UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

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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A	accept (for answers correctly cued by the question, or by extra guidance)
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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) *award two marks if correct answer (4500) is given*
allow +/- 1 mm in reading the line
accept anything within range 4400 to 4600

max 1 mark if unit is given

award one mark if incorrect measurement just beyond acceptable range is divided by the actual length (10 μm) using same unit

expect calculation from measurement of scale bar, but look out for alternative method, e.g. measuring the image and then using the scale bar to determine the width in μm

$\frac{45\,000}{10}$ $\frac{45\times10^{-3}}{10\times10^{-6}}$ $\frac{4.5\times10^{-2}}{10\times10^{-6}}$

4500 ;; [2]

(b) **A** = goblet cell(s), **B** = cilia / ciliated cell **;**

A / goblet cell, secrete / make / produce / release, <u>mucus</u> / <u>mucous</u> **;**
R excrete
bacteria / pathogens / dust / viruses / particles / dirt / AW, stick (to mucus) / trapped (in mucus) **;** **A** collects **R** 'contains'

B / cilia, move mucus, up(wards) / away from alveoli *or* bronchioles / away from lungs / up the trachea / to larynx / to mouth / to throat / AW **;**
bacteria / pathogens / dust / AW, do not accumulate / can be swallowed / do not cause infection (in the trachea) **;** **A** 'stops infections' **I** 'in the lungs'
must be in context of cilia or cilia and mucus [max 4]

(c) *marks can be taken from labels / annotations*
1 chromatids / chromosomes / chromatin, condense / become shorter / become thicker / coil / supercoil / AW **;** **A** 'become (more) visible'
2 centrioles, move to / reach, opposite <u>poles</u> **;** **R** ends
3 nucleolus disappears **;**
4 <u>spindle</u> is formed **;** **A** 'more developed' **A** *description in terms of spindle fibres*
5 ref to assembly of <u>microtubules</u> **;** **A** 'makes' microtubules **R** 9+2
6 nuclear envelope, disintegrates / breaks down / destroyed / AW **;** **A** membrane
7 chromosomes, move to / at, equatorial plate / equator / metaphase plate / AW **;** *ignore* middle / centre
8 centromeres attach to, spindle / fibres **;**
9 ref to random arrangement of chromosomes **;** **A** 'not in pairs' **R** scattered [max 5]

[Total: 11]

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2 (a) diffusion / diffuses ;
down concentration gradient / from high concentration to low concentration / from high to low partial pressure ;
description of pathway ;
two of the following
cell (surface) membrane of (respiring) cell, tissue fluid, (pore in) capillary wall / endothelium / endothelial cell, basement membrane / plasma [max 2]

(b) *assume answer refers to Y unless told that it refers to X*
less pressure ; **A** low pressure
less oxygen ; **A** deoxygenated
less glucose ; *only accept more glucose if identified as liver*
fewer / more, amino acids / fatty acids ;
less water / lower water potential / lower solute potential / higher osmotic pressure / higher concentration of solutes *and / or* rbcs ;
A 'blood is more concentrated'
fewer ions ;
more of **named** cell product ; e.g. insulin / glucagon / albumen / AW

(more), urea / excretory waste ; **R** waste unqualified [max 3]

(c) (i) carbonic anhydrase ; [1]

(ii) (catalyses very) fast / AW, reaction ;
(carbon dioxide as) hydrogen carbonate ions / bicarbonate ions ;
diffuse / move / leaves, out of the (red blood) cell ;
in(to) the plasma ; **R** 'into blood'
(so that) blood can transport more than could be transported as carbon dioxide (in solution) / 80 – 90% CO_2 transported this way ;
idea that
reaction maintains concentration gradient for CO_2 from, tissues / tissue fluid, to blood ;
if carbon dioxide transported then pH would decrease ;
(therefore) maintains pH / prevents pH decreasing / acts as a buffer ; [max 3]

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(d) (i) 55 (%) **A** 54 - 56 (%),
32 (%) **A** 31 / 31.5 (%) **;** [1]

