Cambridge International AS & A Level

BIOLOGY (9700) PAPER 2

Past Paper Questions By Topic
+ Answer Scheme

2015 - 2020

Complete Syllabus

PapaCambridge

Appendix A

Answers

1. 9700_s17_ms_21 Q: 1

(a)	**A** chloroplast / mitochondrion ; **B** chromosome(s) / chromatid / chromatin ; **C** Golgi (body / apparatus / complex) ; **D** nucleolus ;	**4**
(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**

2. 9700_s17_ms_22 Q: 1

(a) *one mark per blank box* — **5**

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

(b) **max 4**

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

Total: 9

3. 9700_w17_ms_23 Q: 1

(a)	actual length = image length / magnification ; **A** A = I / M M = I / A I = A × M or magnification triangle 2.5 (μm) ;; *for 40 mm **X–Y** length* **A** 2.6 (*for 40 / 41 mm*) **A** 2.4 (*for 38 / 39 mm*) *max 1 for* *incorrect or no answer but correct calculation e.g. 40 000 ÷ 16 000* *correct answer but to more than one decimal place* *correct measurement and correct calculation but incorrect conversion*	**3**
(b)(i)	mitochondrion ; **A** mitochondria *max 1 for function* produces / makes / synthesises / provides / AW, ATP **or** releases / provides / supplies, energy **or** aerobic respiration ; AVP ; e.g. part of the urea cycle β-oxidation of fat oxidative phosphorylation	**2**
(b)(ii)	rough endoplasmic reticulum ; **A** rough ER **I** RER ribosomes are attached ; *accept mp2 if organelle identified as endoplasmic reticulum / RER*	**2**

4. 9700_m16_ms_22 Q: 2

(a) magnification = $\frac{\text{image length}}{\text{actual length}}$ / AW ; **A** M = I / A **or** M = O / A

correct calculation or to 2 or 3 significant figures using the correct calculation

(×) 2778 / 2780 / 2800 ; ; (for 25 mm) **A** ± 1 mm in measurement

one mark if correct measurement stated and divided by actual size but incorrect answer owing to, rounding up error / incorrect conversion factor

(25 000 / 9.0) ;

[3]

(b) spherical / spheroid / AW ;

(nuclear) envelope / two (nuclear) membranes / double membrane ;
(containing) nuclear pores ;

(contains) chromatin / chromosomes ;
DNA and, proteins / histones ;

contains, nucleolus / nucleoli
or
nucleolus is / nucleoli are, dark(er) staining / spherical / defined ;

AVP ; e.g. outer membrane continuous with RER
heterochromatin and euchromatin
contains nucleoplasm

[max 3]

[Total: 6]

5. 9700_w15_ms_21 Q: 1

(a) ATP production ; **A** supply energy (to the cell / for cell reactions) **R** energy production
(site of) aerobic respiration / oxidative phosphorylation ;
AVP ; e.g. lipid metabolism / beta oxidation [max 1]

(b) crista / cristae / inner membrane ; [1]

(c) (×) 48 571 **or** (×) 50 000 ;;

$\frac{34\,000}{0.7}$ **or** $\frac{35\,000}{0.7}$

if answer incorrect award one mark for:
correct measurement (34 or 35 mm) and correct formula used (M= I/A), as above but incorrect conversion to μm
or
correct calculation but units given
or
correct calculation but decimal places given [2]

(d) **1** resolution / resolving power, too low ;
2 further detail ; e.g. only 250 nm resolution
resolution only half wavelength of light
wavelength of light, too long / not short enough
width of membranes only 7 nm ;
3 (such) thin sections not possible ;
4 inner membrane / cristae / internal structure, could not be seen ;
5 magnification this high not possible ;
mp1 and mp5 allow correct comparative statement with electron microscope [max 2]

(e) circular DNA ;
small / similar, size ; **A** 0.5–15 μm
70S / small(er) / 18 nm, ribosomes ;
AVP ; e.g. binary fission / naked DNA [max 2]

[Total: 8]

6. 9700_w15_ms_23 Q: 4

(a) (i) (α 1–6) glycosidic ; **A** glucosidic [1]

(ii) many, terminals / ends, for, attachment of glucose / removal of glucose ;
glucose can be stored quickly ;
glucose can be, mobilised / AW, when required / quickly ;
A more easily mobilised / AW **A** glycogen can be hydrolysed easily
makes it more compact / takes up less space / high density ; [max 2]

(iii) no branching / single unbranched chain / straight / linear ;
different monomer / beta glucose / β glucose ; **ora**
alternate position of monomers in cellulose / AW ; e.g. rotated 180°
only one type of (glycosidic) bond / 1–4 only / no 1–6 ;
forms hydrogen bonds with other cellulose molecules (to give parallel chains);
forms, microfibrils / fibres ; [max 2]

(b) (i) *max 1 for correct working if no answer or answer incorrect*

$$\frac{385\,000}{2\,000\,000} \times 100$$

19.25 / 19.3 / 19 ;; [2]

(ii) **1** energy lost in processing crops to make animal feed ;

animals
2 food, not eaten / wasted ;
3 food, not digested / indigestible / not absorbed / egested
or
energy lost in, excretion / urea ;
4 energy lost, in respiration / as heat ; **A** movement / used for metabolism
5 (some) maintain constant body temperature which requires energy ; AW

humans
6 energy lost in processing animals for human food ;
7 (named) animals parts not edible ;
8 AVP ; e.g. some animals do not have enzyme to digest cellulose [max 3]

[Total:10]

7. 9700_s19_ms_22 Q: 5

(a)	glycine in monomer column only ; **monomer**: thymine (nucleotide), α-glucose, β-glucose ; ; **polymer**: cellulose, messenger RNA, glycogen, α-globin ; ; **monosaccharide**: β-glucose, α-glucose ; ; **polysaccharide**: cellulose, glycogen ; ; **I** glycine **I** glycine **I** glycine **I** incorrect spellings *if α-globin appears once and is in monomer column instead of polymer column, and the monomer and polymer columns are otherwise correct, allow one mark (ecf)*	**5**
(b)	*any three from:* *allow points from an annotated diagram* **1** phosphate head = hydrophilic / polar ; **2** fatty acid / hydrocarbon, tail / chains = hydrophobic / non-polar ; *if mps 1 and 2 not gained, allow one mark for, hydrophilic / polar, heads and, hydrophobic / non-polar, tails* **3** (so) heads face, watery environment / tissue fluid / cytoplasm / cytosol / aqueous environment ; **4** (fatty acid) tails, form hydrophobic core / form area away from water / face each other / AW ; **5** ref. tails and hydrophobic interactions ;	**3**

8. 9700_w18_ms_21 Q: 3

(a)(i)	*any three from* (polymer / polysaccharide of) β-glucose ; glycosidic, bonds / linkages ; **A** glucosidic (β) 1–4 (glycosidic) bonds ; **R** if 1–6 also given *ref.* to (β) glucose units, linked at 180° to each other / alternately orientated / AW ; unbranched (polymer) / straight chain / linear ; able to form hydrogen bonds with parallel chains / AW ;	**3**
(a)(ii)	chloroplast / granum / thylakoid / middle lamella / large vacuole / nucleus at edge of cell ;	**1**
(a)(iii)	provide energy (for the cell) ; **R** produce energy any two examples ;; e.g. biosynthesis **A** named example active transport / proton pumping movement / described, e.g. movement of, vesicles / chromosomes endocytosis / exocytosis	**3**
(b)	*any two from* water molecules are dipoles ; **A** polar (each water molecule has) σ+ hydrogen (atoms) and a σ– oxygen (atom) ; the positively charged hydrogen (atom) of one water molecule is attracted to the negatively charged oxygen (atom) of another water molecule ; weak attraction between water molecules ;	**2**
(c)	*any two from* water molecules are polar ; ions are charged ; *ref.* attraction between water molecules and ions ; AVP ; e.g. oxygen σ– faces positive ion	**2**

9. 9700_w18_ms_23 Q: 1

(a)	*any three from* **1** modification / process / described, of, proteins / polypeptides ; **2** further detail of modification ; *examples of modification* folding of polypeptides / protein folding assembly of polypeptides to form quaternary structure addition of (named) prosthetic group addition of sugars / addition of carbohydrate / glycosylation cutting of polypeptides removal of, methionine / first amino acid making proteins functional **3** packaging into vesicles / formation of Golgi vesicles / formation of secretory vesicles ; **A** 'budding off' / 'breaking off' / transport proteins in Golgi vesicles **4** formation of (primary) lysosomes ; **5** AVP ; e.g. modification of lipids synthesis of, phospholipids / glycolipids synthesis of cell wall polysaccharides	**3**
(b)(i)	(mitochondria) provide / make / produce, ATP ; **A** needs a lot of, ATP / energy **R** 'produce / make, energy' (ATP / energy required for) protein synthesis / movement of (secretory / Golgi) vesicles / exocytosis ;	**2**
1(b)(ii)	*any two from* **1** mitochondria have (circular) DNA ; **2** mitochondria, have / make, (70S) ribosomes (for, protein synthesis / translation) ; **R** if 80S ribosomes **3** mitochondria can divide ; **R** by mitosis **4** AVP ; **5** AVP ; e.g. (mitochondrial / mt) DNA codes for (some mitochondrial) proteins mRNA transcribed from mtDNA mitochondria produce their own tRNA can replicate DNA **I** mitochondria have a double membrane	**2**
(c)(i)	*any three from* protein coat / capsid ; **A** protein layer **R** 'cell wall of protein' nucleic acid (core) ; **R** if 'in a nucleus' DNA or RNA ; acellular / non-cellular / 'not a cell' ; size – *accept within range* 15 nm to 1000 nm ; AVP ; e.g. (protein coat made of) capsomeres surrounded by, membrane / envelope / (phospho)lipid bilayer **I** antigens / enzymes	**3**
(c)(ii)	*any one from* (viruses) pass through plasmodesmata ; **A** 'cytoplasmic strands, through cell walls / between cells' via symplast pathway ;	**1**

10. 9700_w18_ms_23 Q: 2

(a)(i)	water shown formed from –OH and –H ; **A** H_2O formed without indicating where from peptide bond shown correctly between C of carboxylic acid and N of amino group ; complete dipeptide drawn ; **A** hydrogen 'up or down'	**3**
(a)(ii)	R group / side chain / variable group / residual group / functional group ; indicate, different amino acids / type of amino acid ; **A** specific to each amino acid **A** the two amino acids are different **A** two examples of R groups, e.g. –H and $–CH_3$ both amino acids have different R groups = 2 marks	**2**
(b)	*any two from* straight chain / linear, v helix / helical ; **I** coil(ed) **R** branched / branching β-glucose, not α-glucose ; **A** β-1:4 glycosidic bond v α-1:4 glycosidic bond (β-)glucose / monomers / residues, are arranged, rotated 180° to each other / AW ; AVP ; e.g. more hydrogen bonds	**2**
(c)	*any four from* **1** (molecules) form fibrils and fibres ; **2** hydrogen bonding between (cellulose) molecules ; **3** (cellulose molecule) is straight / linear ; **4** (straight chain allows) molecules lie parallel to each other ; *mp4 dependent on mp3* **5** gives strength (to cell wall) to, prevent cell bursting / withstand (turgor) pressure / AW ; **R** if only in context of a cellulose molecule **6** *ref.* to fibres at angles / criss-cross / AW ; **7** *idea of* many gaps, in wall / between fibres, allowing passage of water / named) substances / making cell wall permeable ; **I** plasmodesmata **R** partially / AW, permeable **8** AVP ; e.g. cellulose is insoluble many –OH groups (for hydrogen bonding)	**4**

11. 9700_m16_ms_22 Q: 1

A sucrose ;

B peptide ; **A** amide

C cellulose ;

D biuret ; **A** (dilute) potassium / sodium, hydroxide (solution) and (dilute) copper sulfate (solution)
R Millon's solution

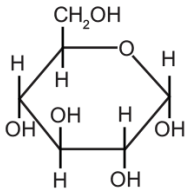
E glycerol ;

[5]

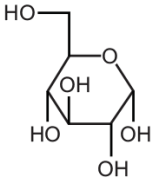
[Total: 5]

12. 9700_s16_ms_22 Q: 6

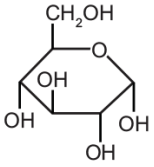
(a) (i)



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]**

(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]**

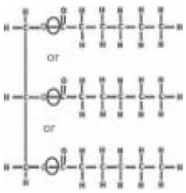
(ii) **1** (in DNA / gene) altered, sequence / AW, of, nucleotides / bases ;
I DNA sequence
2 base substitution
or base / nucleotide, replaces another, base / nucleotide;
A example *must be in context of, DNA / gene*
3 (mRNA synthesised) during <u>transcription</u> ;
4 (mutation leads to) altered / AW,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

13. 9700_w20_ms_21 Q: 2

(a)(i)	circle around any one correct bond ; **R** if circle includes the double bond O  	**1**
(a)(ii)	condensation ; **A** dehydration (synthesis) **A** esterification three ;	**2**
(b)(i)	macromolecule and extracellular enzyme ;	**1**
(b)(ii)	4 (hours) ;	**1**
(b)(iii)	*any **four** from:* **1** triglyceride hydrolysis / action of lipase, produces fatty acids ; **2** decrease in pH / described, because of production of (fatty) acids ; **3** steepest rate of (pH) decrease at start because, substrate / triglyceride, concentration highest ; **4** rate of pH decrease / AW, slows because decrease in rate of formation of fatty acids ; **5** rate of pH decrease /AW, slows because enzymes, not at optimum / begin to denature ; **6** rate of pH decrease slows because, substrate / triglyceride, being used up **or** substrate concentration becomes a limiting factor / AW ; **7** *ref. to* plateau at 18 hours / at pH 6.1, enzymes are denatured ; **8** *ref. to* plateau at 18 hours / at pH 6.1, as all the, triglyceride / substrate, has been, hydrolysed / AW ; **9** optimum pH for lipase activity, is pH 8 / alkaline conditions / at the start ; **10** AVP ; e.g. *ref. to* tertiary structure of lipase	**4**
(b)(iv)	*any **two** from:* (initial) decrease in pH would be more rapid ; plateau would be reached earlier ; AW plateau would be at the same pH (as the previous experiment) ;	**2**

14. 9700_s18_ms_23 Q: 2

(a)	*too small to see* 35 μm is 0.035 mm (smaller than 0.05 mm) **or** 0.05 mm is 50 μm (larger than 35 μm) ;	**1**
(b)	*in context of light microscope* *two from:* 1 resolution / resolving power, poor / not high enough / AW ; 2 ability to distinguish between two points not high enough / AW ; 3 ref. to limit of resolution ; e.g. organelles smaller than, 0.2 μm / 200 nm, not visible **A** organelles smaller than 200 nm (accept range 100–300 nm) 4 organelle too small to interfere with light waves ; **A** wavelength of light too long **I** organelles are small	**2**
(c)(i)	ester ;	**1**
(c)(ii)	facilitated diffusion ; *plus two from:* (diffusion) through (membrane), transport / channel / carrier, protein ; **A** pore **I** transmembrane / integral, protein high to low concentration **or** down, concentration / diffusion, gradient ; passive ; **A** no, ATP / (metabolic) energy, required *if active transport incorrectly stated allow ecf* through (membrane), transport / carrier, protein ; **R** channel protein low to high concentration / against a concentration gradient / requires ATP / requires (metabolic) energy ;	**3**
(c)(iii)	*four from:* 1 ref. to hormones, released into / arrive at adipocyte in, blood stream ; **A** released by another, cell / tissue (elsewhere in the body) 2 hormone is, (chemical) signal / signalling molecule / messenger molecule ; 3 (adipocyte is) target cell ; **A** (adipose is) target tissue 4 (hormone) binds to / AW, receptor ; *in context of* on cell surface membrane of adipocyte 5 ref.to receptor (shape) complementary to hormone ; **A** specific receptor for hormone 6 (binding) triggers / stimulates, reactions within the cell ; **A** cascade of reactions **I** binding causes a reaction to occur 7 cell signalling results in a response, qualified ; e.g. triglyceride breakdown fatty acids (and glycerol) produced fatty acids leave, the cell / via transport protein	**4**
(d)	*any one valid suggestion:* *e.g.* do not have mitochondria / mitochondria required (to produce ATP) ; do not have nucleus (so no mRNA produced) ; no mRNA for enzyme synthesis ; (required) enzymes not present ; impermeable to fatty acids / AW ; have lost / do not have, the required organelles ;	**1**

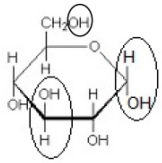
15. 9700_m20_ms_22 Q: 2

(a)	*any **two** from:* *PAP2, because* activity is shown at 0.0 mmol dm^{-3} / does not require Mg^{2+} for activity ; (at 0.0 mmol dm^{-3}) 30 arbitrary units activity ; no / very little, change at all concentrations of Mg^{2+} ;	**2**
(b)	**A** substrate for phosphatidate throughout **A** enzyme for PAP throughout *any **four** from:* 1 increasing concentration of phosphatidate increases PAP activity ; 2 at higher phosphatidate concentrations the increase in PAP activity is less steep ; 3 data to support marking point 1 or 2 ; 4 phosphatidate (concentration) is limiting factor / enzyme concentration begins to be limiting at higher concentrations (of phosphatidate) ; 5 at low phosphatidate concentrations, not all (enzyme) active sites are occupied / active sites are available or more active sites occupied at higher concentrations / AW ; **R** all active sites saturated (at higher concentrations)	**4**
(c)(i)	*any **two** from:* (fatty acid tails are long) hydrocarbon chains / many C-H bonds ; ref. to dense packing / large mass per unit volume ; AVP ; e.g. qualified ref. to role of hydrogens (in oxidative phosphorylation) bond energy released when bonds are broken ;	**2**
(c)(ii)	*any **two** from:* hydrophilic / polar, (phosphate) head and, hydrophobic / non-polar, (fatty acid) tails ; (so) heads face, watery environment / tissue fluid / cytoplasm / cytosol / aqueous environment ; (so) tails, form hydrophobic core / form area away from water / face each other ; **A** ref. to tails and hydrophobic interactions	**2**

16. 9700_s20_ms_21 Q: 3

(a)(i)	*one mark for units* *one mark per column* 		V_{max} µmol min^{-1}	K_m mmol dm^{-3} ;
J	60	0.2
K	50 ;	0.2 ;		**3**
(a)(ii)	*K compared with J* *max 3 from mp4–mp8* *any four from:* 1. rate of reaction is lower at all substrate concentrations ; 2. *ref. to* greater difference as substrate concentration increases ; 3. rate of reactions for **J** and **K** compared at two substrate concentrations to support mp1 or mp2 *or* manipulated data at two substrate concentrations to support mp2 ; 4. less efficient / acts more slowly / AW ; 5. active site is still binding substrate ; 6. *idea that* active site is less effective at catalysing reaction 7. *or* enzyme has lower affinity for substrate ; 8. (replaced / changed) amino acid is important in, shape / structure, of active site ; 9. AVP ; e.g. how the mutation may have changed interaction between substrate and, active / catalytic, site e.g. *ref. to* hydrogen bonding / transfer of electrons	**4**
(b)	each polypeptide shows primary, secondary and tertiary structure ; **A** description of levels of structure both (forms of G6PD / enzyme) composed of more than one polypeptide (so have quaternary structure) ;	**2**

17. 9700_s20_ms_23 Q: 4

(a)	converted the measured length (in mm) to µm (and dropped the, µm / units) *or* multiplied the measurement by 1000 ;	1
(b)	phosphate(-containing) heads are hydrophilic *or* triglycerides do not have a hydrophilic portion ; lipid droplet is stored in / phosphate heads can interact with, cytosol / aqueous environment / watery environment ;	2
(c)	to, digest / break down, worn out organelles / waste metabolic products / toxic substances / AW ; **A** invading pathogens	1
(d)(i)	correct orientation of H and OH on, C1 and on C3 ; OH added to carbon 6 ; 	2
(d)(ii)	positive result is coloured precipitate ; *only allow if hydrolysis noted* **A** green / yellow / orange / brown / red, *for colour* *any two from* *ref. to* (heat with) Benedict's (reagent / solution) and, negative test / no colour change / remains blue, and test again with Benedict's ; boil with (hydrochloric) acid ; **A** hydrolyse with, acid / enzyme AVP ; e.g. use a fresh sample to hydrolyse boil for 5-10 minutes with acid cool before neutralising neutralise (remaining acid) with alkali test with universal indicator paper (to check for pH7) compare with a control *allow one mark for heat with Benedict's and coloured precipitate*	3
(e)(i)	*any two from* *(higher K_m enzyme)* has a lower affinity for its substrate ; **A** binds substrate less easily needs a higher concentration of substrate to reach, V_{max} / maximum activity / ½ V_{max} ; less likely to be saturated with substrate ; variations in substrate have greater effect on rate of reaction ;	2
(e)(ii)	*any two from* *in the vacuole ; **A** in lysosome* qualified ; e.g. has, acidic / low pH, environment contains, acid hydrolases / enzymes that require low pH non-regulatory trehalase needs acidic conditions for optimum activity cytosol has neutral pH so likely to be location of regulatory trehalase (and enzymes are in different locations) if in cytosol then this would mean low pH and other enzymes, would (partially) denature / work below optimum as acid conditions required, will be in area protected from rest of cell and vacuole has the tonoplast as barrier **A** lysosomes are membrane bound	2
(e)(iii)	yes because they both work, within the cell / inside the cell ;	1
(f)	*any three from* *likely to be regulatory trehalase / unlikely to be non-regulatory trehalase* nearer to optimum of regulatory trehalase (of S. cerevisiae) ; ora pH 6.5 / 6.6 nearer to pH 7.0 (than to pH 5.0 of non-regulatory trehalase) ; no / (very) low, activity at pH 4.5 *or* greater activity at pH 7 than pH 4.5(–5.0) ; *alternative* suggestion that enzyme could be a different form of trehalase ; because has different optimum pH to both regulatory and non-regulatory ; pH 6.5 / 6.6, rather than pH 7.0 or pH 5.0 ; *general* (so) likely to act in the cytosol with, neutral pH / pH7 ; unlikely to be found in vacuole / lysosome, with low / acid, pH ;	3

18. 9700_w20_ms_22 Q: 5

(a)	fructose ; **I** α or β	**1**
(b)	*any **two** from:* formation of enzyme-substrate complex / substrate fits into active site ; **A** substrate binds to active site (so) reactants held close together (e.g. for bond formation) ; lowers, activation energy / energy of activation ; **A** Ea / Ae *can award annotated on a sketch* detail ; e.g. transfer of electrons strain on bonds alternative pathway holds substrate in a way that the bonds needed to be broken are exposed	**2**
(c)	**I** *ref. to* denaturation, either mp2 **or** mp10 can be awarded *any **four** from:* *immobilised* **1** higher optimum temperature ; AW e.g. peak / max activity / 100% activity ; **2** 74 / 75 / 76°C, v, 56 / 57 / 58 / 59°C ; **A** one correct value and calculation e.g. 17°C lower **3** *idea that* greater range of pH with, higher activity / greater stability ; AW *allow use of comparative data at one pH value to support if answer unclear* **4** *idea that* if pH changes, less effect on enzyme activity ; **A** resists changes in pH **5** *ref. to* more active at, higher temperatures / temperatures above 68°C ; **A** more thermostable / less effect on enzyme at higher temperatures **A** free enzyme not active above 70°C *allow use of comparative data at one temperature to support if answer unclear*	
(c)	**6** one advantage of immobilised ; **e.g.** reusable ○ less / no, contamination of product (by enzyme) ○ easier, downstream processing / separation of enzyme from product ○ longer shelf-life useful if enzyme, difficult to obtain **A** *ref. to* cost effective ○ can use in continuous processes so more productive ○ suggestion that (can carry out process at) lower pH (more acid conditions and) may be more effective against microorganisms *free enzyme* **7** higher activity, at lower temperatures / between 35°C to 68°C ; *in context of a range, quoting one temperature not enough* **8** two temperatures, comparative values for both enzymes to support mp7 ; **9** optimum temperature lower so cheaper maintaining that temperature ; AW **A** lower temperatures cost efficient to maintain and enzyme works well / AW **10** (values of optimum) 74 / 75 / 76°C, v, 56 / 57 / 58 / 59°C ; **A** calculation, e.g. 17°C lower **11** lower optimum temperature still high enough to kill microorganisms ;	

19. 9700_s19_ms_21 Q: 3

(a)(i)	*any two from:* (Neutrase® breaks down / hydrolyses) protein to, peptides / amino acids / smaller molecules ; **A** idea of increase in solubility during the reaction / AW, more light passes through / more light is transmitted / less light is absorbed ; *idea that* 100 s is long enough to see the progress of the reactions ; **I** 'the rate of reaction can be calculated' **I** 'allow time for reaction to complete'	**2**
(a)(ii)	*accept* ***ora*** *where appropriate* **1** copper sulfate, decreases / AW, the activity of Neutrase (*ref. to* **A** or **B**) ; **2** 0.01 (mol dm^{-3}) / low concentration, $CuSO_4$ has less of an effect than, 0.05 (mol dm^{-3}) / high concentration (*ref. to* **A** and **B**) ; **3** potassium sulfate has, little / no, effect on activity (*ref. to* **C**) ; **4** data quote to show absorbance for two different lines at the same time ; *one time and two absorbance readings from different lines on the graph with the unit for time used once anywhere in answer, allow 'at the end' for 100 s* **5** copper sulfate is an inhibitor of Neutrase ; **6** potassium sulfate is not an inhibitor ; **A** 'less of…' **7** copper sulfate binds to Neutrase ; **A** anywhere **8** substrate cannot enter active site / ESCs do not form (so protein not hydrolysed) ; **A** fewer ESCs	
(b)	*higher productivity / higher yield and fewer costs because* enzyme can be re-used ; enzyme can be easily recovered ; downstream processing is easier ; product, not / less, contaminated ; **A** less purification needed longer shelf-life of enzyme ; reduces product inhibition ; enzyme is, more stable / less likely to denature *or* described ; **A** thermostable / can work at high temperatures **A** in context of change in pH **I** 'can withstand changes in temperature'	**2**

20. 9700_s19_ms_22 Q: 6

(a)(i)	*any two from:* correct ref. to time ; correct ref. to volume of oxygen ; **A** gas for oxygen **A** volume of water displaced by oxygen **A** measuring height of water level (decreasing) **A** cm^3 instead of volume AVP ; subtract volume of gas displaced by H_2O_2 addition	**2**
(a)(ii)	*any two from:* greater surface area (over which catalase released) ; greater number of cells, damaged / cut open, to release catalase ; higher concentration of, catalase / enzyme ; **A** more, catalase / enzyme **A** more active sites available *must be linked to idea of more enzyme (i.e. must get mp 2 or 3)* so, higher rate of reaction / more enzyme-substrate complexes / more oxygen released ; AW	**2**
(b)	increase to optimum and steeper decrease ; **A** if curve does not touch one or both axes	**1**

21. 9700_m18_ms_22 Q: 3

(a)	*any **four** from:* 1 disaccharide to monosaccharides ; 2 **R** is water / water required ; 3 hydrolysis reaction ; 4 glycosidic bond broken ; 5 **S** is α-glucose ; 6 detail of enzyme action ; e.g. induced fit or lock and key hypothesis described 7 AVP ; e.g. (β-)1,4(-glycosidic) bond broken	**4**
(b)(i)	*intracellular advantage:* *idea of* control / maintaining balance / efficient metabolism ; e.g. if, (enough) glucose / galactose / monosaccharides, present then no need for, uptake / breakdown, of lactose avoids osmotic problems as no build-up of monosaccharides high quantities of product means no requirement for use in respiration by cell *disadvantage:* loss of product / reduced productivity / product required continuously / slows rate of reaction / ref. to enzyme needing to remain active ;	**2**
(b)(ii)	*any **one** from:* products and enzyme kept separated / AW ; product removed immediately ;	**1**
(b)(iii)	*any **one** from:* inert / unreactive / cannot be digested by lactase / AW ; non-toxic ; insoluble ; long shelf-life ; AVP ; e.g. can create small mesh size suggestion of enzyme attachment to fibres	**1**
(c)	*any **three** from:* 1 ref. to controlled variables ; e.g. constant, pH / temperature 2 take samples at timed intervals ; **A** regular intervals 3 determine, substrate concentration / product concentration ; 4 plot graph of, dependent variable (*y*-axis) against time (*x*-axis) ; 5 ref. to rate of disappearance of substrate **or** ref. to rate of appearance of product ; 6 determine initial rate ;	**3**

22. 9700_s18_ms_21 Q: 3

(a)	*four from:* activity increases and decreases / activity peaks, for both ; **A** both have maximum activity / optimum temperature, at 60 °C activity is 76% at 40 °C for both ; (overall) activity decreases more steeply for free enzyme after, optimum / maximum / 60 °C ; **A** ora at 80 °C free enzyme is inactive / (fully) denatured / 0%, but immobilised enzyme, is still active / is partially denatured / 27% ; for immobilised enzyme, activity is higher (than free enzyme) at all temperatures above 60 °C ;	**4**
(b)	*two from:* (alginate / immobilisation), is protective / has stabilising effect ; **A** enzyme, less / not, exposed (to solution) hydroxide ions do not penetrate the alginate beads ; shape of active site (of immobilised enzyme) is, less / not, disrupted / AW ; **A** active site is (more) complementary to substrate **A** few(er) active sites are, altered / changed few(er) bond(s) within (immobilised) enzyme break ; **A** hydrogen / ionic **R** peptide / disulfide at pH 8 immobilised enzyme is not fully denatured ; **A** pH 7 / 7.5	**2**
(c)	*explanation must match variable stated* *standardised variable* concentration / volume, of, enzyme / substrate, solution ; *explanation for standardised variable* *idea that:* concentration / volume, of, enzyme / substrate, influences the probability of collisions between enzyme and substrate molecules / formation of enzyme/substrate complexes ; **A** number of / frequency of, collisions between substrate and enzyme **or** *standardised variable* use the same method for determining enzyme activity ; e.g. time when samples are taken *explanation for standardised variable 3* ref. to how enzyme activity is measured by conversion of substrate to product ;	**2**
(d)	*two from:* 1 (may be able to) obtain more product (per unit time) ; 2 can use higher temperatures (to obtain more product) / still active at higher temperatures ; **A** thermostable 3 does not denature (as easily as free) if temperatures increase / AW ; 4 immobilised enzyme can be reused / immobilised enzyme can be recovered ; 5 enzyme does not contaminate product ; **A** no effect on quality of product, e.g. taste 6 less, purification (of product) / downstream processing, needed ; **A** idea that downstream processing less, complex / difficult 7 longer shelf-life of enzyme / AW ; **A** durability 8 AVP ; e.g. allows continuous production (rather than batch) some enzymes are difficult to extract **I** ref. to cost / cost effective unqualified **R** reduces effect of end product inhibition	**2**

23. 9700_s18_ms_23 Q: 5

(a)(i)	*three from:* 1 papain higher optimum temperature than ficin / ora **or** temperature is higher for papain for percentage of maximum activity of 100 **A** 100% activity / maximum activity / peak of activity **or** (100% of maximum activity) papain 60 °C v ficin 45 °C ; 2 papain (overall) less steep increase / AW, (to peak) / ora ; 3 papain steeper decline / AW (after peak) / ora ; *for mp 2 and 3 allow ecf for a ref. to time, e.g. rapidly / slowly* 4 papain lower activity at all temperatures between 20 °C and, 54 °C / 55 °C ; 5 papain higher activity at all temperatures above, 54 °C / 55 °C ; 6 ref. to ficin more active over a greater range of temperatures ; **A** ref. to activity at temperatures around 100% maximum 7 comparative, extracted / manipulated, data to support mp, 2–6 ;	**3**
(a)(ii)	ficin, as higher activity at 37 °C / body temperature ;	**1**
(b)	*one from:* (may be able to) obtain more product (per unit time) ; **A** can use in a continuous system (may be) more, thermostable / tolerant to pH changes / AW ; **A** idea that enzyme less likely to denature product, not / less, contaminated with enzyme ; **A** less downstream processing longer shelf-life / AW ; enzyme, easier to recover / can be reused ; AVP ; e.g. ficin may be, costly / difficult, to extract	**1**
(c)(i)	extracellular (enzyme) ;	**1**
(c)(ii)	*any one valid example:* e.g. collagen / elastin ;	**1**

24. 9700_w18_ms_21 Q: 2

(a)	glycosidic ; **I** any qualification of glycosidic, e.g. β,1–4	**1**
(b)(i)	hydrolysis ;	**1**
(b)(ii)	*any two from* (lactose) lowers the water potential (in the lumen of the intestine) / AW ; reduces the water potential gradient (between the intestine and the blood) ; osmosis occurs ; (must be in the correct context)	**2**
(c)(i)	*any two from* pack more beads into the column ; slows the passage of milk through the column ; more time for enzyme to be exposed to substrate ; (small beads have a) larger surface area to volume ratio ; rate of reaction will be faster / AW ; **A** faster reactions will take less time to collect results (at each temperature) ; fast(er), rate of diffusion of, substrate / product ;	**2**
(c)(ii)	*any three from* both have same activity between 0 and 20 °C ; **A** described with values from **Fig. 2.2** between 20 °C and 40 °C, the activity of **F** increases more steeply than **I** ; **F**, has a lower optimum temperature / peaks at a lower temperature / AW, than **I** ; **A** optimum temperature, **F** is 40 °C v **I** is 50 °C at 70 °C, no activity for **F** but there is activity for **I** ; **A** 4% for **I** and 0% for **F** **A** denatured for 0% above the optimum temperature **I** has a steeper decrease of activity ; **I** is active over a greater range of temperatures (than F) ;	**3**

25. 9700_s17_ms_21 Q: 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**
(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**
(c)	*marks can be taken from a sketch graph* **1** competitive inhibitor, occupies / competes with substrate for / AW, active site (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**

26. 9700_s17_ms_22 Q: 2

(a)	addition of water shown ; **A** H_2O fatty acid(s) and glycerol ;	**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**
(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**
(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**
(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**

27. 9700_s16_ms_22 Q: 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]

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28. 9700_s16_ms_23 Q: 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]

(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]

29. 9700_w16_ms_21 Q: 3

(a) (i) peptide and disulfide ; **R** sulfide [1]

(ii) sequence / arrangement / order, of amino acids ; **I** *ref. to* disulfide bonds [1]

(b) (i) breaking a (covalent) bond with addition of water ; [1]

(ii) peptidoglycan / murein ; **A** carbohydrate / polysaccharide / amino sugar [1]

(iii) *four from*
substrate shape not (exactly) complementary to active site shape / AW ;

active site (partially) flexible / changes shape slightly, when substrate, enters / binds ;
(so) active site and substrate, now complementary / better fit ;

(allows) formation of enzyme-substrate complex ; **A** ES complex / ESC

AVP ; e.g. role of R-groups in active site interacting with substrate
lowers, activation energy / E_A, so products form [4]

(c) outside cells ; *can be in a general context or in context of enzymes* [1]

(d) (i) 2.9 mmol ; **A** 2.75–3.0 mmol [1]

(ii) 1 mmol ; [1]

(e) single graph line with lower gradient ;
reaches or approaches plateau ; [2]

[Total: 13]

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30. 9700_s15_ms_22 Q: 4

(a) either diagram A or B below (or more detailed – e.g. all carbons and all bonds shown in diagram A) ;;
A CH_30 for CH_2OH
I incorrectly numbered carbons

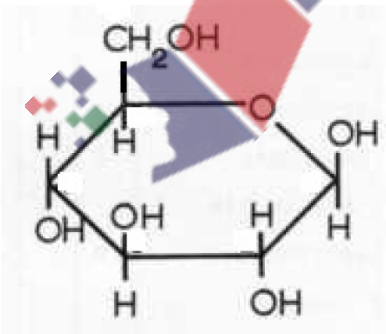


diagram A

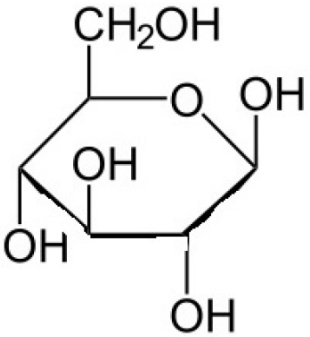


diagram B

if incorrect (e.g. If one or more H missing from the ring in diagram A ***or*** *if an H added to diagram B ring) allow one mark if*:

- hexose ring with oxygen shown in correct position and
- CH_2OH group in correct position and

OH groups of ring in correct position. **[2]**

(b) (i) accept *T. maritima* or **T** and *A.tumefaciens* or **A** throughout for the β-glucosidases
*accept **T** if stated as **B** (as long as **A** is clearly mentioned)*
*if only **A** or **T** stated, look for comparative phrase*
compare optimum temperatures

1 optimum temperature, **A** lower (than **T**) / **T** higher (than **A**) ;
A maximum activity **A** is at a lower temperature

