CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2013 series

9700 BIOLOGY

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

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;	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 excepted)
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

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1 (a) (i) **A –** endothelial / squamous / epithelial (cell) **;**
B – nucleus **;** [2]

(ii) 7 (μm) **;;**
award two marks if correct answer given
award one mark if not rounded to nearest whole number
award one mark if given incorrect unit
if no answer given, award one mark if correct measurement (38–41 / 3.8–4.1 / 38000–41000) is divided by 5700 [2]

(iii) *for two marks - one structure and one function*
only two functions = 1 mark
only two structures = 1 mark

1 (capillary) wall is, thin / single layer of cells / one cell thick **;**
A endothelium / epithelium for wall
2 short diffusion, pathway / distance / AW **;**
R 'easy' diffusion
3 (many have) endothelial pores / fenestrations / gaps / spaces / openings **;**
4 to allow named, substance / cell, to leave the blood **;**
A *idea* of separation / selection, of named substance(s) by size
5 small diameter / small lumen / diameter of red blood cells **;**
6 slows down flow of red blood cells / (capillary / blood) close to cells **;**
7 (capillaries have) large, surface area / surface area to volume ratio **;**
8 *idea that* allows more exchange **;**
Ignore faster exchange [max 2]

(b) *white blood cells*
1 (named) white blood cells can, leave capillaries / enter tissue fluid **;**
A diapedesis / (suggestion that some) too large to leave the, blood / capillaries
2 high number in, lymph nodes / thymus / bone marrow / spleen **;**
A stored / produced

g*lucose*
3 small (molecule) **;**
4 filtered / diffuses / leaves / leaks, from blood / from capillaries / into tissue fluid **;**
5 taken up / used, by cells in respiration **;**
Ignore supply

p*rotein*
6 too large to, leave capillaries / enter lymph / enter tissue fluid **;**
7 (in lymph / tissue fluid) antibodies / proteins, from / secreted by, lymphocytes / other cells **;** [max 5]

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(c) *accept hydrogen carbonate (ions) / bicarbonate (ions) / HCO_3^- penalise HCO_3 once only*

1 carbon dioxide, reacts / combines, with (terminal amine / **N** terminal, of) haemoglobin **;**
R carried by / reacts with, haem

2 to form carbaminohaemoglobin **;**

3 carbonic anhydrase catalyses, formation of carbonic acid (H_2CO_3) / reverse reaction described (in the lungs) **;**

4 (carbonic acid dissociates to) HCO_3^- / CHO_3^- / hydrogen carbonate (and H^+) **;**

5 hydrogen carbonate / HCO_3^-, diffuses / moves / AW, out (into plasma) **;** [max 3]

[Total: 14]

2 **(a)** (infected) person, sneezes / coughs / talks / breathes out, (airborne) droplets / aerosol / moist air **;**
ignore contact
inhaled / inspire / breathed in, by uninfected, person **;**
ignore transplacental transmission [2]

(b) **(i)** *variable region*
binds / attaches / combines, to antigen **;**
R receptor site **R** 'fit'
ref. to specificity **;**
ignore complementary shape (to antigen)
R same / similar shape [max 2]

(ii) *disulphide bond*
ignore ref. to hinge

holds, polypeptides / heavy chains / long chains, together **;**
i**gnore** constant as description of chains
maintains, tertiary / quaternary / 3D, structure / shape **;**
R shape unqualified [max 1]

(iii) *constant region*
binds to, receptors / cell (surface) membrane, on, phagocytes / macrophages **;**
antigen, marking / tagging, for, phagocytosis / macrophage action **;** AW
A ref. to opsonisation
R agglutination [max 1]

[Total: 6]

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3 (a) **R** CO_2 diffusion is a consequence of transpiration
stomata open(ings) to allow carbon dioxide in **;**
carbon dioxide required for photosynthesis **;**
ignore ref. to oxygen
water vapour diffuses out through stomata **;**
A water if evaporation (from mesophyll walls) described
A water as a gas [3]

