Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

BIOLOGY **9700/41**

Paper 4 A Level Structured **May/June 2018**

MARK SCHEME

Maximum Mark: 100

Published

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

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

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Generic Marking Principles

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- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

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- marks are awarded when candidates clearly demonstrate what they know and can do
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GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	alternative valid point

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Question	Answer	Marks
1(a)(i)	*any one from:* positive correlation **;** as area (of forest) increases, number / population / orangutans, increase(s) **; ora**	**1**
1(a)(ii)	25 000 – 7300 2016–1985 **;** 571 (per year) **;**	**2**
1(a)(iii)	12.78 / 12.8 / 13 (years) **;**	**1**
1(b)	*any two from:* 1 hunting / poaching, for, bushmeat / (traditional) medicine / crop protection **;** 2 hunting / (live) capture, for pets / trade **;** 3 disease **;** 4 breeding problems due to, individuals isolated / mates inaccessible / inbreeding in small populations **;**	**2**
1(c)	*any three from:* 1 breeding (programmes) **;** 2 release / reintroduction (to, wild / Sumatra/ reserves) **;** 3 educate / raise public awareness **;** 4 research**,** diet / breeding / behaviour / genetic diversity **;** 5 raise money for**,** reserves / protecting wild population **;** 6 AVP **;** e.g. cooperate with governments	**3**

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Question	Answer	Marks
2(a)	*any four from:* 1 population / a species, show(s) genetic, variation / diversity **;** 2 *ref. to* chance / random / spontaneous, mutation **;** 3 *ref. to* selection pressure / competition / predation / disease **;** 4 fitter / fittest OR better adapted / best adapted, (individuals) survive **; ora** 5 reproduce / breed, more OR have more offspring **; ora** 6 pass on, beneficial / advantageous / favourable / desirable, allele(s) **; ora** 7 change / increase, in allele frequency **;**	**4**
2(b)(i)	*any two from:* normal distribution **;** 5 is, usual / commonest / most frequent / peak, clutch size **;** few(er) clutches, are very large and very small / are of size 2 and 8 / lie at (both) extremes **;**	**2**
2(b)(ii)	*any four from:* 1 stabilising selection **;** 2 4 / 5 (eggs) **or** mean / average (clutch size), is optimum / better / best / selected for / has selective advantage / gives most (surviving) offspring **;** 3 low clutch size / 2 / 3 , gives few(er) (surviving) offspring **;** 4 high clutch size / 6 / 7 / 8 , not all offspring survive **;** 5 high clutch size *linked to* more competition (between chicks) for, food / parental care **;** 6 high clutch size *linked to* (more) predation (of eggs / chicks) **;** 7 high clutch size *linked to* (more) disease (of eggs / chicks) **;**	**4**

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Question	Answer	Marks
2(c)(i)	*step 1:* 17 / 86 **or** <u>0.198</u> / 0.20 (q^2) ; *step 2:* √ 0.198 **or** <u>0.445</u> / 0.45 / 0.44 (q) **AND** 1 – 0.445 **or** <u>0.555</u> / 0.55 / 0.56 (p) ; *step 3:* 2 × 0.555 × 0.445 **or** 0.49(395) / 0.495 ($2pq$) **AND** 0.49(395) × 86 **or** 42 / 42.479 / 42.48 / 42.5 / 42.57 ;	**3**
2(c)(ii)	*any two from:* 1 small population ; 2 (natural / artificial / sexual) selection ; 3 non-random mating / inbreeding ; 4 migration (of individuals) ; 5 (new) mutation (is occurring); 6 non-diploid organisms ; 7 overlapping generations ; 8 asexual reproduction ; 9 allele frequencies not equal in both sexes ;	**2**

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Question	Answer	Marks
3(a)(i)	**1** promoter **2** operator **3** *lac Z I* β-galactosidase gene **4** *lac Y* / lactose permease gene **;** **;**	**2**
3(a)(ii)	*β-galactosidase – any one of:* digests / hydrolyses, lactose to, monomers / glucose + galactose **;** converts / isomerises, lactose to allolactose **;** *lactose permease* increases / allows, lactose uptake / lactose entry / permeability (of cell) **to** lactose **;**	**2**
3(b)(i)	*any one from:* (protein) produced all the time **;** (protein) concentration does not vary (in response to molecular signals) **;**	**1**
3(b)(ii)	*any three from:* **1** repressor (protein) not bound to, lactose / allolactose **;** **2** repressor binds to operator **;** **3** RNA polymerase cannot move to, operator / (structural) genes **;** **4** no / prevents, transcription (of genes) / formation of mRNA **;**	**3**
3(b)(iii)	*any one from:* proteins / enzymes, made, all the time / when not needed / too much / in excess / in uncontrolled fashion **;** waste of, amino acids / ATP / nucleotides **;** decrease growth **;**	**1**

