Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/41**

Paper 4 A Level Structured Questions **October/November 2020**

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 2020 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U 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.

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
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
I	ignore
AVP	alternative valid point

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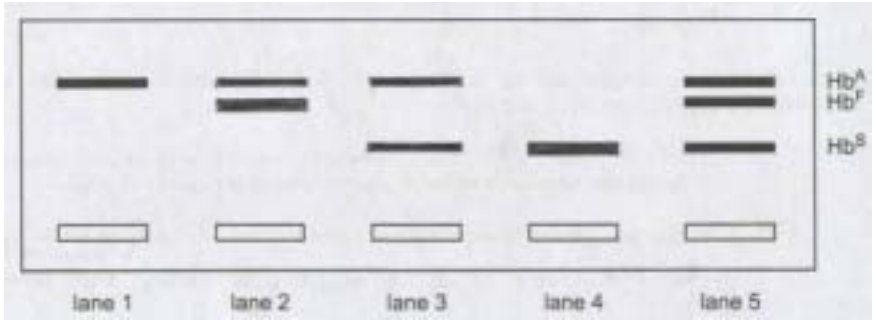
Question	Answer	Marks
1(a)	**A** – line to epidermal cell **;** **B** – line to mesophyll cell **;**	**2**
1(b)(i)	bundle sheath (cell) **;**	**1**
1(b)(ii)	*any **four** from:* **1** decrease / stop, photorespiration **;** **2** mesophyll cells, surround / protect / form ring round, bundle sheath **;** **3** air / oxygen, cannot reach, bundle sheath (cells) **;** **4** oxygen cannot, reach / bind to, RuBP / rubisco (in BSC) **;** **5** high / much, carbon dioxide (in bundle sheath cells) **;** **6** AVP **;**	**4**
1(c)(i)	*any **four** from:* **1** as temperature increases rate increases, up to 25 °C / at low temperatures, for both **;** **2** as temperature increases rate decreases, above 35 °C / at high temperatures, for both **;** **3** C3 rate higher, at low temperatures / < 22 °C **;** **4** C3 rate lower, at high temperatures / > 22 °C **;** **5** C3, peak rate / maximum rate / optimum T °C, at 25 °C **and** C4, peak rate / maximum rate / optimum T °C, at 30–35 °C **;** **6** C3 has lower, maximum rate / peak **;** **7** C3, maximum rate / peak, is at lower temperature **or** C3 has a lower optimum temperature **;** **8** comparative data quote **;**	**4**
1(c)(ii)	*comparison* rate, higher / faster, high CO_2 conditions **;** (at 30–35 °C) rate is maximum for both **;** *explanation (max 1)* carbon dioxide, limits rate / is limiting factor, in low CO_2 conditions **;** AVP **;**	**2**

Question	Answer	Marks
2(a)(i)	*any **three** from:* **1** environmental / not genetic **;** **2** as change in yield occurs in one goat **;** **3** yield increases (from 1st to 2nd) in all genotypes **;** **4** older / 2nd lactation, goats have, bigger / more developed, udders **;** **5** age / maturity, is an environmental factor **;** **6** AVP **;**	**3**
2(a)(ii)	*any **three** from:* **1** (substitution / **G** → **C / CC**) increases milk, yield / production **;** **2** more food / more income / benefit for people **;** **3** little difference between **GG** and **CG /** small effect in heterozygotes **;** **4** AVP **;**	**3**
2(b)(i)	**CC** = $(0.3 \times 0.3 \times 268 =)$ 24 **;** **CG** = $(2 \times 0.3 \times 0.7 \times 268 =)$ 113 **;**	**2**
2(b)(ii)	chi-square(d test) / χ^2 **;**	**1**
2(b)(iii)	**1** **CC,** higher than predicted / 47 instead of 16 **or GG,** higher than predicted / 324 instead of 289 **or CG,** lower than predicted / 69 instead of 135 **;** *plus any **two** from:* **2** could be (natural / artificial) selection against heterozygotes **;** **3** could be (artificial) selection for, high milk yield / **CC** **;** **4** migration / immigration / emigration **;** **5** genetic drift **;** **6** non-random mating **;**	**3**

Question	Answer	Marks
2(c)	*advantage:* **1** treat (genetic) disease / treat people / reduce suffering / therapeutic **;** *problem (max 1):* **2** possible side effects (on human) / drug may not be pure / may contain allergens / risk of harm / may be unsafe / risk of goat disease transmission to humans **;** **3** process may harm goats / animal welfare issues **;** **4** vegetarians / vegans, may not take drug **;**	**2**

