Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

BIOLOGY **9700/41**

Paper 4 A Level Structured Questions **May/June 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 May/June 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

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 (examples given as guidance)

1 (a) both have ribose (sugars) **; R** ribulose
ATP has 1, ribose / pentose / sugar, NAD has 2 **; I** *ref. to* additional hexose
both have, adenine / purine (base) **; I** adenosine
NAD has, nicotinamide / pyrimidine (base) **;**
ATP has 3 phosphates, NAD has 2 **;** [max 3]

(b) *accept synthesise / produce / convert to, for 'make' for all mp*
make (named), protein / polypeptide / peptides **; A** protein synthesis / translation
make (named), disaccharide / oligosaccharide / polysaccharide / glycogen **; R** non-mammalian examples such as starch or cellulose
make (named), triglycerides / lipids / phospholipids / steroids / cholesterol **;**
A glycogenesis
make, nucleotide / polynucleotide / nucleic acid / DNA / RNA **;**
A transcription / DNA replication
AVP **;** e.g. named example of, polymerisation / condensation
A phosphorylation example [max 2]

(c) substrate-linked / substrate-level, phosphorylation **; I** condensation reaction [1]

(d) hydrogen, carrier / acceptor **; A** gets reduced **or** gains H / H^+ and electrons
I donates **R** H_2 / hydrogen molecules
(acts as a) coenzyme **; A** enables dehydrogenases to work
ref. to glycolysis / respiration in anaerobic conditions **; A** anaerobic respiration
I aerobic [max 2]

(e) '*more' needed once plus implied for second mp*
1 more, C-H bonds / hydrogen(s) / reduced **; I** C-C bonds
R more hydrogen bonds **R** hydrocarbons

accept produces / gives / results in *for 'makes' in mp 2 and mp3*
2 (makes) more reduced NAD **;**
3 makes more ATP per, gram / molecule / mole / unit mass **;**
A releases / results in / gives, more energy per, g / etc.
4 more, aerobic respiration / electron transport chain (ETC) / oxidative phosphorylation / chemiosmosis **; A** higher rate of *for 'more'* [max 2]

[Total: 10]

2 (a) at lowest value / in shortest supply **; I** insufficient supply / not enough
(the) one factor of several that affects rate **; A** one factor of several prevents increase in rate [2]

(b) to keep out unwanted CO_2 (in air around leaves) **;**
A to stop CO_2 increasing / entering (upper chamber)
ref. to respiration of soil organisms **; A** respiration of bacteria / fungi / seeds
ref. to respiration of plant roots **;** [max 2]

(c) (i) **I** *ref. to set **B** throughout* **I** *time references*

at low(er) light intensity / light intensity up to a figure in range 6 – 7 au
1 rate increases as light intensity increases **;**
2 light intensity is (main) limiting factor **;**
mp1 and mp 2 need to be in correct context

at high light intensity / light intensity above a figure in range 6 – 7 au
3 rate, levels off / reaches plateau / remains constant **;**
A rate unaffected (by light intensity)
4 another (named) factor / not light intensity, is limiting **;**
A CO_2 concentration / temperature
mp3 and mp4 need to be in correct context [max 3]

(ii) more CO_2 available in **B** / less CO_2 in **A** **;**
A CO_2 concentration in **B** is double that of **A**
ref. to fixation / Calvin cycle / light independent reactions **;**
A description, e.g. CO_2 combines with RuBP
CO_2 concentration is limiting factor in set **A** **;**
A CO_2 concentration is limiting at a higher light intensity in **B** [max 2]

(d) *accept **ora** throughout*
1 **D**, adapted to high CO_2 / can use more CO_2 (per unit leaf area) **;**
A plants in **D** have, adjusted / accommodated, to high CO_2
2 **D** have more, chloroplasts / chlorophyll **;**
3 **D** have more, rubisco / RuBP **;**
4 **D** have more stomata **;**
5 **D** have thinner leaves **;**
6 AVP **;** e.g. *ref. to* diffusion of CO_2 [max 4]

[Total: 13]

