Cambridge International AS & A Level

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BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **May/June 2016**

MARK SCHEME

Maximum Mark: 60

Published

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/	alternatives answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or 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
ecf	error carried forward
I	ignore
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1 *must have correct spellings of* Plasmodium *and* Vibrio cholera

feature	malaria	tuberculosis	cholera
name of pathogen	*Plasmodium* ;	*Mycobacterium tuberculosis*	*Vibrio cholerae* ;
type of organism	protoctist / protoctistan ; **A** protist / protozoan / sporozoan	bacterium	bacterium ; **A** bacteria
mode of transmission	by, a vector **or** (feeding or biting by) *Anopheles* / mosquito ;	via, (airborne) droplets / aerosol(s) (infection) ;	drinking water and food contaminated with human faeces

[6]

[Total: 6]

2 **(a)** **(i)** phagocytosis / endocytosis ; **R** pinocytosis **I** engulfing [1]

(ii) **E** transcription ;
F translation ; **A** post translation(al) modification [2]

(iii) **B** (phagocytic / endocytic) vacuole / phagosome ; **A** vesicle
R incorrectly qualified vacuole or vesicle (e.g. permanent / large / secretory / Golgi / excretory)
I food / pathogenic
G (80S) ribosome ; **A** rough endoplasmic reticulum **R** RER / rough ER
I 70S or any other type of incorrect S as a qualification
H Golgi (body / apparatus / complex) ;
J mitochondrion ; **A** mitochondria [4]

(b) **I** *fusion of lysosomes with phagosome and diffusion of products of digestion*

1 bacteria are, killed / destroyed / broken down / digested ; **A** hydrolysed
A cell wall broken down
R bacteria are cut up
2 (by hydrolytic) enzymes ;
3 any example, e.g. carbohydrase / lysozyme / protease / nuclease ;
4 killed by, hydrogen peroxide / H_2O_2 / free radicals / AW ;
5 AVP ; e.g. correctly named substrate for enzyme
murein / peptidoglycan, polysaccharide(s), polypeptides, nucleic acids, lipids
e.g. correctly named bonds broken
glycosidic, peptide, ester, phosphodiester [max 3]

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(c) **1** *idea that* only, a few / some / small number / AW, with correct specificity **;**
2 (different) T-lymphocytes are specific to different antigens **;**
3 (T cell) receptor is, complementary (in shape to antigen) **;**
4 AVP **;**
e.g. this may be during a primary immune response so no memory cells
e.g. disease state (HIV / AIDS and leukaemia) or treatment where few T-lymphocytes in the body [max 2]

[Total: 12]

3 **(a)** **(i)** **N** ciliated **; A** pseudostratified **I** columnar / cuboidal **R** cilia [1]

(ii) **O** mucous glands **; A** mucus glands / serous glands [1]

(iii) **P** cartilage **;** [1]

(b) **I** more air can enter unqualified
1 more air / oxygen, reaches the, alveoli / gas exchange surface **;**
2 more gas exchange / greater absorption of oxygen / excretes more carbon dioxide **;** AW
A maximises oxygen obtained
3 satisfies increased demand for oxygen / AW **;**
4 trachea / bronchi / airways, widen / AW **;**
e.g. dilate / expand / enlarge **A** diameter of lumen increases
5 reduces resistance to air flow **; R** rate of air flow increases [max 2]

(c) *collagen has*
three polypeptides / a quaternary structure **;**
I more than one polypeptide unqualified
glycine is every third amino acid **; I** at regular intervals **R** roughly / approximately
(triple) helix / helical (shape) **; I** regular coils' **R** alpha helix [max 2]

[Total: 7]

4 **(a)** *transpiration is an inevitable consequence because*
1 stomata open **;**
2 for diffusion in of carbon dioxide / carbon dioxide required for photosynthesis **;**
3 water vapour, diffuses out / moves out down the water potential gradient **;**
A description of water potential gradient / high to low water potential
A vapour pressure gradient / water vapour gradient
allow water vapour if it is clear that evaporation has occurred
A water evaporates and diffuses out
R water evaporates out
I water (vapour) concentration gradient [3]