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Question	Answer	Marks
4(a)	*grey badgerface* **A^bA^g ;** *white* **AA AA^b AA^g Aa ;**	**2**
4(b)	(grandparent cross **A–** x **aa** (any white x black) to give **Aa** white parent may be shown, but no mark) *cross 1:* **Aa** x **A^gA^g** → **AA^g** **A^ga** ; white grey ; *cross 2:* **Aa** x **A^ga** → **AA^g** **Aa** **A^ga** **aa** ; white white grey black ;	**4**
4(c)	**(aa / a),** protein product does not, block / bind, melanocortin 1 / receptor **;** (so) MSH / hormone, binds to, melanocortin 1 / receptor, causing melanin synthesis **;**	**2**

Question	Answer	Marks
5(a)(i)	*any two from: (transgenic pigs – **ora** for normal pigs)* 1 GH (concentration) higher / GH always present not just at certain times **;** 2 hGH, works for longer / broken down less quickly (than pig GH) **;** 3 increase in cell signalling **;** 4 increased / activates, (growth) gene, expression / transcription **;** 5 increased / stimulates, cell division / mitosis **;** 6 (make) more, muscle / bone / fat **;**	**2**
5(a)(ii)	*any three from:* 1 (mouse DNA / it) **is,** the <u>promoter</u> **;** 2 (where) RNA polymerase / transcription factor(s)**,** bind **;** 3 controls / allows / ensures / is needed for, gene expression / gene activation / mRNA production / hGH production **;** 4 gene can be, switched on / transcribed, by adding metal ions **;** 5 *idea of* controlling, when / where / how much, the gene is, expressed / transcribed **;**	**3**
5(b)(i)	*NO arguments (any two to question max three):* 1 few offspring / don't pass on gene(s) / unsustainable / assisted reproduction is expensive (as problem with mating*)* **;** 2 cost of healthcare / less growth / die young (due to ulcers) **;** 3 people may, avoid / refuse to buy / pay less for, GM food **;** 4 (GM) production cost, expensive / outweighs benefits (as 1% success) **;** *YES arguments (any two to question max three):* 1 greater yield / more meat (as higher, body mass / muscle) **;** 2 higher price / worth more money, as more muscle to fat **;** 3 sell / slaughter / process, earlier / at younger age **;**	**3**

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Question	Answer	Marks
5(b)(ii)	*any two from:* *unethical / not good / not right, because:* 1 pigs, suffer / have (stomach) ulcers / experience pain **;** 2 pigs cannot, behave normally / move much / exercise / keep fit / socialise / mate **;** *ethical / good / right, because:* 1 more / better quality, meat / food, for humans **;** 2 pigs suffer less than (normal) pigs given hGH by injection **;**	**2**
5(c)(i)	*any two from:* success rate (in altering gene) is, greater / 100% (instead of 1%) **;** (only) specific gene is altered / targets gene more precisely **;** (unwanted) gene is, removed / deleted / disabled / knocked out **;**	**2**
5(c)(ii)	*one or two arguments about statement's truth to question max 3:* 1 not selective breeding as, DNA / genes, manipulated / altered / changed / removed **;** 2 not selective breeding as IVF is used **;** 3 not selective breeding as no, crossing and, selection (of offspring) / repetition **;** 4 <u>not</u> genetic engineering as no new gene is put into, organism / zygote **;** *one or two reasons why more acceptable to question max 3:* 5 no foreign gene inserted / no cross-species gene transfer **;** 6 (only) one / single, gene, altered / silenced **;** 7 (application) reduces, suffering of / (viral) disease in, pigs **;**	**3**

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Question	Answer	Marks
6(a)	<table><tr><th>compound or structure</th><th>location</th></tr><tr><td>ATP synthase</td><td>**P**</td></tr><tr><td>acetyl CoA</td><td>**Q**</td></tr><tr><td>phospholipid bilayer</td><td>**P**</td></tr><tr><td>oxaloacetate</td><td>**Q**</td></tr></table> **;;;**	**3**
6(b)(i)	$16(.00) \times 10^{-3}$ **;**	**1**
6(b)(ii)	*any two from:* mitochondria / respiration, produce(s) ATP **;** heart / cardiac muscle (cell), is more active OR needs more, energy / ATP **;** heart / cardiac muscle, (cell) <u>contract</u>s **; ora**	**2**
6(b)(iii)	mitochondria vary, in size / in surface area of inner membrane **;**	**1**

