Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/41**

Paper 4 A Level Structured Questions **October/November 2023**

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.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘List rule’ guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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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.

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

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

B	1	Correct, Correct	✓, ✓	**3**
(4 responses)	2	Correct	✓	
	3	Wrong	ignore	

C	1	Correct	✓	**2**
(4 responses)	2	Correct, Wrong	✓, ×	
	3	Correct	ignore	

D	1	Correct	✓	**2**
(4 responses)	2	Correct, CON (of 2)	×, (discount 2)	
	3	Correct	✓	

E	1	Correct	✓	**3**
(4 responses)	2	Correct	✓	
	3	Correct, Wrong	✓	

F	1	Correct	✓	**2**
(4 responses)	2	Correct	✓	
	3	Correct CON (of 3)	× (discount 3)	

G	1	Correct	✓	**3**
(5 responses)	2	Correct	✓	
	3	Correct Correct CON (of 4)	✓ ignore ignore	

H	1	Correct	✓	**2**
(4 responses)	2	Correct	×	
	3	CON (of 2) Correct	(discount 2) ✓	

I	1	Correct	✓	**2**
(4 responses)	2	Correct	×	
	3	Correct CON (of 2)	✓ (discount 2)	

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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)(i)	thylakoid(s) **;**	**1**
1(a)(ii)	*any **four** from:* *up to three descriptions (D) and one / two linked functions (F)* D1 stacked / many (**A** / thylakoids) / large surface area **;** F2 to increase light absorption **;** D3 (thylakoid) membrane has, (named), pigments / photosystems / electron carriers / enzymes **;** F4 (thylakoid membrane role is) light-dependent reaction / photophosphorylation / creates proton gradient / pump protons / chemiosmosis / makes ATP **;** D5 (thylakoid) lumen / space **;** F6 accumulates H^+ / high H^+ concentration **;** D7 appear green (under microscope) **;** F8 as / so, chlorophyll absorbs red and blue light **;**	**4**
1(b)(i)	Calvin (cycle) **;**	**1**
1(b)(ii)	*any **two** from:* 1 no start and end, point / molecules **;** 2 all, molecules / intermediates, present all the time **;** 3 ribulose bisphosphate / RuBP / 5C molecule, is regenerated **;** 4 numerical detail **;**	**2**
1(c)(i)	**B**: oxygen **;** **D**: sugar / hexose / glucose / triose phosphate / carbohydrate / starch **;**	**2**
1(c)(ii)	1 (oxygen linked to) aerobic respiration / oxidative phosphorylation **;** 2 (glucose stated as) source / store, of (chemical) energy / ATP / food **;** 3 *ref. to* energy flow through, food chains / food web / ecosystem **;**	**3**

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Question	Answer	Marks
2(a)	1 number of / range of (different), ecosystems / habitats **;** 2 number of species and their relative abundance **;**	**2**
2(b)	*any **three** from:* 1 to, store / contain, multiple / many, genome / DNA / nucleotide, sequences **;** 2 to, align / compare / search, sequences **;** 3 to, process / analyse / sort / calculate from, large quantities of data **;** 4 to, share / access, data / information from, others / elsewhere **;** 5 to save time / fast(er) **;**	**3**
2(c)(i)	*Anopheles* **;**	**1**
2(c)(ii)	three / 3 **;**	**1**
2(d)(i)	*any **three** from:* 1 less able / not able, to, adapt / evolve **;** 2 little variation for selection to act on **;** 3 few(er) (potentially), useful / beneficial, alleles ; 4 all / most, (could be) killed by same, disease / selection pressure **;** 5 if due to small population size this decreases species survival chance **;**	**3**
2(d)(ii)	low(er) genetic variation means high(er), conservation status / threat / vulnerability / endangerment / risk of extinction **;**	**1**
2(d)(iii)	*any **three** from:* *does **not** support because* 1 chimpanzee has, most / highest, genetic variation but is, EN / endangered **;** 2 minke whale has (joint), least / lowest, genetic variation but is, LC / least concern **;** 3 genetic variation, similar / same, but conservation status is different **;** 4 example **;** 5 gorilla is, most / critically, endangered but has high(er) genetic variation **;** 6 AVP **;** e.g. *ref. to* data limited to only seven species	**3**

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Question	Answer	Marks
3(a)	1 ($q^2 = \frac{440}{1100}$ **or** $q2 = 0.4$) $q = \sqrt{0.4}$ **or** $q = 0.632455532$ **;** 2 ($p = 1 - 0.632455532$ **or** $p = 0.367544468$) $2pq = 2 \times 0.632455532 \times 0.367544468$ **or** $2pq = 0.4649110641$ **;** 3 (heterozygotes = $2pq \times 1100$ e.g. 511.4 **or** 511.5 **or** 511.6672) 511 / 512 **;**	**3**
3(b)	*any **two** from:* 1 colours / shades / categories / phenotypes, not distinct / not discrete / overlap / form a (gradual) range / include intermediates **;** 2 >1 / 4 / several / many, genes **;** 3 environment affects, it / colour / phenotype **;**	**2**
3(c)(i)	*any **two** from:* 1 (as climate changes) increase in CO_2 concentration causes, stomatal aperture to decrease / stomata to be less open **;** 2 less water, lost / evaporated / transpired (though stomata) **;** 3 compensates for / allows survival in, low water availability / dry conditions **;**	**2**

