Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

BIOLOGY **9700/41**

Paper 4 A Level Structured Questions **October/November 2019**

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 2019 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:

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- 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.

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

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Question	Answer	Marks
1(a)(i)	*any **one** from:* 1 decrease in water potential (of the blood) **;** **I** low water potential 2 lower blood volume **;** 3 increase in, ion / salt, concentrations (of the blood) **;**	**1**
1(a)(ii)	posterior pituitary (gland) **;**	**1**
1(b)	**A** – receptor **;** **I** G-protein **B** – vesicle **;** **I** aquaporin	**2**
1(c)	*any **four** from:* 1 (**B** / vesicles) moves towards **/** fuses with, cell surface membrane **;** **Ignore** aquaporins 2 aquaporins added to cell surface membrane **;** **A** water channels 3 cell surface membrane more permeable to water **;** 4 water moves from, collecting duct / lumen / filtrate, into, cell / blood / tissue fluid **;** 5 by osmosis / down water potential gradient **;** 6 water potential of blood, rises / returns to set point **;** 7 less water lost (in urine / from body) **;** **A** urine, more concentrated / lower volume	**4**

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Question	Answer	Marks
2(a)	*any **two** from:* 1 discrete / distinct, categories / phenotypes / morphs / groups **;** **A** (only) 3 groups 2 no range of phenotypes / no intermediates / no normal distribution **;** 3 (only) one gene / only *EDA*, involved **;** 4 not affected by environment **;**	**2**
2(b)	*any **one** from:* 1 saltwater / ocean, fish had colonised the lake **;** 2 *ref. to* protection from predators **;** 3 mutation **;**	**1**

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Question	Answer	Marks
2(c)	*any **five** from:* 1 genetic variation (in population) **;** 2 *ref. to* selective advantage / selection, for fewer armour plates **; ora** 3 (so) could, grow larger / lay more eggs / shed more sperm **or** less energy wasted making armour **; ora** 4 (they) survive / reproduce **; ora** 5 pass on, advantageous / low armour, alleles (to offspring) **; ora** 6 allele frequency of (low armour) increased **; ora** 7 directional selection **;** 8 *ref. to* low calcium supply **;** 9 reduction in numbers of predatory fish **;**	**5**

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Question	Answer	Marks
3(a)	*any **four** from:* 1 identical to human, insulin / protein **; R** similar 2 no, allergic reaction / immune response / side effects **;** 3 human protein may, have high(er) activity / work better / (more) rapid response **;** 4 no chance of developing tolerance (to animal insulin) **;** 5 no risk of transmitting diseases **;** 6 supply unlimited / large-scale production **;** **ora** not enough animal pancreases to meet demand 7 cost (of production) low(er) **;** 8 no ethical objections / no religious objections **; ora**	**4**
3(b)(i)	$\frac{16}{32} \times 100$ **or** $\frac{100}{32} \times 16$ **;** 50 **;** **A** ecf to two or three significant figures	**2**
3(b)(ii)	*any **two** from:* 1 (bioinformatics is) a store / database, of, base / DNA / protein / amino acid / primary, sequence data **;** 2 for comparison (of, database / base / DNA / protein / amino acid / primary, sequence data) **;** 3 (to search for base / DNA / protein / amino acid / primary, sequences) similar to human calcitonin **;** 4 *idea of* modelling / predicting, tertiary / 3D / protein, structure **;** 5 AVP **;** e.g. sequences data pooled from all over the world	**2**

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Question	Answer	Marks
3(c)(i)	restriction, enzyme / endonuclease **;** (DNA) ligase **;**	**2**
3(c)(ii)	*any **two** from:* *one mark if only two features stated without explanation* 1 small **so** can be inserted (into cells) **;** 2 replicate, independently / fast, **so**, high copy number / large number of plasmids **or** have origin of replication **so** high copy number / large number of plasmids **;** 3 has restriction site(s) / can be cut by restriction enzymes, **so** (new) gene can be added **;** 4 have, multiple cloning site / polylinker, **so** can be cut by different restriction enzymes **;** 5 have marker genes **so**, recombinants / transformed bacteria , can be recognised / AW **;** 6 circular **so** stable **;**	**2**

Question	Answer	Marks
3(d)	*any **two** from:* 1 eukaryote and prokaryote promoter <u>sequences</u> are different **;** 2 eukaryote and prokaryote RNA polymerase enzymes are different **;** 3 prokaryotic RNA polymerase does not, recognise / bind to, eukaryotic promoter **or** prokaryotic RNA polymerase only binds to prokaryotic promoter **;** 4 so no, transcription / mRNA made / gene expression **; ora** 5 eukaryotic promoter requires binding of (many) transcription factors that are not present in prokaryotic cell **;**	**2**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)(i)</td><td>
<table>
<tr><th>statement</th><th>meiosis</th><th>mitosis</th></tr>
<tr><td>chromosome number is maintained</td><td>×</td><td>✓</td></tr>
<tr><td>homologous chromosomes pair up</td><td>✓</td><td>×</td></tr>
<tr><td>sister chromatids separate</td><td>✓</td><td>✓</td></tr>
<tr><td>occurs in prokaryotes</td><td>×</td><td>×</td></tr>
</table>
all 4 rows correct = 2 marks
2/3 rows correct = 1 mark

