Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

BIOLOGY **9700/41**

Paper 4 A Level Structured Questions **May/June 2017**

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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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)	maintain / keep / restore, constant / stable / set-point / within narrow limits, internal environment / in body **;**	**1**
1(b)(i)	**A** – pelvis **;** *note if labelled medulla as affects ecf in part (ii)* **B** – ureter **;**	**2**
1(b)(ii)	**A** *full labels instead of letters* *if region **A** (pelvis) was mislabelled as medulla in (i) can apply:* ***ecf** for **L** placed in pelvis* ***ecf U** placed in medulla **only if** word cortex also written by **U** / ultrafiltration* **U** – pointing to the cortex **;** **L** – pointing to the medulla **;** **C** – pointing to the renal vein **;**	**3**

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Question	Answer	Marks
1(c)	*max 5 of:* 1 hypothalamus detects (changes in) water potential (of the blood) **;** 2 osmoreceptors shrink when, low / less, water in blood **; ora** 3 ADH, produced / made, in hypothalamus **;** 4 if low, water / Ψ, ADH secreted from posterior pituitary **; ora** **R** ADH *produced* in posterior pituitary 5 *ref. to* neurosecretory cells **or** impulse / ADH transported, from hypothalamus to posterior pituitary **;** 6 aquaporins **;** 7 ADH increases permeability of, distal convoluted tubule / collecting duct **; ora** 8 ADH causes, more water reabsorption / smaller volume of urine / more concentrated urine **; ora** **A** both with and without ADH compared	**5**

Question	Answer	Marks
2(a)	1 high / increased / better / not limiting, carbon dioxide / temperature / (named) mineral ions **;** **I** nutrients 2 (from) coral / polyp, respiration / metabolism **or** for algae, Calvin cycle / light independent reactions **;** **A** correct use of mineral ions	**2**
2(b)	*max 4 of:* 1 (paper / thin layer) chromatography / chromatogram **;** 2 place spot of, extract / pigments, on pencil mark / at base of, paper / TLC plate **;** 3 dry and repeat (to concentrate spot) **;** 4 dip, paper / chromatogram, in solvent / so solvent travels up paper **;** **A** named organic solvent (**I** water) **R** if spot submerged 5 measure distance travelled by solvent (front) and pigment (spot) **;** 6 (calculate) R_f value $= \frac{\text{distance travelled by pigment}}{\text{distance travelled by solvent (front)}}$ **;** 7 look up / compare results with, known R_f values (to identify pigments) **;**	**4**
2(c)	*max 3 of:* 1 pigments absorb, violet-blue / 400–490 nm / lamp colours, well / best / most / at 8 out of 10 peaks **;** 2 <u>rate of photosynthesis</u> of **algae** increases with more light absorbed **;** 3 **coral** growth (increases) with more (algal) photosynthesis **;** **R** products respond to give growth 4 chlorophyll a and peridinin are, most abundant pigments / most important **;** 5 AVP **;** e.g. violet-blue / 400–490 nm, predominate at the depths where corals live	**3**

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Question	Answer	Marks
3(a)	*max 2 of:* 1 can, kill / control, weeds **;** **R** kill, insects / pests 2 reduce competition / increase yield (of rape) **;** 3 AVP **;** e.g. manual weeding / hoeing, difficult / expensive *ref. to* glufosinate converted to non-toxic compound	**2**
3(b)(i)	circle of / circular, DNA **;** **I** loop **R** single-stranded small / supplementary **;**	**2**
3(b)(ii)	*max 3 of:* 1 small so can be taken up by, cells / bacteria **;** 2 replicate, independently / fast **;** **A** have *ori* / origin of replication / high copy number 3 (DNA) has restriction site(s) / can be cut by restriction enzymes **;** **A** have polylinker 4 have, marker genes / genes for resistance (for screening) **;** 5 AVP **;** e.g. circular so, increased stability / reduced host cell degradation	**3**
3(b)(iii)	*max 2 of:* 1 <u>RNA polymerase</u> binds **;** 2 so, transcription / mRNA synthesis, begins / occurs / allowed **;** 3 AVP **;** e.g. correct / template, strand is transcribed *ref. to* tissue-specific / inducible, expression	**2**
3(c)(i)	28 **;**	**1**

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Question	Answer	Marks
3(c)(ii)	*max 1 of:* spray with herbicide **and**, those that die did not have the *bar* gene / those that survive did have the *bar* gene **;** add gene for fluorescence with *bar* gene and test plants under UV / use PCR with primer complementary to *bar* gene / use (gene) probe (on Southern blot) of electrophoresis gel **;**	**1**
3(c)(iii)	*max 3 of:* *advantage of male sterile GM variety* 1 avoid transferring, *bar* / resistance, gene to wild, radish / relations **; ora** 2 avoid superweeds **; ora** 3 avoid <u>type 2</u> hybrids **; ora** *disadvantage of **type 2 hybrids** (from GM variety that produces pollen)* 4 taller (than wild radish) **; A** very tall / 88 cm / 95 cm 5 produce, more / many, seeds (than wild radish) **; A** 3958 / 443 more 6 may (out)compete, wild radish / crops **;**	**3**

Question	Answer	Marks
4(a)	<table><tr><th>stage of respiration</th><th>ATP used</th><th>ATP produced</th></tr><tr><td>glycolysis</td><td>yes</td><td>yes</td></tr><tr><td>link reaction</td><td>no</td><td>no</td></tr><tr><td>Krebs cycle</td><td>no</td><td>yes</td></tr><tr><td>oxidative phosphorylation</td><td>no</td><td>yes</td></tr></table> **;;** *4 correct = 2 marks, 2 or 3 rows correct = 1 mark* *If ticks and crosses used need all 4 correct for maximum 1 mark*	**2**

