Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/41**

Paper 4 A Level Structured Questions **October/November 2021**

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 October/November 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level 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.

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
mp	marking 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>description</th><th>letter</th></tr>
<tr><td>efferent blood vessel</td><td>B ;</td></tr>
<tr><td>part of nephron containing cells that respond to ADH</td><td>F, G ;</td></tr>
<tr><td>part of nephron where podocyte cells are located</td><td>C ;</td></tr>
<tr><td>part of nephron containing cells that are located in the medulla</td><td>E, G ;</td></tr>
</table>
</td><td>4</td></tr>
<tr><td>1(b)</td><td>any five from:

1 microvilli / basal membrane folds, increase / give large, surface area ;

2 for / many, (named) transport proteins ;

3 Na^+ / sodium ions, and, glucose / amino acids, move / co-transported, into cell (from filtrate / lumen) ;

4 Na^+ / sodium ions, pumped / move (out of cell) to, blood / tissue fluid ;

5 ref. to <u>active transport</u> ;

6 many <u>mitochondria</u>, give / for, energy / ATP ;

7 <u>tight junctions</u> and reason ;</td><td>5</td></tr>
<tr><td>1(c)(i)</td><td>any two from:

1 as water potential (of blood) increases concentration of ADH (in the blood) decreases ;

2 two ADH figures related to two % change in water potential figures ;

3 between 0% and (+)10% change in water potential, <u>ADH</u> (concentration), does not change / is constant / stays the same / plateaus ;</td><td>2</td></tr>
</table>

Question	Answer	Marks
1(c)(ii)	blood, volume / pressure, decreases **;**	**1**

Question	Answer	Marks
2(a)(i)	*any **four** from:* *differences* 1 cotton (enzyme / rubisco activase) has a higher, optimum temperature / temperature at which activity is highest **; ora** 2 maximum / highest / peak, activity higher in flax (enzyme / rubisco activase) (than in cotton) **; ora** 3 cotton (enzyme / rubisco activase) can work at higher temperature (than flax) **;** 4 (at stated temp) <30 °C flax (enzyme) has higher activity than cotton **; ora** 5 (at stated temp) >30 °C cotton (enzyme) has higher activity than flax **; ora** *similarities* 6 (activity of) both increases then decreases as temperature increases **;** 7 (enzyme / rubisco activase) activity, same / 0.104 (au), at 30 °C **;**	**4**
2(a)(ii)	*any **three** from:* 1 cotton, is adapted to / lives in areas with, high(er) temperatures **; ora** 2 *ref. to* different, genes / alleles (in cotton vs. flax) **;** 3 *ref. to* different primary structure of rubisco activase (in cotton vs. flax) **;** 4 *ref. to* different tertiary structure of rubisco activase (in cotton vs. flax) **;** 5 AVP **;**	**3**

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Question	Answer	Marks
2(b)	*any **three** from:* 1 less / no, CO_2 fixation / carboxylation of RuBP **;** 2 less / no, GP, made into / converted to, TP **;** 3 less / no, regeneration of RuBP **;** 4 less / no, glucose / hexose, made **;**	**3**
2(c)	*any **two** from:* 1 take, gene / (c)DNA, for <u>rubisco activase</u> **;** 2 from, <u>cotton</u> and insert into, (false) flax / (named crop) plant / embryo **;** 3 to maintain rubisco action at, high temperatures / >37.5 °C / up to 42.5 °C **;** 4 AVP **;**	**2**

Question	Answer	Marks
3(a)	*any **four** from:* 1 use random sampling (technique) **;** 2 repeat and find mean / multiply estimates up for whole area **;** 3 (frame) quadrats to measure, plants / vegetation / stationary organisms **;** 4 detail of using quadrat **;** 5 mark-release-recapture for (named) animals **;** 6 detail of, trapping / marking, (named) animals **;** 7 calculate / use, Simpson's index (of diversity) **;** 8 species richness and, (relative) abundance / species evenness **;** 9 AVP **;**	**4**

Question	Answer	Marks
3(b)	*any **four** from:* 1 climate change / end of (last) ice age / (global / local) warming ; 2 arctic fox, species / population, not well-adapted / unable to adapt ; 3 hunting, removed / caused extinction of, lynx / large predators ; 4 introduction of, named / alien / invasive / domestic, species / animal ; 5 may, eat / compete with / spread disease to, native, species / animal ; 6 overgrazing problem explained ; 7 may, change / destroy / disrupt, habitats / food webs ; 8 AVP ;	**4**

