Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

BIOLOGY **9700/43**

Paper 4 A Level Structured Questions **October/November 2016**

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 will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.

© UCLES 2016

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

© UCLES 2016

Question	Answer	Mark	Guidance
1(a)	*locus* position of gene on chromosome **;** *homozygous* (has) two identical alleles (of a gene) **;**	**2**	 **I** AA / aa, dominant / recessive **I** similar

© UCLES 2016

<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>1(b)</td><td>
six from
mp1 parental phenotypes yellow <u>fur</u>, black <u>nose</u> X black <u>fur</u>, black <u>nose</u> ;

mp2 parental genotypes Bbee X BbEe ;

mp3 gametes Be be X BE bE Be be ;

mp4 & mp5 offspring genotypes ; ;
<table>
<tr><th></th><th>BE</th><th>Be</th><th>bE</th><th>be</th></tr>
<tr><th>Be</th><td>BBEe</td><td>BBee</td><td>BbEe</td><td>Bbee</td></tr>
<tr><th>be</th><td>BbEe</td><td>Bbee</td><td>bbEe</td><td>bbee</td></tr>
</table>
mp6 offspring phenotypes linked to genotypes ;
<table>
<tr><td>(fur)
(nose)</td><td>black
black</td><td>yellow
black</td><td>black
black</td><td>yellow
black</td></tr>
<tr><td>(fur)
(nose)</td><td>black
black</td><td>yellow
black</td><td>brown
brown</td><td>yellow
pale</td></tr>
</table>
mp7 ratio 3 : 3 : 1 : 1 ;
</td><td>6</td><td>
if monohybrid cross ecf to max 2 for mp3 and mp4

if different letter symbols used to those given in question ecf to max 5 and R mp2

ecf for mp1 if genotypes wrong in mp2

I male and female / paternal and maternal

ecf if gametes match mp2
A paternal gametes written twice

two marks if all 6 genotypes correct
one mark if 5 genotypes correct
one mark if all correct for ecf from mp2 & mp3

phenotypes must clearly match genotypes
</td></tr>
<tr><td></td><td>Total:</td><td>8</td><td></td></tr>
</table>

© UCLES 2016

Question	Answer	Mark	Guidance
2(a)(i)	*in C4 plants* *two from* PEP joins to CO_2 / PEP carboxylase fixes CO_2 **;** (first photosynthetic) product is a 4C compound **;** oxaloacetate / malate / aspartate **;** (4C compound) releases / provides, CO_2 for, rubisco **;**	**2**	**I** photorespiration **I** *ref. to* Kranz anatomy / arrangement of cells in C4 leaf **A** binds to / reacts / combines with **A** CO_2, released / provided, for Calvin cycle / light independent reaction **I** CO_2 transported
2(a)(ii)	made up of more than one <u>polypeptide</u> **;**	**1**	**A** 16 / several / multiple / many / two or more **I** because it has large and small polypeptides **R** it has more than four polypeptides
2(a)(iii)	*two from* hydrophilic / polar / charged, outside / at surface **;** hydrophobic / non-polar / non-charged, inside **;** globular (protein) **;** *ref. to* polar interactions / hydrogen bonds, with water (molecules) **;**	**2**	**I** Van der Waals **A** H bonds with water **R** ionic / covalent bonds
2(b)	*two from* no (new) CO_2 fixed / (previously) fixed carbon lost as CO_2 **;** photosynthesis decreased **;** less, RuBP (re)generated / available **;** less, TP / glucose, will be made **;** energy / ATP, used in making RuBP wasted **;**	**2**	**A** Calvin cycle / light independent reaction, decreased **I** less GP **A** less GALP will be made

© UCLES 2016

Question	Answer	Mark	Guidance
2(c)	*three from* Calvin cycle / light independent reaction, stops **;** no RuBP (for rubisco) **;** as no, ATP **;** as no reduced NADP **;** as no, light dependent reaction / photophosphorylation **;**	**3**	**A** NADPH / $NADPH_2$ **R** reduced NAD
	Total:	**10**	

