

Cambridge International AS & A Level

BIOLOGY**9700/41**

Paper 4 A Level Structured Questions

May/June 2026**MARK SCHEME**Maximum Mark: 100

Published

This mark scheme contains the instructions and marking guidance that our examiners used to mark candidate responses for this component.

Before they start marking, examiners complete a standardisation process. They review a range of candidate responses and discuss the mark scheme in detail to agree which answers can and cannot be accepted. Examiners award marks where it is clear that candidate responses have met the requirements of the mark scheme. These requirements may vary between different components or different versions of the same component, depending on the exact requirements of the question and the candidate responses seen during the standardisation process.

Sometimes, our mark schemes may allow marks to be awarded to responses which contain elements that are factually incorrect or for content not covered by the syllabus. We do this in response to the demands of a specific question to support candidates and make sure that our assessments are fair. However, these allowances should not be used as a guide for teaching and learning.

We cannot discuss the mark scheme with schools, and we recommend that schools read the mark scheme together with the assessment material and the Principal Examiner Report for Teachers.

This document consists of **23** printed pages.

General marking principles

All examiners must apply these marking principles when marking candidate responses.

1	Examiners must award marks for each response in line with: - the specific content defined in the mark scheme - the specific skills defined in the mark scheme or in the level descriptions - the standard of response required as exemplified by the standardisation scripts.
2	Examiners must award whole marks (not half marks, or other fractions).
3	Examiners must award marks positively . This means that: - marks are not deducted for errors or omissions - marks are awarded for correct/valid answers as defined in the mark scheme and also for other valid answers which go beyond the scope of the syllabus and mark scheme referring to your team leader as appropriate - the quality of spelling, punctuation and grammar are judged only when the mark scheme indicates that these features are specifically assessed in the question. However, the meaning of all responses must be unambiguous.
4	Examiners must consistently apply the requirements of the mark scheme and any rules for what to do when candidates have not followed instructions correctly.
5	Examiners must use the full range of marks defined in the mark scheme, unless limited by the quality of the candidate responses seen.
6	Examiners must award marks according to the mark scheme and must not award marks with grade thresholds or grade descriptions 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 <i>n</i> responses (e.g. State two reasons ...): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked <i>ignore</i> in the mark scheme should not count towards <i>n</i>. • Incorrect responses should not be awarded credit but will still count towards <i>n</i>. • 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 <i>n</i> 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.

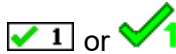
Annotations guidance for centres

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
 or 	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
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

PUBLISHED**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

PUBLISHED

Question	Answer			Marks	Guidance
1(a)	stage	location in the cell	products of this stage	5	IGNORE numbers ALLOW NADH / red NAD / NAD red, for 'reduced NAD' IGNORE NADH ⁺ / NADH ₂ ALLOW 1 mark if 'matrix' alone stated for both link and Krebs ALLOW 1 mark if 'mitochondrion / mitochondria' alone stated for both ALLOW 2 marks if 'matrix' alone stated for one but 'mitochondrion / mitochondrial, matrix' stated for the other IGNORE oxaloacetate / water / GTP (for Krebs cycle) ALLOW FADH ₂ / red FAD / FAD red, for 'reduced FAD' IGNORE FADH
	glycolysis	cytoplasm	pyruvate and ATP and reduced NAD ;		
	link reaction	mitochondrial matrix ;	carbon dioxide and acetyl co(enzyme) A and reduced NAD ;		
	Krebs cycle	mitochondrial matrix ;	carbon dioxide and ATP and reduced, NAD / FAD ;		
1(b)	1 hydrogen ion / H ⁺ / proton ; 2 thylakoid (membrane) ; 3 <u>facilitated diffusion</u> ;			3	1 ALLOW 'hydrogen / H' alone 1 DO NOT ALLOW hydrogen molecule / H ₂ 2 DO NOT ALLOW thylakoid space

