CAMBRIDGE
International Education

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.

[Turn over

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	‘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.

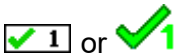
Annotations guidance for centres

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
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

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><th>stage</th><th>location in the cell</th><th>products of this stage</th></tr>
<tr><td>glycolysis</td><td>cytoplasm</td><td>pyruvate
and
ATP
and
reduced NAD ;</td></tr>
<tr><td>link reaction</td><td>mitochondrial matrix ;</td><td>carbon dioxide
and
acetyl co(enzyme) A
and
reduced NAD ;</td></tr>
<tr><td>Krebs cycle</td><td>mitochondrial matrix ;</td><td>carbon dioxide
and
ATP
and
reduced, NAD / FAD ;</td></tr>
</table>
</td><td>5</td><td>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</td></tr>
<tr><td>1(b)</td><td>1 hydrogen ion / H^+ / proton ;
2 thylakoid (membrane) ;
3 <u>facilitated diffusion</u> ;</td><td>3</td><td>1 ALLOW ‘hydrogen / H’ alone
1 DO NOT ALLOW hydrogen molecule / H_2
2 DO NOT ALLOW thylakoid space</td></tr>
</table>

Question	Answer	Marks	Guidance
2(a)(i)	**1** *initial receptors* – osmoreceptors / hypothalamus **;** **2** *coordination systems* – endocrine / hormonal **;** **3** *final effectors* – collecting, duct / tubule **;** **4** *response* – less urine produced / urine more concentrated / less watery urine **OR** more water, reabsorbed / taken up (into blood) **OR** (more) aquaporins added to membrane / membrane 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)	*any **two** from:* **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 *ref.* prevent oedema
2(b)(i)	180 (g) **;**	**1**	calculation = 200 × 5 × 0.18

Question	Answer	Marks	Guidance
2(b)(ii)	*any **four** from:* *in, proximal convoluted tubule / PCT:* **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

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:* *ABA concentration is more likely to increase when light intensity is <u>decreasing</u> because:* **1** ABA stops H^+ moving, out of cell / into cell wall **;** **2** (ABA) causes Ca^{2+} 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

Question	Answer	Marks	Guidance
4(a)	*any **four** from:* **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 ÷ distance solvent moved **;** **5** check / compare with, known / reference / published, data / values **;**	**4**	 **2** e.g. ethanol / acetone / petroleum ether + hexane / trichloromethane **2 DO NOT ALLOW** water **5 ALLOW** database / standard values
4(b)	*any **three** from:* **1** absorb light **;** **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

Question	Answer	Marks	Guidance
5(a)	**Apply list rule for 4 responses** C^PC^P NN C^PC^Y NN C^PC^P Nn C^PC^Y Nn **;** **;**	**2**	 two or three correct = **1 mark** four correct = **2 marks**
5(b)(i)	*genotype:* C^BC^Y Nn **;** *phenotype:* 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)	*any **four** from:* **1** independent / random, assortment / orientation (of chromosomes / alleles / genes) **;** **2** in metaphase I **;** **3** *ref. to* 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** *ref. to* breaking of linkage groups **4 ALLOW** get one of each pair of, chromosomes / alleles for 'haploid / n' **5 ALLOW** digenic for 'with two genes'

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.** alleles for (brown + stripes) and (yellow + no stripes), inherited together / linked / on same chromosome **3** phenotypes were same as original parents

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 selective advantage / are selected for **OR** in rough grass, yellow / striped, snails have a selective advantage / are selected for **;** **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 selected against in rough grass **OR** yellow / striped, snails selected against 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'

Question	Answer	Marks	Guidance
6(a)(i)	*domain:* Eukarya **;** *genus:* <u>*Ailurus*</u> **and** species: *(Ailurus / A.)* <u>*fulgens*</u> **;**	**2**	**ALLOW** Eukaryota / eukaryote(s) / phonetic spelling **CON** for small 'a' for *Ailurus* or big 'F' for *fulgens*
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)	*any **three** from:* *(yes / successful, because):* **1** (red panda species) has not, died out / gone extinct **OR** genetic variation preserved **;** *(no / unsuccessful, because):* **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

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 *ref. to* 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

Question	Answer	Marks	Guidance
7(a)(i)	(92 – 35) ÷ 35 × 100 **OR** (57 ÷ 35) × 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) ÷ 3 × 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** light intensity **;** **2R** limits / affects, rate of, light-dependent stage / photophosphorylation / photoactivation **;** **3F** carbon dioxide concentration **;** **4R** limits / affects, rate of, light independent stage / Calvin cycle / carboxylation / carbon fixation **;** **5F** temperature **;** **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 rate of / affects rate of, photosynthesis' 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

Question	Answer	Marks	Guidance
7(b)	*any **four** from:* **1** sodium ions / Na^+, do not enter, motor neurone / axon **;** **2** no, propagation / transmission / passing on, of, depolarisation / action potential / impulse **;** **3** no Ca^{2+} enter, synaptic knob / presynaptic neurone **;** **4** no acetylcholine, release / exocytosis **;** **5** no, stimulation of / depolarisation of / binding of acetylcholine to, sarcolemma **;** **6** no, T-tubule, 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** Ca^{2+} 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

Question	Answer	Marks	Guidance
8(a)(i)	*any **three** from:* **1** detect stimuli **;** **2** receptor potential **;** **3** impulse / action potential, in sensory neurone **;** **4** *ref. to* chemoreceptors 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** switch gene, on / off **;** **2** transcription factor **;** **3** allows / stops, RNA polymerase to, act / bind **;** **4** gene for enzyme to make, lipid / scent (chemical) **;** **5** AVP **;**	**3**	**IGNORE** gene expression **1 ALLOW** gene switching **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

Question	Answer	Marks	Guidance
9(a)	*any **two** from:* **LIST RULE APPLIES** **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 *ref.* reproduction
9(b)(ii)	substrate-level / substrate-linked, phosphorylation **;** oxidative phosphorylation / chemiosmosis **;**	**2**	
9(c)(i)	1430 / 2020 (= 0.7079) **;** *answer*: 0.71 **;**	**2**	**ECF** for answer rounded to 2 s.f. from incorrect working
9(c)(ii)	**A ;**	**1**	

Question	Answer	Marks	Guidance
10(a)	*any three from:* **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)

Question	Answer	Marks	Guidance
10(b)	*any **six** from:* *prepare the vector* **1** (normal / dominant) allele / gene, for ADA / adenosine deaminase **;** **2** inserted into, vector / virus **;** **3** virus modified so it cannot replicate **;** *obtain and modify patient cells* **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 **;** *return modified cells to patient* **7** reintroduce (GM / transgenic) cells to, patient / bone marrow / blood **;** **8** AVP **;** **9** AVP **;**	**6**	**1 ALLOW** *IL2RG* / *DCLRE1C,* 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)