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Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2015 series

9700 BIOLOGY

9700/21 Paper 2 (AS Structured Questions), maximum raw mark 60

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.

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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)

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1 (a) ATP production ; **A** supply energy (to the cell / for cell reactions) **R** energy production
(site of) aerobic respiration / oxidative phosphorylation ;
AVP ; e.g. lipid metabolism / beta oxidation [max 1]

(b) crista / cristae / inner membrane ; [1]

(c) (×) 48 571 **or** (×) 50 000 ;;

$\frac{34\,000}{0.7}$ **or** $\frac{35\,000}{0.7}$

if answer incorrect award one mark for:
correct measurement (34 or 35 mm) and correct formula used (M= I/A), as above
but incorrect conversion to μm
or
correct calculation but units given
or
correct calculation but decimal places given [2]

(d) **1** resolution / resolving power, too low ;
2 further detail ; e.g. only 250 nm resolution
resolution only half wavelength of light
wavelength of light, too long / not short enough
width of membranes only 7 nm ;
3 (such) thin sections not possible ;
4 inner membrane / cristae / internal structure, could not be seen ;
5 magnification this high not possible ;
mp1 and mp5 allow correct comparative statement with electron microscope [max 2]

(e) circular DNA ;
small / similar, size ; **A** 0.5–15 μm
70S / small(er) / 18 nm, ribosomes ;
AVP ; e.g. binary fission / naked DNA [max 2]

[Total: 8]

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2 (a) (i) facilitated diffusion **;** [1]

(ii) ions are, charged / water-soluble **; A** hydrophilic
unable to pass, through hydrophobic core / hydrophobic (fatty acid) tails of, phospholipid bilayer / phospholipids(s) **;**
(channel of) protein lined with amino acids with, hydrophilic / polar, R groups / side chains **; A** hydrophilic channels [max 2]

(b) (i) quaternary / 4°, (structure) **;** [1]

(ii) secondary structure **; A** alpha / α, helix [1]

(c) *bonds must be named in the correct context of maintaining 4° structure and interactions with phospholipids*

polypeptides held together
bonds between, R groups / side chains **;**
two named bond types **;** *from*
- ionic
- hydrogen
- hydrophobic interactions
- disulfide
- van der Waal's forces

I peptide bond

polypeptides interact with phospholipids
(regions with) hydrophilic / charged / polar (R groups / side chains, of) amino acids interact with, phosphate / hydrophilic head , of phosholipid **;**
(regions with) hydrophobic / non-polar (R groups / side chains, of) amino acids interact with, fatty acid / hydrocarbon / hydrophobic, tails / chains **;**

further detail of named bond **;** [max 3]

[Total: 8]

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3 **(a)** (late) anaphase / (early) telophase **;** **R** early anaphase [1]

(b) produce more genetically identical cells / AW **;**
for growth (of the root) **;**
asexual reproduction **;**
replace (old / worn out) cells **;**
repair (damaged tissue) **;** **A** *ref. to* wounds **R** repair cells [max 2]

(c) **(i)** 8 **;** [1]

(ii) for sexual reproduction **;**
to form gametes **;** **A** pollen and, egg / ovum **R** sperm

ref. to diploid number must be restored (in zygote)
or
fusion / fertilisation, of two haploid cells results in, diploid cell / zygote **;**

prevents chromosome number doubling each generation **;** [max 3]

(d) **1** DNA double helix unwinds **;** **I** unzips **R** DNA strand unwinds
2 hydrogen bonds break between, base pairs / bases / strands **;**
3 both strands used as templates **;**
4 catalysed by / AW, DNA polymerase **;**
5 *ref. to* (free) activated nucleotides / AW **;**
6 complementary DNA nucleotides added **;**
A described in terms of complementary base pairing
7 step-by-step / sequentially / AW **;**
8 *idea that* process, occurs / continues, along whole DNA molecule **;**
9 replication bubbles / described
or
ref. to Okazaki fragments **;**
10 replication is semi-conservative / each newly formed molecule contains one original and one newly synthesised strand
11 AVP **;** e.g. *ref. to* repair / proofreading
ref. to, helicase / ligase *in correct context* [max 5]

[Total: 12]

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4 (a) (i) loss from, leaves / aerial parts of plant ;
of water vapour ; *link to first point*

plus one from:
evaporation of water, from surface of spongy mesophyll cells / into air spaces ;
diffusion of water vapour, out / to atmosphere ; **R** evaporation
movement / diffusion, (out) through (open) stomata ; **R** evaporation
water vapour moves (out) down the water potential gradient ;

[max 3]

