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 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)	*two from:* 1 variation in / diversity of, ecosystems / habitats **;** 2 number of / (how) many / variety of / diversity of, species **;** 3 the (relative) abundance of each species **;** 4 genetic diversity / range of alleles, within a species **;**	**2**
1(b)(i)	genes **and** environment **;**	**1**
1(b)(ii)	*one from:* 1 whales, mobile / swim / migrate **;** 2 (they inhabit) large, area / distances **;** 3 live, underwater / at great depths **;**	**1**
1(c)	*two from:* 1 (water) pollution from, industry / boats **;** 2 accidents involving / damaged by, boats / fishing gear **;** 3 lack of / competition for, food / krill / prey **;** 4 noise / vibration, disturbs whale, communication / behaviour / mating **;** 5 illegal, whaling / hunting **;** 6 reproduction rate is slow / one offspring at a time / long gestation **;**	**2**

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Question	Answer	Marks
1(d)	*two from:* *toxins (PCBs / DDT) are* 1 present in, water / river / sea **;** 2 ingested / absorbed by, producers / phytoplankton / algae **;** 3 bioaccumulation **or** toxins, pass up / accumulate up, food chain **;** 4 persistent / long-lasting / not broken down (in environment / whale) **;** 5 fat / lipid, soluble **;**	**2**
1(e)(i)	*two from:* 1 sodium ions do not enter (neurones / nerve cells / axons) **;** 2 (neurones) cannot depolarise **or** cannot, generate / transmit, impulses / action potentials **;** 3 reason for death **;**	**2**
1(e)(ii)	*one from:* unicellular / not multicellular **;** motile / have flagella **;**	**1**

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Question	Answer	Marks
2(a)(i)	1 reduces, GP / glycerate (3) phosphate **;** 2 to, TP / triose phosphate **;**	**2**
2(a)(ii)	RuBP, decreases / less **either** because it, reacts / is used up / is converted **or** because it is not, replaced / regenerated **; AW**	**1**
2(b)	*any four in total:* *tube A* 1 for comparison / to compare **;** 2 to see, end-point / when all DCPIP has been reduced, in **B** **;** *foil (max 3)* 3 to, stop / limit, light entering (the beaker / mixture) **or** to stop light reaching chlorophyll **;** 4 to, stop / limit, light dependent reaction occurring **;** 5 to, stop / limit, DCPIP, decolourising / being reduced **;** 6 so all tests start with same colour (of DCPIP–chloroplast mixture) **;**	**4**
2(c)(i)	22.2 **;**	**1**

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Question	Answer	Marks
2(c)(ii)	*five from:* *description of rate of, photosynthesis / light (dependent) reaction (max 2)* 1 (it is) highest / fastest / most, in purple **/** at 425 nm **;** 2 (it is) lowest / slowest / least, in green **/** at 525 nm **;** *explanation (max 3)* 3 chlorophyll absorbs purple and orange (best) but does not absorb green **;** 4 accessory pigments **;** 5 light, excites electrons / triggers electron transport **;** 6 non-cyclic photophosphorylation **;** 7 action spectrum **;**	**5**

Question	Answer	Marks
3(a)	(interspecific) competition (with greys) **;** virus / disease / infection, passed, from greys / to reds **;**	**2**
3(b)	*three from:* 1 DNA / base / nucleotide, sequences **;** 2 mitochondrial / mt, DNA **;** 3 protein / polypeptide / amino acid, sequences **;** 4 genetic fingerprinting / DNA profiling **;** 5 compare (sequences from reds and greys) **;**	**3**
3(c)	*three from:* 1 pine marten / predation, is / was, selection pressure **;** 2 red squirrel better adapted (to pine marten predation) **; ora** 3 detail **/** suggestion **;** e.g. red squirrel, faster / better camouflaged **ora** 4 (two squirrel species arose by) allopatric speciation / AW **;** 5 different, selection pressures / predators (in two places / for two species) **;** 6 red squirrels and pine martens co-existed for, 10 000 years / long time **;**	**3**

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Question	Answer	Marks
4(a)(i)	*two from:* 1 (only) kills / targets / acts on, specific / some, insects / pests **;** 2 does not kill, beneficial / useful, insects **;** 3 (such as) pollinators / bees / predators of pests **;** 4 to conserve / protect, biodiversity / food web **; ora** 5 *idea that* other Cry proteins might not kill, right pests / bollworm **;**	**2**
4(a)(ii)	*two from:* 1 (so, new / foreign / inserted) gene(s) are, expressed / switched on / transcribed (and translated) **;** 2 RNA polymerase binds (at promoter) **;** 3 *ref. to* correct / template, strand **;** 4 to control quantity of Cry(1Ac / protein) made **;** 5 to control, where / which part(s) of plant, make Cry(1Ac / protein) **;**	**2**
4(a)(iii)	*three from:* 1 insert, herbicide resistance gene / it, next to, Bt / Cry(1Ac), gene **;** 2 spray / add, herbicide on (transformed) plants / protoplasts / cells **;** 3 survivors have, Bt / Cry(1Ac), gene **;** 4 to identify, successful / GM / insect-resistant, plants **;**	**3**

