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**BIOLOGY**

**9700/41**

Paper 4 A Level Structured Questions

**May/June 2019**

MARK SCHEME

Maximum Mark: 100

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**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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This document consists of **14** printed pages.

**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.

**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
<b>R</b>	reject
<b>A</b>	accept (for answers correctly cued by the question, or guidance for examiners)
<b>I</b>	ignore (for answers that include irrelevant information that does not contradict the expected answer)
<b>AW</b>	alternative wording (where responses vary more than usual)
<b>ora</b>	or reverse argument (for answers which are written as the opposite to the expected answer)
<b><u>underline</u></b>	actual word given must be used by candidate (grammatical variants accepted)
<b>max</b>	indicates the maximum number of marks that can be given
<b>ecf</b>	error carried forward
<b>mp</b>	marking point (with relevant number)

Question	Answer	Marks
1(a)(i)	(auxin) receptor (protein) / auxin binding protein ;	<b>1</b>
1(a)(ii)	<b>B</b> – proton / H <sup>+</sup> / hydrogen ion, <u>pump</u> ; <b>C</b> – potassium / K <sup>+</sup> / ion, channel / pore ; <b>D</b> – <u>aquaporin</u> ;	<b>3</b>
1(b)	<i>any three from:</i> 1 (cell wall) pH decreases / becomes more acidic ; 2 <u>expansins</u> ; 3 break / loosen, non-covalent, bonds / cross-links ; 4 <u>between</u> cellulose and, hemicellulose / matrix / calcium pectate <b>or</b> <u>between</u> cellulose <u>microfibrils</u> ;  5 cell wall, expands / stretches <b>OR</b> microfibrils move past each other ; 6 due to turgor pressure (on wall) ;	<b>3</b>
1(c)	<i>any two from:</i> 1 water potential, decreases / becomes more negative ; 2 water moves into cell, by osmosis / down water potential gradient ; 3 cell, expands / increases in volume / elongates ;	<b>2</b>

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Question	Answer	Marks
2(a)(i)	1 continuous ;	<b>1</b>
2(a)(ii)	<p>any <b>three</b> from:</p> <ol style="list-style-type: none"> <li>1 several / many, genes ;</li> <li>2 additive effect / gene(s) (products) interact ;</li> <li>3 environment has, big / significant, effect ;</li> <li>4 (named) environment(al factors) affects gene expression ;</li> <li>5 e.g. age / diet / disease / parasites / chemicals / mutagens / alcohol in utero, can affect, development / growth / IPD / phenotype ;</li> </ol>	<b>3</b>
2(b)(i)	<ol style="list-style-type: none"> <li>1 <u>regulator</u>(y) (gene) ;</li> </ol> <p>plus any <b>two</b> from:</p> <ol style="list-style-type: none"> <li>2 gene codes for / makes, transcription factor / activator / inducer</li> </ol> <p><b>or</b></p> <ol style="list-style-type: none"> <li>protein is, transcription factor / activator / inducer ;</li> <li>3 TF / (PAX3) protein / gene product / inducer / activator, binds to DNA ;</li> <li>4 (binding site for TF is) promoter / enhancer ;</li> <li>5 helps / stimulates, <u>RNA polymerase</u> (binding / action) ;</li> </ol>	<b>3</b>
2(b)(ii)	<p>any <b>five</b> from:</p> <ol style="list-style-type: none"> <li>1 get (total) mRNA from (embryonic) cell (expressing PAX3) ;</li> <li>2 make, cDNA / ssDNA from mRNA ;</li> <li>3 add fluorescent, label / tag / dye / chemical, to (this) DNA ;</li> <li>4 microarray / chip, has DNA, spots / probes / reporters / oligos, from, known / named, genes ;</li> <li>5 cDNA / ssDNA, hybridises with / binds to / complementary base pairs with, (spots / probes / reporters / DNA, on) chip ;</li> <li>6 fluorescent spots, indicate / show, (gene / DNA) expression ;</li> <li>7 AVP ; e.g. <i>ref. to</i> wash off excess (c)DNA after hybridisation UV / laser (scan), to see fluorescence intensity of fluorescence gives quantitative measure</li> </ol>	<b>5</b>
2(b)(iii)	<p>any <b>three</b> from:</p> <ol style="list-style-type: none"> <li>1 small genetic difference / one gene / PAX3, gives, many / big, phenotypic effect(s) ;</li> <li>2 because PAX3, regulates / controls, many / other, genes ;</li> <li>3 different, level / magnitude / intensity / pattern, of gene expression (of other genes in chimps) ;</li> <li>4 higher PAX3 (expression / protein) makes, chimps eyes closer together / chimp IPD smaller / decreases face width ;</li> </ol>	<b>3</b>

