Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/42**

Paper 4 A Level Structured Questions **February/March 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.

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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	‘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.

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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 usual)
ecf	error carried forward
underline	actual word underlined must be used by the candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument

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Question	Answer	Marks
1(a)(i)	*any **two** from:* 1 high birth rate / short generation time / AW **;** 2 few / no, predators **;** 3 little competition **;** 4 plenty of food available / wide range of food types eaten / omnivore **;** 5 no / fewer, diseases **;** 6 well adapted / no selection pressures against them **; A** description	**2**
1(a)(ii)	*any **three** from:* 1 directional selection **;** 2 blonde spines have a selective advantage / described / AW **;** 3 allele frequency for blonde spines increases / increased homozygosity (for recessive or blonde allele) **;** 4 inbreeding **;** 5 small gene pool (at start) / little genetic variation **;** 6 founder effect / genetic drift / bottleneck effect **; A** description	**3**

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Question	Answer	Marks
1(b)	*any **four** from:* *accept local for native throughout* *because alien species:* 1 compete with native species **;** 2 for, food / same niche / light / resources **or** reduce food source of native species **;** 3 feed on / predators of, native species **;** 4 can cause extinction in native species **;** 5 can breed more successfully than native species **;** 6 often have no, natural predator / grazers **;** 7 may disrupt, habitats / ecosystems / food webs / food chains **;** **ignore** environment 8 cause reduction in biodiversity **;** 9 may introduce disease **;**	**4**

Question	Answer	Marks
2(a)(i)	*any **two** from:* 1 no / less, ATP for the, sodium-potassium pump / active transport of Na^+ and K^+ **;** 2 reduces / prevents, (re-establishment of) resting potential **;** 3 reduces transmission of action potential (along the axon) **;**	**2**
2(a)(ii)	*any **two** from:* 1 decreases (speed) / lower (speed than expected) **;** 2 in both, nerves / median and peroneal / arm and leg **;** 3 processed data quote **;** e.g. median mean 43 m s^{-1} / peroneal mean 31.3 m s^{-1} 4 AVP **;** e.g. person 1 not affected so much	**2**
2(a)(iii)	*any **two** from:* 1 takes longer for impulses to reach, neuromuscular junction / muscles **;** 2 fewer / slower, muscle contractions **;** 3 walking problem described **;** e.g. reduced muscle control / walks slower / stumbles / trips 4 slower reflexes **;**	**2**

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Question	Answer	Marks
2(b)	*accept 'neurone activity' for 'balance time' throughout* *(had benefit is justified because):* 1 (mice with therapy) rate of decline of balance time, slower / less steep, from, 18 to 20 months / initially / at the start **or** (mice with therapy) have a longer balance time **;** *(not cure is justified since):* 2 (mice with therapy and mice with no therapy) have, same / similar, balance time, at 23 months / at the end **or** mice with therapy have a, downwards trend / decrease in balance time **or** mice with therapy have shorter balance time (compared to mice without GAN) **;** *(results are not affected by age is not justified because):* 3 mice without GAN increase balance time, during the experiment / with age **or** balance time decreases for mice with GAN, during the experiment / with age **;** 4 comparative figures to support any marking point **or** ref. to need for statistical test **;**	**4**

Question	Answer	Marks
3(a)	*any **five** from:* *max **four** from mp1–mp6:* 1 (sickle cell anaemia is) homozygous recessive **;** 2 ref. to beta / β, globin / polypeptide **or** *HBB* (allele / gene) **;** 3 base / nucleotide, substitution **or** mis-sense mutation **or** change in, triplet / codon **or** GAG to GTG / A to T **;** 4 causes, change in amino acid (sequence) / glutamic acid to valine **;** 5 valine is non-polar **;** 6 causes change in, 3D shape / tertiary structure / quaternary structure / globular structure (of haemoglobin) **;** 7 haemoglobin has lower affinity for oxygen **;** 8 (in red blood cells) haemoglobin, less soluble / sticks together / forms fibres **;** 9 (red blood) cells become sickle shaped **;**	**5**

Question	Answer	Marks
3(b)(i)	decrease (in ADH) (accept no ADH secreted) **and** reduce water reabsorption (in the collecting duct) **or** decrease (in ADH) **and** increased volume of / more dilute, urine (formed) **;**	**1**
3(b)(ii)	*idea that* fluid / water, is forced (from blood) into alveoli **; R** diffusion / osmosis	**1**
3(c)	*any **four** from:* *describe:* 1 having kidney disease increases the risk of TACO **;** ora 2 AKI has highest risk (of TACO) **;** 3 data quote to support mp1 (comparison) **;** *reasons:* 4 kidney disease reduces ability to remove excess water **;** 5 more water retained increases blood volume **;** 6 AVP **;** e.g. CKD + D less risk as dialysis helps to restore water volume	**4**