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Question	Answer	Marks
4(b)(i)	*two from:* 1 Bt seed costs more but insecticide costs less **;** 2 total cost is more for Bt than for non-GM **;** 3 manipulated figure(s) comparing both Bt and non-GM **;**	**2**
4(b)(ii)	*one from:* non-GM seeds are cheap(er) / (more) affordable **;** non-GM / it, is cheap(er), overall / to grow **;**	**1**
4(c)	*three from:* 1 selective breeding / artificial selection **;** 2 cross Bt cotton with a (Bt) variety that grows well in, dry / drought **;** 3 select / choose, offspring with Bt (trait / gene) **and** grow well in, dry / drought **;** 4 repeat (crossing / selection) for several generations **;**	**3**

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Question	Answer	Marks
5(a)	*four from:* 1 insulator / ions cannot pass through it ; 2 depolarisation / action potentials, occur at nodes of Ranvier (only) ; 3 long(er) local, circuits / currents ; 4 action potential jumps from node to node / saltatory conduction ; 5 transmission / conduction, fast(er) ;	**4**
5(b)	*five from:* 1 action potential / depolarisation, at presynaptic membrane ; 2 Ca^{2+} channels open / increased permeablity to Ca^{2+} ; 3 Ca^{2+} enter, (presynaptic) neurone / knob / axoplasm / AW ; 4 by (facilitated) diffusion / down concentration gradient ; 5 vesicles, of acetylcholine / neurotransmitter, fuse with membrane ; 6 ACh / neurotransmitter, enters / exocytosed into, synaptic cleft ;	**5**

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Question	Answer	Marks
6(a)	<table><tr><th>contents of dishes</th><th>ATP produced</th></tr><tr><td>mitochondria + ADP + Pi + acetyl CoA + oxygen</td><td>✓</td></tr><tr><td>mitochondria + ADP + Pi + acetyl CoA</td><td>×</td></tr><tr><td>mitochondria + ADP + Pi + low concentration of protons (H^+)</td><td>×</td></tr><tr><td>mitochondria + ADP + Pi + high concentration of protons (H^+)</td><td>✓</td></tr></table> ; ; *2 or 3 correct = 1 mark* *4 correct = 2 marks*	**2**
6(b)	*two from:* water enters (mitochondrion / matrix) **;** by osmosis / down the water potential gradient **;** membranes ruptured / mitochondrion bursts **;**	**2**
6(c)	final <u>electron</u> (and proton) acceptor (in ETC) **;**	**1**
6(d)	ATP synth(et)ase **;**	**1**

Question	Answer	Marks
6(e)	*four from:* 1 (site of) electron transport chain **;** 2 moves / pumps, protons / H^+, to inter-membrane space **;** 3 electrochemical / proton / H^+, gradient **;** 4 protons / H^+, diffuse to matrix **;** 5 through**,** stalked particles / ATP synth(et)ase **;** 6 ADP + Pi → ATP **;** 7 oxidative phosphorylation **;**	**4**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>7(a)(i)</td><td>consume, less / no, milk / lactose / (named) dairy products ;</td><td>1</td></tr>
<tr><td>7(a)(ii)</td><td>four from:
1 changes / different, base / nucleotide (sequence), in, DNA / gene ;
2 changes / different, mRNA, codon / triplet ;
3 changes / different, primary structure of, polypeptide / protein / enzyme ;
4 changes / different, tertiary structure (of, polypeptide / protein / enzyme) ;
5 changes / different, allosteric / active, site ;
6 enzyme, non-functional / does not convert galactose (to glucose) ;</td><td>4</td></tr>
<tr><td>7(b)</td><td><table><tr><th>parent 1</th><th>parent 2</th><th>% prob. affected child</th><th>% prob. unaffected child</th><th>% prob . carrier child</th></tr><tr><td>unaffected</td><td>carrier</td><td>0</td><td>50</td><td>50</td></tr><tr><td>carrier</td><td>carrier</td><td>25</td><td>25</td><td>50 ;</td></tr><tr><td>unaffected</td><td>affected</td><td>0</td><td>0</td><td>100 ;</td></tr><tr><td>carrier</td><td>affected</td><td>50</td><td>0</td><td>50</td></tr></table></td><td>2</td></tr>
<tr><td>7(c)</td><td>two from:
genetic screening ;
obtain fetal, cells / DNA ;
by, amniocentesis / chorionic villus sampling ;
electrophoresis + probe ;</td><td>2</td></tr>
</table>

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Question	Answer	Marks
8(a)	*four from:* 1 change in factor away from, the norm / set-point **;** 2 detected / sensed by, receptor **;** 3 hormone released **or** (nerve) impulse sent **;** 4 (hormone / impulse) reaches, target organ / effector **;** 5 (effector) performs corrective action **;** 6 (factor) returns to, norm / set-point **;**	**4**
8(b)	*four from:* 1 hypothalamus detects change in blood glucose concentration **;** 2 autonomic / motor / nerve, impulses **;** 3 (so) β cells secrete insulin when blood glucose increases **;** 4 (so) α cells secrete glucagon when blood glucose decreases **;** 5 (so) adrenal gland secretes adrenaline **either** when blood glucose decreases **or** due to fear / shock / excitement / stress **;** 6 nervous control supplements, endocrine control / control by pancreas **;**	**4**