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(b) **1** adhesion of water to, cellulose / lining / walls (of xylem vessels) **;**
A adhesive force
2 ref to, hydrophilic / polar, property of cellulose (fibres) **;**
A hydrophilic / polar, parts of lignin
3 cohesion between water molecules **;** cohesive force
4 maintains column of water / prevents water column breaking / AW **;**
5 *ref. to* transpiration pull / AW **; I** transpiration *unqualified* [max 3]

(c) *mp3 – units for rates of transpiration must appear once correctly in the whole answer to award this point*

1 rate (of transpiration) of all trees is 0 at, 06.00 / start **; A** no transpiration
2 rates (of transpiration) increase and decrease (in all three) **; A** peaks
3 highest rates:
emergent trees at 14.30 at 8.5 $kg\,h^{-1}$
canopy trees at 14.30 at 3.5 $kg\,h^{-1}$
suppressed trees at 13.00 at 1.6–1.7 $kg\,h^{-1}$ **;**
must have units at least once
accept kg / h or kg per hour
4 emergent trees (always) have highest rate **or** suppressed trees have lowest rate **;**
A emergent trees have higher rate than, canopy and suppressed, trees
5 rate of emergent trees is, much / AW, higher than rates for canopy and suppressed trees **;**
6 emergent trees have, steeper / steepest, increase in (transpiration) rate **;**
A emergent trees have, steeper / steepest, decrease in (transpiration) rate [max 4]

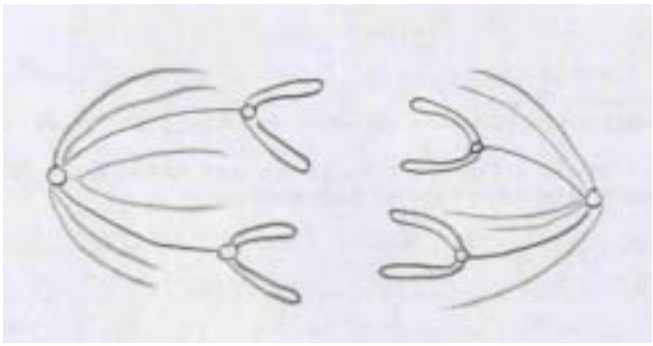
(d) *following factors may be given in answers, any three of these factors = 1 mark*

light, intensity / wavelength **I** 'more light'
humidity
temperature
wind speed / air movement
size of tree / height / area of leaves
water availability / depth *or* length of roots
*transpiration rate for emergent trees is higher because … accept **ora** for suppressed trees*
accept vapour pressure gradient / water vapour pressure gradient / water vapour diffusion gradient for water potential gradient
1 high(er) light intensity for emergent trees increase in stomatal aperture **;** ora
A more sunlight
A stomata open more
I more stomata open
2 lower humidity for emergent trees so steeper water potential gradient **;** ora
A description of water potential gradient
3 higher temperature / AW, for emergent trees so higher rate of, evaporation / diffusion **;** ora
4 higher wind speed for emergent trees so, steeper water potential gradient / lower humidity **;** ora
A *ref. to* diffusion shells / descriptions of water potential gradient
5 emergent trees have longer roots so take up more water **;**
6 emergent trees have more leaves so, greater surface area / more stomata per unit area (of leaf) **;** [max 4]

[Total: 14]

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5 (a) (i) *if draw other stages mark first one only – either left to right or top to bottom*



four chromatids / daughter chromosomes, drawn as single structures between equator and poles **;**
V shaped, chromatids / daughter chromosomes, in correct orientation **;**
spindle (fibres) attached to all four, centromeres / kinetochores / apex, and centrioles **; R** if these extend between chromatids [max 3]

(ii) **1** attach to the, centromeres (at prophase) **; A** kinetochores
I *if attach at metaphase*
2 attach to, centrioles **; A** centrosome / MTOC
3 arrange the chromosomes on the, equator / metaphase plate **;**
4 pull / move, (daughter) chromosomes, apart / to the poles **;**
A separates *for moves apart* **A** (sister / identical) chromatids
I ends **R** homologous chromosomes [max 2]