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Question	Answer	Marks
3(d)	*any **two** from:* 1 fewer sodium (ions) reabsorbed / more sodium (ions) in filtrate **;** 2 decreases water potential of filtrate **or** increases water potential of the medulla **;** 3 less water reabsorbed, by osmosis / down water potential gradient **;** 4 increases volume of urine **;** *plus:* 5 so blood volume (from transfusion) is reduced **;**	**3**

Question	Answer	Marks
4(a)(i)	label line to where white chromatid crosses over grey chromatid **;**	**1**
4(a)(ii)	*any **four** from:* 1 (crossing over is) between non-sister chromatids **;** 2 (non-sister chromatids have) different combinations of alleles **;** 3 exchange alleles **;** 4 (chromatids have) new combinations of alleles **;** 5 linkage groups broken **;** 6 *idea that* gametes have unique combination of alleles **;** 7 random fusion of gametes (during fertilisation) **;**	**4**
4(b)(i)	*any **two** from:* 1 (first) generation of offspring (from parental cross) **;** 2 (parents are) homozygous / true bred / pure bred / pure breeding **;** 3 F1 generation will be heterozygous **;**	**2**

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Question	Answer	Marks
4(b)(ii)		**3**

phenotype	expected ratio	O	E	$O-E$	$(O-E)^2$	$\frac{(O-E)^2}{E}$
full band and rays	9	99	76.5	22.5	506.25	6.62
full band and no rays	3	21	25.5	–4.5	20.25	0.79
broken band and rays	3	8	25.5	–17.5	306.25	12.01
broken band and no rays	1	8	8.5	–0.5	0.25	0.03

1 mark for E and $O-E$ correct ;

1 mark for $(O-E)^2$ and $\frac{(O-E)^2}{E}$ correct ;

χ^2 = 19.45 ;

ecf for 1 mistake in one box

Question	Answer	Marks
4(b)(iii)	*any **three** from:* 1 19.45 / chi-squared value, is greater than, 7.81 / critical value (at p = 0.05) **;** 2 results are / observed ratio is, significantly different to expected ratio **;** 3 so differences are not due to chance **;** 4 due to, increase in full band phenotypes / decrease in broken band phenotypes **;**	**3**
4(b)(iv)	*any **two** from:* 1 epistasis **;** 2 linkage **;** 3 lethal allele **;** 4 chance deviations **;** 5 environmental effects **;** 6 mutations **;** 7 small sample size **;**	**2**

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Question	Answer	Marks
5(a)(i)	haemophilia (A) **;**	**1**
5(a)(ii)	*any **two** from:* *accept ora throughout* 1 large / unlimited, supply **;** 2 no risk of infection **;** 3 no / fewer, ethical issues **;** 4 less chance of, rejection / immune response / allergic response / side effects **;** 5 cheap / quick, to produce **;** 6 no need to wait for donor **;**	**2**
5(b)(i)	reverse transcriptase **;**	**1**
5(b)(ii)	1 genes cut from (donor) DNA **;** 2 genes synthesised (chemically) from nucleotides **;**	**2**
5(c)	*any **two** from:* 1 required, for gene expression / to start transcription **;** 2 (so) transcription factor can bind (to promoter)**;** 3 so RNA polymerase can bind (to promoter) **;**	**2**

Question	Answer	Marks
6(a)(i)	1 CO_2 uptake below zero / CO_2 released / CO_2 uptake is negative / CO_2 uptake is $-1.6\ \mu mol\ m^{-2}\ s^{-1}$ **;** *plus any **two** from:* 2 little photosynthesis occurring / AW **; R** no photosynthesis 3 due to low light intensity **;** 4 rate of respiration higher than rate of photosynthesis **;** **A** *idea that* there is more respiration than photosynthesis	**3**
6(a)(ii)	*any **three** from:* 1 as light intensity increases rate of CO_2 uptake increases / AW **;** 2 data quote to support mp1 **;** e.g. carbon uptake is $-0.2\ \mu mol\ m^{-2}\ s^{-1}$ at 2000 lux and $6.5\ \mu mol\ m^{-2}\ s^{-1}$ at 7000 lux 3 (because) rate of, photosynthesis / light-dependent reactions / light-independent reactions, increases **;** 4 light intensity is limiting factor **;**	**3**
6(a)(iii)	light intensity is no longer limiting **or** carbon dioxide concentration / temperature, now limiting **;**	**1**
6(b)(i)	hydrolytic / extracellular / protease / proteinase / peptidase / AW **;**	**1**
6(b)(ii)	amino acid(s) / proteins / nucleotides **;** glycerate-3-phosphate / GP **or** triose phosphate / TP **;**	**2**

