CAMBRIDGE
International Education

Cambridge International AS & A Level

BIOLOGY **9700/22**

Paper 2 AS Level Structured Questions **May/June 2024**

MARK SCHEME

Maximum Mark: 60

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 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.

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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.

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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

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Question	Answer	Marks
1(a)	*any **two** from:* **1** (by) contracts / contracting / contraction, and, relaxes / relaxing / relaxation **;** *must be in context of bronchioles* **R** if includes *ref. to* stretch / expand / recoil **R** if in context of *bronchus or trachea (then ecf in subsequent mps)* **2** diameter / lumen size, can be, controlled / changed **;** AW **A** contraction, decreases diameter (of lumen) / constricts **A** relaxation (after contraction) increases diameter (of lumen) / widens / dilates / expands **R** vasoconstriction / vasodilation **3** *idea of,* controls / regulates, flow of air / volume of air flowing **;** AW **I** statements such as 'lets air in' / 'allows inhalation and exhalation' **A** oxygen in / carbon dioxide out, *instead of air flow* **R** oxygen out and carbon dioxide **4** AVP **;** e.g. contract to, reduce air movement / prevent entry of contaminants *idea of* normally relaxed but can, contract / cause constriction, when needed *max 1 if response relates function to inhalation and exhalation* *0 marks if incorrectly stated as <u>elastic tissue or elastic fibres</u>*	**2**
1(b)(i)	stage micrometer / stage micrometer scale **;**	**1**

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Question	Answer	Marks
1(b)(ii)	yes, qualified **;** e.g. 0.2 mm = 200 μm 0.2 mm / smallest student can see, is less than 0.25 mm 250 μm = 0.25 mm 250 μm / cell length, is longer than 200 μm the cell is 50 μm longer (than 0.2 mm) the cell is 0.05 mm longer (than 0.2 mm) *allow if converted to standard form* (2×10^{-4} v 2.5×10^{-4} m) *must have units* *must include numerical values*	**1**
1(c)(i)	*any **two** from:* wall, of one layer / is one cell thick **;** **I** capillary is one cell thick **A** thin wall / endothelial cells are a single layer **A** endothelium is, a single layer (of cells) / one cell thick *idea that* red blood cells transported in single file **;** *idea that* red blood cells diameter (approximately), as large / same, as capillary (lumen) **;** **A** if diameter (e.g. 7μm) stated as being similar to capillary size *idea of* diameter of capillary narrower than smooth muscle cell **;** AVP **;** e.g. no muscle and elastic layer muscle fibres / elastic fibres / collagen, not present *ref. to* different shapes of red blood cell / red blood cell showing flexibility, to pass through (narrow) capillary	**2**

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Question	Answer	Marks
1(c)(ii)	*allow tissue fluid / fluid surrounding cells, instead of (smooth muscle) cells* *allow, blood / plasma, for capillary* *allow O_2 for oxygen and CO_2 for carbon dioxide* *any **three** from:* *capillary function* **1** named, substance / type of substance, that is supplied to smooth muscle cells or is a product removed from the cells **;** e.g. (supply) oxygen / nutrients / glucose / amino acids / cell-signalling molecule e.g. (removes) carbon dioxide / lactic acid / waste **A** exchange of respiratory gases (between capillary and cells) **I** plasma proteins into tissue fluid *structure to function* **2** thin wall / AW, so short distance **;** **R** capillary is thin **3** endothelial pores / fenestrations, for more efficient passage / AW **;** **A** gaps, between / within, (endothelial) cells (of capillary wall) **A** increases, quantity / rate of supply (of substances) **A** endothelial pores for formation of tissue fluid (around cells) **R** if blood leaves to make tissue fluid **4** (endothelial) pores / AW, for passage of, phagocytes / monocytes / macrophages / neutrophils **;** **5** small (size) / narrow diameter, to reach cells / so (all) cells are close **;** **A** value in range 5–10 μm **A** small size / narrow lumen, slows (rate of) blood flow **6** detail about red blood cell and, respiratory gases / gas exchange / oxygen / carbon dioxide **;** e.g. narrow lumen slows red blood cell movement for uptake of oxygen slows red blood cell movement to increase time for exchange of gases only one red blood cell fits (at a time) so short diffusion distance red blood cells are close to (muscle) cells for gas exchange red blood cells squeeze through, (so) distance for oxygen to reach cells is minimised	**3**

