Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **May/June 2017**

MARK SCHEME

Maximum Mark: 60

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
AW	alternative wording (where responses vary more than usual)
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max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	alternative valid point

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Question	Answers	Marks
1(a)	**A** chloroplast / mitochondrion **;** **B** chromosome(s) / chromatid / chromatin **;** **C** Golgi (body / apparatus / complex) **;** **D** nucleolus **;**	**4**
1(b)	*max 1 if only written about prokaryote wall or only about plant wall* **1** prokaryote cell wall has, peptidoglycan / murein **;** **2** plant cell wall has, cellulose / polymer of β glucose **; I** lignin **3** AVP **;** e.g. prokaryote wall is made of chains crossed linked by, peptides / amino acids hydrogen bonds between cellulose molecules (within microfibrils) in plant cell wall **A** cellulose chains other components such as pectins / hemicelluloses in plant cell walls	**max 2**

Question	Answers	Marks
2(a)	half V_{max} / AW, = 7 (μmol dm^{-3} min^{-1}) / take half of V_{max} of 14 (μmol dm^{-3} min^{-1}) **;** **A** description of using the graph to find ½ V_{max} without reference to figures read (substrate concentration) from *x*-axis / AW **;** *alternative* plot 1 / [S] = x	**2**

Question	Answers	Marks
2(b)	***allow*** *phosphate group(s) / organic compound for substrate* *if affinity not used, accept idea of ability to form ESC* *check for* ***ora*** **I** *ref. to* competitive inhibition **1** enzyme **B** has a lower affinity for its substrate (than enzyme **A**) **or** the higher the K_m the lower the affinity of the enzyme for its substrate **;** **R** if substrate has affinity for the enzyme **2** enzyme **B** needs a higher concentration of substrate to reach, V_{max} / ½V_{max} / K_m (than enzyme **A**) **;** **3** AVP **;** e.g. enzyme **B** forms fewer ESC in the same unit of time enzyme **B** active site is a less good fit for substrate *idea that* in normal cell enzyme **A** is saturated (with substrate) so works at a constant rate variations in substrate concentration will have less effect on the rate of formation of product by enzyme **A** **I** *ref. to* turnover number(s)	**max 2**
2(c)	*marks can be taken from a sketch graph* **1** competitive inhibitor, occupies / competes with substrate for / AW, <u>active site</u> (of the enzyme) **;** **2** reduces frequency of collisions (with substrate) / fewer ESCs form **;** **R** no ESCs form **3** reduces reaction rate at low substrate concentrations **;** ***4*** *idea that* curve with inhibitor is to the right of the curve without inhibitor **;** **5** at high substrate concentration / with increasing substrate concentration, the inhibitor has, no / less, effect **;** **A** *idea that* substrate outcompetes inhibitor at high substrate concentration **6** therefore V_{max} is the same as it is determined by the enzyme concentration / AW **;** **A** explanation in terms of active sites, saturated / fully occupied ***7*** *idea of* intercept to curve gives a higher value for K_m **;**	**max 4**

Question	Answers	Marks
3(a)	(antibody has) more than <u>one polypeptide</u> **;** **A** <u>four polypeptides</u> **R** two / two or more / two types of / many / AW, polypeptides	**1**
3(b)(i)	*allow epitope for antigen* **1** (two) antigen-binding, site(s) / region(s) **;** **A** binds to / AW, antigens **R** active site **2** (shape / structure is) <u>complementary</u> to antigen **;** ***3*** *idea of* specificity / AW **;** **4** *ref. to*, primary structure / sequence of amino acids **;** **5** *ref. to* R-groups / (amino acid) side chains, and interactions with antigen / giving specific shape **;**	**max 3**
3(b)(ii)	binds to (receptors on), phagocytes / macrophages / neutrophils **;** **A** other correct named cell of the immune system AVP **;** e.g. gives class of antibody (e.g. IgM, IgG, IgA, IgE)	**max 1**
3(c)(i)	**1** <u>antigen</u>, introduced / AW, into, (small) mammal **;** **A** named small mammal **2** B-lymphocytes / B cells / plasma cells / splenocytes / antibody-producing lymphocytes, are taken / are isolated (from the spleen / lymph nodes) **;** **3** (these) cells are fused / AW, with, myeloma / cancer, cells **;** **4** <u>hybridoma</u> cells / <u>hybridomas</u>, formed **;** **R** hybridised cells / hybrid cells **5** hybridoma cell, is cloned / AW **;** **6** screening / testing, for hybridoma that produces desired antibody **;** **7** *ref. to* scaling up / large-scale production / grow in a fermenter **;** **8** AVP **;** e.g. fusion using, fusogen / polyethylene glycol / PEG / electric current (electrofusion) / (Sendai) virus HAT medium, for, hybridoma growth / inhibiting myeloma growth humanisation of monoclonal antibody	**max 4**