2 40 °C(**A**) v 85° C(**T**) / **A** lower by 45 °C ;

3 one difference in shape of curve before or after optimum ;
e.g. after optimum, **T** does not have the less steep decrease after the initial steep decrease (unlike **A**)
before optimum, steepest increase for **A** is at the lower temperatures, (unlike **T**)

compare activity below and above 55 °C

4 below 55 °C, **A** has a higher activity / above 55 °C **A** has a lower activity, (than **T**) ;
ora
A has a higher activity at low(er) temperatures and a lower activity at high(er) temperatures ora

5 comparative data to support mp 4 ;

compare temperature ranges of activity

6 temperature range for activity is greater for **A** ; ora

7 (**A**) spans 80 °C v (**T**) spans 65 °C ; **A** (**A**) 10–90 °C v (**T**) 30–95 °C

*compare **L** for both*

8 **A** has a lower, **L** / lowest temperature for (detectable) activity **or** ora
L is 20 °C lower for **A** ; **A** 10 °C (**A**) v 30 °C (**T**) ;

9 (at **L**), A (relative) activity = 35%, **T** = 10% ;

*compare **H** for both*

10 **T** has a higher, **H** / highest temperature for detectable activity **or** ora
H is 5 °C higher for **T** ; **A** 95° (**T**) v 90 °C (**A**) ;

11 (at **H**) (relative) activity = 4%, **T** = 60% ;

if mp 10 data given to support mp 1, then CON = no marks for mp 1 or 10 **[max 4]**

(ii) **1** primary structure, dictates, folding of the polypeptide chain / tertiary structure ;
A idea that differences in primary structure leads to differences in, secondary / tertiary, structure
A in terms of folding to give the active site

similarity

2 same / (very) similar, (shape of) active site ;

3 active site (shape) is complementary to / AW, substrate / cellobiose ; **R** matches
A ES complex forms

differences

4 differences in, side-chain / R-group, interactions / AW ;

5 qualified ; e.g. differences in, numbers / types, of bonds
differences in bonding to give different stabilities
R different bonds without further qualification
R peptide bond

6 suggestion for thermal stability of **T** ; e.g. more bonds / more of a named bond type

7 suggestion of how active site may work in different ways ;
e.g. at lower temperatures, **T** induced fit mechanism may mean active site does not mould fully round substrate **[max 4]**

[Total: 10]

31. 9700_s20_ms_21 Q: 1

(a)	glycosidic ;	1
(b)	*any one from:* no double, bond / bonds, in hydrocarbon chain ; each carbon (atom) in the hydrocarbon chain is bonded to two hydrogen atoms ; there is, a full complement / maximum number, of hydrogen atoms on the hydrocarbon chain ; **A** aliphatic chain *for hydrocarbon chain* **A** hydrogens *for hydrogen atoms*	1
(c)	β-glucose / beta-glucose ; **R** B-glucose	1
(d)	**C** ;	1
(e)	**E** ;	1
(f)	*any one from:* **A** and **C** are, polar / hydrophilic ; **A** has many, OH / hydroxyl groups **B** is, non-polar / hydrophobic ; **A** has, only one OH / no groups, that interact with water	1

32. 9700_m19_ms_22 Q: 5

(a)	*any **one** from:* provides energy for the, production / secretion, of milk ; a substrate to form, milk sugar / lactose (in milk) ; AVP ;	1
(b)(i)	(pale) blue lilac / mauve / purple / AW ; green / yellow / orange / red green / yellow / orange / red ;	2
(b)(ii)	*any **two** from:* reducing sugar / glucose, diffused, into tubing **or** reducing sugar / glucose, moved into tubing, down a concentration gradient / from high to low concentration ; reducing sugar / glucose, small enough to move across tubing (so positive result in tubing and in beaker) ; hPRL / protein, too large to move into tubing (so only positive result in beaker) ; only movement of glucose was tested so no explanation possible for reducing sugars in general ;	2
(c)	*any **two** from:* facilitated diffusion ; uses (transport / carrier / integral membrane) proteins ; specific / specific binding site ; conformational change / AW ;	2
(d)	*any **four** from:* 1 hPRL is cell signalling molecule ; 2 acts on target, cells / tissues **or** acts on cells with PRLR ; 3 PRLR is (cell surface membrane) receptor ; 4 hPRL binds to PRLR ; 5 complementary binding / ref. to specificity ; 6 leads to / sets off, (specific) responses in mammary gland cell **or** detail ; e.g. secondary messenger triggered enzymes activated	4

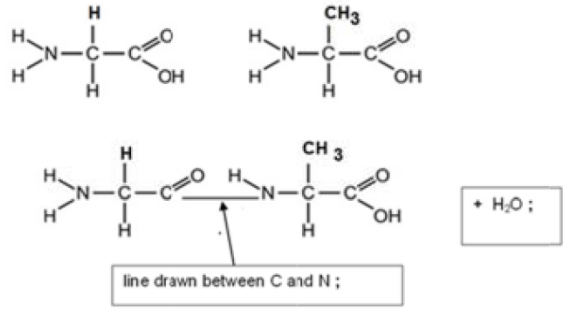
33. 9700_w19_ms_23 Q: 6

(a)(i)	nanometres / nm ;	1
(a)(ii)	**A ora** throughout (presence of) carbohydrate / sugar, chains / residues, on, (glyco)proteins / (glyco)lipids ; **A** there are no sugar chains on the inner surface **A** (presence of) glycoproteins / glycolipids (on external surface) **A** (presence of) cell surface antigens / receptors (on external surface) **A** (presence of) glycocalyx	1
(b)	**R** **1** cholesterol ; *one from* **2** maintains / regulates, fluidity of, membrane / phospholipid bilayer *or* at low temperatures, maintain / increase fluidity / prevents close packing **A** prevents hydrophobic 'tails' interacting at low temperatures *or* at high temperatures, stabilises the membrane / decreases fluidity ; **3** prevents passage (across membrane) of, hydrophilic / polar, substances ; **S** **4** phospholipid (monolayer) ; **R** phospholipid bilayer	4
(b)	*one from* **5** forms a bilayer ; **6** (bilayer is a) barrier to, water soluble molecules / polar molecules / ions ; **ora** not a barrier to lipid soluble molecules / allows lipid soluble molecules to cross membranes **A** non-polar / AW **7** (bilayer is a) non-polar barrier between cytoplasm and (aqueous) surroundings ; **8** hydrophilic 'head' forms hydrogen bonds with water ;	

34. 9700_m18_ms_22 Q: 1

(a)	*assume in context of transmission electron micrograph unless otherwise stated* *any **one** from:* *idea that* can see internal structures ; cannot see surface contours / AW ; **A** not 3-D appearance AVP ; e.g. ref. to small(er) depth of field ;	**1**
(b)	*any **two** from:* (flattened) sacs have layered appearance / no connection between membranes / AW / ora ; not, connected to / contiguous with / continuous with, (outer membrane of) nuclear envelope / ora ; swellings at end of sacs (for vesicle formation) / vesicles at ends of sacs ; no ribosomes / ora ;	**2**
(c)	actual diameter = image length / magnification ; *at 11 mm for X–Y:* 234 nm ; **A** 213 nm (for 10 mm) **A** 255 nm (for 12 mm) **A** 223 nm (for 10.5 mm) **A** 245 nm (for 11.5 mm)	**2**
(d)(i)	**I** glycocalyx **I** glyco / carbohydrate chains **A** points from labelled diagram 1 phospholipid bilayer ; *plus any **two** from:* 2 fatty acid core / fatty acid tails orientated inwards ; 3 protein ; 4 further detail of proteins ; e.g. integral and peripheral / AW scattered (in phospholipid bilayer) 5 cholesterol ;	**3**
(d)(ii)	*any **one** relevant suggestion:* reduced gaps between membrane molecules ; higher proportion of phospholipids with saturated fatty acids / ora ; fewer unsaturated fatty acids so, fewer 'kinks' in tails / closer packing ; higher proportion of cholesterol molecules ; fewer, channel / carrier / transport, proteins ; smaller diameter of channels in non-specific channel proteins ; fewer types of (specific), transport / carrier, proteins ; AVP ; e.g. fewer, aquaporins / channels for water	**1**

35. 9700_s17_ms_23 Q: 4

(a)	✓ × × ✓ ✓ ✓ × ✓ × × ✓ × × ✓ × ✓ one mark per column ;;;;	4
(b)	*allow diagrams with glycine on right*  + H_2O ; line drawn between C and N ; 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
(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**

36. 9700_w17_ms_21 Q: 5

(a)(i)	Golgi (body / apparatus / complex) ;	1
(a)(ii)	animal cell ✓ plant cell ✓ bacterial cell ;	1
(b)	magnification = scale bar length / actual length ; **A** M = I / A M = I / O or magnification triangle 14 500 ;; *for 29 mm scale bar length* **A** 14 000 (*for 28 mm*) **or** 15 000 (*for 30 mm*) *allow one mark only for* *incorrect answer but correct calculation using scale bar e.g. 29 000 ÷ 2* *correct answer but units given* *correct measurement and correct calculation but incorrect conversion*	3
(c)	*mark first two only* nucleus ; mitochondria ; chloroplasts ;	2
(d)(i)	*fluid* *idea of* phospholipid (and protein) molecules, move about / diffuse (within their monolayer) ; *mosaic* protein (molecules), interspersed / scattered / AW ; **A** different / AW, proteins ;	2
(d)(ii)	*any four from* 1 barrier between cytoplasm and, external environment / AW ; e.g. tissue fluid **A** protects, organelles from damage / from pathogens, **I** keeps cell contents in / membrane surrounds the organelles 2 cell signalling **or** has receptors for, cell signalling substance / hormone / neurotransmitter / AW 3 cell recognition / acts as cell surface antigen ; 4 cell-to-cell adhesion ; 5 site for, enzymes / catalysing reactions ; 6 anchoring the cytoskeleton / AW ; 7 selection of substances that enter or leave a cell ; AW 8 formation of hydrogen bonds with water for stability ; 9 AVP ; e.g. *ref. to*, changing shape of cell / flexibility of cells e.g. phagocytosis	4

37. 9700_w17_ms_22 Q: 3

(a)	intracellular (enzyme) ; **R** interacellular	**1**
(b)(i)	8.5 mmol dm^{-3} ;; **A** 8–8.7 *max 1 if no units* *allow one mark if only half V_{max} stated* half V_{max} = 0.5 (au)	**2**
(b)(ii)	*two from* (K_m is the) affinity, of enzyme for its substrate ; **G** / low K_m enzyme, has a, high(er) affinity for its substrate (than **H**) ; **ora** **A** binds more easily *note that if the term 'affinity' is used, then this is also mp1* **G** / low K_m enzyme, needs a lower concentration of substrate to reach, V_{max} / maximum activity / ½ V_{max} (than, **H** / enzyme with high K_m) ; **ora** **G** / low K_m enzyme more likely to be saturated with substrate ; (so) variations in substrate have less effect on rate of reaction (for **G**) ;	**2**
(c)	lysosomes ; *treat as neutral Golgi vesicles* **R** lysozyme **R** if any other organelle named	**1**
(d)	*any one relevant e.g.* leakage (of substances) through / damage to, (mitochondrial) membranes **A** *ref. to* fewer cristae **or** impaired uptake of substances through transport proteins / AW **or** no / impaired, ATP production / aerobic respiration / oxidative phosphorylation **or** no / low, protein / enzyme, synthesis (from mitochondrial ribosomes) **or** change to, number / distribution / presence, of membrane proteins **or** no mitochondrial replication occurring ;	**1**
(e)	*five from* 1 change in nucleotide / base, sequence (of, DNA / gene / *GBA*) ; *must be in context of DNA, ignore if in context of RNA* 2 (because of) base substitution ; **A** substitution of a base 3 altered / AW, mRNA codon ; **A** mRNA triplet **R** genetic code **I** triplet code 4 *idea that* a, codon / triplet, specifies a particular amino acid ; *in context of DNA or RNA* 5 (different) tRNA with different amino acid (brought to ribosome) / tRNA brings Ser instead of Asn / tRNA brings Pro instead of Leu ; **R** tRNA makes a different amino acid 6 altered, primary structure **or** altered, sequence / order / arrangement, of amino acids ; **R** if describing result of frameshift, deletions or insertions e.g. all amino acids changed from mutation on / missing amino acid / added amino acids 7 affects (folding into) / different, secondary structure ; *different tertiary structure* 8 *ref. to* different interactions between, R groups / side chains (because of changed primary structure) ; **A** *idea of* different bonds forming (*if R-groups not stated*) **I** peptide bonds change *9 idea that* differences give different shapes of active site *if shape not stated, allow point if linked to idea of 'tertiary structure changes shape'* **or** *idea of* change to complementarity to substrate 10 mutation 1 / asparagine (Asn) to serine (Ser), change less effect on, active site shape / catalysis **or** mutation 2 / leucine (Leu) to proline (Pro), change greater effect on, active site shape / catalysis ;	**5**

38. 9700_s16_ms_21 Q: 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]

39. 9700_w16_ms_23 Q: 1

(a) *one mark per column* [4]

feature	amylopectin	cellulose	RNA	polypeptide
synthesised from amino acid monomers				✓
contains glycosidic bonds	✓	✓		
polymer is branched	✓			
contains nitrogen			✓	✓
can be found in both animal and plant cells	;	;	✓ ;	✓ ;

(b) *points can be awarded as annotations to the diagram*

*max 2 for structure – **mp1** to **mp3***

1 *ref. to* hydrophilic / polar, phosphate, head / group
and
hydrophobic / non polar, hydrocarbon / fatty acid, tails / chains ;
R *if labelled correctly but incorrectly described in the text*
2 *ref. to* forms part of a bilayer ;
3 (fatty acid) tails / chains, may be saturated or unsaturated ;

*max 2 for function – **mp4** to **mp7***

head
4 forms hydrogen bonds with water / interacts with water / AW ;
5 stabilises the membrane ;

tails
6 *idea that* unsaturated fatty acids contribute to fluidity (of membrane) ;
7 barrier to, hydrophilic substances / water soluble substances / polar substances / ions / AW ; **ora**
A movement of, non-polar / AW, substances [3]

(c) *max two components, one mark each*
one mark for function to match the stated component

I carbohydrate chains *for component but allow ecf 'cell recognition' for function*

glycoprotein ;
one of
antigen / markers / tags / described in terms 'self' ;
receptor (for signalling molecule) / AW ;
cell recognition ;
cell adhesion ;
interacts / AW, with water to stabilise the membrane ;

cholesterol ;
one of
stabilises membrane ;
regulates / maintains / AW, fluidity of membrane ;
A in low temperatures increases fluidity / in high temperatures decreases fluidity
prevents passage of ions / polar molecules, through membrane ;

glycolipid ;
antigen / markers / tags / described in terms 'self' ;
cell adhesion ;
interacts / AW, with water to stabilise the membrane ;

protein ; **I** *any qualification of component* e.g. *channel / carrier / transport*

receptor (for signalling molecule) / AW ;
enzyme / co-enzyme ;
anchoring cytoskeleton ;
for cell to cell adhesion / any named type *e.g. desmosome, tight junction* ;

channel / carrier, allows facilitated diffusion / description ;
A for, protein / carrier protein / channel protein / transport protein

carrier, for active transport / description ;
A for protein / carrier protein / transport protein [4]

[Total: 11]

40. 9700_w15_ms_21 Q: 2

(a) **(i)** facilitated diffusion **;** [1]

(ii) ions are, charged / water-soluble **; A** hydrophilic
unable to pass, through hydrophobic core / hydrophobic (fatty acid) tails of, phospholipid bilayer / phospholipids(s) **;**
(channel of) protein lined with amino acids with, hydrophilic / polar, R groups / side chains **; A** hydrophilic channels [max 2]

(b) **(i)** quaternary / 4°, (structure) **;** [1]

(ii) secondary structure **; A** alpha / α, helix [1]

(c) *bonds must be named in the correct context of maintaining 4° structure and interactions with phospholipids*

polypeptides held together
bonds between, R groups / side chains **;**
two named bond types **;** *from*
- ionic
- hydrogen
- hydrophobic interactions
- disulfide
- van der Waal's forces

I peptide bond

polypeptides interact with phospholipids
(regions with) hydrophilic / charged / polar (R groups / side chains, of) amino acids interact with, phosphate / hydrophilic head , of phosholipid **;**
(regions with) hydrophobic / non-polar (R groups / side chains, of) amino acids interact with, fatty acid / hydrocarbon / hydrophobic, tails / chains **;**

further detail of named bond **;** [max 3]

[Total: 8]

41. 9700_w20_ms_23 Q: 6

(a)	*formula* (magnification =) size of image ; / actual size **A** M = I / A or I = A × M **A** magnification triangle length of line **X–Y** = 30 mm (± 2 mm) / 30 000 µm = 3.0×10^{-2} m actual length = 150 µm / 0.15 mm = 150×10^{-6} m *working* length of the image (in m, mm or cm) divided by the actual size (**A** ± 2 mm) ; (x) 200 ; **A** *answer in range* 187 – 213	3
(b)	**1** endocytosis / phagocytosis ; *two from* **2** particles / bacteria, reach end of, gullet / AW ; **3** binding / fusion / attachment, (of bacteria / food particles) to, receptors / (cell surface) membrane ; **I** 'makes contact with' **4** membrane engulfs, bacteria / food particles ; **5** fusion of phospholipids / membrane fusion ; **6** (phagocytic) vacuole / vesicle, pinches off from, surface / membrane ;	3
(b)(ii)	**I** bulk transport **1** fuse / bind, with, phagosome / food vacuole / phagocytic vacuole / phagocytic vesicle ; **A** food vacuole, etc. implied **2** contain / add, hydrolytic / digestive, enzymes ; **A** hydrolases **A** description of one type of breakdown reaction catalysed by a lysosomal enzyme **3** an example of hydrolase or enzyme ; e.g. protease / lipase / carbohydrase / nuclease / lysozyme	3

42. 9700_m18_ms_22 Q: 4

(a)	**I** any part of the pathway beyond cortical cells **I** incorrect mechanisms *any **four** from:* 1 correct ref. to, apoplastic pathway and symplastic pathway / apoplast and symplast ; 2 cell wall route ; 3 further detail ; e.g. between, cellulose fibres / spaces between cells does not cross (cell) membranes 4 entry into, root hair cell by, crossing (partially permeable) cell surface membrane / osmosis ; 5 (then) cytoplasmic route / within cytoplasm ; 6 from cell to cell via plasmodesmata ; 7 vacuolar route ; **A** crosses, tonoplast / vacuolar membrane	4
(b)	*any **one** from:* for active transport of mineral ions ; **A** for mineral ion uptake against a concentration gradient for, ATP / energy, for active transport ;	1

43. 9700_m17_ms_22 Q: 6

(a)(i)	surface area : volume = 1.67 : 1 ; ; **A** 1.7 : 1, 5 : 3 *if incorrect, **allow** one mark for working* surface area = 90 mm^2 and volume = 54 mm^3 *calculations:* surface area — volume — ratio 6 □ 3 □ 4 (sides) = 72 mm^2 — 6 □ 3 □ 3 — 90 : 54 3 □ 3 □ 2 (sides) = 18 mm^2	**2**
(a)(ii)	(block **X**) has higher, surface area to volume ratio / SA:V ; OR (block **X**) has more surface area proportionately per unit volume / AW ; reference to shorter distance for diffusion to centre ;	**2**
(a)(iii)	*two from:* 1 diffusion (rate) too slow ; **A** idea of cannot rely on diffusion 2 reference to distances too far to reach all, cells / tissues ; 3 time taken is too long / AW ;	**2**
(b)	Benedict's (reagent / solution) ;	**1**

44. 9700_s15_ms_23 Q: 1

(a) phospholipid (and protein) molecules, move about / diffuse / AW ;
protein (molecules), scattered / AW ; **A** different proteins present [2]

(b) *similarity to max 1*
(contains) phospholipid (bilayer); **A** detail of orientation of phospholipid
A lipid bilayer
(contains) protein ;

difference (look for ora)
(Davson Danielli) layer(s) of protein / protein only on outside ;
(fluid mosaic) ref. to proteins, in different locations discrete / different types / named or described ;
(fluid mosaic) presence of cholesterol (molecules) ; [max 2]

(c) **1** requirement for, energy / ATP ; **R** ATP energy
2 uses, carrier / transport, protein ; **A** pump
3 conformational change (of carrier protein) ; AW
4 moving against a concentration gradient ; **A** low to high concentration
5 specific, binding site ; **A** ref. to specificity to substance moved across [max 3]

to max 2
(d) **1** loss of, tertiary structure / quaternary structure / secondary structure ;
A loss of shape of active site *in correct context*
2 loss of globular, shape / structure / form ;
3 breakage of, ionic / hydrogen / hydrophobic, bonds / interactions ;

to max 2
4 loss of function of (membrane) proteins ;
5/6 detail ; ;
e.g. transport of, polar molecules / ions, impaired AW
loss of cell to cell adhesion
unable to receive cell signals
loss of enzyme function
7 ref. to membranes, become leaky / lose partially permeable nature ;
A cannot regulate, entry / exit, substances
8 disrupt interaction between protein and phospholipid bilayer / described ; [max 3]

[Total: 10]

45. 9700_w15_ms_23 Q: 3

(a) *description*

1 activity / rate, increases to a, maximum / plateau ;
A 'levels off' / remains constant / reaches V_{max}

2 increase in, activity / rate, slows ;

3 data quote with units to support any correct statement ;
e.g. mp 1128–132 au at 250–300 mM
e.g. mp 2 0 to 120 au between 0 and 100 mM, 120–128 au between 100 and 200 mM
A au for arbitrary units

explanation
at low / increasing, concentration of hydrogen peroxide

4 substrate / hydrogen peroxide, (concentration) is limiting (factor) ;

5 active sites, unoccupied (low concentration) / become more occupied (increasing concentration) ;
R active side *(penalise once)*

6 (low concentration) few collisions between enzyme and substrate / few ESC formed
or
(increasing concentration) more collisions between enzyme and substrate / increasing ESC formed ;

at high (activity slows) / higher (plateau) concentration of hydrogen peroxide

7 enzyme / catalase, concentration / AW, becomes / is, limiting (factor) ;

8 maximum number of enzyme-substrate complexes formed ;
A ES complexes / ESCs

9 (all) active sites, saturated / (always) occupied ; **A ora** [max 5]

(b) amino acid at position 2, is part of active site / helps to give shape to active site / helps form the structure of the active site ;

plus one from:
idea of different, R group / side chain, gives different properties ;
A tryptophan has a, hydrophobic / larger, R group / serine has a polar R group, different properties ;
(slightly) different, folding of polypeptide / secondary structure / tertiary structure / active site / catalytic site / binding site ;
suggested reasons e.g. electrons less easily transferred
ref. to induced fit , more efficient with **P** ; ora
different interactions between polypeptides (in catalase) ; [2]

(c) **1** increased, metabolic rate / protein metabolism (after feeding) means, increased / more, hydrogen peroxide (produced) ;

2 *idea that* less effective, catalase / **Q**, means, more hydrogen peroxide remains / less hydrogen peroxide broken down ; **ora**
more hydrogen peroxide from increased metabolism is broken down faster in ***P*** *= 2 marks*

3 hydrogen peroxide, interferes with / is damaging to / AW, egg production ;

4 AVP ;
I *ref. to* oxygen production and use in aerobic respiration [max 2]

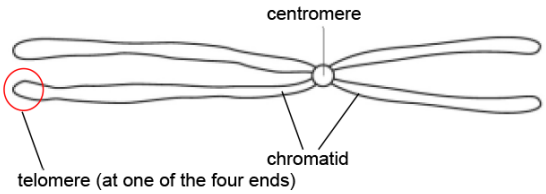
(d) bind to, allosteric site / site other than active site ;
causes change in (shape of) active site ;
A changes shape in active site (so) substrate cannot bind (to enzyme / active site) / enzyme-substrate complex cannot form ; [max 2]

(e) needed for, facilitated diffusion / active transport ;
A description of active transport e.g. moving, molecules / ions, against a concentration gradient
ref. to (some) substances are, water soluble / polar / hydrophilic / ionic / charged ;
I large cannot pass through, phospholipid bilayer / hydrophobic core ; [max 2]

(f) **1** barrier between cell cytoplasm and, external environment / AW ; e.g. tissue fluid
R barrier unqualified
R 'keeps cell contents in'
R 'membrane surrounds the organelles'
R barrier for water soluble substances
2 receptor for, hormone / neurotransmitter / cell signalling substance / AW ;
A signal receptor
3 cell recognition / acts as cell surface antigen ;
4 cell-to-cell adhesion ;
5 site for, enzymes / catalysing reactions ;
6 anchoring the cytoskeleton / AW ;
7 selection of substances that enter or leave a cell ;
R controls / regulates substances that enter cell
8 formation of hydrogen bonds with water for stability ;
9 AVP ; e.g. *ref. to*, changing shape of cell / flexibility of cells e.g. phagocytosis [max 3]

[Total:16]

46. 9700_s20_ms_21 Q: 2

(a)	**P** – chromosomes, arranged randomly / AW *or* *idea that* chromosomes present but not (yet) visible as consisting of two sister chromatids (joined by centromere) ; **A** description related to idea of chromosomes becoming visible / chromatin condensing **Q** – chromosomes are, arranged / aligned / AW, at the, (cell / spindle) equator / metaphase plate ; **A** equatorial plate **R** – no chromosomes visible / nucleolus is present / chromatin not condensed / euchromatin present ;	**3**
(b)(i)	*drawing* two chromatids of identical length joined at the centromere ; *labels* chromatid ; *one label line is sufficient* **R** if second line drawn to arm of sister chromatid centromere ; telomere ;  	**4**
(b)(ii)	histone(s) ; **A** highly basic (protein)	**1**
(b)(iii)	*accept spindle fibres / microtubules as alternative to spindle* *max 2 if stages are named and are incorrect* *any three from:* (prophase) attachment to centromere of each chromosome ; **A** *ref. to* kinetochore *in correct context* (prophase) arranging / orientating / AW, chromosomes at the, equator / metaphase plate / AW ; **A** *ref. to* metaphase in correct context (anaphase) centromere division / separation of sister chromatids ; (anaphase) pulling, chromatids / daughter chromosomes, apart / towards poles ; (because) spindle fibres contract / (as) lengths of microtubules decreases / microtubules are disassembled ; (elongates in telophase to) push, poles / nuclei, apart ;	**3**

47. 9700_w20_ms_21 Q: 1

(a)(i)	(sister) chromatids ; centromere ; histone ;	**3**
(a)(ii)	prophase / metaphase ; **I** late / early **A** prometaphase	**1**
(a)(iii)	**I** *ref. to* replication or cytokinesis *any **two** from:* provides energy ; movement of centrioles to poles ; spindle formation / organisation of microtubules (for spindle) ; movement of chromosomes to the, spindle equator / AW ; separation of, (daughter) chromosomes / (sister) chromatids, to opposite poles (of the cell) / during anaphase ; AW AVP ; e.g. (for) condensation / AW, of, chromatin / chromosomes	**2**
(b)	*assume reference to binary fission unless stated otherwise* *any **two** from:* DNA replication ; **A** *idea* of, doubling / duplicating, DNA cell, elongation / gets longer ; **A** cell increases in size cell wall formation ; (includes) cytokinesis / described ; *max 1 if two ideas correct describing events that only occur in mitosis*	**2**

48. 9700_w20_ms_23 Q: 3

<table>
<tr><td>(a)(i)</td><td>A – G1 / gap 1 ;
B – S / synthesis ; A DNA replication I S1 / S2 / replication unqualified</td><td>2</td></tr>
<tr><td>(a)(ii)</td><td>telophase ;</td><td>1</td></tr>
<tr><td>(a)(iii)</td><td>any two from:
increase in cytoplasm / increase in number of (named) organelle(s), during interphase ; A synthesis of organelles
I cell growth

(re)formation of nuclear envelope ;
nuclear envelope, forms around each group of chromosomes ;
A nuclear membrane as an ECF if used for mp2

(movement of) organelles to be shared between two daughter cells ;

spindle, disassembles / breaks down / degrades / disappears / AW ;

cleavage furrow forms ;
A cytoplasm / cell membrane, pinches in / constricts / infolds

AVP ;
e.g. (actin) microfilaments / microtubules, form contractile ring / AW, around equator of cell / beneath cell surface membrane
A cytoskeleton for microtubules / microfilaments</td><td>2</td></tr>
<tr><td>(a)(iv)</td><td>one mark per row
<table><tr><td></td><td colspan="3">stages of cell cycle</td></tr><tr><td></td><td>A</td><td>B</td><td>D</td></tr><tr><td>number of nuclei within the stem cell</td><td>1</td><td>1</td><td>2 ;</td></tr><tr><td>number of chromosomes ineach nucleus</td><td>12</td><td>12</td><td>12 ;</td></tr></table></td><td>2</td></tr>
<tr><td>(b)</td><td>1 stem cells) continue to divide / divide repeatedly (by mitosis) ;
A at least one daughter cell, retains ability to divide / is a stem cell / A ‘repeated mitosis’ / A ‘to produce more stem cells’

any two from mps 2-5:
to produce cells
2 for growth ;

3 for repair of tissues ; R repair of cells

4 for replacement of, worn out / old / dead, cells ;
A damaged cells if repair of tissues not given

5 to differentiate for formation of, tissues / organs ;
A specialised cells for forming, tissue / organs

and:
6 AVP ; e.g. ref. to potency of stem cells (multipotent or pluripotent)</td><td>3</td></tr>
</table>

49. 9700_s18_ms_23 Q: 1

(a)	(nucleus of cell) **D** has two nucleoli v **E** has one nucleolus ;	1
(b)	**A** = (early / mid) prophase ; **R** late **B** = (mid / late) prophase ; **R** early **C** = anaphase ;	3
(c)	**I** name of stage *two from:* ref. to (daughter) chromosomes at poles ; **A** (sister) chromatids at poles **R** chromatids move to poles **A** two separate groups of (daughter) chromosomes **A** two nuclei form (enclosing chromosomes) **I** there are two nuclei *in context of at each pole* nuclear envelope reassembles (around chromosomes) ; **A** nuclear membranes reassemble nucleolus reappears / nucleoli reappear ; (daughter) chromosomes, become diffuse / become long and thin / decondense / uncoil ; **A** become chromatin **I** disappears spindle, disassembles / AW ;	2

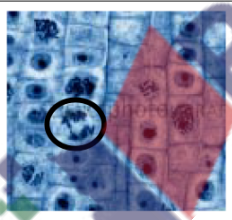
50. 9700_w18_ms_22 Q: 3

(a)	*any two from* 1 (division that) produces, new / daughter, cells **A** produces more cells **or** (so) replaces, damaged / lost / dead, cells ; 2 new / daughter, cells, genetically identical ; **A** *ref. to* clone if correct context **A** genetic information not lost **I** same number of chromosomes 3 (all) new cells can retain function ; AW	2
(b)	*any two from* 1 cell cycle continuous / continually divide / AW ; 2 (produce cells that) can, differentiate / specialise / described ; **A** multipotent / pluripotent **I** totipotent *divide to produce a cell that can divide and a cell that differentiates = 2 marks* 3 can produce, cells / tissue, that can still function (as before) ;	2
(c)	*any three from* 1 chemicals (released) are cell signalling, molecules / compounds ; 2 liver cells, are target cells ; **A** liver tissue for liver cells 3 binding of, chemicals / cell signalling molecules, to receptors (of liver cells) ; **R** receptor cells 4 *ref. to* specificity (of receptors) / chemicals complementary to receptors ; *if **R** above, then allow ecf for idea of complementary* 5 (specific) response is, cell enters the cell cycle / mitosis / cell division ; **A** DNA replication 6 AVP ; e.g. *idea of* communication between cells suggestion of detail following binding, e.g. second messenger activated / enzyme cascade /signal transduction / phosphorylation events / enzyme activation **I** cascade of reactions	3

51. 9700_m17_ms_22 Q: 3

(a)	all three correct ; *with the non-competitive inhibitor* **Z** *with the competitive inhibitor* **Y** *without any inhibitor* **X**	1
(b)	*four from:* V_{max} 1 **X** and **Y** same V_{max} of 10 au ; 2 V_{max} of, **X** / **Y**, higher than **Z** / ORA ; **A** (V_{max} of), **X** / **Y**, 10 au v **Z** 5 au **A** (V_{max} of), **X** / **Y**, double the V_{max} of **Z** K_m 3 **X** and **Z** same K_m ; **A** K_m of both is 4 mmol dm^{-3} 4 **X** / **Z**, lower K_m than **Y** / ORA ; **A** K_m of, **X** / **Z**, 4 mmol dm^{-3} v **Y** 6.5 mmol dm^{-3} 5 reference to affinity for substrate ;	4
(c)	*four from:* 1 double helix ; 2 strands are held together by hydrogen bonds (between bases) ; 3 complementary base pairing / described as A-T and C-G ; **A** purine pairs with pyrimidine R thiamine 4 antiparallel stands / strands are 3' to 5' and 5' to 3' ; **A** strands run in opposite directions 5 (each strand has a sugar phosphate backbone with) phosphodiester bonds ; 6 (monomers / units / DNA) are (DNA) nucleotides / polynucleotide strands ; 7 (nucleotide =) deoxyribose sugar, phosphate, nitrogenous (organic) base ; ***A** points from a diagram*	4
(d)	*two from:* 1 *idea that,* hydrogen peroxide, damage / breaks, DNA and repair errors (may) occur ; 2 (so leads to) incorrect, nucleotide / base, inserted (during replication) / change in, nucleotide / base, sequence (of DNA / RNA) ; 3 new allele (may be) formed ; 4 may result in an altered polypeptide / AW ;	2

52. 9700_w17_ms_21 Q: 1

(a)	 ;	1
(b)	*two from* can observe living, specimens / cells ; (so) the process of mitosis can be seen happening / AW ; **R** easier to see mitosis happening **I** to study cell division ease of use, qualified ; e.g. no need for heavy metal staining, preparation of specimen less time-consuming **I** *ref. to* colour **I** portable	2
(c)	*three from* production of genetically identical cells ; asexual reproduction ; repair of damaged tissue ; **A** replace damaged cells **R** repair damaged cells replace, dead / worn out / old / non-functioning, cells ; gamete production *in context* ;	3

53. 9700_w17_ms_21 Q: 4

(a)	*codon that* terminates / AW, translation / polypeptide synthesis **R** stops production of amino acids **or** does not specify any amino acid **or** has no complementary, tRNA / anticodon **or** causes the release of the (completed) polypeptide chain ;	**1**
(b)	*four from* Asp and Gln R groups, hydrophilic / AW, and Ile R group, hydrophobic / AW ; *ref. to* R group interactions and, folding / coiling, of polypeptide chain (to give globular structure) ; *ref. to* (charged / polar R groups) forming, ionic / hydrogen, bonds ; (amino acids with), hydrophobic / non-polar, R groups, on the inside / AW ; **A** hydrophobic amino acids (amino acids with), hydrophilic / charged / polar, groups on outside / AW ; **A** hydrophilic amino acids detail ; e.g. ionic R groups can interact with water, hydrogen bonds form with water *ref. to* promotes stability / helps to maintain globular structure ; *in context of interaction with water / formation of (compact) hydrophobic core*	**4**
(c)	glycosidic ;	**1**
(d)	*four from* 1 both, increase and decrease / peak ; 2 both active, over range of temperature tested / between 20 to 55°C ; 3 free enzyme lower, optimum temperature / temperature for maximum activity ; **ora** 4 (free) 37°C v (immobilised optimum) 46°C; 5 free enzyme higher, maximum activity / activity at optimum temperature ; **ora** 6 (free) 8.2 / 8.3, a.u. v 7.5 a.u. ; 7 between 20°C and 39°C the activity of free is higher ; **ora** 8 between 39°C and 55°C the activity of free is lower ; **ora** *if mp 7 and 8 not gained, allow 1 mark for free activity higher at lower temperatures and lower at higher temperatures (than immobilised) ora* 9 comparative data to support mp 7 or 8 ; **A** comparison at one temperature (stated or use of numerical data) 10 AVP ; e.g. both have same activity at 39°C, similar activity between 20°C and 30°C	**4**
(e)	substrate concentration that gives half V_{max} / AW ; **A** description of how to use a graph to derive (must refer to substrate concentration)	**1**
(f)	*two from* *look for ora throughout* free / low(er) K_m , has higher affinity for substrate ; free needs a lower concentration of substrate to reach, V_{max} / maximum activity / ½ V_{max} ; takes lower substrate concentration to saturate active sites in free ; free active site more, likely to be saturated with substrate / accessible ; active site (may be) distorted by immobilising ; *ref. to* substrate passing through matrix when immobilised ; *ref. to* some product retained within matrix ;	**2**

54. 9700_w16_ms_21 Q: 1

(a)
A nuclear envelope ; **A** nucleus **A** nuclear membrane
I nuclear pore

B mitochondrion ; **A** mitochondria **A** mitochondrial envelope

C lysosome / Golgi vesicle / secretory vesicle ; **A** vesicle / vacuole **A** plural
I qualification e.g. transport / temporary / phagocytic [3]