(ii) hydrogen ions / protons **;** **A** H^+
either
react *or* combine with haemoglobin / form haemoglobinic acid / form HHb **;**
A 'picks up' / absorb
or
carbon dioxide combines with haemoglobin / forms carboxyhaemoglobin **;**
(so) stimulate haemoglobin to release more oxygen (in areas of low pO_2) **;**
ref. to, allosteric effect / change in tertiary *or* quaternary structure *or* shape **;**
A conformational change
either
haemoglobin has a higher affinity for hydrogen ions than oxygen = 2 marks
or
haemoglobin has a higher affinity for carbon dioxide than oxygen = 2 marks [max 2]

(iii) Bohr (effect / shift) **;** [1]

(iv) **1** carbon dioxide influences percentage saturation of haemoglobin with oxygen / AW **;**
2 tissues / cells, with high rate of (aerobic) respiration **;**
3 high demand for oxygen **;**
4 haemoglobin / blood, releases more oxygen **;** **R** faster
5 than it would in absence of carbon dioxide **;**
6 at same partial pressure of oxygen **;** [max 3]

[Total: 16]

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3 (a) **D** – uracil ;
E – adenine ;
F – ribose ; **I** pentose / sugar
G – phosphate ; **A** phosphate [4]

(b) *answers must be in pairs*

mRNA	DNA
ribose	deoxyribose ;
differences between pentoses / sugar may be described in terms of OH on C2	
uracil / no thymine	thymine / no uracil ;
single, polynucleotide / strand / chain	two, polynucleotides / chains / strands ; **A** double
no hydrogen bonds	hydrogen bonding ;
not a helix / straight chain	(double) helix ;
ratio of A+G to C+T varies / AW	ratio of A+G to C+T = 1 / AW ;
no base pairing (within molecule)	base pairing ;
base pairing A-U with, tRNA / anticodon	base pairing is A-T
shorter	longer ;
found in cytoplasm / leaves nucleus	found in nucleus ;
attached to ribosome(s)	not attached to ribosome(s) ;
short-lived	long-lived ;
transfer of information (to ribosome)	information storage / AW ;
codes for one polypeptide	codes for more than one polypeptide ;
produced by transcription	produced by (semi-conservative) replication

[max 3]

(c) **1** translation ; **R** *if transcription given as well, unless in correct context*
A use of, nucleotide / base, sequence, to make, amino acid chain / polypeptide / protein
I protein / polypeptide, synthesis
2 moves towards / combines with, ribosome ;
3 ref to small and/or large sub-units ; **I** small / large ribosome
4 codon(s) ; *only accept in correct context*
5 transfer / t, RNA, bringing, amino acid(s), to mRNA / ribosome ;
6 anticodon(s) ; *only accept in correct context*
7 (complementary) base pairing ;
8 any e.g. of codon:anticodon base pairing ; *need six bases*
9 ref to polyribosome(s) / used by many ribosomes ;
10 (mRNA short-lived) ref to production of protein for short period of time ; [max 4]

[Total: 11]

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4 (a) (i) hydrolysis / hydrolysing **;** **I** catabolic / digestive **R** hydrolsis [1]

(ii) to stop the reaction **;** **R** 'stop it working'
by denaturing, the enzyme / sucrase **;** **R** incorrect context
A 'change shape of active site'
to make the Benedict's solution, react / AW **;** [2]

(b) *description to max 2*

rate increases to a, maximum / plateau **;** **A** 'levels off' / remains constant
idea that increase in rate slows **;**
11.5 (arbitrary units / au) at 80 - 90, g dm^{-3} **;** **A** range 11.4 – 11.6

explanation to max 4 – accept ora where appropriate

substrate concentration is limiting (factor) **;**

(at low concentration) *may be given in terms of increasing concentration*
few collisions between enzyme and substrate **;**
few, enzyme-substrate / E-S, complexes formed **;**
active sites unoccupied **;**

(at high concentration / >80 g dm^{-3})
enzyme concentration is limiting (factor) **;**
A 'not enough enzyme for substrate to bind to'
maximum number of enzyme-substrate complexes formed **;**
active sites , saturated / always occupied **;** **A** ref to V_{max} [max 5]

[Total: 8]

