Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/41**

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.

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.

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.

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

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)	

I

Question	Answer	Marks
1(a)(i)	Eukarya **;** Animalia **;**	**2**
1(a)(ii)	*any **one** from:* warning to predators / to deter predators **;** AVP **;**	**1**
1(b)	*any **three** from:* **1** Ca^{2+} (stays) in, cytoplasm / sarcoplasm **;** **2** Ca^{2+}, binds / bound, to troponin **;** **3** tropomyosin, shifted / does not cover (myosin) binding sites (on actin) **;** **4** myosin-actin, cross bridges / bonds, exist / remain **;** **5** sarcomere(s) / muscle, contracted / shortened / paralysed **;**	**3**
1(c)	*any **three** from:* **1** Ca^{2+}, enters / diffuses into, synaptic knob **;** **2** through (voltage-gated) calcium (ion) channels **;** **3** vesicles containing acetylcholine **;** **4** move to / fuse with, presynaptic membrane **;** **5** exocytosis of acetylcholine **;**	**3**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>
any four from:
<table>
<tr><th colspan="2">structure</th><th>function</th></tr>
<tr><td>1</td><td>thylakoid(s) / granum / grana</td><td>light dependent reaction / photophosphorylation ;</td></tr>
<tr><td>2</td><td>thylakoid <u>membrane</u>(s)</td><td>have (named), pigments / photosystems / LHC / electron carriers / ETC / ATP synthase ;</td></tr>
<tr><td>3</td><td>thylakoid membranes / grana, have large surface area / are many in number</td><td>to absorb (more) light ;</td></tr>
<tr><td>4</td><td>stroma</td><td>for light independent reaction / Calvin cycle ;</td></tr>
<tr><td>5</td><td>stroma</td><td>has, (named) enzymes / RuBP / reduced NADP ;</td></tr>
<tr><td>6</td><td>stroma colourless OR stroma contains water</td><td>so light reaches thylakoids OR as a medium for reactions / for photolysis</td></tr>
<tr><td>7</td><td>DNA / ribosomes</td><td>make (named), chloroplast proteins / proteins for photosynthesis ;</td></tr>
<tr><td>8</td><td>starch grains / lipid droplets</td><td>store, (named) product of photosynthesis / (chemical) energy ;</td></tr>
<tr><td>9</td><td>envelope</td><td>compartmentalisation ;</td></tr>
</table>
</td><td>4</td></tr>
<tr><td>2(b)</td><td>
any three from:
1 light excites electrons in, P700 / PS1 (reaction centre chlorophyll) ;

2 electrons passed, along carriers / to ETC ;
3 H^+ / protons, pumped into <u>thylakoid</u>, space / lumen ;

4 H^+ / protons, diffuse (back to stroma) through ATP synth(et)ase ;
5 makes ATP ;
6 AVP ;
</td><td>3</td></tr>
</table>

Question	Answer	Marks
2(c)	*any **seven** from:* *description* **D1** identify wavelengths for chlorophyll (a) absorption **;** **D2** identify wavelengths for phycoerythrin absorption **;** **D3** identify wavelengths for phycocyanin absorption **;** **D4** chlorophyll (a), has peaks / absorbs mainly, in blue and red **;** **D5** phycoerythrin absorbs in blue and green and yellow **;** **D6** phycocyanin absorbs in (green) yellow and red **;** *explanation* **E7** red algae / deep water, get(s) green (and yellow) light **;** **E8** chlorophyll (a) absorbs, no / little, green (and yellow) light **;** **E9** phycoerythrin / phycocyanin / accessory pigments, absorbs wavelengths not absorbed by chlorophyll (a) **;** **E10** combined pigments absorb, greater range of / any / all, wavelengths **;** **E11** increases / more / high(er) rate of, light dependent stage / photosynthesis **;** **E12** (so) more / lots of, (named) organic compounds / growth **;**	**7**

Question	Answer	Marks
3(a)	anabolic / condensation / polymerisation **;**	**1**
3(b)	**1** to, phosphorylate / add phosphate to, glucose **;** *and any **one** from:* **2** stops glucose leaving the cell **;** **3** activates glucose / makes glucose less stable **;** **4** to make fructose (1,6) bi(s)phosphate **;**	**2**
3(c)	cytoplasm **and** mitochondrial matrix **;**	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(d)</td><td>any two from:
1 decarboxylated / loses carbon dioxide ;
2 dehydrogenated / oxidised / loses H ;
3 →, 2C / acetyl, (group) joins coenzyme A to make acetyl coA ;</td><td>2</td></tr>
<tr><td>3(e)</td><td>any three from:
<table>
<tr><th></th><th>mitochondria</th><th>chloroplasts</th></tr>
<tr><td>1</td><td>oxidative phosphorylation</td><td>photophosphorylation ;</td></tr>
<tr><td>2</td><td>inner mitochondrial membrane / crista(e)</td><td>thylakoid membrane ;</td></tr>
<tr><td>3</td><td>reduced NAD / reduced FAD, give e^- / H^+</td><td>photolysis / water / PS1 / chlorophyll, give e^- / H^+ ;</td></tr>
<tr><td>4</td><td>(H^+ →) intermembrane space</td><td>(H^+ →) thylakoid, space / lumen ;</td></tr>
<tr><td>5</td><td>oxygen, final, e^- / H^+, acceptor</td><td>NADP final, e^- / H^+, acceptor ;</td></tr>
<tr><td>6</td><td>(makes) water / H_2O</td><td>(makes) reduced NADP ;</td></tr>
</table></td><td>3</td></tr>
</table>

