Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/41**

Paper 4 A Level Structured Questions **October/November 2022**

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 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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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.

Mark scheme abbreviations:

; separates marking points
/ alternative answers for the same marking point
R reject
A accept
I ignore
AVP any valid point
AW alternative wording (where responses vary more than usual)
ecf error carried forward
underline actual word underlined 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

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Question	Answer	Marks
1(a)	*any **two** from:* 1 habitat loss **;** 2 competition with / disease from, farm / invasive / alien, animals / species **;** 3 climate change **;** 4 hunting / poaching / killing by humans **;** 5 AVP **;**	**2**
1(b)	*any **three** from:* 1 global / international / worldwide (authority / advisory) **;** 2 (to give advice to) conserve / protect, nature / biodiversity / habitats **;** 3 assess / categorise, species conservation status **;** 4 ref. Red List (of Threatened Species) **;** 5 influence, governments / policy **;** 6 educate / raise awareness **;** 7 AVP **;**	**3**

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Question	Answer	Marks
1(c)	*any **four** from:* 1 mating / IVF / (super-ovulate female plus) AI **;** 2 remove embryo (from, mated / artificially inseminated, female) **;** 3 check / select, healthy / normal / best, embryos **;** 4 may freeze embryos for, storage / later use **;** 5 implant embryos in (different female) uterus **;** 6 ref. surrogate (mother) **;** 7 ref. (named female reproductive) hormone(s) **;** 8 AVP **;**	**4**

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Question	Answer	Marks
2(a)	chlorophyll *a* / chlorophyll *b* / (β) carotene **;**	**1**
2(b)	*any **two** from:* 1 action (spectrum) shows rate of photosynthesis for light, wavelengths / colours **;** 2 absorption (spectrum) shows how much each, wavelength / colour, is absorbed **;** 3 higher absorption gives higher photosynthesis **;**	**2**
2(c)	*any **three** from:* 1 ref. (named) enzymes **;** 2 high(er) temperature increases rate **;** 3 (temperature affects) photophosphorylation / light-dependent / Calvin cycle / light-independent / ESC formation **; ora** 4 enzymes denature at, too high a temperature / very high temperature / above optimum temperature **;** 5 AVP **;**	**3**
2(d)	*any **three** from:* 1 RuBP joins with CO_2 to make, 6C intermediate / GP **;** 2 GP to TP **;** 3 (GP → TP) uses ATP **and** reduced NADP **;** 4 TP → glucose / hexose → starch **;** 5 condensation / polymerisation / glycosidic bonds **;**	**3**

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Question	Answer	Marks
3(a)(i)	*any **pair** (max 2) from:* 1 cristae / folds, let inner membrane expand **;** 2 when water enters (matrix), by osmosis / down water potential gradient **;** 3 inner membrane (relatively) impermeable to water **;** 4 (so) water does not enter (matrix), by osmosis / down water potential gradient **;** 5 inner membrane moves (H^+) ions out of matrix **;** 6 so less water enters (matrix), by osmosis / down water potential gradient **;**	**2**
3(a)(ii)	*any **three** names plus explanations from:* 1 pyruvate, for link reaction / to bind to coenzyme A / to make acetyl (CoA) / to make reduced NAD / be dehydrogenated **;** 2 oxaloacetate to, accept acetyl / make citrate **;** 3 citrate to, make reduced NAD / be dehydrogenated **;** 4 enzymes to catalyse, link reaction / Krebs cycle **;** 5 oxygen to, accept electrons / accept protons / form water **;** 6 water as a, solvent / medium for reactions **;** 7 DNA / RNA, to make (named) respiratory, enzymes / proteins **;**	**3**

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Question	Answer	Marks
3(a)(iii)	*any **one** from:* 1 so H^+, cannot move through / must move through ATP synthase **;** 2 to maintain proton gradient **;**	**1**
3(b)(i)	*any **four** from:* 1 (H atoms) split into protons and electrons **;** 2 electrons, flow / move, down ETC **;** 3 (releases) energy used to move H^+ to intermembrane space **;** 4 more / build-up of, H^+ / positive charge, in intermembrane space **;** 5 (causes / sets up) proton / electrochemical, gradient **;**	**4**
3(b)(ii)	*any **two** from:* 1 (P_i) by facilitated diffusion **or** through a protein, channel / carrier **;** 2 P_i and H^+ move together **;** 3 (as) H^+ ions diffuse (through ATP synth(et)ase / to matrix) **;**	**2**
3(b)(iii)	1 constant / sufficient / correct, supply / amount of, ADP / reactant **;** 2 (so) ATP can continue to be made / so enough ATP can be made **;**	**2**