5 (a) *put ticks and crosses against the boxes*
1 – 4 and 7 – one letter only – if more than one letter mark as wrong
allow two or three correct letters for 5
allow two correct letters for 6

	statement	letter
1	contains peptide bonds	**H**
2	part of the molecule forms the hydrophobic part of cell membranes	**L**
3	contains 1-4 and 1-6 glycosidic bonds	**K**
4	forms the primary structure of a protein	**H**
5	used for energy storage in plants	**K / M / H**
6	forms a helical structure	**M / H**
7	the sub-unit molecule is β-glucose	**J**

[Total: 7]

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6 (a) *assume answer refers to active immunity unless told otherwise*
accept ora if answer focuses on passive immunity

immune response **;** **A** 'immune system responds'
to antigen **;**
clonal selection occurs / ref to B cells *or* T cells activated **;**
antibodies made **;** **A** ora for passive
memory cells produced **;**
long-lived / long-term effect / permanent **;**
not immediate / slow **;** one week minimum

passive only – antibodies removed from circulation **;** [max 3]

(b) *no mark for passive immunity as in the question*

antibodies from, mother / colostrum / across placenta **;** **R** 'immunity from mother'
interact with, antigen / measles antigens / virus / pathogen **;**
(so) prevents an (active) immune response **; A** no immune response

too early for immune response to occur / T cells *or* B cells not mature **;**
A not immunocompetent / immune system not developed [max 2]

(c) *idea that*
all countries with >90% of districts reporting 90% of children vaccinated have very low death rates (for children under 5 years of age) **;**

ref to any percentage(s) <90% with wide variation in death rates **;**

data quote, giving % and death rate(s) **;** e.g. 95%, less than 50 deaths per 1000

herd immunity / described , decreases transmission **;**
A description of transmission e.g. 'spread' [max 2]

[Total: 7]

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1 (a) **A =** anaphase **;**
B = prophase **;**
C = metaphase **;** [3]

(b) ref. newly formed / daughter cells (following, telophase / mitosis) **;**
cells, entering / at early interphase **;**
cells, at synthesis stage / making proteins **;**
cells growing (to, mature/normal, size) *or* cells not grown to, mature / normal, size **;** AW **R** not elongated [max 1]

(c) *any 2 relevant e.g.*
cells metabolically active / AW **;**
protein synthesis **;**
transcription **;**
translation **;**
gene expression **;**
DNA / semi-conservative, replication **;**
respiration **;**
synthesising, organelles / named organelle(s) **;** e.g. **A** centrioles replicate
synthesising, macromolecules / named macromolecule **;** [max 2]

[Total: 6]

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2 (a) (i) *habitat* = **B**
ecosystem = **A** ;

abiotic component = **C** ;

ecological niche = **F** ;

population = **E**
community = **D** ; [max 4]

(b) *seaweed* = (primary) producer **;** **A** first (trophic level)

limpet / P. vulgata	*crab / C. maenas*
primary consumer	secondary consumer
A 1° consumer	**A** 2° consumer
A second (trophic level)	**A** third (trophic level)

;

max 3 for energy losses

energy losses in
respiration **;**
heat loss, qualified **;** e.g. heat loss, from digestion / movement / metabolism
heat loss in respiration = 1 mark
indigestible parts **;** **A** named, e.g. cellulose
inedible parts **;**
excretion **;** **A** named excretory products
egestion **;** **I** waste
death, not eaten **;** [max 4]

[Total: 8]

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3 (a) **1** small size / 6-8 μm (diameter), to squeeze through capillaries (7 μm) **;**
2 small size / 6-8 μm (diameter), so, haemoglobin (molecules) near to surface (of plasma membrane) / reduces distance for diffusion (in / out of rbc) **;**
3 no nucleus / lack of organelles, so more room for haemoglobin (so more oxygen transported) **;** **R** more room for oxygen
4 biconcave shape / diagram drawn, increases surface area for, diffusion / uptake / release (of oxygen) **;**
5 flexible / AW (membrane), to squeeze through capillaries **;** [max 3]

(b) **1** enzymes are proteins, protein synthesis does not occur **;**
2 no, nucleus / DNA / genes, so no, transcription / mRNA **;** } *
3 no <u>mRNA</u>, so no, translation / protein synthesis **;** }
***A** no nucleus, so no protein synthesis *for one mark*
4 no, RER / ribosomes, site of protein synthesis / AW **;**
5 no mitochondria, insufficient ATP (for synthesis) **;**
6 no RER for modification (of protein) **;** **A** Golgi apparatus [max 2]