A yes / no for ✓ / ×</td><td>**2**</td></tr>
<tr><td>4(a)(ii)</td><td>*any **four** from:*

similarities
1 (both / meiosis) produce 4 (cells) **;**

2 (both / meiosis) halve chromosome number / haploid / n / one set of chromosomes **;**

3 (both / meiosis) produce genetically different cells **;**

Differences – must be comparative statements
4 sperm is a gamete whereas a pollen grain is, not a gamete / a gametophyte **;**

5 sperm cell has one (haploid) nucleus whereas pollen grains contain two (haploid) nuclei **;**

6 sperm mitosis then meiosis whereas pollen grain cells meiosis then mitosis **;**

7 *ref. to* primary spermatocyte versus (pollen grain) mother cell **;**</td><td>**4**</td></tr>
</table>

Question	Answer	Marks
4(b)(i)	**RR dd PP** pale pink petals, red eye **;** **Rr Dd Pp** dark pink petals, red eye **;** **rr Dd Pp** white petals, no red eye / white centre **;** **RR dd pp** white petals, red eye **;**	**4**
4(b)(ii)	*any **four** from:* 1 base, substitution / insertion / deletion **;** 2 frameshift / described **;** 3 changes, primary structure / amino acid sequence / primary sequence **;** 4 changes, tertiary structure / 3D shape **;** 5 STOP codon **;** 6 shortened, protein / polypeptide **;** 7 (protein / enzyme) unable to bind to, substrate / receptor / DNA **;** 8 (so biosynthetic) pathway does not function / AW **;**	**4**
4(b)(iii)	*any **one** from:* 1 is a binding site **;** 2 is a, regulatory region / promoter / enhancers / stop codon / telomere **;**	**1**

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Question	Answer	Marks
5(a)(i)	thylakoid (membranes) / grana / lamellae **;**	**1**
5(a)(ii)	reduced NADP / ATP / oxygen **;** **R** reduced NAD	**1**
5(a)(iii)	*any **four** from:* 1 *ref. to* rubisco **;** 2 forms unstable 6C compound **;** 3 (splits into) two molecules of, GP / glycerate–(3)–phosphate **;** 4 GP reduced to, TP / triose phosphate **;** 5 using reduced NADP **and** ATP **;** 6 TP(s) used to form glucose **;** **Ignore** hexose 7 *ref. to* polymerisation / condensation / formation of glycosidic bonds **;**	**4**
5(b)(i)	more carbon dioxide react with RuBP / more CO_2 fixation / more carbon dioxide available to bind to rubisco **; ora** more, Calvin cycle / light independent reaction / detail **; ora**	**2**
5(b)(ii)	*any **three** from:* 1 as day length increases rate (of photosynthesis) increases / positive correlation **;** 2 data quote: two day lengths in hours **and**, two carbon dioxide concentrations / difference between two carbon dioxide concentrations **;** 3 more light is absorbed by, photosystems / pigments / named pigment **;** 4 *ref. to* more, photophosphorylation / light dependent reaction / photolysis **;** 5 more, oxygen / reduced NADP / ATP / glucose / starch, produced **;**	**3**

Question	Answer	Marks
5(c)(i)	(pH 8.4) optimum pH of, rubisco / enzymes **;** fewer, H^+ / protons, result in higher rate of, photosynthesis / activity of enzymes **;**	**2**
5(c)(ii)	*idea of* less carbon dioxide, absorbed / fixed (so ocean acidification not reduced) **;**	**1**

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Question	Answer	Marks
6(a)(i)	1 (chromosome numbers) are the same **;** **R** similar numbers *reasons* *any **one** from:* 2 as hybrids are fertile / described **;** 3 two identical sets of chromosomes pair up / homologous chromosomes pair up / bivalents form (in meiosis) **;** 4 meiosis occurs **;**	**2**
6(a)(ii)	*any **four** from:* 1 behavioural isolation **;** 2 reproductive isolation **;** 3 no gene flow with parent, species / populations **;** 4 (so) hybrid gene pool maintained / AW **;** 5 different mutations (occur in hybrid population to parent populations) **;** 6 natural selection **;** 7 pre-zygotic isolating mechanism **;** 8 sympatric (speciation) **;**	**4**

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Question	Answer	Marks
6(b)	*any **two** from:* 1 hybrids, are eaten / die / fail to reproduce **; ora** 2 hybrid gene pool not maintained **;** 3 parents better adapted **;** 4 *ref. to* disruptive selection **;**	**2**