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
3(a)	1 <i>symbols</i> : normal (allele) = <b>E</b> and EOPD (allele) = <b>e</b> ; 2 <i>parent genotypes + gametes</i> : <b>Ee</b> x <b>Ee</b> and <b>E e</b> <b>E e</b> ; 3 <i>offspring genotypes</i> : <b>EE</b> <b>Ee</b> ( <b>Ee</b> ) <b>ee</b> ; 4 <i>ratio of offspring phenotypes</i> : <b>3</b> normal : <b>1</b> , EOPD / with disease ;	<b>4</b>
3(b)	<i>any five from:</i> 1 <u>missense</u> mutation ; 2 mRNA forms with different, codon / triplet ; 3 different tRNA, binds / base pairs ; 4 amino acid / primary structure (of, polypeptide / protein / kinase), changed / different ; 5 tertiary / 3D, structure (of, polypeptide / protein / kinase) changed ; 6 (change) may affect / distort, active / catalytic / ATP binding, site ; 7 <u>nonsense</u> mutation ; 8 forms (early) STOP codon ; 9 no, matching tRNA / amino acid added ; 10 shortened / truncated / incomplete, polypeptide ;	<b>5</b>
3(c)	<i>any two from:</i> 1 only need one allele to produce inhibitor ; 2 other proteins cannot be, phosphorylated / activated ; 3 no / less, aerobic respiration / ATP, in (mitochondria of) neurones ; 4 (less ATP so) problem with, dopamine recycling / sodium-potassium pump / establishing resting potential / repolarisation; 5 neurones die ;	<b>2</b>

Question	Answer	Marks																								
4(a)	<table border="1" data-bbox="904 217 1368 1046"> <thead> <tr> <th data-bbox="904 217 1144 284">correct order</th> <th data-bbox="1144 217 1368 284">letter of stage</th> </tr> </thead> <tbody> <tr> <td data-bbox="904 284 1144 360">1</td> <td data-bbox="1144 284 1368 360">E</td> </tr> <tr> <td data-bbox="904 360 1144 430">2</td> <td data-bbox="1144 360 1368 430">I</td> </tr> <tr> <td data-bbox="904 430 1144 501">3</td> <td data-bbox="1144 430 1368 501">F</td> </tr> <tr> <td data-bbox="904 501 1144 571">4</td> <td data-bbox="1144 501 1368 571">A</td> </tr> <tr> <td data-bbox="904 571 1144 641">5</td> <td data-bbox="1144 571 1368 641">G</td> </tr> <tr> <td data-bbox="904 641 1144 711">6</td> <td data-bbox="1144 641 1368 711">J</td> </tr> <tr> <td data-bbox="904 711 1144 782">7</td> <td data-bbox="1144 711 1368 782">B</td> </tr> <tr> <td data-bbox="904 782 1144 852">8</td> <td data-bbox="1144 782 1368 852">K</td> </tr> <tr> <td data-bbox="904 852 1144 922">9</td> <td data-bbox="1144 852 1368 922">C/H</td> </tr> <tr> <td data-bbox="904 922 1144 992">10</td> <td data-bbox="1144 922 1368 992">H/C</td> </tr> <tr> <td data-bbox="904 992 1144 1046">11</td> <td data-bbox="1144 992 1368 1046">D</td> </tr> </tbody> </table> <p data-bbox="1883 1050 1955 1082">; ; ; ;</p>	correct order	letter of stage	1	E	2	I	3	F	4	A	5	G	6	J	7	B	8	K	9	C/H	10	H/C	11	D	4
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8	K																									
9	C/H																									
10	H/C																									
11	D																									
4(b)	<p data-bbox="320 1114 510 1145">any <b>four</b> from:</p> <p data-bbox="320 1150 763 1182">1 acts as, coenzyme / cofactor ;</p> <p data-bbox="320 1187 898 1219">2 to dehydrogenase / in dehydrogenation ;</p> <p data-bbox="320 1224 1200 1256">3 takes / carries / delivers / releases / gives, hydrogen / H (atoms) ;</p> <p data-bbox="320 1260 1151 1292">4 to, (carrier on) ETC / inner mitochondrial membrane / cristae</p> <p data-bbox="376 1297 409 1329"><b>or</b></p> <p data-bbox="376 1334 999 1366">for, ATP production / oxidative phosphorylation ;</p> <p data-bbox="320 1370 1178 1402">5 <i>ref. to</i> redox / reduction and oxidation / reduced <b>and</b> oxidised ;</p> <p data-bbox="320 1407 781 1439">6 2.5 / 3, ATP per reduced NAD ;</p>	4																								