Question	Answers	Marks
3(c)(ii)	**I** *suggestions for treatment* **1** monoclonal antibodies used all have the same specificity **;** **R** 'are specific' unqualified **2** detect only one, antigen / epitope **;** **3** can distinguish between different, pathogens / strains of, pathogens **; A** types of cancer cells **4** can be, labelled / tagged / marked / AW **;** e.g. with fluorescent label **5** monoclonal antibodies can detect location of, tissues expressing antigen / cancer cells / blood clots **; A** *idea of* locating areas of infection **6** fast(er) (diagnosis) **;** **7** can detect antibody levels (e.g. HIV) **;** **8** AVP **;** e.g. some pathogens cannot be cultured **I** *ref. to* cost	**max 2**

Question	Answers	Marks
4(a)	*mRNA* **1** single-stranded **;** **2** no hydrogen bonding / only DNA has hydrogen bonding **;** **3** no base pairs / only DNA has base pairs **;** **4** uracil and not thymine / DNA has thymine instead of uracil **;** *treat as neutral T and U, look for complete term* **5** ribose not deoxyribose **;** **6** detail, e.g. –H and not –OH on C2 **;** **7** short(er) / DNA is longer **; A** smaller / bigger **8** not a helix **;**	**max 4**
4(b)(i)	*third triplet is a stop codon so* only two amino acids are joined by peptide bonds / chain only 2 amino acids long **;** **A** will still have Val-His as the first two amino acids very short molecule is produced / chain stops after His(tidine) **;** **R** frameshift / description of frameshift	**max 1**

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<table>
<tr><th>Question</th><th>Answers</th><th>Marks</th></tr>
<tr><td>4(b)(ii)</td><td>a triplet is deleted so
(polypeptide / sequence / β chain) has one less amino acid ;
polypeptide does not have Leu (as the third amino acid) ;
I Leu is not, produced / made / synthesised</td><td>max 1</td></tr>
<tr><td>4(c)</td><td>
<table>
<tr><th>feature</th><th>DNA replication</th><th>transcription</th></tr>
<tr><td>a single-stranded molecule is produced</td><td>×</td><td>✓</td></tr>
<tr><td>hydrogen bonds are broken</td><td>✓</td><td>✓ ;</td></tr>
<tr><td>both strands of DNA act as templates</td><td>✓</td><td>× ;</td></tr>
<tr><td>phosphodiester bonds are formed</td><td>✓</td><td>✓ ;</td></tr>
<tr><td>DNA polymerase is used</td><td>✓</td><td>× ;</td></tr>
</table>
</td><td>4</td></tr>
<tr><td>4(d)</td><td>I functions of telomerase
permits continued replication (in stem cells / meristematic cells) ; A ora
prevents loss of, genes / genetic material / DNA ; A ora
A prevents shortening of, chromosomes / DNA
length of telomere determines lifespan of, cells / cell lineage ;
AVP ; e.g. prevents ends of chromosomes attaching to each other prevents apoptosis / cell death / cell destruction</td><td>max 2</td></tr>
</table>

Question	Answers	Marks
4(e)	**1** translation / construction of polypeptide(s) **;** **2** provide binding site for mRNA / mRNA attaches to ribosome / AW **;** **A** entering ribosome **3** provides binding sites for (two) tRNA molecules **;** **A** entering ribosome **4** two amino acids are held close together **;** **5** formation of peptide bond(s) **; R** dipeptide / polypeptide, bond **6** (allows) assembly of amino acids into, sequence / primary structure **;** **7** AVP **;** e.g. P and A site (and E site) bond between amino acids catalysed by peptidyl transferase	**max 4**

Question	Answers	Marks
5(a)	sugar (molecules) / glucose / fructose, is polar / is water soluble / not lipid soluble / hydrophilic **;** cannot pass through, (phospho)lipid bilayer / hydrophobic core / fatty acid 'tails' / hydrocarbon 'tails' **; A** non-polar regions	**2**
5(b)	*accept H^+ for proton throughout* **1** (*at* ***Y***) protons, pumped out (of companion cell) / moved out by active transport / move out through proton pump **;** **A** protons are moved out against concentration gradient **2** creates a, proton gradient / electrochemical gradient **;** **3** protons go into the, cell wall / apoplast **; R** mesophyll cell **4** (*at* ***X***) protons enter cell by facilitated diffusion **;** **5** (**X** is) cotransporter / cotransport protein **;** **6** sucrose transported into (companion) cell together with protons **;** **7** (sucrose enters) against concentration gradient **;** **8** sucrose concentration, increases / maintained, in companion cell **;** **9** sucrose diffuses into sieve tube (element) **;** **10** through plasmodesmata **;** **11** AVP **;** e.g. *ref. to*, secondary / indirect, active transport	**max 5**