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Question	Answer	Marks
8(c)	*four from:* *vasoconstriction* 1 arterioles in skin get narrow(er) **;** 2 less blood flow through (skin / surface) capillaries **;** 3 (so) less heat lost (to surroundings) **;** *shivering* 4 muscle contraction **;** 5 releases / provides / gives, heat / thermal energy **;** *increasing secretion of adrenaline* 6 increases, rate of respiration / metabolic rate **;** 7 more heat, released / provided / given (by respiration) **;**	**4**

Question	Answer	Marks
9(a)	*six from:* 1 aerenchyma ; 2 in stem **and** roots ; 3 help oxygen to, move / diffuse, to roots ; 4 shallow roots ; 5 air (film) trapped on underwater leaves ; 6 fast internode growth ; 7 (modified) growth regulated by, gibberellin **/** ethene ; 8 anaerobic respiration, underwater / when submerged ; 9 tolerant to high ethanol concentration / high tolerance to ethanol ; 10 ethanol dehydrogenase (switched on in anaerobic conditions) ; 11 AVP ; e.g. growth stops / carbohydrates conserved / quiescence, in short-term (flash) floods	**6**

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Question	Answer	Marks
9(b)	*nine from:* 1 RuBP / rubisco, in bundle sheath (cells) ; 2 away from, oxygen / air ; 3 to avoid photorespiration ; 4 carbon dioxide combines with PEP ; 5 (catalysed by) PEP carboxylase ; 6 in mesophyll (cells) ; 7 forms oxaloacetate ; 8 converted to malate ; 9 malate passes to bundle sheath (cells) ; 10 (malate) releases (high concentration of) carbon dioxide ; 11 RuBP, carboxylated / reacts with carbon dioxide ; 12 PEP carboxylase / enzyme(s), has high optimum temperature / tolerate high temperatures ;	**9**

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Question	Answer	Marks
10(a)	*six from:* 1 base / nucleotide, substitution ; 2 missense / silent, mutation ; 3 base / nucleotide, insertion / addition ; 4 base / nucleotide, deletion ; 5 may cause frameshift ; 6 alters triplets of following, base / nucleotide, sequence ; 7 (premature) stop codon gives shortened polypeptide ; 8 does not code for amino acid ; 9 nonsense mutation ;	**6**

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Question	Answer	Marks
10(b)	*nine from:* 1 homozygous for, mutant allele / Hb^S ; 2 altered β polypeptide in haemoglobin ; 3 haemoglobin / β-globin, less soluble ; 4 in low(er) oxygen (concentration) ; 5 (Hb) forms long fibres ; 6 red blood cells, sickle / form crescent shape ; 7 (RBCs) carry less oxygen ; 8 (RBCs) get stuck in capillaries ; 9 blocks blood flow ; 10 causes pain ; 11 sickle cell crisis ; 12 RBCs break down faster / lack of RBCs ; 13 protection against, malaria / *Plasmodium* infection ;	**9**

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Question	Answer	Marks
1(a)(i)	*three from:* 1 the numbers of, prey / herbivores / sheep / goats, would increase **;** 2 decrease in number of plants / *idea of* overgrazing **;** 3 damage to habitat **;** e.g. erosion 4 increased competition (for plants) **;** 5 lack of food causes, herbivore numbers to decline / herbivores to migrate away **;** 6 reduction in, biodiversity / species diversity / genetic diversity / genetic variation **;** 7 AVP **;** e.g. increase in other predators / disruption to food web	**3**
1(a)(ii)	*one from:* 1 snow leopards are, hard to see / camouflaged **;** 2 vast habitat to cover (to locate snow leopards) / inaccessible locations / solitary **;** 3 AVP **;** e.g. difficulty getting permission from some governments to go into certain areas	**1**

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Question	Answer	Marks
1(b)	*three from:* 1 ban trade (of, leopard / leopard products) **;** 2 ban hunting **;** 3 detection methods **;** e.g. customs / trading officers / wildlife forensics / extra rangers 4 enforcement measures **;** e.g. fines / prison / punishment 5 raise public awareness / education **;** 6 *ref. to* protected areas / national parks **;**	**3**

Question	Answer	Marks
1(c)	*two from:* 1 genetic diversity decreases / AW ; 2 increased chance of two harmful recessive alleles coming together / increase in inbreeding depression / decrease in hybrid vigour ; 3 (some) less likely to survive ; 4 (because) less likely to adapt to change in, environmental conditions / selection pressure ;	**2**
1(d)	*two from:* 1 appearance / morphology / visible features / looked similar to leopards ; 2 breeding (to produce fertile offspring) ; **ora** 3 *ref. to* behaviour ;	**2**
2(a)(i)	NADP ;	**1**
2(a)(ii)	*two from:* 1 photolysis of water / AW ; 2 *ref. to* photosystem II ; 3 using an enzyme ; 4 hydrogen ions and electrons combine to form hydrogen / AW ;	**2**