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Question	Answer	Marks
1(d)(i)	(a gene mutation is a) change in the sequence of base pairs in a DNA molecule **;** **A** change in the DNA, base / nucleotide, sequence **I** change in RNA base sequence **I** names of mutations codes for / may result in / results in / AW, an altered / a different / a changed, polypeptide **;** **A** protein / amino acid sequence / primary structure, *for polypeptide*	**2**
1(d)(ii)	*any **two** from:* differences owing to, RNA / gene, splicing **; A** primary transcript for RNA **A** *ref. to* alternative splicing **R** DNA splicing **R** mutation occurring during gene splicing (differences occur during) removal of, introns / non-coding sequences **;** **R** if introns described as bases / nucleotides / codons **R** different number of introns removed / some introns remain exons / coding sequences, detail **;** e.g. joined differently / in a different combination in middle (of transcript), removed / not included for repeating sequence, removed / not included (so) messenger RNA / mRNA, formed is different **;**	**2**

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Question	Answer	Marks
1(d)(iii)	*allow ref. to binding sites as plural* **I** *ref. to* active site(s) *any **one** from:* (still have) similar, tertiary structure / binding site shape **;** **A** similar 3D shape **R** same **A** *idea of* binding sites still complementary to attach to (the) proteins removed amino acids are not structural amino acids **;** removed amino acids are not part of binding site **;** **A** description R-group interactions (still) the, same / similar **;** AVP **;** e.g. idea of more than one binding site and only, one / a few, changed **A** same type of binding site, but a different number	**1**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)(i)</td><td>one mark each correct row

<table>
<tr><th>cell structure</th><th>function</th></tr>
<tr><td>nucleolus ;</td><td>manufactures ribosomal subunits from proteins and ribosomal RNA</td></tr>
<tr><td>smooth endoplasmic reticulum ;
R endoplastic</td><td>synthesises triglycerides and other lipids</td></tr>
<tr><td>pair of centrioles ;
R centrosomes</td><td>organise microtubules of the cell cytoskeleton</td></tr>
</table></td><td>3</td></tr>
<tr><td>2(a)(ii)</td><td>structures should be labelled and drawn with enough detail not to be mistaken for another structure

all three correct = 2 marks
one or two correct = 1 mark
all three structures correctly drawn but no labels = 1 mark

• roughly spherical organelle within the nucleus labelled as nucleolus

• minimum of one single membrane-bound tubular sac labelled as, smooth endoplasmic reticulum / smooth ER / SER
R if dots (ribosomes) drawn and resembles RER

• two, short lines or cylinders, not parallel to each other labelled as (pair of) centrioles
R if inside the nucleus</td><td>2</td></tr>
</table>

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Question	Answer	Marks
2(b)(i)	*allow, M. tuberculosis / pathogens / bacteria, for bacterial cells* endocytosis occurs / described **;** e.g. (macrophage cell surface) membrane, surrounds / AW, bacterial cells pseudopodia, surrounds / form round / AW, bacterial cell (alveolar) macrophage / phagocyte / (phagocytic) cell, envelops / engulfs, bacterial cells **;** event occurring before <u>or</u> after **;** *e.g. before* *ref. to* chemotaxis / chemotactic response bacterial cells / bacteria / (bacterial) antigens, bind / attach / join / AW, to (macrophage cell surface), receptors / membrane **I** binding to, macrophage / cell *suggestion of* (in alveolar space) opsonisation of /antibody binding to, bacterial cells *e.g. after* membrane fusion / (phagocytic), vacuole pinches off / AW **A** vesicle for vacuole	**2**
2(b)(ii)	lysosomes / lysosome **;** **A** lysosomal vesicles	**1**