(ii) *adaptation for 1 mark, explanation to max 2*

thick (waxy) cuticle ;
explanation
idea that wax is, (mainly) impermeable to water / hydrophobic / barrier to water vapour movement ;
reduces, water loss from parts with no stomata / uncontrolled water loss / cuticular transpiration ;
idea that increased distance decreases rate of diffusion of water vapour
or
reflective cuticle ;
explanation
reduces heat load ;
reduces evaporation (from spongy mesophyll cells surfaces) ;
reduces rate of diffusion of water vapour (through cuticle) ;
or
folded inner surface / AW ; **A** trichomes / hairs ;
explanation
traps water vapour / AW ;
reduces, diffusion / water potential, gradient ;
(water potential gradient) between sub-stomatal air space and outside / AW ;
or
no stomata (visible) on the, outer / exposed, surface ;
explanation
idea that stomata are main route for water loss ;
idea that reduces area where there is a high rate of water loss ;
surface directly exposed to air currents has no stomata ; ora

R curled or rolled *given as adaptation but allow explanation to max 2*
explanation
stomata on inside ;
no / away from, air currents ; **A** increases humidity within enclosed space / AW
reduces, diffusion / water potential, gradient (between sub-stomatal air space and outside);

[max 3]

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(b) (i) 18 g h^{-1} **;;**

one mark if no units given
one mark if incorrect answer but correct values extracted from Fig. 4.2 (60–42 g h^{-1}) [2]

(ii) *describe to max 3*
rate of, transpiration / water absorption, increases and decreases / reaches a peak **;**
time delay between high rates of transpiration and water absorption / AW **;**
lower values for water absorption until (approx.) 1645 **; ora A** 1630 to 1700
data quote to support **;**

explain to max 3
ref. to daylight and night and stomatal, opening / closure / AW **;**
higher light intensity / greater stomatal opening, higher rate of transpiration **;**
ora
idea that transpiration drives water absorption **;**
further detail **;** e.g. explanation in terms of water potential gradient
ref. to cohesion-tension from leaf to root [max 4]

(iii) xerophyte **;**
example of xeromorphic feature **; A** *ref. to* adaptation(s) (for dry areas)
high light intensity during middle of day / AW (for species **P**) **;**
idea that loss of water during the day needs to be minimised **;**
suggestion that (most) stomata, closed during the day / only open at night **;** [max 2]

[Total: 14]

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5 **(a)** Morbillivirus ; [1]

(b) *must have one ref. to either infected or uninfected to gain max*
aerosol, infection / route ; **A** droplet infection **I** *ref. to* contact
infected person, sneezes / coughs / talks / spits, to release airborne droplets;
inhaled by, uninfected / healthy, person ; [max 2]

(c) RNA nucleotides ;
contains uracil ; **A** no thymine
ribose (instead of deoxyribose) ;
no (double) helical structure ;
AVP ; e.g. small enough to pass through nuclear pores ; [max 2]

(d) cell has no enzyme for RNA replication ;
ref. to enzyme specificity ;
RNA polymerase (in cell) uses DNA template / not RNA template / AW ; [max 2]

(e) *ref. to* recognition and activation by presence of antigen (on APCs / infected cells) ;
T helper and T killer, lymphocytes / cells ; **A** T cytotoxic
T helper
secrete cytokines ;
(cytokines) stimulate / AW, (specific) B-lymphocytes ; **A** humoral response
stimulate / AW, macrophages / phagocytes / phagocytosis / T killer response ;
T killer
kill infected cells ;
detail of killing ; e.g. perforin / H_2O_2
punching 'holes' in membrane
ref. to T lymphocytes become memory cells (for secondary immune response) ; [max 5]

[Total: 12]

6 **(a)** **(i)** grass ; [1]

(ii) rabbit(s) / grasshopper(s) ; [1]

(iii) fox(es) ; [1]

(b) denitrification ;
nitrification ;
nitrogen fixation ; **A** Haber process [3]

[Total: 6]

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1 (a) (i) mitochondria **;** **A** mitochondrion [1]

(ii) can change shape / fluid membrane structure / *ref. to* flexible **;**
different orientation when section taken / AW **;** **A** different sections cut
some may be dividing / *ref. to* mitochondrial fission; **I** growing [max 1]

(b) (i) ribosomes **;** **A** ribosome **I** *ref. to* size e.g. 70 S / 80 S [1]

(ii) *circle around* 0.025 μm **;** [1]

(c) (i) plasmodesmata **;** **A** plasmodesma [1]

