Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/42**

Paper 4 A Level Structured Questions **March 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 March 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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	<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.

6	<u>Calculation specific guidance</u> 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	<u>Guidance for chemical equations</u> 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 point
R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
AW	alternative wording (where responses vary more than usual)
<u>underline</u>	actual word given 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 (with relevant number)
ecf	error carried forward
I	ignore

Question	Answer	Marks
1(a)	*any **two** from:* 1 predation / fishing **;** 2 **food** qualified **;** e.g. competition / limited amount 3 disease **;** 4 AVP **;** e.g. idea that birth rate and death rate are roughly equal	**2**
1(b)	1 organisms have changed over time **;** *any **one** from:* 2 ref. to natural selection / selective advantage for survival / survival of the fittest **;** 3 ref. to long period of time **;** 4 ref. to variation **;**	**2**
1(c)	*any **three** from:* 1 as the generation time increases, the rate of evolution decreases / relationship is inversely proportional / AW **; ora** 2 not linear / exponential / decreasing gradient **;** 3 (longer generation time) so less, reproduction / DNA replication **; ora** 4 ref. to fewer mutations **; ora** 5 *idea of* (so) less chance of evolution **; ora** *mp5 must be linked to mp3 or mp4*	**3**

Question	Answer	Marks
1(d)	*any **three** from:* 1 well adapted to their environment **;** 2 environment / selection pressures, stayed, constant / stable **; ora** 3 mutations qualified **;** e.g. fewer / not selected for / low rate 4 AVP **;** e.g. no natural predators / cannot migrate / no separation of populations (for speciation to occur)	**3**

Question	Answer	Marks
2(a)(i)	*Canis* **;**	**1**
2(a)(ii)	*any **three** from:* 1 decrease in biodiversity **;** 2 prey of grey wolf / herbivores, (may) increase in number **;** 3 (leads to) overgrazing **;** **A** herbivores would decrease plant populations 4 change in, ecosystem / habitat / food web **;** 5 change in genetic variation **;** 6 over many years **;**	**3**

Question	Answer	Marks
2(b)	*any **two** from:* 1 difficult to capture **;** 2 dangerous (to humans) **;** 3 large territory (so unlikely to recapture) **;** 4 migration **;** 5 may not mix with other wolves **;** 6 small, sample size / populations (so inaccurate) **;**	**2**
2(c)(i)	(+)257 / 260 **;**	**1**
2(c)(ii)	*any **three** from:* 1 overall increase in grey wolf numbers **;** 2 decrease in Sierra Morena population **;** 3 alpine population is **new** population **;** 4 data quote **;** 5 increase in, territory / area, for, Iberian / Italian, populations **;** 6 AVP **;** e.g. alpine population arose from, dispersal / migration, of Italian population	**3**

Question	Answer	Marks
2(d)(i)	*any* ***one*** *from:* 1 compensation scheme (for loss of livestock) **;** 2 *idea of* protection of livestock **;** e.g. build, fences / enclosures 3 allow controlled culling (of wolves) **;** 4 move individual wolves to (wild) areas away from livestock **;**	**1**
2(d)(ii)	*any* ***three*** *from:* 1 reserves / national parks **;** 2 education / (public) awareness programmes **;** 3 research qualified **;** e.g. habitat, diet, reproduction 4 ban, hunting / trade (of wolf products) **;** 5 monitor populations **;** 6 AVP **;** **I** ref. to zoos, captive breeding	**3**

Question	Answer	Marks
3(a)	*any **four** from:* 1 gene(s) involved in production of carotene obtained **;** 2 from, another species / bacteria / daffodil / maize / rice **;** 3 ref. to use of named enzyme **;** e.g. restriction enzyme / restriction endonuclease / (DNA) ligase 4 ref. to plasmid / vector / gene gun **;** 5 ref. to recombinant DNA **;** 6 ref. to insertion of gene into rice, cells / embryos / genome / DNA / chromosome **;** 7 gene(s), expressed / transcribed, to produce enzyme(s) that make carotene **;** 8 AVP **;** e.g. extra detail such as promoter	**4**