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Question	Answer	Marks
4(c)(i)	6 ;	1
4(c)(ii)	<p>any <b>one</b> from:</p> <p>1 hydrogen carbonate (ions) prevents decrease in (blood) pH ;</p> <p>2 buffer system / carbonic acid dissociates / ref. to carbonic anhydrase ;</p>	1

Question	Answer	Marks
5(a)(i)	(mean hind limb length) should decrease / legs get shorter ;	1
5(a)(ii)	(mean hind limb length) will vary ;	1
5(b)	<p>any <b>five</b> from descriptions (<b>D</b>), suggestions (<b>S</b>) and explanations (<b>E</b>):</p> <p><b>D1</b> on, all / seven / the, experimental / founder, islands hind limb length decreased ;</p> <p><b>S1</b> <u>directional selection</u> ;</p> <p><b>D2</b> on source island hind limb length stayed the same ;</p> <p><b>S2</b> <u>stabilising selection</u> ;</p> <p><i>explanation in context of experimental islands:</i></p> <p><b>E1</b> <u>selection pressure</u> is, (reduced / thinner) perch / branch, (diameter);</p> <p><b>E2</b> short (hind) limbs are, a <u>selective advantage</u> / <u>selected</u> for, on, experimental islands / founder islands / thin branches ;</p> <p><b>E3</b> (short hind limbs) allow / increase, stability / survival ;</p> <p><b>E4</b> (survivors), reproduce / breed / pass on allele(s) (for short hind limbs) ;</p> <p><b>E5</b> <u>allele(s)</u> for short (hind) limbs increases in frequency ;</p>	5



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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
5(c)	<p>any <b>three</b> from:</p> <ol style="list-style-type: none"> <li>1 <u>allopatric</u> ;</li> <li>2 populations / lizards / <i>A. sagrei</i>, on different islands, geographically / geologically, isolated / separated ;</li> <li>3 have different, selection pressures / environmental conditions ;</li> <li>4 different mutations occur ;</li> <li>5 <u>genetic drift</u> ;</li> <li>6 no gene flow / reproductive isolation, between, lizards on different islands / populations / (new) species ;</li> <li>7 genetic differences accumulate ;</li> </ol>	<b>3</b>
5(d)	<p>any <b>three</b> from:</p> <ol style="list-style-type: none"> <li>1 (each island has a) small population ;</li> <li>2 with, low genetic diversity / small gene pool ;</li> <li>3 inbreeding depression / low heterozygosity / high homozygosity ;</li> <li>4 environmental change / natural disaster, may, kill them all / make (whole / each) population extinct ;</li> </ol>	<b>3</b>