Question	Answer	Marks
7(a)	low, mineral (ions) / named mineral (ion), content of soil **; A** no minerals insects provide, mineral (ion) / named mineral (ion) / amino acids, for growth **;**	**2**
7(b)(i)	(sensory / trigger / receptor) <u>hair</u> **; Ignore** cells	**1**
7(b)(ii)	at least two hairs must be touched within, 35 seconds / short time period / at same time **or** one hair touched twice, within, 35 seconds / short time period **;**	**1**
7(c)	*any **three** from:* *Venus fly trap* 1 smaller change in membrane potential / smaller depolarisation **; ora** 2 longer duration of action potential / shorter duration of depolarisation **; ora** 3 shorter duration of repolarisation / longer duration of hyperpolarisation **; ora** 4 longer refractory period **; ora** 5 data quote to **support** either mp1, mp2, mp3 or mp4 **;** 6 membrane / resting, potential 0mV compared with -70mV for human **;**	**3**

Question	Answer	Marks
7(d)	*any **five** from:* 1 action potential / depolarisation, reaches lobe (of leaf) **;** 2 *ref. to* hinge / midrib, <u>cells</u> **;** 3 H^+, pumped out of cells / pumped into cell walls **;** 4 cell wall, loosens / cross-links broken / AW **;** 5 calcium pectate, dissolves / breaks down (in middle lamella) **;** 6 Ca^{2+} (ions) enter cells **;** 7 water enters, by osmosis / down water potential gradient **;** 8 (hinge / midrib) <u>cells</u>, expand / become turgid **;** 9 leaves / lobes, become concave **;**	**5**

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Question	Answer	Marks
8	NAD / FAD / coenzyme ; intermembrane space ; cristae / inner membrane ; diffuse ; ATP synthase / ATP synthetase / stalked particle ; oxygen ;	**6**

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Question	Answer	Marks
9(a)	*any **seven** from:* *Fungi and Animalia* 1 eukaryotic cells ; 2 & 3 details of eukaryotic cells ;; e.g. nucleus / linear DNA / chromosomes / histones / 80s ribosomes / (named) membrane-bound organelles 4 heterotrophic / described ; 5 *ref. to* glycogen ; *Fungi only* 6 some unicellular ; 7 hyphae / mycelium ; 8 multinucleate parts ; 9 *ref. to* spores ; 10 cell walls of chitin ; *Animalia only* 11 multicellular ; 12 specialised cells ; 13 differentiated into, tissues / organs ; 14 some motile ; 15 (some cells have) cilia / flagella ;	**7**

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Question	Answer	Marks
9(b)	*any **eight** from:* *methods* 1 provide as natural environment as possible / described **;** 2 storage of, sperm / eggs / gametes **;** **A** sperm banks 3 artificial insemination / IVF **;** 4 embryo transfer / surrogate mothers **;** 5 can monitor, health of mother / development of foetus **;** 6 (international) cooperation between zoos **;** 7 genetic records kept / 'stud' book **;** 8 release into the wild **;** *problems* 9 may be stress in captivity **;** 10 mate may be rejected **;** 11 reproductive cycles may be disrupted (in captivity) **;** 12 & 13 named problems with release **;;** e.g. difficulty in finding food / may not integrate into groups / more susceptible to disease / very little natural habitat left to release animals into	**8**

Question	Answer	Marks
10(a)	*any **six** from:* 1 small **;** 2 water soluble **so** can move around cell **;** 3 immediate source of energy **; A** immediate energy donor 4 *ref. to* hydrolysed **;** 5 phosphate removed releases energy **;** 6 30.5 kJ mol^{-1} **; A** molecule of ATP releases 30.5 kJ 7 ATP splits to ADP and Pi **;** *note* ATP ⟶ ADP and Pi + 30.5 kJ gains mp6 and mp7 8 reversible **;** 9 intermediate between, anabolic and catabolic reactions / energy yielding and energy requiring reactions **;** 10 high turnover **;**	**6**

Question	Answer	Marks
10(b)	*any **nine** from:* 1 methylene blue / DCPIP, is a hydrogen acceptor (dye) ; 2 becomes colourless when reduced ; 3 use yeast suspension (in tube) ; 4 add named sugar (solution) **and**, methylene blue / DCPIP ; 5 put thin layer of oil on / put bung on, to prevent oxygen reaching yeast ; 6 *ref. to* water bath (at set temperature) ; 7 time how long it takes (for methylene blue / DCPIP) to go colourless ; 8 use colorimeter ; 9 *ref. to* 5 different temperatures ; 10 repeat (whole) experiment at least twice more ; 11 calculate mean values ; 12 method to calculate rate of respiration ; e.g. graph or $\frac{1}{T}$ 13 plot graph of rate of respiration against temperature ;	**9**