(ii) *assume answer is in context of between adjacent cells but* **R** if <u>within</u> a cell
I incorrect naming of plasmodesmata
I description of cytoplasmic strands

facilitates / more rapid / allows / AW, transport / communication / exchange / transfer (of substances) **;**
substances do not need to cross, cell (surface) membranes / cell walls **;**
for, movement / AW, of, substances / materials / nutrients / water **;**

named example **;**
e.g. movement / diffusion / AW, of sucrose to sieve tube (from companion / transfer, cell)
water travels by, <u>symplastic</u> pathway **I** incorrect mechanism e.g. osmosis
water avoids, apoplastic / cell wall, pathway
proteins too large to cross, cell wall / cell surface membrane

A *idea of* substances moving in and out of cells *only if plasmodesmata given in* ***(i)*** [max 1]

(d) **I** descriptions e.g. extensions / hair-like

microvilli / **A** microvillus **R** villi / villus **R** cilia

and *one from:*

absorption / uptake of products of digestion
secretion / release of (extracellular), enzymes / other named secretion
digestion (at the cell surface) / breakdown of (ingested) food / AW
excretion / release of, waste / excess, substances
increases surface area **;** [1]

[Total: 7]

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2 (a) **I** *ref. to* other components of tobacco smoke that enter bloodstream

1 contains carbon monoxide and nicotine (which contribute) **;**
R if tar also stated

contribution to atherosclerosis

2 damage to / AW, endothelium / (inner) lining / tunica intima / inner wall **;**
A also as consequence of increased blood pressure *mp8*

3 increased accumulation of LDLs **;** AW *in context of the vessel walls*
A cholesterol / lipids / lipoproteins / fats / triglycerides

4 inflammation **;**

5 more / arrival of / attraction of, phagocytes / macrophages / monocytes / neutrophils **;**
A leucocytes / white blood cells
A phagocytes, have increased adherence / 'stick' more, to lining

6 phagocytes engulf, LDLs / AW, and die (in situe)
or
formation of / presence, foam cells **;**

7 (contributes to) formation of, atheroma / atheromatous plaque **; A** plaque
I atherosclerosis

features that may have a consequential effect

8 one risk factor (caused by components of smoke) **;**
one from:
increased blood pressure *must be in context e.g. adrenalin release owing to nicotine* **I** atheroma increases blood pressure
increased stickiness of platelets (promotes clotting)
thrombus formation / thrombosis / (blood) clotting
increased, (serum) cholesterol / triglyceride / LDL, concentration
decreased, HDL / 'good' cholesterol, concentration
increased, oxidation / reactivity / AW, of LDLs [max 3]

(b) (i) phagocytosis **; A** act as phagocytes

engulf / attack / destroy / AW, pathogens / bacteria / microorganisms **;**
A viruses
A act as, antigen presenting cells / APCs
I antigens / foreign organisms / organisms

remove / engulf / AW, foreign substances / dead cells / cell debris / AW **;** [max 1]

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(ii) *following inhalation* **I** *ref. to* contract / relax

1 alveoli / air sacs / lungs, over expand / over inflate / over stretch / AW **;**

2 (alveoli have) no / poor, recoil **; A** do not, rebound
A lungs do not, recoil / deflate properly

3 (alveoli / lungs) cannot return to normal size / remain, (fully) stretched **;**
A do not, decrease in size after, stretching / inhalation / AW

4 alveoli / air sacs, do not push out air (effectively) / have trapped air / AW **;**
I oxygen trapped [max 2]

(c) (i) biological catalyst **/** described **;**
e.g. biological molecule / protein that, increases the rate of / catalyses
speeds up, a reaction
molecule that, increases the rate of / speeds up / catalyses, metabolic
/ biological / cell(ular) reaction

one of:
globular protein **;**
remains unchanged (at end of reaction) / not used up (in reaction) **;**
lowers the activation energy (of a reaction) **;** [max 2]

(ii) *points can be gained from diagrams if not contradicted in written answer*

1 (shape of) substrate / elastin, complementary to (shape of) active site **;**
R matching / same
A description e.g. substrate fits (into) active site
diagram – label active site + substrate (shapes must be complementary)

2 lock is, enzyme / elastase / active site, and key is, substrate / elastin **;**

3 formation of, enzyme-substrate complex / ES complex / ESC **;**
A successful collision between enzyme and substrate
A substrate, binds / AW, at / to, the active site
diagram – ESC no label required if following on from mp1

4 peptide fragments / peptides / products, released / formed **; A** amino acids
diagram – allow without label if sequence clear and products shown

following points need to be annotated if shown on diagram

5 hydrogen / temporary, bonds form between, enzyme / active site, and substrate **;**

6 detail of how Ea lowered **;** *term Ea not required and points can be general*
strain on (peptide) bond
electron transfers
reactants held close for bond forming (i.e. water joining) [max 3]