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Question	Answer	Marks
3(c)	*any **five** from:* 1 obtain, healthy / fertile / wild-caught / captive bred, (founder) animals ; 2 *ref. to* genetic, variation / diversity / testing ; 3 (consider if), sufficient / suitable, habitat / area, available ; 4 (consider if) sufficient, prey / food, available ; 5 public safety advice / education ; 6 (organise) compensation for farmers who lose livestock ; 7 outlaw, killing / disturbing, lynx ; 8 (plan to) monitor, lynx / other animal / prey, populations ; 9 (plan to) cull / control / use contraceptives, if population, grows too much / spreads too far ; 10 AVP ;	**5**

Question	Answer	Marks
4(a)(i)	1 crime scene DNA may be present in, small amount / minute quantity ; 2 PCR, amplifies / replicates / copies / multiplies, DNA ;	**2**
4(a)(ii)	1 (negative) DNA moves to, positive electrode / anode ; 2 smaller / lighter, fragments move, faster / further / longer distance ;	**2**

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Question	Answer	Marks
4(b)(i)	*any **two** from:* 1 (GEDmatch) database is large(r than police database) **;** 2 police database only covers people, convicted of / suspected of, crime **;** 3 GEDmatch has data for, innocent people / people with no reason to hide their DNA **;** 4 provides multiple leads to guilty people who are hiding their DNA **;**	**2**
4(b)(ii)	*any **two** from:* 1 store of / large quantity of / contains, biological / DNA / genome, data / information **;** 2 for, analysis / processing **;** 3 by, computer / software / algorithm / statistics **;**	**2**
4(b)(iii)	*any **two** from:* 1 help police / catch criminals / imprison criminals **;** 2 make, society / community, safe(r) **;** 3 *ref. to* DNA breakthroughs help, justice / law and order **;** 4 sharing own data also shares relations' data without their consent **;** 5 AVP **;**	**2**

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Question	Answer	Marks
5(a)	embryo **;**	**1**
5(b)(i)	*any **two** from:* 1 as water potential increases the germination index increases **; ora** 2 water potential in MPa and index figure given for two points **;**	**2**
5(b)(ii)	*any **three** from:* 1 low / negative, water potential decreases water, uptake / in, seed **; ora** 2 water, needed / used, to activate embryo / produce gibberellin **;** 3 water, needed / used, for hydrolysis (reactions) **;** 4 starch to maltose / maltose to glucose **;** 5 water, needed / used, as a medium for reactions **;** 6 solutes (lowering water potential) may, be toxic / inhibit enzymes **;** 7 AVP **;**	**3**
5(c)	*enzyme* amylase / maltase / protease ; *location* aleurone layer ;	**2**
5(d)(i)	less, energy / resources, to make stem so, more to / larger, flowers **or** less likely to be damaged by, wind / storm / heavy rain **or** takes less, water / fertiliser / time to flower **;**	**1**

Question	Answer	Marks
5(d)(ii)	*any **three** from:* *short / dwarf, plants:* 1 are, homozygous recessive ***/*** *lele* **;** 2 *le* / recessive allele, codes for, non-functional / no, enzyme **;** 3 *le* / recessive allele / non-functional enzyme, gives inactive gibberellin **;** 4 DELLA proteins, not broken down / stay bound to PIF **;** 5 PIF cannot, bind to promoter / start transcription **;** 6 of gene(s) that promote, growth / cell division / cell elongation **;**	**3**

Question	Answer	Marks
6(a)	carbon dioxide **;**	**1**
6(b)	*any **one** from:* 1 triose phosphate dehydrogenated **;** 2 reduced NAD, made / released **;**	**1**
6(c)(i)	*(glycolysis) + (Krebs)* *(ATP + reduced NAD) + (ATP + reduced NAD + reduced FAD)* (4 **– 2**) + (4 × 3) + 2 + (6 × 3) + (2 × 2) **OR** 2 + 12 + 2 + 18 + 4 **;** 38 **;**	**2**

Question	Answer	Marks
6(c)(ii)	*any **two** from:* 1 ATP / energy, used to transport, pyruvate / reduced NAD / products of glycolysis, into (named part of) mitochondria **;** 2 some protons leak from intermembrane space **;** 3 some energy lost as heat **;** 4 glucose may not be completely broken down / some intermediates are used in different metabolic processes **;** 5 reduced NAD may be used for other (metabolic) reactions **;**	**2**
6(d)	*any **three** from:* 1 coenzymes **;** 2 help / for, dehydrogenases / dehydrogenation (reactions) **;** 3 *ref. to* glycolysis / link reaction / Krebs cycle **;** 4 carry / transfer / transport / bring, hydrogens / H **;** 5 to, ETC / inner mitochondrial membrane / crista(e) **;**	**3**

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Question	Answer	Marks
6(e)	*any **three** from:* 1 less / no, energy (release from electron transfer / ETC) ; 2 less / no, chemiosmosis ; 3 fewer / no, protons, move / pumped, to intermembrane space ; 4 less (steep) / no, proton gradient ; 5 fewer / no, protons, move / diffuse, through ATP synth(et)ase ; 6 less / no, ATP synthesised ;	**3**