(b) ribosome(s) / cell surface membrane ; **A** vesicles **A** plasma membrane **I** cytoplasm [1]

(c) *two from*
organise microtubules ;
(to), form spindle / assemble spindle fibres (in prophase) ; AW
ref. to centriole pair / centrioles, at (both) poles ; **R** if description is linked to incorrect mitotic stage
ref. to role in contraction of spindle fibres, at anaphase / to separate sister chromatids ;
AVP ; e.g. make microtubules (as part of the centrosome) [2]

(d) *three from*
(sodium ions are) charged / hydrophilic ; **I** *ref. to* size / polar
cannot pass through hydrophobic, core / interior, (of phospholipid bilayer) ;

(so) must pass through, transport proteins / carrier proteins / channel proteins *(facilitated diffusion)* ;

ref. to hydrophilic (amino acids lining) channels ;
ref. to active transport only way to move sodium ions against concentration gradient / AW ; [3]

[Total: 9]

55. 9700_w19_ms_22 Q: 6

(a)	**I** maintains length of chromosomes / prevents chromosome shortening *any two from:* permit continued replication ; prevent loss of genes ; **I** prevents gene damage genetic material is neutral **A** genetic / coded, information *for genes* **A** information on DNA **A** protein coding regions of DNA **A** exons protect ends of chromosomes from being, degraded / AW ; AVP ; e.g. prevents ends of chromosomes from being attached to each other not mistaken for a break in DNA that needs repairing	**2**
(b)	*Idea that,* mitosis / cell cycle / (DNA) replication / (cell) division, occurs in both cell types (continuously / regularly / AW) ; **R** uncontrolled mitosis **R** meiosis	**1**
(c)	induced fit ;	**1**
(d)	*allow low(er) rate for 0.2 μmol dm^{-3} and high(er) rate for 1.6 μmol dm^{-3}* *any two from:* comparison in terms of active site(s) ; e.g. (low rate) active sites, not all occupied / spare / not all saturated **or** (high rate) active sites all occupied / no spare active sites / active sites saturated bod 'active sites are limited' comparison in terms of enzyme-substrate complexes formed (per unit time) e.g. (low rate) few(er) ES complexes formed **or** (high rate) many / more, ES complexes formed ; **A** (low rate) few(er) collisions between enzyme and substrate ora (low rate) substrate concentration limiting factor **or** (high rate) limiting factor is, enzyme concentration / not substrate concentration;	**2**

56. 9700_w19_ms_23 Q: 2

<table>
<tr><td>(a)</td><td>
<table>
<tr><th>name</th><th>one example of cell from 2.1</th></tr>
<tr><td>interphase</td><td>B / G</td></tr>
<tr><td>prophase</td><td>A</td></tr>
<tr><td>metaphase</td><td>D</td></tr>
<tr><td>anaphase</td><td>E / F / C</td></tr>
<tr><td>telophase</td><td>C / H
R C if stated for anaphase</td></tr>
</table>
all five correct = 3 marks
three or four correct = 2 marks
one or two correct = 1 mark</td><td>3</td></tr>
<tr><td>(b)</td><td>(29 as a percentage of 5000 =) 0.58 (%) ; A 0.6 (%)
(0.0058 × 720 minutes =) 4 (min) / 4.2 / 4.18 / 4.176 ; allow ecf</td><td>2</td></tr>
<tr><td>(c)</td><td>mark first answer
one from

1 cell plate forms (across equator of cell) ;

2 cell wall / cellulose, laid down ; A cell wall forms (between the two)

3 cytoplasm divided (into two) ;
R cytoplasm, constricts / pinches in
I ‘separates into two daughter cells’
I events at late telophase

4 idea that organelles shared out ;

5 AVP ; detail of cell plate formation
e.g. ref. to vesicles transported to equator / involvement of cytoskeletal structures / ref. to phragmoplast</td><td>1</td></tr>
</table>

57. 9700_s18_ms_21 Q: 1

(a)(i)	*answers must be comparative* *one from:* *idea that* the sections are orientated differently / cut in different planes / cut at different angles / AW ; **A** is a cross section / AW, and **B** is a longitudinal section / AW mitochondria show a variety of, sizes / shapes ; mitochondria, are flexible / change shape ; **A** and **B** are of, different ages / stages of development ;	**1**
(a)(ii)	*two from:* replace, old / worn out / damaged, mitochondria ; require more mitochondria as cells, enlarge / grow ; more mitochondria are needed, for new cells / when cell divides ; **A** so numbers remain the same in the new cells / after cell division **A** *idea that* mitochondria are shared out (between daughter cells) (mitochondria) provide (most), energy / ATP ; **I** cell needs (much) energy without stating mitochondria provide energy **R** energy production **I** uses of energy	**2**
(b)	*two from:* nuclear envelope shown as two membranes with closed ends and a gap ; label to nuclear pore ;	**2**
(c)	*four from:* 1 contains / AW, chromosomes / chromatin / DNA / genes / genetic material / inherited material / genetic information ; 2 (coded) information for synthesis of, polypeptides / proteins ; **A** controls protein synthesis 3 ref. to sequence(s) of bases (in DNA) ; 4 transcription (of genes) / production of mRNA ; 5 contains nucleolus ; 6 manufacture of ribosomal sub-units ; **A** makes ribosomes 7 *idea that* DNA is protected from degradation / enzymes / AW ; 8 AVP ; e.g. responds to signals that control, gene expression / AW post-transcription modification / modifies mRNA / any example repairs DNA **I** controls cell's activities **I** sends mRNA to cytoplasm / mRNA travels through nuclear pores	**4**

58. 9700_s18_ms_22 Q: 4

(a)	**1 / 4** ; **3** ; **5** ;	**3**
(b)	*two from:* centromere (of each chromosome) divides ; **A** sister chromatids separated at the centromere spindle fibres, contract / shorten ; **A** spindle contracts (sister / identical) chromatids / daughter chromosomes, pulled / move, to opposite poles ; **A** (sister) chromatids separated **I** chromosomes are at opposite poles centromeres, leading (towards poles) / AW ; **A** ref. to V-shape / diagram	**2**
(c)	*one from:* not sectioned to include (nucleus) ; did not take up the stain / not stained (correctly) / AW ; AVP ; e.g. cells may be dead **I** destroyed / eliminated / AW	**1**

59. 9700_m17_ms_22 Q: 1

(a)	label line and letter G to one of the ends of the chromosome ;	**1**
(b)	anaphase / telophase ;	**1**
(c)	cytokinesis ;	**1**
(d)	receptor(s) ; **I** description of receptor	**1**

60. 9700_w17_ms_22 Q: 1

(a)	**C** ; **R** if more than one area given	1
(b)(i)	*three from* two chromatids drawn ; *must be connected at some point* (sister) chromatid label to correct structure ; centromere label to correct structure ; **A** kinetochore telomere label to end of chromatid ; DNA and histone (proteins) label to chromatid ;	3
(b)(ii)	*two from* disassembles / breaks down / disintegrates / AW, at, prophase ; **A** prometaphase re-forms / re-assembles / AW, after anaphase / at telophase ; *if mp 1 and 2 not gained, one mark can be awarded for knowledge of disassembles and then reassembles* detail ; e.g. breakdown into vesicles re-forms from vesicles / vesicles fuse to form new membranes re-forms around both sets of (daughter) chromosomes	2

61. 9700_w17_ms_23 Q: 6

(a)	EGF binds to receptor(s) on cell **A** ; **ora** **A** has receptor for, EGF / cell signaling compound **A** EGF does not bind to receptor on **B** *idea of* complementary / specific ; **ora** **R** antigen to antibody **I** active site	2
(b)	*accept* **ora** *one from* more, proteins / polypeptides, are made ; proteins are required for growth / to provide (named) protein for DNA synthesis / proteins are required for organelles / AW ; **A** S phase for DNA synthesis during mitosis DNA is highly condensed ;	1
(c)	*three from* ATP ; (activated / free / DNA) nucleotides ; **R** in context of transcription DNA polymerase ; (DNA) ligase ; AVP ; e.g. topoisomerase / gyrase helicase	3
(d)(i)	centromere ; **A** kinetochore *one from* holds / joins / AW, (sister) chromatids together] ; attach to spindle]	2
(d)(ii)	*max 1 if more than one chromosome shown* *two from* separate chromatids that are identical in shape ; one arm larger than the other on both separate chromatids ; V-shaped chromatids with centromeres pointing towards the poles ;	2

62. 9700_s16_ms_22 Q: 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]**

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

[Total: 9]

63. 9700_w16_ms_22 Q: 1

A = chloroplast ;
B = tonoplast ; **A** vacuolar membrane
C = spindle / spindle fibre(s) ;
D = (bacterial / prokaryotic) cell wall ; **R** eukaryotic / cellulose / chitin / plant
E = nucleolus ; [5]

[Total: 5]

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64. 9700_s15_ms_21 Q: 1

(a) *one mark for the stages of the cell cycle in the correct sequence*
one mark for correct matching of each stage with a cell

stage of mitosis	label from Fig. 1.1
prophase	**A** / **H** ;
metaphase	**G** ;
anaphase	**C** / **E** / **F** ;
telophase ;	**B** ;

[5]

(b) microtubules / spindle (fibres), attach to centromere / kinetochore (of chromosome during prophase) ; **I** metaphase
arranging / aligning / orienting / AW, chromosomes at the equator / metaphase plate ; **R** centre
fibres, shorten / contract / retract ; **A** microtubules disassemble / AW
move / pull, (sister) chromatids / (daughter) chromosomes, to opposite poles / centrioles ;
idea that equal number of chromosomes in each daughter, nucleus / cell ; [max 2]

(c) maintaining number of chromosomes ;
ensuring genetic stability / maintaining genetically identical cells / AW ;
asexual reproduction ; **A** vegetative reproduction / cloning
cloning / clonal expansion, of (named) lymphocytes ; **A** B / T cells
replacement of (worn out / dead / damaged) cells ;
regeneration, of (named) tissues / organs ;
(wound) repair (of tissues) ; **R** repair of cells
ref. to production of gametes ;
e.g. mitosis in gametogenesis / gamete production in plants
R 'copying of cells' [max 2]

(d) (i) *accept biological N fixation or Haber-Bosch process for mp1*

1 *either*
converts, (inorganic) nitrogen / dinitrogen / N_2, into organic nitrogen / ammonia / NH_3 / ammonium / NH_4^+ ; **R** if nitrate given
or
lightning converts, nitrogen / ammonia / NH_3 / ammonium / NH_4^+, into, nitrite / nitrate (ions) ;

2 reduces nitrogen / breaks triple bond ;

3 makes (fixed) nitrogen available to, legumes / other organisms / community / AW ; **A** ref. to amino acids / proteins
not to be awarded if it follows nitrification

4 increase soil fertility ;

5 balances the loss of fixed nitrogen in, denitrification / ocean deposits ; [max 2]

(ii) 1 *idea of* decay / decomposition ;
e.g. breakdown by, (saprophytic) bacteria / fungi

2 legumes eaten by, detritivores ; **A** named detritivores

3 decomposers produce proteases ;

4 to, hydrolyse / convert / change / AW, protein to amino acids ;

5 amino acids are deaminated ;

6 (amino acids) to, ammonia / NH_3 / ammonium (ions) / NH_4^+ ;

7 nitrifying bacteria / *Nitrosomonas*, convert ammonia to nitrite (ions);

8 nitrifying bacteria / *Nitrobacter*, convert nitrite to nitrate (ions) ;

if mp7 or mp8 not awarded allow one mark for the following as mp9
9 (named) nitrifying bacteria convert, ammonia / ammonium, to nitrate (ions) ;

mp10 only to be awarded following nitrification
10 nitrate (ions) used for making, amino acids / proteins (hence increase in growth of cereals) ;

[max 3]

[Total: 14]

65. 9700_w15_ms_22 Q: 3

(a) **A** = interphase **I** *ref. to early / late*
C = metaphase ;
both needed for one mark [1]

(b) (**C**) **L**, **N**, **M**, **K** ; [1]

(c) **1** *idea that* centromere, has divided / divides (separating, sister / identical, chromatids) ;
2 centromere attached to spindle fibre; **A** spindle
3 shortening / contraction, of spindle fibres (pulling centromeres) ;
A spindle, contracts / shortens

4 (so) sister / identical, chromatids, move to opposite poles ;
need idea of separated, so **A** ends / sides / halves
A sister / identical, chromatids, will end up, at separate poles / in separate cells

[max 3]

[Total: 5]

66. 9700_s20_ms_22 Q: 1

(a)	*any two from* protein coat / capsid ; **A** capsomeres nucleic acid core / DNA or RNA ; acellular / AW ;	**2**
(b)	*any three from* *no, because* resolution of light microscope, too low / not high enough ; only able to distinguish points 200nm or more apart *or* size of virus / 30 nm, too small for resolution of (light microscope) of 200 nm ; **A** range 100-300 nm wavelength of light too long ; *idea that* virus too small to interfere with light waves ;	**3**
(c)	*any three from* virus binds to receptors (on host cell surface membrane) ; *ref. to* specificity / complementary shapes / complementary binding ; endocytosis ; description ; e.g. membrane infolds / pinches in vesicle formed ; **A** vacuole	**3**

67. 9700_m19_ms_22 Q: 6

(a)	*any **two** from:* asexual reproduction ; growth by increase in number of cells ; (tissue) repair ; regeneration of body parts ; replacement of, dead / worn out, cells ;	**2**
(b)	*any **one** from:* spindle / spindle fibre ; kinetochore ;	**1**
(c)	**A** phosphate ; pentose ; **B** pyrimidine ; **C** ribose ; **D** transcription ;	**5**
(d)(i)	non-cellular / acellular / not made of cells ; protein coat / capsid ; nucleic acid core / DNA or RNA ; AVP ; ; ; e.g. only replicate inside host cells ref. to no characteristics of living organisms (sensitivity, growth, etc.) ref. to size, e.g. most are smaller than bacteria ref. to capsomeres	**3**
(d)(ii)	500 (nm) ;	**1**

68. 9700_s19_ms_23 Q: 1

(a)	one nucleotide circled ;	**1**
(b)	cytosine and guanine ; three hydrogen bonds between the base pairs ;	**2**
(c)	(3) 5,4,1,2 ;	**1**
(d)	**I** maintains length of chromosomes / prevents chromosome shortening *any two from:* permit continued replication ; prevent loss of genes ; **I** prevents gene damage **A** genetic / coded, information **A** protein coding regions of DNA protect ends of chromosomes from being, degraded / AW ; AVP ; e.g. prevents ends of chromosomes from being attached to each other not mistaken for a break in DNA that needs repairing	**2**

69. 9700_w19_ms_22 Q: 4

<table>
<tr>
<td>(a)</td>
<td>
<table>
<tr><th>polymer</th><th>constituent monomer</th><th>type of bond between monomers</th></tr>
<tr><td>amylose</td><td>glucose</td><td rowspan="2">glycosidic
glycosidic ;
A glucosidic

I details of bond</td></tr>
<tr><td>cellulose</td><td>glucose</td></tr>
<tr><td>collagen</td><td>amino acid ;
R protein (amino acid)</td><td>peptide</td></tr>
<tr><td>DNA</td><td>DNA nucleotide</td><td>phosphodiester ;</td></tr>
<tr><td>glycogen</td><td>(α-)glucose ;
R β-glucose</td><td>glycosidic</td></tr>
</table>
</td>
<td>4</td>
</tr>
<tr>
<td>(b)</td>
<td>two from

1 amylose composed of α-glucose (monomers) <u>and</u> cellulose composed of β-glucose (monomers) ;

2 (amylose) α-1,4 v. (cellulose) β-1,4 (glycosidic) bonds ;
R if amylose stated to have α-1,6 bonds
I ref. to cellulose also has hydrogen bonds
If mp 1 and 2 not stated allow one mark for amylose has α-glycosidic bond and cellulose has β-glycosidic bond

3 (cellulose) adjacent, monomers / glucose(s), rotated through 180° ; AW
R ref. to heads / tails

4 amylose has an (energy) storage function v. cellulose has structural function / description relating to cell wall ;</td>
<td>2</td>
</tr>
</table>

(c)	*max 2 from mp 1 and 2 if transcription described or mix and match transcription and replication* *any five from:* **1** DNA (double helix / molecule) unwinds ; **I** unzips **R** DNA, strand / α helix, unwinds **2** hydrogen bonds break between, base pairs / bases / strands ; **A** hydrogen bonds break between nucleotides *only if clear that two strands are separated* **3** both strands used as templates ; *concise statement* **4** DNA polymerase, qualified ; e.g. involved in polynucleotide formation / phosphodiester bond formation / catalyses synthesis **R** joins phosphates **5** *ref. to* (free) activated (DNA) nucleotides / AW ; **A** phosphorylated nucleotides **R** RNA nucleotides **6** complementary (DNA) nucleotides added ; **R** RNA nucleotides **A** described in terms of complementary base pairing **A** A pairs with T and C pairs with G **7** *idea that* process, occurs / continues, along whole DNA molecule ; **8** *ref. to* Okazaki fragments / movement of polymerase in one direction / nucleotides added in one direction ; **A** correct ref. to leading and lagging strands **9** each newly formed molecule contains one original and one newly synthesised strand ; **10** AVP ; e.g. replication bubbles form / described *ref. to* repair / proofreading *ref. to* helicase (unwinding) / ligase (joining Okazaki fragments) *in correct context* **R** ligase joining phosphates process occurs, step-by-step / sequentially / AW *ref. to* RNA primers	**5**

70. 9700_m18_ms_22 Q: 6

(a)	**1** adenine, thymine, cytosine, guanine ; **2** DNA polymerase ; **3** nucleotides ; **4** complementary base pairing ; **5** (DNA) ligase ; **6** semi-conservative (replication) ;	**6**
(b)(i)	**J** metaphase ; **K** prophase ; **L** telophase ; **A** anaphase	**3**
(b)(ii)	large size / same size as cells in mitosis / ora ;	**1**
(b)(iii)	1 chromosomes, orientated / arranged / AW, at, (spindle) equator / metaphase plate ; *plus any **one** from:* 2 chromosomes attached to, spindle / spindle fibres, at centromere / kinetochore ; 3 spindle fully formed ; 4 nucleolus has disappeared ; 5 nuclear envelope, has disassembled / broken down / AW ;	**2**

71. 9700_s17_ms_23 Q: 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**
(b)	telomere(s) ;	**1**
(c)(i)	adenine and guanine ;	**1**
(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**
(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**

72. 9700_w16_ms_22 Q: 3

(a) *two from*

fructose		*sucrose*
no glycosidic bond ;	(v	glycosidic bond) *look for ora*
monosaccharide / one sugar unit **A** monomer *('sugar', is in question)*	v	disaccharide / two sugar units / fructose and glucose ; **A** two monomers / dimer **I** polysaccharide

R if a disaccharides is stated as one of the two monomers

A sucrose is a disaccharide made from the monosaccharides glucose and fructose

one ring (structure)	v	two rings ; **A** *sketch to show one ring v two rings*
$C_6H_{12}O_6$ **A** fewer / less, C and H and O atoms	v ora	$C_{12}H_{22}O_{11}$;

additional points accepted

powder	v	crystalline
linear or ring structure	v	two rings / only ring(s)
reducing, end / AW	v	(no reducing ends)

I reducing sugar **I** non-reducing sugar [2]

(b) *look for ora throughout if describing the other enzyme with low optimum*

three from

1 *idea of* can use high(er) temperatures for process ;

2 increased temperature increases, number of collisions (between enzyme and substrate) / number of ES complexes (formed) ;

3 more product / high(er) rate of reaction ; AW

4 less prone to denaturation ; **A** won't denature
A described in terms of loss of active site

5 more stable / lasts longer ; **A** thermostable **A** reused over and over
I temperature resistant [3]

(c) *accept 'glucose isomerase' for 'enzyme'*
accept '100 percent activity' for 'maximum activity'
accept (initial) rate of reaction for activity

penalise once if 'pH' and/or percentage activity (or %) not stated

three from

1 maximum / peak of, activity, at lower pH for free enzyme ora
or
free enzyme lower optimum pH ora
or
free enzyme pH 7.4 / 7.5 / 7.6 v immobilised pH 8.5 ;

2 free enzyme has higher / AW activity, at pH, 6 / 6.5 / 7 / 7.5 ; **A** up to pH 8
ora for immobilised (lower up to pH 8) *
or
free enzyme has higher activity over greater range of pH** (between pH 6–9) ;

3 data to support mp 2 ; **any one pH and comparative activity*
*** needs two pHs and comparative activities*
A manipulated data

4 free enzyme has lower activity, pH 8 to pH 9 ; **A** after pH 8.0
ora for immobilised (higher after pH 8)

5 data to support mp 4 ; *any one pH and comparative activity / manipulated data*
increase to max activity

6 free enzyme has (slightly) steeper increase in activity as pH increases to pH 7 ; ora

7 data to support mp 6 ;

allow ecf to 2 max if free and immobilised the wrong way round but all statements are correct [3]

(d) (i)

amino acid sequence	met	tyr	glu	pro	lys
student's nucleotide sequence	AUG	UAU	GAC	CCU	UGU
correct = ✓ incorrect = ×	✓	✓	×	✓	×

one mark if bottom row correct ; [1]

(d) (ii) *three from*

1 genetic code is, degenerate ; **A** redundant

2 64 codons and 20 amino acids ;
A 61 codons for 20 amino acids (*3 STOP codons)*

3 *idea that* more than one, codon / triplet, specifies an amino acid ;

specific to the first five amino acids of glucose isomerase

4 example of choice of codons to specify the same amino acid ;
(must use Table 3.2 to find codons for the amino acids from Table 3.1)
tyr UAU UAC
glu GAA GAG
pro CCU CCC CCA CCG
lys AAA AAG
use of another example from Table 3.2 may be used to support mp3

5 AVP ; e.g.
start codon always AUG / met has only one codon, so only sequence for amino acids 2-5 may be different
start codon, may be different / may not always be AUG $_{met}$ [3]

[Total: 12]

73. 9700_w15_ms_21 Q: 3

(a) (late) anaphase / (early) telophase ; **R** early anaphase [1]

(b) produce more genetically identical cells / AW ;
for growth (of the root) ;
asexual reproduction ;
replace (old / worn out) cells ;
repair (damaged tissue) ; **A** *ref. to* wounds **R** repair cells [max 2]

(c) **(i)** 8 ; [1]

(ii) for sexual reproduction ;
to form gametes ; **A** pollen and, egg / ovum **R** sperm

ref. to diploid number must be restored (in zygote)
or
fusion / fertilisation, of two haploid cells results in, diploid cell / zygote ;

prevents chromosome number doubling each generation ; [max 3]

(d) **1** DNA double helix unwinds ; **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 ;
A described in terms of complementary base pairing
7 step-by-step / sequentially / AW ;
8 *idea that* process, occurs / 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]

[Total: 12]

74. 9700_s20_ms_21 Q: 6

(a)	adenine and guanine ;	1
(b)	anticodon ;	1
(c)	CAG / cytosine, adenine, guanine ; **A** GAC	1
6(d)	hydrogen bonds form (between complementary bases) ;	1

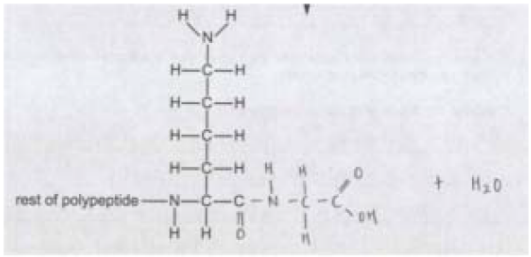
75. 9700_s20_ms_23 Q: 5

(a)	*any two from* sequence of DNA nucleotides ; forms part of a DNA molecule / length of DNA / AW ; coding for a polypeptide ; **A** protein	2
(b)	interphase ; **I** phases of interphase	1
(c)(i)	two phosphates added to existing phosphate ; *base* = adenine ; *sugar* = ribose ;	3
(c)(ii)	purine ;	1
(d)	*any three from* to produce, many / AW, new blood cells ; *idea that* large numbers are required to, transport oxygen / maintain immune system ; produce genetically identical cells ; loss of genetic material may not allow function / cells maintain function / cells are able to function ; replacement of, old / damaged / dead, cells ; AVP ; e.g. to maintain healthy numbers of cells red blood cells have short life	3

76. 9700_w20_ms_21 Q: 6

(a)(i)	*in context of mutations in genes* *any **two** from:* uncontrolled, (cell) division / mitosis ; cell cycle not regulated ; programmed cell death does not occur / cell becomes immortal ; uncontrolled growth not suppressed ; *ref. to* mass of abnormal cells ; AVP ; e.g. cell cycle checkpoints impaired proto-oncogenes become oncogenes tumour suppressor genes switched off	2
(a)(ii)	*any **two** from:* *ref. to* change of a single, nucleotide / base (in sequence of DNA) **or** one base substitution (mutation) ; change in one, DNA triplet / mRNA codon ; *ref. to* tRNA with a different anticodon / tRNA brings a different amino acid ; idea that different primary structure leads to different tertiary structure ;	2
(b)(i)	*any **three** from:* vaccination stimulates an immune response ; antigen presentation, qualified ; e.g. TSA engulfed by, phagocyte / named phagocyte antigen binds to, specific / complementary, receptor, on, T-lymphocyte / cytotoxic T cell / killer T cell ; clonal expansion ; **A** described e.g. divides by mitosis to form a clone (receptor on) cytotoxic T cell / killer T cell, binds to TSA on tumour cell ; release of, perforin / hydrogen peroxide (to kill tumour cell) ; **A** other named e.g. granzymes AVP ; e.g. causes lysis of the cell	3
(b)(ii)	*advantage any **one** relevant e.g.* tumour cells may have more than one TSA ; stimulate a specific immune response to each TSA ; *idea that* TSA on patient's tumour cells has the appropriate antigen *idea that* personalised treatment so more effective *disadvantage any **one** relevant e.g.* high cost of personalised treatment ; immune system may not recognise TSA on own body cell as, foreign / non-self , the cells in the tumour may not have the TSA in the vaccine ; patient's tumour may not be large enough to obtain enough cells for treatment ; patient needs surgery to obtain (large quantity of) cells ; AVP ; e.g. *suggestion that* tumour cell may settle in a part of the body and not be destroyed	2

77. 9700_w20_ms_23 Q: 5

(a)(i)	**I** *presence or absence of water* diagram shows bond between C (of lysine) and N (of glycine) **and** double bond to O shown correctly ; glycine drawn correctly ; **R** if R is used instead of H on glycine  	**2**
(a)(ii)	condensation ; **A** dehydration (reaction)	**1**
(a)(iii)	**I** high tensile strength *any **two** from:* allows close packing of, triple helix / three polypeptides ; **A** chains **I** tight coiling **A** 'binds more tightly' glycine, has smallest R group / R group of glycine is H / is smallest amino acid ; **A** glycine is small glycine, is every third amino acid in the, polypeptide / chain ;	**2**
(b)	**I** collagen is insoluble / collagen is strong *any **four** from:* **1** collagen, has high tensile strength / does not stretch / AW ; **A** withstands large pulling forces **2** *any ref. to* use of collagen in the body ; e.g. (walls of) arteries or veins / tendons / cartilage / skin / basement membranes / around alveoli / bones / teeth **I** hair / **R** if any *ref. to* elastic(icity) *three from* **3** triple helix has many hydrogen bonds between, polypeptides / chains ; *mp4, 5, 6 and 7 – must be clear that answers are about molecules, but accept triple helix for molecule* **4** collagen molecules form, fibrils / fibres ; **5** strong / covalent, (cross) links between molecules ; **6** (ends of) molecules (in fibril / fibre) are staggered ; **7** AVP ; e.g. (many) collagen molecules lie parallel	**4**
(c)	*induced fit* **1** active site changes shape ; **A** active site moulds round substrate **A** 'active site changes to fit the substrate (more closely)' **2** (so) active site becomes (fully) complementary shape to collagen ; *any four from* **3** formation of, enzyme-substrate complex / ESC ; **4** lowering of activation energy ; **5** breakage of peptide bond ; **6** active site returns to, pre-ESC / original, shape **and** can be reused ; **7** AVP ; e.g. *ref. to*, binding site / catalytic site (of active site) e.g. suggestion of how activation energy lowered, e.g. strain put on bond / alternative pathway	**5**

(d)	*description* **1** general description of effect of pH on activity ; e.g. as pH increases the activity increases and then decreases e.g. as pH increases activity reaches a peak e.g. use of data with unit for relative activity to describe increase and decrease (see next page) **2** **2** optimum pH is 7 ; *explanation* *any **three** from:* **3** partial denaturation in, acid **and** alkaline conditions / AW ; **A** 'starts to denature' as alternative to partial denaturation *small changes either side of optimum* **4** (ionisable) R-groups in, active / catalytic, site affected ; *large changes either side of optimum* **5** hydrogen bonds / ionic bonds, break / disrupted ; **6** active site (shape) / (enzyme) tertiary structure, changes, so substrate / collagen, no longer fits into active site / fewer ESC complexes formed ; **A** fits less well *in context of partial denaturation* **7** AVP ; e.g. detail of R groups	**4**

78. 9700_s19_ms_21 Q: 6

(a)(i)	30% ; **A** anywhere in the answer bases, are paired / are complementary ; **A** with *ref. to* binding **A** hydrogen bonds between, A and T / C and G **A** thymine *or* T pairs with adenine *or* A / cytosine or C pairs with guanine or G calculation / explanation for 30% ; e.g. A□T = 40%, C□G = 60%, half of 60% = 30%	**3**
(a)(ii)	mitochondria / mitochondrion (in cytoplasm) ; **R** whole answer if anything else is first or second in answer **R** 'mitochondria and / or cytoplasm'	**1**
(b)(i)	G G U C ;	**1**
(b)(ii)	anticodon ; *any two from:* **Q** / anticodon, binds / AW, to, codon on mRNA ; **I** *ref. to* complementary bases alone *idea that* specificity ensures correct primary structure (of polypeptide / protein) ; **A** correct amino acid sequence (of polypeptide / protein)	**3**
(b)(iii)	site of attachment of (specific) amino acid (to tRNA) / amino acid binding site ;	**1**

79. 9700_s18_ms_22 Q: 2

(a)(i)	A = adenine T = thymine **R** thiamine / thyamine G = guanine C = cytosine *all correct = 2 marks* *one, two or three correct = 1 mark*	**2**
(a)(ii)	*three from:* 1 complementary base pairing / complementary bases / base pairing / base pairs / complementary pairing ; 2 A with T and G with C ; 3 hydrogen bonding / hydrogen bonds ; *in context of between base pairs / holding strands together* 4 ref. to purines with pyrimidines ; 5 double ring (bases) with single ring (bases) ; **A** *idea of* longer base with shorter base 6 two (DNA), strands / polynucleotides ; **A** two chains **A** double helix (as double implies two strands) **7** strands (anti)parallel / distance between strands always the same ;	**3**
(b)	deoxyribose ; **A** 2-deoxyribose / 2-deoxy-D-ribose	**1**
(c)	*two from:* (information could be) sequence of amino acids ; **A** idea that a polypeptide/protein has amino acids arranged in an order / AW **I** primary structure / chains of amino acids (different) proteins have, different / specific, sequences (of amino acids) ; (up to) 20 different amino acids in proteins ; **A** approximately 20 *idea that* there is a great variety in protein structure ; **I** have many functions	**2**

80. 9700_w18_ms_22 Q: 5

(a)	*polymer – context of a chain / strand* (similar) repeating, smaller molecules / subunits **or** repeating / many, monomers / (RNA) nucleotides ; **R** branching **A** *idea of* nucleotides joined together to form a chain **A** made of nucleotides to form polynucleotide *'made of nucleotides' 'made of monomers' not enough* *macromolecule (in context of RNA)* large (biological) molecules / 1000 or more atoms / high molecular mass ; **A** giant / huge, structure **I** long	**2**
(b)	add Benedict's (solution / reagent) and, boil / heat to 95 °C ; **A** temperature 80 °C and above precipitate / (change from clear blue to) green / yellow / orange / red / brown ; **R** if a wrong colour included e.g. black / purple	**2**
(c)		**3**

feature	DNA nucleotide	RNA nucleotide
sugar component	deoxyribose	ribose ;
purine bases	adenine / A guanine / G	adenine / A guanine / G } ;
pyrimidine bases	cytosine / C thymine / T	cytosine / C uracil / U } ;

R *thiamine for thymine*

81. 9700_w18_ms_23 Q: 3

(a)(i)	**D** (nitrogenous organic / nucleotide) base ; **A** pyrimidine / uracil / cytosine **R** purine **E** ribose ; **I** pentose **F** phosphate (group) ;	**3**
(a)(ii)	*any one from* two, strands / polynucleotides (not one) ; **A** two chains **R** polypeptides deoxyribose (not ribose) ; **A** correct ref. to –OH (on C2) instead of –H group on the pentose / sugar thymine (not uracil) ; **R** thiamine have base pairs ; (double) helix / helical (not straight chain) ; longer ;	**1**
(b)	*any four from* **1** template RNA binds to (part of) region **X** ; **2** in active site of, telomerase / enzyme ; **3** DNA / free, nucleotides, pair with / bind to / align with, RNA ; **4** ref. to complementary, bases / base pairs ; **5** A–T and C–G and U–A ; **6** phosphodiester bonds form, between (DNA) nucleotides / AW ; treat as neutral any *refs.* to likely enzymes, e.g. ligase, etc. **7** telomerase moves, in the direction of the arrow / to the right ; **8** AVP ; e.g. hydrogen bonds between bases telomerase acts as a reverse transcriptase	**4**
(c)	*prokaryotes* have, circular DNA ; **A** 'loop of DNA' **I** plasmid(s) do not have telomeres ; do not have chromosomes ; AVP ; e.g. 'DNA has no ends'	**1**
(d)	*any two from* cancer cells divide, uncontrollable / continuously ; **ORA** **A** cancer cells divide but do not undergo cell death telomerase is required to ensure, chromosomes, do not shorten ; telomerase is, synthesised / produced / found, in cancer cells ; **ORA** high levels of telomerase indicate cells that are cancerous / AW ; AVP ; e.g. *idea that* gene for telomerase switched on	**2**

82. 9700_s17_ms_21 Q: 4

<table>
<tr><td>(a)</td><td>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 ;</td><td>max 4</td></tr>
<tr><td>(b)(i)</td><td>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</td><td>max 1</td></tr>
<tr><td>(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>(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>(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>
<tr><td>(e)</td><td>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</td><td>max 4</td></tr>
</table>

83. 9700_s17_ms_23 Q: 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**
(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**
(c)	nucleus ; chloroplast(s) ; mitochondrion ; **A** mitochondria	**max 2**
(d)	***A*** nucleic acid / DNA / RNA ; **A** genetic material **I** strand **R** circular DNA ***B*** protein coat / capsid / capsomere / protein subunit ;	**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**
(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**
(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**

84. 9700_w16_ms_23 Q: 4

(a) hydrogen (bond) ; [1]

(b) *three from*

1 tRNA carries an amino acid to ribosomes ;
2 (each type of) tRNA carries a specific amino acid ;
3 anticodon (on tRNA) binds to codon on mRNA ; *anticodon may be labelled on Fig. 4.1*
4 tRNA molecules hold amino acids, in place / in P and A sites (of ribosome), for peptide bond formation ;
5 tRNA molecules, reused / described ; **I** tRNA leaves ribosome unqualified
6 AVP ; e.g. amino acid is attached to ACC region **I** examples of complementary base pairing between codon and anticodon [max 3]

(c) *max 2 if in context of making mRNA*

1 gene for each tRNA (molecule) is transcribed ;
2 hydrogen bonds in DNA are broken ;
I unwinding / unzipping
3 one strand of DNA is the template ;
4 RNA polymerase ;
5 (free RNA) nucleotides joined together / formation of phosphodiester bonds ;
I complementary base pairing
6 AVP ; e.g. correct ref. to helicase in breaking hydrogen bonds [max 3]

[Total: 7]

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85. 9700_s15_ms_21 Q: 6

(a) **P** – thymine ; **R** thiamine / thiamin / thyamine
Q – cytosine ;
R – guanine ;
S – uracil ; [4]

(b) **1** copy of the, DNA / gene, (coding) for a, polypeptide / globin ; **A** protein

2 travels from, DNA / nucleus / chromosome, to ribosome ;
A mRNA made in nucleus, attached to ribosome *so movement is implied*

3 for translation / for (haemo)globin production ;

4 mRNA codes for, sequence / order, of amino acids ; **A** for primary structure

5 *idea that* (nucleotide / base) sequence is a series of codons ;

6 base pairing / AW, between codon on mRNA and anticodon on tRNA ;
e.g. of AW
hydrogen bonds between bases
examples of base pairing: A–U / C–G
R binding between bases [max 3]