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Question	Answer	Marks
2(c)	*any **four** from:* **1** cells are replicating / AW (because live vaccine) **;** **2** high / increased / AW, levels of (non-self / foreign) antigen (because live vaccine) **;** **3** (so) strong / effective / good / AW, (primary) immune response **;** **A** described e.g. (T-/B-) memory cells are formed *idea that* memory cells present when *Mycobacterium* infects / AW secondary response occurs when *Mycobacterium* infects / AW **4** provides (artificial) active immunity **;** **R** natural active immunity **5** (so) boosters not needed (to build sufficient immunity) **;** **6** vaccine does not cause, disease / TB (because, weakened / attenuated) **;** **I** doesn't show symptoms **7** easy to, transport / store / deliver (because freeze-dried) **;** **8** AVP **;;** e.g. effective against *M. tuberculosis* and *M. bovis* no / few / mild, side effects, so people not discouraged (from having vaccine) memory cells / immunity, (relatively) long-lived / long-lasting only need one dose (good immunity for most individuals) provides herd immunity *(a consequential effect)*	**4**

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Question	Answer	Marks
3(a)	*any **three** from:* active site with a specific shape as part of a lysozyme molecule drawn and active site labelled or included in an annotation **;** complementary shaped peptidoglycan drawn <u>and</u>, peptidoglycan / **s**ubstrate, labelled or included in an annotation**;** enzyme-substrate complex drawn <u>and</u> labelled **;** lysozyme with same shaped active site and, two products / NAM and NAG drawn (formed from hydrolysed peptidoglycan) **;** AVP **;** e.g. water shown enzyme active site labelled 'lock' and substrate labelled 'key' *max 2 if no ref. to specific example e.g. label for lysozyme **or** peptidoglycan **or** murein **or** the products NAG and NAM* *max 1 no labels but otherwise clearly lock and key* ***or** by gaining the enzyme-substrate complex mark if induced fit drawn*	**3**

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Question	Answer	Marks
3(b)	*allow murein for peptidoglycan* *must attempt similarities and differences to gain max* *any **three** from:* *similarities, both* **1** cause cell, lysis / bursting **;** **I** ref.to destroying / killing, bacteria (both) **2** detail **;** e.g. weaken / destroy / AW, cell wall act on peptidoglycan cell wall cell wall cannot withstand turgor pressure / AW *differences* *(lysozyme is, a protein / an enzyme / a catalyst, but)* **3** penicillin is, an antibiotic / an enzyme inhibitor / a beta-lactam **;** *(lysozyme hydrolyses, glycosidic bonds / peptidoglycan molecules, but)* **4** penicillin, inhibits transpeptidase(s) **;** **A** peptidase(s) **5** penicillin, prevents formation of / AW, peptide / cross, bridges / linkages **;** **R** penicillin breaks cross bridges **A** *ref. to* autolysins e.g. 'cannot repair holes made by autolysins' **6** penicillin only effective when cell is, growing / synthesising cell walls, but lysozyme effective, at all stages / AW**;** **7** AVP **;** e.g. lysozyme (much) larger molecule *ref. to* lysozyme denatured v penicillin less affected by heat *idea of* lysozyme more affected by factors affecting enzyme **A** examples lysozyme globular v penicillin contains (beta-lactam / 4-member) ring	**3**