3 (a) (i) database(s) **;**
computer (programs) / software **;**
analysis of, data / biological information / sequences **;**
A compare, genes / genomes [max 2]

(ii) **1** identify / recognise, gene(s) **;** **A** find where genes are
2 predict, primary structure / amino acid sequences, of proteins **;**
3 predict 3D structure of proteins **;** **A** tertiary
4 identify / predict, functions of proteins (from 3D structure) **;**
5 *ref. to* drug to, bind with / block activity of / disrupt structure of, protein / enzyme **;** **A** drug specific to protein **I** denature, protein / enzyme
6 drug prevents, transcription / expression, (of gene) **;** **I** gene editing [max 3]

(b) (i) cheaper **;** **A** more economic(al)
faster / can try many different drugs in a short period of time **;** **A** time-saving
can try out changes to, model / drug structure, to see if more effective **;**
no need for, laboratories / equipment **;** **I** uses less labour
(initially) no need for tests on, animals / humans **;** **A** fewer ethical issues [max 3]

(ii) functionality / to test that drug, actually works / is effective **;**
A cannot assume predictions are correct **I** efficiency
safety **; A** *ref. to* clinical trials / side effects
dosage **; A** theoretical modelling will not give information on doses [max 2]

[Total: 10]

4 (a) 1 best / desirable, plants crossed **; A** cross-pollinated **R** cross with other (maize) species
2 repeatedly / every generation **;**
3 detail of cross-pollination **;** e.g. *ref. to* male tassels and female silks
4 example of desirable characteristic **; A** more kernels / big kernels / high yield / *ref. to* kernel colour / fast-growing / cold-tolerant
5 hybridisation / two inbred (named) lines crossed / F1 hybrids formed **;** **A** description, e.g. cross two, homozygous parents / parents from two pure-bred lines
6 gives more, vigorous / uniform, plants **; A** heterosis
7 *ref. to* dwarf maize / mutant alleles for gibberellin (synthesis) **;** [max 4]

(b) 1 <u>discontinuous</u> **;**
max 2 for mp2–6
2 one gene / single locus / monogenic, inheritance **; A** monohybrid
3 two alleles **;**
4 dominant and recessive **;**
5 1:1 ratio purple to yellow **; A** 50% purple, 50% yellow
6 test cross / Aa × aa **;** [max 3]

(c) (i) 1 as, Bt crops / area, increases the number of resistant, pests / species, increases **; A** the more (the area of) Bt crops grown, the more (the) resistant species
2 figures quote **;** (2 years, area with units once)
3 figures quote **;** (2 years, no. resistant pest species)
4 mutation(s) (in pest species) **;**
5 chance / random / spontaneous (mutations) **;**
6 pests evolve resistance / natural selection for resistant pests **;**
7 AVP **;** e.g. plateau in resistance, 2002–2005 / 2009–2011 first 6 years / 1996–2001, no resistant species [max 4]

(ii) *social*
increased yield / more food / cheaper food / AW **;**

environmental
decreased insecticide use / few hazards to humans / Bt only targets pest species **; A** no / less pesticide used **R** herbicide [2]

[Total: 13]

5 (a) 1 mark-release-recapture / AW **;** **A** catch, mark, return, catch
A mark-and-recapture
description (max 3)
2 detail of trapping **;** e.g. Longworth / Sherman / live / small mammal
3 detail of marking **;** e.g. felt tip pen / clipping fur / not to have adverse effects
4 detail of timing of second trapping **;** e.g. not too soon or mixing will not occur / not too long after as migration may occur / after 24 hours / 1 day (any number of days up to two weeks)
5 detail of calculation **;** e.g. Lincoln Index / Petersen index
or $\frac{\text{number marked time 1} \times \text{no. captured time 2}}{\text{number of marked individuals recaptured time 2}}$
A symbols in equation if key is given [max 4]

(b) glycogen **;**
centrioles / centrosomes **;**
(may have) cilia / flagella / microvilli **;**
no cell wall **;**
no, large / central / permanent, vacuole **;** **A** no tonoplast [max 2]

