CAMBRIDGE
International Education

Cambridge International AS & A Level

BIOLOGY **9700/44**

Paper 4 A Level Structured Questions **May/June 2025**

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 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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PUBLISHED

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 descriptions 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.

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	correct point or mark awarded
	correct awarding one mark from marking point or marking group 1. similar numbered ticks are used for marking point or marking groups 2, 3, 4 etc.
	incorrect point or mark not awarded
	working towards marking point
	information missing or insufficient for credit
	used to highlight part of an extended response
	used to highlight part of an extended response
	allow or accept
	benefit of the doubt given

Annotation	Meaning
BP	blank page
CON	contradiction in response, mark not awarded
ECF	error carried forward applied
GM	mark already given
I	incorrect or insufficient point ignored while marking the rest of the response
MAX	maximum number of marks for a marking point has been awarded
NBOD	benefit of doubt was considered, but the response was decided to not be sufficiently close for benefit of doubt to be applied
O	or reverse argument
R	incorrect point or mark not awarded
SEEN	point has been noted, but no credit has been given or blank page seen

Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
I	ignore
( )	the word / phrase in brackets is not required, but sets the context
AW	alternative wording (where responses vary more than usual)
underline	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
AVP	alternative valid point

Question	Answer	Marks
1(a)	*any **three** from:* **1** osmoreceptors detect (decrease) **or** osmoreceptors, shrink / decrease in volume **;** **2** *ref. to* hypothalamus **;** **3** hypothalamus produces (more) ADH **;** **A** neurosecretory cells produce ADH **R** secretion **4** posterior pituitary releases (more) ADH (into blood) **;** **A** secretes **R** produces	**3**
1(b)(i)	second(ary) messenger **;**	**1**
1(b)(ii)	adds aquaporins into, cell **surface** / luminal, membrane **;** (so) **more permeable** to water **;**	**2**
1(b)(iii)	arrow from lumen into cell **and** arrow from cell into capillary **or** one arrow from lumen through cell and into capillary **;**	**1**

Question	Answer	Marks
1(c)	*any **two** from:* **1** no / less, water reabsorbed **or** no / less, water absorbed into, capillary / blood **;** **I** tissue fluid **2** water potential of **blood**, (remains) low / lower than set point **;** **3** large(r) **volume** of urine / **dilute** urine / low(er) **concentration** of urine **;** **I** amount / more water excreted / more urine **4** AVP **;** e.g. feelings of thirst / dehydration / dizzy / fatigue / ADH release continues / decreased blood volume	**2**

Question	Answer	Marks
2(a)	*any **two** from:* *gene* **1** mutation of, *HTT* / huntingtin, gene **;** **2** *ref. to* dominant **or** only one, mutant / AW, allele, needed **or** heterozygote will have disease **;** **3** *ref. to* (more) CAG repeats **;** *plus any **three** from:* *protein* **4** non-functional / AW, huntingtin (protein) **;** *phenotype* **5** *idea of* cognitive / behavioural / personality / mood, changes **;** **6** coordination / movement, difficulties **;**	**4**
2(b)	**1** **only** males get the disease / females do not get the disease **;** **2** only males have a Y chromosome / males are XY **or** females, do not have a Y chromosome / only have (two) X chromosomes **;** **3** **all**, sons / male offspring, of affected, males / fathers, have the disease **or** **all** sons will not have the disease if father does not have the disease **;**	**3**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(c)</td><td>
parental genotypes $\mathbf{X^AX^a}$ x $\mathbf{X^aY}$
and
gametes $\mathbf{X^A}$ $\mathbf{X^a}$ and $\mathbf{X^a}$ $\mathbf{Y}$;

correct offspring genotypes

<table>
<tr><td></td><td>X^A</td><td>X^a</td></tr>
<tr><td>X^a</td><td>X^AX^a

affected / AW female</td><td>X^aX^a

healthy / normal, female</td></tr>
<tr><td>Y</td><td>X^AY

affected / AW male</td><td>X^aY

healthy / normal, male</td></tr>
</table>
;

phenotypes linked to genotypes (see Punnet Square) ;

ratio of offspring phenotypes: 1 : 1 : 1 : 1 ;
</td><td>4</td></tr>
</table>

Question	Answer	Marks
2(d)	*any **three** from:* **1** no repressor produced / no repressor binds to operator **or** altered / faulty, repressor produced **;** **2** (so) structural genes are, transcribed / expressed / switched on **;** **3** (structural gene) proteins / enzymes, produced **;** **4** (these) proteins / enzyme, damage cell / changes metabolism / causes disease **;** **5** altered repressor, binds more tightly / AW, to operator **;** **6** (so) structural genes, not transcribed / not expressed / switched off **;** **7** (structural gene) proteins / enzymes, not produced **;** **8** (so) lack of, protein / enzyme, causes, damage to cell / change to metabolism / disease **;**	**3**