(c) (i) iron **;** **A** Fe^{2+} / Fe^{3+} / ferrous / ferric [1]

(ii) amino acids / peptides **;** [1]

(d) <u>carbonic anhydrase</u> **;** [1]

(e) **1** <u>diffusion</u> of, carbon dioxide / CO_2**;**
2 into red blood cell from correct source **;**

3 description of <u>carbonic acid</u> formation followed by H^+ production **;**
4 ref. carbonic anhydrase) fast reaction**;** **A** ecf from **(d)**

5 haemoglobin has a higher affinity for hydrogen ions than oxygen **;**
A haemoglobin releases oxygen more easily in acidic conditions
accept idea of H^+ binding to haemoglobin bringing out oxygen release
6 ref. to, allosteric effect / change in tertiary structure **/** AW, in (oxy)haemoglobin, causes, release / AW, of oxygen **;**
7 formation of <u>haemoglobinic acid</u> **;** *must refer to, H^+ binding / decreased pH*
8 ref. higher partial pressures / AW, CO_2, linked to (oxy)haemoglobin releasing, more oxygen / oxygen more readily **;** *Bohr shift*
9 formation of <u>carbamino-haemoglobin</u> **;** **R** carboxyhaemoglobin

10 chloride shift, qualified **;**
e.g. as hydrogen carbonate ions move out of cell, chloride ions move in e.g. to maintain, electroneutrality / a balance of charge / ions **;** [max 5]

[Total: 13]

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4 (a) *Mycobacterium, tuberculosis / bovis* **;** 1

(b) (i) *2 marks for correct answer*
x 30 000 **;;**
(image length = 60 mm) 60 000μm / 2μm **A** 59 / 61 mm (29 500 / 30 500)
1 mark if incorrect answer e.g. not converted correctly, but measurement and method correct [2]

(ii) *any 3 relevant e.g.*
DNA not surrounded by, nuclear, envelope / membrane **;** AW
A no (true) nucleus
circular DNA **; A** loop
DNA not complexed with histone proteins **; A** naked DNA
(only) 70S / smaller / 18nm, ribosomes **; A** ribosomes not attached to membranes
no double membrane-bound organelles**; A** no, mitochondria / chloroplasts
absence of named organelle **;** e.g. Golgi apparatus, ER / RER / SER
if previous mp not given, **A** no membrane-bound organelles
capsule / slime layer **;**
very small diameter / 0.5 to 5.0μm **;**
cell wall of, murein / peptidoglycan **;**

examples of other relevant points
pili / pilus **;**
no 9+2 microtubule arrangement **;**
flagellum not covered by cell surface membrane **;**
presence of plasmids **;** [max 3]

(c) (i) *any 1 relevant e.g.*
ref. (BCG) vaccine / vaccination programme **;**
improvements in housing conditions / less overcrowding (housing) / better ventilated homes **; R** better standards of living *unqualified*
earlier detection / mass, chest X-ray / screening **;** *i.e. in preventing spread*
improvements in diet (leading to better immune system) / AW **;**
improved awareness of, transmission / AW **; R** better education unqualified
contact tracing / explained **;**
ref. testing / treating, cattle / milk **;** [max 1]

(ii) *any 3 relevant e.g.*
development of antibiotic resistance (by organism) **; A** drug resistance
R immunity
ref. impact of HIV infection **;**
higher rate of immigration from countries with high incidence / AW **;**
increase in tourism to countries with high incidence **;**
reduced surveillance leading to undetected cases (and hence spread) **;**
(detected cases, MDR) unwillingness / AW, to maintain drug regimen / AW **;**
ref. to vaccination programmes no longer taking place **;**
ref. to poor / overcrowded, housing (in cities) / AW **;** *must be in context of developed countries* [max 3]

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(d) (i) binding of tRNA prevented **;**
(so) no anticodon-codon binding **;**
peptide bond formation prevented **;**
mRNA attachment prevented **;**
inhibition of enzymes involved in translation **;**
ribosome movement along mRNA, hindered / prevented **;**
inhibits association of large and small subunits / AW **;** [max 2]