Question	Answer	Marks
7(a)(i)	thylakoid (membranes) / lamellae / granum / grana **;**	**1**
7(a)(ii)	**A** photolysis (of water) **;** **B** chemiosmosis / (cyclic) photophosphorylation **;**	**2**
7(a)(iii)	*any one of:* diffuses out / lost / expelled / released, from, leaf / stomata / plant **;** used in, (aerobic) respiration / oxidative phosphorylation **;**	**1**
7(a)(iv)	chlorophyll a **;**	**1**
7(a)(v)	ATP and reduced NADP / NADPH**;**	**1**
7(b)	*any three from:* regenerate / produce / make/ form, RuBP **;** (triose phosphate / glucose / acetyl coA) for respiration **;** to make any two of: glucose / sucrose / ribose / deoxyribose / glycerol / acetyl (coA) / fatty acids / amino acids starch / cellulose **; ;**	**3**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(a)</td><td>
<table>
<tr><th>feature</th><th>nervous system</th><th>endocrine system</th></tr>
<tr><td>method of communication</td><td>electrical / impulses / action potentials / wave of depolarisation</td><td>hormones / chemical(s) (messengers)</td></tr>
<tr><td>method of transmission</td><td>neurones / nerve fibres / nerve cells / axons</td><td>blood (stream / plasma) / circulation</td></tr>
<tr><td>transmission speed</td><td>fast(er) / quick(er) / rapid</td><td>slow(er)</td></tr>
<tr><td>duration of effect</td><td>short(er) / temporary / seconds</td><td>long(er) / permanent / minutes – years</td></tr>
</table>
; ; ; ;
</td><td>4</td></tr>
<tr><td>8(b)</td><td>1 <u>D</u> ;
2 <u>C</u> ;
3 <u>D</u> (and C) ;
4 A / B ;</td><td>4</td></tr>
<tr><td>8(c)</td><td>any five from:

1 reduce / stops, FSH and LH (secretion / concentration) ;
2 ref. to <u>negative feedback</u> ;
3 ref. to hypothalamus / anterior pituitary (gland) ;
4 stops follicle, developing / maturing ;
5 prevents ovulation ;
6 <u>cervical</u> mucus, thick / builds up / is hostile to sperm ;
7 uterine lining / endometrium, thin / not ready, preventing implantation ;</td><td>5</td></tr>
</table>

Question	Answer	Marks
9(a)	*any six from:* 1 (short-term) store of energy ; 2 (energy derived) from, food / respiration / photophosphorylation / chemiosmosis ; 3 transfers energy (to) / (immediate) energy donor (to) ; 4 in <u>all</u>, cells / organisms ; 5 hydrolysis / phosphate loss, releases, energy / 30.5 kJ (per mole) ; 6 reversible reaction / (AMP and) ADP recycled to ATP ; 7 small (molecule) / water soluble, so can move within, cell / cytoplasm ; 8 links energy yielding and energy requiring reactions ; 9 high turnover (rate) ; *and any two uses up to question total of 6 from:* 10 active transport / action potential / electrical discharge ; 11 muscle contraction ; 12 anabolic reactions / condensation reactions / transcription / translation / DNA replication / Calvin cycle / phosphorylation reactions ; 13 exocytosis / endocytosis / intracellular transport ; 14 bioluminescence ;	**6**

Question	Answer	Marks
9(b)	*any nine from:* *anaerobic respiration in, mammalian cells / lactic fermentation (**M**):* 1 pyruvate, is reduced / accepts H / accepts H^+ + electron **;** 2 (process uses) reduced NAD **;** 3 from glycolysis **;** 4 converted to, lactate / lactic acid **;** 5 *ref. to* lactate dehydrogenase **;** 6 regeneration of NAD allows glycolysis to continue **;** 7 small energy yield / 2 ATP, (from glycolysis) **;** *difference to, yeast cells / alcoholic fermentation (**Y**): accept **ora** mps 8–11* 8 **M** no, decarboxylation / CO_2 removed (to form ethanal) **;** 9 **M** single / one, step **/** enzyme **or Y** two, steps / enzymes **;** 10 **M** pyruvate is H acceptor **and** in **Y** ethanal is H acceptor **;** 11 **M** reversible / lactate is (later) converted back to pyruvate **or Y** irreversible or ethanal / ethanol, cannot be converted back to pyruvate **;** 12 **M** needs oxygen / by oxidation / *ref. to* oxygen debt **;**	**9**

Question	Answer	Marks
10(a)	*any six from:* 1 nucleus in, cell body / soma ; 2 (long) dendron ; 3 (short) axon ; 4 many mitochondria (in cell body) ; 5 many, RER / ribosomes **or** presence of Nissl's granules (in cell body) ; 6 synaptic, knobs / terminals / boutons ; 7 Schwann cells **/** myelin sheath ; 8 nodes of Ranvier ;	**6**
10(b)	*any nine from:* 1 Na^+ moves out of, cell **and** K^+ moves into cell ; 2 3 Na^+ for every 2 K^+ ; 3 by, active transport / use of ATP ; 4 sodium-potassium pump / Na^+ K^+ pump ; 5 against concentration gradient ; 6 K^+ diffuses out of cell **and** Na^+ diffuses into cell ; 7 by facilitated diffusion **/** diffusion through (ion) channels ; 8 membrane more permeable to K^+ / more K^+ goes out than Na^+ in ; 9 inside of, cell / membrane, more negative than outside ; **ora** 10 membrane / cell, polarised / repolarised ; 11 (resting potential is), –60 mV / –65 mV / –70 mV ; 12 AVP ; e.g. ion movement only at nodes of Ranvier	**9**