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1(a)(ii)	posterior pituitary (gland) **;**	**1**
1(b)	**A** – receptor **;** **I** G-protein **B** – vesicle **;** **I** aquaporin	**2**
1(c)	*any **four** from:* 1 (**B** / vesicles) moves towards **/** fuses with, cell surface membrane **;** **Ignore** aquaporins 2 aquaporins added to cell surface membrane **;** **A** water channels 3 cell surface membrane more permeable to water **;** 4 water moves from, collecting duct / lumen / filtrate, into, cell / blood / tissue fluid **;** 5 by osmosis / down water potential gradient **;** 6 water potential of blood, rises / returns to set point **;** 7 less water lost (in urine / from body) **;** **A** urine, more concentrated / lower volume	**4**

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Question	Answer	Marks
2(a)	*any **two** from:* 1 discrete / distinct, categories / phenotypes / morphs / groups **;** **A** (only) 3 groups 2 no range of phenotypes / no intermediates / no normal distribution **;** 3 (only) one gene / only *EDA*, involved **;** 4 not affected by environment **;**	**2**
2(b)	*any **one** from:* 1 saltwater / ocean, fish had colonised the lake **;** 2 *ref. to* protection from predators **;** 3 mutation **;**	**1**

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Question	Answer	Marks
2(c)	*any **five** from:* 1 genetic variation (in population) **;** 2 *ref. to* selective advantage / selection, for fewer armour plates **; ora** 3 (so) could, grow larger / lay more eggs / shed more sperm **or** less energy wasted making armour **; ora** 4 (they) survive / reproduce **; ora** 5 pass on, advantageous / low armour, alleles (to offspring) **; ora** 6 allele frequency of (low armour) increased **; ora** 7 directional selection **;** 8 *ref. to* low calcium supply **;** 9 reduction in numbers of predatory fish **;**	**5**

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Question	Answer	Marks
3(a)	*any **four** from:* 1 identical to human, insulin / protein **; R** similar 2 no, allergic reaction / immune response / side effects **;** 3 human protein may, have high(er) activity / work better / (more) rapid response **;** 4 no chance of developing tolerance (to animal insulin) **;** 5 no risk of transmitting diseases **;** 6 supply unlimited / large-scale production **;** **ora** not enough animal pancreases to meet demand 7 cost (of production) low(er) **;** 8 no ethical objections / no religious objections **; ora**	**4**
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Question	Answer	Marks
3(c)(i)	restriction, enzyme / endonuclease **;** (DNA) ligase **;**	**2**
3(c)(ii)	*any **two** from:* *one mark if only two features stated without explanation* 1 small **so** can be inserted (into cells) **;** 2 replicate, independently / fast, **so**, high copy number / large number of plasmids **or** have origin of replication **so** high copy number / large number of plasmids **;** 3 has restriction site(s) / can be cut by restriction enzymes, **so** (new) gene can be added **;** 4 have, multiple cloning site / polylinker, **so** can be cut by different restriction enzymes **;** 5 have marker genes **so**, recombinants / transformed bacteria , can be recognised / AW **;** 6 circular **so** stable **;**	**2**

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</table>
all 4 rows correct = 2 marks
2/3 rows correct = 1 mark

A yes / no for ✓ / ×
</td><td>**2**</td></tr>
<tr><td>4(a)(ii)</td><td>
*any **four** from:*

similarities
1 (both / meiosis) produce 4 (cells) **;**

2 (both / meiosis) halve chromosome number / haploid / n / one set of chromosomes **;**

3 (both / meiosis) produce genetically different cells **;**

Differences – must be comparative statements
4 sperm is a gamete whereas a pollen grain is, not a gamete / a gametophyte **;**

5 sperm cell has one (haploid) nucleus whereas pollen grains contain two (haploid) nuclei **;**

6 sperm mitosis then meiosis whereas pollen grain cells meiosis then mitosis **;**

7 *ref. to* primary spermatocyte versus (pollen grain) mother cell **;**
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4(b)(iii)	*any **one** from:* 1 is a binding site **;** 2 is a, regulatory region / promoter / enhancers / stop codon / telomere **;**	**1**

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5(a)(iii)	*any **four** from:* 1 *ref. to* rubisco **;** 2 forms unstable 6C compound **;** 3 (splits into) two molecules of, GP / glycerate–(3)–phosphate **;** 4 GP reduced to, TP / triose phosphate **;** 5 using reduced NADP **and** ATP **;** 6 TP(s) used to form glucose **;** **Ignore** hexose 7 *ref. to* polymerisation / condensation / formation of glycosidic bonds **;**	**4**
5(b)(i)	more carbon dioxide react with RuBP / more CO_2 fixation / more carbon dioxide available to bind to rubisco **; ora** more, Calvin cycle / light independent reaction / detail **; ora**	**2**
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Question	Answer	Marks
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Question	Answer	Marks
6(a)(i)	1 (chromosome numbers) are the same **;** **R** similar numbers *reasons* *any **one** from:* 2 as hybrids are fertile / described **;** 3 two identical sets of chromosomes pair up / homologous chromosomes pair up / bivalents form (in meiosis) **;** 4 meiosis occurs **;**	**2**
6(a)(ii)	*any **four** from:* 1 behavioural isolation **;** 2 reproductive isolation **;** 3 no gene flow with parent, species / populations **;** 4 (so) hybrid gene pool maintained / AW **;** 5 different mutations (occur in hybrid population to parent populations) **;** 6 natural selection **;** 7 pre-zygotic isolating mechanism **;** 8 sympatric (speciation) **;**	**4**