Question	Answer	Marks
3(a)	*any **four** from:* **1** geographic(al), isolation / barrier between populations **;** **2** no / low / less, (inter)breeding / gene flow **;** **3** different mutations occur **;** **4** different (named), selection pressures / environment(al conditions) **;** **5** natural selection **;** **6** genetic drift **;** **7** allopatric (sub)speciation **;**	**4**
3(b)	cytochrome c oxidase / (mitochondrial) gene / DNA / base, sequences, (nearly) identical / (very) similar **;** small number of bases different / low percentage difference **;** difference to other species is greater **;**	**2**
3(c)	*any **two** from:* **1** identify species, quickly / automatically / by non-experts **;** **2** compare with, Red List / IUCN list / CITES appendix **;** **3** confiscate / destroy / relocate, endangered species / ES products **;** **4** prosecute / stop activities of, smugglers / traders / poachers **;** **5** prevent entry of, predators / competitors / diseases, that could harm native ES **;**	**2**

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Question	Answer	Marks
4(a)	*any **two** from:* **1** changed amino acid / changed 1° structure / polar → non-polar amino acid **;** **2** valine / non-polar R group, forms different bonds (than glutamine) **;** **3** bonds form between HbS molecules / HbS molecules stick together **;**	**2**
4(b)(i)	*any **two** from:* **1** both HbF and HbS present **;** **2** stops / decreases, HbS, shape change / fibre formation **;** **3** fewer red blood cells, change shape / sickle / block capillaries **;** **4** avoids very low pO_2 in, blood / capillaries / tissues **;**	**2**
4(b)(ii)	transcription factor / regulatory protein **;**	**1**
4(c)(i)	*any **four** from:* **1** current / potential difference / electric field (across gel) **;** **2** (protein / Hb) moves / attracted, to, anode / positive electrode **;** **3** HbS (more positive so) moves, more slowly **4** HbS moves, shorter distance / less (far) from negative end **;** **5** compare band positions to, known haemoglobins / reference bands **;** **6** if single band seen at HbS position person has sickle cell anaemia **;**	**4**
4(c)(ii)	 lanes 2, 3 and 4 correct = 2 marks **;;** two correct = 1 mark one or none correct = 0 marks	**2**

Question	Answer	Marks
5(a)	*parent phenotypes:* long hair pointed x short hair full colour ; *parent genotypes:* **hhrr** x **HhRr** ; *gametes:* **hr** **HR Hr hR hr** ; *F1 genotypes:* **HhRr** **Hhrr** **hhRr** **hhrr** ; *F1 phenotypes:* short hair full colour / short hair pointed / long hair full colour / long hair pointed ;	**5**
5(b)(i)	*any **one** from:* **1** two pointed parents (always) give (all) pointed offspring ; **2** two full colour cats can give a pointed offspring ; **3** pointed phenotype has, **– – /** homozygous **– /** no restriction site(s) ;	**1**
5(b)(ii)	*any **two** from:* *autosomal because* **1** males have two alleles ; **2** (marker inheritance shows) sons get one number from father ; **3** colour of sons not determined only by mother ; **4** gene is not on X chromosome (linked to mps 1, 2 or 3) ;	**2**
5(b)(iii)	*any **two** from:* plus or minus and marker number inherited, together / as a block / as a pair ; <u>no</u>, recombination / (results of) crossing over, seen ; no, +3 / +4 / –7, in bottom right hand cat ;	**2**

Question	Answer	Marks
6(a)(i)	(cytoplasm of) presynaptic / terminal, knob ; presynaptic membrane ; presynaptic membrane ; postsynaptic membrane ;	**4**
6(a)(ii)	*any **two** from:* one-way / unidirectional (transmission of impulses) ; communication between (many) neurones ; AVP ;	**2**
6(b)	*any **four** from:* **1** binds to / inhibits, acetylcholinesterase ; **2** active site, blocked / shape changes ; **3** Ach / acetylcholinesterase, not broken down / stays bound to receptors ; **4** Na^+ channels stay open ; **5** sarcolemma, (stays) depolarised / has constant action potentials ; **6** muscles stay contracted ;	**4**
6(c)	*any **two** from:* **1** Ca^{2+} channels open ; **2** Ca^{2+}, diffuses / released, into sarcoplasm ; **3** Ca^{2+} binds to troponin ; **4** tropomyosin, moves / changes position ; **5** cross-bridges form / myosin binds to actin ;	**2**

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Question	Answer	Marks
7(a)	**A ;** **E ;** **C / D ;** **B ;** **H ;** **D ;**	**6**
7(b)	lactate, converted / oxidised **;** to, pyruvate / glucose / glycogen **;** haemoglobin / myoglobin, re-oxygenated **;**	**2**

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Question	Answer	Marks
8(a)	5000 ÷ 350 **;** 14.3 **;**	**2**
8(b)	*any **five** from:* **1** aesthetic / leisure, reasons **;** **2** moral / ethical, reasons **;** **3** resource material **;** **4** economic benefits for local community / (eco)tourism **;** **5** maintain / do not disrupt, food webs / food chains / ecosystem **;** **6** mineral (re)cycling **;** **7** maintain, large gene pool / genetic variation **;** **8** AVP **;**	**5**
8(c)	*any **two** from:* **1** do not buy unsustainable palm oil (products) **;** **2** campaign / raise awareness / educate, for sustainable palm oil **;** **3** donate to, anti-deforestation / conservation, charities **;** **4** AVP **;**	**2**
9(a)	*any **seven** from:* **1** double stranded DNA **;** **2** have, restriction site / target sequence for restriction enzyme **;** **3** allows gene (for cloning) to be inserted **;** **4** small **;** **5** plasmid can, enter / transform, (host) cell / bacterium **;** **6** circular **;** **7** stable **;** **8** contain, (named) marker genes / (named) genes for antibiotic resistance **;** **9** used to identify, GM / transformed / recombinant, (bacterial) cells **;** **10** replicate, fast / independently (of host cell replication) **;** **11** get many copies of cloned gene **;** **12** AVP **;**	**7**