Question	Answer	Marks
3(c)(ii)	*any **four** from:* 1 (abscisic acid / ABA) binds to receptor on, (guard) cell surface membrane **;** 2 H^+ stops moving, out of cell / into cell wall **;** 3 Ca^{2+} ions enter, cytoplasm / cell **or** Ca^{2+} ions act as second messenger **;** 4 K^+ ions leave cell **;** 5 water leaves cell, by osmosis / down water potential gradient **;** 6 less turgid / flaccid, guard cell(s) close stoma(ta) **;**	**4**
3(d)(i)	*any **two** from:* 1 0.1, (μmol) increases / gives higher, rate (compared to control / normal) **;** 2 1(.0) and 10(.0), (μmol) decrease / give lower, rate (compared to control / normal) **;** 3 10(.0) (μmol) rate, stays (approx.) constant / plateaus / does not increase, over, time / (6) days **;** 4 data quote comparing rate at two concentrations on one day **or** data quote comparing rate on two different days for 10 μmol **;**	**3**
3(d)(ii)	1 protons / H^+ (ions) **;** 2 cellulose **;**	**2**

Question	Answer	Marks
4(a)(i)	1 DNA, joined / combined / made, from two / different, sources / species **;** 2 using (named), enzymes / vectors **or** to create a, GMO / transgenic organism **;**	**2**
4(a)(ii)	to, test / compare, effect(iveness) of, genes / proteins / Bt and OCII / plants / varieties / **A** and **B** **or** to see which, (gene / plant / variety / of **A** and **B**), works, better / best **;**	**1**
4(a)(iii)	to compare / provide a baseline / as a control **;**	**1**

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Question	Answer	Marks
4(b)	1 **A** and **B** kill larvae **;** 2 GM increases, yield of / food from (potatoes) **;** 3 **A**, is best / kills most / works faster / should be grown / will provide most food **;**	**3**

Question	Answer	Marks
5(a)	**highest**: malic acid **;** **lowest**: oleic acid **;**	**2**
5(b)	*any **five** from:* *similarities:* 1 use pyruvate **;** 2 occur in, cytoplasm / cytosol **;** 3 make / regenerate, NAD **;** 4 redox reaction **;** *differences:* 5 lactate / lactic acid, made in mammals and ethanol in yeast **;** 6 one step in mammals and two steps in yeast **;** 7 carbon dioxide made in yeast (not in mammals) **;** 8 reversible in mammals and irreversible in yeast **;**	**5**

Question	Answer	Marks
6(a)(i)	*any **two** from:* 1 transparent phenotype (reappears) in F2 (but not F1) **;** 2 so it is, inherited / passed down / genetic / not environmental **;** 3 new / recessive, allele **;**	**2**
6(a)(ii)	9 : 3 : 3 : 1 **;**	**1**

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Question	Answer	Marks
6(a)(iii)	*any **four** from:* 1 two genes **;** 2 on separate chromosomes / not linked **;** 3 not sex-linked / autosomal **;** 4 each gene has / both genes have, two alleles **;** 5 albino / white stripes, is recessive (allele) **;** 6 transparent / non-gold, is recessive (allele) **;** 7 wild type is dominant for both genes **;**	**4**
6(b)	*any **four** from:* 1 homologous chromosomes, pair up / form bivalents **;** 2 at prophase I **;** 3 independent assortment / random orientation **or** independent segregation **;** 4 (happens) at metaphase I **or** at anaphase I **;** 5 one chromosome of (each) pair has dominant allele and one has recessive **;** 6 four, combinations / permutations / different gametes **;** 7 worked example / diagram **;**	**4**

Question	Answer	Marks
7(a)(i)	*any **four** from:* *both* 1 acetylcholine, in / from, vesicles **;** 2 many mitochondria **;** 3 have presynaptic and postsynaptic membranes **;** 4 (synaptic) cleft / gap **;** 5 have receptor(s) (for ACh / neurotransmitter) **;** 6 presynaptic, Ca^{2+}, entry / channels **or** postsynaptic Na^{+}, entry / channels **;**	**4**
7(a)(ii)	*any **three** from:* 1 few(er) Ca^{2+} ions, leave sarcoplasmic reticulum / enter sarcoplasm **;** 2 few(er) Ca^{2+} ions bind to troponin **;** 3 few(er) troponin molecules change shape **;** 4 few(er) tropomyosin molecules move **;** 5 few(er) myosin-binding sites, uncovered / exposed **;** 6 few(er), actin-myosin cross bridges form / myosin (heads) bind to actin **;** 7 AVP **;** e.g. lack of P_i leads to less ATP formed 8 AVP **;** e.g. myosin-actin cross-bridges do not break / myosin heads do not reset	**3**
7(b)	**A**: adenylyl cyclase **;** **B**: protein kinase A **;**	**2**

Question	Answer	Marks
8(a)	letter **X** on rising slope to the left of the angle where line plateaus **;**	**1**
8(b)(i)	reverse transcriptase **;**	**1**
8(b)(ii)	transcription factor(s) **;**	**1**