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Question	Answer	Marks
4(a)	*allow points from correctly labelled diagram* (monomers of) beta-glucose / β-glucose **;** **R** α-glucose / two β-glucoses *plus any **two** from:* *max 1 if no monomer stated* (joined by) 1, 4 glycosidic bonds **;** **A** 1,4 glucosidic bonds **R** 1,4 and 1,6 bonds each (β–) glucose rotated by 180° compared to adjacent (β–)glucose **;** AW linear / straight, chain / molecule**;** unbranched **;**	**3**
4(b)(i)	*any **one** from:* increases rate of translation of, enzyme / nitrate reductase **;** increases, enzyme / nitrate reductase, synthesis / concentration **;** **A** more nitrate reductase produced *idea of* more metabolically efficient **;** e.g. enzyme only produced when needed AVP **;** e.g. more nitrate is reduced to nitrite / more nitrite is formed leads to increased supply of nitrite for amino acids / amino acid synthesis	**1**

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Question	Answer	Marks
4(b)(ii)	*any **two** from:* improves accuracy of results / results not by eye / results not subjective **;** **A** detects smallest change in, (intensity of) colour / concentration / quantity provides quantitative results **/** obtain numerical values **;** **A** described e.g. absorbance values / can measure absorbance/ gives percentage transmission / absorbance readings *idea that* different, intensities / shades of, colour / magenta / red-purple, relate to different, quantities / concentrations, of nitrites **;** **A** relate to (rates of) nitrate uptake can produce calibration curve (for quantitative results) **;** AVP **;** e.g. can detect, (very) low concentrations / faintly coloured samples	**2**

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Question	Answer	Marks
4(c)(i)	*accept hydrogen ions / H^+, for protons* *max 3 if no ref. to amino acids* *any **four** from:* **1** protons, moved by active transport / pumped, out of (companion) cell **;** **A** using, energy / ATP *for active transport* **2** protons, moved into / enter / AW, cell wall / apoplast **;** **R** if moved out to phloem sieve tube **3** proton gradient builds up in, apoplast / cell wall **;** **A** higher concentration **A** high concentration if mp4 gained **4** protons move back (into companion cell), by facilitated diffusion / AW **;** e.g. down, electrochemical / concentration, gradient from high(er) to low(er) concentration **A** diffuse *if movement is described through a transport protein in mp5* **5** protons cotransport amino acids **or** amino acids move with protons through, a cotransporter / a cotransport protein / (amino acid) transporter **;** **6** amino acids, transported / AW, against their concentration gradient **;**	**4**
4(c)(ii)	plasmodesmata present **;** **A** movement is down the, concentration / diffusion, gradient **A** because there is a high(er) concentration in the companion cell **ora** for phloem sieve tube (sap)	**1**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(d)</td><td>0.2 mmol dm^{-3} constant rate v 5.0 mmol dm^{-3}, rate not constant / described ;

0.2 mmol dm^{-3} lower rate than 5.0 mmol dm^{-3} ; ora 5.0 mmol dm^{-3} higher rate
A faster / slower, rate for higher / lower, rate
A (overall) steeper rate / less steep rate

calculated rates to support ;</td><td>2</td></tr>
<tr><td>4(e)</td><td>any four from:

1 (experiments suggest mainly) active transport / active uptake ;
A uptake, is an active process / needs energy / needs ATP
if mp8 given, allow ‘active transport and facilitated diffusion’

2 comparison of experiments with control, any one ;
<table>
<tr><th>expt</th><th>discussion point</th></tr>
<tr><td>1</td><td>oxygen required for (complete) uptake A aeration required
or
almost no /AW, uptake, with no oxygen / in anaerobic conditions</td></tr>
<tr><td>2</td><td>almost no / AW, uptake, in, low temperature / at 3°C
or
uptake, higher / AW, at 30°C / in control</td></tr>
<tr><td>3</td><td>proteins / enzymes, are, required for / involved in, uptake
or
(much) lower / AW, uptake when, proteins not synthesised / protein synthesis inhibitor present</td></tr>
<tr><td>4</td><td>slightly lower / very similar, uptake / AW, without any bacteria
or
slightly higher / very similar, uptake / AW, with bacteria (control)</td></tr>
</table>
3 one comparative result / manipulated data, with units, to support mp2 ;</td><td>4</td></tr>
</table>

