	**2**

Question	Answer	Marks
2(a)(iii)	1. decrease in / no, CO_2, diffusing / moving, to, air spaces / palisade cells / mesophyll cells / chloroplasts / stroma **;** *any **two** from:* 2 **stress** response / AW **;** 3 *ref. to* abscisic acid / ABA **;** 4 *ref. to* action of Ca^{2+} as a second messenger **;** 5 stomata close **;**	**3**
2(b)(i)	$\frac{28 - 20.5}{20.5} \times 100$ **or** $\frac{7.5}{20.5} \times 100$ **;** **A** 20.4 or 20.6 **A** 37.3 or 35.9 *answer to 1 decimal place* 36.6 (%) **;** *apply ecf*	**2**

Question	Answer	Marks
2(b)(ii)	*any **four** from:* *no mention of increased or more – ecf and max 3* 1 Sox4 plants have an **extra copy** of *SBPase* gene **;** 2 (overall) increased, expression / transcription, of *SBPase* gene (so more SBPase) **;** 3 increased (rate of) / more, regeneration / production, of RuBP **;** 4 (so) increased / more, carbon fixation / Calvin cycles / light independent reaction / TP / GP **;** 5 more, glucose / sucrose, for respiration / ATP production **or** more, starch / lipid, for storage **or** more cellulose for cell walls **;** 6 more, amino acids / proteins, for growth **;** 7 more, cell division / cell elongation / mitosis **;** 8 AVP **;** e.g.(new) SBPase / *SBPase* gene, more efficient	**4**
2(b)(iii)	*nitrogen needed to produce:* nucleotides for, transcription (of *SBPase* gene) / expression (of *SBPase* gene) / mRNA production **;** amino acids for, protein synthesis / SBPase production / enzyme production **;**	**2**

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Question	Answer	Marks
3(a)	*any **four** from:* *accept **ora*** 1 pyruvate converted to, acetyl group / 2C group / acetyl CoA (in link reaction) **;** 2 NAD needed (in link reaction) **;** 3 (where) NAD becomes reduced **;** 4 reduced NAD goes to ETC **;** 5 ETC / oxidative phosphorylation, works if oxygen is present **or** oxygen is the final electron acceptor **;** 6 (so) reduced NAD is oxidised / NAD is regenerated **;**	**4**
3(b)	*any **five** from:* 1 <u>glycolysis</u> **;** 2 phosphorylation of glucose **;** 3 splitting of fructose (1,6) bi(s)phosphate / AW **;** 4 (into) two, triose phosphate / TP **;** 5 (TP) oxidised / dehydrogenated, to pyruvate **;** 6 net 2 ATP / 4 ATP, produced **;** 7 (2) reduced NAD produced **;**	**5**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)</td><td>
<table>
<tr><th>statement</th><th>genetic engineering using a plasmid</th><th>gene editing</th></tr>
<tr><td>It may cause the organism to produce a different protein.</td><td>✓</td><td>✓ ;</td></tr>
<tr><td>It may cause a single base pair in a gene to be changed.</td><td></td><td>✓ ;</td></tr>
<tr><td>The success of the technique can be evaluated using marker genes.</td><td>✓</td><td>;</td></tr>
<tr><td>It may use the CRISPR system.</td><td></td><td>✓ ;</td></tr>
<tr><td>It uses DNA ligase.</td><td>✓</td><td>;</td></tr>
</table>
</td><td>5</td></tr>
<tr><td>4(b)(i)</td><td>C ;</td><td>1</td></tr>
</table>

Question	Answer	Marks
4(b)(ii)	*any **three** from:* 1 increased / high, (crop) yield **;** 2 *idea of* less food shortages / more food production / helps solve global demand for food **;** 3 less need to remove weeds (by hand) **;** 4 more income for, growers / farmers **or** *ref. to* economic benefit for, country / region **;** 5 cheaper / lower cost, to buy **;** 6 AVP **;** e.g. less need for deforestation of other land	**3**