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Question	Answer	Marks
6(b)	*any **two** from:* 1 hybrids, are eaten / die / fail to reproduce **; ora** 2 hybrid gene pool not maintained **;** 3 parents better adapted **;** 4 *ref. to* disruptive selection **;**	**2**

Question	Answer	Marks
7(a)	low, mineral (ions) / named mineral (ion), content of soil **; A** no minerals insects provide, mineral (ion) / named mineral (ion) / amino acids, for growth **;**	**2**
7(b)(i)	(sensory / trigger / receptor) <u>hair</u> **; Ignore** cells	**1**
7(b)(ii)	at least two hairs must be touched within, 35 seconds / short time period / at same time **or** one hair touched twice, within, 35 seconds / short time period **;**	**1**
7(c)	*any **three** from:* *Venus fly trap* 1 smaller change in membrane potential / smaller depolarisation **; ora** 2 longer duration of action potential / shorter duration of depolarisation **; ora** 3 shorter duration of repolarisation / longer duration of hyperpolarisation **; ora** 4 longer refractory period **; ora** 5 data quote to **support** either mp1, mp2, mp3 or mp4 **;** 6 membrane / resting, potential 0mV compared with -70mV for human **;**	**3**

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Question	Answer	Marks
7(d)	*any **five** from:* 1 action potential / depolarisation, reaches lobe (of leaf) **;** 2 *ref. to* hinge / midrib, <u>cells</u> **;** 3 H^+, pumped out of cells / pumped into cell walls **;** 4 cell wall, loosens / cross-links broken / AW **;** 5 calcium pectate, dissolves / breaks down (in middle lamella) **;** 6 Ca^{2+} (ions) enter cells **;** 7 water enters, by osmosis / down water potential gradient **;** 8 (hinge / midrib) <u>cells</u>, expand / become turgid **;** 9 leaves / lobes, become concave **;**	**5**

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Question	Answer	Marks
8	NAD / FAD / coenzyme ; intermembrane space ; cristae / inner membrane ; diffuse ; ATP synthase / ATP synthetase / stalked particle ; oxygen ;	**6**

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Question	Answer	Marks
9(a)	*any **seven** from:* *Fungi and Animalia* 1 eukaryotic cells ; 2 & 3 details of eukaryotic cells ;; e.g. nucleus / linear DNA / chromosomes / histones / 80s ribosomes / (named) membrane-bound organelles 4 heterotrophic / described ; 5 *ref. to* glycogen ; *Fungi only* 6 some unicellular ; 7 hyphae / mycelium ; 8 multinucleate parts ; 9 *ref. to* spores ; 10 cell walls of chitin ; *Animalia only* 11 multicellular ; 12 specialised cells ; 13 differentiated into, tissues / organs ; 14 some motile ; 15 (some cells have) cilia / flagella ;	**7**

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Question	Answer	Marks
9(b)	*any **eight** from:* *methods* 1 provide as natural environment as possible / described **;** 2 storage of, sperm / eggs / gametes **;** **A** sperm banks 3 artificial insemination / IVF **;** 4 embryo transfer / surrogate mothers **;** 5 can monitor, health of mother / development of foetus **;** 6 (international) cooperation between zoos **;** 7 genetic records kept / 'stud' book **;** 8 release into the wild **;** *problems* 9 may be stress in captivity **;** 10 mate may be rejected **;** 11 reproductive cycles may be disrupted (in captivity) **;** 12 & 13 named problems with release **;;** e.g. difficulty in finding food / may not integrate into groups / more susceptible to disease / very little natural habitat left to release animals into	**8**

Question	Answer	Marks
10(a)	*any **six** from:* 1 small **;** 2 water soluble **so** can move around cell **;** 3 immediate source of energy **; A** immediate energy donor 4 *ref. to* hydrolysed **;** 5 phosphate removed releases energy **;** 6 30.5 kJ mol^{-1} **; A** molecule of ATP releases 30.5 kJ 7 ATP splits to ADP and Pi **;** *note* ATP ⟶ ADP and Pi + 30.5 kJ gains mp6 and mp7 8 reversible **;** 9 intermediate between, anabolic and catabolic reactions / energy yielding and energy requiring reactions **;** 10 high turnover **;**	**6**