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Question	Answer	Marks
1(a)	*any 3 of:* 1 killed by humans ; 2 difficulty in finding a mate ; 3 loss of habitat / habitat fragmentation / habitat polluted / deforestation ; 4 food shortage ; 5 (new) diseases ;	**3**
1(b)	*any 3 of:* 1 maintains or increases, gene pool / genetic diversity / genetic variation ; 2 maintains or increases, heterozygosity ; 3 hybrid vigour ; 4 reduces / prevents, inbreeding depression ; 5 reduce chances of harmful recessive alleles coming together ;	**3**
1(c)	*any 2 of:* 1 IVF or description; 2 embryo transfer ; 3 surrogacy or description ; 4 artificial insemination ;	**2**

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Question	Answer	Marks
2(a)	*(autosomal)* not a sex chromosome **;** *(linkage)* genes on the same chromosome / alleles inherited together **;**	**2**
2(b)(i)	1 *F1 genotypes* **FG/fg or FGfg or (FG) (fg) ; A FfGg** 2 *gametes* **FG fg FG fg ;** 3 *F2 genotypes* **FGFG FGfg FGfg fgfg ;** **A FFGG FfGg FfGg ffgg** 4 *F2 phenotypes* purple long / purple long / purple long / red round **ecf** *for mp3 from incorrect gametes (mp2)* **R** *if sex linkage*	**4**
2(b)(ii)	*any 1 of:* do not show 9:3:3:1 ratio **;** large(r) numbers of parental phenotypes / low(er) numbers of recombinant phenotypes **;**	**1**
2(c)(i)	**fgfg** / homozygous recessive **; A ffgg**	**1**
2(c)(ii)	12.7 **or** 13 **;**	**1**
2(c)(iii)	low, COV / crossover value, indicates genes closer together **or** high, COV / crossover value, indicates genes further apart **;**	**1**

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Question	Answer	Marks
3(a)(i)	*any 4 of:* 1 chromosomes become visible **;** 2 condensation / coiling / supercoiling **; A** description 3 nuclear envelope or nuclear membrane, disintegrates / disappears **;** 4 nucleolus, disintegrates / disappears **;** 5 centrioles migrate to (opposite) poles **; I** centrosomes 6 spindle forms / microtubules assemble **;** 7 synapsis / bivalents form / homologous chromosomes pair up **;** 8 chiasmata formation / crossing over **;**	**4**
3(a)(ii)	*any 2 of:* 1 (homologous chromosomes / bivalents) line up randomly on the, equator / metaphase plate **;** 2 produces (many) different chromosome combinations **;** 3 number of possible combinations is 2^n **;** 4 new combinations of maternal and paternal alleles **;**	**2**
3(b)(i)	*any 2 of:* 1 protoctist uses up nutrients **;** 2 loss of appetite / inability to feed **;** 3 *idea of* impaired absorption / diarrhoea **;** 4 (so) less nutrients available for, growth / gain of body mass / increase in biomass **;** 5 AVP **;** e.g. *idea of* energy used to fight infection / *ref. to* immune response	**2**

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Question	Answer	Marks
3(b)(ii)	(chicken) body temperature / competition with microbes / presence of drugs / presence of plant extract ;	**1**
3(c)(i)	*t*-test ;	**1**
3(c)(ii)	*any 3 of:* 1 two labelled bell-shaped curves ; 2 high dose curve shifted to left of low dose curve ; 3 high dose curve peak to left of 2063 ; 4 high dose curve, narrower / peak higher ;	**3**

Question	Answer	Marks
4(a)	*any 4 of:* 1 spontaneous / random, mutation ; 2 produces an allele coding for enzyme (that gives resistance) ; 3 toxin is selection pressure ; 4 flies or larvae, with, allele / enzyme / mutation, have selective advantage ; 5 (flies with, allele / enzyme / mutation) survive / reproduce ; **ora** 6 pass on this allele (to offspring) ; 7 this allele increases in frequency ;	**4**

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Question	Answer	Marks
4(b)	*any 3 of:* 1 separated by a geographical barrier / description **;** 2 different, environmental conditions / selection pressures **;** 3 allopatric speciation **;** 4 reproductive isolation / no breeding with mainland flies / no gene flow (between two populations) **; A** pre-zygotic isolation 5 new allele not, lost / diluted in frequency **;** 6 founder effect / genetic drift **;** 7 (more pronounced) in small population **;**	**3**
4(c)	*any 3 of:* 1 obtain, DNA / genome / gene / base / nucleotide, sequences (from database) **;** 2 obtain, amino acid / protein, sequences (from database) **;** 3 compare sequences (of two populations) **;** 4 calculate percentage of, bases / amino acids, changed **;** 5 mitochondrial DNA **;** 6 molecular clock / mutation rate, (to estimate time) **;**	**3**