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Question	Answer	Marks
4(a)	*any **four** from:* 1 add DNA to give a new (named), characteristic / protein **;** 2 restriction, enzyme / endonuclease, to obtain, gene / allele / section of DNA **or** restriction, enzyme / endonuclease, to cut plasmid **;** 3 combine gene with / insert gene into, vector / plasmid **;** 4 introduce, (recombinant) vector / plasmid, to, bacterium / (named host) cell **;** 5 clone / multiply, (named, recombinant / GM) organism **;** 6 AVP **;**	**4**
4(b)(i)	1 stem cells, proliferate / divide / multiply / make new cells **;** 2 (correct) gene is, inherited by / passed on to / present in, new cells **;**	**2**
4(b)(ii)	*any **two** from:* 1 to switch gene on / so gene is expressed / allow transcription **;** 2 at right time / all the time / in sufficient quantities **;** 3 to allow binding of, RNA polymerase / transcription factors **;**	**2**

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Question	Answer	Marks
4(b)(iii)	*any **two** from:* 1 retrovirus / new gene, could / must not, insert in wrong place / disrupt other genes **;** 2 could / must not, cause cancer **;** 3 could / must not, cause, infection / disease **;** 4 could / must not, cause, immune / allergic, response **;** 5 AVP **;**	**2**
4(c)	*any **three** from:* 1 HD is caused by a <u>dominant</u> allele **;** 2 adding a 'normal' recessive allele would not work **;** 3 gene editing can / we need to, delete / remove / inactivate, HD / mutant, allele / DNA **;** 4 ref. (surplus CAG) repeats / triplets / stutter **;**	**3**

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Question	Answer	Marks
5(a)	*any **five** from:* 1 evolution / speciation / natural selection **;** 2 random / spontaneous **;** 3 mutations (occurred) **;** 4 adapting some plants to, alpine habitat / high altitude / mountains **;** 5 (in this habitat) these plants, survived / were selected for **;** 6 (selection pressure is / must resist) cold / strong winds / thin soil **;** 7 alleles for alpine features passed to offspring **;** 8 change in, allele frequency / gene pool (of population) **;** 9 population become, morphologically / physiologically / biochemically, different **;** 10 less, herbivores / competition, in new <u>niche</u> **;** 11 AVP **;**	**5**
5(b)(i)	*any **three** from:* 1 time period = from 0.95 million years (to present) **;** 2 mountains high enough to exceed treeline **;** 3 this provides alpine, habitat / region / niches **;**	**3**

Question	Answer	Marks
5(b)(ii)	*any **two** from:* 1 compare / find similarities in / find differences in, DNA **;** 2 of alpine species and related (lowland) species **;** 3 find (time) when species, evolved / separated / diverged / speciated **;** 4 many, DNA / base / nucleotide, differences / changes / mutations, means they, separated a long time ago / have a distant common ancestor **;** 5 AVP **;**	**2**

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Question	Answer	Marks
6(a)	*any **four** from:* 1 breed / cross, plants with desired (named) characteristics **;** 2 breed, better / best, offspring, repeatedly / for many generations **;** 3 (*correct ref. to*) inbreeding / line breeding **;** 4 (*correct ref. to*) hybridisation / outbreeding / outcrossing **;** 5 (gives) hybrid vigour / heterosis / outbreeding enhancement (in offspring) **;** 6 F1 have, same genotype / uniform phenotype **;** 7 AVP **;**	**4**
6(b)(i)	*any **one** from:* 1 (IR8) less likely to, fall over / lodge / collapse **;** 2 (IR8) higher proportion / more, of plant is, edible / grain **;**	**1**
6(b)(ii)	check for, genes / alleles / DNA, for high yield **and** flood tolerance **;**	**1**
6(b)(iii)	*any **one** from:* 1 to, maintain high yield / increase yield / give higher yield **;** 2 to avoid inbreeding depression **or** to maintain, hybrid vigour / heterosis **;**	**1**

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Question	Answer	Marks
6(c)(ii)	*any **four** from:* *variety A:* 1 gibberellin binds to, receptor / GID1 **;** 2 DELLA protein breaks down **;** 3 PIF / transcription factor (released) to, bind to DNA / transcribe genes **;** 4 stem / internode / cell, elongation / growth, occurs **;** 5 **A**, is *lele* / has no *Le* allele **;** 6 **A** does not produce its own (active) gibberellin **;** *variety B:* 7 does not respond to / no effect from, gibberellin **;** 8 lacks / has non-functional, gibberellin receptor **;**	**4**
6(c)(ii)	*any **two** from:* 1 (BZR1) binds to promoter **;** 2 to switch gene on / so gene is expressed / allow transcription **;** 3 allows binding of RNA polymerase (to DNA / promoter) **;**	**2**

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Question	Answer	Marks
7(a)	1 *symbols* **B** / $\mathbf{X^B}$ = (allele for) black (fur) **G** / $\mathbf{X^G}$ = (allele for) ginger (fur) **;** *parents phenotypes* *tortoiseshell female* *ginger male* 2 *parents genotypes* $\mathbf{X^BX^G}$ $\mathbf{X^GY}$ **;** 3 *gametes* $\mathbf{X^B}$ $\mathbf{X^G}$ $\mathbf{X^G}$ **Y** **;** *4* offspring *genotypes* $\mathbf{X^BX^G}$ $\mathbf{X^BY}$ $\mathbf{X^GX^G}$ $\mathbf{X^GY}$ **;** 5 *offspring phenotypes* tortoiseshell female, black male, ginger female, ginger male **;**	**5**
7(b)	*any **three** from:* 1 *TYR* codes for tyrosinase **;** 2 converts tyrosine into DOPA **;** 3 converts DOPA into dopaquinone **;** 4 dopaquinone converted to melanin **;**	**3**

