Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/43**

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.

This document consists of **23** printed pages.

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

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)(i)</td><td>1 loop of Henle ;

2 collecting duct ;</td><td>2</td></tr>
<tr><td>1(a)(ii)</td><td>antidiuretic hormone / ADH ; A vasopressin</td><td>1</td></tr>
<tr><td>1(a)(iii)</td><td>1 as the RMT increases the concentration of urine increases ; A positive correlation

2 two pairs of comparative figures ;

<table>
<tr><td></td><td>RMT</td><td>urine conc.</td></tr>
<tr><td>beaver</td><td>1.4</td><td>0.90</td></tr>
<tr><td>kangaroo rat</td><td>8.6</td><td>10.50</td></tr>
</table>

any three from:

kangaroo rat
3 little water available / AW ; Ignore desert Ignore rivers & lakes for ora

4 loop of Henle / collecting duct, is longer ;

5 (so) more reabsorption of water occurs ; Ignore retaining more water

6 (so) urine (of kangaroo rat) more concentrated / small volume of urine ;

allow ora for beaver</td><td>4</td></tr>
</table>

Question	Answer	Marks
1(b)	*any **two** from:* 1 *ref. to* metabolic water / water from respiration **;** 2 it obtains water through the (named) food it eats **;** 3 AVP **;** e.g. behavioural response / no or less sweating	**2**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)(i)</td><td>
any four from:

similarities
1 photoactivation of chlorophyll / AW, occurs in both ; A excite electrons (for AW)

2 ETC involved in both ;

3 ATP produced in both ;

differences
<table>
<tr><th>cyclic</th><th>non-cyclic</th><th></th></tr>
<tr><td>4 only PSI</td><td>PSI and PSII both involved</td><td>;</td></tr>
<tr><td>5 no, reduced NADP / oxygen, produced</td><td>reduced NADP / oxygen, produced</td><td>;</td></tr>
<tr><td>6 no photolysis
or
no oxygen-evolving
complex involved</td><td>photolysis
or
oxygen-evolving
complex involved</td><td>;</td></tr>
<tr><td>7 electrons emitted from PSI
returned to PSI
or
PS1 is source of electrons</td><td>electrons emitted from PSII are replaced by water
or
water is source of electrons</td><td>;</td></tr>
</table>
</td><td>4</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)(ii)</td><td>any two from:

1 no ATP and reduced NADP made ;

2 no, GP / TP, made
or
no, Calvin cycle / light-independent reaction ;

3 no regeneration of RuBP ;</td><td>2</td></tr>
<tr><td>2(b)(i)</td><td>any four from:

1 as the CO_2 concentration increases, the rate of fixation of CO_2 increases ;

2 (as) CO_2 concentration is the limiting factor ;

3 as the CO_2 concentration increases, the rate of fixation of CO_2, remains the same / plateaus ;

4 (as) CO_2 concentration is no longer the limiting factor
or
temperature / light intensity / RuBP regeneration, is the limiting factor ;

5 paired data quote with units to support, mp1 / mp3 ;

<table>
<tr><td></td><td>CO_2 concentration / mg m^{-3}</td><td>CO_2 fixation rate / µmol CO_2 m^{-2} s^{-1}</td></tr>
<tr><td rowspan="2">mp1</td><td>50 ±10</td><td>1 ±0.25</td></tr>
<tr><td>1200–1280</td><td>42 A 41.75</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>mp3</td><td>from 1200–1910</td><td>42 A 41.75</td></tr>
</table>
</td><td>4</td></tr>
</table>

Question	Answer	Marks
2(b)(ii)	*any **three** from:* *assume Sox4 – accept ora for wild* 1 the rate of fixation of CO_2 is higher in Sox4 compared to wild type **or** Sox4 reaches a higher (maximum) rate of CO_2 fixation **;** 2 (wild type) 42 vs (Sox4) 47 μmol CO_2 $m^{-2}s^{-1}$ **;** 3 (Sox4 has) more SBPase **or** there is a faster (rate of) regeneration of RuBP **or** (new) SBPase more effective **;** 4 more RuBP to react with, CO_2 / rubisco **;**	**3**

Question	Answer	Marks
3(a)	*any **two** from:* substrate-linked (phosphorylation) **; A** substrate level phosphorylation chemiosmosis / oxidative (phosphorylation) **;**	**2**
3(b)	*any **six** from:* 1 hydrogen / electron, carriers **; R** hydrogen ions / hydrogen molecules 2 in glycolysis NAD becomes reduced **;** 3 (so that) triose phosphate becomes, oxidised / dehydrogenated **;** 4 in the link reaction NAD becomes reduced **;** 5 (so that) pyruvate becomes, oxidised / dehydrogenated **or** for production of acetyl coenzyme A **;** 6 in the Krebs cycle both NAD **and** FAD become reduced **;** 7 to regenerate oxaloacetate **;** 8 (deliver, hydrogen / H^+ and e^-), to inner mitochondrial membrane / to cristae / to ETC / for oxidative phosphorylation / for chemiosmosis **;** 9 *ref. to* ATP production **;** 10 *ref. to* recycling of, NAD / FAD **;**	**6**