Question	Answer	Marks
3(a)(i)	*any **two** from:* $q^2 = 0.068$ **;** $q = 0.260768$ **;** $p = 0.739232$ **;** $2pq = 0.385536$ **;** **and** **38.6 / 39** (%) **;**	**3**
3(a)(ii)	*any **two** from:* **1** migration / AW, occurs **or** population is not isolated **or** gene flow, in / out, of population **;** **2** no **random** mating **;** **3** *ref. to* mutations **;** **4** *ref. to* **selection** **;**	**2**

Question	Answer	Marks
3(b)	*any **three** from:* **1** inbreeding **;** **2** low genetic diversity / small gene pool **;** **3** founder effect / bottleneck **;** **4** genetic drift **;** **5** tailless (cat) has a selective advantage / is selected for **; ora** **6** tailless **allele** is dominant **;** **7** **allele** frequency for tailless (phenotype) increases **;**	**3**
3(c)	*any **three** from:* **1** mutation results in (black) spots (phenotype / allele) **;** **2** selection pressure is, ability to catch prey / AW **or** individuals with spots, have a selective advantage / are selected for **; ora** **3** spotted (cheetahs), survive / reproduce **; ora** **4** spotted, allele / mutation, passed on (to offspring) **;** **5** spotted, allele / mutation, frequency increased **;**	**3**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)</td><td>
<table>
<tr><th>Kingdom</th><th>species may be unicellular</th><th>species may have cell walls</th><th>species may show autotrophic nutrition</th></tr>
<tr><td>Animalia</td><td>no</td><td>no</td><td>no</td></tr>
<tr><td>Fungi</td><td>yes</td><td>yes</td><td>no</td></tr>
<tr><td>Plantae</td><td>no</td><td>yes</td><td>yes</td></tr>
<tr><td>Protoctista</td><td>yes</td><td>yes</td><td>yes</td></tr>
</table>
; ; ; ;

one mark per correct row
</td><td>4</td></tr>
<tr><td>4(b)</td><td>A = metaphase I ;

B = telophase I ;
A anaphase I

C = anaphase II ;
A telophase II</td><td>3</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(c)</td><td>1. Bacteria and Archaea ;

plus any two from:

<table>
<tr><th></th><th></th><th>Bacteria</th><th>Archaea</th><th></th></tr>
<tr><td>2</td><td>cell wall</td><td>peptidoglycan</td><td>no peptidoglycan</td><td>;</td></tr>
<tr><td>3</td><td>cell membrane</td><td>ester-linked lipids / unbranched hydrocarbon chains</td><td>ether-linked lipids / branched hydrocarbon chains</td><td>;</td></tr>
<tr><td>4</td><td>spores</td><td>form spores</td><td>do not form spores</td><td>;</td></tr>
<tr><td>5</td><td>DNA associated proteins</td><td>no histones</td><td>have histones</td><td>;</td></tr>
<tr><td>6</td><td>ribosomal RNA / rRNA (base sequences)
or
ribosomes (structure)</td><td colspan="2">are different</td><td>;</td></tr>
</table></td><td>3</td></tr>
<tr><td>4(d)</td><td>any two from:

1 RNA or DNA ;

2 single-stranded or double-stranded (nucleic acid) ;

3 AVP ; e.g. how mRNA is produced / enveloped or non-enveloped / linear or circular / which diseases they cause / capsid shape</td><td>2</td></tr>
</table>

Question	Answer	Marks
5(a)	*any **five** from:* *Allow any temperature within the ranges given* **1** denaturation at 90–98 °C **;** **2** breaks hydrogen bonds (in DNA) to, produce single strands / separate the (two) strands **;** **3** annealing at 50–65 °C **;** **4** (so that) primers, anneal / bind, (ss)DNA / complementary bases **;** **5** (to provide) binding site / starting point (for Taq polymerase) **;** **6** extension or elongation at 65–75 °C **;** **7** Taq polymerase joins, (free) nucleotides / dNTPs, to (single) strands **or** Taq polymerase synthesises, complementary / new, strand (of DNA) **;**	**5**

Question	Answer	Marks
5(b)(i)	*any **four** from:* *bacteria = E.coli and virus = herpes simplex throughout* **1** extract / isolate / cut, DNA (sequences) using restriction enzyme **or** make DNA (sequences) using mRNA using reverse transcriptase **or** make DNA (sequences) using nucleotides **;** **2** use DNA ligase to join together (the two sequences of) DNA (of bacteria and virus) **;** **3** add promoter **;** **4** add, *tTav* / recombinant DNA / gene, to, vector / virus / liposome **;** **5** infect egg with virus **or** (micro)injection into egg **;** **A** gene gun / DNA gun **6** virus adds, *tTav* / recombinant DNA / gene, into genome (of egg / *A. stephensi*) **;**	**4**
5(b)(ii)	*any **one** from:* **1** *idea that* prevents, transcription factor, functioning / binding to promoter **;** **R** repressor proteins / operator **2** stops RNA polymerase from binding to, DNA / promoter **;**	**1**
5(b)(iii)	(genetically modified males) develop into adults / survive beyond the larval stage **;**	**1**