Question	Answer	Marks
9(b)	*any **eight** from:* *restriction endonucleases* **1** cut DNA **;** **2** at, restriction site / specific (base) sequence / target sequence **;** **3** *ref. to* palindrome **;** **4** give, sticky / blunt, ends **;** *ligases* **5** join gene to, plasmid / (named) vector **;** **6** seal (sugar-phosphate) backbone **;** **7** make, phospho(di)ester / covalent, bonds **;** **8** make recombinant, DNA / plasmid / vector **;** *reverse transcriptase* **9** makes cDNA **;** **10** from mRNA **;** **11** *ref. to* DNA single-stranded initially **;** **12** AVP **;**	**8**

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Question	Answer	Marks
10(a)	*any **seven** from:* **1** adrenaline, binds / joins, to receptor **;** **2** on (cell surface) membrane of liver cells **;** **3** activates / stimulates, G protein **;** **4** activates / stimulates, adenyl(yl) cyclase **;** **5** cyclic AMP made from ATP **;** **6** (cAMP is) second(ary) messenger **;** **7** (cAMP) activates / stimulates / binds to, kinase **;** **8** enzyme cascade **;** **9** amplifies signal **;** **10** (activates) glycogen phosphorylase **;**	**7**
10(b)	*any **eight** from:* **1** ABA is a stress hormone **;** **2** ABA, released / produced / increases, during drought **;** *in context of guard cell* **3** ABA binds to its receptor on (cell surface) membrane **;** **4** stops, H^+ / H ions / protons, leaving (guard cell cytoplasm) **;** **5** Ca^{2+} enters **;** **6** Ca^{2+} is a second(ary) messenger **;** **7** (Ca^{2+} / Cl^- / K+) channel (proteins) open **;** **8** Cl^- / anions, leave **;** **9** K^+ leave **;** **10** water potential (in cell) increases **;** **11** water leaves by osmosis **;** **12** volume of, cell / vacuole, decreases **;** **13** cell becomes flaccid closing, stoma / pore **;**	**8**

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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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ecf	error carried forward
I	ignore
AVP	alternative valid point

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Question	Answer	Marks
1(a)	**A** – label line pointing to starch grain **;** **B** – label line pointing to stroma **;**	**2**
1(b)(i)	granum / grana **; A** stack of thylakoids **I** thylakoid	**1**
1(b)(ii)	*any **four** from:* **1** (stack of) thylakoids **;** **2** (membranes / thylakoids / C) form large / increase, surface area **;** **3** for, (named) pigments / photosystems / light-harvesting clusters **;** **4** for absorption of light energy **;** **5** so, large number of / many, enzymes / ETC / ATP synthase / stalked particles **;** **6** for, light dependent stage / photophosphorylation **;**	**4**
1(c)(i)	**1** oxygen, combines / reacts, with, rubisco / RuBP **;** **2** less / no, carbon dioxide, combines / reacts, with, rubisco / RuBP **; A** less or no carbon fixation **3** *ref. to* photorespiration **;** *ignore refs to denaturation*	**2**

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Question	Answer	Marks
1(c)(ii)	*any **three** from:* **1** photosynthesis (by C3 plants) is occurring **;** **2** decrease in (atmospheric) carbon dioxide **or** increase in (atmospheric) oxygen **or** increase in / high, oxygen to carbon dioxide ratio **;** **3** rubisco favours reaction with oxygen / AW **;** **4** C4 plants have a selective advantage / description **;** **5** oxygen acts as a selection pressure **;** **6** AVP **;** e.g. *ref. to* mutation in C3 plants	**3**

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Question	Answer	Marks
2(a)	1.45 – 0.25 = 1.20 1.20 ÷ 0.25 = 4.8 *allow ecf for mp2* *1.45 ÷ 0.25 = 5.8* **or** 5.17 – 0.25 = 4.92 ; 4.92 ÷ 0.25 = 20 ; *allow ecf for mp2* *5.17 ÷ 0.25 = 21*	**2**
2(b)(i)	*any **two** from:* **1** different breeds at, **same** / named, location / environmental conditions, / have different milk yields ; **2** comparative data quote including units ; **3** (different breeds have) different gene pools / different alleles ; **4** due to selective breeding ;	**2**
2(b)(ii)	*any **two** from:* **1** same breed has different milk yields in, different location / named location / environmental conditions; **2** comparative data quote including units ; **3** how, climate / vegetation / veterinary care, affects milk yield ;	**2**