Question	Answer	Marks
3(c)	*any **two** from:* 1 *ref. to* increase / decrease / control, of (rate of the) link reaction **;** 2 allows build-up of acetyl CoA to be used in the Krebs cycle **;** 3 enzyme becomes active again when, coenzyme A increases / ratio falls **;** 4 allows more coenzyme A, to enter / return to, the link reaction **;** **A** not enough CoA to enter the link reaction **ora** 5 AVP **;** e.g. end product inhibition	**2**

<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 add a new phenotypic characteristic to an organism.</td><td>✓</td><td>✓ ;</td></tr>
<tr><td>It can change an A-T base pair to C-G.</td><td></td><td>✓ ;</td></tr>
<tr><td>It can inactivate a desired selected gene in an organism.</td><td></td><td>✓ ;</td></tr>
<tr><td>It may change DNA in a way that cannot be told apart from a natural mutation.</td><td></td><td>✓ ;</td></tr>
<tr><td>It requires a DNA donor and a recipient.</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 less food waste ; A increases quality of food

2 idea of less food shortages / more food production / helps solve global demand for food ;

3 more income for, growers / farmers
or
ref. economic benefit for, country / region ;

4 crop can be grown, when there is a water shortage / in poor quality soil / in harsh environment ;</td><td>3</td></tr>
</table>

Question	Answer	Marks
5(a)	*any **four** from:* 1 (partial) geographical, isolation / separation / barrier**;** 2 little / no, interbreeding / gene flow (between puma populations) **;** 3 different, environmental (conditions) / selection pressures **;** 4 e.g. climate / vegetation / habitat / available prey **;** 5 random / different, mutations **;** 6 different, alleles selected for / gene pool / changes in allele frequency **;** 7 allopatric (sub speciation) **;**	**4**
5(b)	*any **three** from:* 1 obtain, blood / cells / tissue / DNA **;** 2 from two (or more) individuals, at different locations / across range / from North and South America / from the different subspecies **;** 3 use PCR to, replicate / amplify DNA **;** 4 use, gel electrophoresis / DNA profiling / DNA fingerprinting **;** 5 sequencing of DNA **;** 6 use, genome **/** DNA, microarray **; R** for gene expression 7 *ref. to* bioinformatics / database / (computer) software **;** 8 compare similarity (of different sub species)**;**	**3**

Question	Answer	Marks
5(c)(i)	*any **two** from:* *discontinuous (no mark) because:* 1 feature either present or absent **;** 2 categoric **;** 3 no range / no intermediates **or** qualitative data **or** does not show a normal distribution curve**;**	**2**
5(c)(ii)	*any **three** from:* 1 these features are controlled by, genes / alleles **;** 2 *ref. to* genetic drift **;** 3 (population went through a) <u>bottleneck</u> **;** 4 low / reduced, number of alleles / genetic diversity / genetic variation / genetic polymorphism (in population) **;** **A** some alleles lost 5 inbreeding **;** 6 low / reduced, heterozygosity **or** high / increased, homozygosity **;** 7 rare / deleterious, recessive alleles show their effects (as homozygous) **;** 8 AVP **;** e.g. number of breeding males reduced even more as some have, non-functional / undescended, testes	**3**

Question	Answer	Marks
5(c)(iii)	*any **two** from:* 1 Texas is closest to Florida **; ora A** / **B**, distant / far away 2 (Texas and Florida pumas) are most closely-related / most genetically similar share most recent common ancestor **;** **ora A** / **B** 3 Texas and Florida, climates / habitats / environment, are similar **; ora** for **A / B** 4 AVP **;** e.g. Texas has too many pumas	**2**
6(a)	1 microvilli **; A** brush border **I** papillae 2 increase surface area **;** 3 (so), more (Na^+) channels / more Na^+ enter **;**	**3**

Question	Answer	Marks
6(b)	*any **six** from:* 1 vesicles of neurotransmitter are stimulated to move **;** 2 vesicles fuse with, cell surface membrane / presynaptic membrane **;** 3 exocytosis (described) / secretion, of (named) neurotransmitter **;** 4 neurotransmitter diffuses across, synapse / (synaptic) cleft / gap between cells **A** and **B ;** 5 neurotransmitter binds to receptors **;** 6 on, cell surface / postsynaptic / (sensory) neurone / **B**, membrane **;** 7 Na^+ / sodium, channels open **;** 8 Na^+ enter, (sensory) neurone / **B ;** 9 postsynaptic membrane / (sensory) neurone membrane, depolarised **;** 10 *ref. to* threshold **;**	**6**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>7(a)</td><td>gene – a length of DNA / a sequence of DNA nucleotides, that codes for a particular, protein / polypeptide ;

locus – the position of a, gene / allele, on a chromosome ;</td><td>2</td></tr>
<tr><td>7(b)</td><td>parent genotype (AaBb × AaBb)

parent phenotype brown (brown) ;

gametes AB Ab aB ab × (AB Ab aB ab) ;