Question	Answer	Marks
8(a)	**A** – distal convoluted tub(ul)e **;** **B** – cortex **;** **C** – loop of Henlé **;**	**3**

Question	Answer	Marks
8(b)	*any **three** from:* 1 as ADH concentration increases urine concentration increases **;** 2 as ADH concentration increases urine flow rate decreases **;** 3 as urine flow rate decreases urine concentration increases **;** 4 data quote with units **;** 5 AVP **;**	**3**
8(c)	*any **five** from:* 1 ADH binds to <u>cell</u>, surface / membrane, receptor (of collecting duct cells) **;** 2 *ref*. G protein / adenyl(ate) cyclase **;** 3 second messenger / cAMP **;** 4 protein kinase activated **;** 5 vesicles, move towards / fuse with, cell (surface) membrane **;** 6 *correct ref.* aquaporins **;** 7 collecting duct / cells / membrane, (more) permeable to water **;** 8 more water, leaves, lumen / nephron **or** more water enters, blood / medulla **;**	**5**

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Question	Answer	Marks
9(a)	*any **four** from:* *motor / neurone* 1 resting potential higher **;** 2 –70 mV (motor) versus –90 mV (muscle) **;** 3 smaller change in membrane potential / smaller depolarisation **;** 4 110 mV (motor) versus 130 mV (muscle) **;** 5 action potential / depolarisation, takes less time / is faster **;** 6 (action potential) 2.7 ms (motor) versus 4 ms (muscle) **or** (depolarisation) 1 ms (motor) versus 2 ms (muscle) **;** 7 hyperpolarisation / <u>relative</u> refractory period, occurs **;**	**4**
9(b)(i)	*any **three** from:* 1 transverse / T- , tubules depolarised **;** 2 Ca^{2+} <u>diffuse</u> out of sarcoplasmic reticulum **;** 3 Ca^{2+} bind to troponin **;** 4 tropomyosin, moves from / exposes, binding sites **;** 5 for myosin on actin **;** 6 cross-bridges form / myosin (head) binds to actin **;**	**3**

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Question	Answer	Marks
9(b)(ii)	*any **one** from:* 1 cross bridges break / myosin heads detach, at different times **;** 2 AVP **;**	**1**

Question	Answer	Marks
10	1 internal **;** 2 <u>negative feedback</u> **;** 3 receptor(s) **;** 4 endocrine / islets of Langerhans / α and β **;** 5 glycogen **;**	**5**

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Mark scheme abbreviations:

;	separates marking points
/	alternative answers for the same marking point
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underline	actual word underlined 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

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Question	Answer	Marks
1(a)	*any **three** from:* 1 Red List **;** 2 e.g. threatened / endangered / extinct etc., species **;** 3 ref. education / spreads awareness **;** 4 provides a **global forum** for sharing expertise / AW **;** 5 provides **advice** about conservation issues **;**	**3**
1(b)	1 cattle at edge / old and weak cattle, (easy) for lions to kill (for food) **;** 2 (so) the remaining cattle can survive / AW **;**	**2**
1(c)	*any **four** from:* 1 female given, hormone / FSH / gonadotropins **;** 2 *ref. to* superovulation / AW **;** 3 (secondary) oocytes / ova, harvested / AW **; Ignore** eggs 4 detail of harvest **;** e.g. use of fine needle / using ultrasound 5 sperm / semen, added to (secondary) oocytes / ova **;** 6 cultured / AW, for several days / until embryo or blastocyst stage **; Ignore** number of cells 7 embryo / blastocyst, placed in uterus **;**	**4**

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Question	Answer	Marks
2(a)(i)	*any **four** from:* 1 glycolysis **;** 2 glucose to pyruvate **;** 3 pyruvate to ethanal by, decarboxylation / CO_2 removal **;** 4 ethanal, reduced / hydrogenated, to ethanol **;** 5 reduced NAD to NAD **; A** regeneration of NAD 6 AVP **;** e.g. ethanol / alcohol, dehydrogenase or pyruvate decarboxylase	**4**
2(a)(ii)	*any **two** from:* 1 can survive (in absence of oxygen) **;** 2 (as) ATP still produced (from glycolysis) **;** 3 glycolysis can continue **;** 4 as NAD recycled **;**	**2**
2(b)	*any **two** from:* 1 GM strain has higher (concentration of ethanol / ethanol production) **or** GM strain has steeper increase (in concentration of ethanol / ethanol production) **; ora** 2 (both GM and non-GM) (concentration of ethanol / ethanol production) increases then levels off **;** 3 comparative figs to support trend **;** e.g. (mp1) (max concentration) for GM 19 g dm^{-3} and non-GM 1 g dm^{-3} (mp2) (levels off at) 18 g dm^{-3} for GM and 1 g dm^{-3} for non-GM	**2**