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Question	Answer	Marks
5(a)(i)	*any 2 of:* 1 to treat disease caused by, faulty / recessive, allele **;** **A** cure 2 deliver, gene / allele / DNA (into target cells of individuals) **;** 3 named example **;** e.g. SCID / cystic fibrosis	**2**
5(a)(ii)	(reverse transcriptase) uses mRNA to make (ss)DNA **;** (DNA polymerase) makes DNA double-stranded / description **;**	**2**
5(a)(iii)	1 to prevent virus spreading (throughout the body) **;** 2 to limit, side effects / immune response / cancer / illness / infection / cell destruction **;**	**2**
5(b)(i)	*any 3 of:* 1 control **;** 2 *idea of* to see if gene therapy has worked **or** to compare the effect of no gene therapy with gene therapy **or** to compare the effect of no hG-CSF gene with presence of hG-CSF gene **;** 3 to see where the gene (carried by the vector), goes (in, body / brain) **or** to see if the gene (carried by the vector), enters cells **or** to see where cells have been transformed **;** 4 to see the effects of the, vector / virus, alone **;**	**3**

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Question	Answer	Marks
5(b)(ii)	*any 1 of:* 1 (control) to compare results (of mice without stroke) to mice with stroke **;** 2 to establish baseline figures (in mice without a stroke) / act as a reference point **;** 3 to make the study valid **;**	**1**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>5(c)</td><td>
any 4 of:
survival
1 increases survival ;

brain damage
2 reduces (percentage of brain occupied by) fluid filled space ;

behaviour test
3 improves / lowers, behavioural test score ; A score closer to normal

general
4 comparative data quote to support, mp1 / mp2 / mp3 ; A processed data

<table>
<tr><td>mp1</td><td>25% v 63%
25% v 100%
63% v 100%</td></tr>
<tr><td>mp2</td><td>5.2% v 3.6%
5.2% v 3.0%
3.6% v 3.0%</td></tr>
<tr><td>mp3</td><td>0.90 v 0.67</td></tr>
</table>
5 eye drops four times is better than eye drops once ; ora

6 if effective with mice likely to be effective with humans ;

7 ref. to unknown differences between mice and humans / study is only on mice ;

8 treatment is, non-invasive / quick ;
</td><td>4</td></tr>
</table>

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Question	Answer	Marks
6(a)	link reaction **;** matrix of mitochondrion **;** **2** and **3** **;** substrate–linked phosphorylation **;** **A** substrate-level phosphorylation (**Q** =) NAD and (**R=**) FAD **;**	**5**
6(b)	reduced, NAD / FAD, to ETC **; A** description *ref. to* oxidative phosphorylation **/** chemiosmosis **; A** description	**2**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>7(a)</td><td>
<table>
<tr><th>compound</th><th>location</th></tr>
<tr><td>PEP carboxylase</td><td>C</td></tr>
<tr><td>RuBP</td><td>B</td></tr>
<tr><td>rubisco</td><td>B</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>7(b)</td><td>any 2 of:
1 stop, air / oxygen, getting to cells B / rubisco / RuBP / bundle sheath cells ;

2 so rubisco does not catalyse reaction of oxygen with RuBP ;

3 reduce / stop, photorespiration ;</td><td>2</td></tr>
<tr><td>7(c)</td><td>any 3 of:
describe
1 (enzyme in) Amaranthus / C4, peaks, at higher temperature
or
(enzyme in) Amaranthus / C4, has higher optimum temperature
or
(enzyme in) Pisum / C3, has higher activity at low(er) temperatures ; ora

2 data quote ; e.g. C4 – 45 °C and C3 – 30 °C at 100%
or C4 – 70% and C3 – 25% at 50 °C ;

explain
3 enzyme in, Pisum / C3, less thermostable / denatures at lower temperature ; ora

4 AVP ; e.g. Amaranthus adapted to a hot climate / ora e.g. enzyme in Amaranthus has more S-S bonds</td><td>3</td></tr>
</table>

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Question	Answer	Marks
8(a)	*any 4 of:* 1 (presynaptic) membrane depolarised **;** 2 calcium (ion) channels open / (presynaptic membrane becomes) more permeable to Ca^{2+} **;** 3 Ca^{2+} move in (to presynaptic, neurone / knob) **; R** membrane 4 causes vesicles (of ACh) to move towards (presynaptic) membrane **;** 5 vesicle fuses with (presynaptic) membrane / exocytosis **;**	**4**
8(b)	*any 2 of:* 1 no Na^+ enter (postsynaptic neurone) **;** 2 no depolarisation of (postsynaptic) membrane **;** 3 no, action potentials / impulses (transmitted) **;**	**2**
8(c)(i)	**A** – myelin sheath / Schwann cell **;** **B** – sarcolemma **;** **C** – mitochondria **;**	**3**
8(c)(ii)	*any 2 of:* 1 insulates axon / prevents movement of ions / AW **;** 2 increases speed (of impulses) **;** 3 saltatory conduction / described **;**	**2**