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Question	Answer	Marks
8(b)(iii)	*any **three** from:* 1 in high light intensity plant can photosynthesise more **;** 2 so they need (more) / upregulate / increase / make (more) (named) enzymes / proteins, for photosynthesis **;** 3 (plus) named, enzyme / protein (for photosynthesis) **;** 4 (named) pigments to protect cells from excess light **;** 5 enzymes to make, sucrose / starch / amino acids **;** 6 proteins for, sucrose / amino acid, transport **;** 7/8 AVP **;;** e.g. DELLA breaks down releasing, phytochrome interacting factors / PIF	**3**

Question	Answer	Marks
9(a)(i)	*any **three** from:* 1 (random) mutation(s) allows detection of high frequency **;** 2 selection pressure is bat (predation) **;** 3 those that can detect, high frequencies / bats, survive / don't get eaten / have selective advantage / are selected for **;** 4 these, reproduce / pass on (beneficial) allele(s) **;** 5 those that can detect high sounds / beneficial alleles, increase (in frequency / in population) **;**	**3**
9(a)(ii)	*any **four** from:* 1 *ref. to* receptor / generator, potential **;** 2 vesicles of (named) neurotransmitter, move towards / fuse with, (presynaptic) membrane **;** 3 (named) neurotransmitter, release / exocytosis **;** 4 neurotransmitter binds to receptors on sensory neurone **;** 5 Na^+ / sodium, ions enter (sensory neurone) **;** 6 depolarisation (of membrane of sensory neurone) **;** 7 *ref. to* threshold potential / all-or-nothing response **;**	**4**

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Question	Answer	Marks
9(b)	*any **three** from:* S1 sympatric (speciation) **;** S2 different mutations **;** S3 gave, (named) phenotypic / behavioural, differences **;** S4 which gave behavioural, isolation / separation **;** S5 (leading to) inability to reproduce together / reproductive isolation / genetic isolation / no gene flow between them **;** **or** *any **three** from:* A1 allopatric (speciation) **;** A2 geographical, separation / barrier, in the past **;** A3 different, mutations / selection pressures **;** A4 gave, (named) phenotypic / behavioural, differences **;** A5 inability to reproduce together / reproductive isolation / genetic isolation / no gene flow between them, after populations re-join **;**	**3**

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Question	Answer	Marks
10	*any **seven** from:* 1 genetic engineering / recombinant (DNA technology) **;** 2 (named) drug / treatment / protein, from, (GM) bacteria / (GM) yeast / (named) (GM)O **;** 3 make insulin (drug for diabetes) **;** 4 make factor VIII (drug for haemophilia) **;** 5 make adenosine deaminase (drug for SCID) **;** 6 genetic, screening / diagnosis / testing **;** 7 (detect) BRCA1 / BRCA2 **;** 8 (detect number of repeats / allele for) Huntington's **;** 9 (detect allele for) cystic fibrosis / CFTR **;** 10 example of action if diagnosis positive **;** 11 gene therapy **;** 12 insert / add, normal allele into (named), cells / tissue (of person) **;** 13 to treat, eye disease(s) / LCA / Leber's congenital amaurosis **;** 14 to treat SCID **;** 15/16 AVP **; ;** e.g. *ref. to* help / develop, xenotransplantation GM / antigen-free, pigs / animals, to source, tissues / organs, for transplants GM plants to make vaccines GM / recombinant / DNA / mRNA, vaccines recombinant antibody technology other / different, recombinant therapeutic protein / genetic screening / gene therapy, example	**7**

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	2	Correct	✓	
	3	Wrong	×	

B	1	Correct, Correct	✓, ✓	**3**
(4 responses)	2	Correct	✓	
	3	Wrong	ignore	

C	1	Correct	✓	**2**
(4 responses)	2	Correct, Wrong	✓, ×	
	3	Correct	ignore	

D	1	Correct	✓	**2**
(4 responses)	2	Correct, CON (of 2)	×, (discount 2)	
	3	Correct	✓	

E	1	Correct	✓	**3**
(4 responses)	2	Correct	✓	
	3	Correct, Wrong	✓	

F	1	Correct	✓	**2**
(4 responses)	2	Correct	✓	
	3	Correct CON (of 3)	× (discount 3)	

G	1	Correct	✓	**3**
(5 responses)	2	Correct	✓	
	3	Correct Correct CON (of 4)	✓ ignore ignore	

H	1	Correct	✓	**2**
(4 responses)	2	Correct	×	
	3	CON (of 2) Correct	(discount 2) ✓	

I	1	Correct	✓	**2**
(4 responses)	2	Correct	×	
	3	Correct CON (of 2)	✓ (discount 2)	

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Question	Answer	Marks
1(a)	**A**: carbon dioxide / CO_2 **;** **B**: reduced NAD / NADH and **C**: NAD / NAD^+ **;** **D**: ethanal **;**	**3**
1(b)	*any **three** from:* 1 (recycles / produces) NAD **; I** *ref. to* reduced NAD produced **;** 2 *ref. to* glycolysis **;** 3 *ref. to* ATP (produced) **;** 4 by substrate-linked phosphorylation **;**	**3**
1(c)	*any **three** from:* 1 aerenchyma provides oxygen for aerobic respiration **;** 2 high concentration of ethanol dehydrogenase / high tolerance for ethanol, allows (higher rate of), ethanol fermentation / anaerobic respiration **;** 3 fast growth / grow tall, so leaves, out of water / exposed to air **;** 4 AVP **;** e.g. ridges in submerged leaves to trap air	**3**