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Question	Answer	Marks
2(b)(i)	*two from:* 1 to, reduce / stop, activity of enzymes ; 2 *ref. to* proteases / lipases ; 3 to prevent damage (to chloroplasts) ;	**2**
2(b)(ii)	1 to, control pH / keep pH constant ; 2 so enzyme works at optimum / to prevent denaturation of enzyme ;	**2**
2(b)(iii)	1 to avoid, osmosis / movement of water down a water potential gradient ; 2 to prevent damage (to chloroplasts) / AW ;	**2**
2(c)(i)	43 / 43.0 ;	**1**
2(c)(ii)	23.3 / 23.0 / 23 ; *accept ecf from 2(c)(i)*	**1**

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Question	Answer	Marks
2(c)(iii)	*four from:* *relationship* 1 as light intensity increases time taken for decolourisation decreases **or** as light intensity increases rate of decolourisation increases **or** as light intensity increases decolourisation is faster **;** *explanation (max 3)* 2 more, photons / <u>light</u> <u>energy</u>, absorbed **;** 3 more / faster, photolysis **/** AW **;** 4 more electrons, excited / released **or** faster rate of electron release **;** 5 more protons released **or** faster rate of proton release **;** 6 more / faster, <u>reduction</u> of DCPIP **;**	**4**

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Question	Answer	Marks
3(a)	*two from:* 1 killing by humans / eaten by humans / hunting / poaching **;** 2 loss of, habitat / waste land **;** 3 loss of, (plant) food / grazing **;**	**2**
3(b)	*three from:* 1 DNA / nucleotide, sequencing **;** 2 *ref. to* mitochondrial DNA **;** 3 protein / amino acid, sequencing **;** 4 *idea of* comparing sequences (from **A** and **B**) **;** 5 AVP **;** e.g. sequencing method such as Sanger / dideoxynucleotides / chain termination / automated / next generation **or** *ref. to* bioinformatics / genome analysis / microarray analysis	**3**

Question	Answer	Marks
3(c)	*three from:* 1 **A** (originally) geographically isolated / described, (from ancestors of, **B** / **C** / **D**) **;** 2 for, 12 000 years / long period of time / many generations **;** 3 different mutations (in Ireland and Great Britain) **;** 4 different, selection pressures / environmental conditions, (in Ireland and Great Britain) **;** 5 *ref. to* genetic drift **;** 6 reduction in genetic diversity in **A** / population bottleneck **;** 7 AVP **;** e.g. no gene flow between populations	**3**

Question	Answer	Marks
4(a)	*four from:* *vasodilation* 1 arterioles / blood vessels, (in skin) widen **;** **R** capillaries **I** arteries 2 more blood flows to capillaries / blood flows through capillaries more slowly **;** 3 heat (energy) lost **;** *sweating* 4 more sweat, produced / released **;** 5 sweat / water, evaporates **;** 6 using heat energy / *ref. to* latent heat of vaporisation **;**	**4**
4(b)	*four from:* 1 high blood glucose concentration / hyperglycaemia **;** 2 (causes) decrease in water potential (of blood) **;** 3 detected by, osmoreceptors / hypothalamus **;** 4 feelings of thirst **;** 5 less / no, glucose converted to, fat / glycogen **;** 6 glucose lost in urine / not all glucose reabsorbed / blood glucose concentration above the renal threshold **;** 7 glucose not taken up by cells **;** 8 (so) fats / proteins, are, respired / metabolised **;**	**4**

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Question	Answer	Marks
4(c)(i)	*three from:* 1 (pad contains) glucose oxidase **;** 2 enzyme / glucose oxidase, reacts with glucose (in the blood) **;** 3 oxygen detected **;** 4 (electric) current generated **;** 5 detected by electrode **;** 6 gives numerical value (of blood glucose concentration) **;**	**3**
4(c)(ii)	*one from:* 1 gives the, actual / accurate / exact, reading (of blood glucose concentration) **;** 2 re-usable **;** 3 more precise reading **/** quantitative **;**	**1**
5(a)(i)	*two from:* 1 CAG / repeat, is a triplet **or** triplets of bases / codons, are added **;** 2 (so) other triplets are unchanged **;** 3 (so) no frameshift **;**	**2**