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(e)</td><td>

<table>
<tr><th>experiment</th><th>experiment v control</th><th>or</th><th>lower by</th><td rowspan="5">only needs to state control value once somewhere in response</td></tr>
<tr><td>1</td><td>0.4 v 10.9 μmol g^{-1}</td><td rowspan="4"></td><td>10.5 μmol g^{-1}</td></tr>
<tr><td>2</td><td>0.6 v 10.9 μmol g^{-1}</td><td>10.3 μmol g^{-1}</td></tr>
<tr><td>3</td><td>1.4 v 10.9 μmol g^{-1}</td><td>9.5 μmol g^{-1}</td></tr>
<tr><td>4</td><td>10.0 v 10.9 μmol g^{-1}</td><td>0.9 μmol g^{-1}</td></tr>
</table>

discussion points

4 aerobic respiration needs oxygen **;**

5 lower temperature means lower activity of enzymes involved in respiration **;**

6 *ref. to* ATP (for active transport) **;**
e.g. (aerobic) respiration produces ATP
less respiration means less ATP produced
no ATP for, conformational change / AW (of carrier protein)

7 some (facilitated) diffusion because some uptake without oxygen **;**

8 protein synthesis needed for transport proteins **;**
A membrane / transport / carrier / channel, proteins not being synthesised
A no protein synthesis so less ATP synthase

9 effect of lower temperature on transport **; ora** for control
e.g. reduces rate of (facilitated) diffusion
affects, ATPase / carrier protein, for active transport
transport proteins less efficient at low temperature

10 bacteria will have, little / no, effect on uptake
or
(normally) bacteria (associated with roots), increase / help, nitrate uptake **;**

11 AVP **;** e.g. idea that nitrate uptake involves metabolic processes

</td><td></td></tr>
</table>

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Question	Answer	Marks
5(a)	coiling / supercoiling / condensation / becomes more compact / AW **;** e.g. becomes shorter and fatter	**1**
5(b)	**I** *ref. to* homologous chromosomes to describe the chromosomes in Fig. 5.1 *any **four** from:* each has two, sister / (genetically) identical, chromatids **;** **R** homologous (chromatids) joined by a centromere **;** each chromatid has a (single) <u>DNA molecule</u> **;** **A** 2 chromatids and 2 DNA molecules DNA associated with, histone proteins / histones / basic proteins **;** telomeres / repeating non-coding sequences, at ends of, chromatids / chromosomes **;** AVP **;** e.g. chromosomes, highly / most, condensed	**4**

Question	Answer	Marks
6(a)	<u>human immunodeficiency virus</u> **;**	**1**
6(b)	*max 1 if no mention of benefit of ART* *any **two** from:* helps to, increase / maintain / AW, number of, T-,lymphocytes / T-helper cells **;** **A** helps to prevent death of T-lymphocytes / AW **A** T-cells maintains / improves / AW, strength of, immune system / immune response **;** increases chance of recovery from, infectious / opportunistic, disease **;** AW *idea that* decreases risk of having / helps prevent, other (opportunistic) diseases **;** AVP **;** e.g. (can) decrease viral load / reduce number of HIV	**2**
6(c)(i)	**X** is positioned <u>above</u> the join on the coronary artery on, left-hand side of Fig. 6.1 / right heart **;** **R** if placed at the junction of the vein and artery	**1**

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Question	Answer	Marks
6(c)(ii)	can withstand high(er) blood pressure / less likely to burst **;** **R** collapse **A** *idea that* blood pressure is now higher (so) blood vessel may last longer **;** **A** otherwise unlikely to last a long time (in tunica media) more (smooth) muscle / thicker (smooth) muscle layer / more elastic fibres **;** detail **;** e.g. helps, onward movement / faster flow, of blood / AW **A** otherwise does not have enough, (smooth) muscle / elastic fibres, for onward movement / required speed of flow, of blood thicker tunica, externa / adventitia **;** **A** more collagen	**2**

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