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Question	Answer	Marks
4(b)	*max 5 of:* *group **A** (accept ora for group **B** throughout) **accept** 'they' = group **A*** 1 higher ratio **;** 2 larger / more, inner membrane / cristae (than **B**) **;** 3 more, ETCs / cytochromes / ATP synth(et)ase / stalked particles **; I** ATPase 4 oxidative phosphorylation **;** 5 more ATP produced **;** 6 muscles can contract for, longer / more time / without getting tired **; I** exercise longer **I** muscles contract faster 7 AVP **;** e.g. chemiosmosis or detail thereof: H^+ move, down gradient / through ATP synth(et)ase **I** ATPase *If **B** and **A** switched round penalise once only*	**5**

Question	Answer	Marks
5(a)	***A*** *all figures ± 1%* ***I*** *increase or decrease 'by x%' when difference from start time to end calculated* *max 4 of:* 1 decrease in daisies **and** normal poppies, overall / in 6 years / after 1999–2000 **;** 2 (decrease in, daisies / normal poppies) from 50% to 15% **;** 3 increase in poppy biotype X from 1% to 70% **;** 4 increase in, total / combined, poppies from 52% to 85% **;** 5 daisies and normal red poppies are **always** equal in % frequency **; A** remain equal 6 steep / huge / dramatic, decrease in daisies and normal red poppy after 2001 **or** increase in X, is steeper after 2001 **;**	**4**
5(b)(i)	*max 3 of:* 1 change in <u>primary</u> structure **;** 2 change in, tertiary / 3D / globular, structure **;** 3 <u>active site</u>, binds substrate / forms ESC **;** 4 metsulfuron-methyl does not, inhibit / bind to, enzyme **;** 5 enzyme, functions / forms amino acids **;**	**3**

Question	Answer	Marks
5(b)(iii)	*max 3 of:* *in 2003 (compared to 1998)* 1 more, weeds / poppies, **and** less wheat / higher proportion of weeds in wheat **; I** wheat yield 2 most weeds are now, poppy biotype X / resistant to herbicide **;** 3 poppy biotype X, not killed by / resistant to herbicide **;** 4 <u>wheat</u> have, more competition for / less access to, space / light / water / minerals **; I** nutrients	**3**
5(c)	*max 3 of:* 1 (biotype X) poppies, die / do not survive / do not breed **;** 2 their, numbers / abundance. would decrease **;** 3 selection pressure, removed / changed / new **;** 4 (biotype X) mutant / resistance, <u>allele</u> no longer, advantageous / selected for / passed on **;** 5 possibility of beneficial mutation in gene for different enzyme **or** could adapt / evolve resistance, to new herbicide **; R** if new herbicide causes mutation	**3**

Question	Answer	Marks
6(a)(i)	*max 2 of:* 1 tropomyosin / it, covers / uncovers, myosin binding sites on actin **; R** inhibits **R** active site 2 when calcium ions bind to troponin, tropomyosin / it, moves / changes shape **;** 3 allows myosin to, bind to actin / form cross-bridges **; ora**	**2**

Question	Answer	Marks
6(a)(ii)	*max 4 of:* 1 ATP hydrolysis / ATP → ADP + Pi **;** 2 (causes myosin) head to, pivot / rotate / tilt / stand up **;** 3 myosin / head, binds to actin / forms cross-bridges with actin **; R** active site 4 ADP and Pi detach **;** 5 (myosin) head, swings back / returns to previous position **;** 6 actin is moved / power stroke occurs **;** 7 (new) ATP binds **;** 8 myosin / head, detaches from actin / cross-bridges break **;** ***A*** *mps in any order apart from 1, 4 and 7 which must be linked to correct action*	**4**
6(b)(i)	*max 2 of:* 1 to, supply / provide, (enough / plenty of) glucose **;** 2 for glycolysis **;** 3 as little ATP is produced by anaerobic respiration **;** 4 as few capillaries are present (to supply glucose directly) **;**	**2**
6(b)(ii)	*max 2 of:* 1 to, supply / provide, (enough / plenty of) oxygen **;** 2 aerobic respiration / oxidative phosphorylation **;** 3 to remove, carbon dioxide / lactate **; A** lactic acid 4 to, avoid fatigue **or** promote, stamina / endurance (for exercise / work) **;**	**2**

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Question	Answer	Marks
7(a)	**Aabb** – pink **;** **aaBB** – green **;**	**2**
7(b)	1 parents phenotypes **red** **green ;** 2 gametes **AB** **Ab** **aB** **ab** × **ab ;** 3 offspring genotypes **AaBb** **Aabb** **aaBb** **aabb ;** 4 offspring phenotypes red spines pink spines green spines green spines **;** *(must be linked)* 5 ratio 1 : 1 : 2 **;** **ecf** mp 3 derived from incorrect 2 mp 4 matching incorrect 3 mp 5 matching incorrect 4	**5**
7(c)	*max 2 of:* 1 genes would be, linked / inherited together **;** 2 no independent assortment **;** 3 ratio 1:1 / only two classes (of phenotypes) **; A** red and green **or** pink and green 4 rare cross-over events / recombination (gives small numbers of third phenotype) **;**	**2**