PUBLISHED

Question	Answer	Marks	Guidance
2(a)(i)	1 <i>initial receptors</i> – osmoreceptors / hypothalamus ; 2 <i>coordination systems</i> – endocrine / hormonal ; 3 <i>final effectors</i> – <u>collecting</u>, duct / tubule ; 4 <i>response</i> – less <u>urine</u> produced / <u>urine</u> more concentrated / less watery <u>urine</u> OR more <u>water</u>, reabsorbed / taken up (into blood) OR (more) aquaporins added to <u>membrane</u> / <u>membrane</u> more permeable to water ;	4	1 IGNORE osmoregulators 2 IGNORE ADH 3 IGNORE posterior pituitary gland 3 CON other parts of nephron
2(a)(ii)	<i>any two from:</i> 1 if water potential, rises / high, cells, absorb water / swell / burst / lyse ; 2 if water potential, falls / low, cells, lose water / shrink / crenate / shrivel ; 3 water is a, solvent / medium / site, for, (named) reactions in cells / metabolic reactions ; 4 AVP ;	2	IGNORE flaccid / turgid / plasmolysed 1 ALLOW if too much water in blood / blood dilute, for 'high water potential' 2 ALLOW if too little water in blood / blood concentrated, for 'low water potential' ALLOW 1 mark for 'so cells do not burst or shrink' OR 'so cells do not gain water or lose water' if mps 1 and 2 not given 3 e.g. water needed for hydrolysis (reactions) in cells 4 e.g. control / maintain / important for, blood volume / blood pressure / hydrostatic pressure / glomerular filtration <i>ref.</i> prevent oedema
2(b)(i)	180 (g) ;	1	calculation = $200 \times 5 \times 0.18$

PUBLISHED

Question	Answer	Marks	Guidance
2(b)(ii)	any four from: <i>in, proximal convoluted tubule / PCT:</i> 1 (glucose) reabsorbed / moves, into, blood / (peritubular) capillary ; 2 Na⁺ leaves (epithelial / tubule) cell by active transport (at basal / basolateral, membrane) ; 3 glucose moves into cell by co-transport with Na⁺ (at luminal membrane) ; 4 glucose leaves cell by facilitated diffusion (at, basal / basolateral, membrane) ; 5 AVP ;	4	IGNORE ultrafiltration DO NOT ALLOW basement membrane for mps 2, 3, 4 but ECF after first error If Na⁺ / sodium ion, not stated CON once then ECF max 3 if PCT not stated CON if wrong part of nephron stated then ECF to max 3 ECF if cell not stated or implied (e.g. cytoplasm) for mps 2, 3 and 4 to max 3 2 ALLOW using ATP / pumped / by pumps, for 'active transport' 2 IGNORE transport protein 2 DO NOT ALLOW channel protein 3 ALLOW through co-transporter protein for 'by co-transport' 4 ECF from mp 2 if basement membrane repeated 4 ALLOW diffuses through GLUT, proteins / channels, for 'facilitated diffusion' 5 mp 2 establishes, Na⁺, diffusion gradient / concentration gradient e.g. secondary active transport

PUBLISHED

Question	Answer	Marks	Guidance
3(a)(i)	any four from: (morning / opening / width increasing, context) 1 width increases from 1 to 6.5 mm between 06.00 and 11.00 ; 2 so (more) carbon dioxide can, enter / diffuse in ; 3a high / rising, light intensity → high / more, photosynthesis ; (afternoon / night / closing / width decreasing, context) 3b low / decreasing, light intensity → low / less, photosynthesis ; 4 width decreases from 6.5 to 3 mm between 11.00 and 17.00 ; 5 to, decrease / limit, transpiration / water loss ;	4	IGNORE refs. to K⁺ ions ALLOW mp 3 either in context of 3a or 3b but not twice 1 ALLOW 6.9 for 6.5 mm 3b ALLOW in dark / at night / before 06.00, no photosynthesis 4 ECF from mp 1 if peak time or width wrong 5 CON prevent / stop, for 'decrease'
3(a)(ii)	any three from: 1 K⁺ ions enter (guard) cell ; 2 water enters cell, by osmosis / down water potential gradient → increase in volume / increase in turgor / cell becomes turgid ; 3 action in mp 1 or 2 causally linked to: widens aperture / opens stoma(ta) ;	3	ALLOW ORA throughout 1 CON stoma for 'cell' 2 CON stoma for 'cell' but ECF from mp 1 3 ALLOW opens for 'widens' 3 CON guard cell for 'stoma' 3 IGNORE statement of correlation
3(b)	any three from: <i>ABA concentration is more likely to increase when light intensity is <u>decreasing</u> because:</i> 1 ABA stops H⁺ moving, out of cell / into cell wall ; 2 (ABA) causes Ca²⁺ ions to enter, cytoplasm / cell ; 3 (ABA) causes K⁺ to leave (cytoplasm / cell) ; 4 (ABA) leads to, water leaving (cell) / guard cell becoming flaccid / stomatal closing ;	3	If answer is about when ABA will decrease (not answering question), CON 1 mark then apply ECF after first error If answer states that ABA rises when light intensity is increasing, CON 1 mark then apply ECF after first error 3 IGNORE prevent K⁺ from entering 4 DO NOT ALLOW guard cell closing 4 IGNORE prevent stomata from opening