(b) (i) **1** produces / makes / synthesises, haemoglobin **; I** fills up
2 produces / makes / synthesises, carbonic anhydrase **; I** fills up
3 loss / AW, of the nucleus **;**
4 loss / AW, of (named) organelles **;**
e.g. ribosomes / (R)ER / mitochondria
5 becomes biconcave / described **;**
6 AVP **;** e.g. cell surface / antigens / named antigens
ref. to cytoskeleton [max 3]

(ii) *cell Y*
1 remains / stays as a, stem cell **;**
2 divides / undergoes mitosis **;**
I *ref. to* becoming a type of blood cell / platelet
R if it becomes a cell other than a blood cell / platelet [max 1]

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(c) (i) 13.5 **;** [max 1]

(ii) **1** low(er) partial pressure of oxygen (at high altitude) **;**
A pO_2 / ppO_2
2 less oxygen in, inhaled air / lungs / alveoli **;**
3 so haemoglobin, is not fully saturated / has lower saturation (with oxygen) (than at sea level) / lower affinity for oxygen **;**
4 *idea that* more red blood cells so, higher concentration of / more haemoglobin **;**
5 allows, same / similar / enough, volume of oxygen to be transported in the blood as at sea level **;**
6 volume of oxygen transported in the blood is less **;**
7 less oxygen for (aerobic) respiration / lack leads to anaerobic respiration **;**
8 any consequence, e.g. fatigue, altitude sickness **;** [max 4]

[Total: 14]

6 (a) *fluid*
phospholipids (and proteins), move / AW **;**

mosaic
proteins / glycoproteins, scattered / AW (in the phospholipid bilayer) **;**
A different types of proteins
I pattern unqualified [2]

(b) 7 nm **;** **A** any size or range within 6 nm and 10 nm
A 7 nanometres [1]

(c) cholesterol **;**
unsaturated fatty acids **;** **A** phospholipid tails
carbohydrate chains added to protein(s) / glycoproteins **;**
A oligosaccharides *for carbohydrate chains*
carbohydrate chains added to lipids / glycolipids **;**
glycocalyx **;**
channel protein(s) / AW **;** **A** aquaporin(s) **;**
carrier proteins / AW **;**
peripheral / extrinsic, proteins **;**
attachment to, cytoskeleton / microfilaments **;**
receptor(s) **;**
antigen(s) **;**
AVP **;** [max 4]

[Total: 7]

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AVP	alternative valid point

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1 (a) A activation energy / energy of activation **;**

B induced fit **;** **A** induced fit, model / hypothesis / theory / mechanism

C globular **;**

D extracellular **;**

E Michaelis-Menten constant **;** **A** K_m **[5]**

[Total: 5]

2 (a) (i) curled / rolled, leaf **;** **R** curly / curved / folded
or
trichomes / hairs **;** **A** hair / hairy,-like structures **R** cilia / spines / needles **[1]**

(ii) *allow explanations for stomata in pits, thick cuticle and no stomata on outer surface as ecf from (i)*

curled leaf / trichomes / stomata in pits
ref. to (creates) still / non-moving, air **;**
(in enclosed area) humid / moist **;** AW, e.g. traps water vapour / maintains humidity

water potential gradient less steep **or** decreased rate of diffusion of water vapour (out) **;**
A (water) vapour pressure gradient for water potential gradient
I decreased concentration gradient of water vapour
assume in context of between substomatal air space and enclosed area unless stated otherwise

thick cuticle
greater layer impermeable wax / AW **;** **A** thicker waterproof layer
increases distance for diffusion **;**
of water vapour **;**

no stomata on outer surface
most water lost via (open) stomata **;**
cuticular transpiration only **;**
ref. to where most exposure to, light / air currents / wind **;** **[max 2]**

(b) xerophytic **/** xerophyte **;** **[1]**

[Total: 4]

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3 (a) (i) 1179 **;;**

one mark *if not to the whole person e.g. 1179.24 / 1179.2* **or**
if calculation correct but answer incorrect
e.g. 1.39 × 848.38 **or** 1.39 × (84 838 000/100 000) **or**
if no calculation to check but answer given as 1180 **[2]**

(ii) **1** provides information about / AW, proportion / percentage, (of population) affected / AW **;**