Question	Answer	Marks
10(b)	*any **nine** from:* 1 methylene blue / DCPIP, is a hydrogen acceptor (dye) **;** 2 becomes colourless when reduced **;** 3 use yeast suspension (in tube) **;** 4 add named sugar (solution) **and**, methylene blue / DCPIP **;** 5 put thin layer of oil on / put bung on, to prevent oxygen reaching yeast **;** 6 *ref. to* water bath (at set temperature) **;** 7 time how long it takes (for methylene blue / DCPIP) to go colourless **;** 8 use colorimeter **;** 9 *ref. to* 5 different temperatures **;** 10 repeat (whole) experiment at least twice more **;** 11 calculate mean values **;** 12 method to calculate rate of respiration **;** e.g. graph or $\frac{1}{T}$ 13 plot graph of rate of respiration against temperature **;**	**9**

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BIOLOGY **9700/43**

Paper 4 A Level Structured Questions **October/November 2019**

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.

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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.

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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)(i)	**Q** – receptor **;**	**1**
1(a)(ii)	**R** – proton / hydrogen ion / H^+, pump / carrier **;** **S** – calcium (ion) / Ca^{2+}, channel (protein) **;**	**2**
1(a)(iii)	**T** – cell surface membrane / plasma membrane / plasmalemma **;**	**1**
1(b)	*any five from:* **1** ABA / abscisic acid, binds / attaches, to receptor **;** **2** calcium ions enter cell **;** **3** (Ca^{2+} is) second messenger **;** **4** proton / hydrogen ion / H^+, exit, stops / is inhibited **;** **5** potassium ions / K^+, leave (cell) **;** **6** water potential / ψ, increases (in, cell / cytoplasm) **;** **7** water leaves (cell), by osmosis OR down, ψ / osmotic, gradient **;** **8** cell, volume decreases / becomes flaccid / loses turgidity / loses turgor **;**	**5**

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Question	Answer	Marks
2(a)	two homologous chromosomes circled **;**	**1**
2(b)(i)	*any three from:* **1** same, size / length / number of (kilo)base pairs **;** **2** same shape **;** **3** same banding pattern **;** **4** same (order of), genes / loci **;** **5** they, pair up / form a bivalent, in, prophase 1 / meiosis 1 **;**	**3**
2(b)(ii)	20 **;**	**1**
2(c)(i)	*any two from:* **1** *ref. to* reduction division **;** **2** halves the chromosome number **;** **3** (so) fertilisation / fusion of gametes, gives, diploid / 2n / 40 **;** **4** prevents chromosome number doubling (each generation) **;**	**2**
2(c)(ii)	**1** (by chance) both gametes (may) have recessive allele **;** **2** zygote / offspring, has, pair / two / homozygous, recessive alleles **;**	**2**
2(d)(i)	*any two from:* **1** (causes a) STOP codon **;** **2** does not code for amino acid / no amino acid added to chain **;** **3** stops translation **OR** rest of / later, codons / triplets / mRNA / sequence, not translated **;**	**2**
2(d)(ii)	*parental genotypes* **Aa** X **Aa** **and** *gametes* **A** **a** **A** **a ;** *offspring genotypes* **AA** **Aa** **(Aa)** **aa ;** *offspring phenotypes* normal normal (normal) woolly **;**	**3**

Question	Answer	Marks
3(a)	(10 – 5) / 5 × 100 **;** 100 **;**	**2**
3(b)	restriction, enzyme / endonuclease **;** reverse transcriptase **;**	**2**
3(c)	*any two from:* **1** small / low mass, **so** can enter, cells / *E. coli* (through membrane)**;** **2** self-replicate in cell **so** multiply / make many copies of, gene **;** **3** have restriction site(s) / can be cut by restriction enzymes, **so** new gene can, be added / join **;** **4** have, marker / antibiotic resistance / fluorescence / reporter, genes, **so,** recombinants / transformed cells / cells that took up plasmid, can be recognised **;** **5** have promoter **so** gene can be, expressed / transcribed **;** **6** circular **so**, more stable / not damaged by host cell enzymes **;**	**2**
3(d)	*any four from:* **1** prevents / less / lower, (named) disease / infection / pathogen transmission, risk **;** **2** large / unlimited, supply **OR** mass production (from engineered bacteria) **;** **3** cost of, purification / processing, lower **;** **4** lower risk of, allergy / immune reaction / rejection / side effects **;** **5** potential to, engineer / improve, recombinant proteins **;**	**4**
3(e)(i)	fewer genes, expressed / have increased expression **;**	**1**
3(e)(ii)	*any two from:* **1** transcription factors **;** **2** (help / stop), binding / functioning, of RNA polymerase **;** **3** ref. promoter **;** **4** AVP **;** light, is detected (by eyes) / causes changes melatonin enhancer / silencer, (DNA) sequences signalling, molecules / pathways	**2**