Question	Answer	Marks
8(a)	*max 4 of:* 1 different habitats ; 2 different niches ; 3 many (different) species / large variety of species ; 4 *ref. to* (much) genetic diversity within a species ; 5 different selection pressures ; 6 *ref. to* adaptation ; 7 different, climate / rainfall / temperature / soil / topography / conditions ;	**4**
8(b)(i)	both sites are the same / no (significant) difference between two sites ;	**1**
8(b)(ii)	*genera* 2 **and** *species* 4 ;	**1**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(b)(iii)</td><td>
all figures to 3 d.p. to score but only penalise extra d.p. or rounding error associated with extra d.p. once
<table>
<tr><th>species</th><th>number on grassland not grazed</th><th>n / N</th><th>(n / N)^2</th></tr>
<tr><td>Onthophagus pennsylvanicus</td><td>6641</td><td>0.873</td><td>0.762</td></tr>
<tr><td>Canthon ebenus</td><td>774</td><td>0.102</td><td>0.010</td></tr>
<tr><td>Canthon pilularius</td><td>108</td><td>0.014</td><td>0.000</td></tr>
<tr><td>Onthophagus hecate</td><td>85</td><td>0.011</td><td>0.000</td></tr>
<tr><td>total</td><td>7608</td><td></td><td>0.772</td></tr>
</table>
n / N figures correct / numbers of each species divided by total ;
(n / N)^2 calculated and added up ; ecf from incorrect column 1 including figures with fewer / more than 3 d.p.
0.228 ; ecf total figure subtracted from 1
</td><td>3</td></tr>
<tr><td>8(b)(iv)</td><td>
greater species evenness on grazed grassland ; ora A mostly, one species / O. pennsylvanicus, on not grazed
grazing increases (dung beetle species) (bio)diversity ; ora
if opposite conclusion reached check answer for (iii) and apply ecf for mp2 if D > 0.521
</td><td>2</td></tr>
</table>

Question	Answer	Marks
9(a)	*max 8 of:* 1 stick has, pad containing / immobilised, enzymes **;** 2 glucose oxidase **;** 3 peroxidase **;** 4 stick dipped in urine **; A** person, urinates / AW, on stick 5 glucose reacts to give hydrogen peroxide **;** 6 (hydrogen peroxide reacts with) colourless substance / chromogen **; R** dye / pigment 7 to give, colour change / coloured substance **; A** change to any named colour 8 compare with colour chart **;** 9 more glucose gives darker colour **;** 10 specific / only detects glucose **;** 11 AVP **;** e.g. does not give current <u>blood</u> glucose concentration not numerical	**8**

Question	Answer	Marks
9(b)	*max 7 of:* *high blood glucose concentration* 1 detected by β cells **;** **I** alpha cells **I** receptors 2 in, islets of Langerhans / pancreas **;** 3 (more) insulin secreted **;** **I** produced 4 into blood **;** 5 increases glucose absorption in liver (by phosphorylating glucose) **;** 6 increases permeability to glucose in, muscle / fat, cells **or** adds GLUT 4 proteins to cell surface membranes of, muscle / fat, cells **;** 7 increases (rate of) respiration of glucose **;** 8 conversion of glucose to glycogen / glycogenesis **;** 9 inhibits secretion of glucagon / decreases gluconeogenesis **;** 10 negative feedback **;**	**7**

Question	Answer	Marks
10(a)	*max 6 of:* 1 dendrites (lead to cell body) **;** **R** at both ends 2 nucleus in, cell body / soma **;** **R** if cell body not at one end 3 many mitochondria (in cell body) **;** 4 much RER / Nissl's granules (in cell body) **;** 5 long / one, axon **;** **A** an axon 6 synaptic, knobs / termini / boutons, at end furthest from cell body **;** 7 Schwann cells / myelin **;** 8 nodes of Ranvier **;** *accept points on labelled diagram*	**6**

Question	Answer	Marks
10(b)	*max 9 of:* 1 Na^+ / sodium ion, channels open **;** **I** ligand or voltage gated 2 Na^+ enters, cell / axon **;** **A** Na ions / sodium ions 3 inside / p.d., becomes, less negative / positive / +40 mV **or** causes depolarisation (in correct context) **;** 4 Na^+ / sodium ion, channels close **;** **ecf** from mp1 **I** ligand or voltage-gated 5 K^+ / potassium ion, channels open **;** **ecf** from mp1 **I** ligand or voltage-gated 6 K^+ moves out (of cell) **;** **A** K ions / potassium ions 7 inside / p.d., becomes negative / **A** negative figure **or** causes repolarisation (in correct context) **;** 8 <u>local circuits</u> **;** 9 myelin (sheath) / Schwann cells, insulate / prevent ion movement **;** 10 action potential / depolarisation, <u>only</u> at, nodes (of Ranvier) **;** 11 saltatory conduction / action potential jumps from node to node **;** **A** impulse for AP 12 one-way / unidirectional, transmission **;** 13 AVP **;** e.g. hyperpolarisation / refractory period	**9**

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Question	Answer	Marks
1(a)(i)	**R** – pyruvate **;** **S** – carbon dioxide **;**	**2**
1(a)(ii)	*idea that*, hydrogen(s) / protons **and** electrons, are released **;** **A** (reduced NAD), oxidised / dehydrogenated at ETC / (for) oxidative phosphorylation **;**	**2**
1(b)	1. lactate (produced) **;** **A** lactic acid 2. (lactate) taken to liver **;** 3. converted to pyruvate **;** 4. (pyruvate) converted to, glucose / glycogen **;** 5. carbon dioxide (produced) **;** 6. *ref. to* carbon dioxide / pH, receptors **;** 7. (carbon dioxide) goes into alveoli **;** 8. increased breathing (rate) **;** 9. *ref. to* haemoglobin acts as a buffer for carbon dioxide **;**	**max 5**