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Question	Answer	Marks
6(a)	<p>any <b>four</b> from:</p> <ol style="list-style-type: none"> <li>1 <u>gene</u>(s) from, another species / (soil) bacterium / <i>B.(acillus) thuringiensis</i> ;</li> <li>2 <u>restriction</u>, enzyme / endonuclease ;</li> <li>3 (Ti) plasmid / <i>Agrobacterium (tumefaciens)</i> / vector / virus / liposome / gene gun ;</li> <li>4 (DNA) ligase ;</li> <li>5 (forms) <u>recombinant</u>, DNA / plasmid / vector ;</li> <li>6 new gene / rDNA / plasmid, enters, maize / MON810, embryos / cells / genome / DNA ;</li> <li>7 gene, expressed / transcribed (and translated), to make, protein / toxin ;</li> <li>8 <i>ref. to</i> marker genes / insert promoter ;</li> </ol>	<b>4</b>
6(b)	<p>any <b>four</b> from:  <i>description (D), social (S), ethical (E)</i></p> <p><b>D1</b> ban / 0%, GM maize, decreases, yield / harvest ;  <b>D2</b> (grow) more / 88%, GM maize , increases, yield / harvest ;</p> <p><b>S1</b> GM crops increase food supply ;  <b>S2</b> GM crops decrease food cost ;</p> <p><b>S3</b> GM crops increase a country's wealth ;  <b>E1</b> GM crops relieve, hunger / starvation ;</p> <p><b>E2</b> GM crops reduce land area for crops so, conserve habitats / protect biodiversity / allow biofuel cultivation ;</p> <p>8 less insecticides could be used (in Argentina / Honduras / Spain) ;  9 negative, social / ethical, implication <b>from data</b> ;</p>	<b>4</b>

Question	Answer	Marks
7(a)(i)	<p>any <b>three</b> from:</p> <ol style="list-style-type: none"> <li>1 blood glucose concentration rises in both with drink ;</li> <li>2 diabetic, always / initially, has <b>higher</b> blood glucose concentration ;</li> <li>3 diabetic has, <b>higher</b> peak / <b>steeper</b> rise, in blood glucose concentration ;</li> <li>4 diabetic blood glucose concentration, has slower fall / does not return to normal in 3 hours / is still high after 3 hours ;</li> <li>5 compare two data points with x and y figures and units ;</li> </ol>	<b>3</b>

Question	Answer	Marks
7(a)(ii)	$\beta$ cells / pancreas / islets of Langerhans / hypothalamus ;	1
7(a)(iii)	<u>negative feedback</u> ;	1
7(b)(i)	<b>A</b> – <u>glucose oxidase</u> ; <b>B</b> – (hydrogen) <u>peroxidase</u> ;	2
7(b)(ii)	<i>biosensor</i> – rapid / immediate / 2 seconds, reading <b>or</b> (more), accurate / precise / quantitative / numerical / sensitive <b>or</b> shows current blood glucose / re-usable ;  <i>dipstick</i> – non-invasive / painless / less risk of infection / easy to use / cheap ;	2
7(c)	<i>any five from:</i> 1 (insulin) binds to receptors on, liver / muscle / adipose (cells / tissue / organ) ; 2 GLUT(4) added to membrane of, muscle / adipose, cells <b>or</b> (GLUT 4) increases , muscle / adipose, cell, permeability (to glucose) ; 3 glucokinase phosphorylates glucose in liver cells <b>or</b> increased (rate of) <u>diffusion</u> of glucose into liver cells ; 4 more / faster, respiration of glucose ; 5 activates glycogen synthase / causes glycogenesis / causes glycogen synthesis ; 6 causes, lipid / triglyceride / fatty acid, synthesis <b>or</b> decreases, glycogenolysis / lipolysis / gluconeogenesis ; 7 <u>blood glucose concentration</u> decreases ;	5

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Question	Answer	Marks
8(a)	1 <b>C</b> ; 2 greater / highest / most, number of (plant + insect) species / species richness ; 3 greater / highest / most, number of habitats ;	<b>3</b>
8(b)	area <b>A</b> because if one species, increases / decreases (in abundance), this may affect the whole, community / food web / ecosystem ;	<b>1</b>
8(c)	<i>any one from:</i> 1 species may have, medicinal / economic / aesthetic, benefits ; 2 (to maintain) genetic diversity / genetic variation / alleles ; 3 <i>ref. to</i> ethical / moral / stewardship ;	<b>1</b>

