Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/43**

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.

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

Question	Answer	Marks
1(a)	**P** – citrate **A** citric acid **Q** – NAD / NAD^+ **R** – reduced NAD / NADH **A** $NADH_2$ **S** – carbon dioxide / CO_2 **T** – FAD **U** – reduced FAD / $FADH_2$ **;;;** *6 correct = 3 marks* *5/4 correct = 2 marks* *3/2 correct = 1 mark*	**3**
1(b)	*any **two** from:* 1 transfer of phosphate group to ADP / ADP phosphorylated / ADP + P_i → ATP **;** 2 substrate-linked phosphorylation **;** **A** substrate-level phosphorylation **R** if oxidative phosphorylation 3 enzyme (catalysed reaction) **;**	**2**

Question	Answer	Marks
1(c)	*any **four** from:* 1 small / water-soluble, so can move around cell **;** 2 loss of phosphate / hydrolysis, leads to energy release **;** 3 (release energy) immediately / in small packets **or** *ref.* 30.5 kJ (mol^{-1}) **;** 4 can be, recycled / regenerated **or** ATP ⇆ ADP + Pi **;** 5 link between energy-yielding and energy-requiring reactions / AW **;** 6 high turnover / described **;** 7 *ref to* ATPase **;**	**4**

Question	Answer	Marks
2	*any **seven** from:* 1 (random) mutation **;** 2 directional selection **;** 3 antibiotic acts as selection pressure / AW **;** 4 bacteria with, mutation / gene / allele, (that codes for antibiotic resistance), have selective advantage **;** 5 (so) survive / reproduce **;** 6 *ref.* binary fission / asexual reproduction / vertical transmission **;** 7 *ref.* transduction / transformation / conjugation / horizontal transmission **;** **I** sexual reproduction 8 (resistance) allele frequency increases / gives rise to a population of resistant bacteria **;** 9 fast (evolution) due to short generation time **;** 10 increased chance of resistance if people do not finish full course of antibiotics / overuse of antibiotics **;** 11 AVP **;** e.g. some antibiotics may act as mutagens e.g. enzymes that break down the antibiotic	**7**

Question	Answer	Marks
3(a)(i)	*the operon has:* promoter **;** operator **;** three structural genes / named three structural genes **;** *lacZ* **or** β galactosidase gene *lacA* **or** lactose / β galactoside, permease gene *lacY* **or** transacetylase gene ***I*** *regulatory genes / order of named parts*	**3**
3(a)(ii)	*any **four** from:* *lacI gene* 1 is always expressed **;** 2 controls (structural) gene expression **;** 3 codes for the repressor (protein) **;** 4 repressor, binds to the operator / blocks the promoter **;** 5 prevents, (structural) gene expression / RNA polymerase binding to promoter **;** 6 lactose / allolactose, binds to repressor **;** 7 (so) repressor cannot bind to operator / promoter unblocked / gene expression can occur **;**	**4**

Question	Answer	Marks
3(b)	1 enzymes / proteins, made continuously / all the time **;** 2 (because) enzymes / proteins, needed / necessary (for cell) **;** 3 end product inhibition / made until product concentrations too high **;**	**3**

Question	Answer	Marks
4(a)	*any **three** from:* 1 donor not needed **;** 2 immediate effect **;** 3 *idea that* easy to administer treatment **;** 4 no immune response / no rejection **;** 5 less invasive **;** 6 AVP **;** e.g. lower risk to health / cheaper / quicker	**3**

Question	Answer	Marks
4(b)	*any **four** from:* 1 given a drug to increase number of stem cells (in bone marrow) **;** 2 *ref. to* virus / vector, containing, normal / healthy, allele **;** 3 remove, bone marrow / stem cells **;** 4 mix stem cells with, viral / vector (to allow transfer of normal allele) **;** 5 radiotherapy / drug, to make space in bone marrow / to kill stem cells (in bone marrow) **;** 6 (transduced stem) cells, infused / injected, into blood **;** 7 (lymphocytes) produce functioning ADA **;** 8 AVP **;** e.g. (gamma) retrovirus / adeno-associated virus e.g. tissue from bone marrow, purified / sorted, to obtain stem cells e.g. cells are grown in culture to check the ADA gene is active	**4**

Question	Answer	Marks
4(c)	*any **three** from:* 1 expensive **;** 2 cure / long term treatment / no longer chronically ill / better quality of life **;** 3 no need for regular, injections / treatments **or** only a single treatment **;** 4 cultural / religious, objections **;** 5 no donor needed **;** 6 *ref.* more money available to health system in the long term **;** 7 may cause cancer **;** 8 stressful **;**	**3**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>5(a)</td><td>
<table>
<tr><th>phenotype</th><th>observed</th><th>expected</th><th>O – E</th><th>$(O – E)^2$</th><th>$\frac{(O-E)^2}{E}$</th></tr>
<tr><td>red with black spots</td><td>279</td><td>281.25</td><td>–2.25</td><td>5.0625</td><td>0.018</td></tr>
<tr><td>white with black spots</td><td>95</td><td>93.75</td><td>1.25</td><td>1.5625</td><td>0.017</td></tr>
<tr><td>red</td><td>96</td><td>93.75</td><td>2.25</td><td>5.0625</td><td>0.054</td></tr>
<tr><td>white</td><td>30</td><td>31.25</td><td>–1.25 ;</td><td>1.5625 ;</td><td>0.05(0)</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>0.139 / 0.14 ;</td></tr>
</table>
one mark for each column
</td><td>3</td></tr>
<tr><td>5(b)</td><td>
any two from:

accept null hypothesis (no mark)