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Question	Answer	Marks
2(c)	*any **two** from:* 1 similar / same, concentration of starch hydrolysed **;** 2 similar / same, concentration of glucose available (to yeast) **;** 3 enzymes work at the same rate (in both methods) **;** 4 AVP **;** e.g. GM yeast cells produce more enzymes	**2**
2(d)	*any **one** from:* 1 more (named) fuel or electricity needed **;** 2 need to add enzymes **;** 3 AVP **;** e.g. (whole method) takes longer	**1**

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Question	Answer	Marks
3(a)(i)	**D ;** **B ;**	**2**
3(a)(ii)	*any **four** from:* 1 thylakoid stacks or discs / many thylakoids, for, increased or large, surface area **;** 2 increased or large, surface area maximises the absorption of light (energy) / AW **; Ignore** trap (light energy) *mp 3–5 thylakoid membranes / grana contain* 3 photosynthetic / named / primary / accessory, pigments to absorb light (energy) **;** 4 electron carriers / ETC, to, transfer / release, energy (from excited electrons) **;** 5 photosystems / antenna complex and reaction centre, are light harvesting structures **;** 6 thylakoid space or lumen to, form proton gradient / have high concentration of protons **;** 7 thylakoid membrane is (relatively) impermeable, to maintain the proton gradient (for chemiosmosis) **;** 8 ATP synthase to make ATP **;** 9 contains oxygen-evolving complex / OEC, for the photolysis of water **;**	**4**

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Question	Answer	Marks
3(b)(i)	*any **three** from:* 1 the pH is higher in the light than in the dark **ora** **or** the pH increases (from dark) to light **or** the pH decreases (from light) to dark **;** 2 the pH, increases **sharply** / AW, when changed to light **;** 3 the pH, levels off / AW, in light **;** 4 the pH decreases, **gradually** / less steeply, when returned to the dark **or** decrease in pH does not return to original (dark) pH **;** 5 *ref. to* fluctuations anywhere / described **;** 6 comparative figures to support **;** (mp1) dark(1) ~ pH 7.31–7.6 vs light ~ 7.52–7.61 vs dark (2) ~ 7.51–7.38 (mp2) from pH 7.36–7.56 in 36 s (1½ squares and each square 24 s) (mp4) from pH 7.56–7.4 in 288 s (12 squares)	**3**
3(b)(ii)	*any **three** from:* 1 the stroma has higher pH when H^+ ions, move, out (of stroma) / into thylakoid, space / lumen **;** 2 (leads to) increased H^+ concentration in the thylakoid, space / lumen **;** 3 (then) H^+ diffuse back (into stroma) through ATP synthase **;** 4 AVP **;** e.g. idea not to support theory	**3**

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Question	Answer	Marks
4(a)	*any **four** from:* 1 manipulate DNA to modify organism's characteristics / AW **;** 2 gene / allele / (section of) DNA, obtained using restriction, enzyme / endonuclease **;** 3 use of reverse transcriptase to make, gene / allele / (section of) DNA, using mRNA **;** 4 gene / allele / (section of) DNA, inserted into, vector / plasmid, using ligase **;** 5 add / insert, (recombinant), vector / plasmid, into, (host) cell / bacterium **;** 6 clone / multiply, cell / bacteria **; A** put bacteria in a fermenter 7 gene is expressed and, protein / factor XIII / factor IX, is made **;** 8 AVP **;** e.g. artificial / chemical, synthesis of new gene	**4**
4(b)(i)	*any **three** from:* 1 haemophilia B (first) because (F9) gene is small enough to fit into virus / 1.6kbp and 4.7kbp **; ora** 2 haemophilia A (first) because it is more common **; ora** *therapy not attempted* 3 (because) disease can be managed by recombinant proteins **;** 4 gene therapy (trials) involve, risk of harm / side effects / allergic reactions / immune response **;** *therapy attempted* 5 provides a cure / AW **;** 6 taking clotting factors etc. can involve risk of harm **;**	**3**

Question	Answer	Marks
4(b)(ii)	*any **two** from:* 1 to allow binding of, RNA polymerase / transcription factors **;** 2 to switch gene on / so gene is expressed / allow transcription (of gene) **;** 3 at right time / all the time / in sufficient quantities **;** 4 in correct tissue **;**	**2**
4(b)(iii)	*any **two** from:* *decrease success because:* 1 antibodies / immune response, may, destroy / attack / AW, virus / vector **;** 2 (so) limiting / stopping, delivery of, gene / allele / DNA, to cells **;** 3 destroys GM cells **or** destroys cells that have successfully taken up the, virus / gene / allele / DNA **;**	**2**
4(c)	*any **two** from:* *list rule* 1 (gene editing) is, precise / exact / accurate **;** 2 patient's own gene can be, edited / corrected **or** no introduction of, gene / allele **;** 3 no need to introduce promoter **;** 4 less / no, risk of cancer **or** less / no, immune response **;**	**2**