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Question	Answer	Marks
2(c)	*any **five** from:* **1** human applies selection pressure / artificial selection **;** **2** breed Saanen goat with, local / South African, goat **;** **3** select offspring with, desired characteristics / high milk yield / adaptation to local conditions **;** **4** breed offspring (with desired characteristics) **;** **5** repeat (selection and breeding of offspring) for, several / many, generations **;** **6** *ref. to* progeny testing / test milk yield in female offspring of male goats **;** **7** avoid inbreeding / out-cross to unrelated goats **;** **8** directional selection **;** **9** AVP **;** e.g. carry out programme in South Africa	**5**
2(d)	*any **one** advantage:* **1** stops / reduces, diarrhoea (in children) **;** **2** improves children's, nutrition / growth / development **;** *any **one** disadvantage:* **3** safety risks unknown / potential allergen / side effects **;** **4** may disrupt ('good') bacteria / AW **;** **5** expensive **;** **6** not willing to drink GM milk **;**	**2**

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Question	Answer	Marks
3(a)	*any **four** from:* **1** *ref. to* geographic isolation / geographic barrier / named barrier / populations are separate**;** **2** no, breeding / gene flow, between **populations ;** **3** different, selection pressures / environmental conditions **;** **4** different mutations occur **;** **5** *ref. to* some individuals, better adapted / have selective advantage **; ora** **6** natural selection **;** **7** allopatric (speciation) **;** *ignore sympatric speciation*	**4**
3(b)	*any **three** from:* **1** not pre-zygotic as they mate (to produce hybrids) **;** *post-zygotic as:* **2** (some) hybrids, infertile / sterile **;** **3** (as they) cannot carry out meiosis **;** **4** (because) have problems with pairing of homologous chromosomes / have different chromosome numbers **;** **A** *ref. to* numerical values, e.g. 34 and 40 / 37 / odd number of chromosomes **5** selection against hybrids **or** hybrids, may die / are not viable **;** **6** (due to) *idea that* higher intestinal worm number is a disadvantage **;**	**3**

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Question	Answer	Marks
4(a)	less / no, oxygen for (aerobic) respiration ; cells / tissues / organs, fail to function / die ;	2
4(b)(i)	*any **two** from:* *if child has, sickle cell anaemia / SCT* **1** informed decision can be made about continuing with the pregnancy / AW ; **2** treatment can begin quickly (after birth) ; **3** parents can prepare, mentally / emotionally / for the cost of treatment ; **4** (this) child can make an informed decision about having children when older ; *if child does not have, sickle cell anaemia / SCT* **5** removes worry / AW ;	2
4(b)(ii)	*any **three** from:* *why* **1** (primers) anneal / bind, to DNA ; **A** hybridises **2** so that, DNA / *Taq*, polymerase, can bind to DNA **or** so that, DNA / *Taq*, polymerase, can replicate or amplify DNA ; *how* **3** (if) normal primers bind then, normal (genotype) / Hb^AHb^A ; **4** (if) mutant primers bind then, sickle cell anaemia (genotype) / Hb^SHb^S ; **5** (if) both primers bind then, SCT (genotype) / heterozygote / $Hb^A Hb^S$;	3

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Question	Answer	Marks
4(b)(iii)	**1** correct genotypes for **A** and **B**: **A** – Hb^A Hb^S **accept** Hb^N Hb^S **and** **B** – Hb^S Hb^S **;** **2** correct phenotypes for **A** and **B**: **A** – SCT **and** **B** – sickle cell anaemia **;**	**2**
4(c)(i)	*any **four** from:* **1** heterozygotes / Hb^A Hb^S / SCT / carriers, have, selective advantage **;** **2** malaria is a selection pressure **or** homozygous dominant / Hb^A Hb^A, die of malaria **;** **3** sickle cell anaemia is a selection pressure **or** homozygous recessive / Hb^S Hb^S, die of sickle cell anaemia **;** **4** heterozygotes / Hb^A Hb^S / SCT / carriers, survive / reproduce **;** **5** (so) passes on, Hb^S allele / sickle cell allele / mutant allele (to next generation) **;** **6** stabilising selection **;**	**4**
4(c)(ii)	*any **two** from:* **1** *ref. to* designer babies / choose sex of baby **;** **2** embryos, discarded / destroyed / damaged **;** **3** against personal belief / *ref. to* right to life **;**	**2**

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Question	Answer	Marks
5(a)(i)	*any **two** from:* **1** (codon) 976 where, T is replaced by C / TCT becomes TCC **or** (codon) 977 where, A is replaced by T / TCA becomes TCT **;** **2** ser(ine) in, both / cats and humans **;** **3** degenerate code **;**	**2**
5(a)(ii)	*any **two** from:* **1** base / C, deleted at, second codon / (codon) 975 **;** **2** causes frameshift **;** **3** next 9 codons changed / all codons afterwards are changed **;**	**2**
5(a)(iii)	*any **two** from:* **1** *ref. to* shortened polypeptide **;** **2** no tyrosinase made **;** **3** change in, 3D / tertiary, shape / structure **or** change in active site **;** **4** (so) tyrosinase, non-functional / cannot bind to substrate / inactive **;** **5** tyrosine not converted to, DOPA / dopaquinone **;**	**2**