[Total: 7]

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86. 9700_s15_ms_23 Q: 2

(a) (late) interphase / phase / after G1 phase / before G2 phase ;
A after first growth phase / before prophase / before mitosis / after cytokinesis [max 1]

(b) (i) hydrogen / H, (bonds) ; [1]

(ii) Y, single ring structure ; **A** smaller molecule compared to **X** [1]

(c) (i) change in, nucleotide / base, sequence of DNA ;
any one from
new allele fomed ;
deletion / substitution / addition / frame shift , (mutation) ;
change to / altered, mRNA ; **A** altered codon(s)
(causing) change in, primary structure / amino acid sequence, of, polypeptide / protein ;
A different protein / altered function of protein / non-functional protein [max 2]

(ii) cell cycle shorter / interphase shorter / division more frequent ;
(cell cycle) checkpoints not controlled ;
uncontrolled (growth / division) / AW ;
AVP ; e.g. no differentiation (into epithelial cell)
A no cell death / apoptosis [max 2]

[Total: 7]

87. 9700_s20_ms_22 Q: 5

(a)	presence of sucrose (in sieve tube) lowers water potential (of phloem sap) ; **A** makes water potential more negative water enters (sieve tube), by osmosis / down water potential gradient ; increases volume (in sieve tube) ; increases hydrostatic pressure (in sieve tube at source) ; **A** turgor pressure *ref. to* lower hydrostatic pressure (in sieve tube at sink) ; *allow ecf for no ref. to, hydrostatic / turgor* detail ; e.g. sucrose removed at sink water follows sucrose that exits sink movement of, (phloem) sap / sucrose, down pressure gradient / from high to low hydrostatic pressure ; mass flow ;	4
(b)(i)	glycosidic ;	1
(b)(ii)	nucleotide components are base, pentose sugar, phosphate ; UDP has, uracil and ribose and two phosphates / one extra phosphate ;	2
(b)(iii)	*max three if describing breakdown of sucrose* *allow points from diagrams* *any four from* *induced fit* shape of, substrates / UDP and glucose, not (fully) complementary to shape of active site (of sucrose synthase) ; *lock and key* shape of, substrates / UDP and glucose, complementary to shape of active site (of sucrose synthase) ; *allow ecf if no ref. to shape* *induced fit* active site flexible / moulds around, substrates / UDP and glucose ; AW *lock and key* active site does not change shape / is not flexible / AW ; *induced fit* (active site moulds around so) *idea of* provides better fit / fully complementary ; *lock and key* substrate fits into active site ;	4
(c)	α-glucose ; **A** glucose **R** β-glucose α, 1-4 ; α, 1-6 ; *bond types either way round* glycogen ;	4

88. 9700_s18_ms_21 Q: 2

(a)(i)	**A** – (α-) glucose ; **R** any qualification of glucose other than α, e.g. β-glucose **B** – fructose ; **I** hexose sugar **I** any qualification of fructose, e.g. α	2
(a)(ii)	glycosidic ; **R** glucosidic **I** any qualification of glycosidic, e.g. 1–2, 1–6	1
(a)(iii)	hydrolysis ; **A** acid hydrolysis	1
(b)	*two from:* sucrose is, a non-reducing sugar / non-reducing / not a reducing sugar ; **A** no reducing sugars present no (hydrochloric) acid used (to break down sucrose to reducing sugars) ; **A** sucrose not hydrolysed (to monomers / monosaccharides / reducing sugars) AVP ; (sucrose will not reduce) (blue) copper II ions to (red) copper I ions cannot donate electrons *idea that* reactive groups are not available (to react with Benedict's solution / copper ions) no (free), aldehyde / ketone, group	2
(c)	*hydrostatic required once only in the answers* *four from:* 1 diffusion, into phloem sieve tube (element), from companion cell (through plasmodesmata) ; 2 presence of sucrose (in phloem sieve tube element), lowers water potential / makes water potential more negative ; **R** if in context of xylem vessels or companion cells 3 water enters (sieve tubes), by osmosis / down water potential gradient (into sieve tubes) ; 4 increase in, hydrostatic, pressure (in sieve tube elements) ; **A** turgor pressure 5 low hydrostatic pressure in, storage tissues / root / sink, by removal of sucrose ; 6 movement of, (phloem) sap / sucrose (in solution), down hydrostatic pressure gradient / from high to low hydrostatic pressure ; 7 mass flow ;	4

89. 9700_w18_ms_21 Q: 5

(a)	*any two from* cell wall made from, peptidoglycan / murein ; **A** not cellulose DNA free in the cytoplasm ; **or** circular / closed loop, of DNA ; **or** naked DNA / no histones ; 70s ribosomes ; AVP ; e.g. no membrane around flagellum **or** flagellum is not 9+2 (microtubule pattern) ;	2
(b)	*any two from* transport of sucrose / assimilates / products of photosynthesis (in phloem), is prevented / AW ; *ref.* starch synthesised in root from transported assimilates / AW ; starch not converted in leaf to sugars / sucrose, (for transport) ; idea that pathogen and phloem present in, all organs / many organs / leaves / roots ; AVP ; e.g. reason(s) why it cannot be xylem	2
(c)		5

feature	DNA nucleotide with adenine	RNA nucleotide with adenine	ATP
contains nitrogen (yes or no)	yes	yes	yes ;
contains a pyrimidine base (yes or no)	no	no	no ;
number of phosphate groups	1	1	3 ;
name of the sugar component	deoxyribose ;	ribose	ribose ;

90. 9700_m16_ms_22 Q: 5

(a) phosphate ;
ribose ;
adenine ;
adenosine ;
covalent bond ;
} *labels pointing to correct components*

[max 3]

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

(ii) **D A C B** ; [1]

(iii) source ; [1]

(c) (i) ref. tRNA role in translation ;
e.g. amino acid carried by tRNA molecule to ribosome
anticodon on tRNA (with specific amino acid) binds to codon on mRNA
tRNAs bring amino acids, adjacent to each other / for peptide bond formation

idea that mRNA (sequence of) codons dictate which amino acids will be added (to polypeptide chain) / AW ;
ref. correct, sequence of amino acids / primary structure (of, polypeptide / protein) ;

[max 2]

(ii) hydrogen / ionic, bonds, break / disrupted ; **A** electrovalent for ionic **R** if other bonds named
charges at the active site may be affected ;
changes, shape / (tertiary) structure, of active site ;
A changes, <u>shape</u> / <u>tertiary structure</u>, of enzyme

[max 2]

iii) substrate enters the active site ;
active site, (partially) flexible / changes shape slightly ;
ref. provides a better fit / moulds around ;
allows interaction of R groups (of active site) with substrate ;

[max 2]

[Total: 12]

91. 9700_s15_ms_23 Q: 5

(a) (light microscope) observe living cells / cells would be killed (with EM) ;
vacuum used in electron microscope ;
(light microscope) can have water on slide (to allow cells to move) ; ora
AVP ; e.g. more readily available for use
organisms move in response to light [max 2]

(b) **(i)** (part of / used in synthesis, of) chlorophyll (molecule) ;
R gives chlorophyll green colour

in translation / joining of large and small subunits (of ribosomes) ;

enzyme, cofactor / activator / described ; *idea of role in enzyme catalysis*
A correctly named enzymes e.g. DNA polymerase

AVP ; e.g. stabilizing, cell wall / proteins / nucleic acids / membranes
important in energy transfers / ATP synthesis
DNA, synthesis / replication
ref. to role in, light absorption / capture (for photosynthesis) [max 1]

(ii) *any two from*
1 good solvent / polar (for substances needed by the organism) ; AW
2 transparent / allows light through, (for photosynthesis) ;
3 liquid over wide range of temperatures ;
4 high specific heat capacity ; **A** description
5 high latent heat of vaporisation ;
6 ref. to density ; e.g. ice / solid, less dense than, water / liquid
circulation bringing nutrients to surface
7 ref. to low viscosity for locomotion ; [max 2]

(c) *assume multicellular organisms unless stated, then accept ora*
1 small, surface area to volume ratio / SA:V ;
A as organisms increase in size, SA:V decreases
2 ref. to (larger size means) long distances (to reach, cells / tissues) ;
3 diffusion, too slow / insufficient / unable to satisfy needs ;
4 transport system decreases time to supply cells ;
5 require, bulk / mass, flow ;
6 ref. to transport system means efficient supply (to cells) of nutrients / named / assimilates / water ; **A** brings supplies close to cells (for transfer) [max 4]

(d) **1** mass flow ; **A** pressure flow
2 sucrose / solutes / assimilates / sugars, decreases, water potential / Ψ;
A more negative / lowers, water potential
A for water potential **A** solute potential
3 water enters (sieve tubes) by osmosis ;
4 (water enters) down water potential gradient ;
5 (increased volume) increase in / high(er), hydrostatic pressure ;
ref. to hydrostatic required once only in mp 5 or mp 7or mp 8
6 unloading / removal, of sucrose / AW, at the sink / named sink ;
7 lowers hydrostatic pressure / low pressure at sink ;
8 movement is, down pressure gradient / from high to low (hydrostatic) pressure ; [max 5]

[Total: 14]

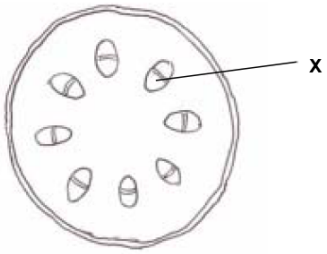
92. 9700_m20_ms_22 Q: 1

(a)	**(F)** **C** **E** **D** **A** **B** ; ; ; ; all five correct = four marks three or four correct = three marks two correct = two marks one correct = one mark	**4**
(b)	1 water, leaves sieve tube (element) / follows sucrose ; *any **two** from:* 2 down the water potential gradient / from higher to lower water potential / by osmosis / sucrose (in companion cell in sink) lowers water potential ; **A** ψ *for water potential* 3 decreases volume in sieve tubes (in sink) ; 4 decreases (hydrostatic) pressure (in sieve tubes in sink) ; 5 pressure higher (in sieve tube) at source than pressure (in sieve tube) at sink / (maintains) pressure gradient from source to sink / sap moves down pressure gradient ;	**3**

93. 9700_m20_ms_22 Q: 6

(a)	*any **two** from:* 1 water moves into, cell / vacuole, by osmosis / down water potential gradient ; 2 (large) vacuole full of, water / sap ; 3 turgid / vacuole exerts outward pressure ; 4 hydrostatic (support) ;	**2**
(b)(i)	number of times an image is larger than, actual / real, size ; **A** image size ÷ actual size **R** increase in size of specimen or object	**1**
(b)(ii)	(×) 2000 ; ; *if incorrect:* one mark for correct working 70 000 / 35 **or** one mark for correct measurement **and** division by 35 e.g. 70 mm / 35 7 cm / 35	**2**
(c)(i)	*transport mechanism:* active, transport / uptake ; *explanation (max 2):* (vacuole) has higher concentration of hydrogen ions (than in cytosol) ; hydrogen ions need to move against the (concentration) gradient ; ATP / energy, needed ; membrane protein needed ;	**3**
(c)(ii)	*any **three** from:* charged particles / ions, cannot cross, hydrophobic core / region of fatty acid tails / AW ; movement through specific membrane protein ; membrane protein only allows one-way movement ; **A** no membrane proteins to allow outward flow AVP ; e.g. suggestion that binding site is on the cytosol side	**3**
(c)(iii)	*any **two** from:* acid hydrolases, break down / digest / hydrolyse ; ref. to leakage from vacuole ; avoids, damage to / breakdown of, cell contents / organelles / molecules (in the cytosol) ;	**2**

94. 9700_s20_ms_23 Q: 1

(a)	any one correct location ; **R** if more than one label line and one is to an incorrect location *allow the mark if more than one label line and all point to xylem locations*  	1
(b)	**I** *ref. to* adhesion / H bonding between water molecules and cellulose lining *any three from* (hydrogen bonding causes) cohesion between water molecules ; water molecules attracted to each other /AW ; water leaving xylem (at top), pulls water molecules below ; transpiration pull ; *idea that* contributes to, an unbroken / a continuous, column of water (within xylem vessels) ; AVP ; e.g. allows movement of water against (pull of) gravity	3
(c)(i)	*any three from* *description max 2* (movement to adjacent cell) via plasmodesmata ; (movement) through symplasm / cytoplasm / symplastic pathway / cytoplasmic pathway ; (includes) movement through vacuole / vacuolar pathway ; *explanation* cell **B** has a lower water potential than **A** **ora** *or* cell **C** has a lower water potential than **B** ; **ora** *or* water moves down the water potential gradient / from high to low water potential / to lower water potential / from less negative to more negative water potential ; **R** from high to low water potential gradient **R** to lower water potential gradient water moves, into / out of, vacuole by osmosis *or* water crosses tonoplast by osmosis ;	3
(c)(ii)	*any three from* cell wall ; large (permanent) vacuole ; tonoplast ; plasmodesmata / cytoplasmic strands between adjacent cells ; nucleus at, edge / periphery, of cell / AW ; AVP ; many small Golgi bodies **A** dictyosomes starch, granules / grains **I** lack of centrioles **I** chloroplasts	3

95. 9700_s20_ms_23 Q: 6

(a)	*any three from* *idea that* water moves down a water potential gradient / from a high to low water potential / AW ; sucrose solutions produce differences in water potential inside the cell and externally *or* different concentrations of external sucrose solution produces different gradients of water potential ; high concentration of, sucrose / solutes, is, lower / more negative, water potential ; ora loss of water by osmosis out of potato cells lowers mass of block ; ora for gain of mass no net gain or loss means water potential inside and out are equal ;	3
(b)	concentration where the, curve / line, crosses the *x*-axis (and use a reference table) *or* the concentration at which there is zero percentage change in mass (and use a reference table) ;	1

96. 9700_w20_ms_21 Q: 4

(a)(i)	plasmodesmata ;	1
(a)(ii)	*any* ***two*** *from:* *ref. to* connecting two cells ; *in context of connecting cytoplasm* (facilitate) movement of substances between cells ; **A** named substances *ref. to* symplast pathway ; cell to cell communication / passage of cell signalling molecules ; AVP ; e.g. removes the need to cross the partially permeable cell surface membrane (when moving between cells) increases the rate of movement of substances between cells	2
(b)(i)	protein coat / capsid ; DNA or RNA / nucleic acid ; **A** genetic material ref. to some viruses have envelope ;	2
(b)(ii)	*allow sucrose for assimilates throughout* *any* ***five*** *from:* viruses / assimilates, enter via plasmodesmata ; movement / diffusion, of assimilates into (phloem) sieve tubes, lowers water potential / AW ; (so) water enters, by osmosis / down water potential gradient / AW ; hydrostatic pressure increases (at source) ; **A** turgor pressure *for hydrostatic pressure* unloading at, sink / named sink, lowers hydrostatic pressure (at sink) ; detail ; e.g. assimilates move out and water follows osmotically pressure gradient created / higher pressure in source (than sink) / lower pressure in sink (than source) ; (so) mass flow; *term to be used in context* from source to sink ; *allow mp if terms source and sink used in correct context within complete response* AVP ; (viruses and assimilates travel) through sieve pores	5

97. 9700_w20_ms_22 Q: 1

(a)(i)	plasmodesmata ; **I** cytoplasmic strands / cytoplasm **R** if other structures also given	**1**
(a)(ii)	(existence of / down, a) water potential gradient ; **I** *ref. to* solute / osmotic, potential **A** lower / more negative, water potential of (cell) **C** (than cell **B**) **A** higher / less negative, water potential of (cell) **B** (than cell **C**) **A** Ψ for water potential	**1**
(a)(iii)	symplastic (pathway) ; **I** vacuolar / vacuole, pathway **A** symplast	**1**
(b)	*max 3 if no ref. to evaporation or water vapour and ref. only to water* *any **four** from:* **1** evaporation of water / water to water vapour ; *must be in context of* **P** **2** **P** described as, surface / cell wall, of (spongy) mesophyll (cell) ; **R** palisade mesophyll cell **A** film / layer, of moisture / water (for surface of cell) **3** water vapour enters (substomatal) air space ; **R** intracellular air space **A** other correct refs. to air space in sequence of events **4** diffusion of water vapour (out) through stoma / stomatal pore (to **Q**) ; **R** through guard cells **R** diffusion by osmosis **5** (towards **Q** because) down water potential gradient / from high to low water potential / to lower water potential ; **I** potential gradient alone **A** down (water) vapour pressure gradient **A** Ψ *for water potential* *context is movement out to atmosphere, not movement from* **P** *to air space* **6** AVP ; e.g. stoma stated as open heat energy required for evaporation / *ref. to* latent heat of vapourisation air space described as, intercellular / saturated / substomatal	**4**
(c)	**1** correct formula ; (magnification) = image length ÷ actual length ; **A** rearranged formula **A** magnification triangle **2** correct working ; **3** correct answer for magnification ; **R** if units given (×) 1440 (36 mm) / 1460 (36.5 mm) /1480 (37 mm) / 1500 (37.5 mm) 1520 (38 mm) / 1540 (38.5 mm) / 1560 (39 mm) ; *if answer given to 2 sig. figs, look for the correct answer at the end of working* ***or*** *allow if stated by answer that this is to 2 sig. figs.* *allow ecf for incorrect conversions used in working or incorrect measured value of X–Y*	**3**

98. 9700_w20_ms_23 Q: 2

(a) *award mp1 and mp8 anywhere in each section of the answer* — **5**

*cell **B** - mesophyll cells*

mp1 photosynthesis / described ;
e.g. conversion of carbon dioxide to sugars using light energy
synthesis of complex organic compounds from inorganic compounds using light energy

adaptation – mp2 and one from mp3 to mp7

mp2 chloroplasts / chlorophyll / chloroplast pigments	to absorb light ;
any **one** from:	
mp3 large vacuole	to keep chloroplasts at the periphery ;
mp4 starch grains	as store of products of photosynthesis ;
mp5 large / moist, surface / cell wall	for evaporation of water for transpiration (stream) ; **A** provides water for photosynthesis in context of water supply transpiration
mp6 thin cell wall	gas exchange / diffusion of gases ;
mp7 isodiametric / (roughly) spherical shape	prevents close packing / gives large air spaces ;

*cell **C** - sieve tube element*

mp8 transport / movement of, (named) sugars / (named) assimilates / photosynthates / organic substances ;
A translocation

(a) *adaptation – any **two** from:*

mp9 peripheral / described, cytoplasm **A** 'at the edge' / 'thin layer'	allowing maximum, volume / space, for transport of, phloem sap / assimilates ; **A** less / little, resistance to flow / AW
mp10 no nucleus / few organelles / little cytoplasm **R** 'no organelles'	allowing maximum, volume / space, for transport of, phloem sap / assimilates ; **A** less / little, resistance to flow / AW
mp11 elongate / elongated (cells, so end to end)	to make (sieve) tubes ;
mp12 plasmodesmata	(un)loading from / AW, companion cells / cell **A** ; **I** 'between cells A and C'
mp13 sieve pores	**A** flow between sieve tube elements ; AW
mp14 sieve plates	prevent, bursting / bulging ; **A** maintaining hydrostatic pressure
mp15 AVP for **C** ; e.g. phloem proteins **and** defence against pathogens / sealing wounds e.g. cell walls with cellulose microfibrils that run around the cells **and** to prevent bursting	

(b) *mp1, 2, 4 and 6 needs idea of increases / more; this is not needed for mp3 and mp5* — **3**

*any **three** from:*

1 increases surface area:volume of cell / increases surface area of (cell surface) membrane ;

2 *idea of* more space for / increased area for / more, proton pumps / carrier proteins in context of moving protons ;

3 pumping protons, from cytoplasm / into cell wall / into apoplast / AW ;
A create / increase, proton / electrochemical / concentration, gradient

4 *idea of* more space for / increased area for / more, cotransporter proteins / carrier proteins in context ;

5 cotransport of sucrose / described, into companion cell / into transfer cell / into cell **A** / from mesophyll cell / from cell **B** ;
A secondary active transport

A *movement of sucrose and protons for cotransport*

6 more space for plasmodesmata (between cell **A** and cell **C**) ;

99. 9700_m19_ms_22 Q: 1

(a)	**A** = palisade mesophyll ; **B** = epidermis ; **C** = spongy mesophyll ;	3
(b)	***accept*** *ora throughout* *any* ***three*** *from:* *Erica v Cedrus:* curled / rolled, leaf (v not, curled / rolled) ; hairs / trichomes (v no trichomes) ; no hypodermis / AW v hypodermis / layer of cells below epidermis / layer of cells between epidermis and palisade mesophyll ; **A** ref. to two layers of outer cells in *Cedrus* AVP ; ; e.g. *Erica* has thicker cuticle *Erica* has larger epidermal cells sunken stoma visible in Cedrus *Cedrus* has cylindrical / needle-shaped, leaf**A** circular in (cross-) section *Cedrus* has lower surface area to volume ratio ;	3
(c)	*any* ***three*** *from:* *idea that* stomata, only open during the day / open during the day and close at night ; *statements about gas exchange:* stomata open to obtain (enough) carbon dioxide for photosynthesis ; **A** carbon dioxide not required at night *statement about transpiration*: (most) water vapour lost via open stomata ; very little water (vapour) lost via cuticle ; **I** ref. to temperature	3

100. 9700_s19_ms_21 Q: 4

(a)	*any one from:* *idea that* to provide cells that can, differentiate / divide ; for (continued) growth of the, shoot tip / (named) tissues ; **I** 'to produce more meristematic cells'	**1**
(b)	*one mark per row* **stages** / **description** **F** and **G** / cell, elongates / enlarges / grows **and**, a vacuole forms / makes a tonoplast ; **G** and **H** / cell divides (longitudinally) **and** one of the cells has a vacuole ; **H** and **J** / developing sieve tube cell, elongates / enlarges / grows **and** loses its nucleus **or** one (developing companion) cell divides (transversely) to form (two) companion cells ; **A** companion cell divides	**3**
(c)	*any four from:* **1** elongated cells to form, long tubes / AW ; **2** little, cytoplasm / cell contents / fewer organelles, to reduce resistance to flow ; **A** peripheral cytoplasm / no nucleus, to allow transport of maximum volume of, (named) assimilates / sap / nutrients **A** 'more space for .....' **R** no organelles **R** 'no cell contents' **3** sieve (plates have) pores, so little barrier to flow from cell to cell / easy (for phloem sap) to pass from cell to cell / allows mass flow ; **4** sieve plates, support / stop collapse of / stop bulging of, sieve tube elements ; **A** become plugged with, P-protein / callose, to prevent losses / after damage **A** maintain hydrostatic pressure (in sieve tubes) **5** plasmodesmata between sieve tube and companion cell for ease of, loading / unloading / AW ; **6** AVP ; e.g. membrane around sieve tube for osmosis to occur / prevent loss of (named) assimilates	**4**
(d)	*allow assimilates / AW for sucrose* **1** movement of sucrose from, mesophyll / parenchyma / source, cells ; **A** movement of sucrose to (named) sink cells **2** move sucrose, into / out of, sieve tubes (through plasmodesmata) ; **3** pump, protons / hydrogen ions / H^+, out of cell / into cell wall/into apoplast ; **A** *ref. to* secondary active transport **4** provides, ATP / proteins, for sieve tubes ; **A** maintain metabolism of sieve tubes	**2**

101. 9700_s19_ms_22 Q: 1

(a)	stem / not a root, because, transport tissue / vascular bundles / vascular tissue(s) / xylem and phloem / xylem / phloem, around the edges / not in the centre / AW ; **A** stem because, pith / parenchyma tissue, is in the centre	1
(b)	*any two from:* (hydrostatic) support / described ; **R** *if incorrect context e.g. support because of thick cell walls* **A** packing tissue (cells), turgid / store <u>water</u> ; storage ; *in context of substances other than water e.g. sucrose / starch / waste*	2
(c)(i)	vascular bundle ;	1
(c)(ii)	0.65 (<u>mm</u>) ;	1
(d)	*mp1-3 must have statements for both xylem and phloem* *mp4-7 need statements for either xylem or phloem* *three from:* *xylem* — *phloem* **1** no cytoplasm / hollow / no contents — (peripheral / little / some) cytoplasm ; **I** protoplasm **R** full of cytoplasm / AW **2** no organelles / hollow / no contents — (a few) organelles ; **A** examples of organelles mitochondria or ER **I** has SER / RER / ribosomes **R** has nucleus **3** lignified **R** idea of lignin within element — no lignin / (only) cellulose ; **4** no end wall(s) / no sieve plate(s) **A** end walls have broken down — **or** sieve plate(s) / perforated end wall(s) ; **A** (end walls) have sieve pores **5** (side walls) contain pits — **or** no pits (in side walls) ; **6** no plasmodesmata — **or** plasmodesmata (to companion cells) ; **7** thick(er), cell wall / walled — **or** thin(ner), cell wall / walled ;	3

102. 9700_s19_ms_23 Q: 4

<table>
<tr><td>(a)</td><td>

any two from:

note that some mark points must have both xylem and phloem mentioned ('v') and some mark points only need xylem or phloem ('or' – below the line)

<table>
<tr><th>xylem</th><th></th><th>phloem</th><th></th></tr>
<tr><td>no cytoplasm / hollow / no contents</td><td>v</td><td>(peripheral / little / some) cytoplasm I protoplasm
R full of cytoplasm / AW
or
has (a few) organelles
A examples of organelles
mitochondria or ER
I has SER / RER / ribosomes
R has nucleus</td><td>;</td></tr>
<tr><td>lignified
R idea of lignin within element</td><td>v</td><td>no lignin / (only) cellulose</td><td>;</td></tr>
<tr><td>no end wall(s) / no sieve plate(s)
A end walls have broken down</td><td>or</td><td>sieve plate(s) / perforated end wall (s)
A (end walls) have sieve pores</td><td></td></tr>
<tr><td>(side walls) contain pits
R piths</td><td>or</td><td>no pits ;</td><td>;</td></tr>
<tr><td>no plasmodesmata</td><td>or</td><td>plasmodesmata (to companion cells) ;</td><td>;</td></tr>
<tr><td>thick(er), cell wall / walled</td><td>or</td><td>thin(ner), cell wall / walled</td><td>;</td></tr>
</table>

thicker lignified wall = thicker wall mark only (for lignin mark need to state what phloem has)

</td><td>2</td></tr>

<tr><td>(b)</td><td>

any two from:

to hydrolyse / break, glycosidic bonds ;

to produce, reducing sugars / fructose and glucose ;
A to make reactive groups (to Benedicts) available

to be able to test with Benedict's solution to obtain a positive result ;
A description of positive result

sucrose, is a non-reducing sugar / has no reactive groups when tested with Benedict's solution ;

</td><td>2</td></tr>

<tr><td>(c)(i)</td><td>

(large number of mitochondria) provide ATP, for active transport / for protein synthesis ;

(large number of ribosomes) to synthesise the, proton pumps / carrier proteins / AW ;

</td><td>2</td></tr>

<tr><td>(c)(ii)</td><td>

any three from:

H^+, pumped / actively transported (out of companion cell into cell wall)
or
ref. to higher concentration of H^+ (in cell wall) / H^+ gradient builds up (between cell wall and cytoplasm of companion cell) ;

H^+ move back (into companion cell) by facilitated diffusion ; **I** sucrose

through, co-transporter protein / cotransporter ; **A** symporter

H^+ cotransports sucrose / sucrose moves (into cell) with H^+ ;

sucrose is transported against the concentration gradient ;
A sucrose transported by secondary active transport

</td><td>3</td></tr>
</table>

103. 9700_w19_ms_21 Q: 1

(a)(i)	**A** amino / amine group ; **B** carboxyl (group) ; **A** carboxylic acid	**2**
(a)(ii)	peptide bond joining nitrogen from amine group to carbon of carboxyl group on adjacent amino acid ; C = O and N – H shown correctly in the dipeptide ; formation of water molecule ;	**3**
(b)(i)	label line to any area of the nucleus ;	**1**
(b)(ii)	correct formula ; e.g. actual diameter = image length / magnification 15 (□m) ;	**2**
(b)(iii)	*any one valid suggestion* ; e.g. *idea of* only very thin section of cell mitochondria found in other sections	**1**
(c)	*two from* *idea that* reduces resistance to flow through sieve tube ; *idea that* less space taken up so increased volume of sap / AW, can pass through (per unit time) ; pressure flow / mass flow, does not need energy from the cell / AW; AVP ; (organelles not needed as) metabolic reactions / AW, carried out by the companion cell ;	**2**

104. 9700_w19_ms_21 Q: 3

(a)	between 0 – 0.2 mol dm^{-3} the mass of the potato increases **or** between 0.2 – 1.0 mol dm^{-3} the mass of the potato decreases ; no change in mass at 0.2 mol dm^{-3} ; from approximately 0.2 mol dm^{-3} increasing concentration gives a greater decrease ; comparative data quote including two concentrations and two percentage changes ; *units for concentration of sucrose and reference to percentage change in mass must appear once to award this point*	**3**
(b)	*three from* *decrease in mass because* water (molecules) leave the cells ; by osmosis ; down a water potential gradient / from higher water potential to lower water potential **or** solution has a more negative water potential than the potato tissue ; *ref. to* plasmolysis / loss of turgidity ;	**3**

105. 9700_w19_ms_22 Q: 1

(a)	label line to phloem in one vascular bundle ;	**1**
(b)	transport / translocation, of, assimilates / photosynthates / sucrose / sugars / amino acids / other named nutrient ; **I** food from, source / areas of synthesis, to, sink / areas of growth / areas of (high) activity / areas of storage ; **A** areas where they are needed *for sink* **I** 'where they used'	**2**
(c)(i)	epidermis / epidermal ; **I** upper / lower	**1**
(c)(ii)	eyepiece graticule ; **I** stage micrometre	**1**
(d)	*drawing max 2:* regular shaped cell and cell wall drawn in ; central vacuole drawn ; *labels:* *max 2 if animal structures also labelled* *max 1 for labels if incorrect non-cellular structure included* *e.g. vascular bundle / stoma* large / permanent, vacuole ; **A** central vacuole **A** vacuole *if clearly drawn as large* tonoplast ; **R** *if drawn as double membrane* (cellulose) cell wall ; **R** chitin / murein plasmodesma(ta) ; chloroplast ; **A** granum / thylakoid *i.e. chloroplast not labelled but internal structures correctly labelled* **A** if drawn with a single or double membrane starch, grain / granule ; **A** amyloplast	**5**

106. 9700_w19_ms_23 Q: 3

(a)	*five from* **1** drought-tolerant plants have smaller stomatal aperture **and** lower, transpiration rate / rate of water uptake ; **A ora** **2** comparative data quote for, mean stomatal aperture / transpiration rate + mmol m^{-2} s^{-1} / mean water uptake + cm^3 per shoot + time + h ; *in drought-tolerant plants* **3** smaller (aperture), stomata so less water (vapour) loss ; **4** water vapour diffuses (out) through stomata ; **5** less evaporation from (cell walls of) mesophyll ; **6** so less transpiration pull ; **7** AVP ; suggestion of other adaptations of leaves to reduce water loss e.g. sunken stomata / thicker cuticle / hairs / trichomes / lower stomatal density **R** closed stomata	**5**
(b)	**I** *any ref. to mutation / inhibition of (RNA) polymerase* **1** microRNA binds to mRNA ; **A** forms hydrogen bonds with (bases on) mRNA **2** bases in microRNA are complementary to bases on mRNA ; **3** microRNA makes mRNA too large to leave nuclear pore / mRNA cannot reach ribosomes ; ***mp4*** *and* ***mp5*** *accept alternatives to bind* **4** mRNA cannot, bind / AW, to (small sub-unit of) ribosome ; **A** prevents ribosome moving along mRNA **5** anticodons of tRNA cannot, bind / AW, to (some) codons on mRNA ; **6** no / not all, amino acids are brought to ribosome / AW ; **7** AVP ; e.g. complex of microRNA and mRNA recognised for degrading	**3**

107. 9700_s18_ms_21 Q: 6

(b)	*five from:* 1 water potential gradient, between leaves and roots ; **A** water potential gradient across the root (root hair to xylem / across cortex) 2 diffusion out (via stomata) of water vapour ; 3 evaporation of water from mesophyll cell, surfaces / walls / membranes ; 4 (transpiration from leaves) creates transpiration pull ; 5 tension is, set up / present, in xylem vessels ; 6 cohesion between water molecules (*in xylem or in roots)* ; 7 hydrogen bonding between water molecules ; 8 adhesion of water molecules to cellulose (in wall of xylem vessels) ; **A** to hydrophilic parts of lignin 9 movement of water from apoplast through endodermis by osmosis ; 10 AVP ; e.g. *idea that* water columns extend from centre of root to root hairs (and to soil water)	**5**
(c)	*two from:* *pathway C is slower* ***accept ora*** *for pathway B is faster* greater resistance ; water passes across membranes ; water flows through, cytoplasm / plasmodesmata ; **A** ora ref. to intercellular spaces **A** protoplast osmosis occurs ; **R** through plasmodesmata ref. to water passes through vacuoles ;	**2**
(d)	*assume answer is about facilitated diffusion unless told otherwise – accept* ***ora*** *for active transport* *two from:* movement is, down a concentration gradient ; passive / ATP not required / (metabolic) energy not required ; carrier and channel proteins are involved ;	**2**

108. 9700_s18_ms_22 Q: 1

(a)	one mark for each label to correct structure on Fig. 1.1 ; ; ; *tonoplast line to anywhere on the vacuolar membrane* **R** if two or more different structures stated for a single label	**3**
(b)	ref. to conversion of measured (**X**-**Y**) line to μm / AW ; e.g. line is measured in, mm and then multiplied by 1000 / cm and then multiplied by 10 000 evidence that, 60 (±1 mm) is multiplied by 1000 / 6 cm is multiplied by 10 000 measured diameter is 60 000 μm (and) divide by, magnification / 2000 ;	**2**
(c)	*two from:* rough endoplasmic reticulum ; **A** rough ER / RER smooth endoplasmic reticulum ; **A** smooth ER / SER endoplasmic reticulum ; *acceptable only if the other structure is <u>not</u> SER / RER* 80S / larger, ribosomes ; **A** 25–30 nm range plasmodesma(ta) ; microtubules ; **A** microfilaments **A** cytoskeleton lysosome(s) ; Golgi (body / apparatus / complex) ; secretory / Golgi, vesicles ; AVP ; ; e.g. chromatin EM detail of chloroplast EM detail of mitochondrion **A** mitochondrion nuclear pore nuclear envelope **R** nuclear membrane	**2**
(d)(i)	*two from:* cell wall, pathway / route / AW ; **A** involves only cell walls **R** if only in roots movement / AW, through intercellular spaces / spaces between cells ; further detail ; e.g. water does not, enter cells / cross membranes / cross cytoplasm / move through plasmodesmata osmosis does not occur membranes not involved **R** osmosis once only	**2**
(d)(ii)	*four from:* hydrogen bonding (between water molecules) ; water molecules are polar ; *movement to spongy mesophyll cells* adhesion / attraction, to, cellulose / cellulose fibres / cell walls ; *this is in context of leaf cells but also allow for xylem* **R** cell walls of lignin **A** hydrophilic parts of lignin cohesion between water molecules / (water molecules are) cohesive ; *idea that* movement of water (molecules) towards, spongy / mesophyll, cells, pulls / AW, other water molecules ; **A** transpiration pull / continuous column / unbroken column **I** continuous stream *movement to intercellular air spaces* water molecules absorb heat (energy) ; bonds break between water molecules ; evaporation / water to water vapour ; **I** latent heat of vapourisation from spongy cell, walls / surfaces ;	**4**

(d)(iii)	*two from:* transpiration occurs ; *in context of via stomata or via cuticle* diffuses / moves / AW, to, (external) environment / atmosphere / outside / out of the leaf / from leaf surface ; **R** evaporation / osmosis **R** from cell surface via (open) stomata (for, gas exchange / carbon dioxide entry / photosynthesis) ; *accept Ψ for water potential* **I** solute potential / ref. to concentration (movement of water vapour) down water potential gradient ; **A** down water vapour potential gradient **A** high to low water potential / to lower water potential / from higher water potential **R** from high to low water potential gradient	**2**

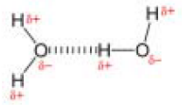
109. 9700_s17_ms_21 Q: 5

(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**
(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**
(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**

110. 9700_s17_ms_22 Q: 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) cytoplasm divided (into two) ; **R** cytoplasm 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**
(a)(ii)	circle round **S** ; synthesis of two 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**
(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**
(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**
(c)(ii)	*strong* high requirement for assimilates ; fast growing / highly active ; AW e.g. requires a lot of energy	**max 1**
(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** cotransport 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**

111. 9700_s17_ms_23 Q: 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**
(b)(i)	cohesion ;	**1**
(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**