Question	Answer	Marks
3(b)	*any **four** from:* 1 33–34 grams of genetically modified rice needed (to meet the RDA of a child) **;** 2 would help to prevent (childhood) blindness **;** 3 would help to prevent death (of children) **;** 4 (seeds) affordable / AW **;** 5 (seeds) scientifically proven to be safe **;** 6 (continuing to campaign would cause) waste of government money **;** 7 AVP **;** e.g. benefits outweigh concerns plant-based GM (no GM animal welfare concerns) would reduce the need for supplementing diets	**4**

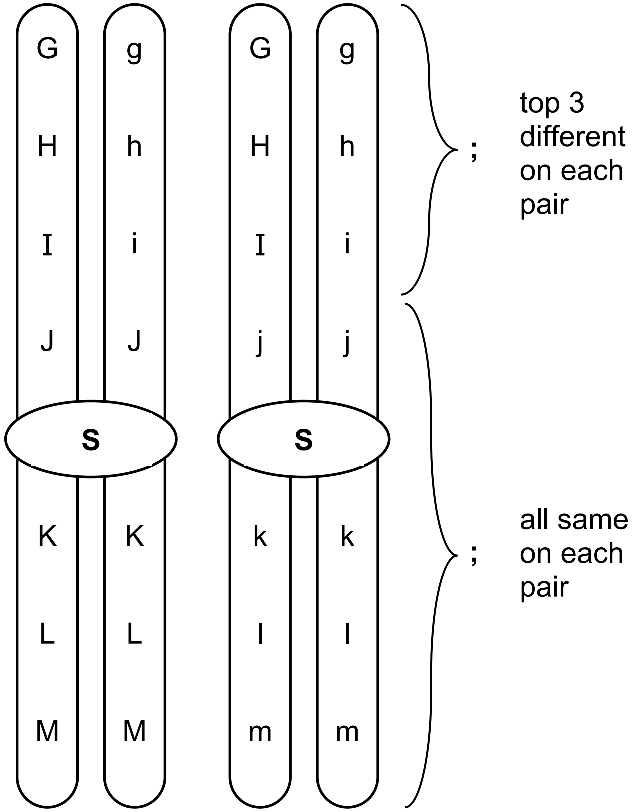
Question	Answer	Marks
4(a)(i)	<u>565 nm</u> **;**	**1**
4(a)(ii)	1 phycoerythrin does not absorb light above 590–600 (nm) **;** **A** suitable value for absorption that answer the question 2 (but) photosynthesis still takes place (above 590–600 nm) **;** **A** suitable value for absorption that answer the question	**2**

Question	Answer	Marks
4(a)(iii)	*any **two** from:* 1 accessory pigment **;** 2 absorbs light energy (up to 595 nm) **;** **R** trap / capture 3 (and) passes it to, primary pigment / reaction centre / chlorophyll *a* **;**	**2**
4(b)(i)	chromatography **;**	**1**
4(b)(ii)	*any **three** from:* 1 calculate R_f value(s) **;** 2 compare R_f values of pigments (in red algae and green plant) **;** 3 find pigment present (on chromatogram) from red algae but absent from green plant **or** R_f value of phycoerythrin will not be the same as Rf values of pigments in green leaves **;** 4 identify pigment using reference values (to confirm it is phycoerythrin) **;**	**3**