Question	Answer	Mark	Guidance
3(a)(i)	(restriction) endonuclease / restriction enzyme **;**	**1**	
3(a)(ii)	(DNA) ligase **;**	**1**	
3(a)(iii)	*two from* (so) gene can be, expressed / transcribed / switched on **;** (so) RNA polymerase can bind **;** (so) transcription factors can bind **;** to control level of expression **;**	**2**	**I** if events stated as happening in bacteria **A** promoters / they are, needed for transcription / gene expression **I** translation
3(a)(iv)	*three from* 1 small **;** 2 circles (of DNA) **;** 3 contain genes (for enzymes) to enable DNA transfer to plant cells **;** 4 contain, restriction sites / polylinkers **;** 5 own origin of replication / can multiply independently **;** 6 *ref. to* marker genes **;**	**3**	**A** contain, vir / virulence, genes **A** can be cut by restriction enzymes e.g. antibiotic resistance genes

© UCLES 2016

Question	Answer	Mark	Guidance
3(b)	*three from* β-carotene, gene(s) come from a different species **;** **ora** β-carotene / new / inserted, gene(s) not in rice cannot breed two different species together **;** local varieties have, desired / adaptive, genes / alleles / characteristics **;** crossing them with Golden Rice combines (good / best) features **;**	**3**	**A** gene(s) for pro-vitamin A **R** genes for vitamin A **R** local varieties of Golden Rice **A** *idea that* crossing or breeding combines features of both parents, or ability to make β carotene **and** local adaptation
3(c)(i)	*idea of*, label / marker **;** to, identify / measure, vitamin A (in body) from Golden Rice **;**	**2**	**A** to track / trace
3(c)(ii)	*one from* β-carotene must be converted to vitamin A **;** absorbing β-carotene takes time **;**	**1**	**I** digestion **R** absorbing vitamin A **A** description of movement into bloodstream
	Total:	**13**	

© UCLES 2016

Question	Answer	Mark	Guidance
4(a)	*three from* Fansidar® is, more effective / better / kills more parasites, (than chloroquine) in >1 situation / overall **; ora** except / chloroquine better (than Fansidar®), in Kenya in 2006 **; ora** % figures with unit for both drugs in one location and year **;** effectiveness of Fansidar® decreases (over time) **;** effectiveness of chloroquine increases <u>in</u> <u>Kenya</u> (over time) **;**	**3**	**A** sulfadoxine-pyrimethamine *for Fansidar®*
4(b)	*two from* (in Kenya) effectiveness of / percentage killed by, chloroquine increases **;** (in Kenya) chloroquine selection pressure removed **;** AVP **;** e.g. non-resistant / chloroquine-susceptible, now have selective advantage	**2**	**A** chloroquine resistance no longer selected for **A** *idea that* chloroquine-susceptible more likely to survive / reproduce
4(c)	*four from* random / spontaneous / chance **;** mutation gives resistance (to drug) **;** natural / directional, selection **;** best-adapted / resistant / mutated, parasites, survive / reproduce **; ora** favourable / resistance, alleles passed on (to offspring) **;** increase in frequency of alleles for resistance **;**	**4**	**R** resistance to antibiotic *but then* ***ecf*** **A** pre-existing allele / variation (already exists) **A** resistants have <u>selective</u> advantage **A** mutated allele gives selective advantage **I** mutated allele has an advantage **A** resistant individuals pass on, their / the, alleles **A** decrease in frequency of allele for susceptibility
4(d)	<u>discontinuous</u> **;**	**1**	

© UCLES 2016

Question	Answer	Mark	Guidance
4(e)	*two from* (parasites are) haploid / not diploid **;** do not reproduce (only) sexually **;** (no need to calculate as) percentage of parasites killed = frequency of non-resistant allele **; ora** percentage of parasites surviving = frequency of resistant allele AVP **;** Hardy-Weinberg principle requires, random mating / no migration / no mutation / no selection	**2**	**A** Hardy-Weinberg assumes organisms are diploid **A** *descriptions* e.g. n / 2n, etc. **A** Hardy-Weinberg assumes organisms (only) reproduce sexually **or** that *Plasmodium* has stages that reproduce asexually **A** non-random mating / migration / mutation / selection affects, Plasmodium / parasites / allele for chloroquine resistance
	Total:	**12**	