(b) **1** both show, little / low / lowest, transpiration, at night / 22.00 to 24.00 / 00.00 to 04.00 **;**
2 both, increase to / peak, at mid day / 12.00 **;**
3 ref. to second peak at 16.00 **;**
4 both, dip / decrease, at 14.00 **;**
5 transpiration (always) lower for trees at exposed site / ora **;**
6 both decrease from 16.00 **;**
for mps 1–4 and mp 6, allow a description at one site only
R if contradictory description given for the other site
7 comparative data quote to support above marking points **; ;**
8 to compare the transpiration rate at two locations at the same time
or transpiration rate at one location at different times
to award data marks arbitrary units (au) must be used at least once [max 5]

(c) *identification of the following features*
1 stomata close (for longer), during the day / when hot / when dry **;**
2 stomata in pits / sunken stomata **;**
3 stomata only on lower surface of the leaf **;**
4 hairs / trichomes **;**
5 low number of / few(er) / less, stomata (per unit area) **;**
ignore 'less open stomata'
6 thick(er) cuticle**;**
7 reflective cuticle (on upper epidermis) **;**
8 thick(er) epidermis / more than one layer of epidermal cells **;**
9 curled / rolled / AW, leaves **;** [max 3]

[Total: 11]

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4 (a) **J** thymine ;
K guanine ;
L hydrogen bond ;
ignore H / H_2 bond [max 3]

(b) **1** zidovudine , competitive inhibitor and efavirenz , non-competitive ;
2 zidovudine, complementary to active site ;
3 efavirenz, binds to allosteric site / reference to allostery ;
4 efavirenz changes the, shape / structure, of the active site ;
A denatures / changes tertiary structure so substrate will not fit
R changes shape unqualified
5 *either*
the effect of zidovudine is, reduced / reversed, by increasing the substrate concentration
or
the effect of efavirenz is not, reduced / reversed, by increasing the substrate concentration ; [max 4]

(c) **1** virus may be resistant to one or more of the drugs / very low chances that HIV is resistant to all of the drugs ;
R virus immune
2 (resistance due to) change to, active site / allosteric site / tertiary structure, of enzyme ;
A drug can no longer fit into active site
3 some drugs may be more effective than others / AW ;
4 reduces risk of drug resistance developing ;
5 HIV, has a high mutation rate / changes surface proteins / changes antigens ;
A antigen(ic), shift / drift
6 person may have mixture of strains of HIV ;
7 *idea that* virus will be at different stages in its, life / replication, cycle ;
8 AVP ;
e.g. more than one competitive to reduce chances of, ES complexes / AW
drugs work better in combination / synergy idea
drugs inhibiting two different enzymes, so more effective [max 2]

(d) **1** antibiotics are not effective against HIV *or* viruses / antibiotics are effective against, (named) bacteria / bacterial disease ;
A fungi / protoctists / protists / malaria
R antibiotics prevent infection
2 *idea that* viruses have no, sites / targets, where antibiotics can work ;
3 viruses have no, cell walls / ribosomes / cell membranes ;
A have different enzymes
4 viruses are within cells, *idea that* antibiotics cannot reach them ;
5 people with HIV are more susceptible to bacterial infections / reference to immune suppression / weak immune system ; [max 2]

[Total: 11]

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5 (a) P – moves, polar substances / hydrophilic molecules / ions, through membrane / in *or* out (of cells) **;**
A facilitated diffusion / active transport / described
Q – receptor / recognition site / cell recognition / binding site **;**
A cell adhesion / 'receives' named signal
A stabilises membrane (as forms hydrogen bonds with water)
R – regulates / AW, fluidity of, membrane / (phospholipid) bilayer **;**
A contributes to hydrophobic layer / impermeability to ions [3]

(b) 7.0 nm **;** [1]

(c) *fluid*
idea of <u>phospholipid</u> (and protein) molecules, move about / diffuse (within their monolayer) **;**

mosaic to max 1
protein (molecules), interspersed / scattered / not a complete layer / AW **;**
different / AW, proteins (molecules) **;** [max 2]

(d) 1 water molecules are polar **;**
R hydrophilic / charged
2 *idea that* few polar molecules pass through the <u>phospholipid</u> (bilayer) **;**
ora for non-polar molecules
A none pass / repelled
3 core of membrane / phospholipid tails, are hydrophobic **;**
A hydrophobic core
4 channels (through aquaporins), are hydrophilic **;**
A core of channel proteins / described as R-groups of amino acids
5 (aquaporins) increase <u>permeability of membrane</u> to water **;**
6 example **;**
e.g. root hairs / small intestine epithelium / nephron
7 role of water in a cell **;**
e.g. solvent / reactant / reaction medium / turgidity *or* support in plant cell
ignore references to osmosis / bursting / crenation / regulation [max 3]

