Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/41**

Paper 4 A Level Structured Questions **May/June 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 May/June 2021 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	‘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

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Examples of how to apply the list rule: State three reasons … [3]

A

1. Correct	✓	**2**
2. Correct	✓	
3. Wrong	×	

B

(4 responses)

1. Correct, Correct	✓ ✓	**3**
2. Correct	✓	
3. Wrong	ignore	

C

(4 responses)

1. Correct	✓	**2**
2. Correct, Wrong	✓ ×	
3. Correct	ignore	

D

(4 responses)

1. Correct	✓	**2**
2. Correct, CON (of 2.)	× (discount 2)	
3. Correct	✓	

E

(4 responses)

1. Correct	✓	**3**
2. Correct	✓	
3. Correct, Wrong	✓	

F

(4 responses)

1. Correct	✓	**2**
2. Correct	✓	
3. Correct CON (of 3.)	× (discount 3)	

G

(5 responses)

1. Correct	✓	**3**
2. Correct	✓	
3. Correct Correct CON (of 4.)	✓ ignore ignore	

H

(4 responses)

1. Correct	✓	**2**
2. Correct	×	
3. CON (of 2.) Correct	(discount 2) ✓	

I

(4 responses)

1. Correct	✓	**2**
2. Correct	×	
3. Correct CON (of 2.)	✓ (discount 2)	

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Question	Answer	Marks
1(a)(i)	*any **two** from:* **1** absorb / harvest / capture / trap, light / photons **;** **2** (to) excite electrons **;** **3** (for, cyclic / non-cyclic) photophosphorylation / electron transport chain **;** **4** accessory pigment passes energy to, primary pigment / reaction centre **;** **5** (pigments) form a, light harvesting cluster / photosystem / PSI / PSII **;**	**2**
1(a)(ii)	thylakoid membrane(s) / granum / grana / lamella(e) **;**	**1**
1(a)(iii)	chromatography **;**	**1**
1(b)(i)	**1** (from 0.25) to 1.00 (mol dm^{-3}), concentration / CO_2, is limiting factor **or** at / >, 1.00 (mol dm^{-3}), concentration / CO_2, no longer limiting factor **;** **2** at / >, 1.00 (mol dm^{-3}), light intensity / temperature, is limiting factor **;** **3** CO_2, needed / used, for Calvin cycle / for light independent stage **or** CO_2, reacts with / fixed by, RuBP **;**	**3**
1(b)(ii)	little / no, photosynthesis **;** (aerobic) respiration uses oxygen **;**	**2**
1(b)(iii)	*any **three** from:* **1** to control a variable / to ensure a fair test / so CO_2 is the only variable **;** **2** low, temperature / kinetic energy, decreases, rate / reaction / photosynthesis / O_2 production / O_2 increase **;** **3** low, temperature / kinetic energy, decreases, (named) enzyme-substrate, collisions / complexes **;** **4** low(er) temperature, is a limiting factor / may limit rate **;** **5** high, temperature / kinetic energy, decreases, rate / reaction / photosynthesis / O_2 production / O_2 increase **;** **6** high, temperature / kinetic energy, denatures (named) enzyme(s) **;** **7** high / increased, temperature, causes / increases, photorespiration **;**	**3**

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Question	Answer	Marks
2(a)(i)	*any **two** from:* *idea of synthesis from smaller units* **1** DNA replication / transcription **;** **2** to, make / build up, (named) protein **;** **3** to, make / build up, (named), lipid / triglyceride / phospholipid **;** **4** to, make / build up, (named) carbohydrate / polysaccharide **;** **5** phosphorylation **;**	**2**
2(a)(ii)	*any **three** from:* **1** phosphorylates glucose **or** glucose → glucose / fructose / hexose, phosphate **;** **2** second phosphorylation **or** glucose / fructose / hexose, phosphate → fructose / hexose, bi(s)phosphate **;** **3** so glucose cannot leave the cell **;** **4** activates / increases energy of / decreases stability of, glucose **;**	**3**
2(b)(i)	*any **three** from:* *decreased production of ATP* **1** smaller / less steep, proton gradient **;** **2** few(er) protons go through, ATP synth(et)ase / stalked particle **;** *increased lipid metabolism* **3** use / burn / respire, body fat / lipid stores **;** **4** as less ATP made from, glucose / food **;**	**3**
2(b)(ii)	*any **two** from:* **1** more / faster / increased, (rate of) glycolysis **;** **2** oxygen, decreased / used faster / shortage **;** **3** (so) more / increased, <u>anaerobic</u> respiration **;**	**2**
2(b)(iii)	*any one from:* energy from, reduced NAD / ETC, released as heat **;** energy not used to join ADP and Pi so released as heat **;**	**1**