© UCLES 2016

Question	Answer	Mark	Guidance
5(a)	*three from* *ref. to* interactions between, biotic and abiotic (components) **;** *yes* tree supports, many species / community / many interactions **;** energy flow / food web, occurs on one tree **;** *no* *idea that* tree is part of larger ecosystem / interactions occur with organisms outside tree **;** part of, savannah / larger, energy flow / food web / nutrient recycling **;**	**3**	**A** interactions between living and non-living **or** between, the community / populations of different species, and the physico-chemical environment **A** idea of, discrete / self-contained / self-sustaining, group of species / community **A** description of three-step food chain on tree
5(b)(i)	105 **;**	**1**	**A** 104.5 / 104
5(b)(ii)	genus *Acacia* **;** species (*Acacia*) *mellifera* / *nilotica* / *tortilis* **;**	**2**	**R** genus name with lowercase first letter **R** species name with uppercase first letter
5(b)(iii)	*two from* *sample sizes in Table 5.1* 1 are small **;** 2 sample size varies (between the 3 species) **; ora** 3 anomaly could be, missed / have disproportionate effect **;** 4 small(er) / decreased, sample size would be, less representative / less valid / less accurate **; ora**	**2**	**ora** *idea that* they should be the same e.g. large sample size reduces effects of anomalies **or** large sample size allows anomalies to be indentified / either maximum or minimum for *A. tortilis* could be an anomaly / high max for *A. nilotica* could be an anomaly

© UCLES 2016

Question	Answer	Mark	Guidance
5(c)	*three from* *idea of*, species, inter-related / interact (in reserve) **;** to conserve one species need to protect whole ecosystem **;** elephants / large animals, eat acacia **;** AVP **;** e.g. research raises, profile of / money for, game reserve **or** presence of research team deters elephant poachers	**3**	**A** *knock-on effects* e.g. insects (needed to) pollinate plants that elephants eat / insect competitors stunt trees so easier for elephants to reach **I** elephants eat insects
	Total:	**11**	

Question	Answer	Mark	Guidance
6(a)(i)	**C ;**	**1**	
6(a)(ii)	*one from* progesterone concentration decreases **;** oestrogen concentration decreases, near end / in **D ;**	**1**	**A** progesterone is low, at end / in **E** **A** oestrogen concentration is low, at end / in **E**
6(a)(iii)	corpus luteum **;**	**1**	
6(a)(iv)	*one from* maintain the endometrium **;** negative feedback / inhibition, of, FSH / GnRH / LH **;**	**1**	**A** maintains the uterus lining **R** maintains the, endometrium wall / uterus wall **I** thickens lining

© UCLES 2016

Question	Answer	Mark	Guidance
6(b)	*four from* inhibits (secretion of), FSH / LH / GnRH **;** from anterior pituitary gland **;** inhibits follicle, formation / development **;** inhibits ovulation **;** thick(ens) cervical mucus (to stop sperm) **;** prevents implantation **;** AVP **;** e.g. negative feedback / endometrium inhospitable	**4**	
	Total:	**8**	

Question	Answer	Mark	Guidance
7(a)	**P** = **Z** line **;** **Q** = **A** band **;**	**2**	**A** Z disc / zwischenscheibe line **I** Z band
7(b)	*five from* 1 calcium ions / Ca^{2+}, ions from sarcoplasmic reticulum **;** 2 calcium ions / Ca^{2+}, bind to troponin **;** 3 troponin changes shape **;** 4 tropomyosin moves **;** 5 from / exposing, (myosin) binding site on actin **;** 6 myosin head binds (to actin) **;** 7 myosin head tilts / power stroke occurs **;** 8 actin pulled **;**	**5**	**R** Ca^{+} *once but then* ***ecf*** **A** actin-myosin cross-bridges form