PUBLISHED

Question	Answer	Marks	Guidance
4(a)	<i>any four from:</i> 1 (put) extract / sample / concentrate / pigments, on, pencil / base, line ; 2 (named) solvent below, extract / line, and idea of time to rise / left till solvent rises / wait till solvent almost reaches top ; 3 remove paper (before solvent reaches end) and mark solvent front ; 4 ($R_f =$) distance pigment moved $\div$ distance solvent moved ; 5 check / compare with, known / reference / published, data / values ;	4	2 e.g. ethanol / acetone / petroleum ether $\pm$ hexane / trichloromethane 2 DO NOT ALLOW water 5 ALLOW database / standard values
4(b)	<i>any three from:</i> 1 absorb <u>light</u> ; 2 for, light dependent (stage) / photophosphorylation / photoactivation ; 3 absorb / use, more / different, wavelengths OR (different pigments have) different / extend, absorption spectra ; 4 AVP ;	3	IGNORE colours throughout 1 ALLOW harvest / capture / trap, for 'absorb' 2 IGNORE photolysis 2 CON if process described with error e.g. pigment passes electrons to another pigment 4 e.g. chlorophyll a is, primary pigment / reaction centre and, carotene / xanthophyll / chlorophyll b, are accessory pigments e.g. (some pigments may) protect from excess light

PUBLISHED

Question	Answer	Marks	Guidance
5(a)	Apply list rule for 4 responses C ^P C ^P NN C ^P C ^Y NN C ^P C ^P Nn C ^P C ^Y Nn ; ;	2	two or three correct = 1 mark four correct = 2 marks
5(b)(i)	<i>genotype</i> : C ^B C ^Y Nn ; <i>phenotype</i> : brown without stripes ;	2	If both correct answers given but on wrong lines give 1 mark ECF for a phenotype that matches a wrong genotype
5(b)(ii)	<i>any four from:</i> 1 independent / random, assortment / orientation (of chromosomes / alleles / genes) ; 2 in metaphase I ; 3 <i>ref. to</i> genes, on separate chromosomes / not linked OR no linkage ; 4 gametes / (daughter) cells / products of meiosis, are, haploid / n ; 5 2 ² / 4, combinations, in dihybrid cross / with two genes OR (get) C ^B N C ^B n C ^Y N C ^Y n ;	4	IGNORE crossing-over 1 ALLOW each pair of, chromosomes / alleles, lines up / separates / segregates, independently of other pairs 2 ALLOW anaphase I if segregation described 2 DO NOT ALLOW metaphase / anaphase, II 3 CON <i>ref. to</i> breaking of linkage groups 4 ALLOW get one of each pair of, chromosomes / alleles for 'haploid / n' 5 ALLOW digenic for 'with two genes'

PUBLISHED

Question	Answer	Marks	Guidance
5(b)(iii)	any three from: 1 (autosomal) linkage OR genes were, linked / on same chromosome ; 2 C^B n, inherited together / linked / on same chromosome, and C^Y N, inherited together / linked / on same chromosome ; 3 (offspring showed) parental phenotypes ; 4 no, recombinants / crossing-over ; 5 as, genes / loci, tightly linked / close together ;	3	1 CON sex linkage 2 ALLOW words e.g. <u>alleles</u> for (brown + stripes) and (yellow + no stripes), inherited together / linked / on same chromosome 3 phenotypes were same as original parents