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Question	Answer	Marks
5(a)(iv)	*any **one** from:* *why* **1** large amount of, data / DNA sequences **;** **2** fast / accurate / efficient **; A** description of fast / accurate / efficient / detects each small difference = accurate *any **one** from:* *conclusions* **3** more similarity the more **recent** a common ancestor / AW **;** **4** molecular clock **;**	**2**
5(b)	*parent phenotypes:* (albino x fully pigmented) *parent genotypes:* **t^at^a** x **Tt^s** **;** *gametes:* (**t^a** **T** **t^s**) *F1 genotypes:* **Tt^a** **t^st^a** **;** *F1 phenotypes:* fully pigmented Siamese **and** *ratio:* **1 : 1 ;** *F1 phenotypes must match genotypes* *ecf for mp2 and mp3 if parent genotype incorrect*	**3**

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Question	Answer	Marks
6(a)	*any **five** from:* **1** opiod binds to receptor **;** **2** activates G protein **;** **3** blocks Ca^{2+} channels **or** no / less, Ca^{2+} enter presynaptic, knob / neurone **;** **4** vesicles do not, move towards / fuse with, presynaptic membrane **or** fewer vesicles, move towards / fuse with, presynaptic membrane **; A** cell surface / plasma, membrane **5** no / less, Ach / acetylcholinesterase, released into (synaptic) cleft **or** no / less, exocytosis of ACh **;** **6** no / less, Ach / acetylcholinesterase, binds to receptors on postsynaptic membrane **;** **7** no / smaller, depolarisation of postsynaptic membrane **;**	**5**
6(b)(i)	automatic / involuntary / no conscious thought / brain not involved **;** response always the same / stereotypic **;**	**2**
6(b)(ii)	(sensory) dorsal root ganglion **or** (sensory) part way along (neurone) / AW **;** **and** (motor) CNS / spinal cord **or** (motor) at end (of neurone) **;**	**2**

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Question	Answer	Marks
6(b)(iii)	*sensory* **1** transmit, impulses / action potentials, from receptor **;** **2** to, relay / intermediate, neurone **or** CNS / spinal cord **or** motor neurone **;** *motor* **3** transmit, impulses / action potentials, from, CNS / spinal cord **or** relay / intermediate, neurone **or** sensory neurone **;** **4** to effector / muscle / gland **;**	**4**

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Question	Answer	Marks
7(a)	cell surface membrane / plasma membrane ; glycoprotein / protein / polypeptide ; **R** channel protein	**2**
7(b)(i)	$\frac{19-5}{5}\times 100$ **or** $\frac{14\times 100}{5}$; 280(%) ; *ecf – if candidate uses 18 instead of 19 then allow correct total of 260 for one mark*	**2**
7(b)(ii)	(catalyses) glycogen production **or** decreases (blood glucose concentration) ;	**1**

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Question	Answer	Marks
8(a)	*any **five** from:* **1** mark–release–recapture **;** **2** capture (sample of) rats **and** count them **;** **3** *ref. to* humane traps **;** **4** mark so as to not adversely affect rats **or** describe method of marking such as, tagging / using dyes **;** **5** return to where they were caught / AW **;** **6** allow time to mix (with population) / AW **;** **7** capture second sample **;** **8** count number caught **and** number marked **;** **9** population size estimate (M_1) = $\frac{\text{number in first sample } (N_1) \times \text{number in second sample } (N_2)}{\text{number in second sample that are marked } (M_2)}$ **;** **10** AVP **;** e.g. repeat	**5**

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Question	Answer	Marks
8(b)(i)	$r_s = 1 - \left(\frac{6\times164}{8^3-8}\right)$ **or** $= 1 - \left(\frac{984}{504}\right)$ **or** $= 1 - 1.95$; $r_s = -0.95$;	**2**
8(b)(ii)	there is a strong correlation ; negative correlation / as the altitude increases the mean height of the soft rush decreases ;	**2**

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Question	Answer	Marks
9(a)	*any **nine** from:* *structural genes* **1** code for, non-regulatory / structural, proteins / polypeptides **;** **2** named example of structural gene **;** e.g. *lac Z / lac Y / lac A* **3** (proteins associated with) rRNA / tRNA **;** **4** (proteins such as) enzyme / named (structural) protein **;** *regulatory genes* **5** code for, regulatory / non-structural, proteins / polypeptides **;** **6** named example **;** e.g. gene coding for repressor protein / *lac I* / PIF / correct ref. DELLA protein / gene for transcription factors **7** detail **;** e.g. switches genes on or off / ref. gene expression / ref. transcription **;** *repressible enzymes* **8** (generally) produced continuously **;** **9** synthesis can be prevented by binding of repressor protein to, specific site / promoter / operator **;** **10** named example **;** e.g. enzyme involved in tryptophan synthesis *inducible enzymes* **11** synthesis only occurs when, substrate / inducer, is present **;** **12** *idea that* transcription of the gene only occurs when, substrate / inducer, binds to, transcription factor / repressor protein**;** **13** named example **;** e.g. β galactosidase / lactose permease / transacetylase	**9**