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(d) (i) **I** active site of A1AT changes shape / acts as non-competitive inhibitor
R if macrophage elastase stated

cannot bind / not complementary, to active site **;** **A** elastase / enzyme
H / temporary, bonds cannot form with active site **;**
no longer, prevents entry / binding, of substrate **;** **A** (so) substrate can bind [max 1]

(ii) *consequence must be correctly linked to an event*

1 neutrophil elastase, active / not inhibited / AW **;** **A** increase rate of reaction
2 (so) TIMP-1 inactivated **;** **A** other / macrophage elastase, inhibitor
3 (so) macrophage elastase, active / functioning / not inhibited / not regulated **;**
4 (so) more, macrophage and neutrophil / of both elastases, (to breakdown elastin) **;**
5 *ref. to* consequence **;** e.g. bursting alveoli / breakdown of alveolar walls / formation one large air sac / decrease in surface area for gas exchange [max 3]

(e) **1** mRNA, binds / AW, to ribosome **;** **A** ribosomal RNA **I** rRNA
A mRNA moves to ribosome
2 tRNA with amino acid (to / at, ribosome) **;** **A** aminoacyl / charged, tRNA
3 tRNA / anticodon, specific to an amino acid **;** **A** specific tRNA / anticodon for the amino acid
4 *ref. to* start codon; **A** $AUG^{(met)}$ / first codon is AUG / initiator tRNA **;**
5 (complementary) base pairing / binding, between anticodon and codon **;**
6 first and second tRNAs bind / two tRNAs bound (at a time)
or (tRNAs bring) amino acids, side by side / close **;**
7 peptide bond formation **;**
8 ribosome moves along, one codon / AW **;**
9 next (aminoacyl) tRNA arrives / amino acids added one at a time **;**
10 elastase / polypeptide, released when STOP codon reached **;**
A process continues until a STOP codon reached
11 AVP **;** e.g. *ref. to*, aminoacyl / A, site, and, peptidyl / P, site
small subunit (of ribosome) attaches to mRNA
aminoacyl tRNA synthetase binds amino acid to tRNA
ATP required for tRNA-amino acid binding
peptidyl transferase for peptide bond formation
ref. to, exit / E, site, on ribosome ribosome moves 5' to 3' [max 5]

[Total: 20]

3 **(a)** **A** = interphase **I** *ref. to early / late*
C = metaphase **;**
both needed for one mark [1]

(b) (**C**) **L**, **N**, **M**, **K** **;** [1]

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(c) **1** *idea that* centromere, has divided / divides (separating, sister / identical, chromatids) **;**

2 centromere attached to spindle fibre; **A** spindle

3 shortening / contraction, of spindle fibres (pulling centromeres) **;**
A spindle, contracts / shortens

4 (so) sister / identical, chromatids, move to opposite poles **;**
need idea of separated, so **A** ends / sides / halves
A sister / identical, chromatids, will end up, at separate poles / in separate cells

[max 3]

[Total: 5]

4

(a) *ignore descriptions or further qualification*
no marks for each box if other mechanisms given

active transport **;** **A** active uptake
exocytosis **;** **I** bulk transport / secretion
diffusion **;** **I** passive / simple **R** facilitated diffusion [3]

(b) **I** *ref. to* small increase in partial pressure causes more oxygen to associate
A pp / pressure, for partial pressures

1 this is the range of (partial) pressures occurring in respiring tissues **;**
A (partial) pressures in respiring tissues are low

2 (for a) small / 1.6 kPa, decrease in partial pressure **;**

3 (so) allows, large quantity of / more, oxygen to, be released / dissociate **;**
A oxygen dissociates more, easily / readily

4 affinity of haemoglobin to oxygen decreases **;**
in context of, as oxygen is released / as partial pressure decreases

5 data to support **;** e.g. 60–62% to 28–30% / 30–32% difference [max 2]

[Total: 5]

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5 (a) *assume response refers to infectious unless otherwise stated*

caused by a pathogen **;** **ora A** microorganism / microbe
transmissible / communicable / passed from one, organism / person, to another **;**
ora

examples to support explanation
two examples of pathogen types **;** *two of:*
bacterium / bacteria
virus / viruses
fungus / fungi
protoctist **A** protozoa

example of non-infectious, disease / category **;**
e.g. genetic disorders / named (e.g. sickle cell anaemia / cystic fibrosis)
cancer / named cancer (e.g. lung)
degenerative disease / named (e.g. chronic bronchitis, emphysema / COPD / coronary heart disease) lifestyle / AW

(b) (red blood cells contain) haemoglobin **;**
plasma proteins **; A** plasma contains proteins
named protein in blood plasma or within (red / white) cells **;**
e.g. fibrinogen / albumin / globulin / antibodies / (protein) hormone / enzyme / transport proteins / membrane proteins
R steroid hormone / named steroid hormone [max 2]