(ii) *mammalian cell*
cell surface membrane impermeable **;**
degraded, before entry into / within, the cell **;**
broken down by enzymes **;**
eukaryotic / 80S (22nm) / larger / different, ribosomes / ribosome structure **;** [max 1]

[Total: 13]

5 (a) **A** = glycerol **;**
B = ester bond **; I** covalent
C = fatty acid *or* hydrocarbon, chain / tail **;** [3]

(b) (i) 2, fatty acid / hydrocarbon, chain / tails **;**
(third fatty acid replaced by a) phosphate group **;**
AVP **;** (most) contain, nitrogen / choline (attached to phosphate in, head / polar portion) **;** [max 2]

(ii) can form a bilayer **;**
link between, hydrophobic core / AW, and barrier to water-soluble substances **; A** polar / ionic
idea of, hydrophilic / phosphate, head, forming H bonds with water **;**
A facing, water / watery environment / aqueous environment / cytoplasm / cytosol

ref. contribution to fluid nature of membrane **;**
further detail **;** e.g. mainly saturated fatty acids, less fluid e.g. mainly unsaturated fatty acids, more fluid
ref. to control over membrane protein orientation **;** e.g. hydrophobic – hydrophobic interaction for 'floating' proteins [max 3]

(c) optimum pH *or* pH at which, lipase / enzyme, works best **;** [1]

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(d) (i) pH, decreases / AW, over time **;**
steep decrease / high rate, in first 5 minutes **;** **A** faster
less steep decrease / levels out, correct time ref **; A** slower
correct, manipulation of data / comparative data quote (ref. to both axes) **;**
e.g. pH 8 – 7.3 from 0 – 5 min
pH 7.3 – 6.45 from, 50 / 60, min [2]

(ii) triglyceride / oil, hydrolysed / broken down / digested, to produce (fatty) acids **;**
increasing, acids / H^+ / hydrogen ions, decreases / AW, pH **;**

accept, triglyceride / lipid, for substrate throughout

steep decrease
ref. enzyme has high initial turnover rate *or* high rate of, collision between enzyme and substrate / ES complex formation **;**
(because initially) high concentration of, substrate / triglyceride **;**

less steep / levelling / plateau,
substrate, being used up / used up / limiting **;**
active sites available *or* fewer enzyme substrate collisions / fewer ES complexes formed**;**
ref. presence of hydrogen ions, partial denaturation (less steep) / denaturation (plateau)**;**
A description of denaturation [4]

[Total: 15]

6 (a) ref. to coronary arteries **;** *in correct context*
makes platelets sticky, so causing blood to clot **;**
increases risk of thrombosis in, coronary arteries / arteries to heart (muscle) **;**
leading to plaque / atheroma / atherosclerosis / AW **;**
increases heart rate **;**
increased blood pressure **;**
damage to, tunica intima / endothelium /endothelial lining / arterial lining **;** [max 4]

(b) *any one valid statement for 1 mark*

agree
less addicted to smoking cigarettes so fewer smoked **;**
fewer smoked, so reduced risk of smoking-related diseases **; A** named disease
fewer smoked so reduced risk from, (effects of) tar / carbon monoxide **;**

disagree as people may smoke more
may smoke more to, increase their nicotine levels / satisfy need for nicotine / AW **;**
more smoked, so increased risk of smoking-related diseases **; A** named disease
may smoke more so increased risk from, (effects of) tar / carbon monoxide **;**

AVP **;** *for either agree or disagree*
e.g. disagree as may still smoke and there are still other carcinogenic chemicals such as tar
[max 1]

[Total: 5]

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1 (a) (i) metaphase **;** [1]

(ii) chromosomes / (sister) chromatids, line up at the, equator / equatorial plate / metaphase plate **;** **A** move to **I** middle / centre
centromeres attached to, spindle / spindle fibres **;**
A (spindle) microtubules **A** kinetochore
centrioles, reach / located at / AW, poles **;** **R** ends
ref. spindle fully formed **;** **A** spindle fibres extend from poles / AW
R ref. to nuclear envelope absent (in anaphase also) [max 3]