Question	Answer	Marks
2(a)	involve mitosis: **1 / 3 ;** involve meiosis: **4 ;** produces new genetic variation: **2 / 4 ;** shows only haploid cells: **1 / 5 ; ignore 2** shows only diploid cells: **3 ; ignore 2**	**5**

Question	Answer	Marks
2(b)	*any **four** from:* 1 genetic variation **;** 2 due to, crossing over / independent assortment **;** 3 some will, be adapted (to changing environment) / survive **or** avoids whole population being wiped out / **ora ;** 4 (allows) stage **1** / stage **3** / asexual reproduction **;** 5 (allows) random, mating / fertilisation / fusion of gametes **;** 6 some have advantageous combinations of alleles **;** 7 AVP **;** e.g. *ref. to* dormancy	**4**
2(c)	*any **three** from:* *haploid* 1 only cell with harmful mutation will, be affected / die **;** 2 rest of population unaffected / AW **;** *diploid* 3 recessive allele for harmful mutation, will be masked by dominant (normal) allele / not expressed in heterozygote **;** 4 AVP **;** e.g. (haploid) removes mutated allele from population	**3**
2(d)	*any **two** from:* 1 eukaryotic (cells) / described **;** 2 heterotrophic / saprotrophic / parasitic / described **;** 3 chitin cell walls **;** 4 (most have) hyphae / mycelium **;** 5 multinucleate (cells) **;** 6 multicellular and unicellular **;**	**2**

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Question	Answer	Marks
3(a)	*any **five** from:* 1 select plants (resistant to disease) / AW **;** 2 by exposing plants to disease to show resistance **;** 3 breed (selected plants with resistance) **;** 4 plant seeds / grow offspring **;** 5 select offspring with resistance and breed together **;** 6 (repeat for) many generations **;** 7 AVP **;** e.g. named wheat disease / rust disease / mildew disease	**5**
3(b)	*any **two** from:* 1 reduction in genetic variation / gene pool made smaller / decrease in heterozygosity / increase in homozygosity **;** **I** loss of biodiversity 2 less hybrid vigour **;** 3 inbreeding depression **;** 4 harmful recessive alleles could, come together / be expressed **;** 5 (population) susceptible to, environmental change / new disease **;** 6 AVP **;** e.g. disadvantageous traits occur / reduced fertility / susceptible to metabolic disorders	**2**

Question	Answer	Marks
4(a)	*any **four** from:* 1 marker gene added with gene of interest (GOI) **;** 2 use same promoter **;** 3 (so) both genes, transcribed / expressed (together) **;** 4 (so) both proteins are produced **;** 5 use UV light (to detect fluorescence) **;** 6 fluorescence shows, transcription / expression, of gene of interest (GOI) **;** 7 AVP **;** e.g. fluorescent proteins not harmful / have no effect on plant / do not affect quantity of desired protein produced	**4**

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Question	Answer	Marks
4(b)	*any **two** from:* 1 high / increase in, yield / productivity / quality **or** more food **;** 2 increased income / reduce costs **;** 3 can use herbicides / AW **;** 4 less / no, competition **;** 5 no need to plough / less labour intensive **;**	**2**
4(c)(i)	complementary (base pairing between DNA strands) / described **;**	**1**
4(c)(ii)	*any **two** from:* 1 use mRNA to make (ss)cDNA **;** 2 fluorescent, tag / dye / substance / label, attached to cDNA **;** 3 hybridisation / binding, of cDNA to probe **;** 4 use, lasers / UV light, to produce fluorescence **;** *plus* 5 idea of intensity of, fluorescence / light, indicates level of (gene) expression **;**	**3**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>5(a)</td><td>all correct (1827) ;

<table>
<tr><th>phenotype</th><th>observed number</th><th>expected number</th></tr>
<tr><td>brown body colour, straight wings</td><td>2843</td><td>1827</td></tr>
<tr><td>brown body colour, curved wings</td><td>855</td><td>1827</td></tr>
<tr><td>black body colour, straight wings</td><td>842</td><td>1827</td></tr>
<tr><td>black body colour, curved wins</td><td>2768</td><td>1827</td></tr>
</table></td><td>1</td></tr>
<tr><td>5(b)</td><td>any four from:

1 ref. to 3 degrees of freedom ;
2 the, χ^2 value / 2098, is greater than 7.815 (at p=0.05) ;
3 there is a significant difference ;
4 reject the null hypothesis ;
5 any difference is not due to chance / less than 5% (probability) that difference is due to chance ;
6 the, χ^2 value / 2098, is greater than, 11.345 at p=0.01 / 16.266 at p=0.001
or
less than, 1% / 0.1% (probability), that difference is due to chance ;</td><td>4</td></tr>
</table>