Question	Answer	Marks
7(a)	*any **four** from:* 1 base / nucleotide, insertion / deletion / substitution ; 2 frameshift / changed reading frame ; 3 *ref. to* stop codon ; 4 changes / different, primary structure / amino acid sequence ; 5 changes / different, folding / 3D shape / 3° structure, of enzyme / protein ; 6 <u>active site</u> does not, bind / fit, substrate / complex molecules ;	**4**

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Question	Answer	Marks
7(b)	1 key e.g. **H** = normal (allele) **h** = Hunter (syndrome allele) **;** parental phenotype normal male normal female 2 parental genotype $\mathbf{X^HY}$ $\mathbf{X^HX^h}$ **;** gametes ($\mathbf{X^H}$ **Y** $\mathbf{X^H}$ $\mathbf{X^h}$ **)** 3 offspring genotypes $\mathbf{X^HX^H}$ $\mathbf{X^HX^h}$ $\mathbf{X^HY}$ $\mathbf{X^hY}$ **;** 4 offspring phenotypes normal female / normal / carrier female / normal male / Hunter S male **;** 5 probability 0.25 / 25% / 1 in 4 **;**	**5**

Question	Answer	Marks
8	*any **five** from:* 1 due to (Great Central) Valley / during migration, populations / they, are separated / geographically isolated **;** 2 no, mating / breeding / gene flow, between, them / populations **;** 3 different (named), selection pressures / environments / conditions / habitats **;** 4 different mutations **;** 5 natural selection **;** 6 genetic drift / founder effect **;** 7 change in allele frequency **OR** change in / different, gene pool **;** 8 leads to different, morphological / behavioural / biochemical / physiological, features **;** 9 allopatric speciation **;**	**5**

Question	Answer	Marks
9(a)	*any **seven** from* 1 (H^+) carrier / pump (protein), in cell surface membrane (of guard cell) ; 2 hydrogen ions / protons / H ions / H^+, leave / exit (cell) ; 3 using, energy / ATP ; 4 low H^+ (in cell) / more negative charge (than outside) ; 5 K^+ channel (proteins) open ; 6 K^+, move into / enter, cell (by facilitated diffusion) ; 7 Cl^- ions, move into / enter (cell) ; 8 water / solute, potential of cell decreases ; 9 water moves in (to cell) by osmosis ; 10 cell / vacuole, volume increases ; 11 (cells) are / become, turgid ; 12 thick inner cell wall (of guard cell) ; 13 AVP ;	**7**

Question	Answer	Marks
9(b)	*any **eight** from:* 1 C4, plants / pathway ; 2 stop / decrease, photorespiration ; 3 mesophyll cells form (tightly packed) ring ; 4 around / surrounding, bundle sheath (cells) ; 5 (initial) CO_2 / carbon, fixation in mesophyll and Calvin cycle in bundle sheath ; 6 RuBP / rubisco, in bundle sheath (cells) ; 7 oxygen / air, cannot reach, RuBP / rubisco / bundle sheath ; 8 CO_2 combines with, PEP / PEP carboxylase (in mesophyll) ; 9 to form, oxaloacetate / malate ; 10 (malate) releases carbon dioxide in bundle sheath (cells) ; 11 RuBP, carboxylated / reacts with carbon dioxide ; 12 PEP carboxylase has high optimum temperature / tolerates high temperatures ;	**8**

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Question	Answer	Marks
10(a)	*any **nine** from:* 1 Na^+ / sodium ion, channels open ; 2 Na^+ / sodium ions, enter, neurone / axon / (nerve) cell ; 3 membrane (potential) becomes, positive / +40 mV / depolarised ; 4 (repolarisation / after peak) Na^+ / sodium ion, channels close ; 5 K^+ / potassium ion, channels open ; 6 K^+ / potassium ions, leave / move out (of cell) ; 7 membrane (potential) becomes, negative / –90 mV / repolarised ; 8 local circuits ; 9 myelin sheath / Schwann cells, insulates / stops ion movement ; 10 action potential / depolarisation, only occurs at nodes of Ranvier ; 11 saltatory conduction ; 12 fast transmission (of, action potential / impulse) ; 13 one-way transmission (of, action potential / impulse) ; 14 AVP ;	**9**

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Question	Answer	Marks
10(b)	*any **six** from:* 1 maintain / keep / regulate, internal, environment / conditions **;** 2 within, narrow / set, limits **or** around, optimum value / set point / norm **;** 3 low (body) temperature **and** consequence **;** 4 high (body) temperature **and** consequence **;** 5 low blood glucose (concentration) **and** consequence **;** 6 high blood glucose concentration **and** consequence **;** 7 low, (blood) water potential / ψ, **and** consequence **;** 8 high, (blood) water potential / ψ, **and** consequence **;**	**6**

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