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Question	Answers	Marks
5(c)	*look for names of plant organs other than leaves, ignore names such as potato, iris, onions* **R** leaves unqualified *any two for max 1* root / root tip stem / stem tip / shoot / shoot tip tubers bulbs corms rhizomes buds flowers fruits seeds young / maturing / developing / infected, leaves AVP	**max 1**

Question	Answers	Marks
6(a)(i)	*Vibrio cholerae* ;	**1**
6(a)(ii)	faecal-oral route ;; *description of faecal / oral route* *infected person* faeces / sewage / stool, contaminating (drinking) water **R** (human) waste unqualified **or** poor hygiene so transferring, faecal material / sewage, onto utensils / food / AW **or** defaecating / putting sewage, onto vegetable plots ; **or** flies in contact with contaminated faeces landing on food and contaminating / AW *uninfected person* eating contaminated food / using contaminated utensils **or** drinking contaminated water ;	**max 2**
6(b)	1 ganglioside is the receptor for choleragen ; 2 choleragen is complementary to ganglioside ; 3 any interaction between molecules ; e.g. (hydrogen / ionic) bonding	**max 2**
6(c)	endocytosis ; **A** phagocytosis / pinocytosis	**1**
6(d)	1 loss of water / dehydration ; 2 by osmosis ; 3 (water moves out) down water potential gradient / from high to low water potential / high Ψ to low Ψ ; 4 Loss of cations / positively-charged ions (as well as chloride ions) ; 5 change in potential (difference) / change in charge across membrane ; 6 AVP ; e.g. disruption of absorption (of products of digestion / vitamins / mineral ions) disruption of digestion	**max 2**

Question	Answers	Marks
6(e)	1 rehydration therapy, is effective / can treat cholera / reduces death rate **;** 2 any detail **;** e.g. solution of glucose and salts 3 antibiotic is a selection pressure / described **;** 4 *ref. to*, antibiotic / tetracycline, resistance **;** 5 *ref. to*, vertical transmission / horizontal transmission, of resistance **;** **A** described, **A** transfer for transmission 6 antibiotics will become, ineffective / less effective / AW **;** 7 keep antibiotics for use 'as last resort' **;** AW 8 *ref. to* cost **;** 9 antibiotics kill gut bacteria **;** 10 *idea that* disrupts functions of digestive system **;** 11 AVP **;** e.g. antibiotics going into the environment / food chain antibiotics can cause mutation decreases need to develop new drugs prevents development of active immunity *idea of* transmission between bacterial species plasmids with resistance genes	**max 3**

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<tr><td>1(a)</td><td>one mark per blank box
<table>
<tr><th>type of cell</th><th>function of cell</th><th>example of organelle required to carry out function</th></tr>
<tr><td>palisade mesophyll</td><td>photosynthesis ;
A (absorb light to) synthesise, organic compounds / glucose / starch (from inorganic compounds)</td><td>chloroplast</td></tr>
<tr><td>Leydig</td><td>synthesis of steroid hormones</td><td>smooth endoplasmic reticulum ;
A SER / smooth ER</td></tr>
<tr><td>plasma cell ;
A B-cell / white blood cell / leucocyte / (B-) lymphocyte / agranulocyte
R T lymphocyte / granulocyte / phagocyte / macrophage / neutrophil</td><td>production of secretory vesicles containing antibody</td><td>Golgi body</td></tr>
<tr><td>root hair cell</td><td>active uptake of nitrates</td><td>mitochondrion ;
A cell surface / plasma, membrane
A cell membrane</td></tr>
<tr><td>pancreas acinar</td><td>synthesis of enzymes</td><td>rough endoplasmic reticulum ;
A RER / rough ER
A ribosomes
A mitochondrion</td></tr>
</table></td><td>5</td></tr>
</table>