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Question	Answer	Marks
3(e)(iii)	*any two from:* **1** *idea of* compare with known, genes / sequences / genomes, in database **;** **2** search / analysis, programme / software / algorithm **;** **3** identify, role of protein / (named) health effects **;**	**2**

Question	Answer	Marks
4(a)	*any two from:* **1** not, discrete / categorical / with only a few values **;** **2** *ref. to* normal / bell(-shaped), distribution / curve **;** **3** polygenic / many genes / multiple loci **;** **4** environment has (large) effect **;**	**2**
4(b)(i)	directional **;**	**1**
4(b)(ii)	*any two from:* **1** (adults / penguins) compete for food **;** **2** large bill size is a selective advantage **OR** those with large bills, get more food / get food more easily / survive **;** **3** food availability is a selection pressure **;**	**2**
4(c)	*any one from:* *males with bigger bills* **1** get more food for, offspring / chicks **;** **2** can better defend, chicks / offspring **;** **3** more chance of, getting / attracting, a, mate / female **;**	**1**

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Question	Answer	Marks
5(a)	*any five from:* **1** cannot, exchange pollen / cross-pollinate / cross-breed / interbreed **;** **2** reproductively isolated **;** **3** because they live, too far apart / not near enough / at different altitudes **;** **4** geographical, barrier / separation / isolation **;** **5** because they have different pollinators **;** **6** *ref. to* ecological isolation / different niches / adaptation / specialisation **;** **7** colour significance explained **;** **8** flower length / distance to nectar, significance explained **;** **9** *ref. to* pre-zygotic **;**	**5**
5(b)(i)	*any two from:* **1** same / equal, number of chromosomes **;** **2** meiosis can occur in, hybrid / F1 / offspring **;** **3** chromosomes (similar enough to) pair up **;**	**2**
5(b)(ii)	*any two from:* **1** (F1 / hybrids have) fewer (F2) offspring / reduced (reproductive) fitness **;** **2** outcompeted by, parent species / non-hybrids **;** **3** parent, species / phenotypes, are, better adapted / more successful **;** **4** *idea of* 'disruptive' selection **;** **5** hybrid breakdown / hybrid line not sustained long-term **;**	**2**

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Question	Answer	Marks
6(a)(i)	thylakoid (membranes) / lamella(e) / grana **;**	**1**
6(a)(ii)	*any three from:* **1** *ref. to* LHC / light harvesting complex **;** **2** (named) accessory pigments **;** **3** pass, light / photons, to, reaction centre / chlorophyll a / primary pigment/chlorophyll P680 **;** **4** non-cyclic photophosphorylation **;** **5** more / different, wavelengths / energy frequencies, absorbed / used **;**	**3**
6(b)	*any two from:* **1** as (concentration of) cadmium (ions) increases PSII activity decreases **;** **2** supporting figures comparative quote with units **;** **3** concentration rises by, order of magnitude / factor of 10, each time **;**	**2**
6(c)(i)	*any four from:* **D1** in month **A** functional chlorophyll concentration is higher in unpolluted lake (than polluted lake) **;** **D2** in month **B** functional chlorophyll concentration is same in both (lakes) **;** **D3** in both (lakes) functional chlorophyll concentration is higher in month **A** than in month **B** **;** **E4** in polluted lake copper ions, inhibit / damage / disrupt, chlorophyll **;** **E5** in month **B,** protoctists are, dormant / spores / resist entry of ions / AW **;** **E6** month **A =,** summer / hotter / higher light intensity / longer days **;** **7** AVP **;** ref. flooding decreases Cu^{2+} concentration in month **B** evaporation increases Cu^{2+} concentration in month **A**	**4**
6(c)(ii)	substitute for, magnesium ion / Mg^{2+} **;**	**1**
6(d)	*any four from:* **1** spot / extract, placed on, pencil line / base line / line of origin **;** **2** repeat / concentrate, spot / extract**;** **3** end / base, of chromatogram, suspended / placed, in solvent **;** **4** R_f value = distance moved by, spot / pigment / solute ÷ distance moved by solvent (front) **;** **5** compare with known R_f value to identify, chlorophyll a / pigment **;** **6** detail of method **;** e.g. cover to stop evaporation of solvent remove chromatogram before solvent front reaches top	**4**