112. 9700_w17_ms_21 Q: 6

(a)	*mark first two statements given* cellulose, cell wall / lining, allows adhesion of water ; thick (cellulose) cell wall prevents collapse / *idea of* providing support (under tension) ; (cell wall impregnated with) lignin, for waterproofing / prevents water loss ; lignin, rings / spirals / thickening / AW (of walls), prevents collapse / *idea of* providing support (under tension) ; **A** lignified walls no cytoplasm / lack of contents / hollow / empty (lumen), gives, less resistance to / unimpeded / uninterrupted / unhindered / ease of, flow ; **A** greater volume per unit time / faster rate **R** continuous, smooth **R** dead ack of end walls / continuous tube, so, less resistance to / unimpeded / uninterrupted / unhindered / ease of, flow ; AW **R** continuous, smooth pits / pores, for lateral movement / for movement around air bubbles / supplies (water) to (surrounding), cells / tissues ; **R** holes wide / large diameter / large lumen, so large volume of water can be transported ; *if max 2 not gained, allow one mark for two correct explanations or descriptions where accompanying descriptions and explanations are in context*	**2**
(b)	*two from* *accept phloem vessels for sieve tubes* only sieve tubes / one type, v, arteries, veins and capillaries (any two) **A** three types; sieve tubes are composed of cells v blood vessels composed of tissues ; **A** ref. to named tissues sieve tubes, have cytoplasm or blood vessels are, hollow / AW; sieve tubes have sieve plates ; **ora** sieve tubes have companion cells (to fully function) ; veins have valves ; **ora** *ref. to* blood vessels and vasoconstriction ; **ora** *idea of transport* open (phloem) v closed (blood vessels) ; **A** sieve tubes have plasmodesmata *ref. to* unidirectional flow in blood vessels ; **ora**	**2**
(c)	*three from* mitochondria, synthesise ATP / carry out aerobic respiration ; more ATP needs to be synthesised / increased ATP synthesis ; **A** need to produce large quantities of ATP to provide more (metabolic) energy ; **R** *in context of water uptake* for active transport / active uptake ; *in context of mineral ions* **A** to move mineral ions against the concentration gradient	**3**

113. 9700_w17_ms_22 Q: 5

(a)	**A** = root hair (cell) ; **B** = Casparian (strip) ; **C** = plasmodesmata / plasmodesma ;	**3**
(b)	xylem has no cytoplasm / symplast pathway is cytoplasmic (and vacuolar) ; **A** empty / hollow / no contents **A** cytosol for cytoplasm xylem (vessel elements) are dead cells / symplastic through living cells ;	**2**
(c)	*three from* stomata close ; **I** stomatal pore smaller / stomata partially open only cuticular transpiration ; no photosynthesis / carbon dioxide not needed ; **I** less photosynthesis transpiration (rate) decreases ; **A** less, transpiration / transpiration pull, **A** described in terms of loss of water vapour from leaves evaporation (rate) (from cell walls of spongy mesophyll cells) decreases ; **R** evaporation, from leaf surface / through stomata water potential gradient between, soil / root, and leaf becomes less steep ;	**3**

114. 9700_w17_ms_23 Q: 5

(a)	*in context of / from a plant* loss of <u>water vapour</u> ; **I** evaporation unqualified from, the aerial parts / leaves ;	**2**
(b)	*description of Fig. 5.1B – accept if correct unit is used only once* *four from* 1 decrease then increases ; 2 data with units and minus sign(s) in support ; i.e. decreases to, –1.35 ± 0.01 MPa at 1400 i.e. –0.35 ± 0.01 MPa at 0600 to –0.58 ± 0.01 MPa at 1800 *explanation to max 3* *overall decrease between 0600 and 1400* 3 water is used *or* lost and is not being replaced ; 4 *idea of* synthesis of (named) solutes increases (so decreasing water potential) ; *0600 to 0900 / 0915 accept any specific time within these time frames* 5 *idea that* not enough water supplied from, xylem / transpiration stream ; 6 (because) stomata are closed / only cuticular transpiration occurs ; *0900 / 0915 to 1400* 7 *idea that there is a* high loss of water (from cell surfaces), by evaporation / because of high rate of transpiration ; *0900 to 1400* 8 photosynthesis occurring, stomata open (for CO_2), water vapour diffuses out / rate of transpiration increases ; *1400 to 1800* 9 less photosynthesis as, stomata closing / lower light intensity 10 (named) solutes converted to, starch / sucrose and transported away ; 11 AVP ; e.g. *0900 to 1400* water is used in photosynthesis so water potential decreases	**4**
(c)	sunken stomata ***or*** stomata in, grooves / crypts / pits ; trichomes / hairs ; rolled / curled, leaves ; **A** folded **R** coiled	**3**

115. 9700_s16_ms_21 Q: 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

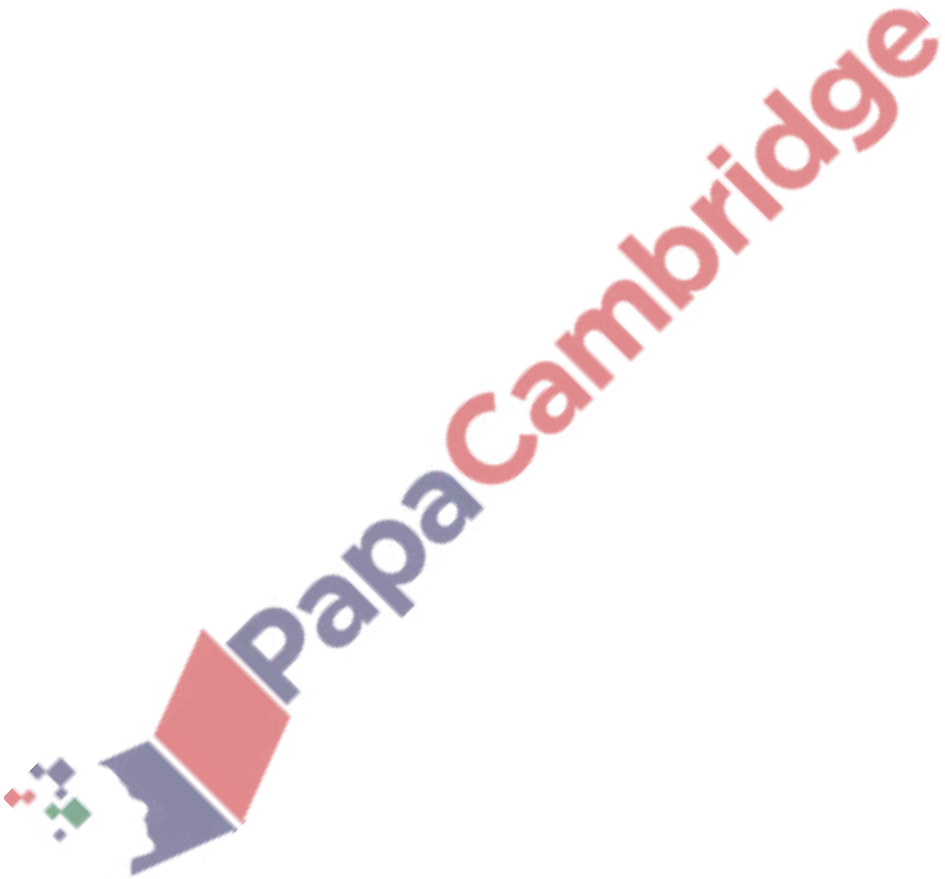
A vapour pressure gradient / water vapour gradient

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]



(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]

116. 9700_s16_ms_22 Q: 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]

117. 9700_s16_ms_23 Q: 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]

118. 9700_w16_ms_21 Q: 2

(a) (i) loss of water vapour from the, leaves / aerial parts of a plant ;
R water evaporates from the surface of the leaf [1]

(ii) *each factor 1 mark, explanation for each factor 1 mark*
look for ora for explanation

temperature ; **I** high / low or hot / cold

increased temperature, increased rate as higher rate of, evaporation (from spongy cell surfaces) / diffusion (of water vapour out via stomata)
or
at very high temperature stomata close so transpiration, stops / slows ;

humidity ; **I** high / low

one from
increased humidity, decreased rate as, less steep water potential gradient / decreased diffusion rate (of water vapour out via stomata) ;

wind (speed) / air movement ; **I** fast / slow

higher wind speed steeper, water potential gradient / higher diffusion rate (of water vapour out via stomata) / diffusion shells do not build up / wind moves moist air away / AW
or
at high wind speed the stomata close so transpiration slows ;

water availability ; **I** high / low
reduced water availability causes stomata to close (so reduced rate of diffusion)
or
more water available, steeper water potential gradient between roots and leaves ;

light intensity ; **I** high / low

higher light intensity, increased rate as stomata open more widely
A more light (as ecf from stating factor)
or
at very high light intensity the stomata close so transpiration slows ; **A** stops [4]

(b) *three from*
cohesion and adhesion ; *in correct context*
transpiration stream / transpiration pull ; **A** continuous column of water moving up (to leaves)
attraction / cohesion, between water molecules ; **A** water is cohesive
A stickiness between water molecules
adhesion / AW, of water molecules to lining of xylem (vessels) ;
only needs 'molecules' once
adhesion to / AW, cellulose molecules / hydrophilic parts of lignin ; [3]

[Total: 8]

119. 9700_w16_ms_22 Q: 2

(a) (i) tubing drawn more swollen ; [1]

(ii) *three from*

1 (mass) increased / AW ;

2 water in by osmosis ; **A** diffuse in by osmosis

if direction of water movement is out in mp2, allow ecf for mp 3

3 lower / more negative, water potential / Ψ (inside tubing) ; ora

A down the water potential gradient / from high to low water potential / from less negative to more negative water potential
R across
R water moves from a high water potential gradient to a low water potential gradient
I *ref. to*, solute / osmotic, potential
I water moves down the concentration gradient

4 sucrose too large to leave (tubing) / pores too small for sucrose to leave ;

5 (Visking tubing) partially permeable membrane ; **A** selectively-permeable [3]

(b) *'source' and 'sink' not required but statements should be in correct context*

three from (source)

1 *idea that* sucrose presence in, phloem / sieve tubes, causes, low(er) / more negative, water potential / Ψ ; AW
A assimilates / photosynthates / sugars / named, *for sucrose*

2 water, enters / AW (sieve tube by osmosis) ; *can be in context of direct entry or from surrounding cells* **R** from root hairs

3 presence of water increases hydrostatic pressure ; **A** turgor *(for hydrostatic)*
A *idea of: causes high(er) hydrostatic pressure because of entry of water (hence increase in volume)*

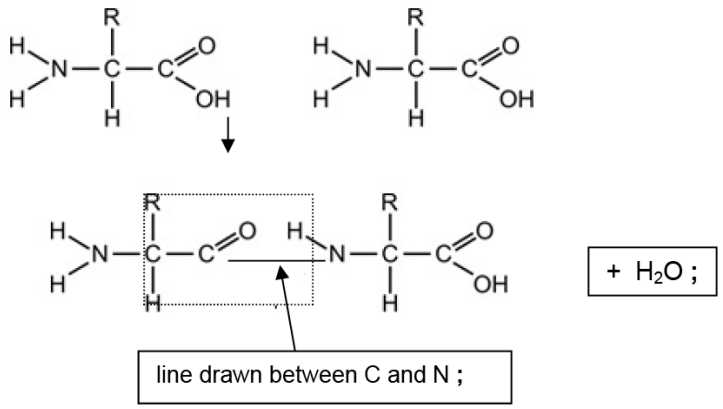
(sink)

4 *idea that* water follows sucrose (via companion cell to sink cells, hence osmosis) ;

5 lower hydrostatic pressure (at sink) ; **A** low *if in context of high at source*
hydrostatic or turgor needed only once (in mp3 or mp5)

6 movement / mass flow (of sap), down a pressure gradient / from high to low pressure ; **R** if osmosis implied for mass flow [3]

(c) *can gain 2 marks if printed diagram is clearly modified to show correct bond and formation of water or/and if described as text*



dotted line area is minimum to gain mark
'peptide bond' label not required to gain mark

bond forms between the C of the carboxyl group and the N of the amino group ;

120. 9700_w16_ms_23 Q: 3

(a) **A** = cortex / parenchyma ; **A** cortical **R** cortical / parenchyma, cells

B = endodermis ; **A** endodermal **R** endodermal cells / pericycle

C = xylem ; **I** vessels / tracheids

D = phloem ; **I** sieve tube (elements) [4]

(b) *allow ecf from incorrect naming of **A** and **B** in (a)*

four from
*from **X** to endodermal cell (**B**) or **X** to **Y** to 3 max*

1 (movement of water) via cell membrane / via tonoplast / by osmosis ;
2 (movement of water) through plasmodesmata ; *do not award **mp1** for 'by osmosis through plasmodesmata'*
3 symplast pathway ; *in correct context only*

*from after **B** to **Y** to 3 max*

4 water moves by apoplast pathway ; *in correct context only*
5 water moves through cell walls ;
6 via pits in cell walls of, xylem (vessel) / **Y** ;
7 down a water potential gradient / described as higher water potential at **X** ; [4]

[Total: 8]

121. 9700_s15_ms_21 Q: 3

(a) increased / faster, movement / diffusion, of, assimilates / amino acids / sucrose / water / solutes / ions / molecules ;
I substances / particles / carbohydrates
I freely / easily / efficiently
I osmosis

(because) more, (symplast) pathways / passages / AW ;
accept in context of blockage of some plasmodesmata

correct ref. to symplast pathway in context of an advantage ;

e.g. of complex plasmodesmata ;
from companion cell into sieve tube (elements) / when loading sucrose into phloem

AVP ; e.g. selectivity / control / regulation, of movement [max 2]

(b) **1** mass flow ; **A** pressure flow

2 sucrose / solutes / assimilates / sugars, decreases, water potential / solute potential ; **A** symbol(s) Ψ

3 water enters (sieve tubes), down water potential gradient / by osmosis ;

4 increase in / high(er), hydrostatic pressure ;

5 unloading / removal, of sucrose at the sink lowers the (hydrostatic) pressure ;

6 movement (from source to sink) is by gradient in (hydrostatic) pressure ; [max 4]

[Total: 6]

122. 9700_s15_ms_21 Q: 5

(a)

structural feature	triglyceride	phospholipid
phosphate (group) / contains phosphorus	×	✓
nitrogen	×	✓
charged / polar	×	✓
(number of) fatty acids	3	2
number of ester bonds	3	2
number of phosphate ester bonds	0	1
award one mark for any of the following comparisons		
number of double bonds (in hydrocarbon chain)	0	1
number of saturated fatty acids / ORA	3	1
presence of double bonds	×	✓
presence of unsaturated fatty acids	×	✓

These are alternatives – award one mark only

[max 2]

(b) *answer may be phrased in the context of amylase / trypsin*
ignore anything before Golgi, e.g. shuttle vesicles from RER

1 vesicles, form from / 'pinch off', Golgi (apparatus / body / complex) ;

2 vesicles moves, through cytoplasm / to cell (surface) *or* plasma membrane ;

3 role of cytoskeleton / microtubules in movement of vesicles ;

4 energy / ATP, is required (movement of vesicles / fusion with membrane) ;

5 vesicle fuses with / AW, cell (surface) / plasma, membrane ;
I bind / attach **A** join / merge / becomes part of

6 exocytosis / vesicle 'opens up' so that enzyme molecules are released ;

7 ref to fluid nature of, membranes / phospholipid bilayer, that makes this possible ;

[max 4]

(c)

role of water	property of water
solvent for glucose and ions	dipolar / polar ; **A** description of polarity of water
transport in the xylem	hydrogen bonding ; **I** cohesion / adhesion
helps to decrease body temperature in humans	high latent heat of vapourisation / high specific heat (capacity) / high enthalpy heat of vapourisation / lots of energy required for evaporation ;

[3]

[Total: 9]

123. 9700_w15_ms_21 Q: 4

(a) (i) loss from, leaves / aerial parts of plant ;
of water vapour ; *link to first point*

plus one from:
evaporation of water, from surface of spongy mesophyll cells / into air spaces ;
diffusion of water vapour, out / to atmosphere ; **R** evaporation
movement / diffusion, (out) through (open) stomata ; **R** evaporation
water vapour moves (out) down the water potential gradient ;

[max 3]

(ii) *adaptation for 1 mark, explanation to max 2*

thick (waxy) cuticle ;
explanation
idea that wax is, (mainly) impermeable to water / hydrophobic / barrier to water vapour movement ;
reduces, water loss from parts with no stomata / uncontrolled water loss / cuticular transpiration ;
idea that increased distance decreases rate of diffusion of water vapour
or
reflective cuticle ;
explanation
reduces heat load ;
reduces evaporation (from spongy mesophyll cells surfaces) ;
reduces rate of diffusion of water vapour (through cuticle) ;
or
folded inner surface / AW ; **A** trichomes / hairs ;
explanation
traps water vapour / AW ;
reduces, diffusion / water potential, gradient ;
(water potential gradient) between sub-stomatal air space and outside / AW ;
or
no stomata (visible) on the, outer / exposed, surface ;
explanation
idea that stomata are main route for water loss ;
idea that reduces area where there is a high rate of water loss ;
surface directly exposed to air currents has no stomata ; ora

R curled or rolled *given as adaptation but allow explanation to max 2*
explanation
stomata on inside ;
no / away from, air currents ; **A** increases humidity within enclosed space / AW
reduces, diffusion / water potential, gradient (between sub-stomatal air space and outside);

[max 3]

(b) (i) 18 g h^{-1} ;;

one mark if no units given
one mark if incorrect answer but correct values extracted from Fig. 4.2 (60–42 g h^{-1}) [2]

(ii) *describe to max 3*
rate of, transpiration / water absorption, increases and decreases / reaches a peak ;
time delay between high rates of transpiration and water absorption / AW ;
lower values for water absorption until (approx.) 1645 ; **ora** **A** 1630 to 1700
data quote to support ;

explain to max 3
ref. to daylight and night and stomatal, opening / closure / AW ;
higher light intensity / greater stomatal opening, higher rate of transpiration ;
ora
idea that transpiration drives water absorption ;
further detail ; e.g. explanation in terms of water potential gradient
ref. to cohesion-tension from leaf to root [max 4]

(iii) xerophyte ;
example of xeromorphic feature ; **A** *ref. to* adaptation(s) (for dry areas)
high light intensity during middle of day / AW (for species **P**) ;
idea that loss of water during the day needs to be minimised ;
suggestion that (most) stomata, closed during the day / only open at night ; [max 2]

[Total: 14]

124. 9700_w15_ms_23 Q: 2

(a) (i) **A** Ψ *for water potential*
I moisture
A aperture *for stomatal aperture throughout*
both units must be used at least once to award mp3 and mp7

similarities
1 when, stomatal aperture is 0 (μm) / stomata are closed, no, transpiration / water loss ;
2 as stomatal aperture increases rate of transpiration increases in both groups of plants ;
3 comparative use of figures with units in support of mp2 for either condition ;

differences
in moving air
4 stomatal aperture, influences / controls / AW, rate of transpiration at all apertures ;
in non-moving air
5 at stomatal apertures 15 μm and above rate of transpiration does not increase further / reaches a plateau / remains constant ;
6 stomatal aperture has most effect on rate of transpiration in non-moving air at low apertures ; **ora**

comparing moving and non-moving
7 comparative use of figures with units to show rates of transpiration at the same stomatal aperture ; [max 3]

(ii) **A** water vapour potential *for water potential*
1 *ref. to* increasing width of stomatal aperture allows more water vapour to diffuse out ; **ora**
R osmosis, **R** evaporate out
I evaporation from mesophyll
2 (intercellular) air spaces in leaf, are fully saturated / have high water potential / AW ;
3 in moving air, water vapour is blown away / does not remain around the leaf ; **A** low humidity around the leaf, **A ora** *for non-moving air*
4 in moving air, water potential gradient, is steep / maintained / increases / AW ; **ora** for non-moving air, **R** concentration gradient
5 so in moving air, high / higher, rate of diffusion of water vapour *in terms of an idea of a* gradient ; **A ora** [max 3]

(b) (i) *advantage of having, stomata in pits / AW*
water vapour / moist air, builds up / trapped, in the, pit / groove / crypt ;
A sunken stoma(ta)
reduces water potential gradient, between air inside the leaf and outside / AW ;
A diffusion gradient
less transpiration / less diffusion of water vapour out (through stomata) / water is conserved ;
R prevents water (vapour) loss
less water needs to be absorbed ; [max 2]

(ii) *treat 'less gas exchange' unqualified as neutral*
cannot absorb carbon dioxide (during the day when photosynthesis occurs) ;
rate of photosynthesis is reduced / no photosynthesis ;
AVP ; e.g. less water / minerals, reaches leaf cells (for other processes)
cooling effect of transpiration does not occur
slow growth [max 1]

(iii) **I** moisture
1 leaves, rolled / curled, so, stomata on inside / humid layer builds up / moist air builds up, (in enclosed area) ;
A less steep water potential gradient
R coiled / curved
2 trichomes / hairs, create, a layer of non-moving air around the leaf / allow humid area to build up ;
A less steep water potential gradient
3 (leaves are), thick / succulent, to store water ;
4 thick(er) (waxy) cuticle reduces, transpiration / water loss ;
A makes more waterproof, **A** waxy layer for cuticle
5 reflective cuticles, reduce heat load / AW ; **A** shiny cuticles reflect heat ;
6 needle-like leaves to reduce surface area (to volume ratio so less, transpiration / water loss) ;
A small leaves
R spikes / spines, unqualified
7 layers of epidermal cells, to reduce (cuticular) transpiration / water loss ;
8 thick walled epidermal cells, to reduce (cuticular) transpiration / water loss ;
9 *ref. to* hinge cells, leaf curling / wilting / AW ;
A leaves wilt to reduce exposure to the sun ; [max 2]

[Total: 11]

125. 9700_s20_ms_22 Q: 6

(a) 3

Stage of cell cycle	
(G_1 phase)	interphase ;
S phase	
G_2 phase ;	
prophase	(mitosis)
metaphase	
anaphase ;	
(telophase)	
(cytokinesis)	

one mark for interphase
one mark for S phase and G_2 phase in correct sequence
one mark for prophase, metaphase and anaphase in correct sequence

(b) 2

Vincristine: ✓ ✓ x x ;

5-fluorouracil : x x x x ;

(c) 3

any three from
blood smear differences
large / larger, numbers of lymphocytes ;
more lymphocytes than normal blood smear ;

as blood smear or lymphocyte difference
immature / not fully developed ;
ref. to no large nuclei / nuclei not pronounced small nuclei ; **A** nuclei not visible

lymphocyte difference
non-functional / AW ;
detail of lack of function for either B-lymphocytes or T-lymphocytes ;

AVP ; e.g. *ref. to* difficult to distinguish between lymphocytes and monocytes ; **A** no monocytes visible

126. 9700_w20_ms_22 Q: 6

(a)(i)	same shape and shift to the right ; *must start to rise within 2 small squares of 0 and end at or near to existing curve*	**1**
(a)(ii)	*max 2 if concept of more not mentioned in response* *any **three** from:* **1** actively respiring tissue means more carbon dioxide ; **2** increase in, formation of carbonic acid **/** dissociation of carbonic acid / hydrogen ions, (in the red blood cell) ; **A** from equation **3** more hydrogen ions, bind to haemoglobin / form haemoglobinic acid ; **A** HHb **4** (causes) more oxygen (to be), unloaded / dissociated / AW (from haemoglobin); **I** *ref. to* faster / quicker **I** incorrect *ref. to* affinity causing unloading, e.g. CO_2 **A** lower (percentage) saturation of haemoglobin with oxygen **A** oxygen released, more easily / readily from haemoglobin **5** haemoglobin affinity for oxygen decreases ; **6** more oxygen to meet demand for (aerobic / cellular) respiration ; AW **I** more oxygen for respiring tissues	**3**
(b)	CO_2 = (passive / simple) diffusion ; HCO_3^- = facilitated diffusion ; **I** *ref. to* size CO_2 is, non-polar / not charged / not ionic and can cross, hydrophobic core / phospholipid bilayer ; HCO_3^- is, charged / ionic / hydrophilic and (needs to) cross, via, transport / carrier, protein ; **A** channel protein *if explanation mps not gained,* allow 1 mark for CO_2 is, non-polar / not charged / not ionic and HCO_3^- is, charged / ionic / hydrophilic	**4**

127. 9700_s19_ms_21 Q: 2

(a)	*any two from:* ('kinks') prevents close packing of, phospholipids / membrane components, (at low temperature) ; keeps / maintains, fluidity ; **A** increases **A** ora - prevents becoming too rigid *idea of* preventing damage to membranes by preventing freezing ; maintains movement of (named) substances across membranes ; **A** any named example of movement across membrane **R** increases AVP ; e.g. maintains movement of proteins within membrane	**2**
(b)(i)	*idea that triglycerides and phospholipids* are not composed of, monomers / repeating (sub-)units ;	**1**
(b)(ii)	*any two from:* *phospholipids have* two fatty acids (residues / tails) not three ; **A** hydrocarbon chains / aliphatic chains **A** one less fatty acid (residue / tail) **A** ora two ester bonds rather than three ; a phosphate (group / head) ; **A** ora **R** 'phosphate not glycerol' AVP ; e.g. may have a (named) additional group, such as choline / AW e.g. triglycerides do not have nitrogen / phospholipids may have nitrogen	**2**
(c)	*any four from:* **1** thromboxane is a (cell) signalling molecule ; **A** 'thromboxane acts as a signal' **I** 'messenger' / hormone **2** released into / circulates in / AW, blood / plasma ; **3** (smooth) muscle, cell / tissue, is target ; **4** thromboxane binds to receptors ; **5** *ref. to* thromboxane is complementary to receptor ; **6** (specific) response is smooth muscle (cell) contraction ; **R** smooth muscle constricts **7** AVP ; e.g. detail of change, such as activating G proteins / secondary messenger / enzyme cascade / chain of reactions / AW	**4**

128. 9700_s19_ms_23 Q: 5

(a)(i)	phagocytosis (of, dead cells / pathogens / AW) ; **A** endocytosis of pathogens	**1**
(a)(ii)	(sodium chloride) solution has lower water potential (than cytoplasm) ; ora **A** Ψ *for water potential* water, leaves / AW, cell by osmosis ;	**2**
(b)(i)	13.56 ; **A** 13.6 / 14	**1**
(b)(ii)	*allow (red) blood cell count for mean red blood cell count* *allow* ***ora*** *any four from:* 1 description of data ; e.g. lowest mean red blood cell count for, (population) **A** / lowest altitude (populations) **B**, **C** and **D** / all other altitudes, have a higher mean red blood cell count than **A** / 695m altitude (population) **B** has highest mean red blood cell count (population) **B** has higher mean red blood cell count than **C** and **D** *physiological explanation population* ***A*** *compared to* ***B/C/D*** 2 decrease in partial pressure of oxygen in the atmosphere with increase in altitude / AW **or** lower partial pressure of / less, oxygen in, inhaled air / lungs / alveoli AW 3 *ref. to* haemoglobin ; e.g. lower saturation of haemoglobin with oxygen (in lungs) lower affinity of haemoglobin for oxygen (in lungs) more haemoglobin required to carry sufficient oxygen to tissues 4 suggestion of increase in count at 1676 m and above ; e.g. rate of production of red blood cells increases higher erythropoietin (EPO) levels *ref. to* changed proportion of plasma to red blood cells / plasma volume decreases 5 little difference between **B**, **C** and **D** / AW ; 6 differences in altitude are not great / AW ; *in context of* ***B***, ***C***, ***D*** 7 *ref. to* genetic differences / adaptation to environment ; *allow if general statement includes population* ***A*** 8 AVP ; e.g. *ref. to* differences in demographics	**4**
(c)	less haemoglobinic acid is formed / fewer hydrogen ions to bind to haemoglobin (to cause dissociation of oxygen) ; *any one from:* binds to allosteric site / site other than active site (of enzyme), qualified ; e.g. causes change in shape of active site substrate cannot bind to active site fewer / no, enzyme-substrate / ES, complex formation prevents / reduces / AW, carbonic acid / H_2CO_3, formation / AW ; **A** fewer hydrogen ions produced from carbonic acid dissociation	**2**

129. 9700_w19_ms_22 Q: 3

(a)	*any two from:* **1** higher / better, resolution **A** higher resolving power **I** clearer resolution **or** greater ability to distinguish between two points / AW ; *ignore wavelength values if stated as wavelength but **R** if stated as resolution values* **2** *ref. to* resolution values ; e.g. able to see points closer together than 200 nm (range 100–300 nm) can see, points up to 0.5 nm (0.0005 µm) apart (range 0.2–1.0 nm) can see structures larger than 0.5 nm **3** thinner sections can be obtained ; **A** idea that complete image will be in better focus **4** able to see, ribosomes / membranes / detail <u>within</u> organelles ;	**2**
(b)	*any three from:* **1** (shape of) red blood cell is biconcave *accept biconcave from a diagram* **or** (shape of) erythroblast is, cuboidal / spherical / not biconcave / irregular / AW ; **2** red blood cell has no nucleus / erythroblast has nucleus ; **3** erythroblast has, mitochondria / organelles / named organelles **or** red blood cell has no, mitochondria / organelles / named organelles ; **4** red blood cell has more haemoglobin / erythroblast has less haemoglobin ; **I** *ref. to* haem *statement only about erythroblast*: **A** erythroblast has no haemoglobin *statement only about rbc: must say <u>more</u> haemoglobin* *statement with both:* **A** red blood cell has haemoglobin, erythroblast has no haemoglobin **5** AVP ; e.g. erythroblast, is larger / basophilic red blood cell is more flexible	**3**

<table>
<tr>
<td>(c)(i)</td>
<td>
3 structures correct and involvement, incorrect / not stated, allow 1 mark
three correct rows
I extra rows added with additional structures
<table>
<tr><td>nucleus / chromosome</td><td>(has) gene / DNA, coding for protein
or (for) transcription / mRNA synthesis ;
A produces ribosomes if stated as made in nucleolus</td></tr>
<tr><td>nucleolus</td><td>produces, rRNA / ribosomes / ribosomal subunits ;</td></tr>
<tr><td>ribosome
A ribosomal subunit</td><td>(site of) polypeptide / protein, synthesis
A described I makes amino acids
A to synthesise enzymes

or (for) translation

or binding of, mRNA / tRNA ;</td></tr>
<tr><td><u>rough</u> endoplasmic reticulum
A rough ER / RER
R wrong word for ‘rough’ if RER also stated</td><td>site of, polypeptide / protein, synthesis
A described
A to synthesise enzymes

or (for) translation

or (for) attachment of ribosomes

or protein / post-translational, modification
A examples

or protein transport ;
I packaging proteins</td></tr>
<tr><td>transport vesicle</td><td>to move protein from RER to Golgi (body / apparatus / complex) ;</td></tr>
<tr><td>Golgi (body / apparatus / complex)</td><td>for, protein / post-translational, modification / AW ;
A examples
I packaging proteins</td></tr>
<tr><td>mitochondrion</td><td>provides / produces, ATP for, tRNA aminoacylation / charging amino acids before attachment to tRNA ;</td></tr>
</table>
</td>
<td>3</td>
</tr>
<tr>
<td>(c)(ii)</td>
<td>carbonic anhydr<u>ase</u> ;
R carbon anhydrase / anhydrase</td>
<td>1</td>
</tr>
</table>

(d)	*assume spherocytosis type 2 unless stated otherwise* *any two from:* spherical means reduced surface area (to volume ratio) (so less oxygen diffuses in) ; **A** SA *for surface area* *idea of* further distance for oxygen to reach, (some) haemoglobin molecules / centre of red blood cell ; not enough time to reach, same level of / 98%, saturation of haemoglobin ; *idea of blood flowing through* *ref. to* spherical shape / larger / less flexible, so less able to pass through, (pulmonary capillary) network / AW ;	**2**
(e)	*any three from:* *(water potential gradient created / loss of equal water potentials, so)* *similarities* **1** water enters cells, by osmosis / down the water potential gradient / from high to low water potential ; **A** Ψ for water potential **2** both type of cell, swell / increase in size ; *differences* **3** spherocytosis cells, burst / lyse, more easily / before red blood cells ; **A** spherocytosis cells burst more quickly **A** spherocytosis cells burst and red blood cells do not burst **4** AVP ; e.g. spherocytosis cells already more swollen spherocytosis cells have more pressure exerted (on their cell surface membrane) than normal red blood cells AW *idea of* spherocytosis cells unable to take in as much water and stay intact ref. to less stable / less support for membrane, so weaker membrane (for spherocytosis cells) **I** less flexible	**3**

130. 9700_w19_ms_23 Q: 1

(a)(i)	haem ; **A** heme / prosthetic group **I** iron / iron ion / Fe / Fe^{2+} **I** porphyrin ring	1
(a)(ii)	*one from* combines with / binds / carries / transports / AW, oxygen (in lungs) ; **R** forms bonds releases / AW, oxygen, in tissues / at low oxygen concentrations ; allows haemoglobin to transport oxygen ;	1
(b)	*two from* **1** spherical / ball-like / rounded / AW ; **R** circular / round **ignore** 3D shape **2** (water) soluble / forms H bonds with water ; **3** hydrophilic R-groups on outside of molecule / hydrophobic R-groups on inside ; **R** *ref. to* 'tails' **4** dynamic / metabolic / physiological / AW, function ;	2
(c)	made of amino acids ; *one from* joined by peptide bonds ; **R** 'peptide bond between two amino acids' **R** 'dipeptide bond(s)' macromolecule / long-chain (molecule) / large molecule ; repeated / many, (sub-)units / monomers ;	2
(d)	*three from* **1** (R-group of) glutamic acid / glu, is polar / hydrophilic **and** (R-group of) valine / val, is non-polar / hydrophobic ; **2** change in tertiary structure ; **A** 'change in globular shape / less globular in shape' **3** change in quaternary structure of haemoglobin ; **R** of β-globin **4** *ref. to* haemoglobin forms fibres (with other Hb) ; **A** 'sticky molecules' **5** haemoglobin is less (water) soluble ; **I** insoluble **6** haemoglobin is less efficient at, binding / transporting, oxygen ; **A** less oxyhaemoglobin **A** haemoglobin / β-globin, has lower affinity for oxygen **A** reduced oxygen carrying capacity **I** haemoglobin, does not / cannot, bind oxygen **7** AVP ;	3
(e)	*three from* **1** haemoglobin combines with carbon dioxide ; **2** carbon dioxide reacts with (terminal), amine group(s) / $–NH_2$ / –NH ; **3** to form carbaminohaemoglobin ; **R** carboxyhaemoglobin / carbonylhaemoglobin **4** each polypeptide can carry a molecule of carbon dioxide / haemoglobin can carry four molecules of carbon dioxide ; **5** carbon dioxide remains, bound / AW, to Hb until in, region of low pCO_2 *or* high pO_2 / pulmonary circulation / lungs / alveoli ; **6** *ref. to* (carbonic acid dissociates to form) hydrogen ions, which bind to / AW, haemoglobin ; **A** H^+ forms haemoglobinic acid *or* HHb **I** hydrogen unqualified **7** AVP ; e.g. hydrogencarbonate ions to plasma	3

131. 9700_w19_ms_23 Q: 4

(a)	*artery wall* **I** *narrow lumen to maintain high (blood) pressure* **I** *ref. to valves / ref. to inner lining being wrinkled or wavy* **1** thick, walled / tunica media, to withstand high (blood) pressure / prevent bursting ; **2** endothelium / endothelial cells / tunica intima, are smooth, little friction to blood flow / easy flow of blood / no eddies of blood flow / AW ; **3** elastic, tissue / fibres, stretches to allow surges in blood flow / recoils to maintain blood pressure *or* force blood forward ; **4** smooth muscle (contracts to), maintains / regulates / controls blood flow ; **A** smooth muscle distributes blood **5** collagen fibres, avoid rupturing / bursting ;	**4**
(b)(i)	red blood cells / erythrocytes ; **R** red and white blood cells *one from* biconcave (shape) ; no nucleus ; *idea of* uniform, cytoplasm / cell contents ; *idea of* rouleau / stacked cells ; **I** 'clumped' **I** size	**2**
(b)(ii)	*assuming arteriole unless told otherwise, accept alternative terminology for layers of wall of arteriole* **I** *ref. to folding* **1** thicker wall / more than one layer of cells in wall / has tunica intima, tunica media and tunica adventitia whereas capillary has tunica intima ; **A** endothelium for tunica intima **2** more cells forming, perimeter / tunica intima ; **3** wider (vessel) / wider lumen / AW ; **A** actual width(s) **4** nucleus / nuclei, present in wall only in arteriole ; **5** cells lining lumen / endothelial cells, are thicker ; **6** lumen smaller, relative to the, thickness of the wall / overall width ; **7** more (red blood) cells (in lumen) ; **8** nuclei projecting inwards only in arteriole ; **9** AVP ; e.g. *ref. to* smooth muscle cells capillaries are surrounded by cells correct calculation of actual sizes using magnifications in Fig. 4.1 arteriole 20–35 μm and capillary 6–7 μm	**4**
(c)(i)	**1** higher (hydrostatic) pressure of blood (at start of capillary) ; **2** (pressure / ultra) filtration of blood ; **3** (causing) leakage / movement out / pushing out, of plasma ; **R** diffusion **4** *either* glucose / amino acids / salts, (filtered) out *or* (large) plasma proteins not (filtered) out ; **5** AVP ; e.g. *ref. to* pores / fenestrations / gaps, within / between, endothelial / lining, cells e.g. molecules smaller than MM ~68 000 ($g\,mol^{-1}$ / daltons) can pass out	**2**
(c)(ii)	lymph ; **A** lymphatic (fluid) *one from* **I** *any cells / waste products / toxins / antibodies / fatty acids and glycerol* no, named / large / plasma, proteins, e.g. albumen no / little / less, oxygen / glucose higher concentration of / more, carbon dioxide AVP ; e.g. higher concentration of / more, fat / lipids / lipoproteins *if fluid identified as tissue fluid give one mark as an ECF for a difference between plasma and tissue fluid* e.g. no, named / large / plasma, proteins e.g. albumen	**2**