Question	Answer	Marks
6(a)	*any **three** from:* **1** self-contained / functional / specific (unit) **;** **2** community / **all** species / **all** populations **;** **3** *ref. to* interactions **;** **4** abiotic / physical / non-living, **and**, biotic / biological / living, factors / environment **;** ***5*** *idea that* linked by, energy flow / mineral cycling / food webs / food chains / nutrient cycle **;**	**3**
6(b)	if individuals can breed to produce fertile offspring **;**	**1**
6(c)	*any **three** from:* **1** allopatric speciation **;** **2** geographical, isolation / barrier / separation **;** **3** (so) no gene flow (between populations) **;** **4** (populations have) different, mutations / advantageous alleles / alleles increase in frequency **;** **5** (populations have) different, selection pressures / environments **;**	**3**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>7(a)(i)</td><td>
oxygenated
1 percentage (of root tissue as aerenchyma), remains low ;

any two from:

deoxygenated
2 percentage (of root tissue as aerenchyma), increases gradually / small increase, initially / until 24 hours ;

3 percentage (of root tissue as aerenchyma), larger / steeper / more rapid, increase after 24 hours ;

4 percentage (of root tissue as aerenchyma), stays the same / is constant / plateaus / levels off / reaches maximum, at, the end / 48 hours ;

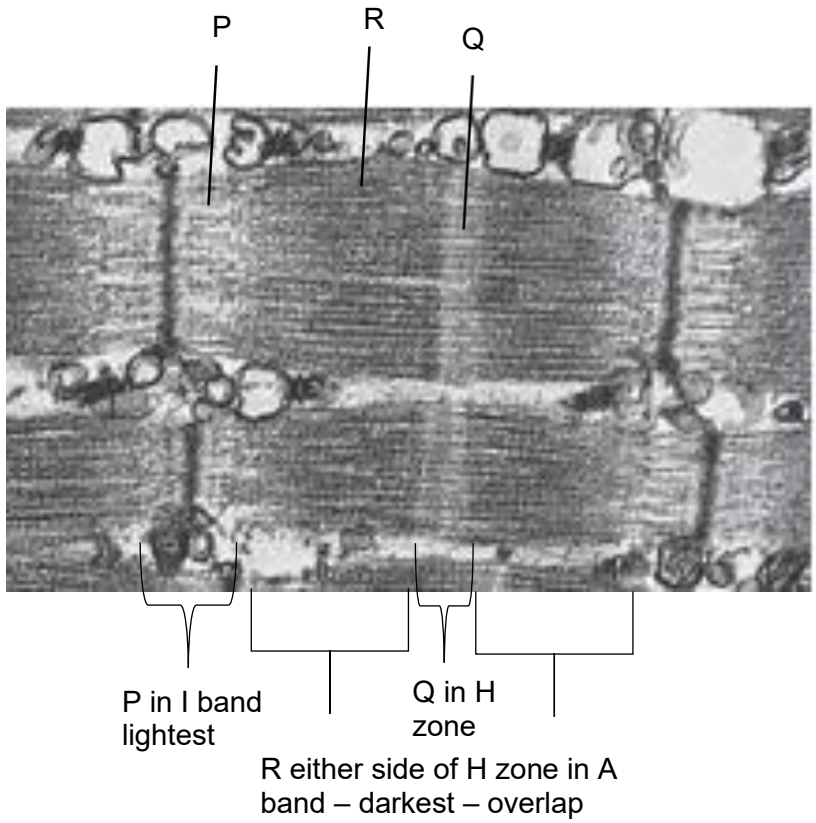
5 data quote ; two times and two percentages with units

<table>
<tr><th>time / h</th><th>percentage of root tissue as aerenchyma when deoxygenated</th></tr>
<tr><td>0</td><td>0.1 – 0.3</td></tr>
<tr><td>12</td><td>0.5 – 0.6</td></tr>
<tr><td>24</td><td>0.8</td></tr>
<tr><td>36</td><td>2.5 – 2.6</td></tr>
<tr><td>48</td><td>6.5 – 6.6</td></tr>
<tr><td>60</td><td>6.5 – 6.6</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>7(a)(ii)</td><td>
1 (aerenchyma is a tissue) with many / more / large, air spaces ;

2 (so) <u>oxygen</u>, diffuses / moves, (from the aerial parts) to root (cells) / lower parts of the plant / AW ;

