Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/42**

Paper 4 A Level Structured Questions **February/March 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 February/March 2023 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	<u>'List rule' guidance</u> 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 normal)
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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Question	Answer	Marks
1(a)		**4**

	region of kidney	
location of loops of Henle	**C**	**;**
location of Bowman's capsules	**A**	**;**
location of glomeruli	**A**	**;**
contains urine at final concentration	**B + D**	**;**

1(b)	*any **three** from:* 1 (aquaporins are) water channel (proteins) **;** 2 (more) aquaporins increase (cell surface) membrane permeability (to water) **; ora** 3 of collecting duct (cells) **; I** distal convoluted tubule cells 4 allow water to, be reabsorbed / move into tissue fluid or blood **;**	**3**
1(c)	*any **three** from:* 1 detected by osmoreceptors **;** 2 in hypothalamus **;** 3 (osmoreceptors send) fewer impulses to posterior pituitary **; I** signals 4 less ADH, released / produced **; I** no ADH released	**3**

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Question	Answer	Marks
2(a)(i)	1 is regulatory gene / codes for repressor (protein) **;** **R** is a transcription factor **R** *lacI* is a repressor protein 2 prevents, transcription / RNA polymerase binding to promoter **;**	**2**
2(a)(ii)	*any **three** from:* *concentration of IFN-α produced* 1 increases steeply (after addition of IPTG) **;** 2 peak is, at 8 hours / 4 hours (after addition of IPTG) **;** 3 decrease is less steep **or** final concentration greater than starting concentration / AW **;** 4 data quote **;**	**3**
2(a)(iii)	*any **one** from:* *IPTG is higher / lactose is lower, because* 1 lactose has to be converted to allolactose **;** 2 lactose is broken down so needs to be continually taken up **or** IPTG is not broken down so continually binds to repressor **;** 3 IPTG will be at higher concentration than allolactose **; A** lactose for allolactose 4 IPTG has higher affinity for repressor protein than allolactose **; A** lactose for allolactose 5 lactose, used up / concentration decreases **;** 6 more IPTG enters **;**	**1**

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Question	Answer	Marks
2(a)(iv)	IFN-α is, unstable / breaks down **;**	**1**
2(b)	(only *E. coli* that have taken up the plasmid) will, grow / survive, in the presence of, ampicillin / antibiotic **;**	**1**
2(c)	*any **five** from:* 1 (random) mutation **;** 2 natural selection / directional selection **;** 3 antibiotic acts as selection pressure / AW **;** 4 bacteria with mutation, have selective advantage / survive / reproduce **or** bacteria with, gene / allele, that codes for antibiotic resistance, have selective advantage / survive / reproduce **;** 5 pass on, mutation / gene / allele, (for antibiotic resistance) by, binary fission / asexual reproduction / vertical transmission **;** 6 pass on, mutation / gene / allele, (for antibiotic resistance) by, transduction / transformation / conjugation / horizontal transmission **;** 7 AVP **;** e.g. increased chance of resistance if people do not finish full course of antibiotics overuse of antibiotics some antibiotics may act as mutagens	**5**

Question	Answer	Marks
3(a)	*any **three** from:* *max **two** from:* 1 (phenotype has) range of values / intermediates **;** 2 (phenotypes) not, in groups / in classes / categoric / discrete / qualitative **or** (phenotypes are) quantitative **;** 3 normal distribution **;** *max **two** from:* 4 polygenic / controlled by many genes **;** 5 different genes / alleles, have additive effect **;** 6 (named) environmental factors (contribute to the variation) **;**	**3**
3(b)(i)	difference between means = 9.4 – 7.7 **or** 1.7 **;** denominator = $\sqrt{\frac{0.4^2}{28} + \frac{1.1^2}{27}}$ **or** $\sqrt{\frac{0.16}{28} + \frac{1.21}{27}}$ **or** 0.22 / 0.23 (no limit on number of decimal places) **;** t = 7.56 **;** must be to 2 decimal places **allow** ECF	**3**

Question	Answer	Marks
3(b)(ii)	1 *t*-value / 7.56, is greater than, 2.01 / critical value **;** 2 difference between two groups **is**, significant / not due to chance **or** null hypothesis rejected **;** *any **two** from:* 3 overlap in, data range / error bars **;** 4 ref. to correlation does not prove causation **;** 5 only a single investigation / needs repeating / small sample size **;** 6 ref. to this is only at 5% probability so may not actually be different / AW **;** 7 *t*-test may not be valid due to unequal, standard deviations / variances**;**	**3**
3(b)(iii)	*any **one** from:* 1 *idea of* less labour intensive **;** e.g. no need for weekly injections / GM only needs to be done once 2 *idea of* less stressful on GM salmon **;** 3 risk of infection with injections **;** 4 *idea that* growth hormone is continuously produced **;** 5 GM salmon may grow faster **;**	**1**