(c) (i) not all countries with *Anopheles* have malaria / example using Fig. 5.2 **;**
e.g. (although, Anopheles / vector, shown as present),
no / few, cases (of malaria) in, North America / Europe
(although, *Anopheles* / vector, occurs elsewhere) malaria, only / mainly, in subtropical and tropical areas **;**

explanations:
Plasmodium / parasite / pathogen, not present in all areas where *Anopheles* is located / AW **;**
conditions (where *Anopheles* located) not always suitable for life cycle of, *Plasmodium* / parasite / pathogen **;**
some, areas / countries, have eradicated the disease (but still have the vector) **;**
AVP **;** e.g. some countries have better prevention methods against malaria
AVP **;** some countries have effective treatment for malaria
I vaccination [max 3]

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(c) (ii) *assume ref. to A. gambiae unless stated otherwise*

occurrence

1 (in Africa) wide distribution / large numbers **;**
2 occurs where high density of humans **;**
3 occurs (in climate) where *Plasmodium* is, present / able to survive **;** AW
A e.g. *idea of* Plasmodium requiring temperatures above approx. 20 °C where *A. gambiae* is also present

*well adapted **or** better adapted than other mosquito vectors*

4 better adapted to complete life cycle / lays eggs in large variety of habitats / can withstand (more) polluted waters / larvae able to eat a wide variety of food **;**
5 short(er) life cycle / long(er) breeding season **; A** reproduces quickly
6 withstands, dry / drier, conditions / larger temperature variation / higher temperatures **; I** better adapted to climate
7 (more) resistant to, pesticides / insecticides **; R** immune

feeding

8 feed mainly / AW, on human blood **;**
9 takes, large(r) / more frequent, blood meals **;**
10 takes blood meal / bites / feeds, at night (when humans less able to notice) **;**
11 mouthparts, well adapted for feeding on humans / can penetrate clothing**;**

as host for Plasmodium

12 good host for / very susceptible to, parasite / *Plasmodium* **;**

AVP **;** e.g. able to migrate to find hosts
quick to adapt to changing human habitation
better adapted to find (human) hosts
females live for longer
A. gambiae present in Africa, where, malaria control is difficult

[max 3]

(d) (i) large egret / yellow winged bat / eastern green mamba **;** [1]

(ii) 1 insufficient numbers of bats **;**
2 (so) not enough energy / energy available is low (to sustain needs) **;**
3 energy loss at each level / progressively less energy transferred / inefficient / transfer of energy / AW **;**
4 example of energy loss from bat intake **;** *in context of mamba feeding*
e.g. inedible parts / named indigestible parts / faeces / egestion
5 example of energy loss in food chain (to bat) **;**
e.g. death but not eaten
excretion
respiration
heat loss, in movement / digestion
allow either point below if not awarded for mp 4
inedible parts / named examples
indigestible parts / faeces / egestion

[max 3]

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(iii) use biological control **;**
introduce / increase numbers of / AW, predators (of mosquito) / named e.g. guppy / dragonfly / yellow winged bats **;**
to eat / consume / reduce number of, mosquitoes **;**
grow crops other than sweet potato / grow less sweet potato **;**
A do not grow sweet potato
numbers (of mosquito) reduce so fewer, act as vectors / feed on humans **;**
AVP **;** e.g. use genetic modification to produce sweet potato crop with toxin against mosquito [max 2]

(e) nectar / nectaries / flowers / phloem (tissue) **/** (phloem) sap / sieve tubes / vascular bundles / stem / leaf **;**
I *ref. to*, source / sink
R if includes, roots / 'potatoes' / xylem, *for this mp only, then for mp 2 allow explanation for the other stated part that is correct*

explanation **;**
e.g. fluid feeders / piercing and sucking mouthparts / proboscis for feeding
(fluids provide) source of carbon / energy / sugar / sucrose
A glucose / fructose
(fluids provide) source of, nitrogen / amino acids
near to, vascular bundles / phloem *for, stem / leaf*
for phloem sap / AW *for vascular bundles* [2]

[Total: 18]

6 (a) 1 *idea of* different distances **;** *must be comparative*
e.g. atria pump blood shorter distance **ora**
atria pump blood a short distance and ventricles pump blood a long distance
atria pump blood to ventricles and ventricles pump blood to, (other parts of) body

2 (so) resistance to overcome by atria is low(er)
or
(so) ventricles need to overcome, great(er) / AW, resistance **;**

3 (so) atria generates lower pressure
ventricles generate higher pressure **;** AW
A force for pressure
R ventricles withstand high pressures
A low pressure / high pressure *if mp1 or mp2 gained* [max 2]