(c) (i) 1 reduce, other organisms' abundance / biodiversity **;** **A** endanger, rare species / water voles **A** causes extinction
2 alter food, chains / webs **;**
3 due to predation **;**
4 due to competition **;**
5 due to spreading disease **;**
6 may change habitat **;** e.g. create shade, change soil pH
7 may be toxic / threaten human health **;** [max 3]

(ii) culling / hunting / trapping **;**
contraceptive measures **;**
biological control disease agent **;** **I** introduce new mink-eating predator
I biological control alone [max 1]

[Total: 10]

6 (a) key to 4 chosen symbols **;**
A any two lettered pairs (e.g. E/e and A/a) identified **I** symbols for wing length
no eyes and *black abdomen* must be lower case (e, a)
with eyes and *striped abdomen* must be upper case (E, A)
allow ecf to max 3 if error in symbols

parents genotypes Eeaa × eeAa **;**
gametes Ea ea × eA ea **;** **A** each gamete written twice
F2 genotypes Eeaa eeaa EeAa eeAa **;** [4]

(b) cross with, homozygous recessive / black no-eyes, fly **;**
A double recessive / aaee (or own symbols) / organism showing recessive characters or phenotype [1]

(c)

observed number (O)	expected number (E)	O – E	$(O - E)^2$	$\frac{(O - E)^2}{E}$
86	83	3	9	0.11
87	83	4	16	0.19
81	83	–2	4	0.05
78	83	–5	25	0.30
332	332	;;	χ^2 = 0.65 ;	

A fractions in last column **A** 3 s.f. in last column [3]

(d) no significant deviation from expected / difference not significant **;**
A (95% probability that) difference is due to chance
A data is a good fit / match
A null hypothesis (no significant difference between O and E)
R comment on significance of results
R 'the value' is not significant

probability (of this deviation) is over 0.05 / χ^2 is less than 7.82 **;**
A χ^2 / results (of χ^2 test), less than value at probability 0.05

ref. to critical value **;** *ecf reverse arguments if answer from 6(c)is over 7.82*
ref. to independent assortment / AW **;** [max 2]

[Total: 10]

7 **(a)** maintaining a constant internal environment **;** AW
R external **I** body conditions [1]

(b) **(i)** ribosomes / rough endoplasmic reticulum / RER **;** [1]

(ii) exocytosis **;** [1]

(iii) causes glucose uptake / increases permeability to glucose **;**
adds transport proteins to cell (surface) membrane **; A** in sarcolemma
A GLUT(4), proteins / channels / carriers
more glucose respired / increase in respiration rate **;**
glucose converted to glycogen / glycogenesis **;** [max 3]

(c) *accept stimulates / stimulated, for activates / activated throughout*

1 (adrenaline) receptor shape change **;**
2 G-proteins activated **; A** description of G protein releases (α) subunit
3 adenylyl cyclase activated **; A** adenyl(ate) cyclase
4 cyclic AMP made **;**
5 (cAMP is) second messenger **;**
6 activates / phosphorylates, kinase **;**
7 *ref. to* enzyme cascade / cascade of reactions **;**
8 glycogenolysis / hydrolysis of glycogen, stimulated / AW **; A** break down glycogen
9 AVP **;** gluconeogenesis / *ref. to* glucose transport proteins
A description / glucose from, amino acids / lipids
A GLUT(2) channels / carriers [max 5]

[Total: 11]

8 **(a)** **A** – dendrite(s) **;**
B – dendron / (sensory) axon **;**
C – cell body (of neurone) / soma / centron **;**
D – axon (membrane) **; A** terminal axon [4]

(b) myelin insulates (axon) **;**
action potentials / depolarisation, only at nodes (of Ranvier) **;**
local circuits set up between nodes **; I** local circuits at nodes
action potentials / impulses, 'jump' from node to node **or** saltatory conduction **;** [max 2]

(c) only, stimulus / depolarisation / receptor potential / potential difference, that reaches <u>threshold</u> produces an action potential **; ora**
A -50mV for threshold **A** generator for receptor

idea that the action potential is the same size no matter how strong the stimulus **;**
ref. to all-or-nothing (law) **; I** all-and-nothing [max 2]