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Question	Answer	Marks
9(b)	*any **six** from:* **1** (TF) can form part of protein complex ; **2** (TF) bind to, DNA / promoter / enhancer ; **3** (so) RNA polymerase binds to promoter ; **4** (so) transcription begins / mRNA synthesised / gene expressed / gene switched on ; **5** (or TF binds to DNA) no transcription / no mRNA synthesised / gene not expressed / gene switched off ; **6** can activate genes in correct, order / time / cells / amount ; **7** *ref. to* correct (pattern of) development ; **8** described example ; e.g. homeobox genes / hox genes / determine sex **9** allow responses to environmental stimuli ; **10** described example ; e.g. correct genes expressed in response to, very high temperatures / light exposure **11** *ref. to* regulate cell cycle ; e.g. role in cell cycle checkpoints / apoptosis **12** *ref. to* cell signalling ; e.g. response to hormones	**6**

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Question	Answer	Marks
10(a)	*any **nine** from:* **1** glycolysis ; **2** glucose phosphorylated by ATP ; **3** to fructose (1,6-)bisphosphate ; **4** lysis / splits, to form 2 × triose phosphate ; **5** (triose phosphate) has hydrogen removed / is dehydrogenated / is oxidised ; **6** reduced NAD formed ; **7** 4 × ATP / net 2ATP, produced ; **8** *ref. to* substrate-linked phosphorylation ; *pyruvate produced* **9** enters mitochondrial matrix ; **10** link reaction ; **11** decarboxylated / carbon dioxide removed ; **12** (pyruvate) has hydrogen removed / is dehydrogenated / is oxidised ; *combines with coenzyme A*	**9**

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Question	Answer	Marks
10(b)	*any **six** from:* **1** reduced NAD / reduced FAD, releases hydrogen **;** **2** *ref. to* inner membrane / cristae ; **3** hydrogen splits into H^+ and e^- **;** **4** e^- passes along, chain of carriers / ETC **;** **5** energy released used to pump H^+ into intermembrane space **;** **6** high concentration of H^+ in intermembrane space / ref. proton gradient **;** **7** H^+ <u>diffuse</u> back into matrix **;** **8** *ref. to* ATP synthase / stalked particle **;** **9** *ref. to* chemiosmosis **;**	**6**

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Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/43**

Paper 4 A Level Structured Questions **October/November 2020**

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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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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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
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
I	ignore
AVP	alternative valid point

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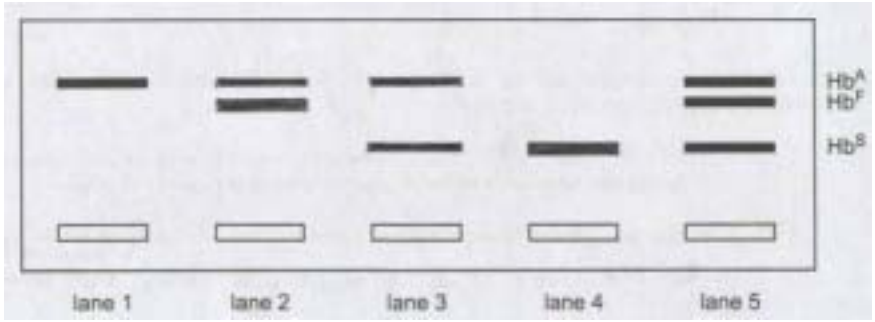
Question	Answer	Marks
1(a)	**A** – line to epidermal cell **;** **B** – line to mesophyll cell **;**	**2**
1(b)(i)	bundle sheath (cell) **;**	**1**
1(b)(ii)	*any **four** from:* **1** decrease / stop, photorespiration **;** **2** mesophyll cells, surround / protect / form ring round, bundle sheath **;** **3** air / oxygen, cannot reach, bundle sheath (cells) **;** **4** oxygen cannot, reach / bind to, RuBP / rubisco (in BSC) **;** **5** high / much, carbon dioxide (in bundle sheath cells) **;** **6** AVP **;**	**4**
1(c)(i)	*any **four** from:* **1** as temperature increases rate increases, up to 25 °C / at low temperatures, for both **;** **2** as temperature increases rate decreases, above 35 °C / at high temperatures, for both **;** **3** C3 rate higher, at low temperatures / < 22 °C **;** **4** C3 rate lower, at high temperatures / > 22 °C **;** **5** C3, peak rate / maximum rate / optimum T °C, at 25 °C **and** C4, peak rate / maximum rate / optimum T °C, at 30–35 °C **;** **6** C3 has lower, maximum rate / peak **;** **7** C3, maximum rate / peak, is at lower temperature **or** C3 has a lower optimum temperature **;** **8** comparative data quote **;**	**4**
1(c)(ii)	*comparison* rate, higher / faster, high CO_2 conditions **;** (at 30–35 °C) rate is maximum for both **;** *explanation (max 1)* carbon dioxide, limits rate / is limiting factor, in low CO_2 conditions **;** AVP **;**	**2**