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Question	Answer	Marks
3(a)(i)	*any **three** from:* *(individuals / organisms / members of a species are similar / same)* **1** morphologically ; **2** physiologically ; **3** biochemically ; **4** genetically ; **5** ecologically / occupy same niche ; **6** behaviourally ; **7** can (inter)breed to form fertile offspring ; **8** reproductively isolated (from other species) ; **9** share, an evolutionary lineage / recent common ancestor ; **10** share a, binomial / Linnaean, name ;	**3**
3(a)(ii)	*domain:* Eukarya ; *kingdom:* Animalia ;	**2**
3(a)(iii)	*any **two** from:* **1** classification / taxonomy, reflects / shows / depends on, evolutionary / phylogenetic, relationships ; **2** organisms / species, that, are closely related / share recent common ancestor, should be classified together ; **3** help identify, larger taxonomic groups / orders / families / genera ; **4** AVP ;	**2**
3(b)(i)	(1478 × 103 × 2 =) 304 468 ;	**1**
3(b)(ii)	*any **three** from:* **1** to, store / analyse / process ; **2** large quantity of data ; **3** to, compare / match, (many) <u>sequences</u> ; **4** to, calculate / measure / quantify, (percentage), similarity / difference ; **5** *ref. to* fast / accurate / efficient ;	**3**

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Question	Answer	Marks
4(a)	*any **five** from:* **1** (named) restriction, enzyme / endonuclease **;** **2** cut / fragment, DNA **;** **3** produced by / present in, bacteria / archaea / prokaryotes **or** to defend against, viruses / (bacterio)phages **;** **4** (DNA) ligase **;** **5** joins DNA / forms phosphodiester bonds / seals sugar-phosphate backbone **;** **6** during DNA, repair / replication **or** joins Okazaki fragments **;** **7** reverse transcriptase **;** **8** forms / makes, (c)DNA from mRNA (template) **;** **9** produced by / present in, retroviruses **;** **10** DNA / *Taq,* polymerase **;** **11** replicates / copies, DNA (at high temperatures) **;** 1**2** produced by / present in, *Thermus aquaticus* **;**	**5**
4(b)(i)	*any **three** from:* **1** increased / higher / more, yield / production / harvest / food **;** **2** increased / higher / better, quality of, produce / crops / food **;** **3** decreased / lower / less, insecticide / pesticide, needed / used **;** **4** decreased / lower / less, fuel use / CO_2 emissions **;** **5** potential for, set-aside / conservation areas (as less land needed for crops) **;** **6** (described) comparative economic benefit **;**	**3**
4(b)(ii)	*any **two** from:* **1** people in other (named) continents eat GM, food / crops **;** **2** GM, food / crops, already in (European) food chain **;** **3** *ref. to* economic benefit of reducing GM (animal food) imports **;**	**2**
4(b)(iii)	**1** do not know / need to know, total crop area / non-GM crop area **;** **2** so can work out, percentage / fraction, of, GM / non-GM **;**	**2**