Question	Answer	Marks
5(a)	<table><tr><th>ion</th><th>direction of movement of ion</th><th>action resulting from movement of ion</th></tr><tr><td>Na^+</td><td>from lumen of proximal convoluted tubule into proximal convoluted tubule cell</td><td>co-transport / secondary active transport, of, amino acids / glucose **or** osmosis of water **;**</td></tr><tr><td>K^+ **;**</td><td>into guard cell</td><td>opening of stoma(ta)</td></tr><tr><td>Na^+ **;**</td><td>into presynaptic knob</td><td>depolarisation of presynaptic membrane</td></tr><tr><td>Ca^{2+} **;**</td><td>into presynaptic knob</td><td>exocytosis of acetylcholine</td></tr><tr><td>H^+</td><td>from intermembrane space into matrix of mitochondrion</td><td>ATP synthesis **;**</td></tr><tr><td>Ca^{2+}</td><td>from sarcoplasmic reticulum to cytoplasm of muscle fibre</td><td>binds to troponin / troponin shape changes / tropomyosin moves / actin binding site on myosin head exposed / binding of myosin head to actin / allows power stroke / sarcomere contracts **;**</td></tr></table>	**6**
5(b)(i)	Ca^{2+} / calcium ions **;**	**1**
5(b)(ii)	to avoid wasting <u>energy</u> **or** *idea of* avoid closing, due to a single contact / by an object such as water drop **;**	**1**
5(b)(iii)	<u>exocytosis</u> **;**	**1**
5(b)(iv)	not enough, nitrogen / nitrate, in the soil **or** poor mineral content of the soil **;** **R** nutrients	**1**

Question	Answer	Marks
6(a)	*any **five** from:* 1 chemicals, stimulate / bind to / enter, (receptor cells) **;** 2 Na^+ enters (receptor cells) via microvilli **;** 3 <u>membrane</u> depolarised **;** 4 ref. to receptor potential **;** 5 ref. to threshold **;** 6 voltage-gated Ca^{2+} channels open / Ca^{2+} ions enter, cytoplasm / cell **;** 7 vesicles (of neurotransmitter), move towards / fuse with, (cell surface) membrane **;** 8 exocytosis of neurotransmitter / AW **;** 9 neurotransmitter binds to receptor **;** 10 (receptor cell) acts as a transducer **;**	**5**
6(b)	*any **two** from:* 1 non-invasive / safe **;** 2 quick / immediate results / saves time / early detection **;** 3 can be done at home / no equipment **;** 4 cheap / cost effective **;**	**2**

Question	Answer	Marks
7(a)(i)	**R** – (sister) <u>chromatids</u> **;** **S** – <u>centromere</u> **;**	**2**
7(a)(ii)	*any **three** from:* 1 have **same** genes **;** **R** same number of genes 2 (genes at) same, loci / position on a chromosome **;** 3 same position of, **S** / centromere **;** 4 same length **;** 5 forms bivalent **;**	**3**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>7(a)(iii)</td><td>
</td><td>2</td></tr>
<tr><td>7(b)</td><td><u>prophase 1</u> ;</td><td>1</td></tr>
</table>

Question	Answer	Marks
7(c)	*any **three** from:* 1 homologous chromosomes / bivalents, align independently of each other **;** 2 at the, equator / metaphase plate **;** 3 *idea that* this leads to different combinations of chromosomes in the daughter cells **;** 4 results in new combinations of alleles **;** 5 AVP **;** e.g. in humans 2^{23} / 2^n, different combinations	**3**

Question	Answer	Marks
8(a)(i)	A – label line pointing to mitochondrial matrix **;**	**1**
8(a)(ii)	crista(e) **;**	**1**
8(a)(iii)	*any **five** from:* 1 folded (inner) membrane / many cristae **;** 2 forms large surface area **;** 3 (for) electron carriers / electron transport chain / ETC / cytochromes **;** 4 ref. to ATP synth(et)ase / ATP synthesis **;** 5 impermeable to, protons / hydrogen ions **;** 6 (so) allows, formation of proton gradient / high concentration of protons in intermembrane space **;** 7 proton pumps **;**	**5**