Question	Answer	Marks
5(c)	*any **four** from:* 1 greater numbers of parental phenotypes / fewer numbers of recombinants **;** 2 genes are linked / autosomal linkage / genes are on same chromosome **;** 3 alleles inherited together **;** 4 **B** inherited with **D** and **b** inherited with **d** **or** **B** and **D** in the same gamete and **b** and **d** in the same gamete **;** 5 no independent assortment **;** 6 crossing over (produces recombinants) **;** 7 during, meiosis / prophase I / gamete formation **;** 8 AVP **;** e.g. idea that genes are far enough apart on chromosome for recombination to occur	**4**

Question	Answer	Marks
6(a)(i)	**P**: receptor **;** **Q**: adenyl(yl) cyclase **;** **R**: G-protein **;** **S**: cyclic AMP / cAMP **;**	**4**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>6(a)(ii)</td><td>
<table>
<tr><th>process</th><th>effect on rate of process when blood glucose concentration decreases</th></tr>
<tr><td>glycogenolysis</td><td>increase</td></tr>
<tr><td>glycogenesis</td><td>decrease</td></tr>
<tr><td>glycolysis</td><td>decrease</td></tr>
<tr><td>fatty acid synthesis</td><td>decrease</td></tr>
</table>
;;;

4 correct = 3 marks
3 correct = 2 marks
1/2 correct = 1 mark
</td><td>3</td></tr>
<tr><td>6(b)</td><td>
any four from:

1 strip contains glucose oxidase and peroxidase ;
2 strip dipped into urine ;
3 glucose (and oxygen) reacts with glucose oxidase to produce hydrogen peroxide ;
4 hydrogen peroxide reacts with peroxidase to produce a colour change ;
5 colour is matched with a colour chart to give, reading / estimate, of glucose concentration ;

any three from:

6 quick(er) ;
7 (more) sensitive / accurate / precise ;
8 gives immediate reading ;
9 results can be stored electronically / can be connected to smart phone / AW ;
10 numerical / digital / quantitative / objective ;
11 reusable ;
</td><td>7</td></tr>
</table>

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Question	Answer	Marks
7(a)	*any **four** from:* 1 mitochondria produce ATP **;** *presynaptic knob* 2 for production of, acetylcholine / ACh **;** 3 for, making / moving, vesicles **; A** exocytosis *sarcomere* 4 active transport of Ca^{2+} into, sarcoplasmic reticulum **;** 5 detachment of myosin heads / break cross bridge **or** allows myosin head to move back to original position **;** 6 AVP **;** e.g. *ref. to* sodium potassium pump / active transport of Ca^{2+} out of synaptic knob	**4**
7(b)	**X** – agree, because Na^+ influx leads to depolarisation **;** **Y** – disagree, because Cl^- influx leads to hyperpolarisation / description **or** disagree, because no Na^+ influx so no depolarisation **;** **X** and **Y** – agree, because Na^+ (influx) is balanced by Cl^- (influx) / AW **;**	**3**
7(c)	*any **two** from:* 1 decrease in transmission speed **;** 2 *ref. to* shorter local circuits **;** 3 no / less, saltatory conduction / described **;**	**2**

Question	Answer	Marks
8(a)	*any **four** from:* 1 both photosystem I and photosystem II involved **;** **A** both photosystems 2 photoactivation of chlorophyll occurs **;** 3 photolysis of water occurs / description **;** 4 oxygen production / oxygen-evolving complex involved **;** 5 electrons emitted by photosystem I used to reduce NADP **or** NADP is the final electron acceptor **;** 6 photosystem I receives electrons from photosystem II **or** photosystem II receives electrons from photolysis (of water) **;** 7 ETC / electron transport chain, sets up proton gradient **or** chemiosmosis / ATP produced **;**	**4**
8(b)	GP used to make, amino acids / fatty acids / lipids **;** TP used to make, hexose / starch / cellulose / amino acids / glycerol / lipids **;**	**2**
8(c)(i)	$\frac{3.10-1.55}{15}$ **or** $\frac{3.10-1.50}{15}$ **;** 0.10 / 0.11 **;**	**2**
8(c)(ii)	*any **three** from:* 1 temperature now not limiting **or** carbon dioxide concentration now limiting **;** 2 closure of stomata **;** 3 lack of water / **AW ;** 4 denaturation of enzymes **or** active site no longer complementary to substrate / no ESCs form **;** 5 AVP **;** e.g. *ref. to* optimum temperature / photorespiration occurs	**3**

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Question	Answer	Marks
8(c)(iii)	similar shape but below high intensity curve **;**	**1**

Question	Answer	Marks
9(a)	*any **four** from:* 1 (drink of water causes) increase in blood water potential / AW **;** 2 detected by, osmoreceptors / hypothalamus **;** 3 causes decrease in release of ADH (into blood in first hour) **;** 4 less water reabsorbed (from collecting ducts) **;** 5 (so) decrease in blood water potential / blood water potential returns to set point **;** 6 causes increase in release of ADH **;** 7 negative feedback **;**	**4**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>9(b)</td><td>