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Question	Answer	Marks
5(a)(ii)	*four from:* 1 allele is dominant **;** 2 so will still be expressed even when, normal / recessive, allele is present **; ora** 3 (gene therapy only) used to treat recessive (allele) disorders **;** 4 cannot, remove dominant allele / replace an allele **;** 5 dominant allele affects tissues in many parts of the body **;**	**4**
5(b)(i)	50% / 1 in 2 / 0.5 / half **; A** 100% if candidate implies parent is homozygous dominant	**1**
5(b)(ii)	*two from:* *advantage (max 1)* 1 can choose whether to have children **;** 2 can prepare for the future **;** 3 (if negative) removes anxiety / AW **;** *not awarded with mp5* *disadvantage (max 1)* 4 (if positive) no treatment possible **;** 5 (if positive) may lead to anxiety / AW **;** *not awarded with mp3* 6 (if positive) social / financial, discrimination **;** e.g. life insurance refusal 7 (if positive) may still not develop disease (*ref. to* below 39 repeats) **;**	**2**
5(c)(i)	removing a cell from an embryo (for testing) **;**	**1**
5(c)(ii)	to amplify the, DNA / gene, (from the embryo cell) **;**	**1**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>5(c)(iii)</td><td>two from:
1 embryos might be destroyed ;
2 wrong for parents to choose / designer embryos ;
3 contrary to, beliefs / values ;
4 less chance of Huntington allele being passed on / decrease in frequency of Huntington allele ;
5 idea that people with the faulty allele who otherwise would not have children can now do so ;</td><td>2</td></tr>
<tr><td>6(a)(i)</td><td>1 as the eugenol concentration increases the percentage decrease in sodium ion movement increases ;
2 percentage at two concentrations of eugenol plus units ;
<table>
<tr><td>conc (mmol dm^{-3})</td><td>%</td></tr>
<tr><td>0.0</td><td>0</td></tr>
<tr><td>0.2</td><td>30</td></tr>
<tr><td>0.4</td><td>50</td></tr>
<tr><td>0.6</td><td>65</td></tr>
<tr><td>0.8</td><td>72</td></tr>
<tr><td>1.0</td><td>80</td></tr>
</table></td><td>2</td></tr>
<tr><td>6(a)(ii)</td><td>57–58 (%) ;</td><td>1</td></tr>
</table>

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Question	Answer	Marks
6(b)	*five from:* 1 reduced entry of Na^+ into sensory neurone ; 2 eugenol prevents opening of sodium ion channels / described ; 3 no / reduced, depolarisation of sensory neurone <u>membrane</u> ; 4 receptor potential / threshold potential, not reached ; 5 no / fewer, action potentials / impulses ; 6 may affect sodium-potassium pump ; 7 resting potential not restored ; 8 action potentials / impulses, do not reach brain ;	**5**
7(a)	1 inorganic phosphate added to ADP / ADP + Pi ; 2 *ref. to* (named) phosphorylated compound ;	**2**
7(b)(i)	<u>ester</u> ;	**1**
7(b)(ii)	carrier of, 2C (unit) / acetyl group / acetate, to, the Krebs cycle / oxaloacetate ;	**1**
7(b)(iii)	*two from:* 1 more C–H (bonds) / more reduced / more hydrogen ; 2 produces more reduced NAD ; 3 more, aerobic respiration / oxidative phosphorylation / chemiosmosis ; 4 produces more ATP per, gram / unit mass ;	**2**

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Question	Answer	Marks
7(c)(i)	17 **;**	**1**
7(c)(ii)	0.71 **;;** *one mark for 12 ÷ 17* *allow ecf from **(i)** for one mark*	**2**
8(a)	*two from:* 1 (two or more) genes on same chromosome **;** 2 not sex chromosome **;** 3 will be inherited together **;**	**2**
8(b)	*four from:* 1 most offspring are, purple long **and** red round / parental phenotypes **;** 2 fewer offspring are, purple round **and** red long / non-parental phenotypes **;** 3 recombinants / new combinations of alleles **;** 4 (because of) crossing over **;** 5 between the two gene loci **;** 6 AVP **;** e.g. COV is 12% / low COV / two genes not very far apart	**4**

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Question	Answer	Marks
8(c)	*three from:* 1 change in, base (pair) / nucleotide, sequence in DNA ; 2 random / spontaneous ; *due to* 3 *ref. to* base, substitution / deletion / insertion ; 4 (during) DNA replication ; 5 failure of proof reading mechanism ; 6 *ref. to* mutagenic agents ; e.g. ionising radiation / UV radiation	**3**

Question	Answer	Marks
9(a)	*eight from:* 1 double membrane **;** *inner membrane* 2 folded / cristae **;** 3 increased / large, surface area **;** 4 has, ATP synthase / stalked particles **;** 5 has, carrier (proteins) / cytochromes **;** 6 (site of) ETC / oxidative phosphorylation / chemiosmosis **;** *intermembrane space* 7 has low pH / high concentration of protons **;** 8 accepts protons from ETC / AW **;** 9 proton gradient between intermembrane space and matrix **or** protons move from intermembrane space to matrix **;** 10 *ref. to* ATP synthesis **;** *matrix* 11 contains enzymes **;** 12 site of, link reaction / the Krebs cycle **;** *outer membrane* 13 presence of carriers for, pyruvate / reduced NAD **;** 14 AVP **;** e.g. ribosomes / DNA, **plus** function	**8**