[Total: 9]

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6 (a) ref. to mutation(s) **;**
in context of initiating uncontrolled mitosis OR as a consequence of uncontrolled mitosis
proto-oncogenes convert to oncogenes / oncogenes switched on / tumour suppressor genes switched off **;**
(cell division is by) mitosis **;**
formation of, tumour / mass of (unspecialised) cells **;**
no response to (extracellular / intracellular) signals to control mitosis / AW **;**
no contact inhibition / AW **;**
no cell death / no apoptosis **;**
immune system does not recognise the cells as foreign and destroys them **;**
A reference to, not non-self / self
metastasis / described **;** [max 3]

(b) **R** way in which cancer develops / epidemiological evidence
A beagles for dogs

1 tar painted on skin of, mice / rabbits / rats / (small) mammal, led to development of (cancerous / malignant) tumour **;**
2 dogs that smoked (plain) cigarettes developed, cancer / tumour **;**
3 dogs that smoked filter-tipped cigarettes did not develop cancer / tumour **;**
A developed precancerous changes
4 control group / dogs, which did not smoke and did not develop, cancer / tumour **;**
5 AVP **;**
e.g. evidence from any other named mammal
e.g. inhaling substances from, tar / tobacco [max 3]

(c) *similarities*
1 all (named) countries, increase and decrease / reach a peak and decrease **;**

differences
2 peaks / AW, have occurred at different years in at least two countries **;**
3 all maximum mortality rates are different **;**
4 any comparative, data quote / calculation, with units given at least once **;**
e.g. dates and mortality rates for at least two countries
e.g. mortality rates for one country at two different dates [max 3]

accept a range or a single figure within the ranges given

countries	peak mortality rate	year
USA	53–57	1984–1990
Spain	45-48	1993–1997
Finland	69–71	1970–1973
UK	72–75	1970–1975
Hungary	83–87	1996–2000

[Total: 9]

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1 (a) (i) *if one box of a pair left blank, no mark for that row*
mark first on row unless one row left completely blank

	mitosis	*meiosis*
1	diploid / two chromosome sets / 2n	haploid / one chromosome set /n **;**
2	same number of chromosomes as parent / AW	half the number of chromosomes as parent / AW **;**
3	two, copies / alleles / forms, of each	one, copy / allele / form, of each **;**
4	(cells) genetically identical (to, each **A** (cells have) same / AW, DNA / **A** no genetic variation	(cells) genetically different **A** (cells have) different / AW, DNA / genetic material **A** genetic variation **;**

[max 2]

(ii) 1 for sexual reproduction **; A** for, gamete / sperm and egg / pollen and ovum, formation *or* **A** gametogenesis

2 to produce, haploid cells / cells with one set of chromosomes, for, fertilisation / fusion **; A** to form zygote
A cells with half the number of chromosomes for, fertilisation / fusion

3 restores / AW, diploid / original, number when, fertilisation / fusion (of gametes) occurs **;** *only need ref. to fertilisation / zygote once*

4 *idea of* ploidy consequences at fertilisation if not **;**
e.g. ref. to doubling of chromosome number of original

5 ref. genetic variation, linked to evolution / natural selection**;** [max 2]

(b) (i) 13 μm **; ;** *two marks for correct calculation*
(39 000 / 3000)
allow one mark
if calculation of 12.6 μm or 13.3 μm (i.e. measured as 38 mm or 40 mm and not rounded to nearest micrometre)
measurement of, 39 mm / 3.9 cm, incorrectly converted to μm but correct formula used (i.e. divided by 3000) [2]

(ii) *assume cancer cell unless stated otherwise*
(undergoing) uncontrolled, mitosis / division **; A** fast / rapid / abnormally

mitochondria, provide / produce, ATP **;** **R** ATP energy
A provide energy **R** produce energy