Question	Answer	Marks
5(a)	1 at 95 °C, (DNA) denatures / (dsDNA) splits into single strands / H bonds break **;** 2 at 50 °C, primers, anneal / bind, (to ssDNA) **;** 3 at 72 °C, complementary / second, (DNA) strand is made **; A** DNA replicated / (ssDNA) is made into dsDNA	**3**
5(b)	*any **four** from 1–7:* 1 *M. pygmaea* (populations) geographically isolated / separated by sea or water **;** 2 *M. pulvinaris* (populations) geographically isolated / mountain tops separated **;** *M. pygmea* or *M. pulvinaris / South Island or Stewart Island species:* 3 no / little, interbreeding / gene flow, between populations **;** 4 different, selection pressures / environment **;** 5 different / random, mutations **;** 6 different changes in allele frequencies / different gene pools **;** 7 (so) allopatric speciation could be occurring (within either species) / AW **;** *M. pottsiana / North Island species:* 8 no geographical isolation **;** 9 (so) interbreeding / gene flow, occurs, within / between, population(s) **;** 10 similar, selection pressures / environment **;**	**5**

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Question	Answer	Marks
5(c)	*any **two** from:* 1 genetic drift / bottleneck / founder effect **;** 2 migration **;** 3 mutation **;** 4 artificial selection / selective breeding **;**	**2**

Question	Answer	Marks
6(a)(i)	*any **three** from:* 1 *trp* operon regulatory gene / *trpR*, codes for an inactive repressor **and** *lac* operon regulatory gene / *lacI*, codes for active repressor **;** 2 *lac* operon does not have an attenuator **; ora** 3 *lac* operon has fewer structural genes **or** 3 vs 5 structural genes **;** 4 *lac* operon uses, an inducer / (allo)lactose **and** *trp* operon uses, a repressor / tryptophan **;** 5 (allo)lactose, binds / inactivates, repressor, so repressor, leaves / cannot bind to, **operator** **and** tryptophan, binds / activates, repressor, so repressor can bind to **operator ;** 6 (allo)lactose causes genes to be, transcribed / switched on / expressed **and** tryptophan causes genes to be **not**, transcribed / switched on / expressed **;**	**3**
6(a)(ii)	*any **one** from:* 1 (share) one promoter **;** 2 all, enzymes / proteins / products, work together **;**	**1**
6(a)(iii)	*structural genes*: code for, enzymes / structural proteins / non-regulatory proteins / rRNA / tRNA **;** *regulatory genes*: code for, proteins / products, that control, gene expression / transcription **;** **A** code for, transcription factors / repressor proteins	**2**

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Question	Answer	Marks
6(a)(iv)	*any **two** from:* 1 end-product inhibition / negative feedback / feedback inhibition **;** 2 tryptophan, binds to / activates, repressor **or** tryptophan allows repressor to bind to operator **;** 3 tryptophan, stops / reduces, *trpA or* gene transcription / *trpA or* gene expression / protein synthesis / tryptophan synthase being made **;**	**2**
6(b)(i)	*any **four** from:* 1 (gibberellin) binds to receptor **;** 2 ref. enzyme **;** 3 (enzyme causes) DELLA breakdown **;** 4 DELLA no longer, binds to / inhibits, transcription factor / PIF **;** 5 (so) transcription factor / PIF / RNA polymerase, binds to, DNA / promoter **;** 6 (growth) genes, switched on / expressed / transcribed **;**	**4**
6(b)(ii)	*mark first answer* transcription factor(s) **;**	**1**

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Question	Answer	Marks
7(a)	*dominant* – allele always has effect on phenotype / allele expressed in homozygote and heterozygote / allele always expressed **;** *recessive* – allele only has effect on phenotype if dominant allele absent / only expressed in homozygote **;**	**2**
7(b)	*symbols* $\mathbf{Z^B}$ = allele for bronze feathers $\mathbf{Z^b}$ = allele for brown feathers **;** *parents phenotypes* *bronze male* x *brown female* *parents genotypes* $\mathbf{Z^BZ^b}$ x $\mathbf{Z^bW}$ **;** *gametes* $\mathbf{Z^B}$ $\mathbf{Z^b}$ $\mathbf{Z^b}$ $\mathbf{W}$ **;** *offspring genotypes* $\mathbf{Z^BZ^b}$ $\mathbf{Z^BW}$ $\mathbf{Z^bZ^b}$ $\mathbf{Z^bW}$ **;** *offspring phenotypes* bronze male bronze female brown male brown female**;** *ecf for putting allele on **W*** *ecf for incorrect symbols with no superscript* *ecf for different letters for alleles* *no sex chromosomes = no marks*	**5**
7(c)	1 cross with brown female **;** 2 if **all** offspring bronze then male is, homozygous / $\mathbf{Z^BZ^B}$ **;** 3 if (some offspring are bronze and) some are brown then male is, heterozygous / $\mathbf{Z^BZ^b}$ **;**	**3**