Question	Answer	Marks
9(a)	<i>any seven from:</i> 1 reaction / photosynthesis, controlled / affected, by more than one / several, factors ; 2 factor / variable, nearest its minimum value / in shortest supply ; 3 which, prevents increase in <u>rate</u> / restricts <u>rate</u> / makes <u>rate</u> plateau ;  <i>to increase crop yield in glass house:</i> 4 <u>light intensity + temperature + carbon dioxide concentration</u> ; 5 artificial lights / lamps / provide lighting at night ; 6 heaters / open windows / control ventilation ; 7 CO <sub>2</sub> from, cylinders / dry ice / combustion / (named) fuel heater ; 8 automation / computerised control / digital control ; 9 <i>ref. to optimum</i> , light intensity / temperature / CO <sub>2</sub> concentration / conditions ; 10 AVP ; e.g. water / irrigation / sprinklers control / optimum, humidity (named) fertiliser / nitrate / manure	<b>7</b>

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Question	Answer	Marks
9(b)	<p><i>any eight from:</i></p> <p><i>meiosis I</i></p> <ol style="list-style-type: none"> <li>1 chromosomes, condense / thicken / spiralise ;</li> <li>2 homologous chromosomes pair up / bivalents form ;</li> <li>3 crossing over / chiasma(ta) ;</li> <li>4 spindle fibres / microtubules, attach to / pull, centromeres / kinetochores ;</li> <li>5 bivalents, line up / arranged, on equator ;</li> <li>6 independent / random, assortment (of homologous pairs) ;</li> <li>7 chromosomes, move / pulled, to poles ;</li> </ol> <p><i>meiosis II</i></p> <ol style="list-style-type: none"> <li>8 (single) chromosomes / pairs of chromatids, line up on, equator / mid-line ;</li> <li>9 at right angles to first equator ;</li> <li>10 centromeres divide ;</li> <li>11 chromatids separate ;</li> <li>12 <i>ref. to haploid / chromosome no. halved / one set of chromosomes ;</i></li> </ol>	8

Question	Answer	Marks
10(a)	<p><i>any seven from:</i></p> <ol style="list-style-type: none"> <li>1 impulse / action potential / depolarisation, reaches, synaptic knob ;</li> <li>2 (voltage-gated) Ca<sup>2+</sup> channels open (in pre-synaptic membrane) ;</li> <li>3 Ca<sup>2+</sup> enters (synaptic knob / pre-synaptic neurone) ;</li> <li>4 vesicles with acetylcholine, move towards / fuse with, <u>pre-synaptic membrane</u> ;</li> <li>5 (ACh) released / secreted / exocytosis ;</li> <li>6 ACh <u>diffuses</u> across <u>synaptic cleft</u> ;</li> <li>7 binds to receptors on post-synaptic membrane ;</li> <li>8 (ligand-gated) Na<sup>+</sup> channels open <b>and</b> Na<sup>+</sup> enters post-synaptic neurone ;</li> <li>9 depolarisation / action potential / EPSP ;</li> <li>10 <u>acetylcholinesterase</u>, breaks down ACh / recycles Ach ;</li> </ol>	7

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Question	Answer	Marks
10(b)	<p><i>any eight from:</i></p> <ol style="list-style-type: none"> <li>1 Hill reaction ;</li> <li>2 oxidised DCPIP is blue ;</li> <li>3 (DCPIP) goes colourless when reduced ;</li> <li>4 method for making chloroplast, extract / suspension ;</li> <li>5 <i>ref. to</i> buffer solution / control osmosis / control pH ;</li> <li>6 expose chloroplasts + DCPIP to wavelength of light ;</li> <li>7 (method 1) measure time for, blue to disappear / blue-green → green / colour to match control with no DCPIP <b>or</b> (method 2) leave for fixed time and measure with colorimeter ;</li> <li>8 calculate rate as, (method 1) <math>1/t</math> <b>or</b> (method 2) change in colour value divided by time ;</li> <li>9 test five (or more), wavelengths / colours ;</li> <li>10 do three repeats / calculate means ;</li> <li>11 plot wavelength on x-axis against, dependent variable / calculated rate, on y-axis ;</li> <li>12 AVP ;</li> </ol>	<b>8</b>