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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
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)

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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** 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]

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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_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]

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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 <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]

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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]

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(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]

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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** 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]

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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]

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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 <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]

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1 (a) (i) three phosphates ;
ribose / pentose ;
adenine ; **I** nitrogenous base [max 2]

(ii) combines with, acetyl group / acetate ;
ref. to link reaction ;
(delivers, acetyl group / acetate) to the Krebs cycle ;
(acetyl group / acetate) combines with oxaloacetate ;
R Acetyl CoA combines with oxaloacetate [max 3]

(b) (i) muscle / liver ; [1]

(ii) facilitated diffusion ; [1]

(iii) **F** – condensation / polymerisation / anabolic / glycogenesis / dephosphorylation ;
G – hydrolysis / catabolic / glycogenolysis / phosphorylation ; [2]

(iv) glycolysis / respiration / lipid synthesis ; [1]

[Total: 10]

2 (a) *describe*
1 increased temperature increases the rate of photosynthesis at high light intensities ;
2 increased temperature has little effect at low light intensity ;

explain
3 increased kinetic energy ;
4 (leads to) increased, no. of collisions / (rate of) enzyme activity / ESCs / enzyme-subtrate complexes ;
5 (high light intensity) temperature is the limiting factor ;
6 (low light intensity) light intensity is the limiting factor ; [4 max]

(b) (i) *absorption spectrum*
shows the, absorbance / absorption, of different wavelengths
(of light by chloroplast pigments) ;

action spectrum
shows the rate of photosynthesis at different wavelengths (of light) ; [2]

(ii) *idea that* light / energy, (absorbed by the pigments) is used in photosynthesis ;
idea that greater rate of photosynthesis at wavelengths that are absorbed most ;
ora [2]

(c) passes energy to, chlorophyll a / primary pigment / reaction centre ;
may absorb light wavelengths that, chlorophyll a / primary pigment / reaction centre, does not absorb ;
forms part of, light-harvesting cluster of pigments / photosystem / antenna complex ;
[max 2]

[Total: 10]

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3 (a) *explain (max 3)*
1 cuts DNA at specific, site / base sequence **;**
2 detail of cut **;** e.g. palindromic or blunt / sticky, ends or staggered cut
3 enzyme derived from, bacteria / prokaryotes **;**
4 *ref. to* destroys viral DNA in bacteria **;**

suggest
5 only X chromosome has the I-PpoI, restriction / recognition, site **;** ora
6 X and Y chromosomes are different in, size / shape / base sequence **;** [max 4]

(b) as a marker **;**
to identify the GM mosquitoes
or
to see which, cells / mosquitoes, have the gene (for I-PpoI) **;**
transformed cells / GM mosquitoes, glow / fluoresce **; R** gene glows [max 2]

(c) zygotes contain an X chromosome **;**
from female **;**
X chromosome (in zygote) destroyed (by I-PpoI) **;**
(so) zygote will, die / not develop **;** [max 2]

(d) (i) *describe*
1 generally more females in **A** than in **B ;**
2 numbers of females, remain high / oscillate, in **A** but fall in **B ;**

suggest (max2)
3 in **A** GM males have no effect on the number of females **;**
4 in **A** all offspring were from non-GM males
or
all offspring from GM males die **;**
5 in **B**, no female offspring from GM males **;**
6 because GM males cannot produce a sperm carrying an X chromosome **;** [max 3]

(ii) *idea that* large numbers of GM males needed to affect the wild population **;**
inflow of non-GM mosquitoes from other areas **;**
GM males might not survive in the wild / AW **;**
people not prepared to accept the release of (GM) mosquitoes **;** [max 2]

[Total:13]

4 (a) 1 *ref. to* humans (select) **;**
2 cross / breed, plants with desirable characteristic **;**
3 named desirable characteristic **;** e.g. bigger ears / more grains per ear / bigger grains / higher yield / fast-growing / tolerance to high temperature / disease-resistant / pest-resistant
4 over several generations **;**
5 (only) using offspring with desirable characteristic(s) **;**
6 frequency of desirable allele(s) increases **;**
7 AVP **;** e.g. polyploidy / hybridisation of ancestor grasses [max 4]