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Question	Answer	Marks
1(b)	**I** functions of individual tissues *if all cell types named as single cell, allow max 1 for named tissue types* *(organ because more than one tissue type)* three named tissue types **; ; ;** endothelium **A** squamous epithelium **A** endothelial cells **A** epithelial cells smooth muscle **A** smooth muscle cells connective tissue elastic tissue **A** elastic fibres **R** elastin / elastic muscle fibrous tissue **A** collagen **A** collagen fibres nervous tissue **A** nerve cells blood **A** blood cells *only in context of vasa vasorum* *general function* transports / carries / AW, blood **; A** delivers **R** pumps blood **I** provides detail **;** e.g. to tissues / to body cells / to body / away from heart / AW **R** to lungs (blood) is oxygenated / contains oxygen	**max 4**
	Total:	**9**

Question	Answer	Marks
2(a)	addition of water shown **;** **A** H_2O fatty acid(s) and glycerol **;**	**2**
2(b)	*positive result* emulsion **;** **I** on top / throughout **A** milky (layer) / cloudy (suspension) / opaque / white droplets **R** precipitate *ref. to* mixing with / dissolving in / adding / adding to, alcohol / ethanol **;** **R** *if incorrect substance added to alcohol, e.g. fatty acids, then allow ecf* then, add / add to, water **;** *max 1 for method if heated or added additional chemicals* *max 1 if wrong sequence or all contents into one test tube at once* *no marks if both of above (wrong sequence and heated)* *accept other valid methods*	**3**

Question	Answer	Marks
2(c)	**1** increase (pH2) to pH7, decrease from pH7 (to pH10.5) **;** **A** trend described as increase then decrease **or** optimum / peak / maximum activity / 99% / 100% (relative) activity, at pH7 **;** **2** steep(er) decrease from, pH7 / optimum, (to pH10.5) **;** *in context of steepness of increase from pH2–7* **3** detail either side of optimum (pH2–7 **or** pH7–10.5) **;** *pH2–7* less steep (increase) pH5–pH7 / little difference between pH5 and 6 / steepest increase between pH2–4 **or** *pH 7–10.5* steeper decrease between pH 7 and 7.5 / less steep decrease between pH 7.5 and 10.5 **4** activity, pH2–7 / below 7, higher than activity, after pH8 **;** **A** in, alkaline / basic, pH / conditions **A** enzyme works better in acidic and neutral conditions ora **A** enzyme works better in acidic than, alkaline / basic, conditions ora **5** enzyme active throughout the pH range **;** **6** data / manipulated data, (to support above mps) **;** *needs comparison values, pH and, percentage activity / %* **7** *ref. to* partial denaturation at higher pH **; A** starts to denature	**max 4**
2(d)(i)	*suggestion of changed conditions for immobilised compared to free e.g.* (immobilised) support material / AW, affects enzyme action **;** support material is charged **;** *idea that* free has greater exposure to hydrogen ions **or** immobilised has protection from hydrogen ions **;** *idea that* immobilised has changed ability to catalyse **;** immobilised has (slightly) altered active site **; R** *ref. to* denaturation **I** changes to tertiary structure support material causes change to, external / substrate, solution **;**	**max 1**

Question	Answer	Marks
2(d)(ii)	can be re-used **;** can be easily recovered **;** easier downstream processing **;** product, not / less, contaminated **;** longer shelf life of enzyme **;** more stable **;** can use higher temperatures (owing to protective matrix) **;** more productive **;** less time-consuming **;** *cost alone is not enough*	**max 1**
	Total:	**11**

Question	Answer	Marks
3(a)	*(Plasmodium) falciparum / malariae / ovale / vivax* **;**	**1**
3(b)	*Anopheles* **;** **I** female / male **I** specific epithet e.g. *gambiae*	**1**
3(c)	*look for ora* **1** higher / better / AW, resolution / resolving power **;** **2** 0.5 nm (**A** 0.2–1 nm) compared to, 200 nm 0.2 μm (**A** range 100–300 nm) **or** electrons have shorter wavelength **;** **R** electron microscope has a shorter wavelength **or** *idea that* cell structures too small to interfere with light waves ora **3** better able to distinguish between two points **;** **A** as a definition if mp 1 achieved **4** (can see) more detail **;** *treat 'clearer' as neutral* **5** able to make thinner sections / able to see inside (oocyst) **;** **6** can continue to obtain higher magnifications and see more detail **;**	**max 2**
3(d)	(magnification =) $\frac{\text{image / scale bar (length)}}{\text{actual / object (length)}}$ **;** **A** triangle / letters only (x) 500 **;;** *using 10 mm as measured length* **A** calculated values for measured length of 9 mm or 11 mm *allow one mark if correct answer given with units* *allow one mark if incorrect answer and* *correct measurement and correct working* *correct measurement and formula but incorrect conversion* *measurement ±2 mm and correct working*	**3**