PUBLISHED

Question	Answer	Marks	Guidance
5(c)	any four from: 1 in woodland, non-yellow / brown / pink / unstriped, snails, are not seen / are camouflaged / are hidden / are not eaten / survive OR in rough grass, yellow / striped, snails, are not seen / are camouflaged / are hidden / are not eaten / survive ; 2 in woodland, non-yellow / brown / pink / unstriped, snails have a <u>selective advantage</u> / are <u>selected for</u> OR in rough grass, yellow / striped, snails have a <u>selective advantage</u> / are <u>selected for</u> ; 3 in woodland, non-yellow / brown / pink / unstriped, snails, reproduce / pass on alleles OR in rough grass, yellow / striped, snails, reproduce / pass on alleles ; 4 in woodland, non-yellow / brown / pink / unstriped, snails, increase in frequency OR in rough grass, yellow / striped, snails, increase in frequency ; 5 in woodland, C^B / C^P / N, are selected for / increase (in frequency) OR in rough grass, C^Y / n, are selected for / increase (in frequency) ;	4	ALLOW ORA throughout ECF after first CON to max 3 e.g. in rough grass brown snails selected for, survive and reproduce = CON mp2 then gets mp 1 and mp 3. 2 ORA non-yellow / brown / pink / unstriped, snails <u>selected against</u> in rough grass OR yellow / striped, snails <u>selected against</u> in woodland 2 ALLOW selection pressure favours for 'selected for' 2 ALLOW selection pressure is against for 'selected against' 3 ALLOW pass on genes (to offspring / next generation) for 'reproduce' 4 ORA in rough grass, non-yellow / brown / pink / unstriped, snails, decrease in frequency OR in woodland, yellow / striped, snails, decrease in frequency 5 ALLOW words e.g. allele for pink (shell) for 'C^P'

PUBLISHED

Question	Answer	Marks	Guidance
6(a)(i)	<i>domain:</i> Eukarya ; <i>genus:</i> <u>Ailurus</u> and <i>species:</i> (<i>Ailurus</i> / <i>A.</i>) <u>fulgens</u> ;	2	ALLOW Eukaryota / eukaryote(s) / phonetic spelling CON for small 'a' for <i>Ailurus</i> or big 'F' for <i>fulgens</i>
6(a)(ii)	1 similar / shared, (described) morphological features / DNA sequences, to, other Carnivora / others in that order ; 2 shared, common ancestor / phylogeny / evolutionary relationships (with, other Carnivora / others in that order) ;	2	1 ALLOW share, physical / anatomical / biochemical, features / traits / characteristics with Carnivora
6(b)	<i>any three from:</i> (<i>yes / successful, because:</i> 1 (red panda species) has not, died out / gone extinct OR genetic variation preserved ; (<i>no / unsuccessful, because:</i> 2 habitat loss / wild population decline, has, continued / not stopped ; 3 few reintroductions have occurred / reintroduction only started in 2011 ; 4 AVP ;	3	IGNORE advice for future actions 1 ALLOW insurance population maintained 2 ALLOW habitats not, conserved / protected / restored 4 e.g. captive bred / zoo bred / released, animals may not survive in wild

PUBLISHED

Question	Answer	Marks	Guidance
6(c)	any five from: 1 increase <u>birth rate</u> / overcome reluctance to mate ; 2 IVF / in vitro fertilisation / fertilisation in test tube ; 3 hormone / FSH / LH, so produce many (mature), eggs / oocytes / follicles OR hormone / FSH/ LH, for superovulation / to increase ovulation ; 4 harvest, oocytes / eggs (from, ovary / oviduct), and sperm(atazoa) ; 5 embryo transfer / introduce embryo, to <u>uterus</u> ; 6 hormone / oestrogen / progesterone, prepares, uterus lining / endometrium ; 7 correct <i>ref. to</i> surrogate, mother / female ; 8 of, same / related, species ; 9 AVP ; 10 AVP ;	5	2 ALLOW petri dish for 'test tube' 4 ALLOW take gametes from both male and female 7 CON in wrong context e.g. AI / SCNT 8 ALLOW another red panda (female) 9, 10 e.g. artificial insemination / AI / semen placed in uterus embryo screening / select healthy embryos to implant zoos exchange, sperm / embryos, for genetic diversity OR frozen, ova / semen, from dead pandas, for genetic diversity OR sperm bank for, genetic diversity / store alleles idea