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Question	Answer	Marks
8(c)(iii)	1 produces / releases, ATP **;** *any 3 of mp2-5:* 2 (for) production / recycling, of ACh **;** 3 (for) production / movement, of vesicles **or** exocytosis **;** 4 (for) contraction of sarcomere **;** 5 (for) sodium potassium pumps / active transport **;**	**4**

Question	Answer	Marks
9(a)	*any 8 of:* 1 no, nucleus / nuclear envelope **;** 2 circular DNA / plasmid **; A** circular chromosome 3 cell membrane composition different (from, bacteria / eukarya) **;** 4 no membrane-bound organelles / named example **;** 5 70S ribosomes **;** 6 cell wall present **;** 7 cell wall does not contain peptidoglycans **;** 8 cells divide by, binary / multiple, fission **;** 9 (mostly) unicellular **;** 10 (some) have histones associated with DNA **;** 11 (some) are extremophiles / description **;**	**8**

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Question	Answer	Marks
9(b)	*any 7 of:* 1 variety / collection, of seeds **;** 2 long-term storage **;** 3 (storage) to, prevent germination / maintain dormancy **;** 4 detail of storage conditions **;** e.g. frozen **or** stored at temperatures below –13 °C dried 5 seeds regularly tested for viability / description **;** 6 seeds re-stocked regularly **;** 7 maintain genetic diversity / genetic material preserved / acts as a gene bank **;** 8 detail of future use **;** e.g. can be used after environmental disaster / new diseases / used to increase numbers 9 maintains biodiversity **;** 10 research / education **;** 11 AVP **;** e.g. takes up less space than growing plants / *ref. to* cheaper to store than whole plants	**7**

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Question	Answer	Marks
10(a)	*any 9 of:* *structure* 1 microvilli **;** **A** brush border 2 many mitochondria **;** 3 tight junctions **;** 4 folded, basal membrane / described **;** 5 many, transport proteins / cotransporters / pumps / carrier proteins **;** *process* 6 active transport of Na^+, out of (pct) cells / into blood **;** 7 Na^+ ion concentration, gradient (produced) / reduced in cell **;** 8 Na^+ enters (pct) cells from, lumen / tubule / filtrate **;** 9 by facilitated diffusion **/** using carrier protein **;** 10 cotransport (from lumen to pct cell) **;** 11 of, glucose / amino acids / ions **;** *only award if mp10 given* 12 AVP **;** e.g. water enters (pct) cells	**9**

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Question	Answer	Marks
10(b)	*any 6 of:* 1 hypothalamus detects water potential of blood ; 2 (using) osmoreceptors ; 3 (if) water potential, decreases / is low ; 4 ADH produced ; 5 *ref. to* neurosecretion / neurosecretory cells ; 6 which extend into posterior pituitary ; 7 ADH released from posterior pituitary ; 8 enters blood stream ; 9 water potential of blood, increases / returns to set point ; 10 negative feedback ;	**6**

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BIOLOGY **9700/43**

Paper 4 A Level Structured Questions **May/June 2018**

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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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	alternative valid point

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Question	Answer	Marks
1(a)(i)	0.03 ;	**1**
1(a)(ii)	*three from:* 1 more humans result in fewer macaques / ora ; 2 (humans) kill macaques ; 3 (humans) destroy macaque habitat / named example ; 4 (humans) bring disease ;	**3**
1(b)	*four from:* 1 captive breeding / assisted reproduction ; 2 release into wild ; 3 education ; 4 ban, hunting / trade ; 5 reserves / national parks / zoos ; 6 provide food ; 7 provide healthcare / monitor populations for disease ; 8 limit / ban, on new building ;	**4**

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Question	Answer	Marks
2(a)(i)	<table><tr><th>number of individuals expected</th><th>expected ratio</th></tr><tr><td></td><td>9</td></tr><tr><td>75</td><td></td></tr><tr><td></td><td>3</td></tr><tr><td>25</td><td></td></tr></table> **; ;** 4 correct boxes = 2 marks 3 correct boxes = 1 mark	**2**
2(a)(ii)	*parental genotypes* **EeNn** × **eenn ;** *encircled gametes* **EN** **En** **eN** **en** × **en** **;** *offspring genotypes* **EeNn Eenn eeNn eenn ;** *phenotypes correctly linked to genotypes* red eyes and normal wings, red eyes and vestigial wings, purple eyes and normal wings, purple eyes and vestigial wings **;**	**4**

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Question	Answer	Marks
2(b)(i)	prophase I ; crossing over ; **A** chiasmata	**2**
2(b)(ii)	genes on the same chromosome / alleles inherited together ; no independent assortment ; **A** description	**2**