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Question	Answer	Marks
2(a)	*Example 1* rate increases **as**, chlorophyll / chloroplasts, for light dependent reaction / described **;** *Example 2* rate decreases **as**, fewer thylakoids / less chlorophyll / fewer chloroplasts, for light dependent reaction / described **;**	**2**
2(b)	1. chromatography / *ref. to* chromatogram **;** 2. place, extract / sample / AW, on base line of, (paper / TLC plate) **;** 3. dry and repeat **;** 4. place paper in solvent **;** 5. measure distance travelled by solvent and pigment **;** 6. (calculate) R_f value = distance travelled by pigment divided by distance travelled by solvent **;** 7. compare R_f values against published values to identify pigments **;**	**max 4**
2(c)	1. (generally) those (pre-treated) in fluorescent light have greater absorbance than those grown in red light **; ora** 2. (except) those (pre-treated) in red light have, greater absorbance in 580 – 660nm / a peak at 625nm **; ora** 3. (because) during pre-treatment (with fluorescent or red light) different (named) pigments are made **;**	**3**

Question	Answer	Marks
3(a)(i)	decreases / shortens / AW ;	**1**
3(a)(ii)	stays the same / nothing ;	**1**
3(b)	1. (when) sarcoplasmic reticulum / SR, depolarised ; 2. calcium (ion) channels / voltage-gated channels, open ; 3. calcium ions, diffuse / move down a concentration gradient, (through open channels) ; 4. bind to troponin which changes shape ; 5. tropomyosin moves ; 6. binding sites exposed ; 7. allows myosin to bind (to actin) / cross bridge formation ; 8. *ref. to* power stroke / AW ;	**max 4**
3(c)	1. no detachment of myosin heads ; 2. so no, energy transferred to myosin / ATPase activity / hydrolysis of ATP ; 3. so no, cross bridge formation ; 4. so no, power stroke / pulling of actin ; 5. so no recovery stroke / myosin head does not return to original position ; 6. no pumping of calcium ions into SR ;	**max 3**

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Question	Answer	Marks
4(a)(i)	1. no resistance to any herbicide at start of use **;** 2. resistant to photosystem II inhibitors – increases, to 101–103 **or** from 1969 to 2013 **;** 3. resistant to ALS inhibitors – increase to 153 – 155 **or** from 1981 to 2014 **;** 4. resistant to glyphosate - increase to 32 / 33 **or** from 1993 - 1995 to 2014 **;** 5. comparative point described **;** e.g. ALS steepest gradient / ALS has highest number of species	**max 3**
4(a)(ii)	1. random / spontaneous, mutation **;** 2. herbicide is selection pressure **;** 3. mutant / resistant, individuals, survive / reproduce **;** ora 4. pass on, mutant / resistance, allele **;** ora 5. (mutant / resistance) allele increases in frequency (in population) **;** ora 6. *ref. to* many generations **;**	**max 4**
4(b)(i)	(668 × 3) + 3 (stop codon) = 2007 bp **or** 668 × 3 = 2004 bp **;**	**1**
4(b)(ii)	1. after folding substituted amino acids are close together **;** 2. *ref. to* different bonding **;** 3. (substituted amino acids) causes change to protein, 3D / tertiary / quaternary / globular, structure **;** 4. herbicide / inhibitor, unable to bind to, active / allosteric, site **;**	**max 2**

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Question	Answer	Marks
4(c)	*method 1 benefits max 3* 1. hybrid vigour / reduces inbreeding depression **;** 2. increase in, genetic variation / gene pool / variety of alleles **;** 3. increase in heterozygosity **;** ora 4. *idea that* low tech / easy to do / cheaper **;** *method 2 benefits* 5. no need to find a suitable (wild) plant / can proceed even if no resistant (wild) plant exists **;** 6. will not introduce, unwanted alleles / poor characteristics, from (wild) plant **;** 7. no chance of disease transfer **;**	**max 4**

Question	Answer	Marks
5(a)	1. individual 8 or 11 has, BRCA2 / allele, but does not have cancer **;** 2. no evidence / unknown, that individuals (apart from 15) with cancer have, *BRCA2* / allele **or** individuals with cancer (apart from 15) may have a different mutation **;** 3. no children of individual 15, (known to) have the allele / have cancer **;** 4. individuals in fourth generation / children of individual 15, may develop cancer later in life **;** 5. individual 15 has cancer and, *BRCA2* / allele **;** 6. (some) individuals with cancer in third generation had a parent with cancer **or** (some) individuals with cancer in third generation had a parent with, *BRCA2* / allele **;** ora 7. individual 3 or 4 may have had the, BRCA2 / allele **or** any individual from 8 to 11 may have inherited, *BRCA2* / allele, from 3 or 4 **;** 8. *idea that* overall data inconclusive **;**	**max 4**
5(b)(i)	all the, DNA / genetic material (in a person's cell) **;**	**1**
5(b)(ii)	(named) white cell, **because** it contains a nucleus **;**	**1**

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Question	Answer	Marks
5(b)(iii)	1. *ref. to* probes are (short) lengths of ssDNA **;** 2. complementary to the, alleles / DNA, being tested for **;** 3. many copies of one type of probe placed in each cell (of the microarray) **;** 4. (target), alleles / DNA, made single-stranded **or** single-stranded DNA made from mRNA **;** 5. (target), alleles / DNA, labelled, (with fluorescent 'tags') **;** 6. (target), alleles / DNA, hybridises / binds, with, probes / ssDNA **;** 7. unbound (target), alleles / DNA, washed off **or** bound (target), alleles / DNA, will not be washed off **;** 8. laser / UV light, used to detect presence of, fluorescence / hybridised probes / alleles / DNA **;**	**max 4**

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Question	Answer	Marks
5(b)(iv)	*advantage* max 1 1. if present, enables lifestyle change / early treatment / regular check-ups **;** 2. if not present removes worry **;** 3. preventative treatment may be cheaper than treating disease itself **;** *disadvantage* max 1 4. if present may cause worry **;** 5. if present person may not develop cancer **;** 6. test is expensive **;** 7. may have implications for life insurance / AW **;** 8. may decide to not have children / may be tested after they have children **;**	**max 2**