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Question	Answer	Marks
5(a)(i)	*any **three** from:* **1** wider / thicker / larger diameter → increases / higher, speed **;** **2** large(r) membrane surface area so more ion movement **;** **3** myelin → increases / faster / higher, speed **;** **4** saltatory conduction (in myelinated) **;** **5** pairwise data comparison **;**	**3**
5(a)(ii)	*any **one** from:* **1** impulses, for touch / in **A^{β}** neurones, travel faster **;** **2** (**A^{β}** neurones) inhibit, spinal cord / relay / projection, neurones **;** **3** AVP **;**	**1**
5(b)(i)	*any **four** from:* **1** endorphins bind to (endorphin) receptors **;** **2** stop, calcium ions / Ca^{2+}, entering presynaptic knob **;** **3** no / fewer, vesicles, move towards / fuse with, (presynaptic) membrane **;** **4** no / less, acetylcholine / ACh, released **;** **5** no / less, binding of ACh to postsynaptic receptors **;** **6** no / less, depolarisation of postsynaptic, neurone / membrane **;** **7** no / fewer, action potentials / impulses, to, pain centre / brain **;**	**4**
5(b)(ii)	*any **one** from:* **1** (drug) dependency / addiction / tolerance **;** **2** (drug) side-effects **;** **3** expensive **;** **4** work more slowly **;**	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>6(a)</td><td>
<table>
<tr><th>response</th><th>explanation</th></tr>
<tr><td>blood vessels near the surface of the skin constrict (narrow)</td><td>less heat lost as, less / slower, blood (flow) at, skin / surface ;</td></tr>
<tr><td>shivering occurs</td><td>muscle contraction, creates / generates / produces, heat ;</td></tr>
<tr><td>hairs rise</td><td>trapped air, insulates / reduces thermal gradient ;</td></tr>
<tr><td>reduction in the production of sweat</td><td>to stop / decrease, heat loss by evaporation ;</td></tr>
</table>
</td><td>4</td></tr>
<tr><td>6(b)</td><td>decrease / less, surface area to, conserve / retain heat
or
decrease / less, surface area so less heat lost ;</td><td>1</td></tr>
<tr><td>6(c)(i)</td><td>any three from:
1 Sitatunga’s (core / body) temperature (fairly) constant ;
2 Nile monitor’s / lizard’s, (core / body) temperature rises as environmental temperature rises ;
3 figures for two animals at one temperature with units
or
one animal at two temperatures with units ;
4 AVP ;</td><td>3</td></tr>
<tr><td>6(c)(ii)</td><td>problem with, catching prey / feeding / avoiding predation ;</td><td>1</td></tr>
<tr><td>6(d)</td><td>1 ref. to set point / norm(al) / ideal value ;
2 rise / fall / change / fluctuation ;
3 reversed / corrected / counter-acted ;</td><td>3</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>7(a)</td><td>codominant
1 both (alleles), affect / seen in / expressed in / contribute to (phenotype) ;
2 in heterozygote ;

recessive
3 affects / seen in / expressed / contributes to, (phenotype) (only) when dominant (allele) absent / in homozygote ;</td><td>3</td></tr>
<tr><td>7(b)</td><td>
<table>
<tr><td>parental phenotype</td><td colspan="2">A</td><td colspan="2">B</td></tr>
<tr><td>parental genotype</td><td colspan="2">$I^A I^o$</td><td colspan="2">$I^B I^o$</td></tr>
<tr><td>gametes</td><td>I^A</td><td>I^o</td><td>I^B</td><td>I^o ;</td></tr>
<tr><td>offspring genotype</td><td>$I^A I^B$</td><td>$I^A I^o$</td><td>$I^B I^O$</td><td>$I^o I^o$;</td></tr>
<tr><td>offspring phenotype</td><td>AB</td><td>A</td><td>B</td><td>O ;</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>7(c)</td><td>any three from:
1 males / men / boys, are, XY / have (only) one X chromosome ;
2 man / father, passes Y to, male offspring / son ;
3 man / father, does not pass X to, ♂ offspring / son ;
4 man / father, passes, X / mutation, to, female offspring / daughter ;
5 woman / mother, passes X / mutation, to, male offspring / son ;</td><td>3</td></tr>
</table>