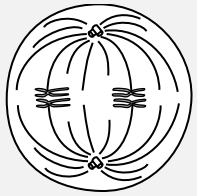
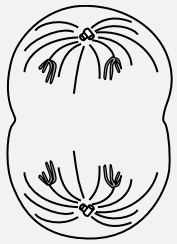
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Question	Answer	Marks
4(a)	*any **three** from:* 1 ref. to isolate / extract, DNA, from, cells / tissue / named **;** 2 ref. to cut DNA, into small fragments / using restriction enzymes **;** 3 ref. to denature / AW, into single-stranded DNA **;** 4 add fluorescent, tag / marker / dye **;**	**3**
4(b)(i)	2 400 000 or 2 500 000 **;**	**1**
4(b)(ii)	*any **three** from:* 1 DNA from DiGeorge syndrome and control DNA labelled with different colour fluorescent tags **;** 2 DNA hybridises with probes (on microarray) **;** *DiGeorge Syndrome* 3 less DNA binds to probes (than control DNA) **;** 4 so there is, less / 50%, fluorescence where nucleotides have been deleted **;** 5 fluorescence is, equal / 100%, where nucleotides have not been deleted **;**	**3**

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Question	Answer	Marks
4(b)(iii)	*any **three** from:* 1 different number of nucleotides may be deleted **;** 2 different genes may be deleted **;** 3 an individual only has one allele (of the deleted genes) **;** 4 different individuals may have different alleles of the same gene **or** in one individual remaining allele may be recessive but dominant in another individual **;** 5 so different proteins made **;** 6 ref. to individuals may have different environments **; A** diet	**3**

Question	Answer	Marks
5(a)		**4**

stage of meiosis	spindle fibres	diagram
metaphase I	attach to centromeres and arrange homologous pairs of chromosomes at the equator of the cell	
anaphase I	(contract to) pull, centromeres / chromosomes, towards poles / to centrioles **;**	
prophase II **;**	re-form spindle in daughter cells	
telophase II	disassemble	(forming) four daughter cells **;** two single chromosomes inside a (re-forming) nuclear envelope **;**

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Question	Answer	Marks
5(b)	*any **four** from:* 1 (meiosis / reduction division) produces gametes **;** 2 (two) gametes fuse / fertilisation occurs, to form a zygote **;** 3 zygote will have maternal and paternal chromosomes / AW **;** 4 gametes, are haploid / are *n* / have half the normal number (of chromosomes) **;** 5 so the zygote, is diploid / 2*n* **;** 6 prevents, doubling of chromosome number / polyploidy / having too many chromosomes **or** allows chromosome number to remain constant **;**	**4**

Question	Answer	Marks
6(a)(i)	**D ;**	**1**
6(a)(ii)	**D** and **C ;**	**1**
6(b)	*any **three** from:* 1 site of, link reaction / Krebs cycle **;** 2 DNA / ribosomes, for production of proteins (used in respiration) **;** 3 named example **;** e.g. enzymes / coenzymes / electron carriers **;** 4 production of, reduced FAD / reduced NAD, for oxidative phosphorylation **;** 5 substrate-linked phosphorylation **;**	**3**

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Question	Answer	Marks
6(c)	*any **four** from:* *process, stops / decreases, because:* 1 no / fewer, electrons accepted by oxygen **or** oxygen is the final electron acceptor **;** 2 no / fewer, electrons, enter / move along, electron transport chain / ETC **or** ETC stops **;** 3 no /fewer, H^+ pumped into intermembrane space **or** no / less steep, proton gradient **;** 4 no / less, chemiosmosis **;** 5 reduced NAD / reduced FAD, not oxidised / **or** NAD / FAD, not recycled **;** 6 no / less, ATP produced **;** 7 AVP **;** e.g. no / less, pyruvate enters mitochondrion.	**4**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>7(a)</td><td>any four from:

1 0.1 g dm^{-3} chemoreceptor (membrane), is not depolarised / does not release neurotransmitter / remains at resting potential ;

2 so, dendrite / sensory neurone, is not depolarised / remains at resting potential / has no action potential ;

3 1.0 g dm^{-3} / 10.0 g dm^{-3}, chemoreceptor (membrane), is depolarised / releases neurotransmitter ;

4 so, depolarisation / action potential / impulse, in, dendrite / sensory neurone ;

5 receptor / generator, potential qualified ;