(b) replacement of cells **;**
repair of tissue **;** **R** repair of cells
growth / increase in cell numbers **;**
asexual reproduction / vegetative propagation **;** **R** cloning
maintains / same, number of chromosomes **;** **A** two sets of chromosomes / diploid / 2n
genetically identical to parents **;**
A produces daughter cells that are genetically identical **A** ref. clone(s)
ref to rejection / self vs non-self **;** [max 3]

(c) ref. coordination of growth / limiting growth **;**
ref. minimising exposure to mutations / alterations to DNA (during replication) / AW **;**
prevent tumour formation **;** **A** prevent, cancer / uncontrollable growth
effect of, tumour / cancer **;** e.g. compress other organs / invades other tissues or organs
AVP **;** e.g. example of timing of cell cycle linked to cell function / idea of producing cells when required [max 2]

[Total: 9]

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2 **(a)** *one mark per complete correct row*

DNA	RNA	
two, polynucleotides / chains / strands **A** double	single, polynucleotide / strand / chain	;
(double) helix	not a helix / straight chain **;**	;
deoxyribose	ribose *differences between pentoses / sugar may be described in terms of OH on C_2*	;
<u>thymine</u> / no uracil	uracil / no <u>thymine</u>	;
hydrogen bonding (between all bases)	hydrogen bonds between some bases **A** no hydrogen bonds	;
ratio of A+G to C+T = 1 / AW	ratio of A+G to C+T varies	;
longer	shorter	;
one type	more than one type / three types / mRNA + tRNA + rRNA	;

[max 3]

(b) *(GCG)* CGC **;**
(ACA) UGU **;** [2]

(c) 714 **;; A** 717 / 720
if, no / incorrect, answer given, award one mark for correct working [2]

(d) 1 (tRNA) carries amino acid to ribosome **;**
2 ref. to specificity of amino acid carried **; A** role in ensuring correct primary structure
3 ref. anticodon (on tRNA): codon (on mRNA) binding **;**
4 ref. complementary / base pairing **; A** A-U, C-G
5 ref to tRNA binding sites within ribosome **;**
6 two tRNAs bound to, mRNA / ribosome, at same time **;**
7 amino acids held close to each other / AW **;**
8 (for) <u>peptide</u> bond formation **;**
9 (tRNA) can be reused / binds another amino acid **;** [max 4]

[Total: 11]

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3 (a) (i) active, transport / uptake **;** [1]
carrier / transport, protein **; A** pump protein **R** channel protein
ref. (protein) changing shape / conformational change **;**
ref to specificity **;**
ATP / energy, required **;** [max 2]

(ii) ATP / ADP / DNA / RNA / nucleic acid / NADP / phospholipid **;**
A nucleotide / named nucleotide / nucleoside **A** phospholipid bilayer [1]

(b) (i) W in the central X-shaped region **;** [1]

(ii) osmosis *in correct context* **;** e.g. through, cell surface / partially permeable, membrane or into, cytoplasm / cell
diffusion, into / through, cell walls **;**

from (region of), high(er) / less negative, water potential, to (region of), low(er) / more negative, water potential *or* down a water potential gradient **;**

transpiration pull **;** [max 2]

(iii) through cortex / via cortical cells **;**

apoplast pathway
(by) via cell walls (of adjacent cells) **; R** *if named as* symplast pathway **;**
symplast pathway
via cytoplasm and plasmodesmata **; R** *if named as* apoplast pathway
ref. vacuolar pathway **;**

ref. apoplast to symplast / pathway described, at endodermis **;**
(via) passage cells **;**
ref to, suberised / Casparian, strip **;** *in correct context* [max 4]

[Total: 11]

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4 (a) (i) red blood cells / erythrocytes / red blood corpuscles **;** [1]

(ii) *myoglobin* 78% **A** 77% } **;**
haemoglobin 21% } *must have both correct for 1 mark* [1]

(iii) myoglobin has higher affinity for oxygen / myoglobin binds oxygen while haemoglobin releases oxygen **;** ora
(myoglobin) acts as a store of oxygen **;**
myoglobin will only release oxygen, at (very) low oxygen partial pressures / AW when oxygen demand (in muscles) exceeds supply **; A** during exercise
AVP **;** e.g. myoglobin has, one / fewer haem groups, so no cooperative binding effects
e.g. allows aerobic respiration to continue (in muscle) [max 2]