(b) septum **; R** atrioventricular septum [1]

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(c) (i) **I** *ref. to* xylem / transpiration stream

transpiration
involves only water (molecules) **;**
involves, evaporation / diffusion / evaporation and diffusion **;**
I *ref. to* evaporating surface
movement out to (external) environment / loss from leaves **; A** aerial parts
affected by, external factors / humidity / light / wind speed / temperature **;**
occurs in one direction / from air spaces through stomata **;**
ATP not required **;**

translocation
involves, assimilates / photosynthates / sucrose / other named **; A** cell sap
involves (hydrostatic) pressure gradients **; A** mass flow
involves transport in phloem (sieve tubes) **;**
flow from source to sink / AW **;**
ATP used (to enable loading of sucrose into phloem sieve tube) **; A** active [max 1]

(ii) both involve, transport / movement of substances **; R** if transport in xylem stated
both involve water **;**
both require energy **;** *(transpiration – evaporation requires heat energy and translocation – hydrogen ions pumping out of companion cells)* [max 1]

[Total: 5]

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MARK SCHEME for the October/November 2015 series

9700 BIOLOGY

9700/23 Paper 2 (AS Structured Questions), maximum raw mark 60

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.

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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)

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1 (a) (i) **A** – nuclear envelope **;**
B – rough endoplasmic reticulum **; R** RER / ER / smooth ER
C – (large sub-unit of) ribosome **; A** ribosomal RNA, **R** rRNA [3]

(ii) **D** – transfer / t, RNA **;** [1]

(iii) *at* **1** – transcription **;**
A post-transcription modification / removal of introns
A DNA / gene, copied (to synthesise mRNA)
A genetic information copied
R DNA copied onto mRNA
R DNA code copied onto mRNA

at **2** – amino acid activation **;**
A attachment / AW, of (specific) amino acid (to specific tRNA)

at **3** – translation / condensation of amino acids / formation of peptide bond(s) (between amino acids) **;**
A codon-anticodon binding
I (poly)peptide synthesis [3]

(b) a protein combined with, a carbohydrate / sugars / AW **;**
A protein with sugar
R protein with, glycogen / polysaccharide [1]

(c) *antibody molecule*
has (2) heavy and (2) light chains / two types of polypeptide / different types of polypeptide **;**
idea that each different, polypeptide / chain, is coded for by a gene **;**
ref. to gene coding for enzyme for carbohydrate attachment (to make the glycoprotein) **;**
[max 2]

(d) *points can be taken from an annotated diagram*
1 variable region / Fab region, has antigen binding sites **;**
2 *ref. to* specificity for binding antigen / complementary (shape) to the antigen **;**
A *idea of* sequence of amino acids (on light and heavy chain) giving specific shapes
3 (IgG has) two (antigen) binding sites (per antibody molecule) **;**
4 heavy chains / Fc / constant, region binds to (receptors on), phagocytes / named phagocyte **;**
5 hinge region gives flexibility when binding to, antigen / pathogen / AW **;**
6 disulfide bridges, give stability / hold chains together / AW **;**
award on a diagram if bond and chains are labelled
7 AVP **;** e.g. R groups bind to antigen
bind to antigen by, hydrogen bonding / ionic bonding
constant region gives antibody class / AW [max 4]

[Total: 14]

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2 (a) (i) **A** Ψ *for water potential*
I moisture
A aperture *for stomatal aperture throughout*
both units must be used at least once to award mp3 and mp7

similarities
1 when, stomatal aperture is 0 (μm) / stomata are closed, no, transpiration / water loss **;**
2 as stomatal aperture increases rate of transpiration increases in both groups of plants **;**
3 comparative use of figures with units in support of mp2 for either condition **;**

differences
in moving air
4 stomatal aperture, influences / controls / AW, rate of transpiration at all apertures **;**
in non-moving air
5 at stomatal apertures 15 μm and above rate of transpiration does not increase further / reaches a plateau / remains constant **;**
6 stomatal aperture has most effect on rate of transpiration in non-moving air at low apertures **; ora**

comparing moving and non-moving
7 comparative use of figures with units to show rates of transpiration at the same stomatal aperture **;** [max 3]

(ii) **A** water vapour potential *for water potential*
1 *ref. to* increasing width of stomatal aperture allows more water vapour to diffuse out **; ora**
R osmosis, **R** evaporate out
I evaporation from mesophyll
2 (intercellular) air spaces in leaf, are fully saturated / have high water potential / AW **;**
3 in moving air, water vapour is blown away / does not remain around the leaf **; A** low humidity around the leaf, **A ora** *for non-moving air*
4 in moving air, water potential gradient, is steep / maintained / increases / AW **;**
ora for non-moving air, **R** concentration gradient
5 so in moving air, high / higher, rate of diffusion of water vapour *in terms of an idea of a* gradient **; A ora** [max 3]