132. 9700_s18_ms_21 Q: 4

(a)	**E** – haem / porphyrin (ring) ; **I** iron / iron-containing group **A** conjugated group / prosthetic group **F** – α helix ; **R** a helix **G** – tertiary structure ; **A** 3° structure **H** – primary structure ; **A** 1° structure **J** – quaternary structure / 4° structure / 2α and 2β globins ; **A** polypeptides for globins	5
(b)(i)	98 (%) ;	1
(b)(ii)	*four from:* 1 Bohr, shift / effect ; 2 (at any pO_2 on the left of graph) percentage saturation of haemoglobin decreases / haemoglobin releases more oxygen (to muscle tissue) / increases dissociation of oxyhaemoglobin ; **A** any comparative data quote for any one value of pO_2 between 1 and 5 kPa 3 (increase in carbon dioxide) increases production of carbonic acid ; 4 increase in hydrogen ions (in red blood cells) ; 5 haemoglobin accepts hydrogen ions / formation of haemoglobinic acid (HHb) ; **A** haemoglobin has an affinity for hydrogen ions 6 decreases the affinity between haemoglobin and oxygen ;	4

133. 9700_w18_ms_21 Q: 6

(a)(i)	*any three from* haem group containing iron (atom) ; four haem groups (per molecule of haemoglobin) ; each iron (atom) / haem / prosthetic group, binds one oxygen molecule ; **or** four oxygen molecule per haemoglobin molecule ; cooperative binding / allosteric effect described ; AVP ;	3
(a)(ii)	*any two from* *ref.* folding of polypeptide chain(s) / globin(s) fold (to give globular structure) ; **A** *ref.* to, tertiary structure / quaternary structure (so) hydrophilic R groups (of amino acids) are on the outside of the molecule / hydrophobic R groups (of amino acids) on the inside of the molecule ; **A** hydrophilic and hydrophobic amino acids hydrogen bonds form with water (molecules) ;	2
(b)(i)	llama = 90.5% human = 78.5% ;	1
(b)(ii)	*any two from* lower partial pressure of oxygen at high altitude ; at the same partial pressure the percentage saturation is (much) higher than for humans ; *ref.* to haemoglobin has a higher affinity for oxygen ; *idea that* sufficient oxygen delivered to tissues to satisfy demand ;	2

134. 9700_w18_ms_22 Q: 6

(a)	*rough endoplasmic reticulum* protein / polypeptide / named protein, synthesis / transport / modification ; **A** post-translational modification / examples *named protein e.g. haemoglobin, carbonic anhydrase, membrane proteins* *Golgi body* modification / processing, of, proteins / lipids **A** post-translational modification / examples / makes proteins functional **or** packaging (molecules) into vesicles **or** formation of, Golgi / secretory, vesicles **or** forms (primary) lysosomes ; *centrioles* formation of, spindle fibres / spindle **or** microtubule organisation ;	3
(b)	**A** iron / Fe ; **I** oxidation status of Fe **A** iron atom / iron ion **R** iron molecule **B** carbaminohaemoglobin ; **C** haemoglobinic acid ;	3

135. 9700_s17_ms_22 Q: 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
(b)	*mRNA strand produced* UGU ; *tRNA anticodon sequence* UGU ;	2
	Total:	5

136. 9700_w17_ms_22 Q: 2

(a)	*two from* cell (surface) membrane / plasma membrane / phospholipid bilayer, damaged / AW ; **A** phospholipids are in cell surface membrane (and will be broken down by phospholipase) cell, bursts / lyses / lysis / ruptures ; *haemolysis is neutral* cell contents / AW / haemoglobin, leaks out / AW ; **I** water	2
(b)	*allow, fatty acids / fatty acid tails / hydrocarbon chains, for fatty acid residues* *both have / similarities (max 3)* glycerol (residue) ; fatty acids ; **I** *ref. to* saturation, **R** both have, two / three, fatty acids ester, bonds / linkages ; C and H and O ; double bonds ; **A** both have C=O *differences (max 3)*	4
(c)	smooth endoplasmic reticulum ; **A** smooth ER **R** SER **R** if more than one organelle given **R** endoplastic *two from* membranous / membranes ; **A** *ref. to* vesicles, formed / bud off **R** envelope / double membrane tubular ; **A** cisternae but **R** if described as flattened fluid filled, channels / sacs ; not associated with ribosomes ;	3

triglyceride / fat / oil / lipid		phosphatidylcholine / phospholipid
no, choline / nitrogen **A** no / small / delta, charges	**or**	has, choline / nitrogen ; **A** choline / nitrogen, ion **A** charged / ionic
three fatty acid residues **or** one extra fatty acid residue ; **A** triglyceride has three ester bonds		**R** *if comparison includes phosphatidylcholine and the number of fatty acid residues is incorrect*
no, phosphate (group) / phosphorus **A** no, phosphoester / phosphodiester bond	**or**	has phosphate ; **A** has phosphoester / phosphodiester bond

137. 9700_m16_ms_22 Q: 3

(a) (i) a gene codes for a protein / gene coding for EPO ;

ref. transcription ; **A** gene 'switched on'
A increase gene expression

mRNA (required) for, EPO / protein, synthesis
or
mRNA involved in translation ;

[max 2]

(ii) vesicles move to, cell (surface) / plasma, membrane (via cytoskeleton) ;

(vesicles) fuse / merge, with cell (surface) membrane ;

exocytosis (occurs) ;

(movement of vesicle / exocytosis) requires, energy / ATP ;
A active (process)
R active transport

[max 2]

(b) (i) EPO, binds to / combines with / AW, <u>receptors</u> ;

receptors, complementary to / specific <u>shape</u> for, EPO ;
A EPO fits into receptors

cell signalling / EPO binding leads to (specific) responses within the (target) cells / AW ;
I cells respond to EPO

<u>only</u>, target / bone marrow, cells, have receptors, for EPO / specific to EPO ;
ora
A binding triggers responses only within, target / bone marrow, cells

[max 3]

(ii) too large ;

ref. to shape, cannot pass through ;

(protein) is, hydrophilic / water soluble, <u>and</u> cannot cross hydrophobic core (of phospholipid bilayer) / AW ;

no specific membrane transport protein ;

[max 1]

(c) stem cell ; **A** haematopoietic stem cell
treat as neutral adult / non-embryonic / multipotent / stromal [max 1]

(d) **max 3** *if all description (***D***) or all explanation (***E***)*
A Hb for haemoglobin and Hb concentration for mean Hb concentration
A g per kg / g kg^{-1}, for g per kg body mass

constant
D Hb concentration, remains constant / of 12.6 g kg^{-1}, for first two weeks (of investigation) / up to start of injections ;

E idea of regulation ;
e.g. sufficient oxygen so no requirement for increased EPO

increase then decrease description
D (then) increase in Hb concentration (from week 2) for 5 weeks / AW, then decrease (for last three weeks / to week 10) ;

D data quote / manipulated data, to support ;
e.g. increase from 12.6 g kg^{-1} (week 2) to15.3 g kg^{-1} (week 7)
increases by 2.7 g kg^{-1} (to week 7)
decrease from 15.3 g kg^{-1} (week 7) to 13.7 g kg^{-1} (week 10)
decreases by 1.6 g kg^{-1} (to week 10)

increase explanation
E EPO increases production of red blood cells that contain Hb / AW ;

decrease explanation
E red blood cells, short life span / die ;
E cell signalling stops / (target / bone marrow) cells no longer stimulated / AW ;
A EPO, degraded / AW

increase after injections stop
D Hb concentration increases for 1 week after injections have finished ;

E *idea of*, time delay for red blood cell production to stop / time for immature red blood cells to mature and be released into blood stream ;

AVP ; e.g. steady increase as time required for, mitosis / cell proliferation / differentiation into red blood cells / production of haemoglobin
contributory factor for increase may be, accumulation / increased concentration, of EPO with injections

[max 4]

(e) *high altitudes and low oxygen partial pressure so*
less oxygen in inhaled air / less oxygen (would be) transported to tissue / AW ;

lower oxygen saturation of haemoglobin / haemoglobin has lower oxygen affinity ;

body requires more red blood cells that contain haemoglobin / AW ;
A more red blood cells produced so more haemoglobin (to bind oxygen)

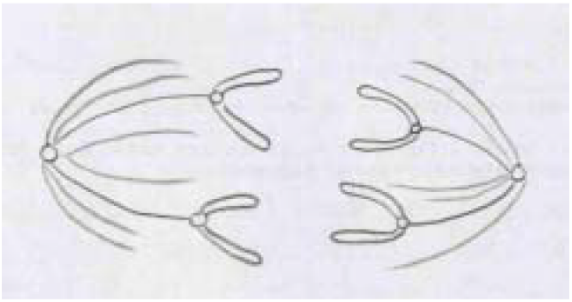
idea of compensation ; **R** *idea of* body getting more oxygen

[max 3]

[Total: 16]

138. 9700_s16_ms_21 Q: 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]

(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]

139. 9700_w16_ms_22 Q: 4

(a) *allow middle coat / intermediate layer / middle layer, for tunica media*
allow adventitia for externa

one from
a thick tunica media ;
a thicker tunica media than tunica externa ; ora

a thick layer of, (smooth) muscle / muscle and elastic tissue ;
A thick muscular wall
R striated / skeletal, muscle
many (layers of) smooth muscle cells ;

a, well-defined / firm / oval / regular / AW, shape (in cross section) ;

narrow / AW, lumen in relation to thickness of wall ; **A** narrow lumen

convoluted / folded / AW, endothelium / tunica intima ; [1]

(b) *2 correct functions with no link to a structural feature – award one mark only*

R muscle / collagen, stretching and recoiling / recoiling
R elastic tissue contracting and relaxing

two from
1 (smooth) muscle / elastic tissue, maintains (blood) pressure ;
A increases blood pressure

2 thick (tunica media) / elastic tissue / (smooth) muscle / collagen (fibres), withstands high pressure / prevents rupture / AW ; **A** bursting

3 elastic tissue to smooth out (pulsatile) flow ; **R** smooths flow to give pulses

4 muscle / elastic tissue, helps to, maintain blood flow / move blood / keep blood moving forwards / AW ;
R *idea of* pumping / forcing blood forward / pushing blood

5 (smooth) muscle, contraction / relaxation, altering volume of blood delivered ;
A *idea of*, diverting blood / regulating blood flow
I muscle dilates [2]

(c) magnification = image diameter ÷ actual diameter ; **A** M = I ÷ A

allow one mark only if correct answer but units given

if calculation is shown measurement must be correct and working must lead to correct answer

× 3.5 ;; 18 (mm) / 5.2 (mm) = 3.46
A × 4 if correct working, and / or, 3.5 shown
A × 3 if 3.46 only shown from correct working

other acceptable answers using same criteria
× 3.3 ;; 17 / 5.2 = 3.27 **A** × 3

× 3.4 ;; 17.5 / 5.2 = 3.37 **A** × 3

× 3.6 ;; 18.5 / 5.2 = 3.56 **A** × 4

× 3.7 ;; 19 / 5.2 = 3.65 **A** × 4 [3]

(d) *three from*

1 (good) solvent ; **R** organic solvent

2 statement linking solvent properties to role of plasma ; e.g.
standalone statements do not need mp1
polar molecules / ions / ionic compounds / named substance(s), dissolve in, water / plasma **R** blood cells
ions dissociate, in water / plasma
many / AW, substances dissolve in, water / plasma **R** blood cells
water is attracted to (many different) substances
water / plasma, is the transport medium for substances / transports substances
presence of solutes to maintain (constant) water potential

3 cohesion between water molecules / water is cohesive ;
A water molecules are sticky

4 so, continuous / uninterrupted / AW, blood flow ; *in context of mp3*

5 high specific heat (capacity) ;

6 statement linking high specific heat capacity to role of plasma ;
allow ecf for high heat capacity / specific heat capacity
e.g. helps, stabilise / (body to) regulate, temperatures
helps maintain constant (blood) temperature
water resists changes to temperature

7 high (latent) heat of, vaporisation / evaporation ;

8 in body temperatures, plasma stays liquid / water does not evaporate ; AW

other acceptable points – note that mps 10, 12, 14 are linked to water property

9 low compressibility ; **A** incompressible

10 maintains efficient blood flow / helps to push blood through vessels ; AW

11 low viscosity ;

12 allows efficient circulation of blood / AW ;

13 pH 7 / neutral ;

14 *ref. to* stability proteins ; **A** prevents denaturation [3]

[Total: 9]

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140. 9700_w16_ms_22 Q: 6

(a) (i) **J** = mitosis ; **A** mitotic division **I** nuclear division
R mitotic cell division
K = cytokinesis; **A** cytoplasmic, division / cleavage **I** cell division
L = interphase; [3]

(ii) interphase ; **A** S-phase / synthesis phase / late interphase
R early interphase [1]

(b) (i) bone marrow ; [1]

(ii) lobed / irregular ; [1]

(iii) lysosomes / vesicles ; [1]

(c) (i) *two from*
ref. to loss of control over entry and exit substances ;
A membrane no longer partially / selectively, permeable
A becomes more permeable
lose, ions / nutrients ; **A** gains, ions / nutrients
lose water ; **R** gains water *(as cell wall still intact)*

metabolic reactions, prevented / impaired ; AW
enzymes no longer function ; AW

water potential affected ;
increase or decrease depends on rest of answer
e.g. gains ions so decreases water potential

cytoplasm shrinks ; AW **R** lysis / bursting
contents leak out ; [2]

(ii) breakdown / weaken / digests / AW, cell wall ; **A** destroyed / damaged
I breaks cross-links / cross-links cannot form

(water enters so) lysis occurs / bursts / AW ; [2]

[Total: 11]

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141. 9700_w16_ms_23 Q: 5

(a) (i) 98.5 / 98 / 98.48 (%) ; **R** 98.4 [1]

(ii) (in solution / dissolved) in the plasma / cytoplasm of red blood cells ; [1]

(iii) *two from*
carbon monoxide, combines with haemoglobin / forms carboxyhaemoglobin ;
irreversible / permanent / stable compound / AW ;
reduces haemoglobin available to transport oxygen ;

alveolar walls / elastin, broken down (in emphysema/COPD) ;
less surface area for, absorption of oxygen / gas exchange ; [2]

(b) *accept steps of reaction if in reverse – as in the lungs*

1 catalyses / AW, the reaction (in red blood cells), between carbon dioxide and water / to form carbonic acid ; **A** correct equation
2 (carbonic acid dissociates to form) hydrogencarbonate ions / bicarbonate ions / HCO_3^- ;
3 very fast reaction ;
4 maintains (steep) concentration gradient for diffusion of carbon dioxide from tissues to blood ;
5 catalyses reverse reaction in the lungs ;
6 hydrogencarbonate ions / bicarbonate ions / HCO_3^- , diffuse / AW, into the plasma ; [3]

(c) 1 Bohr, effect / shift ;

AND

to max 2 ('more' only needs to be used once)
2 carbon dioxide decreases affinity of haemoglobin for oxygen ;
3 more oxyhaemoglobin dissociates (than at a lower concentration of carbon dioxide) ;
A oxyhaemoglobin dissociates more readily
A haemoglobin, releases / AW, more oxygen
4 more oxygen for (rapidly) respiring, tissues / cells ;
5 to meet the demand for increase in (aerobic) respiration ;
A to provide, enough / sufficient, oxygen for respiration
ora e.g. delays onset of / prevents, anaerobic respiration [3]

[Total: 10]

142. 9700_s15_ms_21 Q: 4

(a) enzyme **A** uses 'lock and key' **and** enzyme **B** uses induced fit ;
A enzymes work by 'lock and key' and induced fit
enzyme **A** / lock and key, (shape of) active site is complementary / AW, to (shape of) substrate (molecule) ;
enzyme **B** / induced fit, has an active site that, moulds around / AW, the substrate ; [3]

(b) **(i)** **1** **P** is β-pleated sheet, **Q** is α-helix ;
accept if P and Q are identified by a description

2 determined by, coiling / folding / sequence, of amino acids / polypeptide ;
A primary structure for sequence of amino acids

3 stabilised / held / AW, by hydrogen bonds ;

4 between C = O and H–N (of peptide bonds) ;
A carbonyl / carboxyl group, and, amine / amino group

5 ref to, parallel / anti-parallel, nature of β-pleated sheet ; [max 3]

(ii) **1** catalyses reaction between carbon dioxide and water to form carbonic acid ;
A correct, formulae / equation

2 very fast reaction ;

3 in (cytoplasm of) red blood cell / erythrocyte ;

4 (so there are) hydrogen ions / protons, and hydrogencarbonate ions ;

5 hydrogen ions promotes oxyhaemoglobin dissociation / AW ;
e.g. reduces affinity of haemoglobin for oxygen / (oxy)haemoglobin
gives up oxygen more readily

6 increases supply of oxygen to (respiring) tissues ;

7 carbon dioxide is transported as hydrogencarbonate ions ;

8 in the plasma ; **A** carbon dioxide diffuses from red blood cell to plasma

9 AVP ; e.g.
carbonic anhydrase catalyses reverse reaction in the lungs
ref to hydrogencarbonate ions as buffer in plasma (as a consequence of reaction)
R buffering action of haemoglobin in red blood cells [max 4]

[Total: 10]

143. 9700_s15_ms_22 Q: 3

(a) same, water potential / Ψ(inside + outside) / no water potential gradient ;
A same solute potential **I** osmotic potential
(so) no, net / overall, movement of water (molecules) ;
A osmosis does not occur **[2]**

(b) *for two marks match correct plasma component and, mechanism / membrane component if no mechanism given*

plasma component ;	**mechanism ;**	**membrane component ;**
oxygen carbon dioxide steroids / steroid hormones	(passive) diffusion **A** movement from high to low concentration	(phospho)lipid bilayer / hydrophobic core (of membrane)
glucose amino acid(s) named amino acid mineral / inorganic, ions named ion e.g. sodium ions / Na^+, magnesium ions / Mg^{2+} chloride ions / Cl^-, hydrogen ions hydrogen carbonate ions / HCO_3^- phosphate ions / HPO_4^{2-} potassium ions (K^+)	facilitated diffusion ; **A** active transport **A** cotransport	transport(er) / carrier / integral / intrinsic / transmembrane, protein ; **A** channel protein for facilitated diffusion **A** pump protein for active transport

A urea, with any of the three mechanisms and relevant membrane component to match the mechanism stated **[3]**

(c) (x) 1000 **;; A** (x) 947 / 947.4 or 1053/1052.6
if units given = one mark only

if incorrect allow one mark for correct length measured 9 / 9.5 / 10 mm and knowledge of formula is correct (magnification = image length / actual length – this can also be seen by workings e.g. 9.5 mm ÷ 9.5 μm) but incorrect conversion factor used for final calculation **[2]**

(d) *feature = one mark, with appropriate explanation = one mark*

F red blood cells / haemoglobin, close to body cells ;
F (capillary) endothelium / capillary wall, one cell thick / thin ; **A** epithelium
E short distance / AW (for oxygen to move to cells) ;

F ref. to, diameter / size, red blood cell and capillary (lumen) similar ;
E slows down flow (to allow sufficient oxygen to move out) / short distance (for oxygen to move to cells) ; **[max 2]**

(e) no / fewer, gaps / fenestrations / pores, in endothelium / capillary wall ;
A spaces
ref. tight junctions between (endothelial) cells ; **A** epithelial cells
idea that cells wrap round / fewer cells make up capillary wall, so reduces (endothelial) cell-cell contact ;
idea of layer around capillary / basement membrane, impermeable ; **[max 1]**

[Total: 10]

144. 9700_s15_ms_23 Q: 4

(a) (i) ***A** bp for blood pressure throughout*

1 bp decreases with distance (from, heart / LV) ;
A named vessels to indicate distance

2 difference between minimum and maximum bp decreases (with distance) ;

3 maximum and minimum bp are the same, at the capilaries / after arterioles ;

4 (BP) reaches zero kPa, at large veins / vena cava(e) ; **A** after small veins
A no blood pressure

5 steepest decrease in bp between aterioles and capillaries ;

6 correct data quotes ;
e.g. mp 1 from 16 kPa to 0 kPa for maximum bp
mp 1 from 10.6–10.8 kPa to 0 kPa for minimum bp
mp 2 11.6 / 11.8 kPa, in aorta / nearest to left ventricle and 0 kPa at capillaries
mp 3 (same bp of) 5 kPa [max 3]

(ii) (presence of) valves ; **R** bicuspid / tricuspid, valves
to stop backflow / allows one-way flow / flow only towards heart ; [max 2]

(b) hydrolysis ; **A** breaking bond using water
(of / breaking of) peptide bond ;
between Phe and His / Phe-His bond ;
removal of, two amino acids / His and Leu / dipeptide ; [max 3]

(c) 1 (ACE) inhibitor / drug, has similar shape as, substrate / polypeptide ;

2 complementary (shape) to active site (shape) ;

3 binds to / fits into / enters, active site (of ACE enzyme) ;
A forms enzyme-substrate complex

4 substrate cannot, enter / bind ;
A competes with substrate for active site
A no / few / prevents formation of, ES complexes

5 reduces rate of, reaction / formation of angiotensin / product formation ; [max 3]

[Total: 11]

145. 9700_m20_ms_22 Q: 3

(a)	superior vena cava and inferior vena cava ; **A** venae cavae **A** vena cava	**1**
(b)	*any **four** from:* 1 pressure in ventricles decreases (in context of relaxation) ; 2 semilunar valves close ; 3 atria filling with blood / blood entering atria 4 bicuspid and tricuspid / left and right atrioventricular, valves open ; **A** mitral *for bicuspid* 5 blood enters ventricles (passively) ; allow once only (either marking point 5 or 8) 6 atria contract / atrial systole ; 7 pressure in atria exceeds pressure in ventricles ; 8 (so) blood enters ventricles (from atria) ; allow once only (either marking point 5 or 8) 9 AVP ; e.g. ref. to heart sounds (from valve closure)	**4**
(c)(i)	**P** C T C ; **Q** G T G ; **R** G U G ;	**3**
(c)(ii)	β-globin / beta globin ;	**1**
(d)	*any **three** from:* *in terms of sickle cell:* 1 low(er) affinity for oxygen / low(er) carrying ability of haemoglobin for oxygen / (more) difficult for oxygen to bind to haemoglobin / AW ; *uptake:* 2 lower uptake of oxygen / lower saturation of haemoglobin (at same partial pressures) ; *release* 3 oxygen is more easily released (at same partial pressures) ; 4 AVP ; e.g. requires higher partial pressure of oxygen to reach same level of saturation ref. to structure of abnormal haemoglobin, e.g. sticky fibres reduced allosteric effect of haemoglobin molecule for uptake ref. to allosteric release of oxygen in respiring tissues ref. to sketch curve on graph and numerical comparison increase in, 2,3-BPG / 2,3-DPG	**3**

146. 9700_s20_ms_22 Q: 2

(a)	sinoatrial node / SAN, sends out, wave of excitation / impulses / electrical impulses ; R nerve impulses wave of excitation / AW, spreads across atrial wall ;	**2**
(b)	*any two from* non-conducting fibres between atrial and ventricle walls ; impulse must pass down septum ; AVN (in interatrial septum) delays impulse ; (gives) time for atria to, complete contraction / empty ;	**2**
(c)(i)	one mark if **F** and **G** are semilunar and **E** and **H** are bicuspid ; one mark for **E** and **G** opens ; one mark for **F** and **H** closes ; ***E** bicuspid / (left) atrioventricular, valve, closes* ***F** semilunar / aortic, valve opens* ***G** semilunar / aortic, valve closes* ***H** bicuspid / (left) atrioventricular, valve opens*	**3**
(c)(ii)	(during contraction) left ventricle, generates / AW, higher pressure (than left atrium) ; **A** do not produce the same pressure when contracting *any one from* (because) wall of left ventricle thicker / more (cardiac) muscle, so reaches higher ; data from Fig. 2.1 to show difference in pressure ;	**2**

147. 9700_s19_ms_21 Q: 5

(a)	*closed* blood flows through, (blood) vessels; **A** three of heart, arteries, veins, capillaries *double* blood flows through the heart twice in one complete circulation (of the body) / AW ; **A** *ref. to* pulmonary and systemic circuits / to lungs and rest of body	**2**
(b)(i)	pulmonary vein ; semi-lunar / AW, valve ; **A** pulmonary valve **R** aortic valve right, atrium / auricle ;	**3**
(b)(ii)	*any three from:* **1** left ventricle / chamber **Y**, pumps blood into, systemic circulation / described ***or*** right ventricle / chamber **X** pumps blood into, pulmonary circulation / described ***or*** distance travelled by blood in systemic circulation is greater than distance travelled by blood in pulmonary circulation / AW; **2** to overcome great(er) resistance to flow in systemic circulation ; **ora** **3** high (blood) pressure is required for blood to travel around the systemic circulation ; **4** high pressure requires more muscular force ; **ora** **5** pulmonary capillaries, rupture easily / damaged by high pressure ; **I** more cardiac muscle	**3**
(c)	*any four from:* **1** impulse / wave of excitation / AW, passes from SAN to atria (muscles) ; **R** nervous impulse / signal *once only* **2** atria both contract, together / at the same time ; **A** atrial systole *if not contradicted by one contracting before the other* **3** atria contract before ventricles ; **4** fibrous / non-conducting, tissue prevents impulse travelling to ventricles ; **5** impulse delayed at AVN ; **6** AVN passes impulse to, bundle of His / Purkyne fibres ; **7** Purkyne fibres conduct impulses to muscle in wall of ventricles ; **8** ventricles contract together (if mp2 not awarded) ; **A** ventricular systole if not contradicted as for atria **9** ventricles contract from the bottom upwards ;	**4**

148. 9700_s19_ms_23 Q: 6

(a)	<table><tr><th>structure in the heart</th><th>letter</th></tr><tr><td>valves preventing back flow of blood into the ventricle</td><td>**S** ;</td></tr><tr><td>blood vessel carrying blood under highest pressure</td><td>**P** ;</td></tr><tr><td>chamber that pumps blood to the lungs</td><td>**N** ;</td></tr></table>	3
(b)	*treat as neutral effects of nicotine on the brain and ref. to adrenaline* *any three from:* increased heart rate ; **I** increased heart beat increased blood pressure ; increases risk of, blood clotting / thrombus formation ; **A** increases risk of thrombosis **A** increases stickiness of platelets damages the endothelium ; AVP ; e.g. stimulates vasoconstriction / reduces the diameter of blood vessels **A** named blood vessel types	3
(c)(i)	*any one from:* two nuclei vs one ; *ref. to*, DNA / chromosome, content ; cytokinesis has not occurred ; **A** cytoplasm has not divided (into two cells)	1
(c)(ii)	*any two from:* *in context of cardiac myocyte or overall heart function* unable to replace, damaged / worn out / old, cardiac myocytes ; **R** repair myocytes unable to repair (damaged) cardiac, muscle / tissue ; **A** heart tissue repair (to cardiac muscle may be) with, unspecialised cells / scar tissue ;	2

149. 9700_m18_ms_22 Q: 5

(a)	*any **three** across both sections:* SAN (max **two**): 1 pacemaker / sets rate of heart beat / responsible for rhythmic contraction ; 2 sends out, impulses / waves of excitation / waves of depolarisation ; 3 initiates / brings about / AW, heart beat / contraction of the heart / atrial contraction / atrial systole ; *AVN (max **two**)*: 4 acts to relay impulses / described ; 5 introduces delay to ventricular, systole / contraction(s) / prevents simultaneous contraction of atria and ventricles / AW ; **A** allows time for, atria to empty / ventricles to fill 6 conducts, waves of excitation / impulses, to, bundle of His / Purkyne fibres ;	3
(b)(i)	**D** = vein / veins **E** = artery / arteries **F** = capillary / capillaries } ;	1
(b)(ii)	*any **two** from:* single layer / one cell thick ; flattened / thin, cells ; **A** squamous / pavement, cells / epithelia smooth surface (facing lumen) ;	2

150. 9700_w18_ms_22 Q: 2

(a)	xerophyte / xerophytic ; **R** succulent / cactus / named	**1**
(b)(i)	phloem ; **A** sieve tube(s) **R** phloem sieve / phloem tube **A** sieve tube elements **R** phloem companion cell	**1**
(b)(ii)	*any two from* **1** for, transport / translocation, } *accept assimilates / products* **or** *of metabolism, if in context of* movement / AW, from source to sink ; } *cardiac glycosides* **I** *ref. to* transport of, amino acids / sucrose **2** *ref. to* source, is place of synthesis / AW **or** sink is / movement to, area where not manufactured / storage area / area where they are required ; **3** as defence mechanism (e.g. against sap feeders) ;	**2**
(c)(i)	using / AW, water / H_2O ; to break bond (between phosphate groups) ; **R** if bond incorrectly named	**2**
(c)(ii)	active transport ;	**1**
(c)(iii)	*any four from* **1** (reversibly) binds / attaches / AW, to, allosteric site / site other than active site ; **2** (which) changes, shape / tertiary structure / 3-D structure, of active site ; **A** active site distorted **I** protein structure **3** substrate / ATP, cannot, enter / bind / fit / AW, to active site ; **A** active site no longer complementary to substrate **A** enzyme substrate / ES, complexes cannot form **A** ESCs cannot form **I** ATP / substrate, cannot bind to enzyme *without a link to active site* **4** no / less, hydrolysis of ATP **A** breakdown **or** no / less, energy released ; **I** no energy, synthesised / created / produced **5** Na^+ not moved, out and K^+ not moved in ; **I** active transport, stops / decreases	**4**
(d)(i)	*allow* *systole for contraction and diastole for relaxation* *bicuspid valve or mitral valve for (left) atrioventricular* *aortic valve for semi-lunar valves* *any four from (max 3 if whole response based on right side of heart)* *before atrial contraction / during relaxation of the left atrium and left ventricle* **1** atrioventricular valve, opens / is open **A** *following atrial contraction* **or** blood trickling into ventricle / some blood enters ventricle ; **2** atrial contraction, blood flow to ventricles / ventricles fill (with blood) **or** atrial contraction then ventricular contraction ; *ventricular contraction* **3** biscuspid valve closes and semi-lunar valve opens ; **R** *if occurs before ventricular contraction* **4** blood flows into aorta ; **R** if states 'from atrium' or 'then to lungs' **R** *if occurs before ventricular contraction* **5** *ref. to* atrium in relaxation during ventricular contraction ; *pressure changes* **6** contraction of, atrium / ventricle, increases pressure (of that chamber) **or** *ref. to* (blood) pressure differences to cause opening or closing of valves ; e.g. pressure in atrium greater than in ventricle so atrioventricular valve opens pressure in ventricle greater than aorta so semilunar valves open pressure in ventricle greater than atrium so bicuspid valve closes	**4**

(d)(ii)	**I** *ref. to* fibrillation / cardiac cycle rhythm *any three from* **1** more powerful contraction of (cardiac) muscle / increased ability for (cardiac) muscle (**A** cardiac cells) to contract ; **A** stronger contraction / contract strongly / increased contractility **I** contracts more / increased contraction **2** blood (pumped) at higher pressure ; **I** blood at high pressure **3** more force to overcome resistance (in blood vessels) ; **4** more blood reaches lungs to obtain oxygen (per unit time) / more oxygen reaches (rest of) body / tissues (per unit time) (in blood) ; *allow idea of efficient delivery of oxygen* **A** more oxygenated blood can be delivered to heart, muscle / tissue AW **5** less fatigue / increased energy / increased mobility / AW ;	**3**

151. 9700_w18_ms_23 Q: 4

(a)	*any four from* **I** signals **R** nerve impulse first time *SAN* **1** acts as a pacemaker / initiates heart beat / initiates cardiac cycle ; **A** regulates heartbeat **A** described, e.g. as rhythm / emits impulses at regular intervals **2** releases / AW, waves of excitation / (electrical) impulses ; **A** *ref.* to, action potentials / depolarisation **R** nerve impulses **3** spread across / AW, atria / atrial walls **or** leads to atrial, systole / contraction(s) ; *AVN* **4** allows a (short) delay / ~0.1 s ; **5** passes the impulse / wave of excitation, to the Purkyne fibres / down the septum ; **A** Bundle of His **R** nerve impulse **6** detail ; e.g. so atria contract before ventricles allows ventricles to fill / allow atria to empty completely so atria have, emptied / contracted, before ventricular contraction begins so atria and ventricles don't contract at the same time	**4**
(b)	*any two from* contraction / ventricular systole, begins at the base of the ventricles ; both ventricles contract at the same time ; blood is forced, upwards / into arteries / through (named) semi-lunar valves ; **A** pushed *idea that* so ventricles, empty / pump out most of the blood ; AVP ; e.g. so impulses / waves of excitation, travel upwards from the base	**2**
(c)	*any four from* **1** noradrenaline is, signalling, molecule / compound ; **A** noradrenaline is the signal **I** noradrenaline is a (neuro)transmitter **2** SAN cell is the target cell ; **3** noradrenaline / signalling molecule, binds to (cell surface) receptors (of target cell) ; **A** 'fits' **R** 'receptor cells' **4** receptors are specific to noradrenaline ; **A** *ref.* to complementary (shapes) **5** *ref.* to formation of cAMP / second messenger *or* activating enzyme ; **6** response is the opening of channel proteins (so calcium ions enter) ;	**4**

152. 9700_m17_ms_22 Q: 4

(a)	(closed) double circulation ; capillary ; pulmonary vein ; right atrium ; **A** auricle septum ;	**5**
(b)(i)	*two from:* 1 *idea* that (to be transported) many substances need to, dissolve / be in solution ; 2 ionic compounds / named, can, dissociate / dissolve ; 3 polar compounds / named, e.g. glucose / amino acids, can dissolve ; 4 globular proteins / named, e.g. antibodies, can dissolve ;	**2**
(b)(ii)	*three from:* 1 water molecules attracted to each other ; **A** sticky / stickiness *cohesion:* 2 (hydrogen bonding provides) cohesion between water molecules ; **A** water is cohesive 3 reference to water leaving xylem (at top), pulling water (molecules below) ; **A** there is a transpiration pull *adhesion:* 4 adhesion to cellulose lining (of xylem) ; **A** cellulose wall 5 maintains / prevents falling of, column of water ; 6 AVP e.g. reference to cellulose hydrophilic / adhesion to hydrophilic parts of lignin ;	**3**

153. 9700_w17_ms_21 Q: 2

(a)	capillary ; *two from* single celled wall / AW ; **A** thin wall *ref. to* wall composed only of one, squamous epithelial / endothelial, cell ; *ref. to* lumen diameter approx 7 μm ; **A** 5–8 μm **A** *ref. to* similarity to dimension of red blood cell in direct contact with tissue fluid ; *if vein named, allow one mark for, thin wall (relative to lumen)* ***or*** *wide / AW, lumen (relative to wall thickness)*	**3**
(b)(i)	0.24 s / 0.25 s ;	**1**
(b)(ii)	0.08 s / 0.09 s ; **A** range	**1**
(b)(iii)	*four from* *similarity* *ref. to* increases and decreases in pressure at same time ; **A** description for part of the graph e.g.starts to rise at same point as RV, returns to minimum at same point as RV *idea that* events in cardiac cycle occur are coordinated ; **A** described e.g. impulses pass up both ventricles at the same time, ventricles both contract at same time *difference* reaches higher, blood pressure / peak, (than RV) ; systolic pressure higher in LV (than RV) left ventricle pumps blood to (whole) body / RV only to lungs) overcome greater resistance / ora for RV walls of left ventricle, thicker / more muscular more force exerted by LV *any two* ;;	**max 4**

154. 9700_w17_ms_22 Q: 6

(a)(i)	**S** ;	1
(a)(ii)	pulmonary vein ; **R** ;	2
(a)(iii)	wall of right atrium ; **A** muscle of right atrium	1
(b)	*two from* passes the, impulse / wave of excitation, to the Purkyne fibres / down the septum ; **A** Bundle of His **R** nerve impulse allows a (short) delay ; detail ; e.g. so atria contract before ventricles allows ventricles to fill so atria have, emptied / contracted, before ventricular contraction begins so atria and ventricles don't contract at the same time	2