3 (for) <u>aerobic</u> respiration ;
</td><td>3</td></tr>
</table>

Question	Answer	Marks
7(b)	*any **four** from:* **1** fast(er), stem / internode, growth **;** **2** (so) leaves / flowers, above water level **;** **3** (so) photosynthesis / gas exchange / reproduction, can occur **;** **4** (root cells) tolerant to (increased concentration of) ethanol **or** (root cells) have more ethanol dehydrogenase **;** **5** so, anaerobic respiration / ethanol fermentation, can occur **;** **6** AVP **;** e.g. leaves have ridges **7** AVP **;** e.g. to trap air (so oxygen can be taken in by plant)	**4**

Question	Answer	Marks
8(a)	**P** to light area ; **A** on Z line **Q** to medium area ; **A** on M line **R** to darker area ;  	**3**

Question	Answer	Marks
8(b)	*any **four** from:* **1** (at rest) tropomyosin, covers / AW, the binding sites on actin **;** **R** active sites **2** Ca^{2+} binds to troponin **;** **3** troponin changes shape **;** **4** (causing) tropomyosin to move **;** **5** (so) exposes binding site **;** **6** (so) myosin <u>head</u>, binds (to binding sites) / forms crossbridge **;**	**4**
8(c)	*any **two** from:* **1** no / less, Ca^{2+} **;** **2** no / less, ATP **;** **3** no / less, glucose / glycogen **;** **4** no / less, oxygen **;** **5** build-up / presence of, lactate / lactic acid **;** **6** AVP **;** e.g. no / less, creatine phosphate	**2**

Question	Answer	Marks
9(a)	*any **seven** from:* **1** light absorbed by, chlorophyll / pigments (in PI and PII) **or** photoactivation of chlorophyll (in PI and PII) **;** **2** electrons, emitted (to higher energy levels) / excited, in **both** photosystems **;** **3** electrons pass along, electron transport chain / ETC / electron carriers **;** **4** detail **;** e.g. electrons releasing energy to pump H^+ into thylakoid, space / lumen *ref. to* proton gradient set up protons diffusing through ATP synthase **5** ATP synthesised from ADP and P_i / *ref. to* chemiosmosis **;** **6** (PII contains) oxygen-evolving complex **;** **A** water-splitting enzyme **7** *ref. to* photolysis (of water) **;** **8** oxygen **and** hydrogen ions **and** electrons produced **;** **A** $H_2O \rightarrow 2e^- + 2H^+ + ½O_2$ **9** electrons emitted from PI replaced by electrons from PII **or** electrons emitted from PII replaced by electrons from photolysis (of water) **;** **10** electrons (from PI) combine with H^+ to form reduced NADP **or** electrons (from PI) combine with NADP to form reduced NADP **or** electrons (from PI) combine with H^+ to form hydrogen that reduces NADP **;** **R** H^+ reduce NADP	**7**

Question	Answer	Marks
9(b)	**1** increase in light intensity increases rate of photosynthesis until it levels off (at higher light intensities) **;** **2** (increase means) more, light dependent reaction / cyclic photophosphorylation / non-cyclic photophosphorylation / photoactivation **;** **3** (as rate levels off) carbon dioxide concentration / temperature, becomes limiting factor **or** light <u>intensity</u> is no longer a limiting factor **;**	**3**

Question	Answer	Marks
10(a)(i)	<u>molecules / moles / volume, carbon dioxide produced</u> molecules / moles / volume, oxygen taken in **;**	**1**
10(a)(ii)	25 **;**	**1**
10(a)(iii)	0.72 **;** **A** ecf 18 divided by their answer to ***10(a)(ii)***	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>10(b)</td><td>
any four from:

1 RQ (initially) at 1.0 as, carbohydrates / (named) sugar, respired / metabolised ;

2 RQ decreases (over time) as, carbohydrates / (named) sugar, running out / used up ;

3 RQ decreases (over time) as a mixture of carbohydrate and lipid respired ;
I proteins

4 RQ at, 0.65 / 0.7, as, fatty acids / fats / lipids, respired (as main respiratory substrate)
or
from 120 min onwards, fatty acids / fats / lipids, respired (as main respiratory substrate) ;

5 data quote ; RQ of 1.0 at 40 min plus any RQ value at any other time

<table>
<tr><th>Time after feeding / min</th><th>RQ ratio</th></tr>
<tr><td>40</td><td>1.0</td></tr>
<tr><td>80</td><td>0.75</td></tr>
<tr><td>120</td><td>0.7</td></tr>
<tr><td>160</td><td>0.65</td></tr>
<tr><td>200</td><td>0.7</td></tr>
<tr><td>240</td><td>0.7</td></tr>
</table>
</td><td>4</td></tr>
</table>