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Question	Answer	Marks
8(a)	**C** pointing to the microvilli adjacent to the proximal convoluted tubule lumen **;** **P** pointing to the basal membrane adjacent to the blood capillary **;** *label line must touch a membrane (not a space)*	**2**
8(b)	*any **five** from:* 1 microvilli for large surface area (for reabsorption) **;** 2 (large surface area) for **many**, cotransporters / carrier proteins **;** 3 cotransporter (proteins) to absorb sodium ions with, glucose / amino acids **; A** idea of secondary active transport 4 tight junctions between cells so substances have to pass through the cells / AW **;** 5 **many** mitochondria to produce ATP **;** 6 (ATP) for the sodium (potassium) pumps **or** (ATP) to pump / actively transport, sodium ions (into the blood) **;** 7 folded basal membrane for **many** sodium (potassium) pumps **;**	**5**
8(c)	$\frac{2.00}{0.03}$ **;** 67 **;** *if* $\frac{2.00 - 0.03}{0.03}$ *given then accept 66 ecf for second mark point only*	**2**

Question	Answer	Marks
9(a)	<table><tr><th>phase of action potential</th><th>state of voltage-gated channels</th></tr><tr><td>A</td><td>2</td></tr><tr><td>C</td><td>1</td></tr><tr><td>E</td><td>3</td></tr><tr><td>F</td><td>3</td></tr><tr><td>G</td><td>2</td></tr></table> **;;;** *5 correct = 3 marks* *3/4 correct = 2 marks* *1/2 correct = 1 mark*	**3**
9(b)	*any **three** from:* 1 Schwann cells, wrap around the axon / form the myelin sheath **;** 2 insulates (axon) / prevents movement of ions **;** 3 depolarisation / action potentials, can only occur at nodes (of Ranvier) **;** 4 *ref. to* long(er) local circuits / (nodes are) 1–3 mm apart **;** 5 action potentials, move by saltatory conduction / jump from node to node **;** 6 speed of transmission is, fast(er) / 100 m s^{-1} **;**	**3**

Question	Answer	Marks
10(a)	*any **four** from:* 1 decreasing / low, blood glucose concentration **causes**, increase in glucagon concentration / glucagon secretion **;** 2 glucagon acts on liver cells **;** 3 glycogenolysis / described **; R** is glucagon breaks down glycogen 4 gluconeogenesis / described **;** 5 **so**, glucose is released into the blood / blood glucose concentration increases **;** 6 *ref. to* negative feedback **;**	**4**
10(b)	complementary **;** G-protein **;** adenyl(yl) cyclase **;**	**3**

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Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/43**

Paper 4 A Level Structured Questions **October/November 2022**

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.

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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.

Mark scheme abbreviations:

; separates marking points
/ alternative answers for the same marking point
R reject
A accept
I ignore
AVP any valid point
AW alternative wording (where responses vary more than usual)
ecf error carried forward
underline actual word underlined 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

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Question	Answer	Marks
1(a)	*any **two** from:* 1 habitat loss **;** 2 competition with / disease from, farm / invasive / alien, animals / species **;** 3 climate change **;** 4 hunting / poaching / killing by humans **;** 5 AVP **;**	**2**
1(b)	*any **three** from:* 1 global / international / worldwide (authority / advisory) **;** 2 (to give advice to) conserve / protect, nature / biodiversity / habitats **;** 3 assess / categorise, species conservation status **;** 4 ref. Red List (of Threatened Species) **;** 5 influence, governments / policy **;** 6 educate / raise awareness **;** 7 AVP **;**	**3**

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Question	Answer	Marks
1(c)	*any **four** from:* 1 mating / IVF / (super-ovulate female plus) AI **;** 2 remove embryo (from, mated / artificially inseminated, female) **;** 3 check / select, healthy / normal / best, embryos **;** 4 may freeze embryos for, storage / later use **;** 5 implant embryos in (different female) uterus **;** 6 ref. surrogate (mother) **;** 7 ref. (named female reproductive) hormone(s) **;** 8 AVP **;**	**4**

Question	Answer	Marks
2(a)	chlorophyll *a* / chlorophyll *b* / (β) carotene **;**	**1**
2(b)	*any **two** from:* 1 action (spectrum) shows <u>rate</u> of photosynthesis for light, wavelengths / colours **;** 2 absorption (spectrum) shows how much each, wavelength / colour, is absorbed **;** 3 higher absorption gives higher photosynthesis **;**	**2**
2(c)	*any **three** from:* 1 ref. (named) <u>enzymes</u> **;** 2 high(er) temperature increases rate **;** 3 (temperature affects) photophosphorylation / light-dependent / Calvin cycle / light-independent / ESC formation **; ora** 4 enzymes denature at, too high a temperature / very high temperature / above optimum temperature **;** 5 AVP **;**	**3**
2(d)	*any **three** from:* 1 RuBP joins with CO_2 to make, 6C intermediate / GP **;** 2 GP to TP **;** 3 (GP → TP) uses ATP **and** reduced NADP **;** 4 TP → glucose / hexose → starch **;** 5 condensation / polymerisation / glycosidic bonds **;**	**3**