RER, produce / synthesise / make / AW, (more), proteins / enzymes, for (cell) growth / mitosis / division **;** *if mp 1 gained, no need ref. to mitosis* [max 2]

[Total: 8]

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2 (a)

1	transport of water and mineral ions **;** **A** minerals
2	elongated cells / cells end to end (to form) tubes for transport **;** **A** (e)long(ated) tubes for transport
3	no, end / cross, walls *or* end / cross, walls broken down so minimal resistance to / unimpeded / free, flow of water **;** AW
4	hollow / no cytoplasm / no contents / no organelles / empty, *ignore* dead so more space for greater volume to flow / greater volume per unit *or* minimal resistance to / unimpeded / free, flow of water **;** AW
5	cellulose lining **A** cellulose walls so hydrophilic / adhesion of water molecules / for movement of water up stem / to maintain column of water / AW **;** **A** hydrophilic lining, for movement of water up stem / to maintain column of water
6	lignified (walls) / walls contain(s) lignin **A** thickened walls **R** lined with lignin so prevents (inward) collapse / withstands negative pressure **R** prevents bursting
7	lignified (walls) / walls contain(s) lignin **A** thickened walls **R** lined with lignin so waterproof / prevents loss of water / prevents leakage / maintains column
8	additional ref. to lignin **;** e.g. for support of plant spiral / annular, thickening allows elongation (of stem) for support of plant
9	pits / pitted walls to allow, sideways / lateral, movement (of water) *or* to connect to all parts of plant / AW **;**
10	relevant ref. to diameter of lumen **;** e.g. narrow, for adhesion **R** capillarity (relatively) wide to transport maximum volume of water

[max 5]

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(b) *look for ora*

1 can observe living tissue **;** **A** observing processes (e.g. like mitosis)

2 ref. portability **;** e.g. ref. to size, easy to move, no requirement for special room (e.g. vibration-free)

3 ease of use, qualified **;** e.g. no technical training required, slide preparation easier, takes less time

4 see (actual / natural / real-life) colour **;**

5 ref. to, differential staining / staining particular types of tissue **;**

6 fewer problems with artefacts **;**

7 lower cost of, purchase / maintenance / running / AW **;** [max 2]

[Total: 7]

3 **(a)** **1** caused by, a pathogen **;**

2 transmissible / communicable **;** **A** passed from, person / animal, to person
ignore contagious

in context of tuberculosis

3 (pathogen is) a bacterium / *Mycobacterium (tuberculosis / bovis)* / *M. tuberculosis* / *M. bovis* **;**

4 mode of transmission detail **;** *one from*
aerosol / droplet, infection / transmission
in droplets, from (infected) person, exhaling / AW / coughing / sneezing / talking in droplets, / inhaled / AW, by (uninfected) person
person, drinks (unpasteurized) milk / eats meat, from infected cattle
if both of these given this is also mp 2

A contaminated, milk / meat [max 3]

(b) **1** kill bacteria / bactericidal **;** **A** cause bacteria to, lyse / burst **A** destroy

2 (or) bacteriostatic / prevents bacterial growth / prevents bacterial replication**;**
A ref. to preventing protein synthesis / inhibiting metabolic reactions

3 ref. to preventing spread (of bacteria) within body **;** **A** prevents reservoir for re-infection

4 do not affect, human cells / human tissue / not toxic (to humans) **;**

5 prevents death / consequences may be fatal if no antibiotic treatment / AW **;**
A ref. to, alleviating symptoms / faster recovery
A restores good health / person feels well again / person cured

6 ref. to role in preventing, transmission / spread, of disease **;** *do not confuse with mp 3*

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7 ref. to (antibiotic) treatment of TB **;** e.g.
one of isoniazid, rifampicin (rifampin), pyrazinamide, ethambutol, streptomycin
one of 6–12 months (latent), longer for active disease, two years or more for drug-resistant forms
need combination treatment if active disease
ref. to, MDR-TB / multidrug- resistant TB *or* XDR-TB / extensively drug-resistant TB

8 part of DOTS regimen / described **;**
(directly observed therapy short-course / direct observation treatment short course)
[max 4]

(c) 1 statistical, correlation / link / association, between smoking and TB **;** AW
A another valid suggestion in addition to mps 2-6 suggesting link