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(b) range of, phenotypes / heights **;** AW
normal distribution **;** **A** described or drawn
polygenic / genes or alleles have an additive effect **;**
environment has an effect **;**
named environmental factor **;** e.g. nutrients / light intensity / (soil) water availability / soil pH / soil mineral availability / disease or pest attack / temperature / wind [max 3]

(c) *description*
1 as area increases number of resistant weed species increases / positive correlation **;**
2 figure quote **;** (year, area with units and number of resistant weed species)
3 later figure quote **;** (later year, area with units and number of resistant weed species)

explanation
4 mutations in weed (species) **;**
5 chance / random / spontaneous (mutations) **;**
6 *idea that* resistant weeds have selective advantage **;** [max 4]

(d) *social*
increased yield / more food / cheaper food **;**

environmental
glyphosate, less hazardous than other weed killers / breaks down in soil
or
less fertiliser used (because weed competition reduced) **;** [2]

[Total: 13]

5 **(a)** **1** mark-release-recapture **;** AW
2 detail of trapping **;** e.g. live mammal trap
bait with, food / chocolate / peanut butter
3 detail of marking **;** e.g. paint / clipping fur / not to have adverse effects
4 time of second trapping detail **;** e.g. not too soon or mixing won't occur / not too long after as migration may occur
5 detail of calculation **;** e.g. Lincoln / Petersen, index
or
population size = $\frac{\text{number caught / marked, time 1 x no. captured time 2}}{\text{number of marked individuals recaptured time 2}}$
6 public reports **;** e.g. online site / use of reporting app
7 detail of reporting, time frame / areas **;** e.g. raccoon spotting week
8 detail of calculating numbers per unit area / use of computer modelling ; [max 3]

(b) **(i)** Eukarya **;** **A** Eukaryota **R** eukaryotes [1]

(ii) **1** (cells) have a nucleus **;**
2 (cells) contain membrane-bound organelles **;** **A** mitochondria / ER / golgi
3 ribosomes are, large / 22 nm / 80S **;**
4 DNA is linear **;**
5 histones present **;**
6 *ref. to* cytoskeleton / microtubules / undulipodia / cilia **;** [max 3]

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(c) *max 2 for mp1–4*
1 may compete with other species for, food / habitat **;**
2 may be predators of other species **;**
3 may spread disease to other species **;**
4 may reduce population sizes / cause extinction of other species **;**
5 may spread, disease / rabies, to humans **;**
6 may bite humans **;** [max 3]

[Total: 10]

6 **(a)** codominance **;**
sex linkage **;** [2]

(b) (male) $\mathbf{C^BC^BZ^aZ^a}$ **;** x (female) $\mathbf{C^SC^SWZ^A}$ **;**

(gametes) $\mathbf{C^BZ^a}$ $\mathbf{C^SZ^A}$ **or** $\mathbf{C^SW}$ **;**

$\mathbf{C^BC^SZ^AZ^a}$ **;** (male, blue, barred)

$\mathbf{C^BC^SWZ^a}$ **;** (female, blue, non-barred)

accept other symbols but only with key [5]

(c) blue colour is, heterozygous / $\mathbf{C^BC^S}$ **;**
test cross *;*
with non-barred female **;**
if all offspring barred, must be $\mathbf{Z^AZ^A}$ / homozygous **;**
if offspring not all barred, must be $\mathbf{Z^AZ^a}$ / heterozygous **;** [max 3]

[Total: 10]

7 **(a)** deamination / amine group removed **; A** amino / NH_2
ammonia / NH_3, formed **;**
combined with carbon dioxide **;**
urea cycle **; A** ornithine cycle [max 3]