Question	Answer	Marks
6(a)	**E** – pointing to the vessel on the left **;** **G** – pointing to capillaries **;** **P** – pointing to the inner epithelium of the capsule **;**	**3**
6(b)	1. microvilli **;** 2. **many** mitochondria **;** 3. tight junctions / described **;** 4. folded, basal membrane / described **;** 5. **many**, transport proteins / cotransporters / pumps **;** 6. aquaporins **;** 7. AVP **;** e.g. more ER for increased protein synthesis	**max 5**
6(c)	osmoreceptors **;** ADH / antidiuretic hormone **;** posterior pituitary (gland) **;** negative feedback **; A** homeostatic	**4**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>7(a)</td><td>
parental genotypes AaBb x AaBb ;

gametes AB Ab aB ab x AB Ab aB ab ;

offspring
<table>
<tr><td></td><td>AB</td><td>Ab</td><td>aB</td><td>ab</td></tr>
<tr><td>AB</td><td>AABB
white</td><td>AABb
white</td><td>AaBB
white</td><td>AaBb
white</td></tr>
<tr><td>Ab</td><td>AABb
white</td><td>AAbb
white</td><td>AaBb
white</td><td>Aabb
white</td></tr>
<tr><td>aB</td><td>AaBB
white</td><td>AaBb
white</td><td>aaBB
black</td><td>aaBb
black</td></tr>
<tr><td>ab</td><td>AaBb
white</td><td>Aabb
white</td><td>aaBb
black</td><td>aabb
brown</td></tr>
</table>
;;
max 2 for all offspring correct
max 1 if one error
max 0 if more than one error

offspring phenotype correctly linked to genotype ;

ratio 12 white : 3 black : 1 brown ;
</td><td>6</td></tr>
</table>

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Question	Answer	Marks
7(b)	1. example of, gene interaction / epistasis **;** 2. *ref. to* blocking (one step in) pathway to pigment production **;** 3. (allele **A**) product / protein, inhibits enzyme (producing pigment) **;** 4. (allele **A**) product / protein, is a repressor **;** **A** allele codes for a repressor 5. (which) blocks transcription / RNA polymerase cannot bind / switches off allele (coding for pigment) **;** 6. (by), binding to / blocking, operator / promoter **;** 7. (allele **A**) product / protein, prevents transcription factor complex formation / AW **;**	**max 3**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(a)</td><td>1. <u>random sampling</u> ;
2. (using) random number generator for coordinates ;
3. in both sites ;
4. measure, percentage cover / (Braun-Blanquet / ACFOR) scale cover ;
5. using (square frame) quadrats ;
6. repeat sampling ;</td><td>max 4</td></tr>
<tr><td>8(b)(i)</td><td>family / sub-family ;</td><td>1</td></tr>
<tr><td>8(b)(ii)</td><td>that there is no significant difference (between the two sites) ;</td><td>1</td></tr>
<tr><td>8(b)(iii)</td><td>
<table>
<tr><th>animal taxon</th><th>number present in soil under brambles</th><th>$\frac{n}{N}$</th><th>$(n / N)^2$</th></tr>
<tr><td>pseudoscorpion</td><td>21</td><td>0.512</td><td>0.262</td></tr>
<tr><td>wireworm</td><td>12</td><td>0.293</td><td>0.086</td></tr>
<tr><td>gamasid mite</td><td>7</td><td>0.171</td><td>0.029</td></tr>
<tr><td>springtail</td><td>1</td><td>0.024</td><td>0.001</td></tr>
<tr><td>total</td><td>41</td><td></td><td>0.378</td></tr>
</table>
n / N figures correct or numbers of each species divided by total ;
$(n / N)^2$ calculated and added up ;
total figure subtracted from 1 / 1 – 0.378 = 0.622 ; ecf
</td><td>3</td></tr>
</table>

Question	Answer	Marks
8(b)(iv)	*apply **ecf** from (iii) if D is very different to 0.663 / 0.622* 1. bracken and bramble / both sites, have similar Simpson's Index of Diversity (D) numbers **;** **or** bracken and bramble / type of vegetation, has little effect on soil organism diversity **;** 2. soil organisms more abundant under bracken **;** ora	**2**

Question	Answer	Marks
9(a)	1. proton pumps in cell surface membranes (of guard cells) **;** 2. pump H^+ out (of cells) **;** 3. low(er) H^+ conc inside (cell) **;** 4. inside of cell more negative (than outside) **;** 5. K^+ channels open **;** 6. K^+ move into (cell) **;** 7. by facilitated diffusion **;** 8. Cl^- ions enter **;** 9. water potential of cell decreases **;** 10. water moves into cell, by osmosis / down a water potential gradient **;** 11. *ref. to* aquaporins **;** 12. volume of (guard) cells increases **; A** expands 13. (guard) cells become turgid / increase in turgor pressure of (guard) cells **;** 14. *ref. to* unequal thickness of cell wall (guard cell) **;**	**max 9**

Question	Answer	Marks
9(b)	*open* 1. increase in light (intensity) / high light (intensity) ; 2. gains CO_2 for photosynthesis ; 3. allows oxygen out ; 4. allows transpiration (stream) to occur ; 5. (which) brings water / mineral ions, in ; 6. (for) photosynthesis / turgidity ; *close* 7. in darkness / decrease in light (intensity) / low light (intensity) ; 8. carbon dioxide not required as no photosynthesis ; 9. in, low humidity / high temperature / high wind speed / water stress ; 10. to maintain (cell) turgidity / to prevent wilting / to prevent water loss (by transpiration) ;	**max 6**