(b) (i) *advantage of having, stomata in pits / AW*
water vapour / moist air, builds up / trapped, in the, pit / groove / crypt **;**
A sunken stoma(ta)
reduces water potential gradient, between air inside the leaf and outside / AW **;**
A diffusion gradient
less transpiration / less diffusion of water vapour out (through stomata) / water is conserved **;**
R prevents water (vapour) loss
less water needs to be absorbed **;** [max 2]

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(ii) *treat 'less gas exchange' unqualified as neutral*
cannot absorb carbon dioxide (during the day when photosynthesis occurs) **;**
rate of photosynthesis is reduced / no photosynthesis **;**
AVP **;** e.g. less water / minerals, reaches leaf cells (for other processes)
cooling effect of transpiration does not occur
slow growth [max 1]

(iii) **I** moisture

1 leaves, rolled / curled, so, stomata on inside / humid layer builds up / moist air builds up, (in enclosed area) **;**
A less steep water potential gradient
R coiled / curved

2 trichomes / hairs, create, a layer of non-moving air around the leaf / allow humid area to build up **;**
A less steep water potential gradient

3 (leaves are), thick / succulent, to store water **;**

4 thick(er) (waxy) cuticle reduces, transpiration / water loss **;**
A makes more waterproof, **A** waxy layer for cuticle

5 reflective cuticles, reduce heat load / AW **; A** shiny cuticles reflect heat ;

6 needle-like leaves to reduce surface area (to volume ratio so less, transpiration / water loss) **;**
A small leaves
R spikes / spines, unqualified

7 layers of epidermal cells, to reduce (cuticular) transpiration / water loss **;**

8 thick walled epidermal cells, to reduce (cuticular) transpiration / water loss **;**

9 *ref. to* hinge cells, leaf curling / wilting / AW **;**
A leaves wilt to reduce exposure to the sun **;** [max 2]

[Total: 11]

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3 (a) *description*

1 activity / rate, increases to a, maximum / plateau **;**
A 'levels off' / remains constant **/** reaches V_{max}

2 increase in, activity / rate, slows **;**

3 data quote with units to support any correct statement **;**
e.g. mp 1128–132 au at 250–300 mM
e.g. mp 2 0 to 120 au between 0 and 100 mM, 120–128 au between 100 and 200 mM
A au for arbitrary units

explanation
at low / increasing, concentration of hydrogen peroxide

4 substrate / hydrogen peroxide, (concentration) is limiting (factor) **;**

5 active sites, unoccupied (low concentration) / become more occupied (increasing concentration) **;**
R active side *(penalise once)*

6 (low concentration) few collisions between enzyme and substrate / few ESC formed
or
(increasing concentration) more collisions between enzyme and substrate / increasing ESC formed **;**

at high (activity slows) / higher (plateau) concentration of hydrogen peroxide

7 enzyme / catalase, concentration / AW, becomes / is, limiting (factor) **;**

8 maximum number of enzyme-substrate complexes formed **;**
A ES complexes / ESCs

9 (all) active sites, saturated / (always) occupied **; A ora** [max 5]

(b) amino acid at position 2, is part of active site / helps to give shape to active site / helps form the structure of the active site **;**

plus one from:
idea of different, R group / side chain, gives different properties **;**
A tryptophan has a, hydrophobic / larger, R group / serine has a polar R group, different properties **;**
(slightly) different, folding of polypeptide / secondary structure / tertiary structure / active site / catalytic site / binding site **;**
suggested reasons e.g. electrons less easily transferred
ref. to induced fit , more efficient with **P ;** ora
different interactions between polypeptides (in catalase) **;** [2]

(c) 1 increased, metabolic rate / protein metabolism (after feeding) means, increased / more, hydrogen peroxide (produced) **;**

2 *idea that* less effective, catalase / **Q**, means, more hydrogen peroxide remains / less hydrogen peroxide broken down **; ora**
more hydrogen peroxide from increased metabolism is broken down faster in ***P*** *= 2 marks*

3 hydrogen peroxide, interferes with / is damaging to / AW, egg production **;**

4 AVP **;**
I *ref. to* oxygen production and use in aerobic respiration [max 2]

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(d) bind to, allosteric site / site other than active site **;**
causes change in (shape of) active site **;**
A changes shape in active site (so) substrate cannot bind (to enzyme / active site) / enzyme-substrate complex cannot form **;** [max 2]

(e) needed for, facilitated diffusion / active transport **;**
A description of active transport e.g. moving, molecules / ions, against a concentration gradient
ref. to (some) substances are, water soluble / polar / hydrophilic / ionic / charged **;**
I large cannot pass through, phospholipid bilayer / hydrophobic core **;** [max 2]