2 to, make (valid) comparisons / compare **;** *between countries / in one country over time*

3 provides information about severity of disease **;** AW

4 population size, taken into account / different for different countries / changes over time in a country **;**
do not need 'size' if 'use of 'population' is in correct context

5 *idea that* countries with larger populations will usually have more cases / higher number of cases may just mean larger population of country**;**

6 AVP **;** gives guidance about whether the disease is, spreading / becoming an epidemic / dying out (in one country) *in context of over time*
idea that number of cases per 100 000 are, standardised / normalised, values

7 use of data to support **;** *only two of Chad, Eritrea or Ethiopia where comparisons between countries stated* **I** *ref. to* other countries

(2009) actual cases and standardised cases

comparison (2009) to support mp 5 population size and actual cases

stated values of similar number of cases per 100 000 and populations of different sizes

countries compared, number of cases per 100 000 for any stated year, with comment about severity

number of cases per 100 000 for one country over time, with comment about severity / spreading / dying out / control / AW **[max 3]**

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(b) *can give values of percentage vaccinated to describe 'increasing / decreasing' percentage vaccination*

support

1 Gambia high percentage vaccinated (throughout) and low number of cases **;**
A Eritrea

2 data to support **;** *e.g. a percentage vaccination for a year <u>and</u> number of cases (same, or following, year after vaccination) or a range given for percentage vaccinations over the whole, or stated, number of years or a compilation of the two*

partial / weak, support

3 Central African Republic decreasing vaccination and number of cases in 2011, higher / 15.31 **;**

4 Chad (from 2008) increasing percentage vaccination and, low / stated, number of cases,
2009 / 2010 / 2012 **;**
1.45 1.66 0.96

do not support

5 Niger / Ethiopia / Chad, (generally) increasing percentage vaccinated and number of cases, fluctuates / increase and decrease (ora) / AW **;**
A stated correct data *to show increase and decrease*
A for Chad if mp 4 given and ref. to increase / 71.6 in 2011

6 (generally) increasing percentage vaccinated and number of cases, increases / goes from 2.34–4.67, in 2011 in Niger **or**
increases / goes from 1.39–4.86, in 2010 in Ethiopia **or**
increases / goes from 1.66–71.6, in 2011 in Chad **A** 1.45–1.66 in 2010 **;**

7 Central African Republic decreasing vaccination and low number of cases in, 2009 / 2010 / 2012 **;**

8 / 9 AVP **;;** e.g.

- *idea that* most values for number of cases are low irrespective of vaccination percentage
- *ref.to* needs, high / 90%, vaccination to be effective
  A < 80% / low, vaccination ineffective
- *idea that* generally Gambia / Eritrea, have higher percentage vaccinated and have lower number of cases than, (three of) Ethiopia, Chad, Central African Republic, Niger / the other countries
- *ref. to* Chad / Central African Republic, in 2011 and, epidemics / inability to keep number of cases down / ineffectiveness of vaccination programme **I** *ref. to* 71.6 (Chad) or 15.31 (Central African Republic)
- Eritrea 2012 high vaccination but, increase in / 3.16, cases
- *ref. to* increasing percentage of vaccination in Niger and decrease in cases, 2009–2010 from 5.23 to 2.34 / 2011–2012 from 4.67–1.59
  A 2009–2012 from 5.23 to1.59 **[max 4]**

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(c) *points refer to smallpox, look for points written as ora*
any two from

1 high, percentage / proportion, immunised / vaccinated **;** AW
A mass vaccination

2 no boosters required / one dose enough / immunity very long-lived **;**
A *idea of* long-lasting effect of vaccine

3 same, vaccine / antigens, used (throughout) **;**
treat as neutral ref. to, low mutation rate / stability, of smallpox virus

4 heat stable / thermostable / freeze-dried / lyophilised, vaccine **; I** frozen
A no need to refrigerate / AW
A *idea of* longer shelf-life

5 ease of, administering vaccine / training people to give vaccine **;**

6 ring vaccination / described, e.g. contact tracing **;**

7 easy to identify infected people / AW, (to begin ring vaccination) **;**

8 lower percentage cover required for smallpox than measles / lower herd immunity required **;**