Question	Answer	Marks
3(a)	*three from:* 1 *idea of* halving the number of chromosomes ; 2 (to make) haploid / n, gametes ; 3 (so) on fertilisation, (restores) diploid number / 2n ; 4 maintains constant chromosome number / prevent chromosome number doubling ;	**3**
3(b)(i)	*two from:* 1 ref. to light intensity **and** change in size of, plant / part of plant ; 2 wind speed **and** size of plant ; 3 waterlogged soil **and** leaves / flowers, above water ; 4 pH **and** flower colour ; 5 AVP ; environmental condition **and** effect 6 AVP ; environmental condition **and** effect	**2**
3(b)(ii)	*two from:* 1 genetic variation / new alleles ; 2 (therefore) new phenotypes ; 3 (new phenotype) has a selective advantage / is selected for ; 4 more likely to survive (selection pressure) ;	**2**

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Question	Answer	Marks
3(c)	*two from:* 1 in full nutrient there is little difference (between two populations) **;** 2 in low phosphate non-functional **X** root growth is, longer / **ora ;** 3 in low phosphate both populations grow less well than in full nutrient / **ora ;** 4 comparative data quote to support mp1 / mp2 / mp3 **;** **A** processed data	**2**
3(d)(i)	69.67 to 70.6 **; ;** *max 2 d.p* allow 1 working mark for 21 – 33 = (–)12 (for calculating difference between means) $\sqrt{0.5^2 / 30 + 0.8^2 / 30}$ (for calculating the standard error in the difference)	**2**
3(d)(ii)	*reject null hypothesis* *t* / 69.67, is higher than, 2.00 / the critical value (at $p = 0.05$) **;** there is a significant difference between, the means of the functional **X** and non-functional **X** populations **;** **allow** ecf from calculated value of *t*	**2**

Question	Answer	Marks
4(a)	*four from:* 1 spontaneous / random, mutation **;** 2 produces an allele coding for insect-deterring chemicals **;** 3 (grazing by) insects, is selection pressure **;** 4 plants with, alleles / mutations, have selective advantage / were selected for / **ora ;** 5 (plants with alleles / mutations) survived / reproduced / produced more seeds / **ora ;** 6 passed on this allele (to offspring) **;** 7 this allele increases in frequency **;**	**4**
4(b)(i)	directional **;**	**1**
4(b)(ii)	stabilising **;**	**1**
4(c)	(genetic drift) occurs due to chance events / **ora** for natural selection **;** (genetic drift) shows no trend in results / **ora** for natural selection **;**	**2**

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Question	Answer	Marks
5(a)(i)	*four from:* 1 obtain (dominant *APP*) allele **;** 2 detail **;** *any one from:* e.g. synthesise gene make cDNA from mRNA use probe select and amplify with PCR gel electrophoresis 3 restriction enzyme **;** 4 use, vector / plasmid / virus **;** **A** gene gun / direct (micro)injection 5 (on) zygote / secondary oocyte / egg (cell) / early embryo **;** **I** sperm 6 AVP **;** e.g. cloning / embryo splitting add promoter marker gene / tag gene	**4**
5(a)(ii)	*one from:* to test treatments without harming humans **;** to investigate, cause / progress, of disease **;**	**1**
5(b)	*four from:* 1 identifies, active / switched on / expressed / transcribed, genes **;** 2 transcription of a gene produces mRNA **;** 3 ssDNA act as, probes / reporters **;** 4 (ssDNA) bound at known positions to a, solid surface / slide / chip **;** 5 cDNA, binds to / hybridises with, complementary (probe) ssDNA **;** 6 show up / identified as, fluorescent spots / named colour **;** 7 positions / intensity, recorded by, laser / scanner **;** 8 positions identified as named genes **;** 9 intensity proportional to gene expression **;**	**4**

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Question	Answer	Marks
5(c)(i)	2.7 (%) **;** **;** **A** 2.68 allow 1 working mark for: 932 – 28 = (904) 904 ÷ 33 696	**2**
5(c)(ii)	training causes more genes to be expressed **;**	**1**
5(d)(i)	gene therapy **;**	**1**
5(d)(ii)	*two from:* 1 switches on genes needed for forming, memories / synapses **;** 2 allows better learning (of water maze) **;** 3 reduces, memory loss / symptoms of Alzheimer's **;**	**2**

Question	Answer	Marks
6(a)(i)	*two from:* glycolysis **;** link reaction **;** Krebs cycle **;**	**2**
6(a)(ii)	*two from:* 1 splits H into electrons and H^+ **;** 2 ref. to electrons along, ETC / carriers, provides energy **;** 3 (energy) used to pump H^+ into intermembrane space **;**	**2**

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Question	Answer	Marks
6(a)(iii)	**Y** oxygen **;** **Z** ATP synthase / ATP synthetase **;** **A** stalked particle **R** ATPase	**2**
6(b)	*two from:* increase in surface area **;** more, carriers / ATP synthase / ETCs **;** more ATP (produced) **;**	**2**