*any **four** from:*

<table>
<tr><th colspan="2"></th><th>nervous system</th><th></th><th>endocrine system</th></tr>
<tr><td>1</td><td>communication</td><td>action potential / impulse</td><td>and</td><td>hormone ;</td></tr>
<tr><td>2</td><td>nature of communication</td><td>electrical (and chemical)</td><td>and</td><td>chemical ;</td></tr>
<tr><td>3</td><td>mode of transmission</td><td>neurone</td><td>and</td><td>blood ;</td></tr>
<tr><td>4</td><td>response destination</td><td>muscle</td><td>and</td><td>target, organs / tissue / cells ;</td></tr>
<tr><td>5</td><td>transmission speed</td><td>fast(er)</td><td>and</td><td>slow(er) ;</td></tr>
<tr><td>6</td><td>location of effect</td><td>specific / localised</td><td>and</td><td>(can be) widespread ;</td></tr>
<tr><td>7</td><td>response speed</td><td>fast(er)</td><td>and</td><td>slow(er) ;</td></tr>
<tr><td>8</td><td>duration of effect</td><td>short-lived / temporary</td><td>and</td><td>can be long-lasting / permanent ;</td></tr>
</table>

</td><td>**4**</td></tr>
</table>

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Question	Answer	Marks
10(a)	1 dye / paint / clipping fur / collar / electronic chip **;** 2 death / birth / reproduction **;** 3 Lincoln **;** 4 repeated / replicated **;**	**4**
10(b)	*any **four** from:* 1 *idea of* negative impact on, the environment / ecosystems / habitat / food webs / food chain **;** 2 decreases biodiversity **;** 3 large / fast, increase in number **;** 4 competition for (named) resources **;** 5 *ref. to* new disease **;** 6 may be toxic **or** few animals able to eat it **;** 7 attracts pollinators (away from native species) **;**	**4**

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Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/43**

Paper 4 A Level Structured Questions **October/November 2023**

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 October/November 2023 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 descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘List rule’ guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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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.

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

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

B	1	Correct, Correct	✓, ✓	**3**
(4 responses)	2	Correct	✓	
	3	Wrong	ignore	

C	1	Correct	✓	**2**
(4 responses)	2	Correct, Wrong	✓, ×	
	3	Correct	ignore	

D	1	Correct	✓	**2**
(4 responses)	2	Correct, CON (of 2)	×, (discount 2)	
	3	Correct	✓	

E	1	Correct	✓	**3**
(4 responses)	2	Correct	✓	
	3	Correct, Wrong	✓	

F	1	Correct	✓	**2**
(4 responses)	2	Correct	✓	
	3	Correct CON (of 3)	× (discount 3)	

G	1	Correct	✓	**3**
(5 responses)	2	Correct	✓	
	3	Correct Correct CON (of 4)	✓ ignore ignore	

H	1	Correct	✓	**2**
(4 responses)	2	Correct	×	
	3	CON (of 2) Correct	(discount 2) ✓	

I	1	Correct	✓	**2**
(4 responses)	2	Correct	×	
	3	Correct CON (of 2)	✓ (discount 2)	

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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)(i)	thylakoid(s) **;**	**1**
1(a)(ii)	*any **four** from:* *up to three descriptions (D) and one / two linked functions (F)* D1 stacked / many (**A** / thylakoids) / large surface area **;** F2 to increase light absorption **;** D3 (thylakoid) membrane has, (named), pigments / photosystems / electron carriers / enzymes **;** F4 (thylakoid membrane role is) light-dependent reaction / photophosphorylation / creates proton gradient / pump protons / chemiosmosis / makes ATP **;** D5 (thylakoid) lumen / space **;** F6 accumulates H^+ / high H^+ concentration **;** D7 appear green (under microscope) **;** F8 as / so, chlorophyll absorbs red and blue light **;**	**4**
1(b)(i)	Calvin (cycle) **;**	**1**
1(b)(ii)	*any **two** from:* 1 no start and end, point / molecules **;** 2 all, molecules / intermediates, present all the time **;** 3 ribulose bisphosphate / RuBP / 5C molecule, is regenerated **;** 4 numerical detail **;**	**2**
1(c)(i)	**B**: oxygen **;** **D**: sugar / hexose / glucose / triose phosphate / carbohydrate / starch **;**	**2**
1(c)(ii)	1 (oxygen linked to) aerobic respiration / oxidative phosphorylation **;** 2 (glucose stated as) source / store, of (chemical) energy / ATP / food **;** 3 *ref. to* energy flow through, food chains / food web / ecosystem **;**	**3**

Question	Answer	Marks
2(a)	1 number of / range of (different), ecosystems / habitats **;** 2 number of species and their relative abundance **;**	**2**
2(b)	*any **three** from:* 1 to, store / contain, multiple / many, genome / DNA / nucleotide, sequences **;** 2 to, align / compare / search, sequences **;** 3 to, process / analyse / sort / calculate from, large quantities of data **;** 4 to, share / access, data / information from, others / elsewhere **;** 5 to save time / fast(er) **;**	**3**
2(c)(i)	*Anopheles* **;**	**1**
2(c)(ii)	three / 3 **;**	**1**
2(d)(i)	*any **three** from:* 1 less able / not able, to, adapt / evolve **;** 2 little variation for selection to act on **;** 3 few(er) (potentially), useful / beneficial, alleles ; 4 all / most, (could be) killed by same, disease / selection pressure **;** 5 if due to small population size this decreases species survival chance **;**	**3**
2(d)(ii)	low(er) genetic variation means high(er), conservation status / threat / vulnerability / endangerment / risk of extinction **;**	**1**
2(d)(iii)	*any **three** from:* *does **not** support because* 1 chimpanzee has, most / highest, genetic variation but is, EN / endangered **;** 2 minke whale has (joint), least / lowest, genetic variation but is, LC / least concern **;** 3 genetic variation, similar / same, but conservation status is different **;** 4 example **;** 5 gorilla is, most / critically, endangered but has high(er) genetic variation **;** 6 AVP **;** e.g. *ref. to* data limited to only seven species	**3**