9 AVP **;** smallpox less infectious (so lower percentage cover required)
idea of less, civil unrest / war / movement of populations (so easier to implement)
suggestion that smallpox live vaccine (and measles not live) **[max 2]**

(d) active artificial / artificial active **;** *treat as neutral* acquired **[1]**

(e) *can be from point of view of country programme or WHO programme cost*

1 preparing / manufacturing / purchasing, vaccine **; A** cost to provide vaccine free to developing countries

2 disposables / equipment to administer (vaccine) **;**
e.g. syringes / needles / (protective) gloves

3 storage **;** e.g. space, security

4 refrigeration / maintaining cold chain **;**

5 transport (of, vaccine / health care workers) **;**

6 wages / training, of staff involved **;** e.g. wages for, health care workers administering vaccine / staff involved in training health care workers

7 record keeping / contact tracing **;**

8 advertising / informing / marketing / education **;**

9 research / development **;**

10 setting up vaccination / immunisation, camps (for remote / epidemic, areas) **;**
I building, hospitals / clinics **[max 2]**

[Total: 14]

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4 **(a)** blood contained in (blood) vessels AW
or
blood contained in *any three of*
heart, arteries, veins, capillaries **;**

systemic and pulmonary, systems / circulation **; A** 'systematic'
A described *if circulations not named*
e.g. for each complete circuit (round the body) passes through heart twice
from heart to lungs and back, then to (rest of) body and back **[2]**

(b) **W** = aorta / aortic arch **;**
X = pulmonary vein **;**
Y = right atrioventricular / tricuspid, (valve) **;**
Z = left, atrium / auricle **;** **[4]**

(c) red blood cells **;** **A** rbc
A platelets
A plasma proteins / named **[1]**

(d) **1** *idea of* carbon dioxide out (of blood to alveolus) and oxygen in (to alveolus from blood) **;**

2 diffusion / diffuses
or
(movement from) high concentration to low concentration / down a concentration gradient **; A** diffusion / pressure, gradient

3 (across) squamous epithelium / squamous cells (of alveolar wall) **;**
A pavement cells

4 (and) endothelium / endothelial cells (of capillary wall) **;**
A squamous cells *but must be clear that this is for capillary wall*

5 oxygen, into / AW, red blood cells **; I** oxygen binds to Hb

6 steep gradient maintained by, ventilation / uptake by haemoglobin / blood carries oxygen away / blood arrives with carbon dioxide / deoxygenated blood arriving low in oxygen **[max 4]**

(e) **(i)** **F** = nucleolus **; A** nucleus
G = cell surface / plasma, membrane **;** **[2]**

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(ii) transport / transporter / carrier, protein **;** **R** pump protein

specific protein **;**
glucose, binding site / AW **;** **I** glucose binds **R** glucose receptor
specific binding site (in protein) = 2 marks

(glucose binding causes) conformational change **;** AW, e.g. changes shape

passive / no energy required / no ATP required **;**

movement is, down the concentration gradient / from high to low concentration **;** *must be in context of through the membrane protein* **[max 3]**

[Total: 16]

5 **(a)** **(i)** coiling / supercoiling / condenses / condensation **;**
A become shorter and thicker **R** contracts **[1]**

(ii) *accept from labelled diagram*
two chromatids **;**
identical / sister, chromatids **;**
joined by a centromere **;** **A** kinetochore

one from
(reach chromatid) DNA complexed with protein
histone proteins / histones
telomeres at end of chromatids
} **;** **[max 3]**

(b) *metaphase versus anaphase*
idea of single chromosome of two chromatids versus two separated chromatids / daughter chromosomes
e.g. two chromatids versus, one chromatid / one daughter chromosome **;**
sister chromatids joined at centromere versus chromatids separated
distance between sister chromatids zero versus increasing distance between chromatids
share a centromere versus do not share a centromere / centromere divides

two DNA molecules versus one DNA molecule **;**

at, equator / metaphase plate versus towards / at, poles **;** **R** centre **R** ends

linear / straight versus V shape / AW **;** **[max 2]**

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(c) acts at <u>target</u> cell **;**

binds to receptor **;** **R** receptor cells *allow ecf for other mps*
R trapped / caught

ref. specificity **;** **A** receptor complementary (shape) for cytokinin
A cytokinin fits into receptor *this is also mp2*
A recognition of cytokinin by receptor