Question	Answer	Marks
10(a)	*Differences*	**max 8**

		nervous		*endocrine*
1	communication	action potential / impulse	**and**	hormone ;
2	nature of communication	electrical (and chemical)	**and**	chemical ;
3	mode of transmission	neurone / nerve cell	**and**	blood ;
4	response destination	muscle / gland	**and**	target, organs / tissue / cells ;
5	transmission speed	fast(er)	**and**	slow(er) ;
6	effects	specific / localised	**and**	(can be) widespread ;
7	response speed	fast(er)	**and**	slow(er) ;
8	duration	short-lived / temporary	**and**	can be long-lasting / permanent ;
9	receptor location	on cell surface membrane	**and**	either on cell surface membrane **or** within cell ;

Similarities

10	cell signalling	both involve cell signalling ;
11	detail	both involve signal molecule binding to receptor ;
12	chemicals	both involve chemicals ;

Question	Answer	Marks
10(b)	1. chemicals act as a stimulus ; 2. *ref. to* specificity of chemoreceptors ; 3. sodium ions diffuse into cell ; 4. via microvilli ; 5. membrane depolarised ; 6. receptor potential / generator potential ; 7. stimulates opening of calcium (ion) channels ; 8. calcium ions enter cell ; 9. causes movement of vesicles containing neurotransmitter ; 10. neurotransmitter released by exocytosis / described ; 11. neurotransmitter stimulates, action potential / impulses, in sensory neurone ; 12. *ref. to* (chemoreceptors are) transducers / description ; 13. AVP ; e.g. threshold / all or nothing law / papilla	**max 7**

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Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

BIOLOGY **9700/43**

Paper 4 A Level Structured Questions **May/June 2017**

MARK SCHEME

Maximum Mark: 100

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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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)	maintain / keep / restore, constant / stable / set-point / within narrow limits, internal environment / in body **;**	**1**
1(b)(i)	**A** – pelvis **;** *note if labelled medulla as affects ecf in part (ii)* **B** – ureter **;**	**2**
1(b)(ii)	**A** *full labels instead of letters* *if region **A** (pelvis) was mislabelled as medulla in (i) can apply:* ***ecf** for **L** placed in pelvis* ***ecf U** placed in medulla **only if** word cortex also written by **U** / ultrafiltration* **U** – pointing to the cortex **;** **L** – pointing to the medulla **;** **C** – pointing to the renal vein **;**	**3**

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Question	Answer	Marks
1(c)	*max 5 of:* 1 hypothalamus detects (changes in) water potential (of the blood) **;** 2 osmoreceptors shrink when, low / less, water in blood **; ora** 3 ADH, produced / made, in hypothalamus **;** 4 if low, water / Ψ, ADH secreted from posterior pituitary **; ora** **R** ADH *produced* in posterior pituitary 5 *ref. to* neurosecretory cells **or** impulse / ADH transported, from hypothalamus to posterior pituitary **;** 6 aquaporins **;** 7 ADH increases permeability of, distal convoluted tubule / collecting duct **; ora** 8 ADH causes, more water reabsorption / smaller volume of urine / more concentrated urine **; ora** **A** both with and without ADH compared	**5**

Question	Answer	Marks
2(a)	1 high / increased / better / not limiting, carbon dioxide / temperature / (named) mineral ions **;** **I** nutrients 2 (from) coral / polyp, respiration / metabolism **or** for algae, Calvin cycle / light independent reactions **;** **A** correct use of mineral ions	**2**
2(b)	*max 4 of:* 1 (paper / thin layer) chromatography / chromatogram **;** 2 place spot of, extract / pigments, on pencil mark / at base of, paper / TLC plate **;** 3 dry and repeat (to concentrate spot) **;** 4 dip, paper / chromatogram, in solvent / so solvent travels up paper **;** **A** named organic solvent (**I** water) **R** if spot submerged 5 measure distance travelled by solvent (front) and pigment (spot) **;** 6 (calculate) R_f value $= \frac{\text{distance travelled by pigment}}{\text{distance travelled by solvent (front)}}$ **;** 7 look up / compare results with, known R_f values (to identify pigments) **;**	**4**
2(c)	*max 3 of:* 1 pigments absorb, violet-blue / 400–490 nm / lamp colours, well / best / most / at 8 out of 10 peaks **;** 2 <u>rate of photosynthesis</u> of **algae** increases with more light absorbed **;** 3 **coral** growth (increases) with more (algal) photosynthesis **;** **R** products respond to give growth 4 chlorophyll a and peridinin are, most abundant pigments / most important **;** 5 AVP **;** e.g. violet-blue / 400–490 nm, predominate at the depths where corals live	**3**

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Question	Answer	Marks
3(a)	*max 2 of:* 1 can, kill / control, weeds **;** **R** kill, insects / pests 2 reduce competition / increase yield (of rape) **;** 3 AVP **;** e.g. manual weeding / hoeing, difficult / expensive *ref. to* glufosinate converted to non-toxic compound	**2**
3(b)(i)	circle of / circular, DNA **;** **I** loop **R** single-stranded small / supplementary **;**	**2**
3(b)(ii)	*max 3 of:* 1 small so can be taken up by, cells / bacteria **;** 2 replicate, independently / fast **;** **A** have *ori* / origin of replication / high copy number 3 (DNA) has restriction site(s) / can be cut by restriction enzymes **;** **A** have polylinker 4 have, marker genes / genes for resistance (for screening) **;** 5 AVP **;** e.g. circular so, increased stability / reduced host cell degradation	**3**
3(b)(iii)	*max 2 of:* 1 <u>RNA polymerase</u> binds **;** 2 so, transcription / mRNA synthesis, begins / occurs / allowed **;** 3 AVP **;** e.g. correct / template, strand is transcribed *ref. to* tissue-specific / inducible, expression	**2**
3(c)(i)	28 **;**	**1**