(f) **1** barrier between cell cytoplasm and, external environment / AW **;** e.g. tissue fluid
R barrier unqualified
R 'keeps cell contents in'
R 'membrane surrounds the organelles'
R barrier for water soluble substances
2 receptor for, hormone / neurotransmitter / cell signalling substance / AW **;**
A signal receptor
3 cell recognition / acts as cell surface antigen **;**
4 cell-to-cell adhesion **;**
5 site for, enzymes / catalysing reactions **;**
6 anchoring the cytoskeleton / AW **;**
7 selection of substances that enter or leave a cell **;**
R controls / regulates substances that enter cell
8 formation of hydrogen bonds with water for stability **;**
9 AVP **;** e.g. *ref. to*, changing shape of cell / flexibility of cells e.g. phagocytosis [max 3]

[Total:16]

4 **(a)** **(i)** (α 1–6) glycosidic **; A** glucosidic [1]

(ii) many, terminals / ends, for, attachment of glucose / removal of glucose **;**
glucose can be stored quickly **;**
glucose can be, mobilised / AW, when required / quickly **;**
A more easily mobilised / AW **A** glycogen can be hydrolysed easily
makes it more compact / takes up less space / high density **;** [max 2]

(iii) no branching / single unbranched chain / straight / linear **;**
different monomer / beta glucose / β glucose **; ora**
alternate position of monomers in cellulose / AW **;** e.g. rotated 180°
only one type of (glycosidic) bond / 1–4 only / no 1–6 **;**
forms hydrogen bonds with other cellulose molecules (to give parallel chains)**;**
forms, microfibrils / fibres **;** [max 2]

(b) **(i)** *max 1 for correct working if no answer or answer incorrect*

$$\frac{385\,000}{2\,000\ 000} \times 100$$

19.25 / 19.3 / 19 **;;** [2]

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(ii) **1** energy lost in processing crops to make animal feed **;**

animals
2 food, not eaten / wasted **;**
3 food, not digested / indigestible / not absorbed / egested
or
energy lost in, excretion / urea **;**
4 energy lost, in respiration / as heat **;** **A** movement / used for metabolism
5 (some) maintain constant body temperature which requires energy **;** AW

humans
6 energy lost in processing animals for human food **;**
7 (named) animals parts not edible **;**
8 AVP **;** e.g. some animals do not have enzyme to digest cellulose [max 3]

[Total:10]

5 **(a)** **I** *ref. to* walls, unqualified **I** *ref. to* vasoconstriction

nicotine
1 damages the, endothelium / (inner) lining / tunica intima **;**
2 increases blood pressure (which can damage the endothelium) **;**
3 increases risk of, blood clotting / thrombus formation **;**
A thrombosis, **A** increases stickiness of platelets

carbon monoxide
4 damages the, endothelium / inner lining / tunica intima **;**
allow even if mp1 given
5 so increases risk of, blood clotting / thrombus formation **;**
A thrombosis
6 *idea of* overall reduced oxygen supply to coronary artery walls **;**
7 AVP **;** e.g. inflammation / (increases risk of) atheroma *or* plaque *or* atherosclerosis [max 3]

(b) **(i)** (the by-pass vessels) supply (oxygenated) blood from the aorta **;**
supply oxygen to, cardiac / heart / ventricle, muscle **;**
supply, glucose / fat / fatty acids **;**
reduce / prevent, anaerobic respiration **;**
A so (muscles) can (continue to) respire aerobically
prevent death of, muscle / heart cells / heart tissue
A prevents angina [max 3]

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(ii) **I** lifestyles, healthy or otherwise
I 'better health care'

education
early education / educate children (about heart disease)
or
leaflets / posters / continuing education, about effects of heart disease **;**

diet
encourage / educate about, healthy eating / balanced diet **;**
ref. to labelling of foodstuffs **;**
tax on, sugar / fats **ora** e.g. reduce cost of 'healthy' foods
or
idea of regulation against foods with, high sugar / fat **;**
A junk food

smoking
educate about dangers of smoking / anti-smoking campaigns **;**
provide ways to stop smoking / example **;** e.g. tax on cigarettes / nicotine patches / E-cigarettes
smoking bans **;**

exercise
finance use of / build more, activity centres / AW **;**
encourage, greater activity / exercise **;**

medical
idea of, check-ups / screening population (at risk of heart disease / high blood pressure / high cholesterol) **;**

provide / subsidise, drugs to, reduce blood pressure / lower cholesterol **;**

research
funding research into heart disease **;** [max 3]

[Total: 6]

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