6 ref. to threshold / all or nothing law (in context of either cell) ;</td><td>4</td></tr>
<tr><td>7(b)</td><td>any three from:

<table>
<tr><th></th><th>sensory</th><th></th><th>motor</th></tr>
<tr><td>1</td><td>cell body, between dendron and axon / in ganglion</td><td>and</td><td>cell body, at end / in CNS ;</td></tr>
<tr><td>2</td><td>has dendron and axon</td><td>and</td><td>has (long) axon ;</td></tr>
<tr><td>3</td><td>no dendrites from cell body</td><td>and</td><td>dendrites extend from cell body ;</td></tr>
<tr><td>4</td><td>carries impulses from receptor to, CNS / intermediate neurone</td><td>and</td><td>carries impulses from, CNS / intermediate neurone, to effector ;</td></tr>
</table>
</td><td>3</td></tr>
</table>

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Question	Answer	Marks
8(a)	*any **seven** from:* 1 photosynthetic / named / primary / accessory, pigments to absorb light (energy) **;** 2 ref. to, photosystems / antenna complex and reaction centre / light harvesting structures **;** 3 photoactivation / electrons excited / emission of electrons **;** 4 electrons move along electron transport chain **;** 5 (cyclic / non-cyclic) photophosphorylation / light-dependent stage **;** 6 site of photolysis / location of oxygen-evolving complex **;** 7 thylakoids stacked to form grana **;** 8 gives large surface area **;** 9 thylakoid space or lumen to, form proton gradient / have high concentration of protons **;** 10 thylakoid membrane is (relatively) impermeable, to maintain the proton gradient **;** 11 ATP synthase to make ATP**;** 12 chemiosmosis **;**	**7**

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Question	Answer	Marks
8(b)	*any **four** from:* *describe* 1 **A** activity increases and **B** activity remains, low / constant **;** 2 comparative data quote **;** e.g. 3.0–3.2 at 0.5 mins and 11.4–11.6 at 6 mins for **A** 0.4 throughout for **B** *max **three**:* *explanation:* 3 RA / rubisco activase, activates rubisco **;** 4 by changing the active site of rubisco **;** 5 by enabling rubisco to bind more readily with, RuBP / substrate **or** more enzyme–substrate complexes **;** 6 enables products to leave active site more quickly **;** 7 AVP **;** e.g. cofactor action qualified	**4**

Question	Answer	Marks
9(a)(i)	**P** pointing to thin filament **;** **R** pointing to thick filament **;**	**2**
9(a)(ii)	A-band – stays the same **;** **I**-band – gets narrower **;**	**2**

Question	Answer	Marks
9(b)(i)	*any **four** from:* 1 competes with, acetylcholine / neurotransmitter **or** acetylcholine cannot bind to receptors **or** blocks receptors **;** 2 Na^+ channels do not open **or** no / fewer, sodium ions enter (muscle fibre) **;** 3 so, no / less, depolarisation of sarcolemma **;** 4 no / fewer, action potentials / impulses (spread across muscle fibre) **;** 5 Ca^{2+} (voltage-gated) channels do not open in sarcoplasmic reticulum **or** no / fewer, Ca^{2+} ions released by sarcoplasmic reticulum **;** 6 no / fewer, Ca^{2+} ions bind to troponin **or** no exposing of binding sites **or** no / fewer, cross bridges / AW **;**	**4**
9(b)(ii)	*any **two** from:* 1 affects, rib muscles / intercostal muscles / diaphragm, so unable to breathe **;** 2 affects cardiac muscle so, stops blood circulation / heart failure / attack **;** 3 cannot move so unable to escape from predators **;** 4 cannot eat so starves **;**	**2**

Question	Answer	Marks
10(a)	abundance / numbers / population (size) ; Simpson's ; genes ; alleles ; adapt / evolve ; habitats / niches ;	**6**
10(b)(i)	$\frac{14\,234 - 7851}{12}$; 532 ;	**2**

Question	Answer	Marks
10(b)(ii)	*any **four** from:* *fish:* 1 overfishing **;** 2 (on water / at sea) difficult to **enforce** protective, laws / regulations **or** **fewer** laws to protect fish **;** 3 trophy hunting **;** 4 climate change qualified **;** e.g. increased ocean temperatures / predatory species moving into new areas now water is warmer 5 pollution qualified **;** e.g. plastics in the sea / oil spills / eutrophication 6 there are more species of fish than there are species of mammals **;** *mammals:* 7 more conservation projects for mammals / AW **; ora** for fish 8 laws in place, banning hunting / protecting mammals **;** 9 AVP **;**	**4**

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