2 where TB, cases / death rates, are high tobacco smoking is also high **;**

3 in areas where there is, no overcrowding / AW, smokers have higher number of TB cases **;**

4 (ref. projects) death rates from TB reduced where patients stop smoking **;**

5 higher cases TB in work places where smoking occurs **;**

6 higher cases of TB in children living with parents who smoke **;** [max 2]

(d) 1 lack of / paralysed / AW, cilia, so mucus, not wafted away / accumulates **;**

R dead cilia

2 pathogen / bacteria / *Mycobacterium*, remains in lungs / accumulates **;**

3 ref. to increased opportunity / AW, for bacteria to, enter cells / infect **;**

4 nutrients provided by excess mucus encourage growth **;** AW

5 smoking weakens the <u>immune</u> system **;**

6 detail **;** e.g. fewer / less active / AW, phagocytes / macrophages [max 3]

(e) coronary bypass (surgery) / coronary artery bypass (graft) **;**
A bypass, surgery / graft / operation
R heart bypass
heart transplant **;**
angioplasty **;**
stent (insertion / AW) **;** [max 2]

[Total: 14]

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4 **(a)** glycosidic **;** **A** glucosidic [1]

(b) **A** = trehalose **;**
B = maltose **;**
C = cellobiose **;**
D = sucrose **;** [max 3]

(c) **1** *idea of* separation / barrier / AW, from surroundings / external environment **;**

2 regulates / controls / AW, entry / exit, substances / named substances **;**

3 enables recognition of self (antigens) / cell recognition / avoids cell destruction / act as antigens / AW **;**

4 allows binding of / receptors for, hormones / signal molecules / neurotransmitters / antigens **;**

5 cell to cell adhesion **;**

6 location for enzymes / multi-enzyme systems / enzyme pathways **;**

7 AVP **;** e.g. idea of flexibility (for some cells,
ref. glycoproteins / glycolipids, form H bonds with water for stability [max 3]

(d) **(i)** **1** active site has, specific / particular, shape **;**

2 complementary to substrate **;** **A** substrate fits into active site

3 ref. to (some enzymes) induced fit mechanism **;** **A** described

4 formation of enzyme-substrate complex **;** AW

5 lowering, activation energy / Ea **;** **A** detail of how activation energy lowered
e.g substrates held close together for bond formation
facilitates transfer of electrons
places strain on bond(s) to be broken [max 3]

(ii) **1** loss of tertiary structure **/** hydrogen bonds broken / ionic bonds broken **;**
R if include disulfide or peptide bonds

2 changes shape / substrate unable to fit, active site**;** **A** enzyme changes shape so alters active site

3 loss of / AW, <u>globular</u> structure **;**

4 hydrophobic groups to outside of molecule **;**

5 hydrophilic groups no longer interact with water / AW **;** [max 2]

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(e) *penalise once for no units*

1 with no cryoprotectant, enzyme (remains), inactive / AW **;**
A at 0 mmol of cryoprotectant, 0% (of maximum) activity

2 for both, increasing concentration increases % (enzyme) activity recovered **;**
A comparative data quote with ref. to increase *need units*

3 trehalose, steeper curve / AW, up to 10 mmol (cryoprotectant) **;** ora **R** rapid

4 at all concentrations (below 90 mmol), trehalose has higher percentage of (maximum enzyme) activity

5 comparative data quote to support either mps 3 or 4 **;**
for mp 3 trehalose from 0 to 80% and glycerol from 0 to 10%

6 both cryoprotectants can produce,100% / maximum, (enzyme,activity / recovery) **;**

7 trehalose produces, 100% (enzyme) activity / full (enzyme) recovery at,
lower concentrations than glycerol / 30 mmol
compared to, 90-100 (mmol) **;** *this is also mp 6*

8 trehalose more effective than glycerol (up to 90 – 95 mmol cryoprotectant) **;**
A trehalose is a better cryoprotectant (than glycerol) [max 4]

[Total: 16]

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5 **(a)** *three from* **;;;**
allow mps without naming DNA / RNA if already gained in previous point
must be comparison statement per row
mark first comparison per row unless one row left blank