PUBLISHED

Question	Answer	Marks	Guidance
7(a)(i)	$(92 - 35) \div 35 \times 100$ OR $(57 \div 35) \times 100$; 163 (%) ;	2	ECF answer to 3 s.f. from correct working with mis-read graph figures (from bars or trend line) e.g. if $(63 - 3) \div 3 \times 100$ ALLOW 2000 ECF
7(a)(ii)	LIST RULE APPLIES but IGNORE incompletely named factors any two pairs of a factor (F) and reason (R) from: 1F <u>light intensity</u> ; 2R limits / affects, rate of, light-dependent stage / photophosphorylation / photoactivation ; 3F carbon dioxide <u>concentration</u> ; 4R limits / affects, rate of, light independent stage / Calvin cycle / carboxylation / carbon fixation ; 5F <u>temperature</u> ; 6R limits / affects, rate of, (named) enzyme-catalysed reactions / formation of enzyme-substrate complexes / Calvin cycle / light independent stage / photolysis ; 7F AVP ; 8R AVP ;	4	ALLOW 1 mark for 'limiting factor for / limits <u>rate</u> of / affects <u>rate</u> of, <u>photosynthesis</u>' if 2R / 4R / 6R not given 2R ALLOW limiting factor for 'limits rate of' 2R ALLOW description e.g. if light intensity is higher photophosphorylation, increases / occurs more / is faster 4R ALLOW limiting factor for 'limits rate of' 4R ALLOW description 6R ALLOW limiting factor for 'limits rate of' 6R ALLOW description 6R IGNORE high temperature denatures enzymes 6R CON low temperature denatures enzymes 7F (concentration in water of) nitrate / phosphate / (other named) mineral ion / mineral nutrients / dissolved oxygen OR fertiliser run-off / sewage discharge (into water / ocean) OR (water / ocean) pH 8R linked to, role in metabolism / named organic molecule

PUBLISHED

Question	Answer	Marks	Guidance
7(b)	<i>any four from:</i> 1 <u>sodium ions / Na⁺</u>, do not enter, <u>motor</u> neurone / <u>axon</u> ; 2 no, propagation / transmission / passing on, of, depolarisation / action potential / impulse ; 3 no Ca²⁺ enter, synaptic knob / presynaptic neurone ; 4 no acetylcholine, release / exocytosis ; 5 no, stimulation of / depolarisation of / binding of acetylcholine to, sarcolemma ; 6 no, <u>T-tubule</u>, depolarisation / action potential / impulse transmission ;	4	IGNORE SR, troponin, tropomyosin, actin, myosin ECF after first error of each type: 'into membrane', wrong ion symbol, omitting to state ion ECF for 'less' instead of 'no' after first error 1 ALLOW Na⁺ moves in at ligand-gated channels only 1 DO NOT ALLOW Na⁺ enter membrane for 'enter neurone' 1 DO NOT ALLOW toxin, mimics ACh / binds to ACh receptors (i.e. affects ligand-gated channel) 2 ALLOW impulse, not sent to / doesn't reach, synaptic knob 3 ALLOW Ca²⁺ channels don't open at, synaptic knob / presynaptic neurone 4 ALLOW ACh 4 ALLOW acetylcholine does not diffuse across, cleft / neuromuscular junction / synapse 5 ALLOW muscle cell membrane / postsynaptic membrane, for 'sarcolemma' 5 DO NOT ALLOW membrane of postsynaptic knob / postsynaptic neurone 5 DO NOT ALLOW toxin, mimics acetylcholine / binds to acetylcholine receptors (i.e. affects ligand-gated channel) but ECF from mp1

