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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2009 question paper for the guidance of teachers

9700 BIOLOGY

9700/21 Paper 2 (Structured Questions AS), 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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International Examinations

1 (a) (i) circle around one *or* two variable regions **;** [1]

(ii) line(s) between **one** light polypeptide and **one** heavy polypeptide,
line(s) between the two heavy polypeptides **;**
maximum of six lines in each site [1]

(iii) **1** (disulfide) bonds are between, cysteine(s) / cysteine residues **;**
A between R groups S-H S-H
2 covalent bond **;**
3 strong bond / not easily broken **;**
4 hold, polypeptides / chains / protein , together **;** **R** proteins / strands
5 (in protein with) tertiary / quaternary (structure) **;**
6 maintain shape / stop loss of shape / prevent deforming **;**
A 3D structure **R** structure unqualified [3 max]

(b) **1** secreted / synthesised / produced / released, by, plasma cells / B lymphocytes / B cells **;**
2 combines / AW, with, antigens / pathogens / toxins / viruses / bacteria / microbes **;**
A 'bonds with' / 'sticks to' / 'attaches to' **R** 'disease'
3 ref to, specificity / described **;** *in context of antibody / B cells / antigen*
4 variable region is antigen binding region **;** **R** 'receptors on antibodies'
5 neutralises toxins / antitoxin(s) **;**
6 lysis of pathogens / described / lysin(s) **;** **R** breaks down
7 prevents viruses entering cells **;**
8 clumps / agglutinates / aggregates / AW, bacteria **;** **R** 'coagulation'
9 opsonisation / opsonins **;** **A** enable recognition
10 coats / AW, bacteria to facilitate phagocytosis **;** *only in context 8 or 9*
11 receptors on phagocytes for constant regions (of antibodies) **;** [4 max]

(c) **1** (carrier / channel protein for) facilitated diffusion / described **;**
A action of (co-) transport protein described
2 (carrier protein for) active transport / described **;**
3 cell recognition / distinguishing self from non-self / act as antigens / AW **;**
4 receptor **;** **A** binding site qualified in terms of, hormones / neurotransmitters / cytokines / cell signalling molecules **;**
5 T-cell receptor / described **;**
6 cell (to cell) adhesion / described **;**
7 enzyme **;**
8 form (hydrogen) bonds with, water / fluid surroundings, to stabilise membrane **;** **[3]**

[Total: 12]

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2 (a) *marking points are independent*

iodine in potassium iodide solution / I in KI solution / iodine solution **;**
R iodine / iodine test
A if 'solution' not used, but clear that it is a solution

positive result = (from yellow / red brown to) blue-black / blue / black **;**
R blue-black precipitate [2]

(b) no activity at pH 2.0 **and** pH 9.0, some activity at pH 3.0 **and** 8.0 **;**
optimum between pH 5.5 and 6.5 **;** [2]

(c) *description*
1 optimum / peak / described, at pH 6.0 **;** *allow ecf from graph*
A 'enzyme works best at' / 'most efficient at'
'rate of reaction / activity, is greatest at…'
2 low / no, hydrolysis / activity, with **at least one** correct pH **;**
3 data quote (from table) using time **;**
e.g. within 10 minutes / change within 2 minutes / 1/t

explanation to max 4 accept ora
4 at optimum pH, most successful collisions **;** **A** alternative wording

greater or less than optimum
5 high / low, hydrogen ion concentration **;**
6 enzyme denatured (fully) at / <pH2 *or* at / >pH9 **;**
7 partial denaturation / AW, at other stated value(s) of pH **;**

at any pH – optimum or sub-optimum
8 ref to, hydrogen bonds / ionic bonds **;** **R** if other bonds named
9 ref to tertiary structure **;** **A** ref to allosteric site
10 shape of active site **;**
11 detail of active site **;**
e.g. changes to charge on active site / no longer complementary to substrate forms, no / fewer, enzyme-substrate complexes [5 max]

[Total: 9]

