
BIOLOGY

9700/43

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 |
| R | reject |
| A | accept (for answers correctly cued by the question, or by extra guidance) |
| AW | alternative wording (where responses vary more than usual) |
| <u>underline</u> | 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) |

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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⁺ and electrons
I donates **R** H₂/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 CO₂ (in air around leaves) ;
A to stop CO₂ 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 CO₂ concentration/temperature
- mp3 and mp4 need to be in correct context

[max 3]

(ii) more CO₂ available in **B**/less CO₂ in **A** ;

- A** CO₂ concentration in **B** is double that of **A**
ref. to fixation / Calvin cycle / light independent reactions ;
A description, e.g. CO₂ combines with RuBP
CO₂ concentration is limiting factor in set **A** ;

A CO₂ concentration is limiting at a higher light intensity in **B**

[max 2]

(d) accept **ora** throughout

- 1 **D**, adapted to high CO₂/can use more CO₂ (per unit leaf area) ;
A plants in **D** have, adjusted/accommodated, to high CO₂
- 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 CO₂

[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 $\frac{\text{number marked time 1} \times \text{no. captured time 2}}{\text{number of marked individuals recaptured time 2}}$
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 | ∴ $\chi^2 = 0.65$; | | |

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 / 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]

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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 (α) 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/NADH₂/NADH + H⁺ for reduced NAD
 - 2 passed to ETC ;
 - 3 inner membrane/cristae ;
 - 4 hydrogen released (from reduced, NAD/FAD) ; **R** H₂
 - 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]