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Question	Answer	Marks
9(b)	*seven from:* *liver cells (max 6)* 1 only glycolysis occurs ; 2 pyruvate, cannot enter mitochondrion / remains in the cytoplasm ; 3 (pyruvate) becomes, hydrogen acceptor / reduced ; 4 by reduced NAD (from glycolysis) ; 5 lactate produced ; 6 lactate dehydrogenase ; 7 production of, 4 ATP / 2 ATP / small amount of ATP ; 8 allows glycolysis to continue ; *yeast cells* 9 decarboxylation / CO_2 removed ; 10 ethanal becomes, hydrogen acceptor / reduced ; 11 two steps (instead of one) ; 12 irreversible reaction (instead of reversible) ; 13 ethanol dehydrogenase ; 14 ethanol produced ;	**7**

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Question	Answer	Marks
10(a)	*eight from:* 1 chiasmata formation ; 2 crossing over ; 3 exchange of genetic material ; 4 between non-sister chromatids of homologous chromosomes ; 5 at prophase 1 ; 6 new combination of alleles ; 7 linkage groups broken ; 8 independent / random, assortment, of homologous pairs / bivalents / AW ; 9 in metaphase 1 ; 10 2^n combinations / very large number of combinations ; 11 independent / random, assortment of, chromatids / chromosomes (correct context) ; 12 in metaphase 2 ; 13 *ref. to* mutation ;	**8**

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Question	Answer	Marks
10(b)	*seven from:* 1 *ref. to TYR* gene **;** 2 normal gene product is tyrosinase **;** 3 tyrosine converted to, DOPA / dopaquinone **; ora** 4 melanin / pigment, made **; ora** 5 in melanocytes **;** 6 mutant allele is recessive **;** 7 tyrosinase, not produced / inactive **;** 8 affects, hair / skin / irises **;** 9 only in homozygous recessive people **;**	**7**

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BIOLOGY **9700/43**

Paper 4 A Level Structured Questions **October/November 2017**

MARK SCHEME

Maximum Mark: 100

Published

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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)	*two from:* 1 variation in / diversity of, ecosystems / habitats **;** 2 number of / (how) many / variety of / diversity of, species **;** 3 the (relative) abundance of each species **;** 4 genetic diversity / range of alleles, within a species **;**	**2**
1(b)(i)	genes **and** environment **;**	**1**
1(b)(ii)	*one from:* 1 whales, mobile / swim / migrate **;** 2 (they inhabit) large, area / distances **;** 3 live, underwater / at great depths **;**	**1**
1(c)	*two from:* 1 (water) pollution from, industry / boats **;** 2 accidents involving / damaged by, boats / fishing gear **;** 3 lack of / competition for, food / krill / prey **;** 4 noise / vibration, disturbs whale, communication / behaviour / mating **;** 5 illegal, whaling / hunting **;** 6 reproduction rate is slow / one offspring at a time / long gestation **;**	**2**

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Question	Answer	Marks
1(d)	*two from:* *toxins (PCBs / DDT) are* 1 present in, water / river / sea **;** 2 ingested / absorbed by, producers / phytoplankton / algae **;** 3 bioaccumulation **or** toxins, pass up / accumulate up, food chain **;** 4 persistent / long-lasting / not broken down (in environment / whale) **;** 5 fat / lipid, soluble **;**	**2**
1(e)(i)	*two from:* 1 sodium ions do not enter (neurones / nerve cells / axons) **;** 2 (neurones) cannot depolarise **or** cannot, generate / transmit, impulses / action potentials **;** 3 reason for death **;**	**2**
1(e)(ii)	*one from:* unicellular / not multicellular **;** motile / have flagella **;**	**1**

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Question	Answer	Marks
2(a)(i)	1 reduces, GP / glycerate (3) phosphate **;** 2 to, TP / triose phosphate **;**	**2**
2(a)(ii)	RuBP, decreases / less **either** because it, reacts / is used up / is converted **or** because it is not, replaced / regenerated **; AW**	**1**
2(b)	*any four in total:* *tube A* 1 for comparison / to compare **;** 2 to see, end-point / when all DCPIP has been reduced, in **B** **;** *foil (max 3)* 3 to, stop / limit, light entering (the beaker / mixture) **or** to stop light reaching chlorophyll **;** 4 to, stop / limit, light dependent reaction occurring **;** 5 to, stop / limit, DCPIP, decolourising / being reduced **;** 6 so all tests start with same colour (of DCPIP–chloroplast mixture) **;**	**4**
2(c)(i)	22.2 **;**	**1**

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Question	Answer	Marks
2(c)(ii)	*five from:* *description of rate of, photosynthesis / light (dependent) reaction (max 2)* 1 (it is) highest / fastest / most, in purple **/** at 425 nm **;** 2 (it is) lowest / slowest / least, in green **/** at 525 nm **;** *explanation (max 3)* 3 chlorophyll absorbs purple and orange (best) but does not absorb green **;** 4 accessory pigments **;** 5 light, excites electrons / triggers electron transport **;** 6 non-cyclic photophosphorylation **;** 7 action spectrum **;**	**5**