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Question	Answer	Marks
3(a)(i)	*any **pair** (max 2) from:* 1 cristae / folds, let inner membrane expand **;** 2 when water enters (matrix), by osmosis / down water potential gradient **;** 3 inner membrane (relatively) impermeable to water **;** 4 (so) water does not enter (matrix), by osmosis / down water potential gradient **;** 5 inner membrane moves (H^+) ions out of matrix **;** 6 so less water enters (matrix), by osmosis / down water potential gradient **;**	**2**
3(a)(ii)	*any **three** names plus explanations from:* 1 pyruvate, for link reaction / to bind to coenzyme A / to make acetyl (CoA) / to make reduced NAD / be dehydrogenated **;** 2 oxaloacetate to, accept acetyl / make citrate **;** 3 citrate to, make reduced NAD / be dehydrogenated **;** 4 enzymes to catalyse, link reaction / Krebs cycle **;** 5 oxygen to, accept electrons / accept protons / form water **;** 6 water as a, solvent / medium for reactions **;** 7 DNA / RNA, to make (named) respiratory, enzymes / proteins **;**	**3**

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Question	Answer	Marks
3(a)(iii)	*any **one** from:* 1 so H^+, cannot move through / must move through ATP synthase **;** 2 to maintain proton gradient **;**	**1**
3(b)(i)	*any **four** from:* 1 (H atoms) split into protons and electrons **;** 2 electrons, flow / move, down ETC **;** 3 (releases) energy used to move H^+ to intermembrane space **;** 4 more / build-up of, H^+ / positive charge, in intermembrane space **;** 5 (causes / sets up) proton / electrochemical, <u>gradient</u> **;**	**4**
3(b)(ii)	*any **two** from:* 1 (P_i) by facilitated diffusion **or** through a protein, channel / carrier **;** 2 P_i and H^+ move together **;** 3 (as) H^+ ions <u>diffuse</u> (through ATP synth(et)ase / to matrix) **;**	**2**
3(b)(iii)	1 constant / sufficient / correct, supply / amount of, ADP / reactant **;** 2 (so) ATP can continue to be made / so enough ATP can be made **;**	**2**

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Question	Answer	Marks
4(a)	*any **four** from:* 1 add DNA to give a new (named), characteristic / protein **;** 2 restriction, enzyme / endonuclease, to obtain, gene / allele / section of DNA **or** restriction, enzyme / endonuclease, to cut plasmid **;** 3 combine gene with / insert gene into, vector / plasmid **;** 4 introduce, (recombinant) vector / plasmid, to, bacterium / (named host) cell **;** 5 clone / multiply, (named, recombinant / GM) organism **;** 6 AVP **;**	**4**
4(b)(i)	1 stem cells, proliferate / divide / multiply / make new cells **;** 2 (correct) gene is, inherited by / passed on to / present in, new cells **;**	**2**
4(b)(ii)	*any **two** from:* 1 to switch gene on / so gene is expressed / allow transcription **;** 2 at right time / all the time / in sufficient quantities **;** 3 to allow binding of, RNA polymerase / transcription factors **;**	**2**

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Question	Answer	Marks
4(b)(iii)	*any **two** from:* 1 retrovirus / new gene, could / must not, insert in wrong place / disrupt other genes **;** 2 could / must not, cause cancer **;** 3 could / must not, cause, infection / disease **;** 4 could / must not, cause, immune / allergic, response **;** 5 AVP **;**	**2**
4(c)	*any **three** from:* 1 HD is caused by a <u>dominant</u> allele **;** 2 adding a 'normal' recessive allele would not work **;** 3 gene editing can / we need to, delete / remove / inactivate, HD / mutant, allele / DNA **;** 4 ref. (surplus CAG) repeats / triplets / stutter **;**	**3**

Question	Answer	Marks
5(a)	*any **five** from:* 1 evolution / speciation / natural selection **;** 2 random / spontaneous **;** 3 mutations (occurred) **;** 4 adapting some plants to, alpine habitat / high altitude / mountains **;** 5 (in this habitat) these plants, survived / were selected for **;** 6 (selection pressure is / must resist) cold / strong winds / thin soil **;** 7 alleles for alpine features passed to offspring **;** 8 change in, allele frequency / gene pool (of population) **;** 9 population become, morphologically / physiologically / biochemically, different **;** 10 less, herbivores / competition, in new <u>niche</u> **;** 11 AVP **;**	**5**
5(b)(i)	*any **three** from:* 1 time period = from 0.95 million years (to present) **;** 2 mountains high enough to exceed treeline **;** 3 this provides alpine, habitat / region / niches **;**	**3**

Question	Answer	Marks
5(b)(ii)	*any **two** from:* 1 compare / find similarities in / find differences in, DNA **;** 2 of alpine species and related (lowland) species **;** 3 find (time) when species, evolved / separated / diverged / speciated **;** 4 many, DNA / base / nucleotide, differences / changes / mutations, means they, separated a long time ago / have a distant common ancestor **;** 5 AVP **;**	**2**