Question	Answer	Marks
8(b)	DCPIP / methylene blue **;** changes, colour / blue to colourless, when, reduced / accepts electrons (from succinate) **;**	**2**
8(c)(i)	*any **three** from:* 1 rate of respiration increases (as succinate concentration increases) up to 1.0 mmol dm^{-3} **or** maximum rate at 1.0 mmol dm^{-3} **;** 2 rate of respiration higher at 37 °C than at 10 °C (in liver and muscle) **;** 3 rate of respiration higher in muscle than in liver (at both temperatures) **;** 4 comparative data quote to support mp2 or mp3 **;**	**3**
8(c)(ii)	*any **three** from:* *muscles have higher rate of respiration because:* 1 respiration produces ATP **;** 2 muscle has higher need for, ATP / energy **; ora** 3 for muscle contraction **or** muscle is more metabolically active / AW **;** 4 AVP **;** e.g. shivering to maintain body temperature **;**	**3**
8(c)(iii)	muscle, is contracted / generates heat / is more metabolically active / AW **; ora**	**1**

Question	Answer	Marks
9(a)	*any **eight** from:* *Eukarya v Bacteria* 1 nucleus v no, nucleus / nuclear envelope **;** 2 linear DNA v circular DNA / plasmid **;** 3 histone proteins associated with DNA v no histone proteins **;** 4 (double) membrane-bound organelles v no membrane-bound organelles **;** **ignore** named organelles 5 80S ribosomes v 70S ribosomes **;** 6 cell wall sometimes present v cell wall always present **;** 7 cell wall (if present) made of cellulose / chitin v cell wall made of peptidoglycans **;** 8 cells divide by mitosis v cells divide by binary fission **;** **I** ref. to meiosis 9 (can be) multicellular v unicellular **;** 10 AVP **;** e.g. differences in flagellum structure	**8**

Question	Answer	Marks
9(b)	*any **seven** from:* 1 <u>botanic gardens</u> **;** 2 research **;** 3 controlled named growing conditions **;** e.g. light / water / nutrients / temperature 4 propagation **/** named method **;** e.g. cuttings / tissue culture / controlled pollination 5 plant back to natural environment **;** 6 seed banks / collect seeds **;** 7 detail of seed storage **;** e.g. low oxygen / low moisture / low temperature 8 seeds regularly, tested for viability / re-stocked **;** **A** description 9 maintain genetic diversity / genetic material preserved / acts as a gene bank **;** 10 can be germinated prior to introduction back into natural habitat **;** 11 ref. to <u>CITES</u> **;** 12 ref. to (conservation) projects *in situ* / named example **;** e.g. remove alien species / forestry project	**7**

Question	Answer	Marks
10(a)	*any **six** from:* 1 analysis of biological data using computer software / AW **;** 2 databases of, gene / DNA / protein / amino acid, sequences **;** 3 ref. to large databases **;** 4 fast / accurate / efficient **;** 5 ref. to allows data to be, shared / pooled **;** 6 can predict, amino acid sequences / protein structure (from DNA sequence data) **;** 7 ref. to analytical tool **;** e.g. BLAST 8 ref. to comparisons **;** 9 used to find methods to control parasites **;** 10 named example of control **;** e.g. vaccine 11 AVP **;** e.g. personalised medicine identify new diseases ref. common ancestor phylogenetic analysis biodiversity / new species	**6**

Question	Answer	Marks
10(b)	*any **nine** from:* 1 probes are, single-stranded DNA / ssDNA **;** 2 each probe is unique to a particular gene **;** 3 probes correspond to thousands of different genes **;** 4 extract mRNA **;** 5 mRNA used (as a template) to make cDNA **;** **R** mRNA converted to cDNA 6 by reverse transcription / using reverse transcriptase **;** 7 (c)DNA linked to fluorescent dye **;** 8 (c)DNA added to microarray **;** 9 (c)DNA, binds to / hybridises, to probes **;** 10 by complementary base pairing **;** 11 excess (c)DNA washed off **;** 12 exposed to, UV light / laser **;** 13 fluorescence shows the expressed genes / AW **;** 14 intensity of fluorescence shows level of gene expression **;**	**9**