1 χ^2 value / 0.139 / 0.14, is lower than, the critical value / 7.815 ;

2 the observed numbers are not significantly different to the expected numbers (at $p = 0.05$) ;

3 any differences are due to chance ;

allow ecf from 5(a)
</td><td>2</td></tr>
</table>

Question	Answer	Marks
5(c)		4

male gametes \ female gametes	X^RB	X^rB	X^Rb	X^rb
X^rB	X^RX^rBB	X^rX^rBB	X^RX^rBb	X^rX^rBb
	female	female	female	female
	red + black spots	white + black spots	red + black spots	white + black spots
Y^RB	X^RY^RBB	X^rY^RBB	X^RY^RBb	X^rY^RBb
	male	male	male	male
	red + black spots	red + black spots	red + black spots	red + black spots
X^rb	X^RX^rBb	X^rX^rBb	X^RX^rbb	X^rX^rbb
	female	female	female	female
	red + black spots	white + black spots	red + no spots	white + no spots
Y^Rb	X^RY^RBb	X^rY^RBb	X^RY^Rbb	X^rY^Rbb
	male	male	male	male
	red + black spots	red + black spots	red + no spots	red + no spots

;;;;

Question	Answer	Marks
5(d)	*mark as pairs* 1 allele **R** / dominant red allele, is on **Y** chromosome **;** 2 (so all) males **inherit**, dominant red allele / allele **R** **or** only $\mathbf{Y^R}$ is present in the gametes **;** 3 no, allele **r** / recessive white allele, on **Y** chromosome **or** allele **r** only exists on the **X** chromosome **;** 4 (so) males never inherit, recessive white allele / allele **r** **;**	**2**
5(e)	*any **two** from:* 1 mutation **;** 2 detail of mutation **;** 3 crossing over **;** 4 (of) the **R** allele / dominant red allele, from a **Y** chromosome to an **X** chromosome **;**	**2**

Question	Answer	Marks
6(a)	**A** – endothelial cell **;** **B** – basement membrane **;** **C** – podocyte **;**	**3**

Question	Answer	Marks
6(b)	*any **two** from:* 1 acts as the filter **;** 2 prevents molecules more than 68 000 – 70 000 MM from passing through **; ora** 3 stops, large (plasma) proteins / red blood cells **;**	**2**
6(c)	$\frac{180-1.4}{180} \times 100$ **or** $\frac{178.6}{180} \times 100$ **;** 99.2 **;**	**2**

Question	Answer	Marks
6(d)	*any **seven** from:* 1 ADH, acts as / is, a cell signalling molecule **;** 2 ADH binds to receptors **;** 3 on cell surface membrane (of collecting duct cells) **; I** activates G protein 4 cAMP / second messenger, produced **;** 5 enzyme cascade / activation of kinase **;** 6 vesicles / aquaporins, phosphorylated / activated **;** 7 vesicles (with aquaporins) move towards cell surface membrane **;** 8 aquaporins added to (cell surface) membrane **;** 9 increases, cell / membrane, permeability to water **;** 10 water moves out (of collecting duct), by osmosis / description **;** 11 into, (collecting duct) cells / tissue fluid / blood **;** **I** water is reabsorbed as in Q	**7**

Question	Answer	Marks
7(a)	*any **three** from:* 1 opens (voltage-gated) Ca^{2+} channels in sarcoplasmic reticulum **or** calcium ions leave sarcoplasmic reticulum **;** 2 calcium ions bind to troponin **;** 3 troponin changes shape / tropomyosin moves **;** 4 exposes binding site on actin **;** 5 myosin <u>head</u>, binds to (binding) site / forms cross bridge **;** ***plus*** 6 myosin <u>head,</u> tilts / AW **;** 7 pulls actin / power stroke (so sarcomere shortens) **;**	**4**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>7(b)</td><td>

*any **two** from:*

1 young mice have more (muscle fibres) that are smaller (in diameter) **; ora**

2 young mice have smaller range (of diameters of muscle fibres) **; ora**

3 comparative data quote **;** e.g.