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Question	Answer	Marks
3(a)	1 ($q^2 = \frac{440}{1100}$ **or** $q2 = 0.4$) $q = \sqrt{0.4}$ **or** $q = 0.632455532$ **;** 2 ($p = 1 - 0.632455532$ **or** $p = 0.367544468$) $2pq = 2 \times 0.632455532 \times 0.367544468$ **or** $2pq = 0.4649110641$ **;** 3 (heterozygotes = $2pq \times 1100$ e.g. 511.4 **or** 511.5 **or** 511.6672) 511 / 512 **;**	**3**
3(b)	*any **two** from:* 1 colours / shades / categories / phenotypes, not distinct / not discrete / overlap / form a (gradual) range / include intermediates **;** 2 >1 / 4 / several / many, genes **;** 3 environment affects, it / colour / phenotype **;**	**2**
3(c)(i)	*any **two** from:* 1 (as climate changes) increase in CO_2 concentration causes, stomatal aperture to decrease / stomata to be less open **;** 2 less water, lost / evaporated / transpired (though stomata) **;** 3 compensates for / allows survival in, low water availability / dry conditions **;**	**2**

Question	Answer	Marks
3(c)(ii)	*any **four** from:* 1 (abscisic acid / ABA) binds to receptor on, (guard) cell surface membrane **;** 2 H^+ stops moving, out of cell / into cell wall **;** 3 Ca^{2+} ions enter, cytoplasm / cell **or** Ca^{2+} ions act as second messenger **;** 4 K^+ ions leave cell **;** 5 water leaves cell, by osmosis / down water potential gradient **;** 6 less turgid / flaccid, guard cell(s) close stoma(ta) **;**	**4**
3(d)(i)	*any **two** from:* 1 0.1, (μmol) increases / gives higher, rate (compared to control / normal) **;** 2 1(.0) and 10(.0), (μmol) decrease / give lower, rate (compared to control / normal) **;** 3 10(.0) (μmol) rate, stays (approx.) constant / plateaus / does not increase, over, time / (6) days **;** 4 data quote comparing rate at two concentrations on one day **or** data quote comparing rate on two different days for 10 μmol **;**	**3**
3(d)(ii)	1 protons / H^+ (ions) **;** 2 cellulose **;**	**2**

Question	Answer	Marks
4(a)(i)	1 DNA, joined / combined / made, from two / different, sources / species **;** 2 using (named), enzymes / vectors **or** to create a, GMO / transgenic organism **;**	**2**
4(a)(ii)	to, test / compare, effect(iveness) of, genes / proteins / Bt and OCII / plants / varieties / **A** and **B** **or** to see which, (gene / plant / variety / of **A** and **B**), works, better / best **;**	**1**
4(a)(iii)	to compare / provide a baseline / as a control **;**	**1**

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Question	Answer	Marks
4(b)	1 **A** and **B** kill larvae **;** 2 GM increases, yield of / food from (potatoes) **;** 3 **A**, is best / kills most / works faster / should be grown / will provide most food **;**	**3**

Question	Answer	Marks
5(a)	**highest**: malic acid **;** **lowest**: oleic acid **;**	**2**
5(b)	*any **five** from:* *similarities:* 1 use pyruvate **;** 2 occur in, cytoplasm / cytosol **;** 3 make / regenerate, NAD **;** 4 redox reaction **;** *differences:* 5 lactate / lactic acid, made in mammals and ethanol in yeast **;** 6 one step in mammals and two steps in yeast **;** 7 carbon dioxide made in yeast (not in mammals) **;** 8 reversible in mammals and irreversible in yeast **;**	**5**

Question	Answer	Marks
6(a)(i)	*any **two** from:* 1 transparent phenotype (reappears) in F2 (but not F1) **;** 2 so it is, inherited / passed down / genetic / not environmental **;** 3 new / recessive, allele **;**	**2**
6(a)(ii)	9 : 3 : 3 : 1 **;**	**1**

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Question	Answer	Marks
6(a)(iii)	*any **four** from:* 1 two genes **;** 2 on separate chromosomes / not linked **;** 3 not sex-linked / autosomal **;** 4 each gene has / both genes have, two alleles **;** 5 albino / white stripes, is recessive (allele) **;** 6 transparent / non-gold, is recessive (allele) **;** 7 wild type is dominant for both genes **;**	**4**
6(b)	*any **four** from:* 1 homologous chromosomes, pair up / form bivalents **;** 2 at prophase I **;** 3 independent assortment / random orientation **or** independent segregation **;** 4 (happens) at metaphase I **or** at anaphase I **;** 5 one chromosome of (each) pair has dominant allele and one has recessive **;** 6 four, combinations / permutations / different gametes **;** 7 worked example / diagram **;**	**4**