Question	Answer	Marks
5(a)	*any **four** from:* 1 geographical isolation / barrier qualified **; Ignore** separation 2 no, interbreeding / gene flow (between European and American populations) **;** **Ignore** reproductive isolation here (needs to be late on in process) 3 different, environmental (conditions) / selection pressures **;** 4 random / different, mutations **;** 5 **different**, alleles selected for / gene pool / changes in allele frequency **;** 6 populations have different, morphological / physiological / behavioural, features **;** 7 after, a long time / many generations, reproductive isolation occurs / cannot interbreed to produce fertile offspring **;** 8 allopatric (speciation) **;**	**4**

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Question	Answer	Marks
5(b)	*any **three** from:* 1 not possible / difficult, to come to a (reliable) conclusion **; A** AW 2 small difference in height / heights are similar (so natural selection **not** more important than genetic drift) **;** 3 taller / lighter, bison could be an advantage in reaching higher vegetation (so natural selection **may** be important) **;** 4 difference in mass, may not be due to genetic factors / may be due to nutrient value of diet / may be due to quantity of food, (so natural selection may **not** be important) **;** 5 genetic drift (in ancestral population) may have led to, European bison being, taller / lighter **or** American bison being, shorter / heavier **;**	**3**
5(c)	1 European bison has a, close / recent / common, ancestor with that of, cattle / *Bos* **or** European bison is more closely related to, cattle / *Bos*, (than to American bison) **;** 2 European bison may have interbred with, cattle / *Bos* **;** 3 mitochondria are inherited from, mother / female **;**	**3**

Question	Answer	Marks
5(d)	*any **four** from:* 1 obtain / use, blood / cells / tissue / DNA **;** 2 from, both species / cattle and European bison **;** 3 use PCR to, replicate / amplify, DNA **;** 4 use, electrophoresis (described) / DNA profiling / DNA fingerprinting, to see genetic differences / compare the banding (patterns) **;** 5 sequence DNA and, count / identify, (percentage) difference / similarity **or** sequence DNA and compare the, nucleotide / base, sequence **;** 6 use, genome / DNA, microarray **; R** for gene expression 7 *ref. to* bioinformatics / database / (computer) software **;** 8 similarity indicates, close relationship / more recent split **;** 9 if they can breed to produce (viable) offspring (they are closely related) **;**	**4**

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Question	Answer	Marks
6(a)	**G** – embryo to aleurone layer **;** **A** – aleurone layer to endosperm **;**	**2**
6(b)	*any **three** from:* 1 hydrolyses / breaks down / digests / converts, starch / amylose **;** 2 in endosperm **;** 3 to, maltose / glucose **;** 4 (glucose) used by embryo **;** 5 (glucose used) for, respiration / growth **;**	**3**

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Question	Answer	Marks
6(c)	*any **four** from:* *accept distilled water for **A**, 500mg dm^{-3} for **B** and 1000mg dm^{-3} for **C**.* 1 seeds of **B** and **C** germinated before seeds of **A** **or** seeds soaked in gibberellin germinated before seeds soaked in distilled water **; ora** 2 **rate** of (increase in percentage) germination was, highest in **C** **or** higher in **C** than, **B** / **A** **or** higher as the concentration of gibberellin increases **; ora** 3 **final** / **day 10** / **maximum** (percentage) germination was, highest in **C** **or** higher in **C** than, **B** / **A** **or** higher as the concentration of gibberellin increases **; ora** 4 data quote between two groups **;** mp1 – **A** by day 6 and **B** and **C** by day 2 mp1 – **A** germinates four days after **B** and **C ora** mp2 – **A** – 2.2 **B** – 5.2 **C** – 9.2, percentage germination day^{-1} mp3 – **A** – 22% **B** – 52% **C** – 92% mp3 – **A** to **C** = 70% more, **A** to **B** = 30% more, **B** to **C** = 40% more 5 percentage germination in **C** levels off after 9 days **;** 6 AVP **;** e.g. no seeds germinate by day 1	**4**