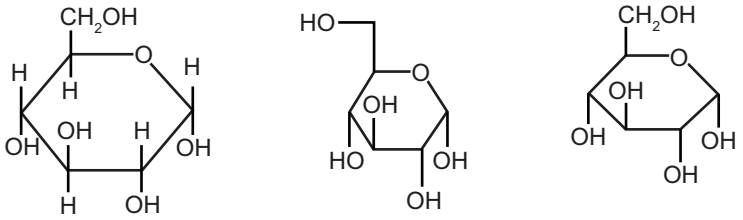
receptor (located) in, cell surface / plasma, membrane **;**
A cell membrane **A** phospholipid bilayer **A** transmembrane receptor

sets off / AW, response in the cell / described response(s) **;** e.g.
triggers secondary messenger
activates enzyme(s)
I signals / causes / stimulates, cell to divide / cytokinesis

(acts) <u>extracellularly</u> / <u>extracellular signal</u> **or** (acts) <u>intracellularly</u> / <u>intracellular signal</u> **;** *must be in context of candidate's answer* **[max 3]**

[Total: 9]

6 (a) (i)



1 2 3

two marks for correct drawing of ring structure **;;**
*all atoms shown **or** one of diagrams 1–3 above*

one mark if, inconsistent / incomplete, drawing:
diagram 1 – <u>one</u> missing H from any of carbons 2–6 (OH groups and rest of drawing must be correct)
diagrams 2 and 3 – adding the H to <u>one</u> of carbons 1–5 (OH groups and rest of drawing must be correct) **[2]**

(ii) glycosidic **;** **A** glucosidic **[1]**

(iii) to form / has, (glycosidic α) 1–6, bonds / links (to make branches) **;**

ref. to different shaped / specific / complementary, active site required to form bonds (for branching) **;** **[max 1]**

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(b) (i) *treat as neutral unit of inheritance*
sequence of, nucleotides / bases **;**
section / length / part, of DNA (molecule) **;**
codes for a polypeptide **; A** protein *for polypeptide* **A** enzyme
A information to produce a polypeptide
A codes / information, for sequence of amino acids / primary structure (of a, polypeptide / protein)
R genetic code for a polypeptide **[max 2]**

(ii) **1** (in DNA / gene) altered, sequence / AW, of, nucleotides / bases **;**
I DNA sequence
2 base substitution
or base / nucleotide, replaces another, base / nucleotide**;**
A example *must be in context of, DNA / gene*
3 (mRNA synthesised) during <u>transcription</u> **;**
4 (mutation leads to) altered / AW, <u>mRNA</u> / <u>messenger RNA</u> **;**

5 (only) one (mRNA) <u>codon</u> changed / a different <u>codon</u> **;**
A one DNA, triplet / codon, changed **I** *ref. to* codon<u>s</u> changed

6 tRNA, with / has, a different anticodon **;**
7 (tRNA) brings, a different / a changed / the incorrect, amino acid, during <u>translation</u> / to the ribosome **;**
8 codon-anticodon, binding / complementary / AW **; A** matches
R amino acid with anticodon **[max 3]**

(c) nucleolus **;** **R** if other cell structures given
mitochondrion **;** **R** if other cell structures given

rough endoplasmic reticulum **or** Golgi (body / apparatus / complex) **;** **[3]**

[Total: 12]

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1 (a) (i) letter **X** written in space above cilia **;** **A** label line into this space [1]

(ii) nucleus **;** [1]

(iii) cilia **;**
columnar / tall / not flat / not thin **;**
nuclei rounded / AW **;**
presence of goblet cells **;** [max 1]

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

(ii) *presence of any 3 of:*
1 shorter / no / fewer / damaged, cilia **;** **A** paralysed
2 undifferentiated / AW, cells **;**
3 flattened / squamous, cells / epithelium **;**
4 scar tissue **;** **A** scar tissue forms
5 enlarged goblet cells **;**
6 excess / accumulated / AW, mucus **;** **A** excess mucus secreted
7 tar deposits **;** **A** description of tar on lining
8 phagocytes **;**
9 AVP **;** e.g. inflammation (of bronchial lining)