Question	Answer	Marks
7(a)(i)	*any **four** from:* *both* 1 acetylcholine, in / from, vesicles **;** 2 many mitochondria **;** 3 have presynaptic and postsynaptic membranes **;** 4 (synaptic) cleft / gap **;** 5 have receptor(s) (for ACh / neurotransmitter) **;** 6 presynaptic, Ca^{2+}, entry / channels **or** postsynaptic Na^{+}, entry / channels **;**	**4**
7(a)(ii)	*any **three** from:* 1 few(er) Ca^{2+} ions, leave sarcoplasmic reticulum / enter sarcoplasm **;** 2 few(er) Ca^{2+} ions bind to troponin **;** 3 few(er) troponin molecules change shape **;** 4 few(er) tropomyosin molecules move **;** 5 few(er) myosin-binding sites, uncovered / exposed **;** 6 few(er), actin-myosin cross bridges form / myosin (heads) bind to actin **;** 7 AVP **;** e.g. lack of P_i leads to less ATP formed 8 AVP **;** e.g. myosin-actin cross-bridges do not break / myosin heads do not reset	**3**
7(b)	**A**: adenylyl cyclase **;** **B**: protein kinase A **;**	**2**

Question	Answer	Marks
8(a)	letter **X** on rising slope to the left of the angle where line plateaus **;**	**1**
8(b)(i)	reverse transcriptase **;**	**1**
8(b)(ii)	transcription factor(s) **;**	**1**

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Question	Answer	Marks
8(b)(iii)	*any **three** from:* 1 in high light intensity plant can photosynthesise more **;** 2 so they need (more) / upregulate / increase / make (more) (named) enzymes / proteins, for photosynthesis **;** 3 (plus) named, enzyme / protein (for photosynthesis) **;** 4 (named) pigments to protect cells from excess light **;** 5 enzymes to make, sucrose / starch / amino acids **;** 6 proteins for, sucrose / amino acid, transport **;** 7/8 AVP **;;** e.g. DELLA breaks down releasing, phytochrome interacting factors / PIF	**3**

Question	Answer	Marks
9(a)(i)	*any **three** from:* 1 (random) mutation(s) allows detection of high frequency **;** 2 selection pressure is bat (predation) **;** 3 those that can detect, high frequencies / bats, survive / don't get eaten / have selective advantage / are selected for **;** 4 these, reproduce / pass on (beneficial) allele(s) **;** 5 those that can detect high sounds / beneficial alleles, increase (in frequency / in population) **;**	**3**
9(a)(ii)	*any **four** from:* 1 *ref. to* receptor / generator, potential **;** 2 vesicles of (named) neurotransmitter, move towards / fuse with, (presynaptic) membrane **;** 3 (named) neurotransmitter, release / exocytosis **;** 4 neurotransmitter binds to receptors on sensory neurone **;** 5 Na^+ / sodium, ions enter (sensory neurone) **;** 6 depolarisation (of membrane of sensory neurone) **;** 7 *ref. to* threshold potential / all-or-nothing response **;**	**4**

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Question	Answer	Marks
9(b)	*any **three** from:* S1 sympatric (speciation) **;** S2 different mutations **;** S3 gave, (named) phenotypic / behavioural, differences **;** S4 which gave behavioural, isolation / separation **;** S5 (leading to) inability to reproduce together / reproductive isolation / genetic isolation / no gene flow between them **;** **or** *any **three** from:* A1 allopatric (speciation) **;** A2 geographical, separation / barrier, in the past **;** A3 different, mutations / selection pressures **;** A4 gave, (named) phenotypic / behavioural, differences **;** A5 inability to reproduce together / reproductive isolation / genetic isolation / no gene flow between them, after populations re-join **;**	**3**

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Question	Answer	Marks
10	*any **seven** from:* 1 genetic engineering / recombinant (DNA technology) **;** 2 (named) drug / treatment / protein, from, (GM) bacteria / (GM) yeast / (named) (GM)O **;** 3 make insulin (drug for diabetes) **;** 4 make factor VIII (drug for haemophilia) **;** 5 make adenosine deaminase (drug for SCID) **;** 6 genetic, screening / diagnosis / testing **;** 7 (detect) BRCA1 / BRCA2 **;** 8 (detect number of repeats / allele for) Huntington's **;** 9 (detect allele for) cystic fibrosis / CFTR **;** 10 example of action if diagnosis positive **;** 11 gene therapy **;** 12 insert / add, normal allele into (named), cells / tissue (of person) **;** 13 to treat, eye disease(s) / LCA / Leber's congenital amaurosis **;** 14 to treat SCID **;** 15/16 AVP **; ;** e.g. *ref. to* help / develop, xenotransplantation GM / antigen-free, pigs / animals, to source, tissues / organs, for transplants GM plants to make vaccines GM / recombinant / DNA / mRNA, vaccines recombinant antibody technology other / different, recombinant therapeutic protein / genetic screening / gene therapy, example	**7**

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