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Question	Answer	Marks
7(a)	RNA polymerase attached to promoter **;** repressor detached from operator **;**	**2**
7(b)(i)	structural (gene) **;**	**1**
7(b)(ii)	lactose permease **; A** beta-galactoside permease movement / transport, of lactose into cell **or** makes (cell surface) membrane (more) permeable to lactose **;**	**2**
7(c)	1 population increases, then levels off, increases, then levels off / AW **;** *any **three** from:* 2 (first increase) glucose, metabolised / respiration **;** 3 (first levelling off) glucose has run out **;** 4 (first levelling off) lactose, hydrolysed / broken down, into, glucose / galactose **;** 5 (second increase) glucose / galactose, metabolised / respired **;** 6 (second levelling off) lactose / glucose / galactose, has run out **;** 7 AVP **;** e.g. *idea of* time delay (for, lactose permease / beta galactosidase, to work)	**4**

Question	Answer	Marks
8(a)	microvilli **;** **A** brush border	**1**
8(b)	no movement of, chemicals / substances / ions, between the, chemoreceptor / cells / (cells) **A ;** **Ignore** food **A** named dissolved substance	**1**

Question	Answer	Marks
8(c)	*any **seven** from:* 1. Na^+ ions enter, (chemo)receptor cell / **A**, through, microvilli / **Y** / channel (proteins) **;** 2 cell **surface** membrane depolarised **;** 3 receptor potential **;** 4 *ref. to* threshold **;** 5 (voltage-gated) Ca^{2+} / calcium, channels open **;** 6 Ca^{2+} ions enter, cytoplasm / cell / **A ; A** presynaptic knob 7 vesicles (of neurotransmitter), move towards / fuse with, cell **surface** membrane / presynaptic membrane **;** 8 exocytosis (described) / secretion, of (named) neurotransmitter **;** 9 neurotransmitter binds to receptor on, postsynaptic / (sensory) neurone / **B**, <u>membrane</u> **;** 10 Na^+ / sodium, channels open **or** Na^+ enter (sensory) neurone / **B ;** 11 postsynaptic membrane / (sensory) neurone membrane, depolarised **;** 12 *ref. to* threshold **;** *allow either mp4 or mp12*	**7**

Question	Answer	Marks
9(a)	to generate a high, blood pressure / hydrostatic pressure **;** **Ignore** to increase the blood pressure to force, plasma / fluid / water, through basement membrane / into the Bowman's capsule / into lumen **;** **R** osmosis / diffuse **Ignore** named substance e.g. glucose	**2**
9(b)(i)	**A** – basement membrane **;** **B** – podocyte **;**	**2**
9(b)(ii)	*any **three** from:* **A** basement membrane 1 acts as a, filter / filtration barrier **;** 2 only, named molecules / ions / molecules less than 68 000–70 000 (R)MM, can pass through **or** red blood cells / large proteins, cannot pass through **;** **B** podocyte 3 has, gaps / slits / projections / pores **;** 4 allows, fluid / water / filtrate, to pass into the, lumen / Bowman's capsule **;** 5 produces, **A** / basement membrane **;**	**3**

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Question	Answer	Marks
10(a)	*any **three** from:* 1 marking, not harmful (described) / cannot be removed (described) **;** 2 constant population size **;** 3 no, births / deaths (described) **or** no, immigration / emigration / migration **;** 4 (sufficient time for) marked individuals to mix with rest of population **;** 5 (penguins are) mobile ;	**3**
10(b)	*any **three** from:* 1 loss of habitat / example **;** 2 climate change **;** 3 predation **;** 4 competition for, food / resources / breeding sites / example **;** 5 new disease **;** 6 pollution / example **;** 7 numbers get so low that population can't recover / AW **;**	**3**
10(c)	13 000 / 1.3×10^4 **;**	**1**

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Question	Answer	Marks
10(d)	*any **four** from:* 1 multicellular ; 2 eukaryote / eukaryotic / (cells) contain a nucleus ; 3 specialised cells / tissues / organs ; 4 heterotrophic (nutrition) / described ; 5 nervous system ; 6 cilia / flagella ; 7 mobile / motile ;	**4**

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