Question	Answer	Marks
3(e)	vector **;** *ref. to* feeding / taking / AW, blood (from a person) **;** e.g. taking blood meals / *Plasmodium* enters blood during feeding infective cells / *Plasmodium* / pathogen / parasite / AW, enter (person) with, anticoagulant / saliva **;** **I** malaria / disease, enters **A** *idea that,* infective cells / *Plasmodium*, in saliva / salivary glands AVP **;** e.g. *ref. to* providing correct conditions for, part of *Plasmodium* life cycle / sexual reproduction in *Plasmodium*	**max 2**
	Total:	**9**

Question	Answer	Marks
4(a)(i)	**1** circle round **5 ;** *to max 2 but 4 cells produced = max 1 out of 2* **I** details of telophase leading to cytokinesis **2** { cell plate forms (across equator of cell) **or** cell wall / cellulose, laid down **; A** cell wall forms (between the two) } **3** (so) <u>cytoplasm</u> divided (into two) **;** **R** <u>cytoplasm</u> constricts / pinches in / cleavage furrow forms / cleavage forms *(i.e. referring to animal cell)* **4** AVP **;** detail of cell plate formation e.g. *ref. to* vesicles transported to equator / involvement of cytoskeletal structures *idea that* organelles shared out	**max 3**
4(a)(ii)	circle round **S ;** synthesis of <u>two</u> identical DNA, molecules / double helices (from one) **;** each new molecule consists of one, original / parental, strand, and one, new / newly synthesised, strand **;** AW **A** daughter *for newly synthesised*	**3**

Question	Answer	Marks
4(b)	*role* **1** form cells that can, differentiate / become specialised **;** **A** can develop into other cell types / totipotent **A** named examples **2** for, cell replacement / tissue repair / growth **; R** for cell growth **I** found in growing region **3** divides to give continuous supply of, meristematic / stem, cells **;** **A** divides to forms more, meristematic / stem, cells *feature* **4** (stem cells are) undifferentiated **; A** not specialised / unspecialised **5** able to divide **;** *must be in context of mitosis* **A** able to undergo mitosis **A** can replicate **I** reproduce **R** uncontrolled division **6** *idea that* genes not switched off **;** ora	**max 3**
4(c)(i)	growing / storage, area / region / correct named part of plant **;** *examples of part of plant that stores / growing* root / shoot tip / bud / flower / maturing leaf / tuber / fruit / seed **I** where sucrose, used / used up **I** nutrients unqualified receives, assimilates / sucrose / AW **; A** area where sucrose unloaded *in context of, via phloem / from source / from leaf*	**max 1**
4(c)(ii)	*strong* high requirement for assimilates **;** fast growing / highly active **;** AW e.g. requires a lot of energy	**max 1**

Question	Answer	Marks
4(d)	*accept H^+ / protons, throughout for hydrogen ions* **1** active process / uses ATP / requires energy **;** **2** hydrogen ions, pumped / active transport / move(d), out of companion cells **;** *this also gets mp1 if stated as, pumped / active transport / move by proton pump* **3** into cell wall / apoplast **;** **A** intercellular space **R** pumped into phloem sieve tube **4** hydrogen ion gradient builds up **;** **5** hydrogen ions re-enter companion cell, down gradient / AW **;** **A** facilitated diffusion **6** via, cotransport protein(s) / cotransporter(s) **; A** carrier protein(s) '*hydrogen ions diffuse back into companion cell through cotransport protein' is two marks* **7** <u>cotransport</u> sucrose (molecules) **; A** secondary active transport **A** idea of bringing sucrose into companion cell if cotransport / er stated for previous mp **R** cotransport if into phloem sieve tube from companion cell **8** transport of sucrose against gradient **;** **9** diffusion of sucrose into phloem sieve tube (element) **; R** facilitated diffusion **A** moves from high to low concentration **10** via plasmodesmata **;**	**max 4**
	Total:	**15**

Question	Answer	Marks
5(a)(i)	trachea / windpipe + bronchus / bronchi + bronchiole / bronchioles **;** *treat as neutral type of bronchiole*	**1**
5(a)(ii)	goblet **;**	**1**
5(b)	*D = accept points from diagram* **1D** recognition / AW / binding / attachment, (of macrophage) to, bacterium / *S. pneumoniae* / (bacterial) antigen **;** **A** detects / identifies *(D) must label, bacteria / S. pneumoniae, or macrophage and show bacterium attached* **2** endocytosis / phagocytosis **;** **3D** described **;** e.g. engulfing / enveloping / pseudopodia surround phagocytic / endocytotic, vacuole formed **A** phagosome **A** vesicle **4D** fusion of lysosome(s) (to vacuole) **;** *(D) must label lysosome* **5D** breakdown / destruction / digestion / AW, of bacterium / *S. pneumoniae* **;** **A** kills *(D) annotated on diagram* **6D** *ref. to*, hydrolytic / digestive, enzymes **; A** named digestive enzymes *must be in context of lysosome (D) labelled as such*	**max 3**
5(c)	elastin broken down / elastic fibres damaged **;** **A** elastic fibres broken down **A** less, elastin / elastic fibres *detail e.g.* (alveolar) wall becomes overstretched / AW weakened (alveolar) wall / AW e.g. cannot withstand higher pressure bursts on inhalation **;** (bronchioles collapse) on exhalation, trapped / remaining, air bursts alveoli	**2**