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

(ii)
1 chromosomes / chromatids, move to / at, poles / centrosomes **;**
2 attached to, spindle / microtubules **;**
3 by, centromeres / kinetochores **; A** centromeres leading
4 pulled by, microtubules / spindle fibres / AW **;**
A contracting / shortening / disassembling [2 max]

(iii) *these points are independent*
1 cannot follow, movement of chromosomes / AW **;**
e.g. 'processes in mitosis'
2 can only view dead material **;**
3 sections have to be thin **;**
4 overstaining obscures details (of chromosomes) **; A** artefacts
5 cannot see, all of the chromosomes / whole chromosomes **;** [2 max]

(b) (i)
1 carcinogen / cancer-causing / named carcinogen (in tobacco smoke / tar) **;**
e.g. benzpyrene / phenol / nicotine *check any others*
2 mutation / change to DNA **;**
3 ref to named gene **;** e.g. oncogene / tumour suppressor
4 in (bronchial) epithelium **;**
5 uncontrolled, cell division / mitosis / cell cycle **; R** 'rapid'
6 grows into, mass of cells / lumen of airway(s) / lung tissue **;**
A squeezes against blood vessels / enters lymphatic vessels
7 growth of blood capillaries (into tumour) **;**
A angiogenesis / vascularisation / ref to thrombospondin
8 no programmed cell death **;** [3 max]

(ii) must be a sign or symptom
1 coughing up blood **;**
2 persistent cough / coughing a lot **;**
3 coughing up increased volume of sputum / AW **;**
4 chest / shoulder / back, pain **;**
5 wheezing / breathlessness / breathing difficulty **;**
6 weight loss **;**
7 AVP **;** e.g. fatigue **R** tiredness [2 max]

[Total: 10]

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4 **(a)** loss of water vapour **;**
from leaves / aerial parts of plant **;** **R** stomata unqualified
ignore evaporation [2]

(b) **1** rate for species **A** is always higher / ora for **B ;**
similarity
2 the rates of both species, increase and then decrease / reach a peak **;**
3 peak is, around midday / around noon / 11.30 to 12.30 **;**
difference
4 rate for species **B** decreases earlier than that for species **A ;**
A species **B** at ~11.45 **and** species **A** at ~12.15 +/– 5 mins
5 steeper / faster, increase / decrease, for **A ;**
6 comparative data quote for rates of transpiration **;** +/– ½ a square
A µg min^{-1} for unit [4 max]

(c) *two adaptations plus explanation – explanation may be the same for each answer*
*accept ora for species **A***

f1 sunken stomata **;** **A** stomata in, pits / chambers / grooves
f2 hairs / trichomes (on epidermis) **;** **R** needles
f3 rolled / curled / AW, leaves **;** *ignore curved unqualified*
e1 high humidity / retains moist air / high concentration of water vapour, to reduce diffusion gradient *or* water potential gradient / AW **;**
R 'moisture'

f4 small leaves / leaves are spines / leaves are needles **;** **R** spikes
R 'no leaves'
e2 reduce surface area (for transpiration) **;**
reduce SA explained but unqualified by size of leaf = 1 mark (see F9)

f5 thick leaves **;** **A** succulent
e3 reduce surface area : volume ratio **;**

f6 thick (waxy) cuticle **;**
e4 decreases permeability / is impermeable / provides **a** barrier / ora **;** **A** e5

f7 reflective cuticle **;**
f8 several layers of hypodermis **;** **A** layers of epidermis / described
f9 epidermis with thick walled cells **;**
f10 few stomata / low stomatal density **;**
e5 reduce (rate of) diffusion of water **;** **R** close of stomata [4 max]

[Total: 10]

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5 **(a)** meiosis in lowest box **;**
mitosis in the other two boxes **;** [2]

(b) larger / 80S, ribosomes **;**
mitochondria **;**
Golgi (body / apparatus) **;**
(smooth / rough) endoplasmic reticulum **;** **A** (smooth / rough) ER
vacuole(s) / vesicle(s) / lysosomes **;**
centriole / centrosome **;**
A membrane-bound organelles if no examples given
R chloroplast/ chromosomes / nucleus [2 max]