Question	Answer	Marks
2(a)(i)	*any **three** from:* **1** environmental / not genetic **;** **2** as change in yield occurs in one goat **;** **3** yield increases (from 1st to 2nd) in all genotypes **;** **4** older / 2nd lactation, goats have, bigger / more developed, udders **;** **5** age / maturity, is an environmental factor **;** **6** AVP **;**	**3**
2(a)(ii)	*any **three** from:* **1** (substitution / **G** → **C / CC**) increases milk, yield / production **;** **2** more food / more income / benefit for people **;** **3** little difference between **GG** and **CG /** small effect in heterozygotes **;** **4** AVP **;**	**3**
2(b)(i)	**CC** = $(0.3 \times 0.3 \times 268 =)$ 24 **;** **CG** = $(2 \times 0.3 \times 0.7 \times 268 =)$ 113 **;**	**2**
2(b)(ii)	chi-square(d test) / χ^2 **;**	**1**
2(b)(iii)	**1** **CC,** higher than predicted / 47 instead of 16 **or GG,** higher than predicted / 324 instead of 289 **or CG,** lower than predicted / 69 instead of 135 **;** *plus any **two** from:* **2** could be (natural / artificial) selection against heterozygotes **;** **3** could be (artificial) selection for, high milk yield / **CC** **;** **4** migration / immigration / emigration **;** **5** genetic drift **;** **6** non-random mating **;**	**3**

Question	Answer	Marks
2(c)	*advantage:* **1** treat (genetic) disease / treat people / reduce suffering / therapeutic **;** *problem (max 1):* **2** possible side effects (on human) / drug may not be pure / may contain allergens / risk of harm / may be unsafe / risk of goat disease transmission to humans **;** **3** process may harm goats / animal welfare issues **;** **4** vegetarians / vegans, may not take drug **;**	**2**

Question	Answer	Marks
3(a)	*any **four** from:* **1** geographic(al), isolation / barrier between populations **;** **2** no / low / less, (inter)breeding / gene flow **;** **3** different mutations occur **;** **4** different (named), selection pressures / environment(al conditions) **;** **5** natural selection **;** **6** genetic drift **;** **7** allopatric (sub)speciation **;**	**4**
3(b)	cytochrome c oxidase / (mitochondrial) gene / DNA / base, sequences, (nearly) identical / (very) similar **;** small number of bases different / low percentage difference **;** difference to other species is greater **;**	**2**
3(c)	*any **two** from:* **1** identify species, quickly / automatically / by non-experts **;** **2** compare with, Red List / IUCN list / CITES appendix **;** **3** confiscate / destroy / relocate, endangered species / ES products **;** **4** prosecute / stop activities of, smugglers / traders / poachers **;** **5** prevent entry of, predators / competitors / diseases, that could harm native ES **;**	**2**

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Question	Answer	Marks
4(a)	*any **two** from:* **1** changed amino acid / changed 1° structure / polar → non-polar amino acid **;** **2** valine / non-polar R group, forms different bonds (than glutamine) **;** **3** bonds form between HbS molecules / HbS molecules stick together **;**	**2**
4(b)(i)	*any **two** from:* **1** both HbF and HbS present **;** **2** stops / decreases, HbS, shape change / fibre formation **;** **3** fewer red blood cells, change shape / sickle / block capillaries **;** **4** avoids very low pO_2 in, blood / capillaries / tissues **;**	**2**
4(b)(ii)	transcription factor / regulatory protein **;**	**1**
4(c)(i)	*any **four** from:* **1** current / potential difference / electric field (across gel) **;** **2** (protein / Hb) moves / attracted, to, anode / positive electrode **;** **3** HbS (more positive so) moves, more slowly **4** HbS moves, shorter distance / less (far) from negative end **;** **5** compare band positions to, known haemoglobins / reference bands **;** **6** if single band seen at HbS position person has sickle cell anaemia **;**	**4**
4(c)(ii)	 lanes 2, 3 and 4 correct = 2 marks **;;** two correct = 1 mark one or none correct = 0 marks	**2**

Question	Answer	Marks
5(a)	*parent phenotypes:* long hair pointed x short hair full colour ; *parent genotypes:* **hhrr** x **HhRr** ; *gametes:* **hr** **HR Hr hR hr** ; *F1 genotypes:* **HhRr** **Hhrr** **hhRr** **hhrr** ; *F1 phenotypes:* short hair full colour / short hair pointed / long hair full colour / long hair pointed ;	**5**
5(b)(i)	*any **one** from:* **1** two pointed parents (always) give (all) pointed offspring ; **2** two full colour cats can give a pointed offspring ; **3** pointed phenotype has, **– – /** homozygous **– /** no restriction site(s) ;	**1**
5(b)(ii)	*any **two** from:* *autosomal because* **1** males have two alleles ; **2** (marker inheritance shows) sons get one number from father ; **3** colour of sons not determined only by mother ; **4** gene is not on X chromosome (linked to mps 1, 2 or 3) ;	**2**
5(b)(iii)	*any **two** from:* plus or minus and marker number inherited, together / as a block / as a pair ; <u>no</u>, recombination / (results of) crossing over, seen ; no, +3 / +4 / –7, in bottom right hand cat ;	**2**