155. 9700_w17_ms_23 Q: 2

(a)	*two from* 1 to generate a high(er) blood pressure (during systole) ; **A** force **I** withstands / AW, high blood pressure 2 to overcome high(er) resistance (in systemic circuit than in pulmonary circuit) ; 3 to transport blood a greater distance / greater distance in systemic circuit ; 4 *ref. to* right ventricle generating low pressure to avoid damaging (capillaries in the) lungs / AW ;	2
(b)(i)	**F** (inferior / posterior) vena cava ; **I** superior **G** pulmonary artery ;	2
(b)(ii)	diastole ; **I** ventricular / atrial	1
(c)	*five from* 1 wave of excitation / wave of depolarisation / impulses, from, atrioventricular node / AVN ; 2 pass(es) down Purkyne fibres (to ventricles) ; **A** Bundle of His 3 (both) ventricles contract / ventricular systole ; 4 from the base (upwards) / AW ; 5 blood pressure in ventricles, increases / becomes higher ; 6 blood pressure in ventricles greater than in atria ; 7 atrioventricular / AV / tricuspid and bicuspid, valves close ; 8 blood pressure in ventricles greater than in, artery / aorta / pulmonary artery ; 9 semi-lunar / pulmonary and aortic, valves open ; **A** blood flows through 10 blood flows, into arteries / to lungs and rest of the body ; *at end of description only* 11 atria relaxing / atrial diastole / blood flows into atria ;	5

156. 9700_s16_ms_23 Q: 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]

157. 9700_s15_ms_22 Q: 1

(a) **A** right ventricle ; **A** r. ventricle **R** RV

B vena cava ; **A** vena cavae
I superior / upper / inferior / lower / posterior
R if other terms used

C atrioventricular node ; **A** AVN

D coronary arteries ; **A** coronary artery **A** coronary capillaries
I coronary vessels

E bicuspid / left atrioventricular / mitral (valve) ; **[5]**

[Total: 5]

158. 9700_w15_ms_22 Q: 6

(a) **1** *idea of* different distances **;** *must be comparative*
e.g. atria pump blood shorter distance **ora**
atria pump blood a short distance and ventricles pump blood a long distance
atria pump blood to ventricles and ventricles pump blood to, (other parts of) body

2 (so) resistance to overcome by atria is low(er)
or
(so) ventricles need to overcome, great(er) / AW, resistance **;**

3 (so) atria generates lower pressure
ventricles generate higher pressure **;** AW
A force for pressure
R ventricles withstand high pressures
A low pressure / high pressure *if mp1 or mp2 gained* [max 2]

(b) septum **;** **R** atrioventricular septum [1]

(c) **(i)** **I** *ref. to* xylem / transpiration stream

transpiration
involves only water (molecules) **;**
involves, evaporation / diffusion / evaporation and diffusion **;**
I *ref. to* evaporating surface
movement out to (external) environment / loss from leaves **;** **A** aerial parts
affected by, external factors / humidity / light / wind speed / temperature **;**
occurs in one direction / from air spaces through stomata **;**
ATP not required **;**

translocation
involves, assimilates / photosynthates / sucrose / other named **;** **A** cell sap
involves (hydrostatic) pressure gradients **;** **A** mass flow
involves transport in phloem (sieve tubes) **;**
flow from source to sink / AW **;**
ATP used (to enable loading of sucrose into phloem sieve tube) **;** **A** active [max 1]

(ii) both involve, transport / movement of substances **;** **R** if transport in xylem stated
both involve water **;**
both require energy **;** *(transpiration – evaporation requires heat energy and translocation – hydrogen ions pumping out of companion cells)* [max 1]

[Total: 5]

159. 9700_m20_ms_22 Q: 4

(a)	*trachea and bronchus (max 1):* C-shaped cartilage rings in trachea vs, irregular / plates of, cartilage in bronchus ; more mucous glands in trachea / fewer mucous glands in bronchus ; pseudostratified / description, epithelium in trachea vs columnar epithelium in bronchus ; *bronchus and bronchiole (max 1):* cartilage in bronchus **or** no cartilage in bronchiole ; many goblet cells in bronchus vs few or no goblet cells in bronchiole / more goblet cells in bronchus / fewer goblet cells in bronchiole ; mucous glands in bronchus **or** no mucous glands in bronchiole ; more smooth muscle in bronchus / less smooth muscle in bronchiole ; *bronchiole and alveolus (max 1):* ciliated epithelium / ciliated cells / cilia / columnar epithelium / cuboidal epithelium, in bronchiole **or** squamous / pavement, epithelial cells in alveolus ; thick wall / wall of several layers, in bronchiole, vs, thin / single layered, wall in alveolus ; smooth muscle in bronchiole **or** no smooth muscle in alveolus ;	**3**
(b)	*one mark for correct order:* G_1, S, G_2 ; *G_1 phase:* transcription **or** translation **or** polypeptide / protein / enzyme, synthesis **or** (named) organelle synthesis ; *S phase:* DNA replication / formation of 2 (sister) chromatids ; *G_2 phase:* as G_1 **or** microtubule synthesis **or** centriole replication **or** mitochondria division **or** check for / correct, errors in replication of DNA ;	**4**

160. 9700_s20_ms_21 Q: 4

(a)	*any four from:* carbaminohaemoglobin ; **A** combined with haemoglobin hydrogencarbonate ions / HCO_3^- ; **R** HCO_3 CO_2 dissolved in the plasma ;	**2**
(b)	*any four from:* 1. correct direction of movement for oxygen and carbon dioxide ; e.g. oxygen, moves from, alveolus / **W**, to, capillary / blood / red blood cells, and carbon dioxide moves from, capillary/ blood /plasma to alveolus / blood to **W** ; 2. diffusion of, oxygen / carbon dioxide / respiratory gases ; **A** movement down, partial pressure / concentration, gradient **A** from high(er), partial pressure / concentration, to low(er), partial pressure / concentration **I** along a concentration gradient 3. use of data from Table 4.1 to support movement of oxygen or carbon dioxide ; *needs ref. to kPa once* *allow ecf from mp2* 4. (diffusion) through, alveolar wall / squamous epithelium ; 5. (diffusion) through, endothelium / capillary wall ; 6. AVP ; e.g. haemoglobin binding oxygen	**4**
(c)	*any four from:* alveoli / alveolar walls, stretch / expand, during, inspiration / AW ; arteries / arterioles / blood vessels, stretch / expand, as blood, volume / pressure, increases ; stretch to prevent (alveoli / arteries), bursting / rupture / AW ; **A** prevent overstretching recoil during expiration / AW, to help, expel / force out, air ; ***AW*** *in context of alveoli* recoil to apply pressure to blood so maintaining blood pressure ; *in context of arteries* AVP ; e.g. allows trachea / bronchus / bronchioles, to expand during inspiration	**4**
(d)(i)	$\frac{50}{86} \times 100$; 58(%) ; *if extracted values are different allow ecf for calculated answer* *accept ± 1 mm when reading from graph (49 to 51 and 85 to 87)*	**2**
(d)(ii)	*allow 'volume of blood' for 'mean volume of blood per kg body mass'* *any four from:* *description to max 3* 1. trend is / overall / AW, increase in volume of blood, over time / AW *or* increase in volume of blood over time except between 0 and 1–2 months ; 2. trend is / overall / AW, increase in red blood cell volume, over time / AW ; *or* increase in red cell volume over time except between 7–8 and 12 months ; 3. *ref. to* percentage of mean blood volume represented by red blood cells / haematocrit ; e.g. fluctuates / mainly increasing / decreases between 1–2 and 3–4months / decreases between 7–8 and 12 months ; 4. any comparative use of, figures / percentages ; *to support mp1, mp2 or mp3* *explanation to max 3* 5. lower partial pressure of oxygen at high altitude / less oxygen in inhaled air ; 6. lower oxygen saturation of haemoglobin / haemoglobin has lower oxygen affinity ; 7. compensation *or* *idea that* changes occur to make up for less, oxygen taken in / transported to tissues **R** *idea of* body getting more oxygen than at sea level 8. (over time) more red blood cells produced so more haemoglobin / AW ; 9. (over time) proportion of red cells / concentration of haemoglobin, increases so, take up / AW, greater volume of oxygen ; **A** more red blood cells per unit time passes through, lungs to take up oxygen / tissues to deliver oxygen 10. AVP ; e.g. *ref. to* erythropoietin / EPO	**4**

161. 9700_s20_ms_22 Q: 4

(a)	much / AW, rough endoplasmic reticulum / rough ER / RER for, polypeptide / protein / collagen, synthesis ; **A** for translation many mitochondria provide, energy / ATP, for, polypeptide / protein / collagen, synthesis ; large nucleus indicates, active cell / (much) transcription ;	**2**
(b)(i)	*any two from* in trachea ; in, bronchus / bronchi ; *if only one correct structure named, allow one qualification mark* *trachea* C-shaped / incomplete, rings ; surround smooth muscle ; *bronchus* plates / irregular ;	**2**
(b)(ii)	*any two from* keep airways open ; provides support ; allow flexibility ; *allow described e.g. bending neck, swallowing food* rings allow, lengthening / widening, during, breathing in / inspiration / inhalation ;	**2**
(c)(i)	peptide (bond) ;	**1**
(c)(ii)	*any three from* collagen, structural / fibrous, protein *or* collagen gives strength / flexibility ; glycine / gly, small / smallest, amino acid ; **A** has H as, R-group / side chain glycine / gly, regular / every third amino acid ; (so) triple helix tightly packed / three polypeptides closely associated / AW ; *ref. to* (peptide bond) NH of gly can form hydrogen bond with (peptide bond) C=O of adjacent amino acid (in other polypeptide) ;	**3**

162. 9700_s20_ms_23 Q: 3

(a)(i)	**X** = artery **Y** = vein ;	**1**
(a)(ii)	*any two from* cross section not regular / no defined shape / AW ; **A** not circular tunica intima smooth; **A** inner layer *for tunica intima* **A** not, crinkly / wavy thin / thinner (than **X**) tunica media ; **A** thin middle layer wide lumen diameter relative to wall thickness / relatively large lumen / AW ; tunica, externa / adventitia, as thick / thicker, than tunica media ;	**2**
(b)(i)	*any two from* tissue fluid and blood plasma do not have red blood cells ; **A** blood contains red blood cells red blood cells are too large to pass through endothelial pores ; *idea of* tissue fluid and blood plasma similar viscosity / blood more viscous ; AVP ; *ref. to* similar colour (versus blood is red)	**2**
(b)(ii)	*any one from* taken up by / transported into / AW, (body) cells (from tissue fluid) ; used by (body) cells to, synthesise polypeptides / proteins / enzymes ;	**1**
(c)	*any two from* contraction and relaxation ; changes diameter of (lumen) of, trachea / bronchus / bronchiole ; **A** (contraction causes) constriction control of air flow (in the bronchioles) ; AVP ; e.g. changed size of lumen during coughing / forced air out	**2**

163. 9700_w20_ms_21 Q: 5

(a)	*any **one** from :* (*when the air pressure lowers inside bronchus*) holds, bronchus / airway open ; **A** supports, bronchus / airway ; prevents, bronchus / airway, from collapsing ;	**1**
(a)(ii)	*idea that* (cartilage arranged as) incomplete / C-shaped, rings in the trachea ; *idea of* more regular distribution (of incomplete rings) along the length of trachea ;	**1**
(a)(iii)	*max 1 if cilia or mucus linked to incorrect cell* (ciliated epithelial cells have) cilia, to, waft / sweep / AW, mucus, away / up the trachea / AW ; (goblet cells that) secrete mucus to trap, dust / bacteria / pathogens ;	**2**
(b)(i)	the larger elephant has a smaller surface area to volume ratio ; **ora**	**1**
(b)(ii)	*any **three** from:* are multicellular / have many cells ; need a large quantity of / enough, oxygen to supply, every cell / all parts of body ; active so high demand for, oxygen / removal of CO_2 ; diffusion across body surface is not fast enough (to meet needs) ; AW long diffusion distance (so diffusion is not fast enough to meet needs) ;	**3**
(b)(iii)	*any **four** from:* three polypeptide chains ; (three polypeptides) form triple helix ; **A** coil around each other **R** *ref. to* alpha helix hydrogen bonds hold the three. polypeptides / strands. together ; the three polypeptides, lie close together / form a tight coil / are tightly wound ; every third amino acid (in the polypeptide chain) is glycine / many glycine-proline alanine repeats / many gly-pro-ala repeats ; glycine is found on the inside of each, polypeptide / strand; AVP ; e.g. detail hydrogen bonds, between peptide bond NH (of a glycine) and C=O group in adjacent polypeptide	**4**
(b)(iv)	*allow reference to collagen fibrils instead of collagen molecules, in correct context (collagen molecules form fibrils, which form fibres)* *any **one** from:* (many) collagen molecules lie parallel ; *no weak points because* strong / covalent, (cross) links between molecules ; (ends of) molecules (in, fibril / fibre), are staggered ;	**1**

164. 9700_w20_ms_22 Q: 3

(a)	irregular / plates / AW, of cartilage ; **A** cartilage not C-shaped rings *other features* *any **two** from:* smooth muscle ; elastic, tissue / fibres ; mucous glands ; thick wall / wall many layers ; large lumen (relative to thickness of wall) ; large size relative to surrounding alveoli ; **I** surrounded by alveoli	**3**
(b)	*evidence must match stated structure* blood vessel ; *plus any **one** from:* presence of tunica media / circular layers of smooth muscle ; three layers in wall ; similar to structure on left, which has blood cells ; not bronchiole, qualified ; e.g. as no ciliated epithelium not rounded shape / no definite shape **OR** artery ; **A** arteriole *plus any **one** from:* small lumen relative to thickness of wall ; **A** small lumen with thick wall thick, tunica media / muscle layer ; thick tunica externa ; **OR** vein ; *plus any **one** from:* no definite shape / not rounded / not oval / AW ; large lumen relative to thickness of wall / large lumen and thin wall ; thin tunica media ;	**2**
(c)	goblet cells, produce / secrete / AW, mucus to trap, pathogens / AW ; **A** dust / dirt / particles etc for AW cilia, waft / moves / carries / push, mucus, to back of throat / AW ;	**2**

165. 9700_m19_ms_22 Q: 2

(a)	*any **four** from:* 1 globular protein ; **A** spherical / ball-shaped **I** circular 2 acts as a catalyst ; 3, 4 further detail ; ; e.g. increases the rate of a reaction (cf. to no enzyme) **A** speeds up a reaction / makes the reaction go faster does not get used up (in the reaction) **I** does not take part in the reaction **A** can be re-used **A** is not changed (by the reaction) does not alter the (chemical) equilibrium (between reactants and products) 5 lowers the, activation energy / energy needed for substrate to reach transition state ; 6 detail ; e.g. holds substrate to place strain on bond (for bond to break) holds substrates, in position / close, for bonds to form facilitates transfer of, electrons / protons 7 effective in tiny quantities / AW ; 8 shows specificity / active site shape complementary to substrate / forms enzyme–substrate complex / lock and key or induced fit mechanism of action ; 9 AVP ; e.g. may need, cofactor / coenzyme / prosthetic group, to function each has an optimum, temperature / pH	**4**
(b)	carbon dioxide / CO_2 + water / H_2O ; body tissues ⇌ lungs carbonic acid / H_2CO_3 ; *one mark for each side of the equation* *allow one mark only if, wrong way round / carbonic acid shown as proceeding to dissociate*	**2**
(c)	*any **four** from:* *primary:* sequence of amino acids not shown ; **A** cannot see primary structure of amino acids *secondary:* alpha / α, -helices shown ; beta / β, -pleated sheets shown ; (areas of) random arrangement shown ; *tertiary*: folding / coiling, (of polypeptide chain) shown / ref. to 3-D configuration ; globular shape shown ; interactions between, R-groups / side-chains, (of amino acids) not shown ; ref. to any two bond types not shown ; e.g. H bonds / disulfide bridges / ionic bonds / hydrophobic interactions folding allows presence of zinc / AW ;	**4**

166. 9700_s19_ms_22 Q: 2

(a)	mucous gland cells / mucous gland(s) ; **I** mucosa goblet cell(s) ; *list containing trachea and / or bronchus and / or bronchioles* **I** *and allow to two max* *BUT if alveoli stated or incorrect cell types (e.g. ciliated cells) max 1*	**2**
(b)	*any one from:* Golgi (body / complex / apparatus) ; rough endoplasmic reticulum ; **A** rough ER / RER **R** SER **I** ER	**1**
(c)	*two marks to complete table* first process — transcription second process — translation third process — glycosylation fourth process — exocytosis *allow one mark if transcription first process and exocytosis last process but other two wrong way round* *allow one mark if transcription and translation wrong way round and other two correct*	**2**
(d)	*accept symbol Ψ for water potential* *three from:* **1** chloride presence outside cell causes water potential (outside cells) to, decrease / become more negative / become lower **or** chloride leaving cell causes water potential (in cell) to increase / AW ; **2** water potential gradient, created / present (between inside and outside of cell) ; **3** water leaves cell by osmosis (to be taken up by mucin to form mucus) ; **4** from higher to lower water potential / AW ; **R** if term gradient included	**3**
(e)	*any three from:* *to produce, new / daughter, cells…* **1** that are genetically identical ; **2** to replace, old / damaged / dead, cells ; **A** named cells **3** to repair (damaged / injured / diseased) tissue ; **A** named tissue *if mp 2 and 3 not gained, allow 1 mark for replacing damaged tissue* **4** *ref.to* function ; *in context* **5** AVP ; *idea of* increase in number of cells / growth, to accommodate increase in size of gas exchange system in growing infants / AW	**3**

167. 9700_s19_ms_23 Q: 2

(a)	correctly stated formula ; e.g. actual diameter = image length / magnification magnification = image length / actual diameter allow a magnification triangle 1750 (μm) ; (*for 70 mm*) *credit also measurements made to 0.5 mm* **A** 1700 (μm) (*for 68 mm*) **A** 1725 (μm) (*for 69 mm*) **A** 1775 (μm) (*for 71 mm*) **A** 1800 (μm) (*for 72 mm*)	**2**
(b)(i)	squamous epithelial (tissue) ; **A** pavement epithelial (tissue)	**1**
(b)(ii)	*any two from:* (alveoli have) thin wall / wall is one cell thick ; **A** wall composed of thin cells **R** thin membrane **R** thin cell wall *idea of* short diffusion distance ; *in context of between alveolar space and, blood / capillary* elastic tissue, qualified ; **A** elastin / elastic fibres e.g. stretch and recoil for, ventilation / inhalation and exhalation maintaining steep, diffusion / partial pressure, gradient (many) alveoli provide a large surface area (for diffusion) ; **I** *idea that a single alveolus has a large surface area* AVP ; surfactant, prevents alveolar collapse / maintains inflation **I** *ref. to* moist lining	**2**
(c)	*any three from:* 1 loosely packed spongy mesophyll cells / spongy mesophyll cells surround air spaces / air spaces between spongy mesophyll cells ; 2 large, surface / area, for evaporation (of water to air space) ; *In context of spongy mesophyll cells, surfaces / cell walls* 3 (cells arranged so that), air spaces above the stomata / sub-stomatal air spaces ; 4 *ref. to* evaporation creates saturated air spaces / water vapour collects in air spaces ; 5 *idea of* creates water potential gradient between air in air spaces and air in external environment ; 6 AVP ; e.g. guard cells situated in epidermis to form stomatal pore *ref. to* xylem, close proximity to spongy mesophyll cells for passage of water / passes on water to spongy mesophyll cells	**3**
(d)(i)	*accept au for arbitrary units and first hour etc. for 08.00 etc.* *any three from:* 1 between 08.00 and 09.00, steep increase / increase from 2.5 au to 5 au ; 2 highest rate / peak, at 09.00 ; **A** maximum rate is at 09.00 3 fluctuates / AW, between 10.00 and 15.00 ; 4 (continued) decrease between 15.00 and 19.00 ; **A** steep /steepest, decrease between 15.00 and 16.00 **A** less steep (than 15.00 to 16.00) decrease between 16.00 and 19.00 5 comparative data quote for decrease ; e.g. 3.8 au at 15.00 to 0.5 au at 19.00 **or** 3.8 au at 15.00 to 2.00 au at 16.00 **or** 2.0 au at 16.00 to 0.5 au at 19.00	**3**
(d)(ii)	*any two from:* *change in external environmental factor* decrease in light intensity / AW ; **A** (less sunlight because it was) cloudy decrease in temperature / AW ; *temperature decreased because it was cloudy is mp2 only* decrease in, wind speed / air movement / AW ; increase in humidity / raining / AW ; stomata, decrease in (aperture) size / open less wide ; decreased evaporation (rate) ; water vapour diffuses out less rapidly / less steep water potential gradient ; AW AVP ; e.g. suggestion of xerophytic feature occurring in response to increased, temperature / light intensity (to 09.00)	**2**

168. 9700_w18_ms_22 Q: 1

(a)	bronchiole ; **I** respiratory / terminal, before bronchiole	1
(b)	(actual diameter) = image / observed, length, ÷ magnification ; **A** (A =) I ÷ M **or** magnification triangle 300 □m ; (12 000 / 40) **A** 275 □m (11 000 / 40) **A** 288 □m (11 500 / 40) **A** 313 □m (12 500 / 40) **A** 325 □m (13 000 / 40)	2
(c)	*any four from* *in healthy lungs* **1** correct direction of movement of <u>both</u> respiratory gases ; e.g. oxygen from alveolus towards blood and carbon dioxide from blood to alveolus ; oxygen enters the blood system and carbon dioxide leaves **A** red blood cell / haemoglobin, *as ref. to blood* **2** diffusion (of, oxygen / carbon dioxide) **or** movement, down a concentration gradient / from high(er) to low(er) concentration ; **A** implied e.g. oxygen enters blood from a high<u>er</u> concentration **I** diffusion of gases **3** detail of pathway ; **R** *ref. to* cell walls e.g. across, alveolar wall / squamous (epithelial) cells across endothelium / capillary wall ; **A** squamous cells *in context of capillary* crosses two layers of cells (*alveolar wall and capillary wall)* *comparison healthy with diseased – look for ora* **4** higher rate of exchange / increased rate of diffusion / steeper concentration gradient ; **A** more oxygen to blood per unit time / more carbon dioxide to alveolus per unit time **I** more efficient gas exchange **I** better gas exchange / faster diffusion **5, 6** AVP ; ; e.g. larger surface area (for, gas exchange / diffusion) shorter diffusion distance *ref. to* (greater) ability to, stretch / recoil (for ventilation to maintain gradient) **or** *ref. to* elasticity *(more v fewer elastic fibres is not sufficient)*	4

169. 9700_s16_ms_21 Q: 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 <u>polypeptides</u> / 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]

170. 9700_s16_ms_22 Q: 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]**

(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]

171. 9700_w15_ms_22 Q: 1

(a) (i) mitochondria ; **A** mitochondrion [1]

(ii) can change shape / fluid membrane structure / *ref. to* flexible ;
different orientation when section taken / AW ; **A** different sections cut
some may be dividing / *ref. to* mitochondrial fission; **I** growing [max 1]

(b) (i) ribosomes ; **A** ribosome **I** *ref. to* size e.g. 70 S / 80 S [1]

(ii) *circle around* 0.025 μm ; [1]

(c) (i) plasmodesmata ; **A** plasmodesma [1]

(ii) *assume answer is in context of between adjacent cells but* **R** if within a cell
I incorrect naming of plasmodesmata
I description of cytoplasmic strands

facilitates / more rapid / allows / AW, transport / communication / exchange / transfer (of substances) ;
substances do not need to cross, cell (surface) membranes / cell walls ;
for, movement / AW, of, substances / materials / nutrients / water ;

named example ;
e.g. movement / diffusion / AW, of sucrose to sieve tube (from companion / transfer, cell)
water travels by, symplastic pathway **I** incorrect mechanism e.g. osmosis
water avoids, apoplastic / cell wall, pathway
proteins too large to cross, cell wall / cell surface membrane

A *idea of* substances moving in and out of cells *only if plasmodesmata given in* ***(i)*** [max 1]

(d) **I** descriptions e.g. extensions / hair-like

microvilli / **A** microvillus **R** villi / villus **R** cilia

and *one from:*

absorption / uptake of products of digestion
secretion / release of (extracellular), enzymes / other named secretion
digestion (at the cell surface) / breakdown of (ingested) food / AW
excretion / release of, waste / excess, substances
increases surface area ; [1]

[Total: 7]

172. 9700_w20_ms_23 Q: 1

<table>
<tr><td>(a)</td><td>one mark per row
A if names and labels reversed

<table>
<tr><th>description</th><th>name of part of gas exchange system</th><th>label from Fig. 1.1</th></tr>
<tr><td>supported by incomplete (C-shaped) rings of cartilage</td><td>trachea</td><td>B ;</td></tr>
<tr><td>lined by ciliated epithelium and supported by blocks of cartilage</td><td>bronchus
A bronchi</td><td>C / J ;
A C and J</td></tr>
<tr><td>lined by squamous epithelium</td><td>alveolus / alveoli</td><td>M ;</td></tr>
<tr><td>lined by ciliated epithelium, but not supported by cartilage</td><td>bronchiole(s)
I terminal / respiratory</td><td>H ;</td></tr>
</table></td><td>4</td></tr>
<tr><td>(b)</td><td>A mutagen(s) / carcinogen(s) ; A tar A named carcinogens
B nicotine ;
C carbon monoxide ;
D tar ;
E nicotine ;</td><td>5</td></tr>
</table>

173. 9700_m19_ms_22 Q: 4

<table>
<tr><td>(a)</td><td>any three from:

right ventricle pumps blood to lungs (and back to heart) and left ventricle pumps blood to (rest of) body (and back to heart) / AW ;

(so) short(er) / less, distance (for blood to travel) / ora ;

less resistance (to, flow / overcome) / ora ;

less force / lower pressure, required / ora ;</td><td>3</td></tr>
<tr><td>(b)</td><td>any two from:

ventilation / breathing (movements) / inspiration / inhalation, brings in oxygen ;
blood flow (in pulmonary capillaries) removes oxygen ;

oxygen binding to haemoglobin / oxyhaemoglobin formation, (removes oxygen) ;
deoxygenated blood arriving / blood arriving low in oxygen ;</td><td>2</td></tr>
<tr><td>(c)(i)</td><td>any one from:

in context of, airways / trachea / bronchi:
less air because:
diameter of lumen decreases / ref. to smooth muscle contraction ;
inflammation ;
thicker layer of mucus ;

smoke present in inhaled air (so lower proportion of air) ;

AVP ;</td><td>1</td></tr>
<tr><td>(c)(ii)</td><td>any two from:

carbon monoxide (present in smoke) binds to haemoglobin ;
ref. to competitive / permanent / irreversible, binding ;
presence of carbon monoxide (from smoke) lowers affinity of haemoglobin for oxygen ;
ref. to carboxyhaemoglobin formed ;
comparatively less haemoglobin per red blood cell to bind oxygen ;</td><td>2</td></tr>
</table>

174. 9700_w19_ms_21 Q: 6

(a)	*three from* joins a nucleotide to extending, polynucleotide / strand ; (only allows) complementary base pairing ; forms phosphodiester bonds (between nucleotides) / forms the sugar phosphate backbone ; proofreading the new strand ; repairs any mismatched base pairs ;	**3**
(b)(i)	stops, cell cycle / mitosis / cell division / cell replication / AW ;	**1**
(b)(ii)	thymine only present in DNA / no thymine in RNA ; uracil (nucleotide) replaces thymine (nucleotide) in transcription ;	**1**
(c)(i)	cytokinesis ;	**1**
(c)(ii)	*three from* tobacco smoke / tar, contains (named) carcinogens ; cause, damage to DNA / mutations ; detail ; e.g. proto-oncogenes to oncogenes / tumour suppressor genes switch off (in) epithelial cells in the, trachea / bronchus / gas exchange system / lungs ; uncontrolled, mitosis / cell division ; AVP ; e.g. forms a mass of undifferentiated cells / AW cells do not respond to signals	**3**

175. 9700_w19_ms_22 Q: 2

(a)	EMRO and SEARO / Eastern Mediterranean and South-East Asia (Regions)	**1**
(b)	*max 1 (tar data mark or nicotine makes platelets sticky) if tar / CO also stated* *any two from:* (AFRO) has more nicotine ; **R** has more, tar / tar and nicotine / CO and nicotine (*see below)* nicotine makes platelets sticky / AW ; **A** damages endothelial lining (so turbulent blood flow) so increases clotting risk **R** if also state tar makes platelets sticky 0.92 and 0.77–0.79 mg (per cigarette) **or** 9.2 v. 7.7–7.9 mg (per cigarette) **or** (AFRO) 1.3–1.5 mg (per cigarette) higher ; *correctly extracted numerical data for tar is alternative to gain mp 3 ecf* 12.5–12.7 v. 11.3–11.5 mg / (AFRO) 1.0–1.4 mg higher	**2**
(c)	*allow, Hb / hb, for haemoglobin and allow CO for carbon monoxide* *any four from:* **1** haemoglobin, has a higher affinity for / binds more readily with, carbon monoxide (than oxygen) ; **A** carbon monoxide displaces oxygen from haemoglobin **A** carbon monoxide binds to Hb and decreases its affinity for oxygen **2** carboxyhaemoglobin formed ; **3** binding is, (mainly) irreversible / permanent / (more) stable (than oxygen binding) / AW ; **4** decreases saturation of haemoglobin with oxygen (in the lungs) / less haemoglobin available to bind oxygen ; **A** less oxyhaemoglobin formed / less oxygen binds to haemoglobin *cigarette smoke:* **5** low concentration of oxygen in inhaled cigarette smoke ; **6** *ref. to* (in airways), narrowed lumen / inflammation / increased mucus / accumulated, mucus ; **A** bronchial constriction **7** (so) lower concentration of / less, oxygen, reaching alveolus / in alveolar air **or** (so) less oxygen, diffuses / AW, (from alveolus) into bloodstream / reaches red blood cells / reaches haemoglobin (in red blood cells) ; **R** *ref. to* consequence of emphysema *must be in context of mp 5 or 6* **8** AVP ; e.g. nicotine causes vasoconstriction and reduces blood supply (to extremities)	**4**

176. 9700_m17_ms_22 Q: 5

(a)	bronchus } ; trachea } bronchiole ; alveolus ; **I** same structure written on more than one line	**3**
(b)	*two from:* 1 (tobacco) smoke contains, tar / carcinogens / named carcinogen ; 2 causes mutations / mutagenic / described mutation e.g. protooncogene to oncogene / oncogene forms / tumour suppressor gene switched off ; 3 uncontrolled mitosis / AW ;	**2**
(c)	*three from:* 1 many layers v few(er) layers ; **A** one layer / thicker 2 cells all the same v more than one type of cell / goblet cells and (epithelial) cells ; **A** no goblet cells 3 cells, flatter / smaller / cubical / AW v columnar cells ; 4 reference absence of cilia ; 5 large / prominent, nuclei / ORA ;	**3**

177. 9700_s17_ms_22 Q: 5

(a)(i)	trachea / windpipe + bronchus / bronchi + bronchiole / bronchioles ; *treat as neutral type of bronchiole*	**1**
(a)(ii)	goblet ;	**1**
(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**
(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**
(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**

178. 9700_s17_ms_23 Q: 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**
(b)	2 4 1 3 5 1st and 5th boxes (2 and 5) correct ; 2nd and 4th boxes (4 and 3) correct ;	**2**
(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**
(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**

179. 9700_m16_ms_22 Q: 6

(a) trachea / windpipe
bronchus / bronchi
bronchiole / bronchioles
alveolus / alveoli } *all correct two marks* ; ;

one mark for:
one structure, incorrect / missing, but others in correct order
or
trachea and alveolus correct but bronchus and bronchiole wrong way round

[2]

(b) emphysema ;
chronic bronchitis ;

[2]

[Total: 4]

180. 9700_s16_ms_23 Q: 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]

181. 9700_w16_ms_21 Q: 6

(a)

	cartilage	cilia	elastic fibres	
trachea	✓	✓	✓	;
bronchioles	×	✓	✓	;
alveoli	×	×	✓	;

[3]

(b) *changes max 2*
fewer / no / damaged / AW, cilia ; **A** paralysed / destroyed **R** killed
A ciliated (epithelial) cells destroyed
scar tissue, develops / replaces ciliated (epithelial) cells / AW ;
goblet cells enlarged ;

increased risk max 2
thicker layer / more, mucus traps bacteria ;
mucus not removed (by cilia action) so, (trapped) bacteria remain / longer time for bacteria to infect cells / AW ;
bacteria multiply / bacterial population growth, in mucus (so increases chance of infection) ; [3]

(c) *four from*
oxygen used up in (aerobic) respiration (in tissues) ;
low(er) / decrease in, partial pressure of oxygen / AW ;
allosteric mechanism / described ;
small decrease in partial pressure leads to a large dissociation of oxygen ;

ref. to decrease in haemoglobin affinity for oxygen (so oxygen released) ; AW

high(er) CO_2, partial pressure / AW ;
haemoglobinic acid formation / H^+ combines with haemoglobin (causes oxygen release) ;
AVP ; e.g. H^+ from carbonic acid dissociation
A H^+ results from action of carbonic anyhydrase to form carbonic acid
effects of carbaminohaemoglobin formation [4]

(d) too large to pass through, (endothelial) pores / capillary walls ; [1]

[Total: 11]

182. 9700_w15_ms_23 Q: 5

(a) **I** *ref. to* walls, unqualified **I** *ref. to* vasoconstriction

nicotine
1 damages the, endothelium / (inner) lining / tunica intima ;
2 increases blood pressure (which can damage the endothelium) ;
3 increases risk of, blood clotting / thrombus formation ;
A thrombosis, **A** increases stickiness of platelets

carbon monoxide
4 damages the, endothelium / inner lining / tunica intima ;
allow even if mp1 given
5 so increases risk of, blood clotting / thrombus formation ;
A thrombosis
6 *idea of* overall reduced oxygen supply to coronary artery walls ;
7 AVP ; e.g. inflammation / (increases risk of) atheroma *or* plaque *or* atherosclerosis [max 3]

(b) **(i)** (the by-pass vessels) supply (oxygenated) blood from the aorta ;
supply oxygen to, cardiac / heart / ventricle, muscle ;
supply, glucose / fat / fatty acids ;
reduce / prevent, anaerobic respiration ;
A so (muscles) can (continue to) respire aerobically
prevent death of, muscle / heart cells / heart tissue
A prevents angina [max 3]

(ii) **I** lifestyles, healthy or otherwise
I 'better health care'

education
early education / educate children (about heart disease)
or
leaflets / posters / continuing education, about effects of heart disease ;

diet
encourage / educate about, healthy eating / balanced diet ;
ref. to labelling of foodstuffs ;
tax on, sugar / fats **ora** e.g. reduce cost of 'healthy' foods
or
idea of regulation against foods with, high sugar / fat ;
A junk food

smoking
educate about dangers of smoking / anti-smoking campaigns ;
provide ways to stop smoking / example ; e.g. tax on cigarettes / nicotine patches / E-cigarettes
smoking bans ;

exercise
finance use of / build more, activity centres / AW ;
encourage, greater activity / exercise ;

medical
idea of, check-ups / screening population (at risk of heart disease / high blood pressure / high cholesterol) ;

provide / subsidise, drugs to, reduce blood pressure / lower cholesterol ;

research
funding research into heart disease ; [max 3]

[Total: 6]