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Question	Answer	Marks
6(a)	*any **four** from:* 1 breed / cross, plants with desired (named) characteristics **;** 2 breed, better / best, offspring, repeatedly / for many generations **;** 3 (*correct ref. to*) inbreeding / line breeding **;** 4 (*correct ref. to*) hybridisation / outbreeding / outcrossing **;** 5 (gives) hybrid vigour / heterosis / outbreeding enhancement (in offspring) **;** 6 F1 have, same genotype / uniform phenotype **;** 7 AVP **;**	**4**
6(b)(i)	*any **one** from:* 1 (IR8) less likely to, fall over / lodge / collapse **;** 2 (IR8) higher proportion / more, of plant is, edible / grain **;**	**1**
6(b)(ii)	check for, genes / alleles / DNA, for high yield **and** flood tolerance **;**	**1**
6(b)(iii)	*any **one** from:* 1 to, maintain high yield / increase yield / give higher yield **;** 2 to avoid inbreeding depression **or** to maintain, hybrid vigour / heterosis **;**	**1**

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Question	Answer	Marks
6(c)(ii)	*any **four** from:* *variety A:* 1 gibberellin binds to, receptor / GID1 **;** 2 DELLA protein breaks down **;** 3 PIF / transcription factor (released) to, bind to DNA / transcribe genes **;** 4 stem / internode / cell, elongation / growth, occurs **;** 5 **A**, is *lele* / has no *Le* allele **;** 6 **A** does not produce its own (active) gibberellin **;** *variety B:* 7 does not respond to / no effect from, gibberellin **;** 8 lacks / has non-functional, gibberellin receptor **;**	**4**
6(c)(ii)	*any **two** from:* 1 (BZR1) binds to <u>promoter</u> **;** 2 to switch gene on / so gene is expressed / allow transcription **;** 3 allows binding of <u>RNA polymerase</u> (to DNA / promoter) **;**	**2**

Question	Answer	Marks
7(a)	1 *symbols* **B** / $\mathbf{X^B}$ = (allele for) black (fur) **G** / $\mathbf{X^G}$ = (allele for) ginger (fur) **;** *parents phenotypes* *tortoiseshell female* *ginger male* 2 *parents genotypes* $\mathbf{X^BX^G}$ $\mathbf{X^GY}$ **;** 3 *gametes* $\mathbf{X^B}$ $\mathbf{X^G}$ $\mathbf{X^G}$ **Y** **;** *4* offspring *genotypes* $\mathbf{X^BX^G}$ $\mathbf{X^BY}$ $\mathbf{X^GX^G}$ $\mathbf{X^GY}$ **;** 5 *offspring phenotypes* tortoiseshell female, black male, ginger female, ginger male **;**	**5**
7(b)	*any **three** from:* 1 *TYR* codes for tyrosinase **;** 2 converts tyrosine into DOPA **;** 3 converts DOPA into dopaquinone **;** 4 dopaquinone converted to melanin **;**	**3**

Question	Answer	Marks
8(a)	**A** – distal convoluted tub(ul)e **;** **B** – cortex **;** **C** – loop of Henlé **;**	**3**

Question	Answer	Marks
8(b)	*any **three** from:* 1 as ADH concentration increases urine concentration increases **;** 2 as ADH concentration increases urine flow rate decreases **;** 3 as urine flow rate decreases urine concentration increases **;** 4 data quote with units **;** 5 AVP **;**	**3**
8(c)	*any **five** from:* 1 ADH binds to <u>cell</u>, surface / membrane, receptor (of collecting duct cells) **;** 2 *ref*. G protein / adenyl(ate) cyclase **;** 3 second messenger / cAMP **;** 4 protein kinase activated **;** 5 vesicles, move towards / fuse with, cell (surface) membrane **;** 6 *correct ref.* aquaporins **;** 7 collecting duct / cells / membrane, (more) permeable to water **;** 8 more water, leaves, lumen / nephron **or** more water enters, blood / medulla **;**	**5**

Question	Answer	Marks
9(a)	*any **four** from:* *motor / neurone* 1 resting potential higher **;** 2 –70 mV (motor) versus –90 mV (muscle) **;** 3 smaller change in membrane potential / smaller depolarisation **;** 4 110 mV (motor) versus 130 mV (muscle) **;** 5 action potential / depolarisation, takes less time / is faster **;** 6 (action potential) 2.7 ms (motor) versus 4 ms (muscle) **or** (depolarisation) 1 ms (motor) versus 2 ms (muscle) **;** 7 hyperpolarisation / <u>relative</u> refractory period, occurs **;**	**4**
9(b)(i)	*any **three** from:* 1 transverse / T- , tubules depolarised **;** 2 Ca^{2+} <u>diffuse</u> out of sarcoplasmic reticulum **;** 3 Ca^{2+} bind to troponin **;** 4 tropomyosin, moves from / exposes, binding sites **;** 5 for myosin on actin **;** 6 cross-bridges form / myosin (head) binds to actin **;**	**3**

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Question	Answer	Marks
9(b)(ii)	*any **one** from:* 1 cross bridges break / myosin heads detach, at different times **;** 2 AVP **;**	**1**

Question	Answer	Marks
10	1 internal **;** 2 <u>negative feedback</u> **;** 3 receptor(s) **;** 4 endocrine / islets of Langerhans / α and β **;** 5 glycogen **;**	**5**

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