Question	Answer	Marks
5(d)	*accept (the) glycoprotein for GM-CSF throughout* **1** (excess surfactant) stimulates immune system cells **;** **2** release / secretion, of, GM-CSF **; I** produce **3** GM-CSF is a signal **or** GM-CSF is a signalling, molecule / protein / glycoprotein **; A** messaging molecule **4** binds to / combines with / AW, (cell surface membrane) receptors (on alveolar macrophages) **;** **5** *ref. to* specificity **;** **A** described as GM-CSF receptor complementary shape for GM-CSF **6** leads to / sets off / triggers / AW, response (in the cell) / removal of surfactant **;** *in context of macrophage* **A** stimulates **7** detail **;** e.g. triggers secondary messenger activates enzymes / enzyme cascade signal transduction phosphorylation events	**max 4**
	Total:	**11**

Question	Answer	Marks
6(a)	*row 1* globular + globular **;** *row 2* 2, alpha / α, globin, and 2, beta / β, globin (chains) **;** **A** 2 alpha and 2 beta chains *row 3* disulfide (bridges / bonds) **;** covalent is neutral	**3**
6(b)	*mRNA strand produced* UGU **;** *tRNA anticodon sequence* UGU **;**	**2**
	Total:	**5**

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Question	Answer	Marks
1(a)	blood contained in (blood) vessels AW **or** blood contained in *any three of* heart, arteries, veins, capillaries **;** systemic and pulmonary, systems / circulation **;** **A** described *if circulations not named* e.g. for each complete circuit (round the body) blood passes through heart twice blood transported from heart to lungs and back, then to (rest of) body and back	**2**
1(b)	**2** **4** 1 **3** **5** 1st and 5th boxes (2 and 5) correct **;** 2nd and 4th boxes (4 and 3) correct **;**	**2**
1(c)(i)	*assume answer refers to arteries unless stated otherwise* withstand / AW, higher pressure (of blood) **;** prevent rupturing / bursting (from high blood pressure) **; I** collapsing *one from* thicker / AW, tunica media **;** more elastic, tissue / fibres, and (smooth) muscle tissue **;** more / AW, elastic, tissue / fibres, to maintain, blood pressure / blood flow **;** more (smooth) muscle to maintain, blood pressure / blood flow **;**	**max 2**

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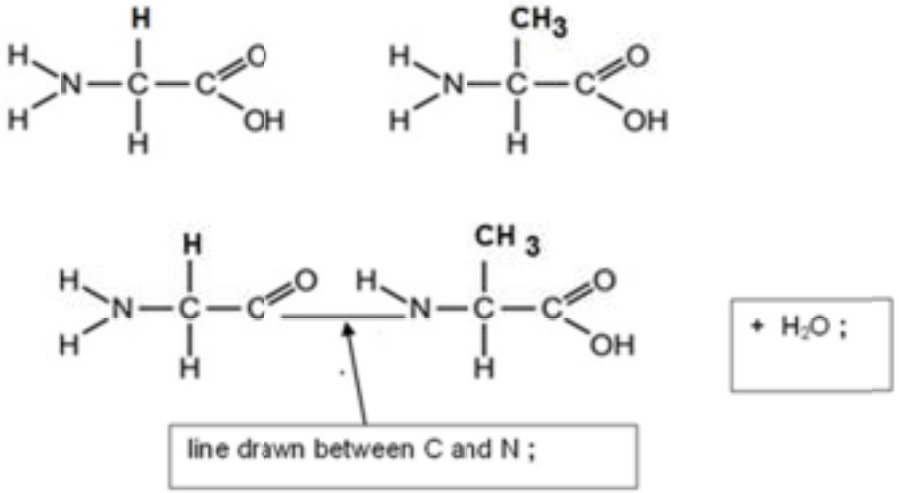
Question	Answer	Marks
1(c)(ii)	*carbon monoxide max 3* forms carboxyhaemoglobin **;** **A** binds to haemoglobin less haemoglobin available to bind oxgen / haemoglobin has greater affinity for carbon monoxide / AW **;** reduces, percentage saturation of haemoglobin (with oxygen) / AW **A** less oxygen binds to haemoglobin **I** prevents oxygen binding **or** reduces oxygen carrying capacity of, haemoglobin / blood **;** *nicotine max 3* increases heart rate **;** increases blood pressure **;** constricts, arteries / arterioles **;** **A** vasoconstriction makes platelets sticky / promotes clotting / promotes thrombosis **;** *for either* damages, endothelium / tunica intima / lining of blood vessels **;**	**max 4**
	Total:	**10**