<table>
<tr><th></th><th>number of muscle fibres at mean diameter / μm</th><th>spread of diameters / μm</th></tr>
<tr><td>young mice</td><td>35 at 30</td><td>16–44</td></tr>
<tr><td>adult mice</td><td>16 at 50</td><td>20–80</td></tr>
</table>

plus
*any **two** from:*

young mice

4 fewer, (muscle) fibres / myofibrils / sarcomeres **; ora**

5 less, muscle protein / actin and myosin **; ora**

6 so, weaker contraction / AW **; ora**

</td><td>4</td></tr>
</table>

Question	Answer	Marks
8(a)	<table><tr><th></th><th>letter</th></tr><tr><td>high concentration of protons</td><td>**M ;**</td></tr><tr><td>location of photosynthetic pigments</td><td>**L** or **N ;**</td></tr><tr><td>site of light-independent stage</td><td>**K ;**</td></tr><tr><td>site of light-dependent stage</td><td>**L** or **N ;**</td></tr></table> *ignore **M** in the last row*	**4**
8(b)	*any **four** from:* 1 any one named **;** e.g. chlorophyll b / carotene **/** xanthophyll / carotenoids **;** 2 act as accessory pigments / part of antenna complex / part of light harvesting system **;** 3 absorb, light / photons **;** 4 pass energy on to, chlorophyll a / primary pigment / reaction centre **;** 5 absorb different wavelengths of light / wavelengths not absorbed by chlorophyll a **;**	**4**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(c)</td><td>1 absorption higher for (whole) chloroplasts (throughout) ;

2 comparative data quote or greatest difference at 525 / 530 nm ;

<table>
<tr><th rowspan="2">wavelength / nm</th><th colspan="2">absorbance / au ±0.05</th></tr>
<tr><th>whole</th><th>pigment</th></tr>
<tr><td>500</td><td>9.2</td><td>6.4</td></tr>
<tr><td>510</td><td>8.4</td><td>3.8</td></tr>
<tr><td>520</td><td>7.4</td><td>2.3</td></tr>
<tr><td>525</td><td>7.0</td><td>1.95</td></tr>
<tr><td>530</td><td>6.6</td><td>1.85</td></tr>
<tr><td>540</td><td>6.2</td><td>2.05</td></tr>
<tr><td>550</td><td>5.8</td><td>2.35</td></tr>
<tr><td>560</td><td>5.8</td><td>2.7</td></tr>
<tr><td>600</td><td>6.65</td><td>4.7</td></tr>
<tr><td>650</td><td>8.85</td><td>8.1</td></tr>
<tr><td>670</td><td>9.6</td><td>9.2</td></tr>
</table>

3 (because) pigments arranged for better absorption in chloroplasts / thylakoid membranes are stacked / AW ;

4 (because) chloroplasts contain more pigments ;</td><td>4</td></tr>
</table>

Question	Answer	Marks
9(a)(i)	*any **four** from:* 1 (dopamine) diffuses across synaptic cleft **;** 2 binds to receptors **;** 3 on postsynaptic membrane **;** 4 Na^+ channels open **R** voltage gated channels **or** influx of Na^+ into post synaptic neurone **;** 5 depolarisation of postsynaptic membrane **;** 6 *ref.* threshold **;**	**4**
9(a)(ii)	dopaquinone **; A** melanin	**1**
9(b)	*any **three** from:* 1 Cl^- influx makes (inside of postsynaptic neurone) more negative / stays negative **;** 2 hyperpolarisation / remains polarised **;** 3 (not enough Na^+ enter so) less likely to reach threshold **;** 4 no depolarisation of (postsynaptic) membrane **;** 5 (so) no action potential **;**	**3**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>10(a)</td><td>any four from:
<table>
<tr><th></th><th>Animalia</th><th></th><th>Plantae</th><th></th></tr>
<tr><td>1</td><td>no cell walls</td><td>and</td><td>cell walls</td><td>;</td></tr>
<tr><td>2</td><td>no, chlorophyll / chloroplasts</td><td>and</td><td>chlorophyll / chloroplasts</td><td>;</td></tr>
<tr><td>3</td><td>heterotroph</td><td>and</td><td>autotroph / photosynthesis</td><td>;</td></tr>
<tr><td>4</td><td>glycogen</td><td>and</td><td>starch</td><td>;</td></tr>
<tr><td>5</td><td>nervous system</td><td>and</td><td>no nervous system</td><td>;</td></tr>
<tr><td>6</td><td>move from place to place</td><td>and</td><td>unable to move from place to place</td><td>;</td></tr>
<tr><td>7</td><td>no, permanent / central, vacuole</td><td>and</td><td>permanent / central, vacuole</td><td>;</td></tr>
</table></td><td>4</td></tr>
<tr><td>10(b)(i)</td><td>$\frac{0.86-0.28}{4}$ or $\frac{0.58}{4}$;

0.15 ;

or

$\frac{0.85-0.28}{4}$ or $\frac{0.57}{4}$;

0.14 ;

Allow ecf if divided by 5 and equals 0.12</td><td>2</td></tr>
</table>

Question	Answer	Marks
10(b)(ii)	*any **three** from:* 1 climate change / described ; 2 less food / less watermilfoil ; 3 less, snow / cover, so more predation ; 4 more hunting ; 5 increased competition ; 6 loss of habitat / deforestation ; 7 (new) disease ;	**3**