[max 3]

[Total: 7]

2 (a) (i) 3.4 μM min^{-1} **;** **A** 3.4 μM / min [1]

(ii) 0.15 mM **;;** **A** ecf from **(a) (i)**
allow 1 mark if no units given

if answer incorrect allow one mark for evidence of ½ V_{max}
3.4 / 2 = 1.7 [2]

(b) *max 3 if no attempt at description (D) with explanation (E)*

at lower substrate concentrations
1 *(D)* rate of reaction proportional to substrate concentration **;** AW
2 *(D)* up to 0.25 mM **;** **A** range 0.25–0.30 mM
3 *(E)* not all active sites occupied **;**
A few, enzyme-substrate complexes / ES complexes / ESC
A more active site occupied as substrate concentration increases
4 *(E)* substrate concentration is limiting **;**

at higher substrate concentrations
5 *(D)* less steep increase in rate (from 0.25 mM) **;**
6 *(D)* further increase in substrate concentration gives, no further increase / plateau / levelling out, in rate **;** **A** rate remains at 3.4 μM min^{-1}
7 *(D)* greater than / at, 0.45 mM **;** **A** 0.46 / 0.47, mM
8 *(E)* enzyme concentration is limiting **;** **A** idea that some other factor is limiting
9 *(E)* all active sites occupied / AW **;**
10 *(E)* **A** *for mp3 / mp6* description in terms of enzyme-substrate collisions in context **;** [max 4]

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(c) (i) folding / coiling, (of polypeptide chain) **;**
tertiary structure **;**
(held in position by) *ref. to* R group interactions **;**
A two or more bond types in context
brings distant, amino acids / parts of the chain, close **;** AW [max 3]

(ii) water **;** **A** H_2O [1]

[Total: 11]

3 (a) *non-self*
foreign / AW **;** **A** not from the person's own body
triggers / AW, an immune response / production of antibodies **;**
A other events in immune response described

antigen
protein / glycoprotein **;** **A** polysaccharide
ref.to, binding of specific antibody / formation of antigen-antibody complex **;** [max 3]

3 (b) (i) **P** antigen-binding site / site for antigen attachment **;** **A** variable region

Q hinge region **;**

R constant region / site of attachment to receptors on phagocytes / AW **;** [3]

(ii) disulfide (bonds) **;** **R** *if more than one type of bond stated* [1]

(c) (i) **1** TNF-α / antigen, introduced into, mice / small mammals / named **;**
2 (antibody-producing), B-cells / B-lymphocytes / plasma cells / splenocytes, isolated (from spleen) **;** **A** produced
3 fused with myeloma cells **;**
4 using fusogen / PEG **;**
5 hybridoma cells formed **;**
6 *ref. to* screening / testing, for hybridoma producing desired antibody **;**
7 *ref. to* scaling up / large-scale production **;**
8 AVP **;** e.g. HAT medium for, hybridoma growth / inhibiting myeloma growth [max 3]

(ii) antibodies bind to TNF-α **;**
inactivate / destroy TNF-α **;**
inflammation cannot be triggered / AW **;** in context of destroying TNF- α [max 2]

[Total: 12]

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4 **(a)** label line to wall or lumen of any phloem sieve tube **;** [1]

(b) transport of assimilates **;** **A** named assimilate e.g. sucrose / amino acids / auxins
from source to sink **;** **A** from leaves to named sink e.g. roots / fruits
translocation / mass flow **;** [max 2]

(c) lignin for, waterproofing **;**
lignin, for support / to prevent (inward) collapse / AW (of vessel or plant) **;**
R prevent bursting **I** withstand (high) pressure
cellulose for, adhesion of water / formation of hydrogen bonds with water **;**
A hydrophilic parts of lignin
pits for lateral movement of water **;**
AVP e.g. rings / spirals, for, extension / growth **;** [max 3]

(d) **(i)** *surface area* $(0.1 \times 0.1 \times 6 =) 0.06$ (m^2) **;**
volume $(0.1 \times 0.1 \times 0.1 =) 0.001$ (m^3) **;** **A** 1×10^{-3}
surface area to volume ratio
(0.06 / 0.001 =) 60 **;** **A** ecf using values given for surface area or volume [3]