Question	Answer	Marks
2(a)	*one mark for the formula and two marks for the correct answer* (magnification =) $\frac{\text{image / scale bar (length)}}{\text{actual / object (length)}}$ **;** **A** triangle / letters only 3000 **;;** 30 000 ÷ 10 **;** *using 30 mm as measured length* **A** calculated values for measured lengths of 29 mm or 31 mm *allow one mark if correct answer given with units* *allow one mark if incorrect answer and* *correct measurement and correct working* *correct measurement and formula but incorrect conversion* *measurement ± 2 mm and correct working*	**3**
2(b)	*name* (large permanent) vacuole **;** *function* *one from* store of / holds / AW, cell sap **;** **R** if contains organelles store of / holds / AW, water / ions / named ion(s) / minerals / salts / pigments / sugars / named sugars **;** **A** nutrients **I** substances / molecules / food **I** storage unqualified pushes chloroplast to edge of cell **;** gives, turgidity / turgor pressure / hydrostatic pressure / support / AW **;** **A** makes, firm / rigid **A** controls / maintains, turgidity **I** gives shape / strengthen / provides structure store of / holds, waste (products) **;** **A** breakdown of (large) waste products **I** reactions occur in vacuole, unqualified *allow function mark even if name of organelle left blank or incorrect*	**2**
2(c)	nucleus **;** chloroplast(s) **;** mitochondrion **;** **A** mitochondria	**max 2**

Question	Answer	Marks
2(d)	***A*** nucleic acid / DNA / RNA **;** **A** genetic material **I** strand **R** circular DNA ***B*** protein coat / capsid / capsomere / protein subunit **;**	**2**
2(e)(i)	gene coding for systemin is (a length of) DNA **;** **A** *idea that* a length of DNA codes for systemin transcription / production of mRNA **;**	**2**
2(e)(ii)	herbivore proteases and plant proteases have different (shaped) active sites **;** serpin / competitive inhibitor, only complementary to (shape of) active site of herbivore proteases **; ora** **A** can only fit serpin is specific to (active sites of) herbivore proteases **;** AW proteases act on different, substrates / (parts of) proteins **;** **A** similar shape only to herbivore substrates AVP **;** e.g herbivore proteases cut at different amino acid sequences *allow other acceptable suggestions e.g.* *suggestion that* serpin physically separated from plant proteases **;** detail, e.g. in vesicle / plant proteases in vacuole **;** cannot bind to active site of plant proteases **;** serpin released when plant parts ingested by herbivores **;**	**max 3**
2(e)(iii)	affinity for substrate has decreased **;** needs a higher concentration of substrate to saturate active sites / AW **;** **A** needs a higher concentration to reach, ½ Vmax / Vmax *idea that* inhibitor prevents substrate from binding (to active site) so more substrate required (to compete) **;**	**1**
	Total:	**15**

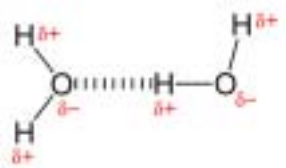
Question	Answer	Marks
3(a)	*Mycobacterium tuberculosis I Mycobacterium bovis* **;** *correct spelling*	**1**
3(b)	**1** deaths decrease to zero **/** new cases fall to 4 per 100 000, (in 2010) **;** **A** other values that confirm decrease *(after introduction of antibiotics*) **2** deaths relatively constant / approx. 52 per 100 000, until 1943–6 (*accept any in range*) **; A** for a few years **A** *idea that* rate of decrease not improved **3** number of new cases initially stops increasing / plateaus **;** **4** (overall) number of new cases increases before decreases **;** **5** data to support mp 3 or 4 **;** e.g. 88–90 per 100 000 (1940–44) rises to / drops from, 104 per 100 000 in 1946 **;** *(after introduction of vaccination)* **6** no change in trend of decrease in deaths / deaths continue to decrease **;** **7** decrease from 36–40 per 100 000 (in 1948) **;** **8** short plateau / 100 per 100 000 (until 1950), in new cases, then decreases **;** **9** antibiotics may not have been in widespread use at first **; ora** **10** vaccine, reduces spread / gives (herd) immunity **;** **11** *ref. to* decrease less steep initially as time needed to build up herd immunity **;** **12** AVP **;** e.g. suggestion why increase in new cases after introduction of antibiotics suggestion why cases have not decreased to zero not possible to tell relative effect of vaccine v antibiotic	**max 5**