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Question	Answer	Marks
3(c)(ii)	*max 1 of:* spray with herbicide **and**, those that die did not have the *bar* gene / those that survive did have the *bar* gene **;** add gene for fluorescence with *bar* gene and test plants under UV / use PCR with primer complementary to *bar* gene / use (gene) probe (on Southern blot) of electrophoresis gel **;**	**1**
3(c)(iii)	*max 3 of:* *advantage of male sterile GM variety* 1 avoid transferring, *bar* / resistance, gene to wild, radish / relations **; ora** 2 avoid superweeds **; ora** 3 avoid <u>type 2</u> hybrids **; ora** *disadvantage of **type 2 hybrids** (from GM variety that produces pollen)* 4 taller (than wild radish) **; A** very tall / 88 cm / 95 cm 5 produce, more / many, seeds (than wild radish) **; A** 3958 / 443 more 6 may (out)compete, wild radish / crops **;**	**3**

Question	Answer	Marks
4(a)	<table><tr><th>stage of respiration</th><th>ATP used</th><th>ATP produced</th></tr><tr><td>glycolysis</td><td>yes</td><td>yes</td></tr><tr><td>link reaction</td><td>no</td><td>no</td></tr><tr><td>Krebs cycle</td><td>no</td><td>yes</td></tr><tr><td>oxidative phosphorylation</td><td>no</td><td>yes</td></tr></table> **;;** *4 correct = 2 marks, 2 or 3 rows correct = 1 mark* *If ticks and crosses used need all 4 correct for maximum 1 mark*	**2**

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Question	Answer	Marks
4(b)	*max 5 of:* *group **A** (accept ora for group **B** throughout) **accept** 'they' = group **A*** 1 higher ratio **;** 2 larger / more, inner membrane / cristae (than **B**) **;** 3 more, ETCs / cytochromes / ATP synth(et)ase / stalked particles **; I** ATPase 4 oxidative phosphorylation **;** 5 more ATP produced **;** 6 muscles can contract for, longer / more time / without getting tired **; I** exercise longer **I** muscles contract faster 7 AVP **;** e.g. chemiosmosis or detail thereof: H^+ move, down gradient / through ATP synth(et)ase **I** ATPase *If **B** and **A** switched round penalise once only*	**5**

Question	Answer	Marks
5(a)	***A*** *all figures ± 1%* ***I*** *increase or decrease 'by x%' when difference from start time to end calculated* *max 4 of:* 1 decrease in daisies **and** normal poppies, overall / in 6 years / after 1999–2000 **;** 2 (decrease in, daisies / normal poppies) from 50% to 15% **;** 3 increase in poppy biotype X from 1% to 70% **;** 4 increase in, total / combined, poppies from 52% to 85% **;** 5 daisies and normal red poppies are **always** equal in % frequency **; A** remain equal 6 steep / huge / dramatic, decrease in daisies and normal red poppy after 2001 **or** increase in X, is steeper after 2001 **;**	**4**
5(b)(i)	*max 3 of:* 1 change in <u>primary</u> structure **;** 2 change in, tertiary / 3D / globular, structure **;** 3 <u>active site</u>, binds substrate / forms ESC **;** 4 metsulfuron-methyl does not, inhibit / bind to, enzyme **;** 5 enzyme, functions / forms amino acids **;**	**3**

Question	Answer	Marks
5(b)(iii)	*max 3 of:* *in 2003 (compared to 1998)* 1 more, weeds / poppies, **and** less wheat / higher proportion of weeds in wheat **; I** wheat yield 2 most weeds are now, poppy biotype X / resistant to herbicide **;** 3 poppy biotype X, not killed by / resistant to herbicide **;** 4 <u>wheat</u> have, more competition for / less access to, space / light / water / minerals **; I** nutrients	**3**
5(c)	*max 3 of:* 1 (biotype X) poppies, die / do not survive / do not breed **;** 2 their, numbers / abundance. would decrease **;** 3 selection pressure, removed / changed / new **;** 4 (biotype X) mutant / resistance, <u>allele</u> no longer, advantageous / selected for / passed on **;** 5 possibility of beneficial mutation in gene for different enzyme **or** could adapt / evolve resistance, to new herbicide **; R** if new herbicide causes mutation	**3**

Question	Answer	Marks
6(a)(i)	*max 2 of:* 1 tropomyosin / it, covers / uncovers, myosin binding sites on actin **; R** inhibits **R** active site 2 when calcium ions bind to troponin, tropomyosin / it, moves / changes shape **;** 3 allows myosin to, bind to actin / form cross-bridges **; ora**	**2**

Question	Answer	Marks
6(a)(ii)	*max 4 of:* 1 ATP hydrolysis / ATP → ADP + Pi **;** 2 (causes myosin) head to, pivot / rotate / tilt / stand up **;** 3 myosin / head, binds to actin / forms cross-bridges with actin **; R** active site 4 ADP and Pi detach **;** 5 (myosin) head, swings back / returns to previous position **;** 6 actin is moved / power stroke occurs **;** 7 (new) ATP binds **;** 8 myosin / head, detaches from actin / cross-bridges break **;** ***A*** *mps in any order apart from 1, 4 and 7 which must be linked to correct action*	**4**
6(b)(i)	*max 2 of:* 1 to, supply / provide, (enough / plenty of) glucose **;** 2 for glycolysis **;** 3 as little ATP is produced by anaerobic respiration **;** 4 as few capillaries are present (to supply glucose directly) **;**	**2**
6(b)(ii)	*max 2 of:* 1 to, supply / provide, (enough / plenty of) oxygen **;** 2 aerobic respiration / oxidative phosphorylation **;** 3 to remove, carbon dioxide / lactate **; A** lactic acid 4 to, avoid fatigue **or** promote, stamina / endurance (for exercise / work) **;**	**2**