<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>
;;

offspring phenotypes linked to genotypes ;

ratio – 9 brown : 3 black : 4 white ;</td><td>6</td></tr>
</table>

Question	Answer	Marks
7(c)	*any **three** from:* 1 (base), substitution / deletion / insertion **or** frame shift **;** 2 *ref. to* change in, primary / secondary / tertiary, structure (of polypeptide / protein) **or** change in, 3D / active site, shape **;** 3 *ref. to* stop codon **;** 4 (so) no / inactive, tyrosinase produced **;** 5 tyrosine not converted to, DOPA / dopaquinone **;** 6 melanin not formed **;**	**3**

Question	Answer	Marks
8(a)	*any **two** from:* 1 loss of habitat / described **;** 2 climate change / global warming **;** 3 predation **;** **I** hunting 4 competition for, food / resources / breeding sites / example **;** **A** not enough food 5 new disease **;** 6 numbers get so low that population can't recover / AW **;**	**2**
8(b)	*any **three** from:* 1 trade ban (if species is in danger of extinction) **;** 2 if species is not (yet) at risk of extinction permit required **;** 3 *ref. to* border controls / checks **;** **A** fines / punishment if caught 4 (provide countries with) lists of species that are, rare / endangered **;** 5 encourages governments, to join CITES / to abide by CITES regulations **;** 6 AVP **;** e.g. every few years they have a conference with their members	**3**

Question	Answer	Marks
8(c)	*any **four** from:* 1 captive breeding / description **;** 2 assisted reproduction / example **;** 3 reintroduce into the wild **;** 4 medical care **;** 5 education / public awareness **;** 6 research **;** 7 projects in the field **;** 8 *ref. to* maintaining genetic databases, to avoid inbreeding **or** working with other zoos **;**	**4**

Question	Answer	Marks
9(a)	**A** – axon / axoplasm **;** **B** – Schwann cell nucleus **;**	**2**
9(b)	1 myelinated has faster speed (of transmission of action potential) **;** *plus* *any **three** from:* 2 (myelinated) Na^+ channels **only** occur at nodes of Ranvier **or** (non-myelinated) Na^+ channels occur along length of neurone **;** 3 (myelinated) depolarisation **only** occurs at nodes **or** (non-myelinated) depolarisation occurs along length of neurone **;** 4 (myelinated) long local circuits **or** (non-myelinated) short local circuits **;** 5 (myelinated) saltatory conduction / described **;** 6 AVP **;** e.g. 100 ms^{-1} v 2 ms^{-1}	**4**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>10(a)(i)</td><td>
any three from:

1 as the, blood glucose / glucose concentration, increases the, blood insulin / insulin concentration, increases ; A positive correlation

2 data quote with unit ;

data quote for mp1
<table>
<tr><td>time of day ±1.5 min</td><td>blood glucose conc / mmol dm^{-3} ±0.025</td><td>time of day ±1.5 min</td><td>blood insulin conc / pmol dm^{-3} ±1</td></tr>
<tr><td>07.00</td><td>4.3</td><td>07.15</td><td>30</td></tr>
<tr><td>08.00</td><td>6.2</td><td>08.00</td><td>280</td></tr>
</table>
data quote for mp5
<table>
<tr><td>time of day ±1.5 min</td><td>blood glucose conc / mmol dm^{-3} ±0.025</td><td>time of day ±1.5 min</td><td>blood insulin conc / pmol dm^{-3} ±1</td></tr>
<tr><td>08.00</td><td>6.2</td><td>08.00</td><td>280</td></tr>
<tr><td>09.00</td><td>4.45</td><td>09.00</td><td>120</td></tr>
</table>
3 increase in, blood glucose / glucose concentration, causes release of insulin (from pancreas) ; ora

4 insulin stimulates the conversion of glucose to glycogen / glycogenesis
or
insulin increases permeability (of liver / muscle) cells to glucose / AW ;

5 insulin causes, blood glucose / glucose concentration, to return back to set point ;

6 ref. to negative feedback ;
</td><td>3</td></tr>
</table>

Question	Answer	Marks
10(a)(ii)	*any **three** from:* *max 2 if only glucose or insulin curve mentioned* 1 *ref. to* delay before both graphs increase / AW **;** 2 peaks for both would be lower **;** 3 both curves would take longer to decrease **;** 4 time is needed for starch to be, broken down / converted (to glucose) **;** 5 to glucose **;**	**3**
10(b)	*any **four** from:* 1 *ref. to* adenylyl cyclase **;** 2 formation of, cyclic AMP / cAMP **;** 3 cAMP acts as a second messenger **;** 4 activation of (protein) kinase **;** 5 enzyme cascade **;** 6 amplification of signal **;** 7 glycogenolysis / gluconeogenesis / described **;** 8 glucose released into blood **;**	**4**