PUBLISHED

Question	Answer	Marks	Guidance
8(a)(i)	any three from: 1 detect stimuli ; 2 receptor potential ; 3 impulse / action potential, in <u>sensory</u> neurone ; 4 <i>ref. to chemoreceptors</i> on (moth) antenna ; 5 act as transducers ;	3	CON receptor cell confused with receptor protein once then ECF 2 ALLOW generator potential 3 DO NOT ALLOW pass, receptor potential / stimulus, to sensory neurone 5 ALLOW description e.g. convert energy from one form to another / convert (named) stimulus energy to electrical energy
8(a)(ii)	any three from: 1 <u>switch gene</u>, on / off ; 2 transcription factor ; 3 allows / stops, <u>RNA polymerase</u> to, act / bind ; 4 gene for <u>enzyme</u> to make, lipid / scent (chemical) ; 5 AVP ;	3	IGNORE gene expression 1 ALLOW <u>gene switching</u> 2 ALLOW activator / repressor 5 e.g. light detected / light receptor / phytochrome e.g. clock genes e.g. negative feedback e.g. mRNA / protein, degradation (→ daily cycle)
8(b)	A: mRNA ; B: cDNA / ssDNA ; C: (ss DNA) probe / reporter / oligo ;	3	A: ALLOW messenger RNA B: ALLOW complementary / single-stranded, DNA C: IGNORE complementary

PUBLISHED

Question	Answer	Marks	Guidance
9(a)	<i>any two from: LIST RULE APPLIES</i> 1 make, nucleic acid / polynucleotide / DNA / RNA ; 2 make (named), peptide / polypeptide / protein ; 3 make, lipid / triglyceride / phospholipid (from smaller units); 4 make (named), disaccharide / polysaccharide (from smaller units) ; 5 Calvin cycle ; 6 AVP ;	2	IGNORE phosphorylation 1 ALLOW DNA replication / transcription 2 ALLOW protein synthesis / translation 3 ALLOW lipogenesis 4 ALLOW glycogenesis 5 ALLOW regenerate RuBP 6 e.g. join amino acid to tRNA
9(b)(i)	1 growth / larger / more cells (to support) ; 2 mobile / moves / locomotion / swims / muscle contraction ; 3 AVP ;	2	3 e.g. nerve impulses / nervous system activity <i>ref.</i> reproduction
9(b)(ii)	substrate-level / substrate-linked, phosphorylation ; oxidative phosphorylation / chemiosmosis ;	2	
9(c)(i)	1430 / 2020 (= 0.7079) ; <i>answer:</i> 0.71 ;	2	ECF for answer rounded to 2 s.f. from incorrect working
9(c)(ii)	A ;	1	

PUBLISHED

Question	Answer	Marks	Guidance
10(a)	<i>any three from:</i> 1 change / manipulate / alter / modify, (organism's) DNA / genetic material / genome ; 2 to, change / modify, (organism's) characteristics / phenotype ; 3 new / different / functional, protein produced ; 4 transfer / add / insert, gene / allele / DNA (into a recipient organism) ;	3	IGNORE genetic screening 1 IGNORE genetic information 1 ALLOW recombinant DNA in organism context 1 ALLOW adjust for 'change' 2 ALLOW traits / features, for 'characteristics' 4 ALLOW gene editing / edit genes 4 ALLOW delete / replace, gene (in GMO)

PUBLISHED

Question	Answer	Marks	Guidance
10(b)	<i>any six from:</i> <i>prepare the vector</i> 1 (normal / dominant) allele / gene, for ADA / adenosine deaminase ; 2 inserted into, vector / virus ; 3 virus modified so it cannot replicate ; <i>obtain and modify patient cells</i> 4 get (haemopoietic / lymphoid) stem cells from (patient) bone marrow ; 5 mix / culture, (engineered) vector, with, patient's / stem, cells (in vitro / ex vivo) ; 6 drug to increase stem cells (in bone marrow) before mp 4 OR drug / chemotherapy / radiotherapy, to kill stem cells (to make space) before mp 7 ; <i>return modified cells to patient</i> 7 reintroduce (GM / transgenic) cells to, patient / bone marrow / blood ; 8 AVP ; 9 AVP ;	6	1 ALLOW <i>IL2RG / DCLRE1C</i>, for 'gene for ADA' 2 ALLOW retrovirus / lentivirus 2 IGNORE adenovirus / AAV / plasmid 3 ECF if incorrect virus named e.g. adenovirus / AAV 4 ALLOW get T, lymphocytes / cells, from blood 5 ALLOW idea of inserting, virus / vector, into patient's / stem, cells (in vitro / ex vivo) 5 ALLOW if patient cells stated to be T cells 7 ALLOW patient T cells returned to blood 8, 9 gene, cloned in / taken from, GM bacteria multiply transformed, patient / T / stem, cells T-lymphocytes / T-cells, produce ADA (protein / enzyme)