Question	Answer	Marks
7(a)	*any **seven** from:* 1 reduced, NAD / FAD ; 2 releases hydrogen / hydrogen splits into proton and electron ; 3 ref. to, inner mitochondrial membrane / cristae ; 4 electrons pass through, electron transport chain / ETC ; 5 ref. to energy release ; 6 protons transferred, through inner membrane / into intermembrane space ; 7 proton gradient established / high proton concentration in intermembrane space ; 8 protons diffuse through ATP synth(et)ase ; 9 ATP produced from ADP and Pi ; 10 ref. to chemiosmosis ; 11 oxygen acts as final electron acceptor (to form water) / described ;	**7**

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Question	Answer	Marks
7(b)	*any **four** from:* 1 population **B** produces more ATP (than population **A**) **;** ora 2 production of ATP increases at a higher rate for population **B** (than for population **A) ;** ora 3 paired data quote **;** 4 population **B** carries out, glycolysis / substrate-linked phosphorylation, **and** oxidative phosphorylation **;** 5 population **A** carries out (only) glycolysis / respiration in anaerobic conditions / (ethanol) fermentation / substrate-linked phosphorylation **or** population **A** cannot carry out oxidative phosphorylation **;**	**4**

Question	Answer	Marks
8(a)	1 sympatric **;** *any **two** from:* 2 no geographical barrier / not geographically isolated **;** 3 ref. to behavioural isolation / described **;** 4 ref. to reproductive isolation / described **;**	**3**

Question	Answer	Marks
8(b)	*any **three** from:* *ora in terms of easier for crop yields* 1 longer time to, grow / mature ; 2 fewer offspring (per cross / AW) ; 3 feature can only be measured in, about 50% of offspring / females ; 4 milk yield must be measured over period of time ; 5 ref. to ethical issues ; 6 ref. to difficulty in identifying suitable males for use in crosses ; 7 cattle require more, care / support **or** more expensive ; 8 AVP ; e.g. more dangerous to carry out breeding of large cattle	**3**
8(c)	*any **two** from:* 1 mass / quantity / size ; 2 disease resistance ; 3 resistance to, insects / pests ; 4 rate of growth ; 5 drought resistance ; 6 resistance to herbicides ; 7 AVP ; e.g. resistance to, flooding / wind	**2**

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Question	Answer	Marks
9(a)	1 individuals (within a population) can, breed / mate / reproduce **;** 2 to produce fertile offspring **;** 3 are reproductively isolated (from other species) / AW **;**	**3**
9(b)	*any **one** from:* 1 for organisms that, do not breed sexually / are asexual **;** 2 for, fossil / extinct, organisms **;** 3 morphological differences are easier to determine **;** 4 often not possible to observe reproductive behaviour **;** 5 time required for mating behaviour may take too long (to be observed) / not possible to achieve conditions in which mating can occur (while being observed) **;**	**1**

Question	Answer	Marks
9(c)	*any **four** from:* *max **three**:* 1 both are prokaryotes **or** both have no, nucleus / (double) membrane-bound organelles **;** 2 both have circular DNA **;** 3 both have 70S ribosomes **;** 4 both reproduce by, binary fission / budding / fragmentation **;** *max **three**:* 5 bacteria cell wall made of peptidoglycan whereas Archaea cell wall does not have peptidoglycan **;** 6 bacteria cell membrane has ester-linked lipids whereas Archaea cell membrane has ether-linked lipids **;** 7 have different ribosomal RNA **;** 8 Bacteria do not have (DNA associated with) histones whereas Archaea do have (DNA associated with) histones **;** 9 Bacteria form spores whereas Archaea do not form spores **;**	**4**

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Question	Answer	Marks
10(a)	**A** – chloroplast **;** **B** – vacuole **;** **C** – cell wall **; A** cell surface membrane	**3**
10(b)	*any **four** from:* 1 abscisic acid binds to receptors on cell surface membrane (of guard cell) **;** 2 proton pumps are inhibited / AW **;** 3 stimulates Ca^{2+} uptake **/** opens Ca^{2+} channels **;** 4 Ca^{2+} acts as second messenger **;** 5 K^{+} diffuses out of the (guard) cell **;** 6 water potential of (guard) cell increases **;** 7 water leaves (guard) cell, by osmosis / down water potential gradient **;** 8 (guard) cell becomes flaccid / cell volume decreases (so stoma closes) **;**	**4**

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