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Question	Answer	Marks
7(a)	*any three from:* **1** rate of amylase production higher with gibberellin (compared to without) **;** **2** with and without gibberellin figures **;** *with gibberellin* **3** rate of amylase production increases, over time / for 13 hours **OR** amylase production gets faster, over time / till 13 hours **OR** rate increases more after 5 hours / rate is at maximum 13–15 hours / rate plateaus from 13–15 hours **;** *without gibberellin* **4** rate of amylase production, is constant / does not change much / fluctuates in a narrow range / is low throughout **;**	**3**
7(b)	*any three from:* **1** amylase enters endosperm **;** **2** hydrolyses / breaks down / converts, starch / amylose / amylopectin **;** **3** maltose / glucose, moves to / used by / needed by, embryo **;** **4** (maltose / glucose) for respiration / to release energy / for ATP production **;** **5** for growth of embryo **;**	**3**
7(c)(i)	*Le* **;**	**1**
7(c)(ii)	**1** (dominant allele) codes for enzyme **;** **2** converts inactive (gibberellin) to active gibberellin **;**	**2**
7(c)(iii)	*any two from:* **1** cell division / mitosis **;** **2** cell, elongation / enlargement **;** **3** increase in internode length **;**	**2**

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Question	Answer	Marks
8	**1** glycolysis **;** **2** cristae **;** **3** ATP synth(et)ase **;** **4** protons / hydrogen ions / H^+ **;** **5** matrix **;** **6** Krebs / TCA / citric acid, cycle **;**	**6**

Question	Answer	Marks
9(a)	*any eight from:* **1** not cellular **;** **2** contain, nucleic acid / genetic material / DNA / RNA (core) **;** **3** DNA may be single-stranded or double-stranded **;** **4** (core surrounded by) protein coat / capsid / capsomeres **;** **5** may have, external / lipoprotein, envelope / membrane **;** **6** 20–750 nm **;** **7** obligate parasites **;** **8** reproduced / replicated, in / by, host cells **;** **9** disease-causing / pathogenic **;** **10** no, metabolism / respiration / nutrition / excretion / growth **;** **11** cannot move / immobile **;** **12** have, proteins / enzymes, to help, infection / replication **;** **13** (highly) specific to host (cells) **;** **14** not (thought to be) living **;** **15** AVP **;** e.g. lytic / lysogenic, life cycles antigenic, variability / drift / shift	**8**

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Question	Answer	Marks
9(b)	*any seven from:* **1** name 1 **;** **2** name 2 **;** e.g. WWF / Greenpeace / Nature Conservancy / Wildlife Conservation Society / Oceana / Sea Shepherd / Conservation International / CITES / IUCN / IFAW / WAZA / World Seed Bank / IPBES **3** raise, funds / donations **;** **4** influence, governments / businesses **;** **5** ban / reduce, hunting / polluting / oil drilling / mining / deforestation **;** **6** research / reports **;** **7** conserve, species / populations / habitats / biodiversity **OR** prevent extinction **;** **8** education / publicity campaigns / raise awareness **;** **9** hold protests **OR** take direct action to prevent, development / exploitation **;** **10** promote coexistence of wildlife and people **;** **11** regulate / legislate for, trade in wild species **;** **12** estimate / monitor / categorise, threatened / endangered, species **;** **13** detail of CITES trade categories **;**	**7**

Question	Answer	Marks
10(a)	*any seven from:* **1** action potential / depolarisation / impulse, at pre-synaptic membrane **;** **2** (voltage-gated) calcium ion channels open / calcium ions enter (cell / cytoplasm / (motor) neurone / pre-synaptic knob) **;** **3** vesicles fuse with pre-synaptic membrane **;** **4** acetylcholine / ACh, released, by exocytosis / into synaptic cleft **;** **5** (ACh) binds to receptors on, muscle cell membrane / sarcolemma / motor end plate **;** **6** sodium ion channels open / sodium ions enter (muscle cell / sarcoplasm) **;** **7** depolarisation of, (muscle) cell surface membrane / sarcolemma **;** **8** (depolarisation) spreads / transmitted, to / down / via, T-tubules **;** **9** depolarisation of (adjacent) sarcoplasmic reticulum (membrane) **;** **10** (voltage-gated) calcium ion channels open **;** **11** calcium ions, move / diffuse, out of SR / out of cisterna(e) **;** **12** calcium ions, move / diffuse, into, sarcoplasm / cytoplasm **;** **13** calcium ions, start contraction / bind to troponin **;**	**7**

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Question	Answer	Marks
10(b)	*any eight from:* **1** mutation / allele / gene, on chromosome 4 / autosome **;** **2** dominant **;** **3** normal / recessive, allele has 10–35 repeats of CAG **;** **4** HD / dominant / mutant, allele has, more / extra, repeats of CAG **;** **5** larger number of repeats gives earlier onset **;** **6** usual onset, after 28 / in middle age / before 65 **;** **7** onset, in babies / from 1 year old, if very numerous repeats **;** **8** ref. extra glutamine / polyglutamine **;** **9** mis-folded, protein / huntingtin **;** **10** neurological condition / brain problem **OR** (brain) neurones, die / destroyed **;** **11** motor control uninhibited / involuntary movements / chorea **;** **12** cognitive / mood, changes **;** **13** AVP **;** e.g. GABA producing neurones lost *ref. to* basal ganglia / striatum, affected (first)	**8**

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