Question	Answer	Marks
7(a)	<table><tr><th>substrate or product</th><th>location</th></tr><tr><td>oxygen produced</td><td>A</td></tr><tr><td>carbon dioxide used</td><td>B</td></tr><tr><td>reduced NADP used</td><td>B</td></tr><tr><td>ATP produced</td><td>A</td></tr><tr><td>hexose produced</td><td>B</td></tr></table> **; ; ;** 5 correct = 3 marks 3 or 4 correct = 2 marks 1 or 2 correct = 1 mark	**3**

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Question	Answer	Marks
7(b)(i)	*two from:* 1 light dependent reaction / photophosphorylation / photolysis occurred **;** 2 hydrogen, produced / released **;** **R** H^+ 3 DCPIP reduced **;**	**2**
7(b)(ii)	*one from:* to show that any change in colour is, due to chloroplasts / not due to buffer **;** to make (the experiment) valid / to act as reference point **;**	**1**
7(b)(iii)	*two from:* 1 swell / burst / lyse / lysis **;** 2 higher water potential outside chloroplast **; ora** 3 water enters, by osmosis / down water potential gradient **;**	**2**
7(c)	carbon dioxide concentration **;** not involved in, light dependent reaction / photophosphorylation / photolysis **or** only involved in light independent reaction / Calvin Cycle / **ora ;**	**2**

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Question	Answer	Marks
8(a)	*four from:* *thick filaments (max 3)* 1 myosin ; 2 fibrous protein ; 3 globular heads / ATPase ; 4 AVP ; e.g. 15 nm diameter / M lines *thin filaments (max 3)* 5 actin ; 6 globular protein ; 7 tropomyosin / troponin ; 8 binding site for myosin (head) ; 9 AVP ; e.g. 7 nm diameter / Z lines	**4**
8(b)	*five from:* 1 (when) sarcoplasmic reticulum depolarised ; 2 calcium (ion) channels open ; 3 calcium ions, move in (sarcoplasm) ; 4 bind to troponin ; 5 troponin / tropomyosin, changes shape ; 6 moves tropomyosin out of the way / exposes (actin-myosin) binding sites ; 7 (allows) myosin to bind (to actin) / cross bridge formation ;	**5**

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Question	Answer	Marks
8(c)	*four from:* *description* 1 (pyruvate) accepts hydrogen / becomes reduced ; 2 from reduced NAD ; 3 produce lactate ; 4 ref. to lactate dehydrogenase ; *importance* 5 glycolysis can continue ; 6 ref. to small amount of ATP produced ; 7 AVP ; e.g. cannot continue for long / reversible / pyruvate does not enter mitochondrion	**4**

Question	Answer	Marks
9(a)	*eight from:* 1 nucleus **;** 2 (double) membrane-bound organelles **;** **A** example 3 80S ribosomes **;** 4 chloroplasts / mitochondria, have 70S ribosomes **;** 5 linear DNA **;** 6 DNA associated with, histones / proteins **;** 7 chloroplasts / mitochondria, DNA is circular **;** 8 unicellular, colonial and multicellular **;** 9 cells divide by mitosis **;** 10 reproduction can be asexual **and** sexual **;** 11 AVP **;**	**8**
9(b)	*seven from:* 1 useful for species where reproduction is difficult / AW **;** 2 example **;** e.g. from habitat fragmentation / reproductive physiology 3 increases the rate of, reproduction / offspring production **;** 4 IVF **;** 5 hormone treatment / superovulation **;** 6 (many) oocytes harvested **;** 7 (oocytes) mixed with sperm **;** 8 embryos placed in uterus **;** 9 surrogacy **;** 10 detail **;** e.g. use a similar species / non-rare breed 11 ref. to portmanteau animal / embryo transfer **;** 12 AVP **;** e.g. embryo splitting cryopreservation of sperm artificial insemination	**7**

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Question	Answer	Marks
10(a)	eight from: 1 ADH reaches (cells of) collecting duct ; 2 binds to receptor on cell surface membrane ; 3 enzyme-controlled reactions / enzyme cascade ; 4 (active) phosphorylase ; 5 (which causes) vesicles with, aquaporins / water channels ; 6 to, move to / fuse with, (cell surface) membrane ; 7 increase (membrane) permeability (to water) ; 8 (more) water moves out of collecting duct ; 9 by osmosis / down water potential gradient ; 10 (then) into blood ; 11 urine (more) concentrated / small volume of urine ; 12 AVP ; e.g. role of loop of Henle in creating water potential gradient movement of urea increases water potential gradient	**8**
10(b)	*seven from:* 1 (glucagon) acts as cell signalling molecule ; 2 binds to receptor on cell surface membrane ; 3 liver cell ; 4 G-protein activated ; 5 adenylyl cyclase activated ; 6 formation of cAMP ; 7 (which is) second messenger ; 8 enzyme-controlled reactions / enzyme cascade ; 9 signal amplified ; 10 glycogen hydrolysed to glucose / glycogenolysis ; 11 (glucose released) into blood ; 12 AVP ; e.g. ref. to glucose exits via GLUT2 proteins / gluconeogenesis	**7**

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