	DNA replication	*DNA transcription*
1	DNA, formed / AW	mRNA / pre-mRNA (transcript) , (formed)
2	two (identical) DNA molecules formed	one mRNA molecule (formed)
3	product double-stranded DNA	product single stranded (m)RNA
4	all of DNA molecule, replicated / unwinds / involved	part of DNA molecule / gene, involved
5	both strands involved	one strand (involved) *treat ref. to sense / antisense strands as neutral*
6	(involves / uses) DNA polymerase	RNA polymerase
7	(free) DNA nucleotides, required / used	RNA nucleotides
8	(process involves complementary) base pairing A–T *ignore* C–G	(complementary) base pairing A–U
9	takes place in late interphase / S-phase / synthesis phase	takes place throughout interphase
10	important in, cell division / mitosis / meiosis	for, polypeptide / protein, synthesis

[max 3]

(b) change / alteration / AW, in sequence / order / arrangement, of, bases /nucleotides (of DNA / gene) **;** change to give a new allele **;**

one additional detail **;**
(may result in) altered, changed / non-functioning / no, polypeptide / protein
ref. to changed genetic code / different codons
different sequence of amino acids / different primary structure
named type of mutation
example e.g. HbS [max 2]

(c) **(i)** ref. specificity **;** *in context of the immune response*
qualified **;** e.g. existing , (B / T) lymphocytes / B-cells / T-cells, no longer activated / no recognition ora
R if T lymphocytes produce antibodies
existing plasma cells do not produce new antibody ora
existing memory cells no longer activated / AW ora
different / new, immune response required ora [2]

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(ii) artificial active / active artificial / active acquired artificial / acquired active artificial **;** [1]

(d) *penalise once if not worded as a problem*

1 ref. malnourishment / poor diet, vaccine ineffective / poor immune response / insufficient protein for antibody production **;**

2 some (healthy) people do not respond to vaccines **;**

3 one-dose not always effective / problems administering boosters **;** AW

4 ref. percentage cover / herd immunity, insufficient **; A** description
A idea of people in rural areas have less / no, access to vaccine
A people avoid vaccine, worry about side-effects / other reason

5 ref. cost to authorities **;** e.g. of, administering vaccination programme

6 people in some areas cannot afford to buy vaccine

7 vaccine may not be thermostable **;** AW

8 high density of population / overcrowding, increases chance of spread **;** [max 2]

[Total: 10]

6 **(a)** *all correct* **;;;**

event	*sequence*
Purkyne tissue conducts the wave of excitation	4
atrioventricular node sends out a wave of excitation	3
atria contract	2
ventricles contract	5
sinoatrial node sends out a wave of excitation	1

if not correct sequence, mark to max 2
SAN = 1 **;**
atria contract before ventricles **;** [max 3]

(b) left ventricle pumps blood to the body**,** right ventricle pumps blood to the lungs **;**
(left) round the body further distance / (right) to lungs shorter distance **;** AW
(left) greater force required / (right) less force required **; A** (left) blood needs to be pumped at a higher pressure / (right) blood needs to be pumped at a lower pressure
A needs to overcome greater resistance
less force / lower pressure, to lungs, to prevent damage to capillaries **;** [max 2]

[Total: 5]

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1 (a) **A** = chloroplast **;** **A** granum / grana
B = (intercellular) air space **;**
C = nucleolus **;** **A** nucleus [3]

(b) *two marks for correct answer*
9 (μm) **;;**
award one mark if not to nearest micrometre, 9.3 / 9.28
or correct measurement incorrectly converted but correct formula used
64 / 65 / 66 mm ÷ 7000 [2]

(c) **1** phospholipid bilayer **;**
A lipid bilayer
2 phospholipids have, phosphate / hydrophilic, heads, and, hydrophobic tails / fatty acid chains **;**
3 ref. to, labile nature of bilayer structure / phospholipid (molecules) moving (within their monolayer) **;**
4 protein molecules, interspersed / scattered / not a complete layer **/** AW **;**
5 many / AW, different / AW (protein molecules) **;**
6 example of type of protein **;**
7 *idea of* (most) proteins, moving / not in fixed position **;**
8 reference to cholesterol **;** [max 4]