[Total: 8]

9 (a) *accept proton / hydrogen ion / H^+ / H ion as equivalent throughout*

1 reduced, NAD / FAD **;** **A** NADH / $NADH_2$ / NADH + H^+ *for reduced NAD*
2 passed to ETC **;**
3 inner membrane / cristae **;**
4 hydrogen released (from reduced, NAD / FAD) **;** **R** H_2
5 split into electrons and protons **;** **A** released as electron and proton
6 electrons pass along, carriers / cytochromes **;** **A** electrons pass along proteins of, ETC / carrier chain
7 energy released pumps protons into intermembrane space **;**
8 proton gradient is set up **;** **A** concentration gradient of protons is created **A** full description
9 protons diffuse, (back) through membrane / down gradient **;** **A** protons <u>diffuse</u> into matrix
10 ATP synthase / stalked particles / protein channels **;** **A** ATP synthetase **R** ATPase
11 (ATP produced from) ADP and (inorganic) phosphate **;** **A** context for 'final'
12 *idea of* oxygen as final electron acceptor **;**
13 addition of proton (to oxygen) to form water / (oxygen) reduced to water **;** [max 8]

(b) 1 pyruvate formed by <u>glycolysis</u> **;**
2 reduced NAD formed by <u>glycolysis</u> **;**
3 pyruvate decarboxylated / AW **;**
4 ethan<u>a</u>l produced **;**
5 pyruvate decarboxylase **;**
6 ethan<u>a</u>l is, hydrogen acceptor / reduced **;** **A** gains H **or** gains H^+ <u>and</u> e^-
7 from / by, reduced NAD **;**
8 ethan<u>o</u>l formed **;**
9 ethan<u>o</u>l / alcohol, dehydrogenase **;**
10 not reversible reaction **;**
11 NAD, regenerated / can now accept hydrogen atoms **;** **A** reduced NAD oxidised
12 so glycolysis can continue **;** [max 7]

[Total: 15]

10 (a) **I** *ref. to* nuclear envelope **I** names of stages

meiosis I

1 chromosomes, condense / thicken / spiralise **;**
2 homologous chromosomes pair / bivalents form **;**
3 crossing over / described **;**
4 chiasma(ta) **;**
5 spindle fibres / microtubules, attach to / pull, centromeres / kinetochores **;** *allow once in mp5* ***or*** *in meiosis II*
6 bivalents line up on, equator / mid-line **; A** pairs of homologous chromosomes
7 independent assortment (of homologous pairs) / described **; A** random assortment
8 chromosomes move to, two ends of cell / poles **; A** (pairs of) homologous chromosomes separate

meiosis II

9 (individual) chromosomes / pairs of chromatids, line up on, equator / mid-line **;**
10 at right angles to first equator **;**
11 centromeres divide **;**
12 chromatids separate **; A** chromatids move to (opposite) poles
13 *ref. to* haploid / chromosome number halved / one set of chromosomes **;** **A** n *for haploid* [max 9]

(b) **I** polypeptide *throughout*

structural gene

1 structural protein / enzyme / rRNA **; A** any named protein other than a transcription factor (e.g. transporter / receptor / named hormone / immunoglobulin / haemoglobin / etc.) **R** *if any of these are identified as product of regulatory gene*
2 named, structural protein / other protein / enzyme, **or** tRNA **; R** named protein if function wrongly described
3 *idea that* needed for, structure / function, of cell **;**

regulatory gene

4 (product) controls, gene expression / transcription **; A** promote / prevent / start / stop, gene expression or transcription
5 (codes for) transcription factor / DNA-binding protein **;**
6 binds to, promoter / operator / DNA response element **;**
7 stops / allows, binding of <u>RNA polymerase</u> **;**
8 *ref. to* repressor / repressible **; A** silencer
9 *ref. to* inducer / inducible **; A** activator / enhancer
10 named example of regulatory gene **; A** lac repressor / DELLA repressor / homeobox **or** homeotic **or** *Hox* gene [max 6]

[Total: 15]