Question	Answer	Marks
6(a)(i)	(cytoplasm of) presynaptic / terminal, knob ; presynaptic membrane ; presynaptic membrane ; postsynaptic membrane ;	**4**
6(a)(ii)	*any **two** from:* one-way / unidirectional (transmission of impulses) ; communication between (many) neurones ; AVP ;	**2**
6(b)	*any **four** from:* **1** binds to / inhibits, acetylcholinesterase ; **2** active site, blocked / shape changes ; **3** Ach / acetylcholinesterase, not broken down / stays bound to receptors ; **4** Na^+ channels stay open ; **5** sarcolemma, (stays) depolarised / has constant action potentials ; **6** muscles stay contracted ;	**4**
6(c)	*any **two** from:* **1** Ca^{2+} channels open ; **2** Ca^{2+}, diffuses / released, into sarcoplasm ; **3** Ca^{2+} binds to troponin ; **4** tropomyosin, moves / changes position ; **5** cross-bridges form / myosin binds to actin ;	**2**

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Question	Answer	Marks
7(a)	**A ;** **E ;** **C / D ;** **B ;** **H ;** **D ;**	**6**
7(b)	lactate, converted / oxidised **;** to, pyruvate / glucose / glycogen **;** haemoglobin / myoglobin, re-oxygenated **;**	**2**

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Question	Answer	Marks
8(a)	5000 ÷ 350 **;** 14.3 **;**	**2**
8(b)	*any **five** from:* **1** aesthetic / leisure, reasons **;** **2** moral / ethical, reasons **;** **3** resource material **;** **4** economic benefits for local community / (eco)tourism **;** **5** maintain / do not disrupt, food webs / food chains / ecosystem **;** **6** mineral (re)cycling **;** **7** maintain, large gene pool / genetic variation **;** **8** AVP **;**	**5**
8(c)	*any **two** from:* **1** do not buy unsustainable palm oil (products) **;** **2** campaign / raise awareness / educate, for sustainable palm oil **;** **3** donate to, anti-deforestation / conservation, charities **;** **4** AVP **;**	**2**
9(a)	*any **seven** from:* **1** double stranded DNA **;** **2** have, restriction site / target sequence for restriction enzyme **;** **3** allows gene (for cloning) to be inserted **;** **4** small **;** **5** plasmid can, enter / transform, (host) cell / bacterium **;** **6** circular **;** **7** stable **;** **8** contain, (named) marker genes / (named) genes for antibiotic resistance **;** **9** used to identify, GM / transformed / recombinant, (bacterial) cells **;** **10** replicate, fast / independently (of host cell replication) **;** **11** get many copies of cloned gene **;** **12** AVP **;**	**7**

Question	Answer	Marks
9(b)	*any **eight** from:* *restriction endonucleases* **1** cut DNA **;** **2** at, restriction site / specific (base) sequence / target sequence **;** **3** *ref. to* palindrome **;** **4** give, sticky / blunt, ends **;** *ligases* **5** join gene to, plasmid / (named) vector **;** **6** seal (sugar-phosphate) backbone **;** **7** make, phospho(di)ester / covalent, bonds **;** **8** make recombinant, DNA / plasmid / vector **;** *reverse transcriptase* **9** makes cDNA **;** **10** from mRNA **;** **11** *ref. to* DNA single-stranded initially **;** **12** AVP **;**	**8**

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Question	Answer	Marks
10(a)	*any **seven** from:* **1** adrenaline, binds / joins, to receptor **;** **2** on (cell surface) membrane of liver cells **;** **3** activates / stimulates, G protein **;** **4** activates / stimulates, adenyl(yl) cyclase **;** **5** cyclic AMP made from ATP **;** **6** (cAMP is) second(ary) messenger **;** **7** (cAMP) activates / stimulates / binds to, kinase **;** **8** enzyme cascade **;** **9** amplifies signal **;** **10** (activates) glycogen phosphorylase **;**	**7**
10(b)	*any **eight** from:* **1** ABA is a stress hormone **;** **2** ABA, released / produced / increases, during drought **;** *in context of guard cell* **3** ABA binds to its receptor on (cell surface) membrane **;** **4** stops, H^+ / H ions / protons, leaving (guard cell cytoplasm) **;** **5** Ca^{2+} enters **;** **6** Ca^{2+} is a second(ary) messenger **;** **7** (Ca^{2+} / Cl^- / K+) channel (proteins) open **;** **8** Cl^- / anions, leave **;** **9** K^+ leave **;** **10** water potential (in cell) increases **;** **11** water leaves by osmosis **;** **12** volume of, cell / vacuole, decreases **;** **13** cell becomes flaccid closing, stoma / pore **;**	**8**

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