© UCLES 2016

Question	Answer	Mark	Guidance
7(c)	*three from* synthesise / produce, ATP **;** (ATP needed to) synthesise acetylcholine **;** (ATP needed for) movement of vesicles / exocytosis **;** (ATP needed to) transport calcium ions, out of presynaptic neurone / into sarcoplasmic reticulum **;** (ATP needed to) synthesise acetylcholinesterase **;** (ATP needed for) Na^+(– K^+) pumps / pumping / active transport **;**	**3**	**A** provides ATP *but* **R** releases ATP **R** *ref. to* makes / produces, energy **A** make / produce, *or description* **A** vesicle fuses with cell membrane **A** pumping of Ca^{2+} into sarcoplasmic reticulum **A** sodium(-potassium) pump **R** *if direction wrong, i.e. Na+ in or K+ out*
	Total:	**10**	

Question	Answer	Mark	Guidance
8(a)(i)	potassium hydroxide / sodium hydroxide (solution) **;**	**1**	**A** KOH / NaOH **I** limewater, calcium hydroxide, soda lime, (sodium) bicarbonate or hydrogen carbonate
8(a)(ii)	*one from* must not raise temperature too high for animals **;** woodlice, movement / activity **;**	**1**	**A** high temperature / 30 °C or over, could, harm / kill / distress, woodlice
8(a)(iii)	oxidative phosphorylation **;**	**1**	**A** electron transport chain / ETC

© UCLES 2016

Question	Answer	Mark	Guidance
8(b)(i)	<table><tr><th>temperature /ºC</th><th>difference /cm^3</th><th>rate of oxygen uptake /cm^3 min^{-1}</th></tr><tr><td>15</td><td>0.18</td><td>0.012 ;</td></tr><tr><td>25</td><td>0.42</td><td>0.028 ;</td></tr></table>	2	**A** 0.01 **A** 0.03
8(b)(ii)	*at 25 °C (**ora** for 15 °C)* *three from* 1 increased kinetic energy ; 2 enzymes / substrates / molecules, move faster ; 3 more collisions (between enzyme and substrate) ; 4 more ESCs formed ; 5 AVP ; Q_{10} = 2	3	**I** optimum temperature **A** rate of collisions, higher / faster

© UCLES 2016

<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>8(c)</td><td>
five from
similarities
1 reduced NAD (used) in both;
2 NAD regenerated / glycolysis can continue, in both;

differences
<table>
<tr><th></th><th>yeast / ethanol</th><th></th><th>mammalian tissue / lactate</th><th></th></tr>
<tr><td>3</td><td>decarboxylation</td><td>or</td><td>no decarboxylation</td><td>;</td></tr>
<tr><td>4</td><td>irreversible</td><td>or</td><td>reversible</td><td>;</td></tr>
<tr><td>5</td><td>two steps / pyruvate → ethanal → ethanol</td><td>and</td><td>one step / pyruvate → lactate</td><td>;</td></tr>
<tr><td>6</td><td>ethanal accepts H</td><td>and</td><td>pyruvate accepts H</td><td>;</td></tr>
<tr><td>7</td><td>ethanol dehydrogenase</td><td>and</td><td>lactate dehydrogenase</td><td>;</td></tr>
</table>
</td><td>5</td><td>
A NADH / $NADH_2$
R reduced NAD produced
A NAD^+ regenerated
A (NADH) re-oxidised to NAD / NAD^+

A CO_2 released (yeast) or not (mammals)