(c) *ignore any other methods of transmission given*
(spores) in droplets / moist air, coughed / sneezed / breathed, out **;** **A** aerosol
breathed in (by other person) **;** [2 max]

(d) **1** no (effective) vaccine **;**
2 HIV has a high mutation rate **;**
3 antigens change / different antigens / different strains **;**
4 no cure **;**
5 drugs, are expensive / not widely available / not effective / AW **;**
6 vertical transmission / mother to child **;**
problems with:
7 symptomless carriers (spreading the virus) **;**
8 testing people for HIV status **;**
9 providing, condoms / femidoms **;**
10 promiscuity **;**
11 educating about risks / AW **;**
12 reuse of needles **;**
13 tracing contacts (of infected people) **;**
14 testing / screening, blood donations **;**
15 treating, blood / blood products, to, destroy / inactive / 'kill', HIV **;**
16 ref to cultural issues **;** *accept relevant examples*
17 ref to poverty **;**
18 AVP **;** e.g. war / civil disturbance, out of date drugs, ref to transport links
ignore resistance of HIV [4 max]

[Total: 10]

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6 (a) 'self contained' / 'self-sustaining' / determined by same physical feature / defined area **;**

community / all organisms / biotic factors, **and**, physical factors / abiotic factors / non-living factors / environment **;**

ref. to interaction between, organisms (and physical environment) **;** [2 max]

(b) *award two marks for the correct answer (5.5%)*
if no answer or incorrect answer or answer to too many decimal places, award one mark for working (88 / 1609)
88 / 1609 (× 100)
5.5 (%) **;;** [2]

(c) *these are points for producers to primary consumers – accept ora for secondary consumers to tertiary consumers*
1 some parts inedible **;**
2 indigestible / cannot digest cellulose or lignin **;**
3 more material goes to decomposers (rather than consumers) **;**
4 plant material is less energy rich / animal flesh is more energy rich **;**
5 manipulated data in support **;** e.g. ×2 to decomposers from producers
0.8% (energy available to primary consumers divided by the energy available to plants)
[3 max]

(d) *decomposers in recycling nitrogen*
protein → ammonia / ammonium ions = 1 mark
1 convert protein → amino acids **;**
2 deamination **;**
3 urea / amino acids → ammonia / ammonium ions **;** **A** ammonification
4 make, ammonia / ammonium ions, available to nitrifying bacteria **;**
A role of nitrifying bacteria / correctly named [2 max]

[Total: 9]

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1 (a) (i) calcium ions are, water soluble / charged / not, fat / lipid, soluble / hydrophilic / ionic **;** **A** not oil soluble
phospholipid bilayer / AW, is hydrophobic / AW **;** [2]

(ii) active transport / active uptake **;** [1]

(calcium ions) moved against their concentration gradient **;**
ref. to, carrier protein / transport protein / pump protein **;** **ignore** ion pump
R channel protein
ref. to calcium ions combine with binding site **;**
carrier protein, changes shape / conformational change **;**
ref. to ATP **;** [2 max]

(b) bacteria / antigen / epitope, combine(s) with / attach to/ recognition by, receptor **;**
antibody on bacteria combines with receptor **;**
opsonisation / opsonisation described **;** e.g. facilitates phagocytosis
ref. to constant region **;**

membrane infolds / invaginates / envelops / engulfs / enclose / AW **;**
accept answers without 'membrane' where implied previously / later
membrane fuses **;**
to form, vacuole / vesicle / phagosome (enclosing bacteria) **;** [3 max]

(c) lysosomes fuse with, vacuole / vesicle / phagosome **;**
A form secondary lysosomes
lysosomes contain, enzymes / named digestive enzyme **;**
(catalyse) hydrolysis / digestion **;** **A** breakdown
(digests / breaks down) protein / murein (or peptidoglycan) / carbohydrate / lipid / phospholipid / nucleic acid / DNA / RNA **;**
named bond **;** e.g. peptide, glycosidic, ester, phosphodiester [4 max]