Question	Answer	Marks
3(c)(i)	some people who are HIV+ will have developed HIV / AIDS **;** HIV / AIDS weakens immune, system / response **; ora** *allow **ecf** for HIV+ people* detail of why immune response weakened **;** people with HIV / AIDS, prone to opportunistic diseases **;** **A** TB is an opportunistic disease **A** more susceptible to, diseases / TB (Table 3.1 shows that) a greater proportion / AW, people die of TB if they are HIV+ **;** AW e.g. greater chance of dying from TB if HIV+ dormant TB more likely to become the active form in, HIV+ people / people with HIV / AIDS **;** AW AVP **;** a high proportion of deaths from HIV / AIDs is due to TB mortality HIV+ people do not respond well to treatment for life-threatening diseases inability to pay for treatment for all conditions for HIV+ people	**max 3**
	Total:	**9**

Question	Answer	Marks
4(a)	✓ ✗ ✗ ✓ ✓ ✓ ✗ ✓ ✗ ✗ ✓ ✗ ✗ ✓ ✗ ✓ one mark per column ;;;;	**4**
4(b)	*allow diagrams with glycine on right*  bond forms between the C of the carboxyl group and the N of the amino group **;** **A** amine *for amino* water / H_2O, is formed **;** **A** condensation (reaction) **R** hydrolysis amino acid residues correctly drawn **;**	**3**

Question	Answer	Marks
4(c)	receptor(s) / cell signalling ; cell recognition / antigens ; cell adhesion ; form H-bonds with water to stabilise membrane ; enzyme ; AVP ; e.g. *ref. to* role in antigen presentation / MHC	**max 2**
	Total:	**9**

Question	Answer	Marks
5(a)	**1** DNA (double helix) unwinds **;** **A** uncoils **I** unzips **R** DNA strand unwinds **2** hydrogen bonds break between, base pairs / bases / strands **;** **3** both strands used as templates **;** **4** catalysed by / AW, DNA polymerase **;** **5** *ref. to* (free) activated nucleotides / AW **;** **6** complementary (DNA) nucleotides added **;** **R** RNA nucleotides **A** described in terms of complementary base pairing **7** step-by-step / sequentially / AW **;** **8** *idea that* process continues, along whole DNA molecule **;** **9** replication bubbles / described **or** *ref. to* Okazaki fragments **;** **10** replication is semi-conservative / each newly formed molecule contains one original and one newly synthesised strand **11** AVP **;** e.g. *ref. to* repair / proofreading *ref. to*, helicase / ligase *in correct context*	**max 5**
5(b)	telomere(s) **;**	**1**
5(c)(i)	adenine <u>and</u> guanine **;**	**1**
5(c)(ii)	*idea that* purines and pyrimidines are different sizes / two rings and one ring **;** purine normally bonds with pyrimidine (to maintain DNA double strand width) **;** *idea that* two purines or two pyrimidines will distort the double helix width (in a transversion event) **; ora** AVP **;** e.g. (transversion event) more likely to be detected by the repair mechanism **ora**	**max 2**
5(d)	*idea that* mutation occurs for a gene controlling cell division **;** detail **;** e.g. proto-oncogene to oncogene tumour suppressor gene switched off **;** *ref. to* disruption of cell cycle / shortened interphase **;** (results in) uncontrolled cell division **; I** uncontrolled growth other detail of result of mutation **;** e.g. divide indefinitely / no programmed cell death do not respond to signals to stop dividing loss of, specialisation / function	**max 3**
	Total:	**12**

Question	Answer	Marks
6(a)	two water molecules drawn with correct bonding **;** **I** Fischer projections partial charges shown as σ+ on at least one H and σ– on at least one O **;** hydrogen bond shown **;** e.g. labelled or as dashed or dotted lines between H of one molecule and O of another **;** 	**3**
6(b)(i)	cohesion **;**	**1**
6(b)(ii)	high / large, latent heat of, vapourisation / evaporation **;** **A** takes a large amount of, heat / energy, to evaporate / turn liquid to water vapour	**1**
	Total:	**5**