A description of two steps
A pyruvic acid / lactic acid

A ethanol and pyruvate, reduced / gain H^+ and e^-
R they are dehydrogenated

A alcohol dehydrogenase
R lactase dehydrogenase
</td></tr>
</table>

© UCLES 2016

Question	Answer	Mark	Guidance
9(a)	*eight from* 1 (happens in) proximal convoluted tubule **;** 2 all / 100%, glucose (reabsorbed / moves into blood) **;** 3 active transport / pumping, of Na^+ out of cells into tissue fluid **;** 4 Na^+ concentration decreases inside cells **;** 5 therefore Na^+ enters (epithelial / tubule) cells from, lumen / filtrate **;** 6 by facilitated diffusion **;** 7 this is secondary active transport **;** 8 Na^+ brings glucose with it **;** 9 this is co-transport **;** 10 (facilitated) diffusion of glucose out of cells into tissue fluid **;** 11 GLUT proteins (on basolateral membranes) **;** 12 *ref. to* microvilli (on lumen side / apical membrane) **;** 13 to increase surface area for reabsorption **;** 14 tight junctions separate proteins of front and basolateral membranes **;**	**8**	**A** epithelial layer for cells of proximal convoluted tubule throughout but **R** endothelial layer / tubule wall **A** interstitial fluid / blood / capillary **I** diffusion from tissue fluid to blood **A** *ref. to* co-transporter **A** interstitial fluid / blood / capillary

© UCLES 2016

Question	Answer	Mark	Guidance
9(b)	*seven from* 1 (low blood water potential) detected by osmoreceptors **;** 2 in hypothalamus **;** 3 neurosecretory cells (stimulated to) produce ADH **;** 4 ADH released by posterior pituitary **;** 5 ADH transport in blood **;** 6 (ADH) binds to receptors (on cell surface membranes) **;** 7 (of) collecting duct / distal convoluted tubule **;** 8 aquaporins / water transport proteins, added to membranes **;** 9 increases permeability to water (of collecting duct / distal convoluted tubule) **;** 10 water moves out of, filtrate / tubule lumen **;** 11 by osmosis **;** 12 into, interstitial fluid / tissue fluid / blood / capillaries **;** 13 small volume of / concentrated, urine produced **;** 14 increases water potential of blood (back to norm) **;**	**7**	**I** ADH secreted into blood **A** description of vesicles with aquaporins fusing with (cell surface) membranes **R** *if in context of, proximal convoluted tubule / loop of Henle* **A** returns Ψ to normal
	Total:	**15**	

© UCLES 2016

Question	Answer	Mark	Guidance
10(a)	*eight from* 1 mechanical energy converted to electrical **;** 2 *ref. to* sensory hair cell (is receptor / detects touch) **;** 3 cell membrane depolarises **;** 4 (if at least) <u>two</u> hairs touched (within 35 seconds) **;** 5 action potential occurs **;** 6 action potential / depolarisation, spreads over, leaf / lobe **;** 7 *ref. to* hinge / midrib, cells **;** 8 H^+, pumped out of cells / pumped into cell walls **;** 9 cell wall, loosens / cross-links broken **;** 10 calcium pectate dissolves (in middle lamella) **;** 11 Ca^{2+} (ions) enter cells **;** 12 water, enters / follows, by osmosis **;** 13 cells, expand / become turgid **;** 14 change from convex to concave **;** 15 trap shuts, quickly / in <1s / in 0.3s **;** 16 AVP; acid growth hypothesis / expansins / elastic tension **;**	**8**	**A** sensory or trigger hairs **A** receptor / generator, potential **A** if only one hair touched no closure **R** nerve impulses **A** to midrib / to hinge

© UCLES 2016

Question	Answer	Mark	Guidance
10(b)	*seven from* *control* 1 gibberellin synthesis / dwarfism, controlled by gene *Le* / *le* **;** 2 dominant allele / *Le*, gives, functional enzyme / active gibberellin **; ora** 3 enzyme converts inactive to active gibberellin **;** *stem elongation* 4 without GA, transcription factor / PIF, attached to DELLA protein **;** 5 GA binds to receptor (complex) **;** 6 causes DELLA (protein) destruction **;** 7 transcription factor / PIF / RNA polymerase, binds to DNA **;** 8 (growth) genes, switched on / expressed / transcribed **;** 9 causes cell division **;** 10 causes cell elongation **;** 11 increases internode length **;** 12 loosens cell walls / acid growth **;** 13 so cells can expand when water enters **;** 14 AVP **;** e.g. interaction with auxin, *ref. to* expansins	**7**	**I** seed context throughout **A** recessive allele / *le*, gives, non- functional enzyme / non-active gibberellin **A** inhibition of transcription removed **A** breaks cross-links in cell wall
	Total:	**15**	

© UCLES 2016