Question	Answer	Marks
3(a)	(interspecific) competition (with greys) **;** virus / disease / infection, passed, from greys / to reds **;**	**2**
3(b)	*three from:* 1 DNA / base / nucleotide, sequences **;** 2 mitochondrial / mt, DNA **;** 3 protein / polypeptide / amino acid, sequences **;** 4 genetic fingerprinting / DNA profiling **;** 5 compare (sequences from reds and greys) **;**	**3**
3(c)	*three from:* 1 pine marten / predation, is / was, selection pressure **;** 2 red squirrel better adapted (to pine marten predation) **; ora** 3 detail **/** suggestion **;** e.g. red squirrel, faster / better camouflaged **ora** 4 (two squirrel species arose by) allopatric speciation / AW **;** 5 different, selection pressures / predators (in two places / for two species) **;** 6 red squirrels and pine martens co-existed for, 10 000 years / long time **;**	**3**

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Question	Answer	Marks
4(a)(i)	*two from:* 1 (only) kills / targets / acts on, specific / some, insects / pests ; 2 does not kill, beneficial / useful, insects ; 3 (such as) pollinators / bees / predators of pests ; 4 to conserve / protect, biodiversity / food web ; **ora** 5 *idea that* other Cry proteins might not kill, right pests / bollworm ;	**2**
4(a)(ii)	*two from:* 1 (so, new / foreign / inserted) gene(s) are, expressed / switched on / transcribed (and translated) ; 2 RNA polymerase binds (at promoter) ; 3 *ref. to* correct / template, strand ; 4 to control quantity of Cry(1Ac / protein) made ; 5 to control, where / which part(s) of plant, make Cry(1Ac / protein) ;	**2**
4(a)(iii)	*three from:* 1 insert, herbicide resistance gene / it, next to, Bt / Cry(1Ac), gene ; 2 spray / add, herbicide on (transformed) plants / protoplasts / cells ; 3 survivors have, Bt / Cry(1Ac), gene ; 4 to identify, successful / GM / insect-resistant, plants ;	**3**

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Question	Answer	Marks
4(b)(i)	*two from:* 1 Bt seed costs more but insecticide costs less **;** 2 total cost is more for Bt than for non-GM **;** 3 manipulated figure(s) comparing both Bt and non-GM **;**	**2**
4(b)(ii)	*one from:* non-GM seeds are cheap(er) / (more) affordable **;** non-GM / it, is cheap(er), overall / to grow **;**	**1**
4(c)	*three from:* 1 selective breeding / artificial selection **;** 2 cross Bt cotton with a (Bt) variety that grows well in, dry / drought **;** 3 select / choose, offspring with Bt (trait / gene) **and** grow well in, dry / drought **;** 4 repeat (crossing / selection) for several generations **;**	**3**

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Question	Answer	Marks
5(a)	*four from:* 1 insulator / ions cannot pass through it ; 2 depolarisation / action potentials, occur at nodes of Ranvier (only) ; 3 long(er) local, circuits / currents ; 4 action potential jumps from node to node / saltatory conduction ; 5 transmission / conduction, fast(er) ;	**4**
5(b)	*five from:* 1 action potential / depolarisation, at presynaptic membrane ; 2 Ca^{2+} channels open / increased permeablity to Ca^{2+} ; 3 Ca^{2+} enter, (presynaptic) neurone / knob / axoplasm / AW ; 4 by (facilitated) diffusion / down concentration gradient ; 5 vesicles, of acetylcholine / neurotransmitter, fuse with membrane ; 6 ACh / neurotransmitter, enters / exocytosed into, synaptic cleft ;	**5**

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Question	Answer	Marks
6(a)	<table><tr><th>contents of dishes</th><th>ATP produced</th></tr><tr><td>mitochondria + ADP + Pi + acetyl CoA + oxygen</td><td>✓</td></tr><tr><td>mitochondria + ADP + Pi + acetyl CoA</td><td>×</td></tr><tr><td>mitochondria + ADP + Pi + low concentration of protons (H^+)</td><td>×</td></tr><tr><td>mitochondria + ADP + Pi + high concentration of protons (H^+)</td><td>✓</td></tr></table> ; ; *2 or 3 correct = 1 mark* *4 correct = 2 marks*	**2**
6(b)	*two from:* water enters (mitochondrion / matrix) **;** by osmosis / down the water potential gradient **;** membranes ruptured / mitochondrion bursts **;**	**2**
6(c)	final <u>electron</u> (and proton) acceptor (in ETC) **;**	**1**
6(d)	ATP synth(et)ase **;**	**1**