<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 can produce a transgenic organism.</td><td>✓</td><td>✓ ;</td></tr>
<tr><td>It can modify the characteristics of an organism.</td><td>✓</td><td>✓ ;</td></tr>
<tr><td>It can delete unwanted DNA.</td><td></td><td>✓ ;</td></tr>
<tr><td>It uses an enzyme that cuts DNA.</td><td>✓</td><td>✓ ;</td></tr>
<tr><td>It can use RNA to precisely locate the target gene.</td><td></td><td>✓ ;</td></tr>
</table>
</td><td>5</td></tr>
<tr><td>4(b)(i)</td><td>A ;</td><td>1</td></tr>
<tr><td>4(b)(ii)</td><td>any three from:
1 more food / increase yield / help solve global demand for food ;
2 improves quality of, fruit / oranges / crop ;

3 more income for, growers / farmers ;
4 cheaper / lower cost, fruit / oranges / food (to consumer) ;
5 spend less on / use less / no need for, (bactericidal) chemicals / pesticides ;</td><td>3</td></tr>
</table>

Question	Answer	Marks
5(a)	*any **four** from:* **1** geographical isolation **/** allopatric (sub)speciation **;** **2** little / no, (inter)breeding / gene flow, between <u>populations</u> **;** **3** different, <u>selection</u> / <u>selective</u>, pressures (on each population) **;** **4** different mutations (in each population) **;** **5** <u>adaptation</u> to, environment / habitat / climate / food / vegetation **;** **6** gives, morphological / ecological / behavioural, differences **;**	**4**
5(b)(i)	*any **two** from:* **1** natural / <u>selection</u> **;** **2** dark, colour / fur, selected for / adaptive / good, in woods / warm / shade **;** **3** camouflage / right colour, protects against, (named) predators **;**	**2**
5(b)(ii)	*any **two** from:* **1** genetic drift / not natural selection **;** **2** as small size in north not, adaptive / beneficial **;** **3** (small) lose heat faster / harder to keep warm **;** **4** smaller fat reserves not good with unstable food supply **;** **5** less food in north reduces, growth / size **;** **6** AVP **;**	**2**
5(c)	*any **three** from:* **1** (hybrid populations have) more, genetic variation / alleles **;** **2** genes / mutations / alleles, from both (sub)species **;** **3** more potential to adapt / can adapt better (in future) **;** **4** genes / alleles, for migration may let some find new habitats **;** **5** have, genes / alleles, for, warm and cold / different temperatures **;**	**3**

Question	Answer	Marks
5(d)	*any **three** from:* **1** obtain, blood / tissue / DNA **;** **2** (test) both (sub)species / migratory and non-migratory **;** **3** use PCR to amplify DNA **;** **4** use, (gel) electrophoresis / DNA profiling / DNA fingerprinting, **and EITHER** compare results **OR** to see genetic, differences / changes **;** **5** sequence DNA and, count / identify, differences / changes **;** **6** check / test, for correlation between, DNA / genetic profiles / alleles / markers, and migratory behaviour **;** **7** use, databases / bioinformatics, to find, name / role of, genes / sequences (that, differ / are associated with migration) **;** **8** AVP **;**	**3**

Question	Answer	Marks
6(a)	homeostasis / negative feedback **;**	**1**
6(b)(i)	blood(stream) / circulation **;**	**1**
6(b)(ii)	**A** – adenyl,(-yl) / (-ate), cyclase **;** **B** – cyclic AMP / cAMP **;**	**2**
6(b)(iii)	amplifies signal / expands message **;**	**1**
6(b)(iv)	break down glycogen / glycogen → glucose / glycogenolysis **;**	**1**
6(c)	*any **four** from:* **1** blood on, pad / strip, inserted into, biosensor / glucometer **;** **2** glucose oxidase **;** **3** (glucose) → gluconic acid and hydrogen peroxide **;** **4** (electric) current / flow of electrons / voltage **;** **5** (current) proportional to glucose, quantity / concentration **;** **6** digital / numerical, reading (on screen) **;**	**4**