(d) **1** ref. to movement, down water potential gradient / from high(er) to low(er) **;**
2 apoplastic / cell wall, pathway from xylem to cell walls of (palisade mesophyll) cells **;**
3 ref. to osmosis **;** *in context of* movement, into cell / through cell surface membrane / through tonoplast,
R osmosis from xylem to vacuole
4 symplastic / cytoplasmic, pathway (within cell) **;**
5 via plasmodesmata **;** *in context of water arriving from adjacent cell*
6 ref. to channel proteins / aquaporins **;**
7 solutes / named, in vacuole **;** [max 3]

[Total: 12]

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2 (a) (i) cells have machinery for protein synthesis / AW ;
A plant / animal, cells have RER
(assumption that) cells will continue to produce protein at high rate ;
large number of / many / AW, ribosomes ;
available supply of / AW, amino acids ;
ref. to presence of tRNA molecules ;
ATP available ;
ref. to easier to harvest high levels of protein ; [max 2]

(ii) *idea that* any added mRNA, has easier access to / can reach, ribosomes / RER ;
so that the cell's own, DNA / mRNA can be accessed / AW ;
easier to, harvest / extract, protein products ; [max 1]

(iii) only the desired protein is produced / AW ; ora
unwanted protein does not have to be separated from desired protein ;
idea that inefficient process if translation machinery used to produce other proteins ;
cell's proteins may, inhibit / affect / hinder / AW, process ; [max 1]

(iv) ref. to ribosome function not altered ;
R ref. to prokaryotic and eukaryotic ribosomes being the same
mechanism of translation / described, is the same in all cells ;
e.g. tRNA can respond to introduced mRNA
all types of cells use mRNA for protein synthesis ;
mRNA only has one role ;
genetic code / codons, are the same in all cells ;
A genetic code is universal
mRNA, contains only exons / introns removed, so translation can occur ; [max 2]

(b) different, structure / rRNA, (of ribosomes) ;
(ribosomes), larger / 80S, in eukaryotes *or* smaller / 70S in prokaryotes ;
(some) attached to / AW, (eternal surface of) RER in eukaryotes ; ora
A only found in cytoplasm in prokaryotes [max 2]

(c) other organelles / components, damaged *or* whole cell all organelles intact ;
some, ribosomes / RER, lost / damaged ;
idea that cell-free system is disorganised ; ora
fewer amino acids available ; ora
no / reduced, respiration ; AW
other, components / AW, required are, lost / at lower levels ;
organelles / components, not replaced ; ora
ref. to difficulty in creating identical conditions to cell environment ;
may be able to use cells that can replicate (hence continuous production) ;
AVP ; [max 1]

[Total: 9]

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3 (a) (i) **A =** denitrification / reduction **;**
B = nitrogen fixation / lightning **;**
C = nitrification / oxidation [3]

(ii) decomposition / decay **;**
A reference to decomposers
saprotrophs / bacteria / fungi **;**
A detritivores
digest / breakdown / hydrolyse, organic nitrogen / protein / amino acids / urea **;**
protease / urease **;**
deamination **;**
production of ammonium (ions) / ammonification **;**
nitrification / ammonium (ions) to nitrate (ions) **;**

accept correct formulae for ammonium ions, nitrite ions and nitrate ions [max 3]

(b) (i) *phosphate*
any one relevant **;**
e.g. part of structure of
AMP / ADP / ATP
nucleotide
nucleic acid / DNA / RNA / polynucleotide
phospholipid
A phospholipid bilayer
phosphorylation / enzyme activation
bone tissue

nitrate
any one relevant **;**
e.g. (nitrogen for) amino acids / proteins / enzymes / named (e.g. haemoglobin)
AMP / ADP / ATP
nucleotide
nucleic acid / DNA / RNA / polynucleotide named nitrogen base (adenine / cytosine / thymine / uracil / guanine)
(some) phospholipids [2]

(ii) **1** growth linked to, increase in cell size / cell number **;**
2 growth linked to, increase in biomass / reproduction **;**
3 increases energy available as food for next trophic level **;**
4 nitrogen is in, amino acids / proteins, for growth **;**
5 ATP (containing phosphate) required for, transcription / protein synthesis / enzyme synthesis / anabolic reactions / growth **;**
6 *idea that,* growth of cells / cell division, requires membrane synthesis **;**
7 nitrogen in membrane proteins / phosphate in membrane phospholipids **;**
8 (cell division and), DNA, synthesis / replication **;**
9 *idea that* more biomass (per unit time) returned to soil **;**
10 AVP **;** e.g. ref. to phosphate taken up by plants and passed into food chain **;** [max 3]