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Question	Answer	Marks
6(e)	*four from:* 1 (site of) electron transport chain **;** 2 moves / pumps, protons / H^+, to inter-membrane space **;** 3 electrochemical / proton / H^+, gradient **;** 4 protons / H^+, diffuse to matrix **;** 5 through**,** stalked particles / ATP synth(et)ase **;** 6 ADP + Pi → ATP **;** 7 oxidative phosphorylation **;**	**4**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>7(a)(i)</td><td>consume, less / no, milk / lactose / (named) dairy products ;</td><td>1</td></tr>
<tr><td>7(a)(ii)</td><td>four from:
1 changes / different, base / nucleotide (sequence), in, DNA / gene ;
2 changes / different, mRNA, codon / triplet ;
3 changes / different, primary structure of, polypeptide / protein / enzyme ;
4 changes / different, tertiary structure (of, polypeptide / protein / enzyme) ;
5 changes / different, allosteric / active, site ;
6 enzyme, non-functional / does not convert galactose (to glucose) ;</td><td>4</td></tr>
<tr><td>7(b)</td><td><table><tr><th>parent 1</th><th>parent 2</th><th>% prob. affected child</th><th>% prob. unaffected child</th><th>% prob . carrier child</th></tr><tr><td>unaffected</td><td>carrier</td><td>0</td><td>50</td><td>50</td></tr><tr><td>carrier</td><td>carrier</td><td>25</td><td>25</td><td>50 ;</td></tr><tr><td>unaffected</td><td>affected</td><td>0</td><td>0</td><td>100 ;</td></tr><tr><td>carrier</td><td>affected</td><td>50</td><td>0</td><td>50</td></tr></table></td><td>2</td></tr>
<tr><td>7(c)</td><td>two from:
genetic screening ;
obtain fetal, cells / DNA ;
by, amniocentesis / chorionic villus sampling ;
electrophoresis + probe ;</td><td>2</td></tr>
</table>

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Question	Answer	Marks
8(a)	*four from:* 1 change in factor away from, the norm / set-point **;** 2 detected / sensed by, receptor **;** 3 hormone released **or** (nerve) impulse sent **;** 4 (hormone / impulse) reaches, target organ / effector **;** 5 (effector) performs corrective action **;** 6 (factor) returns to, norm / set-point **;**	**4**
8(b)	*four from:* 1 hypothalamus detects change in blood glucose concentration **;** 2 autonomic / motor / nerve, impulses **;** 3 (so) β cells secrete insulin when blood glucose increases **;** 4 (so) α cells secrete glucagon when blood glucose decreases **;** 5 (so) adrenal gland secretes adrenaline **either** when blood glucose decreases **or** due to fear / shock / excitement / stress **;** 6 nervous control supplements, endocrine control / control by pancreas **;**	**4**

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Question	Answer	Marks
8(c)	*four from:* *vasoconstriction* 1 arterioles in skin get narrow(er) ; 2 less blood flow through (skin / surface) capillaries ; 3 (so) less heat lost (to surroundings) ; *shivering* 4 muscle contraction ; 5 releases / provides / gives, heat / thermal energy ; *increasing secretion of adrenaline* 6 increases, rate of respiration / metabolic rate ; 7 more heat, released / provided / given (by respiration) ;	**4**

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Question	Answer	Marks
9(a)	*six from:* 1 aerenchyma ; 2 in stem **and** roots ; 3 help oxygen to, move / diffuse, to roots ; 4 shallow roots ; 5 air (film) trapped on underwater leaves ; 6 fast internode growth ; 7 (modified) growth regulated by, gibberellin **/** ethene ; 8 anaerobic respiration, underwater / when submerged ; 9 tolerant to high ethanol concentration / high tolerance to ethanol ; 10 ethanol dehydrogenase (switched on in anaerobic conditions) ; 11 AVP ; e.g. growth stops / carbohydrates conserved / quiescence, in short-term (flash) floods	**6**

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Question	Answer	Marks
9(b)	*nine from:* 1 RuBP / rubisco, in bundle sheath (cells) ; 2 away from, oxygen / air ; 3 to avoid photorespiration ; 4 carbon dioxide combines with PEP ; 5 (catalysed by) PEP carboxylase ; 6 in mesophyll (cells) ; 7 forms oxaloacetate ; 8 converted to malate ; 9 malate passes to bundle sheath (cells) ; 10 (malate) releases (high concentration of) carbon dioxide ; 11 RuBP, carboxylated / reacts with carbon dioxide ; 12 PEP carboxylase / enzyme(s), has high optimum temperature / tolerate high temperatures ;	**9**

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Question	Answer	Marks
10(a)	*six from:* 1 base / nucleotide, substitution ; 2 missense / silent, mutation ; 3 base / nucleotide, insertion / addition ; 4 base / nucleotide, deletion ; 5 may cause frameshift ; 6 alters triplets of following, base / nucleotide, sequence ; 7 (premature) stop codon gives shortened polypeptide ; 8 does not code for amino acid ; 9 nonsense mutation ;	**6**

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Question	Answer	Marks
10(b)	*nine from:* 1 homozygous for, mutant allele / Hb^S ; 2 altered β polypeptide in haemoglobin ; 3 haemoglobin / β-globin, less soluble ; 4 in low(er) oxygen (concentration) ; 5 (Hb) forms long fibres ; 6 red blood cells, sickle / form crescent shape ; 7 (RBCs) carry less oxygen ; 8 (RBCs) get stuck in capillaries ; 9 blocks blood flow ; 10 causes pain ; 11 sickle cell crisis ; 12 RBCs break down faster / lack of RBCs ; 13 protection against, malaria / *Plasmodium* infection ;	**9**

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