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Question	Answer	Marks
7(a)	**Aabb** – pink **;** **aaBB** – green **;**	**2**
7(b)	1 parents phenotypes **red** **green ;** 2 gametes **AB** **Ab** **aB** **ab** × **ab ;** 3 offspring genotypes **AaBb** **Aabb** **aaBb** **aabb ;** 4 offspring phenotypes red spines pink spines green spines green spines **;** *(must be linked)* 5 ratio 1 : 1 : 2 **;** **ecf** mp 3 derived from incorrect 2 mp 4 matching incorrect 3 mp 5 matching incorrect 4	**5**
7(c)	*max 2 of:* 1 genes would be, linked / inherited together **;** 2 no independent assortment **;** 3 ratio 1:1 / only two classes (of phenotypes) **; A** red and green **or** pink and green 4 rare cross-over events / recombination (gives small numbers of third phenotype) **;**	**2**

Question	Answer	Marks
8(a)	*max 4 of:* 1 different habitats ; 2 different niches ; 3 many (different) species / large variety of species ; 4 *ref. to* (much) genetic diversity within a species ; 5 different selection pressures ; 6 *ref. to* adaptation ; 7 different, climate / rainfall / temperature / soil / topography / conditions ;	**4**
8(b)(i)	both sites are the same / no (significant) difference between two sites ;	**1**
8(b)(ii)	*genera* 2 **and** *species* 4 ;	**1**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(b)(iii)</td><td>
all figures to 3 d.p. to score but only penalise extra d.p. or rounding error associated with extra d.p. once
<table>
<tr><th>species</th><th>number on grassland not grazed</th><th>n / N</th><th>(n / N)^2</th></tr>
<tr><td>Onthophagus pennsylvanicus</td><td>6641</td><td>0.873</td><td>0.762</td></tr>
<tr><td>Canthon ebenus</td><td>774</td><td>0.102</td><td>0.010</td></tr>
<tr><td>Canthon pilularius</td><td>108</td><td>0.014</td><td>0.000</td></tr>
<tr><td>Onthophagus hecate</td><td>85</td><td>0.011</td><td>0.000</td></tr>
<tr><td>total</td><td>7608</td><td></td><td>0.772</td></tr>
</table>
n / N figures correct / numbers of each species divided by total ;
(n / N)^2 calculated and added up ; ecf from incorrect column 1 including figures with fewer / more than 3 d.p.
0.228 ; ecf total figure subtracted from 1
</td><td>3</td></tr>
<tr><td>8(b)(iv)</td><td>
greater species evenness on grazed grassland ; ora A mostly, one species / O. pennsylvanicus, on not grazed
grazing increases (dung beetle species) (bio)diversity ; ora
if opposite conclusion reached check answer for (iii) and apply ecf for mp2 if D > 0.521
</td><td>2</td></tr>
</table>

Question	Answer	Marks
9(a)	*max 8 of:* 1 stick has, pad containing / immobilised, enzymes **;** 2 glucose oxidase **;** 3 peroxidase **;** 4 stick dipped in urine **; A** person, urinates / AW, on stick 5 glucose reacts to give hydrogen peroxide **;** 6 (hydrogen peroxide reacts with) colourless substance / chromogen **; R** dye / pigment 7 to give, colour change / coloured substance **; A** change to any named colour 8 compare with colour chart **;** 9 more glucose gives darker colour **;** 10 specific / only detects glucose **;** 11 AVP **;** e.g. does not give current <u>blood</u> glucose concentration not numerical	**8**

Question	Answer	Marks
9(b)	*max 7 of:* *high blood glucose concentration* 1 detected by β cells **;** **I** alpha cells **I** receptors 2 in, islets of Langerhans / pancreas **;** 3 (more) insulin secreted **;** **I** produced 4 into blood **;** 5 increases glucose absorption in liver (by phosphorylating glucose) **;** 6 increases permeability to glucose in, muscle / fat, cells **or** adds GLUT 4 proteins to cell surface membranes of, muscle / fat, cells **;** 7 increases (rate of) respiration of glucose **;** 8 conversion of glucose to glycogen / glycogenesis **;** 9 inhibits secretion of glucagon / decreases gluconeogenesis **;** 10 negative feedback **;**	**7**

Question	Answer	Marks
10(a)	*max 6 of:* 1 dendrites (lead to cell body) **;** **R** at both ends 2 nucleus in, cell body / soma **;** **R** if cell body not at one end 3 many mitochondria (in cell body) **;** 4 much RER / Nissl's granules (in cell body) **;** 5 long / one, axon **;** **A** an axon 6 synaptic, knobs / termini / boutons, at end furthest from cell body **;** 7 Schwann cells / myelin **;** 8 nodes of Ranvier **;** *accept points on labelled diagram*	**6**

Question	Answer	Marks
10(b)	*max 9 of:* 1 Na^+ / sodium ion, channels open **;** **I** ligand or voltage gated 2 Na^+ enters, cell / axon **;** **A** Na ions / sodium ions 3 inside / p.d., becomes, less negative / positive / +40 mV **or** causes depolarisation (in correct context) **;** 4 Na^+ / sodium ion, channels close **;** **ecf** from mp1 **I** ligand or voltage-gated 5 K^+ / potassium ion, channels open **;** **ecf** from mp1 **I** ligand or voltage-gated 6 K^+ moves out (of cell) **;** **A** K ions / potassium ions 7 inside / p.d., becomes negative / **A** negative figure **or** causes repolarisation (in correct context) **;** 8 <u>local circuits</u> **;** 9 myelin (sheath) / Schwann cells, insulate / prevent ion movement **;** 10 action potential / depolarisation, <u>only</u> at, nodes (of Ranvier) **;** 11 saltatory conduction / action potential jumps from node to node **;** **A** impulse for AP 12 one-way / unidirectional, transmission **;** 13 AVP **;** e.g. hyperpolarisation / refractory period	**9**