[Total: 11]

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4 **(a)** any one valid **;**
e.g.(first) appearance of (brown) colour
use of, colour standards / colour charts
use of colorimeter
time-lapse photography / video [1]

(b) *allow catechol for substrate throughout*
rate of reaction 0 au, no substrate to act on / AW **;**

at substrate concentrations lower than 5mM
substrate (concentration) is limiting (factor in rate of reaction) **;**
presence of free active sites / enzyme is in excess **;**
few collisions between enzyme and substrate **;**
rate increases with substrate concentration as more, active sites can be occupied / E-S complexes can form **;**
one data quote to support response
V_{max} reached / rate becomes maximum, at 4.5–5 mM substrate concentration**;**
rate constant / levels out / AW, from 4.5–5 mmol substrate concentration **;**

at substrate concentrations greater than 5 mM
enzyme (concentration) becomes limiting (factor) **;**
all active sites, saturated / occupied **;**
(so) further increase in substrate concentation does not increase rate **;** [max 5]

(c) **(i)** curve always lower than that with no inhibitor **;** *must be similar shape*
curve reaches the maximum **;** **A** curve heading to maximum [2]

(ii) PHBA / inhibitor, similar shape to, substrate / catechol **;**
(so) binds to active site **;**
blocks access to substrate / fewer (successful) enzyme-substrate collisions **;**
reduces rate of, reaction / conversion of substrate to product **;**
AVP **;**
e.g. inhibitor has a greater effect on rate at lower substrate concentrations
V_{max} reached at higher substrate concentrations
inhibitor forms same interactions with R-groups in active site [max 2]

(d) enzymes work in a limited pH range / either side of optimum pH rate decreases **;**
(acid so) presence of H^+ ions, partially denatures / denatures (some), enzymes **;**
further detail **;** e.g. ref. to breaking ionic or hyrdrogen bonds
change of active site shape means substrate can no longer fit **;**
AVP **;** e.g. ref. to antioxidant effect of, lemon juice / citric acid / vitamin C [max 2]

[Total: 12]

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5 **(a)** growth (by increase in cell number) **;**
production of genetically identical cells **;**
replacing (damaged) cells **;**
repair (of tissue) **;** *allow 'regeneration' if mp3 and mp4 not awarded*
R repair cells
asexual reproduction **;**
A cloning **A** vegetative propagation [max 3]

(b) one tick in each box **;** [1]

(c) appearance of chromosomes / condensation of chromatin / AW **;**
chromosomes visible as two, sister chromatids / chromatids joined by a centromere **;**
spindle formation / spindle fibres form / microtubules assemble / AW **;**
centrioles, move to / reach, opposite poles **;**
R sides / ends
disappearance of nucleolus **;**
disassembly / breakdown of, nuclear envelope **;**
A nuclear membrane [max 4]

(d) mitosis / prophase, will begin again, too soon / immediately **;**
uncontrolled / repeated, cell division / mitosis **;**
ignore (risk of), tumour formation / cancerous growth
ref. to consequences on the timing of the cell cycle **;** [max 3]

[Total: 11]

6 **(a)** causes (mainly) linked to habits during life of person / AW **;**
result of choices made by person / AW **;**
example **;**
e.g. (tobacco) smoking / exposure to asbestos at work [max 2]

(b) *pathogen* = virus **;**
ignore Morbilli / measles
transmission: aerosol, infection / transmission *or* droplet, infection / transmission **;**
A aerosol route described from infected to uninfeccted
ignore contact [2]

(c) (infected), visitors / immigrants / returning residents, from countries where measles occurs **;**
unvaccinated people returning from travel abroad **;**
reduction in vaccination rates **;**
percentage cover too low **;**
change in reporting pattern **;**
existing vaccine no longer, effective / AW **;**
AVP **;**
e.g. mutation of virus produces new antigens, vaccines ineffective
increase in malnourished children, no immune response to vaccine [max 1]

[Total: 5]

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