[Total: 12]

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2 **(a)** denature, sucrase / enzyme **;** **A** deactivate
stop the reaction (in each tube at the same time) **;**

idea that Benedict's test requires a high temperature **;**
ref to reducing sugars **;** [2 max]

(b) starts at, the origin / 5 g dm^{-3}, increases to 45–55 g dm^{-3} **;**
constant from 80 to 100 g dm^{-3} **;** [2]

(c)

description	*conc*	*rate**
	5	0.0036
	10	0.0069
	15	0.0105
	20	0.0133
	50	0.0213
	100	0.0222

penalise lack of units once only

1 increase in rate of hydrolysis to approx 50 g dm^{-3} **;**
A decrease in time taken to approx 50 g dm^{-3} / correct rate calculations* to show an increase
2 remains constant / plateaus / levels out / AW, from approx 50 g dm^{-3} to 100 g dm^{-3} **;**

explanation to max 4
3 (sucrase / enzyme) hydrolyses / breaks , glycosidic bonds **;**
4 forming, reducing sugars / glucose / fructose **;**

5 *idea that* concentration is the limiting factor, at low concentration of, sucrose / substrate **;**

6 (at low concentrations) active sites, unoccupied / available **;**
A as concentration increases, more active sites are occupied / more enzyme-substrate complexes formed / AW

7 at higher concentrations all active sites, occupied / saturated / AW **;**
R enzymes for 'active sites'
8 substrate, in excess / AW **;**
9 V_{max} reached / working at maximum rate **;**

idea that
10 at higher concentrations, enzyme / sucrase, is the limiting factor **;** [5 max]

[Total: 9]

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3 **(a)** so they have the same number of chromosomes (as parent cell) **;**

idea that cells would be rejected (if genetically different) **;**
ref. to role of the immune system in removing genetically different cells **;** [2]

(b) *reject 'smoking' or 'radioactive transmissions' unqualified*

(chemical) carcinogen(s) / named **;**
any two named chemical carcinogens to max 2 if term carcinogen not used
e.g. benzpyrene / ethidium bromide / phenol / tar *check any others*

UV **;**
X rays **;**
ionising radiation **;**
gamma rays **;**
radon **;**
virus(es) / correctly named virus **;** **A** HIV / HPV / HTLV / HSV **R** named disease
genetic / hereditary, factors **;** [2 max]

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

(ii) chromosomes, uncoil / become diffuse / decondense / AW **;**
A chromosomes unwind / become long and thin
A chromosomes become chromatin
A cell enters interphase
spindle breaks down / microtubules disassemble / AW **;** **R** disappears

nuclear envelope, reforms / forms / forming **;** **A** nuclear membrane **R** (re)appears
nucleolus / nucleoli, reform(s) / forms / forming **;** **R** (re)appears

cell membrane, drawn together / furrows / AW **;**
idea of role of, microfilaments / AW, in 'drawstring' effect **;**

division of cytoplasm / cell separation / cleavage / cleavage furrow develops **;**
A cytokinesis *if not credited in* ***(i)***
cell membrane fuses **;** [3 max]

(iii) divide / replicate, uncontrollably **;** **ignore** quickly / fast
A uncontrolled mitosis **R** grow uncontrollably
do not, differentiate / become specialised **;** **A** loss of function
form an (irregular) mass (of cells) / AW **;** **A** (a) growth
promotes growth of blood vessels / AW **;**
AVP **;** e.g. ref to genes / no programmed cell death / loss of contact inhibition [2 max]

[Total: 10]

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4 (a) (i) moist / AW, surface of mesophyll cells **;**
water evaporates / evaporation **;** *in correct context*
from spongy mesophyll cell walls **;**
into (intercellular) air spaces **;**
air within leaf is fully saturated **;**
water vapour diffuses through stomata **;** **A** 'water' if evaporated

down water potential gradient / from a high to a low water potential / from less negative to more negative water potential [3 max]