Question	Answer	Marks
7(a)	*gene* length of DNA coding for a polypeptide **;** *allele* alternative / different, form / version, of a gene **;**	**2**
7(b)	*parents phenotypes* red eyes apricot eyes *parents genotypes* $\mathbf{C^RC^H}$ $\mathbf{C^AC^W}$ *gametes* ($\mathbf{C^R}$ $\mathbf{C^H}$ $\mathbf{C^A}$ $\mathbf{C^W}$) *offspring genotypes* $\mathbf{C^RC^A}$ $\mathbf{C^RC^W}$ $\mathbf{C^HC^A}$ $\mathbf{C^HC^W}$ **;** *offspring phenotypes* red eyes (red eyes) apricot eyes honey eyes **;** *ratio* 2 : 1 : 1 **;**	**3**
7(c)	**1** cross with, white-eyed fly / $\mathbf{C^WC^W}$ **;** *any **two** from:* **2** if all red-eyed then $\mathbf{C^RC^R}$ **;** **3** if (some red-eyed and) some apricot-eyed then $\mathbf{C^RC^A}$ **;** **4** if (some red-eyed and) some honey-eyed then $\mathbf{C^RC^H}$ **;** **5** if (some red-eyed and) some white-eyed then $\mathbf{C^RC^W}$ **;**	**3**

Question	Answer	Marks
8(a)(i)	*any **three** from:* **1** habitat loss **;** **2** for, agriculture / building / roads / forestry / mines / development **;** **3** hunting / fishing **;** **4** collecting plants **;** **5** humans aid spread of (animal / plant) disease **;** **6** humans aid spread of, alien / invasive / competing, species **;** **7** (named) pollution / pesticides **;**	**3**
8(a)(ii)	**1** $\frac{29\,000-7000}{2000-1950}$ **or** $\frac{29\,000-7000}{50}$ $\frac{22\,000}{50}$ **;** **2** 440 **;**	**2**

Question	Answer	Marks
8(b)	*any **seven** from:* **1** (named) food **;** **2** (named) medicines **;** **3** wood / fibres / paper / rubber **;** **4** genetic diversity for future use **;** **5** science / technology / research **;** **6** education **;** **7** aesthetic / wellbeing **;** **8** (eco)tourism / attract visitors **;** **9** ethical / moral / stewardship **;** **10** local cultural significance **;** **11** maintain / protect / stability of, food chains / food webs **;** **12** pollination / ecosystem services **;** **13** protect against, soil erosion / coastal erosion / flooding **;** **14** soil formation **;** **15** (named) mineral, cycles / recycling **OR** *ref. to* stage in cycle of named element **;** **16** climate stability **;**	**7**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>9(a)</td><td>
<table>
<tr><th>letter</th><th>feature</th></tr>
<tr><td>B</td><td>location of Calvin cycle</td></tr>
<tr><td>D</td><td>made of cellulose</td></tr>
</table>
; ;
</td><td>2</td></tr>
<tr><td>9(b)</td><td>any four from:

1 H^+ pumped, out of guard cell / into cell wall of guard cell ;
2 inside of cell becomes (relatively) negatively charged ;
3 K^+ enters cell by facilitated diffusion ;

4 water potential of cell decreases ;
5 water enters cell by osmosis ;
6 cell, expands / increases in volume / becomes turgid ;
7 stoma opens due to thick inner wall ;</td><td>4</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>10(a)</td><td>
<table>
<tr><th>motor</th><th></th><th>sensory</th></tr>
<tr><td>1 transmits impulses from CNS to effector</td><td>and</td><td>transmits impulses from, receptors / (named) sense organs, to CNS</td></tr>
</table>
;
plus two from:
<table>
<tr><th>motor</th><th></th><th>sensory</th></tr>
<tr><td>2 cell body at end of, neurone / axon</td><td>and</td><td>cell body, in middle of / part-way along, neurone OR cell body not at end of, neurone / axon</td></tr>
<tr><td>3 cell body in, CNS / brain / spinal cord</td><td>and</td><td>cell body in (dorsal root) ganglion</td></tr>
<tr><td>4 long axon OR
axon</td><td>and</td><td>short axon OR
axon and dendron</td></tr>
<tr><td>5 dendrites attached to cell body</td><td>and</td><td>dendrites attached to dendron</td></tr>
</table>
;
</td><td>3</td></tr>
<tr><td>10(b)</td><td>any three from:
1 no myelin slow and myelin fast(er) / myelin increases speed ;
2 no myelin = 0.5–2 m s^{-1} and with myelin > 5 / up to 120 m s^{-1} ;
3 as axon diameter increases speed increases ;
4 diameter (+ units once) and speed (+ units once) for two neurones ;</td><td>3</td></tr>
</table>

Question	Answer	Marks
10(c)	*any **three** from:* **A –** *any one reason from:* **1** Na^+ / sodium, channels already open **OR** Na^+ has already entered neurone **OR** no more Na^+ channels to open **OR** less Na^+ outside to diffuse in **OR** less steep Na^+ concentration gradient **;** **B –** *any one reason from:* **2** sodium channels are, inactive / unresponsive **OR** potassium channels are open **OR** membrane is, impermeable / less permeable, to Na^+ **OR** membrane is more permeable to K^+ **;** **C –** *any one reason from:* **3** harder to reach threshold **OR** potassium channels are (still) open **OR** sodium-potassium pumps need to restore the resting potential **;** **4** hyperpolarisation at **C ;**	**3**