(ii) *idea that*
diffusion (via, body surface / to cells), cannot satisfy needs / too slow **;**
or
transport system delivers materials to cells more quickly **;**
A efficient supply of, nutrients / oxygen, to all cells

long(er) distances (to reach some, cells / tissues) **;**
takes, materials / AW, close to cells **;** [max 2]

[Total: 11]

5 **(a)** *0 marks if another mode of transmission given (e.g. faecal-oral / contact / sexual)*
I in unpasteurised milk / contaminated meat (*M. bovis*)

1 aerosol / droplet, infection **;**
only need to have one of 'infected' / 'uninfected' to gain mp2 and mp3
2 infected / AW, person, coughs / breathes / spits / talks / sneezes **;**
3 uninfected / AW, person, inhales / inspires / breathes in, droplets **;**

allow one mark if mp2 and mp3 given with no reference to, infected / uninfected
4 organism / pathogen / bacteria / *M. tuberculosis*, in, airborne droplets / droplets in air **;** **A** without 'airborne ' or 'in air' if mp2 gained [max 2]

(b) **1** incomplete treatment / dose not finished **;**
2 not all bacteria killed / some bacteria survive **;** **R** TB for bacteria
3 mutation **;** **R** mutation to give immunity
4 further detail of mutation **;**
5 selection of resistant bacteria / resistant bacteria selected for **;**
6 resistant bacteria reproduce / vertical resistance **;**
7 death of, susceptible / non-resistant, bacteria **;**
8 AVP **;** e.g. horizontal resistance / described [max 4]

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(c) **(i)** making / synthesis of, (m)RNA **;**
from a DNA, template / sequence of bases / sequence of nucleotides **;**
A from a gene [2]

(ii) *idea that* pathogen and human RNA polymerase are (slightly) different **;** e.g. (slightly) different shaped active sites
A rifampicin unable to, cross cell surface membrane / enter nucleus / cross nuclear envelope [1]

(d) *points can be general or TB specific*
1 prescribing / take, antibiotics, only when (absolutely) necessary **;**
2 ensure, correct / effective, antibiotic(s) prescribed / used **;**
3 complete course / follow instructions for use, of antibiotics **; A** *ref. to* DOTS
4 patients to, use only antibiotics prescribed / not use leftover antibiotics at a later date / AW **;**
5 *ref. to* monitoring situation to check if antibiotic is effective **;**
6 use other antibacterials **;**
7 develop new, drugs / antibiotics **;**
8 ensure / improve, knowledge of, healthcare professionals / public **;** AW
9 reduce / control, antibiotics in, agriculture / animals used for food **;**
10 reporting patterns of antibiotic resistance / AW **;**
11 *ref. to* breaking transmission cycle / described example **;** e.g. vaccines good hygiene in hospitals
12 break transmission cycle of resistant bacteria **;** e.g. quarantine
13 AVP **;** e.g. WHO Global Plan Stop TB
14 *further detail of mp1 or mp2* **;** e.g. only prescribe wide-spectrum antibiotics when narrow spectrum not known [max 3]

(e) *idea that* antibiotics act at a cell structure not possessed by a virus **;**
e.g. viruses, do not have, a cell wall / a cell surface membrane / ribosomes

suggestion that viruses, are inside host cells / not within reach(of antibiotics) **;**
antibiotics act only on, living / growing, cells (viruses do not grow) **;**
A can prevent metabolic processes not occurring in viruses
antibiotics do not act on, protein coat / capsid / capsomeres / viral envelope **;** [max 2]

[Total: 14]

6 **(a)** (superior / inferior) vena cava **;** [1]

(b) left (ventricle) pumps blood to the body / right ventricle pumps blood to lungs **;**
A further distance
(left ventricle) requires higher pressure **;** ora
ref. to overcoming greater resistance / lungs less resistance **;**
pulmonary capillaries damaged by higher pressure **;**
higher pressure requires more muscular force / AW **;** ora [max 3]

(c) sinoatrial node **;** [1]

[Total: 5]

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