(ii) mass / water, loss increases from 0400 to 1600 and then decreases **;**
0.3–4.4 g h^{-1} **;** **A** other correct comparative data quote with units

mass / water, uptake increases from 0800 to 1900–1930 and then decreases **;**
0.8–0.9 – 3.4 g h^{-1} **;** **A** other correct comparative data quote with units

rate of, mass / water, loss peaks before rate of water uptake **;**
A description related to light (mass loss) and dark (uptake)
data quote for times of peaks for both rates **;** 1600 and approx 1900

0600 to 1600 rate of mass loss, ref. to steeper gradient **;**

(rate of) mass / water, loss is higher than uptake, between 0700 and approx 1830 **;**
A ora [4 max]

(b) cohesion-tension **;**
cohesion / AW between water molecules **;**
hydrogen bonds **;** *accept here or for adhesion once only*
transpiration pull / water is pulled up the xylem / water in a continuous column **;**

ignore negative / hydrostatic pressure

adhesion to (cell) walls **;**
water molecules 'stick' to cellulose / cellulose is hydrophilic **;**
A lignin (although it is hydrophobic!) [3 max]

[Total: 10]

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5 (a) (i) **H** nucleolus **;**
J Golgi (body / apparatus) **;**
K cell wall **; R** murein / peptidoglycan **ignore** cellulose or chitin
L vacuolar membrane / vacuole **; A** tonoplast **R** cell sap [4 max]

(ii) no double membrane-bound organelles **;**
no, nucleus / nuclear membrane / nuclear envelope / nucleolus **;**
A DNA lies free in the cytoplasm
no mitochondrion **;**
mesosomes **;**
no (large) vacuole **;**
no, ER / RER / SER **;**
no Golgi (body / apparatus) **;**
smaller / 70S / 18nm, ribosomes **;**
cell wall made of, murein / peptidoglycan / different compounds (from eukaryote) **;**
circular DNA / plasmid(s) / no linear DNA **;**
no histones / not complexed with proteins **; A** naked DNA / no chromosomes
AVP **;** e.g. pili / no 9+2 microtubule pattern [2 max]

(b) nucleus, transcription / described as DNA to complementary RNA code / AW **;**

nuclear pore, mRNA to, cytoplasm / ribosome / RER **;**
RER / ribosome, assembly of amino acids / translation / polypeptide *or* protein synthesis **;**
RER, transports protein to Golgi (apparatus / body) / modifies protein **;**

Golgi adds, carbohydrates / sugars, to proteins **; A** glycosylation
A post translational modification / other e.g.s
Golgi, packages protein / makes vesicle(s) **;**

(Golgi) vesicle fuses with cell (surface) membrane **;**

mitochondrion, provides / produces / synthesises, ATP *in correct context* **;** [4 max]

[Total: 10]

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6 (a) *community*

all populations / all organisms / all plants + animals (+ microorganisms) **;**
R all the species

in same, place / ecosystem / area / (common) habitat, (at same time) **;** [2 max]

(b) (i) *award two marks for the correct answer (4.5%)*

if no answer or incorrect answer or answer to too many decimal places, award one mark for working (2946/65 800 × 100)

2946 / 65 800 (× 100)

4.5 (%) **;;** [2 max]

(ii) energy available (from secondary consumers) is too small **;** **R** no energy
2 kJ m^{-2} (per week) **;** [2]

(iii) decomposers are, saprophytes / saprotrophs / saprobionts / bacteria / fungi **;**

plant matter provides little, protein / AW **;** ora **A** high carbon / low nitrogen
plant matter / cellulose / lignin, not easy to decompose **;**
ref. to organic matter / energy source, in plants not easy to obtain **;**
supply of nitrogen is, limiting factor / limits growth of decomposers **;**
(animal waste) protein / amino acids / urea, provides nitrogen **;**
(animal wastes) provide materials for growth of, decomposers **;**
further detail e.g. amino acids for proteins / membrane proteins / (hydrolytic) enzymes / other named protein(s) / nucleotides / nucleic acids **;**

more decomposers leads to faster decomposition (hence more energy flow) **;** [3 max]

[Total: 9]

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