(b) **1** (diameter of lumen of) afferent arteriole wider than efferent arteriole **;**
2 (leads to) high, blood / hydrostatic, pressure **;**
3 plasma / fluid, passes through, gaps / fenestrations, between endothelial cells (of capillaries) **;**
4 *ref. to* basement membrane acts as a, filter / selective barrier **;**
5 red cells / large proteins / molecules greater than 68 000(MM), cannot pass through **;**
6 podocytes qualified **;**
7 (filtrate) passes into (renal) capsule **;** [max 4]

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(c) *(passes through the medulla)* collecting duct / loop of Henle ;
(glucose is reabsorbed into the blood) proximal convoluted tubule / PCT ;
(ADH acts on its walls) collecting duct / distal convoluted tubule / DCT ;
(most of the water is reabsorbed into the blood) proximal convoluted tubule / PCT ; [max 4]

[Total: 11]

8 (a) **X** – label line to an invagination of the membrane ;
Y – label line to post-synaptic membrane ;
Z – label line to synaptic cleft ; [3]

(b) acts as a competitive inhibitor ;
complementary (shape) to active site ;
binds with / blocks, active site ;
ACh not, broken down / hydrolysed ; [max 3]

(c) ensure one-way transmission ;
allow interconnection of nerve pathways / AW ;
involved in, memory / learning ;
idea of filtering out, less frequent impulses / low level stimuli / AW ; [max 2]

[Total: 8]

9 (a) **1** lysis / splitting / break down, of glucose ; **R** sugar splitting
2 (glucose) phosphorylated by ATP ;
3 raises energy level / to activate the reaction / reduces activation energy / to make it reactive ;
4 fructose (1,6) bisphosphate ;
5 (breaks down to) two, triose phosphate / TP ;
6 hydrogen removed by NAD ; **A** triose phosphate oxidised by NAD
7 reduced NAD formed ;
8 pyruvate produced ;
9 small yield of ATP ; [max 6]

(b) **1** oxaloacetate accepts, acetate / acetyl group / 2C fragment ;
2 to form citrate ;
3 4C to 6C ;
4 decarboxylation ;
5 CO_2 released ;
6 dehydrogenation / oxidation ;
7 reduced NAD produced ;
8 reduced FAD produced ;
9 ATP produced ;
10 substrate-linked / substrate-level, phosphorylation ;
11 *ref. to* intermediate compounds ;
12 enzyme-catalysed reactions ;
13 oxaloacetate regenerated ; [max 9]

[Total: 15]

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10 (a) **1** chiasma / crossing over **;**
2 between *non*-sister *chromatids* **;**
3 of, homologous chromosomes / bivalent **;**
4 in prophase 1 **;**
5 exchange of, genetic material / DNA **; R** genes unqualified
6 linkage groups broken **;**
7 new combination of alleles **;**
8 random / independent, assortment of, homologous chromosomes / bivalents (at equator) **;**
9 (during) metaphase 1 **;**
10 random / independent, assortment (of, sister chromatids / chromosomes) at metaphase 2 **;**
11 possible chromosome mutation **;**
12 random mating **;**
13 random, fusion / fertilisation, of gametes **;** [max 8]

(b) **1** *ref. to* regulatory gene **;**
2 codes for repressor protein **;**
3 (repressor protein) binds to operator **;**

In presence of lactose
4 lactose binds to repressor protein **; A** allolactose
5 (repressor protein) changes shape **;**
6 (repressor protein), moves away from / no longer binds to, operator **;**

In absence of lactose
7 repressor protein blocks promoter **or** promoter region now unblocked **;**
8 RNA polymerase cannot bind to promoter **or** RNA polymerase can now bind to promoter **;**
9 (named) gene cannot be transcribed / mRNA not synthesised **or** (named) gene now, transcribed / 'switched on' **;**
10 enzymes / named enzyme, cannot be synthesised **or** enzymes / named enzyme, can now be synthesised **;** [max 7]

[Total: 15]

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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)
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)

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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** 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]

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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_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]

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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 <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]

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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]

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(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]

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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** 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]

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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]

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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 <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]

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