Question	Answer	Marks
8(a)(i)	artificial selection ;	**1**
8(a)(ii)	*any **five** from:* **1** (humans) choose / cross / breed from, females / cows / cattle, with, good / high, milk yield ; **2** (humans) choose / cross / breed from, males / bulls, with, mother / sisters / daughters, with, good / high, milk yield ; **3** (humans) choose / cross / breed from, desirable offspring ; **4** continue / repeat, for (several) generations ; **5** allele(s) for, high milk yield / desired trait, passed on ; **6** increase in frequency of, good / best / high yield, allele(s) ; **7** artificial insemination / A.I. ; **8** AVP ;	**5**
8(b)	*any three from:* **1** mean / mode / median / average / intermediate, selected against / not favoured / less fit / die ; **2** (both) extremes, selected for / favoured / more fit / survive / reproduce ; **3** bimodal distribution ; **4** diversifying selection ; **5** causes / maintains, polymorphism / genetic diversity ;	**3**

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Question	Answer	Marks
9(a)	*any **eight** from:* **1** vary / different / range of, glucose / fructose, concentrations **;** **2** control / same, volume of yeast (suspension) **;** **3** control / same, <u>volume</u> of glucose (solution) **;** **4** control / same, volume / concentration, of indicator (solution) **;** **5** control temperature (between 20–45^{o}C) **;** **6** oil layer to exclude, air / oxygen **;** **7** indicator turns from blue (start / oxidised) to colourless (end / reduced) **;** **8** due to, hydrogen atoms / H^{+} / electrons, from, glycolysis / dehydrogenation / respiration **;** **9** time how long it takes for colour change **OR** fix time interval and measure with colorimeter **;** **10** repeat experiment **;** **11** calculate mean(s) **;** **12** graph with glucose concentration (on *x* axis) and, time taken / % absorbance / % transmission / rate (on *y*) **;** **13** rate is 1/*t* **;** **14** AVP **;**	**8**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>9(b)</td><td>
any seven from:

both
1 occur in cytoplasm ;
2 (only) involve glycolysis ;
3 make, 2 (net) / small amount of, ATP ;
4 regenerate NAD (from NADH) ;

comparison
<table>
<tr><th></th><th>mammalian tissue</th><th>yeast cells</th></tr>
<tr><td>5 H acceptor / reduction of</td><td>pyruvate / pyruvic acid</td><td>ethanal</td></tr>
<tr><td>6 (end) product</td><td>lactate / lactic acid</td><td>ethanol</td></tr>
<tr><td>7</td><td>no, CO_2 / decarboxylation</td><td>CO_2</td></tr>
<tr><td>8 (enzyme)</td><td>lactate dehydrogenase</td><td>ethanol dehydrogenase</td></tr>
<tr><td>9 steps / stages</td><td><u>one</u> / <u>1</u></td><td><u>two</u> / <u>2</u></td></tr>
<tr><td>10 (process)</td><td>reversible</td><td>irreversible</td></tr>
</table>
</td><td>7</td></tr>
</table>

Question	Answer	Marks
10(a)	*any **eight** from:* **1** named geographical barrier **;** e.g. river / mountain / sea / lake **2** population, separated / divided (into two) **;** **3** no, mating / breeding / gene flow, between, populations / groups **;** **4** different (named), selection pressures / environments / conditions **;** **5** different mutations **;** **6** individuals with beneficial alleles, are selected for / survive / reproduce / have a selective advantage **;** **7** genetic drift / founder effect **;** **8** change in, allele frequency / gene pool **;** **9** over a long time / many generations **;** **10** can no longer (successfully), interbreed / reproduce / produce fertile offspring, with, old / original / other, population / species **;** **11** allopatric (speciation) **;**	**8**
10(b)	*any **seven** from:* **1** environment changes **;** **2** species cannot adapt (fast enough) **;** **3** climate / temperature / sea level, change **;** **4** extinct species / species at risk **;** **5** competition / predation / disease, from, new / introduced / alien / invasive, species **;** **6** extinct species / species at risk **;** **7** (named) habitat, degradation / loss **;** **8** extinct species / species at risk **;** **9** hunting by humans / poaching / (over)fishing **;** **10** extinct species / species at risk **;** **11** AVP **;** **12** extinct species / species at risk **;**	**7**

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