(b) (i) fetal haemoglobin has higher oxygen affinity (than adult / maternal haemoglobin) / AW **;**
(higher oxygen affinity) over all ppO_2 / use of data at more than one ppO_2 (from Fig. 4.1) **;**

oxygen uptake from, adult / maternal, blood / AW **;**
or
gas exchange taking place between fetal and, adult / maternal, blood **;**

ref. to fetal reliance on mother to supply oxygen / mother only source of oxygen for fetus **;** [2]

(ii) at lower ppO_2 both, unload / AW, oxygen **;**
sufficient / more, adult haemoglobin present or adult haemoglobin provides sufficient oxygen / AW **;**
ref. to compensating by producing additional red blood cells **;**
AVP **;** e.g. ref. to similarity of position of both curves [max 1]

(c) (all) to the right of given curve, same overall shape as adult haemoglobin curve **;**
to the right of given curve, begins at 0.2 kPa, ends at 97% **;**
A *within range of* 0–0.4kPa and 95–99% [2]

[Total: 9]

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5 **(a)** (phloem) sieve plate **;** [1]

(b) **(i)** sucrose / amino acids / named amino acid / AVP **;** **R** sugar [1]

(ii) *source* – leaf / named photosynthetic part **;**
sink – roots / seeds / fruits / petals / bud / named non-photosynthetic part **;** [2]

(c) *accept, assimilate / named assimilate, throughout*
allow ecf from ***(b)(i)***

1 H^+ / protons, (move) out of companion cells by, active transport / AW **;**
R diffuse by active transport
2 H^+ / protons, diffuse (back) in with / cotransport sucrose, into companion cells **;**
A description of (facilitated) diffusion
R active transport
ref. to companion cell required only once for mps 1 and 2
3 via, cotransporter / cotransporter described **;**
4 sucrose, diffuses / AW, into (phloem) sieve, tube / element, via plasmodesmata **;**
5 (entry of sucrose into sieve tube so) water potential lowers **;**
6 water enters by osmosis **;**
7 (hydrostatic) pressure builds up **;** **A** pressure difference created
8 unloading at, sink / named sink, gives a difference in pressure (between source and sink) **;** AW
9 (so) mass flow **;** *term to be used in context* [max 5]

(d) *any one relevant e.g.*
obtain, sucrose / amino acids / other named assimilate **;** **R** nutrients unqualified
pressure forces, sap / AW, into aphid **;** [max 1]

[Total: 10]

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

(ii) nitrate required for, amino acid / protein / nucleic acid, production in plants **;**
A other relevant named N-containing biochemicals
nitrogen (gas) not useable form for (most) plants **;**

removal of nitrate
slows / AW, growth of plants **; A** reduces crop yield **A** plants need nitrates for growth
decreases fertility of soil / fertilisers need to be added to soil **;** [2]

(b) (i) nitrification **;** [1]

(ii) *P. stutzeri* / bacteria, can be (added to the water and) used to, remove nitrate / carry out denitrification **;**
detail **;** e.g. use of filter bed
ref. to leave for sufficient time to remove nitrates
nitrogen escapes to air [2]

(c) 1 air / oxygen, will not get into soil **;**
2 lack of oxygen reduces uptake of ions by plants / AW **;**
3 ref. saprobiotic bacteria and fungi / nitrifying bacteria / (some) nitrogen fixing bacteria, are aerobic **;**
4 ref. reduced populations (of bacteria in mp 2) **;**
5 example of effect on nitrogen cycle **;;**
6 e.g. slower rate / AW, of decomposition / decay
nitrogen fixation cannot occur (as rapidly)
nitrification cannot occur / nitrate will not be produced / less nitrate produced
(more) denitrification will occur
7 crops / plants, will use up remaining nitrate **;**
8 ref. leaching of, nitrates / other nutrients, for growth or (only) low levels of nitrates / other nutrients, for growth remain in soil **; A** ref. leaching reducing soil fertility
9 AVP **;** e.g. named example of another nutrient, with role
will take time to, recover nitrate levels / resume nitrogen fixation **;**
fertilisers (previously) applied washed away **;** [max 4]

[Total: 10]

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