

**BIOLOGY****9700/41**

Paper 4 A Level Structured Questions

**May/June 2016**

MARK SCHEME

Maximum Mark: 100

**Published**

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Mark scheme abbreviations:

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

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- 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<sup>+</sup> and electrons  
**I** donates **R** H<sub>2</sub>/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<sub>2</sub> (in air around leaves) ;  
**A** to stop CO<sub>2</sub> increasing/entering (upper chamber)  
*ref. to* respiration of soil organisms ; **A** respiration of bacteria/fungi/seeds  
*ref. to* respiration of plant roots ; [max 2]

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(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<sub>2</sub> concentration /temperature
- mp3 and mp4 need to be in correct context

[max 3]

(ii) more CO<sub>2</sub> available in **B** /less CO<sub>2</sub> in **A** ;

- A CO<sub>2</sub> concentration in **B** is double that of **A**  
ref. to fixation / Calvin cycle /light independent reactions ;  
A description, e.g. CO<sub>2</sub> combines with RuBP  
CO<sub>2</sub> concentration is limiting factor in set **A** ;  
A CO<sub>2</sub> concentration is limiting at a higher light intensity in **B**

[max 2]

(d) accept **ora** throughout

- 1 **D**, adapted to high CO<sub>2</sub> /can use more CO<sub>2</sub> (per unit leaf area) ;  
A plants in **D** have, adjusted /accommodated, to high CO<sub>2</sub>
- 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<sub>2</sub>

[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]

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- (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 discontinuous ;  
*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 /  $Aa \times aa$  ; [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]

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- 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 number marked time 1 × no. captured time 2  
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]

|        |                                                    |          |       |
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(c)

| observed number (O) | expected number (E) | O – E               | (O – E) <sup>2</sup> | $\frac{(O - E)^2}{E}$ |
|---------------------|---------------------|---------------------|----------------------|-----------------------|
| 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                 | ∴ $\chi^2 = 0.65$ ; |                      |                       |

**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 /  $\chi^2$  is less than 7.82 ;

**A**  $\chi^2$  / results (of  $\chi^2$  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]

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

- 1 (adrenaline) receptor shape change ;
- 2 G-proteins activated ; **A** description of G protein releases ( $\alpha$ ) subunit
- 3 adenylyl cyclase activated ; **A** adenylyl(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 threshold 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]

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- 9 (a) *accept proton/hydrogen ion/ $H^+$ /H ion as equivalent throughout*
- 1 reduced, NAD/FAD ; **A** NADH/NADH<sub>2</sub>/NADH +  $H^+$  for reduced NAD
  - 2 passed to ETC ;
  - 3 inner membrane/cristae ;
  - 4 hydrogen released (from reduced, NAD/FAD) ; **R** H<sub>2</sub>
  - 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 diffuse 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 glycolysis ;
  - 2 reduced NAD formed by glycolysis ;
  - 3 pyruvate decarboxylated / AW ;
  - 4 ethanal produced ;
  - 5 pyruvate decarboxylase ;
  - 6 ethanal is, hydrogen acceptor/reduced ; **A** gains H **or** gains  $H^+$  and  $e^-$
  - 7 from/by, reduced NAD ;
  - 8 ethanol formed ;
  - 9 ethanol / 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]

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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 RNA polymerase ;
- 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]