183. 9700_s19_ms_22 Q: 4

(a)	*max 3* if any membrane-bound organelles drawn inside cell e.g. nucleus, Golgi body, mitochondrion, lysosome, ER, a large vacuole BUT **I** vesicle / small vacuoles **I** detail of cell wall / cell surface membrane around flagellar area *four from:* cell wall ; *must add another line to diagram* **R** cellulose cell wall cell (surface) membrane ; **A** plasma membrane *label line to the inside of cell wall* **I** if outer line labelled as cell membrane DNA ; **A** bacterial chromosome / nucleoid *as label* *allow one or two circular molecules* (*circle, loop, ball of string, tangled)* **R** *if obviously linear* **R** if label includes, histones / histone proteins / chromatin **R** if nuclear, envelope / membrane, shown **R** if nucleolus shown or labelled ribosomes ; **R** 80S ribosomes *shown as, dots / small spheres* cytoplasm / cytosol ; plasmid ; *smaller than DNA, circular* AVP ; e.g. 70S / smaller / 17–20 nm, *for ribosome* murein / peptidoglycan (for cell wall – allow even if cell wall label not added) pilus /pili *drawn as external hair-like structure(s)* basal granule *at base of flagellum* capsule drawn to outside *(some do have a capsule)*	**4**
(b)(i)	0.8 % ; **R** 0.80 %	**1**
(b)(ii)	*any two from:* delay in / no, diagnosis ; delay in / no, treatment / therapy ; **A** feature of, oral rehydration, treatment /solution **A** ORT / ORS e.g. lack of supply of ORT unwillingness by health workers to give ORT greater belief in herbal remedies thinking drug treatment is sufficient lack of clean water to make up ORT solution no rehydration programmes **I** improper treatment / treatment not effective *ref. to* no / lack of, antibiotic therapy ; e.g. lack of supply of / less efficacious (AW) antibiotics used / less supervision in taking full dose *ref. to* antibiotic resistant strains ; *idea that* already have a weak immune system / malnourished ; **A** may have HIV/AIDS (hence weak immune system)	**2**
(c)(i)	*any one from:* damaged sanitation system / poor sanitation following earthquake ; **I** poor sanitation unqualified damage to, sewage treatment plants / water purification plants ; AW (contaminated) sewage contaminates drinking water ; **I** pollution **A** water becomes contaminated lack of purified drinking water; **A** lack of, clean / treated / safe / bottled, water AVP ; no, proper / safe, disposal of sewage	**1**
(c)(ii)	*any three from:* **1** 2011, peak in / highest / AW, number of, cases / countries / countries and cases ; **A** decrease, increase in 2011, decrease *for countries* **A** increase to 2011 and decrease *for cases* **2** (2010 outbreak in) *ref. to* Haiti and epidemic (so high number of 2011 cases) ; **3** *ref. to* spread of disease to countries neighbouring Haiti (hence increase in countries in 2011) ; **4** overall / generally / AW, decrease in number of countries with cases of cholera **or** 2008 54–56 countries and 2015 41–43 countries, with ref. to decrease ; *decrease, peak at 2011 / increase in 2011, decrease is mp1 only* **5** suggestion for trend in decrease in number of countries ; e.g. improved infrastructure for sewage / water treatment improved health education to prevent spread providing piped (treated) water **6** 2008–2010 number of cases increased and number of countries decreased ; **7** AVP ; e.g. lowest / AW, number of cases in 2013 **R** if also state that 2013 is lowest for countries similar number of countries in 2008 and 2011 but, approx 3× / much higher / stated values, number of cases in 2011	**3**

184. 9700_s18_ms_22 Q: 5

(a)	*three from:* any four named structures ; mouth / nose / nostrils / nasal passages (count as one structure) pharynx larynx trachea **A** windpipe bronchus / bronchi bronchiole / bronchioles alveolus / alveoli / alveolar ducts / alveolar sacs lungs trachea, branches / divides, into (two main) bronchi ; correct sequence from bronchus (branching) to bronchioles to (end with) alveoli ; further detail ; ; e.g. trachea has, C-shaped / incomplete rings, of cartilage bronchus has cartilage, plates / AW diameters of gas exchange structures / respiratory tubes, decrease (towards alveoli)	**3**
(b)	*two from:* blood pressure, decreases / returns to normal ; platelets no longer sticky / risk of thrombosis decreases / risk of blood clotting decreases ; endothelial repair (more likely to be) successful ; **A** endothelium no longer damaged **A** decreased risk of, atheroma / atherosclerosis **I** less fatty deposits heart rate, decreases / returns to normal ; **I** heartbeat decreases AVP ; e.g. increased peripheral circulation / AW blood vessels, not / less, constricted **A** less vasoconstriction **A** blood vessel (lumen) diameter increases / vasodilation occurs	**2**
(c)	*four from:* *assume from point of view of giving up smoking unless stated otherwise* *in lungs / at high partial pressures of oxygen* 1 (so) more oxygen taken up by haemoglobin / haemoglobin more saturated (with oxygen) / AW ; **A** haemoglobin has, increased / normal, affinity for oxygen 2 before and after data / calculated difference in data, to support, from 10 kPa ; 3 carbon monoxide no longer binding to haemoglobin / AW ; **A** carboxyhaemoglobin no longer forming / ora with ref. to smoking **A** haemoglobin has a higher affinity for CO than oxygen 4 more (sites on) haemoglobin available to take up oxygen ; *in respiring tissues* 5 more oxygen dissociates from (oxy)haemoglobin / AW, at, lower partial pressures / below 4 kPa / in (respiring) tissues (after stopping) ; **A** haemoglobin less saturated (with oxygen) **A** haemoglobin has, less / decreased, affinity for oxygen 6 before and after data / calculated difference in data, to support ; 7 ref. to increase in allosteric effect / regains ability for conformational change / AW ; *health benefits after stopping* 8 more / sufficient, oxygen to, transport / deliver to, tissues / body **or** more oxygen to reach (respiring) tissues ; **A** less, tired / fatigued **A** more able to, do work / carry out exercise / be mobile **R** more energy unless qualified with link to aerobic respiration	**4**
(d)	*two from:* *non-infectious* not from a pathogen ; **A** bacteria / viruses / fungi *for pathogens* **A** from lifestyle **A** tar / carcinogen in smoke, causes mutation (in cells of lung) cannot be passed onto another person / not transmissable / AW ; *disease* abnormal condition (affecting an organism) / condition that reduces the effectiveness of the functions of the organism / AW ;	**2**

185. 9700_s18_ms_23 Q: 4

(a)	*answers must be in context of oxygen* *three from:* 1 diffusion 2 movement, down a, concentration / diffusion, gradient / from high(er) to low(er) concentration ; **A** in terms of partial pressure 3 passive (process) ; 4 through alveolar wall / across alveolar cells / across squamous epithelial cells (of alveolus) / across pavement cells (of alveolus) ; **A** squamous cells 5 across, endothelium / endothelial cells / capillary wall ; **A** squamous, epithelium / cells (in context of capillary wall) 6 ref. to diffusion / AW, through the phospholipid bilayer of cell surface membranes / between the phospholipids of the bilayer (of squamous or endothelial cells) ;	**3**
(b)(i)	65 / 66 / 67 (%)	**1**
(b)(ii)	1 higher partial pressures in lungs / lower partial pressures in (respiring) tissues ; **A** correct values / range of values, of kPa **A** in alveoli *advantages of differences (higher v lower partial pressure)* *only higher partial pressure or lower partial pressure explanation required to gain mark* 2 oxygen, binds to v released from, haemoglobin **or** oxyhaemoglobin, is formed v dissociates / AW ; 3 (so) percentage saturation of haemoglobin (with oxygen) high v low ; 4 affinity of haemoglobin for oxygen high v low ; 5 data from Fig. 4.1 to support ; 6 (body), cells / tissues, need oxygen for aerobic respiration ;	**3**
(c)	*idea of* abnormal, change in the body / condition, which produces, poor / ill-, health **or** absence of, good health / well-being ; **A** disorder / illness further detail ; e.g. having an adverse effect reduces the effectiveness of functions produces, (specific) signs / symptoms lack of social, physical and mental, well-being can be infectious or non-infectious AW	**2**
(d)	*five from:* 1 base substitution (in gene coding for, β-globin / polypeptide) ; 2 different / altered, mRNA codon ; 3 different tRNA brings a different amino acid (to ribosome) / leads to a change in one amino acid (in the polypeptide chain) ; 4 altered, primary structure / sequence of amino acids (in β-globin) ; 5 changed, tertiary / quaternary, structure ; 6 haemoglobin / molecule, less soluble ; 7 (haemoglobin) molecules, stick together / form fibres ; 8 (haemoglobin) less able to bind oxygen / AW ; *points above may be qualified* 9 details ; ; + e.g. thymine / T, replaces, adenine / A 10 in sixth, codon / triplet **or** sixth amino acid in sequence is changed (non-template strand) GTG instead of GAG / GTA instead of GAA **or** (template strand) CAC instead of CTC / CAT instead of CTT mRNA codon is, GUG instead of GAG / GUA instead of GAA 11 (amino acid change is) valine instead of glutamic acid ; 12 amino acid with non-polar side chain instead of polar side chain ; 13 position of amino acid, is to the exterior / faces cytosol ;	**5**

186. 9700_s18_ms_23 Q: 6

(a)	**A** HIV / AIDS, measles, smallpox ; **B** cholera, tuberculosis ; **C** cholera ; **D** malaria ;	**4**
(b)	one mark for each correct column ; ; nuclear envelope circular / (closed) loop / **A** ring of 80S mitochondria / chloroplasts **A** nucleus murein / peptidoglycan	**2**

187. 9700_w18_ms_23 Q: 5

(a)(i)	*Mycobacterium*, *tuberculosis* / *bovis* ;	**1**
(a)(ii)	*any three from* **1** phagocytes / macrophages / neutrophils / elastase, breaks down / weakens, alveolar walls ; **2** (reduced elastin so) alveoli cannot stretch and recoil / alveoli overstretch ; **3** alveoli burst / one large air sac formed ; **4** surface area (for gas exchange) is reduced ; **5** less oxygen absorbed by blood / reduced oxygen supply (to tissues) / not enough oxygen for (aerobic) respiration / AW ;	**3**
(b)	**R** cost *any five from* **1** *Transmission* ; e.g. aerosol / droplet, infection **I** airborne **A** lack of pasteurised milk overcrowded, housing / living conditions / AW migration / travel, from areas with high rates of TB reservoir of infection in people not, diagnosed / not treated **2** *HIV / immunodeficiency* ; e.g. infection with HIV may activate (dormant) TB (pathogen) immunodeficiency / AW, makes people more susceptible to TB intravenous drug taking increases risk of, immunodeficiency / HIV **3** *Diagnosis is difficult* ; e.g. TB (pathogen) remains dormant / symptomless carriers limited access to health care for diagnosis / AW *idea that* contact tracing is difficult	**5**
(b)	**4** *Treatment* ; e.g. treatment is long term / treatment may not start early enough people may not finish the course of treatment limited access to health care for treatment **5** *Acquired resistance* ; e.g. bacterium / TB (pathogen), develops resistance to, antibiotic(s) / drug(s) multi-drug resistance / MDR-TB / XDR-TB **6** *Vaccination* ; e.g. vaccine may not always be effective in providing protection difficult to achieve herd immunity concerns / misconceptions, about vaccination limited access to vaccination (programmes) poor (immune) response in people who are malnourished poor thermostability of vaccine **7** *Education* ; e.g. limited education / low awareness, about prevention for general population limited education / low awareness, for health care professionals	**5**

188. 9700_s17_ms_22 Q: 3

(a)	*(Plasmodium) falciparum / malariae / ovale / vivax* ;	1
(b)	*Anopheles* ; **I** female / male **I** specific epithet e.g. *gambiae*	1
(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
(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
(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

189. 9700_s16_ms_21 Q: 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]

190. 9700_s15_ms_22 Q: 2

(a) **1** cilia, qualified **;** e.g. absent / short / destroyed / smaller / damaged / AW
R cilia killed **R** hairs for cilia **R** mucus damages cilia
A ciliated (epithelial) cells, absent / destroyed / damaged

2 ref. to presence of, scar tissue / scarring **; BOD** scar
R cilia are scarred (idea is, scar tissue formation / more connective than usual)
note idea of scar tissue in place of, cilia / ciliated epithelium = 2 marks

3 idea of affecting, coordinated movement / synchronous rhythm, (of cilia) **;**
A cilia paralysed
A if stated that excess mucus inhibits movement
A ecf if 'hairs' instead of cilia for mp 1

4 mucus, not moved (effectively) / accumulates **;**

5 idea that, bacteria / *B. pertussis* / *Bordetella* / pathogens, accumulate (in airways) / are trapped in mucus
A mucus, good growth medium for pathogens / AW **[max 3]**

(b) mucous gland **;** **A** mucous glands **[1]**

(c) if another mode of transmission given (e.g. faecal-oral / contact / sexual transmission) = 0 marks for this part-question **I** in unpasteurised milk

1 aerosol / droplet, infection **;**

only need to have one of 'infected' / 'uninfected' to gain mps 2 and 3

2 infected / AW, person, coughs / breathes / spits / talks / sneezes **;**

3 uninfected / AW, person, inhales / inspires / breathes in, droplets **;**

2 / 3 *allow one mark if mps 2 and 3 given with no reference to, infected / uninfected*

4 organism / pathogen / bacteria / *B. pertussis*, in, airborne droplets / droplets in air **;**
A without 'airborne' or 'in air' *if mp 2 gained* **[max 2]**

(d) (i) **1** DNA / gene / *MUC5AC*, unwinds / AW ; **I** unzips
2 H-bonds break between, (complementary) bases / base pairs / strands ;
I unzips
3 one / a, strand, acts as template / (complementary) copied ;
I ref. to, sense / coding and antisense / non coding
4 ref. to (involvement of) RNA polymerase ;
I ref. to direction of, movement / strand formation
5 (free) complementary RNA nucleotides added ;
A described in terms of correct base-pairs (C with G and A with U minimum)
6 step-by-step / sequentially / AW ;
7 sugar phosphate backbone sealed / phosphodiester bonds formed ;
A sugar phosphate backbone formed
8 (product is) messenger RNA / mRNA ; **A** primary transcript
9 AVP ; e.g. transcription factors required to initiate transcription
RNA polymerase binds to promoter (sequence)
helicase unwinds
ref. to activated (RNA) nucleotides
ref. to proof reading
(transcription ends at) transcription terminator **[max 4]**

(ii) Golgi (body / complex / apparatus) ;
A RER / rough ER / rough endoplasmic reticulum
one of
2 transport / movement, to cell (surface) membrane (from Golgi) ;
A through cytoplasm (for Golgi or RER)
A transport to Golgi *if RER given in mp1*
3 ref. to bulk transport, across cytoplasm / to cell surface membrane ;
4 ref. large size and difficulty of movement across, cell / cell surface membrane ;
5 it, functions extracellularly / is released to the outside of the cell / is secreted ;
I ref. to exocytosis *as it is in the question* **[max 2]**

(e) **1** shortness of breath / dyspnea / difficulty breathing / restriction of airflow ;
A rapid breathing **R** heavy breathing
2 chronic / persistent / AW, cough / coughing ; **I** cough, blood / mucus
A constant coughing **A** smoker's cough
3 chest tightness ; **A** chest pain **R** heart pain
4 wheezing ;
5 fatigue / weakness ;
6 difficulty, when exercising / with physical activity / with mobility ;
7 more prone to / frequent, chest / respiratory / named, infections ;
8 barrel (shaped) chest ;
9 cyanosis (blue, face / fingers)
10 AVP ; e.g. weight loss / anorexia
swollen, ankles / feet
not excess mucus as this is in the question **[max 4]**

[Total: 16]

191. 9700_w15_ms_22 Q: 5

(a) *assume response refers to infectious unless otherwise stated*

caused by a pathogen ; **ora A** microorganism / microbe
transmissible / communicable / passed from one, organism / person, to another ;
ora

examples to support explanation
two examples of pathogen types ; *two of:*
bacterium / bacteria
virus / viruses
fungus / fungi
protoctist **A** protozoa

example of non-infectious, disease / category ;
e.g. genetic disorders / named (e.g. sickle cell anaemia / cystic fibrosis)
cancer / named cancer (e.g. lung)
degenerative disease / named (e.g. chronic bronchitis, emphysema / COPD / coronary heart disease) lifestyle / AW

(b) (red blood cells contain) haemoglobin ;
plasma proteins ; **A** plasma contains proteins
named protein in blood plasma or within (red / white) cells ;
e.g. fibrinogen / albumin / globulin / antibodies / (protein) hormone / enzyme / transport proteins / membrane proteins
R steroid hormone / named steroid hormone [max 2]

(c) **(i)** not all countries with *Anopheles* have malaria / example using Fig. 5.2 ;
e.g. (although, Anopheles / vector, shown as present),
no / few, cases (of malaria) in, North America / Europe
(although, *Anopheles* / vector, occurs elsewhere) malaria, only / mainly, in subtropical and tropical areas ;

explanations:
Plasmodium / parasite / pathogen, not present in all areas where *Anopheles* is located / AW ;
conditions (where *Anopheles* located) not always suitable for life cycle of, *Plasmodium* / parasite / pathogen ;
some, areas / countries, have eradicated the disease (but still have the vector) ;
AVP ; e.g. some countries have better prevention methods against malaria
AVP ; some countries have effective treatment for malaria
I vaccination [max 3]

(c) (ii) *assume ref. to A. gambiae unless stated otherwise*

occurrence
1 (in Africa) wide distribution / large numbers ;
2 occurs where high density of humans ;
3 occurs (in climate) where *Plasmodium* is, present / able to survive ; AW
A e.g. *idea of* Plasmodium requiring temperatures above approx. 20 °C where *A. gambiae* is also present

well adapted ***or*** *better adapted than other mosquito vectors*
4 better adapted to complete life cycle / lays eggs in large variety of habitats / can withstand (more) polluted waters / larvae able to eat a wide variety of food ;
5 short(er) life cycle / long(er) breeding season ; **A** reproduces quickly
6 withstands, dry / drier, conditions / larger temperature variation / higher temperatures ; **I** better adapted to climate
7 (more) resistant to, pesticides / insecticides ; **R** immune

feeding
8 feed mainly / AW, on human blood ;
9 takes, large(r) / more frequent, blood meals ;
10 takes blood meal / bites / feeds, at night (when humans less able to notice) ;
11 mouthparts, well adapted for feeding on humans / can penetrate clothing;

as host for Plasmodium
12 good host for / very susceptible to, parasite / *Plasmodium* ;

AVP ; e.g. able to migrate to find hosts
quick to adapt to changing human habitation
better adapted to find (human) hosts
females live for longer
A. gambiae present in Africa, where, malaria control is difficult

[max 3]

(d) (i) large egret / yellow winged bat / eastern green mamba ; [1]

(ii) **1** insufficient numbers of bats ;
2 (so) not enough energy / energy available is low (to sustain needs) ;
3 energy loss at each level / progressively less energy transferred / inefficient / transfer of energy / AW ;
4 example of energy loss from bat intake ; *in context of mamba feeding*
e.g. inedible parts / named indigestible parts / faeces / egestion
5 example of energy loss in food chain (to bat) ;
e.g. death but not eaten
excretion
respiration
heat loss, in movement / digestion
allow either point below if not awarded for mp 4
inedible parts / named examples
indigestible parts / faeces / egestion [max 3]

(iii) use biological control ;
introduce / increase numbers of / AW, predators (of mosquito) / named e.g. guppy / dragonfly / yellow winged bats ;
to eat / consume / reduce number of, mosquitoes ;
grow crops other than sweet potato / grow less sweet potato ;
A do not grow sweet potato
numbers (of mosquito) reduce so fewer, act as vectors / feed on humans ;
AVP ; e.g. use genetic modification to produce sweet potato crop with toxin against mosquito [max 2]

(e) nectar / nectaries / flowers / phloem (tissue) **/** (phloem) sap / sieve tubes / vascular bundles / stem / leaf ;
I *ref. to*, source / sink
R if includes, roots / 'potatoes' / xylem, *for this mp only, then for mp 2 allow explanation for the other stated part that is correct*

explanation ;
e.g. fluid feeders / piercing and sucking mouthparts / proboscis for feeding
(fluids provide) source of carbon / energy / sugar / sucrose
A glucose / fructose
(fluids provide) source of, nitrogen / amino acids
near to, vascular bundles / phloem *for, stem / leaf*
for phloem sap / AW *for vascular bundles* [2]

[Total: 18]

192. 9700_w20_ms_21 Q: 3

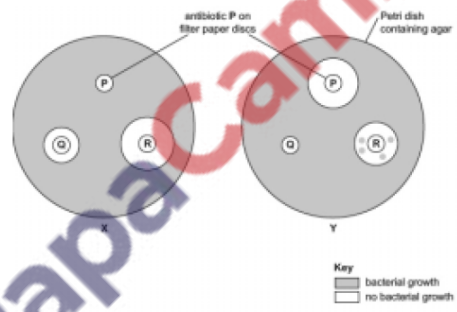
(a)(i)	blood, travels through the heart twice for every one complete, circuit (of the body) / circulation **or** blood, travels through the heart twice and through pulmonary and systemic, circulations / systems / circuits ; **A** description of both circulations	**1**
(a)(ii)	chordae tendineae / tendinous cords ; **A** tendons / 'heart strings' *any **two** from:* *idea that* (atrioventricular) valve, held in position / prevented from inverting, during ventricular, systole / contraction ; **A** AV valve *for atrioventricular valve* connect the papillary muscle to the (atrioventricular / AV), valve ; *ref. to* tension, in the chordae tendineae / AW, (during ventricular contraction) ; (allows valve to) prevent backflow of blood into atrium / ensure one way blood flow (through the heart) ; *ecf max 2 marks for function if structure A is a correctly named valve (atrioventricular / tricuspid / bicuspid)*	**3**
(b)(i)	*idea of* using both antibiotics makes sure all bacteria are killed ; if, resistance against one antibiotic occurs then, the other antibiotic will be effective / bacteria still susceptible to the other antibiotic **or** if, some bacteria are less susceptible to one antibiotic, then, the other antibiotic will be effective / bacteria still susceptible to the other antibiotic ; *any **one** from:* antibiotics / gentamicin and penicillin G, have different sites of action / AW ; **A** suggestion of how the antibiotics have different ways of killing *ref. to* mutations, qualified ; e.g. need two mutations to occur to be resistant to both antibiotics probability / AW, of these two mutations occurring in the same bacterium is very small mutations must be in different genes	**2**
(b)(ii)	*any **three** from:* course of antibiotic is not completed ; less susceptible bacteria survive ; **A** not all bacteria destroyed replication / population growth, increases chance of mutation ; *ref. to* random mutation, ref to gene / allele, for resistance to gentamicin ; suggestion of outcome of different mutations ; e.g. changed ribosome structure so gentamicin cannot bind enzyme to breakdown gentamicin *ref. to* transmission of allele for resistance ; e.g. vertical transmission / described horizontal transmission / described (conjugation / transformation) e.g. frequency of allele for resistance increases in the population ; *when antibiotic next prescribed* antibiotic in the environment is the selection pressure / resistant bacteria selected for / susceptible bacteria selected against ;	**3**

193. 9700_w20_ms_22 Q: 2

(a)	*any* ***four*** *from:* **1** (in combination treatment) antibiotics (in Table 2.1), act at different targets / have different modes of action / AW ; **A** comparison of any two antibiotics from Table 2.1 **A** suggestion of how two antibiotics have different ways of killing **2** *idea that* if resistance / mutation, occurs / exists, unlikely to be against all antibiotics / other antibiotics should still be effective ; **3** (in combination treatment) if resistance / mutation, occurs / exists, all bacteria will (still) be, killed / destroyed / AW ; **A** no bacteria remain to develop resistance / no reservoir of resistant bacteria **4** antibiotic resistance, not / less likely to be, spread to affect people because no bacteria surviving (with combination treatment) ; AW **5** long treatment time / 6 months, with, combination treatment / AW, increases chance of killing all bacteria **or** long treatment time with a single antibiotic not effective in killing all bacteria if, resistance develops / a mutation occurs ; **6** AVP ; e.g. combination treatment (is likely to) eliminate bacteria more quickly (so less chance of resistance occurring) resistance to different antibiotics involves more genes so less chance of resistance occurring gene for antibiotic resistance has more chance of being passed on if using single antibiotic (and not all killed) ora if using single antibiotic (and not all killed) more chance of being passed on (to other bacteria) by horizontal / vertical / AW, transmission ora	**4**

(b)(i)	transcription ;	**1**
(b)(ii)	*any **three** from:* **I** stops transcription **1** alters shape of / blocks, active site ; **R** enters / fits into, active site *as it is not competitive* **R** *ref. to* choice of competitive or non-competitive **A** alters shape of enzyme *only if mp2 gained* **2** substrate / nucleotides, cannot, bind to / enter, active site ; **A** fewer / no, enzyme-substrate complexes / ESCs, form *allow ecf from mp1 if rifampicin described as, competitive / enters active site* **3** complementary (base) pairs / (complementary) base pairs, cannot form / form less easily (between DNA and RNA nucleotides) ; **4, 5, 6** *(in context of rifampicin binding to RNA polymerase)* prevents / AW, unwinding of DNA (double helix) ; **A** uncoiling **I** unzipping prevents / AW, attachment to DNA (strand) **A** prevents / AW, attachment to promoter prevents / AW, movement along DNA (strand) ; prevents / AW, elongation (of polynucleotide) / formation of polynucleotide /nucleotides being joined ; prevents / AW, phosphodiester bond formation ; prevents / AW, proof reading ; **7** AVP ; e.g. prevents / AW, tRNA / rRNA, formation	**3**
(c)(i)	Phe Tyr ; *one mark for both correct*	**1**
(c)(ii)	**B D F G** ; *in any order*	**1**
(c)(iii)	*resistance* **1** shape / tertiary structure, of, β-subunit / enzyme, altered / AW ; **I** active site changes shape **A** quaternary structure of enzyme altered **2** rifampicin / antibiotic, cannot / does not, bind (as well) ; AW **R** *if context is binding to active site* *different levels of resistances* *any **two** from:* **3** (because) other mutations are involved ; AW **A** described from Table 2.1 e.g. **C** has 2 (other) mutations and **D** and **E** have 3 **4** mutations may result in different changes to, structure / shape of, β-subunit / enzyme, and result in different, effects / levels of resistance ; **5** data from Table 2.2 to support mp 4 ; *must be linked to concept of mp4* **6** AVP ; e.g. *ref. to* different binding abilities (of rifampicin to enzyme) some (of the other) mutations may cause more of a change to binding site for rifampicin mutation(s) may make it harder to bind lower resistance = binds, more strongly / for longer time lower resistance = higher proportion of transcription events hindered e.g. idea that mutations still, produce functioning enzyme / allow catalysis to occur	**3**

194. 9700_w20_ms_23 Q: 4

(a)(i)	**X – R** *and* **Y – P ;**	**1**
(a)(ii)	*any **two** from:* ***mp1** = resistance with ref. to **P / Q / R*** **Y**, is resistant to **Q** / has no resistance to **P ;** **A Y** has some resistance to (antibiotic) **R** ***mp2** = antibiotics used at different concentrations* (antibiotic) **R** may, have different concentration / be less effective, compared with **P ;** ***mp3** = reason for resistance* *ref. to* gene(s) for resistance (on plasmids) ***or*** **Y** has, cell wall / cell membrane, that prevents entry of antibiotic **Q** ***or*** **Y** has enzyme that breaks down, **Q / R ;** ***mp4** = action of antibiotics* *idea that* antibiotics have, different / specific, target(s) / AW ; **A** any example of process inhibited by antibiotic, e.g. cell wall synthesis transcription translation DNA replication cell surface membrane function synthesis of folic acid	**2**
(a)(ii)	***mp5** = AVP ;* e.g. *idea that* **P** may be bacteriocidal / (antibiotic) **R** is bacteriostatic e.g. *idea that* gene for resistance to antibiotic **R** passed by, vertical / horizontal, transmission  	
(b)	*any **three** from:* *to award the MP1 to MP5 you **must be able to see a difference** between the two stated clearly*	**3**

	vaccines		*antibiotics*
1	(generally) are preventative / are not a treatment / are not a cure **or** use before a person, has an infection / is ill	**v**	are (generally) not preventative / are a treatment / are a cure **or** used when a person, has an infection / is ill ;
2	effective against bacteria and viruses (in context of different vaccines)	**v**	not effective against viruses / only effect against bacteria ;
3	*idea of* indirect effect on pathogens	**v**	*idea of* direct effect on pathogens ; **A** example of effect
4	not given as a course / give once or a few times (or with boosters)	**v**	given as a course / over many days / AW ;
5	specific for particular, pathogen	**v**	(most) antibiotics act on a range of pathogens ;
6	stimulate an immune response	**or**	do not stimulate an immune response ;
7	detail e.g. stimulate, (B- / T-) lymphocytes / production of antibodies **A** stimulates production of memory cells	**or**	do not stimulate, (B- / T-) lymphocytes / production of antibodies ; **A** no stimulation of memory cells
8	provide long-term, protection / immunity	**or**	do not provide long-term, protection / immunity ;
9	does not lead to resistance	**or**	may lead to resistance ;
10	time delay before being effective / AW	**or**	have effect, faster / sooner / AW ;

195. 9700_s17_ms_21 Q: 6

(a)(i)	*Vibrio cholerae* ;	1
(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**
(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**
(c)	endocytosis ; **A** phagocytosis / pinocytosis	1
(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**
(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**

196. 9700_s17_ms_23 Q: 3

(a)	*Mycobacterium tuberculosis* / *Mycobacterium bovis* ; *correct spelling*	**1**
(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**
(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**

197. 9700_s16_ms_23 Q: 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]

(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]

198. 9700_w16_ms_21 Q: 4

(a) (i) *Vibrio cholerae* ; [1]

(ii) **R** if other modes of transmission listed

ref. to 'infected' and 'uninfected' not required (as in question) but statements must be in correct context

I polluted water

one mark for infected person
passed in, faeces / stools / sewage ; **R** waste, unqualified

one mark for uninfected person
ingests / eats, contaminated, food / crops
or
drinks / ingests, contaminated, water / liquids ;
A uses utensils washed in contaminated water / AW

if above 2 mps not gained, one mark for
idea of (infected person) sharing drinking bottles / utensils (with uninfected person)

two marks for
faecal-oral, route / transmission ;; [2]

(iii) **A** poor sanitation *once only for mp 1 or 3*
two from
1 damage to, sewers / drains / foul water systems ;
2 (so) mixing of sewage and drinking water ;
3 (contaminated) water supplies cannot be treated ;
A water (for drinking) from untreated (contaminated) sources
4 *ref. to* spread by flies exposed to, contaminated faeces / untreated sewage ;

5 *idea of* people in high density temporary accommodation facilitating spread ;
6 unable to practice good hygiene ; **A** examples e.g. lack of soap
restrictions on (treated) water for cleaning
7 unable to thoroughly cook foods ;
8 need to share (contaminated) water containers / cooking pots / AW ;

9 disruption to health care facilities / AW ; **A** example
e.g. lack of ORT (so higher proportion of infected people)

10 AVP ; e.g. increased risk of malnutrition linked to increased risk of disease [2]

(b) (i) *two from*
different mRNA codon (formed during transcription) ;
A triplet / triplet of bases / triplet code / 3-base code
R codons
idea that, each codon specifies a particular amino acid / a different codon specifies a different amino acid ; **A**

(different) tRNA with different amino acid binds to, ribosome / mRNA ; [2]

(ii) *two from*
change in, tertiary / quaternary, structure (of enzyme) ;
A change in polypeptide, folding / coiling ;

(enzyme) binding site for antibiotic, lost / changes shape ;
R active site *unless clear that substrate binding and catalytic site remains unchanged*

antibiotic / nalidixic acid, cannot bind (so enzyme remains active) ;
allow ecf for active site [2]

(c) *four from*
1 risk of, further spread / wider epidemic, (from people still infected) ; AW
2 reduces chance of succesful treatment / higher death rates ;
3 increased, treatment / hospitalisation times ; **A** takes longer to treat
A more complex treatment
4 increased costs of treatment / strain on health budget / AW ;

5 risk of, further resistance / resistance to all antibiotics ;
6 fewer antibiotics left that are effective ;
A risk that no antibiotics will be left to successfully treat

7 need to find, new antibiotics / alternative treatment ;
A difficulty in finding new treatments / AW
8 (so) cost of research ; *allow cost once*

9 AVP ; e.g. strain on, resources / health personnel, to treat other diseases
need to identify type of resistance so that effective treatment is given
education, qualified [4]

[Total: 13]

199. 9700_w16_ms_23 Q: 2

(a) *two from*
- **1** provide an alternative pathway ;
- **2** brings reactants close together (in active site / to form ESC) ;
- **3** put a strain on the reactant(s) ;
- **4** so bonds, break / form, more easily ;
- **5** transfer of, charges / groups ;
- **6** AVP ; e.g. involvement of R groups [2]

(b) (i) *quoting figures with no qualitative description = **mp4** only*

four from
- **1** as time increases the concentration of PABA increases ;
- **2** increasing the concentration of inhibitor, decreases concentration of PABA / slows the reaction ;
- **3** from 0 to 2 / 2.5 / 3 minutes, no difference in concentration of PABA produced / same rate, for all concentrations of inhibitor ;
- **4** use of data ; *from plotted points or from curves*
  e.g. concentrations of PABA at different times for any one inhibitor
  e.g. concentrations of PABA at same time for two different inhibitor concentrations
  e.g. concentration of PABA = 2 – 3.5 μM at a specific time
- **5** AVP ;
  e.g. for all concentrations of inhibitor, rate becomes less steep after approximately 5 minutes
  e.g. for last 20 minutes rate of reaction is linear (for all or any one concentrations of inhibitor)
  e.g. little difference, in rate / final [PABA], between 0 and 1 μM
  e.g. greater difference, in rate / final [PABA], between 1 μM and 3 μM [4]

(ii) *three from*
- **1** carry out / AW, with different concentrations of substrate ;
  A use a low concentration and a high concentration of substrate *if a number of different concentrations of substrate without any reference to high and low this must be a minimum of 5*
- **2** with and without inhibitor ;
- **3** all other variables constant ;
  A one key variable, e.g. enzyme concentration / temperature / pH
- **4** interpretation of results ;
  e.g. draw a graph to see change to, K_m / V_{max}
  e.g. *idea that* if the effect of the inhibitor decreases with an increase in substrate concentration then inhibitor is competitive **ora**
  e.g. competitive: increase in K_m / no change in V_{max}
  e.g. non-competitive: no change in K_m / decrease in V_{max} [3]

(iii) *one from*
bacteria, cannot make / make less, folic acid, so they die / cannot grow / cannot reproduce / cannot multiply ;
inhibitor targets only bacterial cells ;
inhibitor will not harm human cells ; [1]

(iv) *allow drugs for antibiotics throughout*

two from
1 *idea that* there are few targets for drugs ;
A e.g. virus has no, cell wall / cell membrane / ribosomes
2 no / few, enzymes ;
3 antibiotics only work on, growing / living, cells ;
A viruses have no, metabolism / growth
4 viruses are inside (host) cells / not within reach of antibiotics ;
R if antibodies
5 antibiotics do not work on, protein coat / capsid / viral envelope ;
I capsule [2]

(c) *two from*
do not use for viral infections ;
do not use as preventative medicine ;
antibiotics should only be used (for treatment) when necessary ;

carry out antibiotic sensitivity test ;
ensure, correct / effective, antibiotic, prescribed / used ; AW
ensure people take the correct dose ;
ensure people complete the course of their antibiotic ; **A** ensure people follow the instructions
ensure people do not use, left-over / other people's, antibiotics ;
only supply on prescription / not over the counter / AW ;

only use, wide / broad, spectrum antibiotic when pathogen not known ; **A ora** use narrow spectrum antibiotic when pathogen is known
use more than one antibiotic (at the same time) ; **A** mixture of antibiotics / antibiotics in combination
monitor antibiotics to check that they are effective ;
report cases of antibiotic resistance ;
reporting patterns of antibiotic resistance (temporal and geographical) ;

rotate antibiotics so not used all the time ;
keep some antibiotics to use as a last resort ;
do not use the same antibiotics for animals as for humans ;
reduce use of antibiotics in, food production / (livestock) agriculture ;

use other antimicrobial drugs ;
develop new, types of antibiotics / drugs, to kill bacteria ;
ensure / improve, knowledge of, healthcare professionals / public ; **A** *ref. to* education about awareness of antibiotic resistance
ref. to breaking transmission cycle / described example of a method ; e.g. vaccines / good hygiene in hospitals
break transmission cycle of resistant bacteria / described example ; e.g. quarantine [2]

[Total: 14]

200. 9700_s19_ms_22 Q: 3

(a)	**C** =neutrophil ; **A** polymorphonuclear leucocyte **A** basophil **A** eosinophil **D** = lymphocyte ; B / T *is neutral* **E** = monocyte ; **A** macrophage **I** *leucocyte / white blood cell, throughout*	**3**
(b)(i)	*any two from:* lymphocytes / blood cells, produced in / originate from, bone marrow ; *ref. to* stem cell(s) ; *ref. to* cell division ; e.g. bone marrow has cells that can carry out, mitosis / cell division **A** (stem cells are) multipotent	**2**
(b)(ii)	*any three from:* *measles* immune response stimulated ; detail ; e.g. **either** antigen recognition / presence / binding **or** lymphocyte / white blood cell, stimulated / triggered **or** clonal selection / AW **plus** clonal, expansion / proliferation / cell division / mitosis **R** incorrect pathogen name **R** bacteria *CLL* result of, uncontrolled mitosis ; **A** uncontrolled, division / cell cycle **I** rapid mitosis detail ; owing to, mutation / named mutation **or** cell cycle checkpoints not working **or** cells don't respond to signals to control division	**3**
(c)(i)	*any two from:* (passive / simple) diffusion (of oxygen) across the phospholipid bilayer ; **A** movement from a higher to a lower concentration *for diffusion* **A** between phospholipids / between fatty acid chains / across hydrophobic core / across bilayer / AW, *for phospholipid bilayer* small size ; non-polar / uncharged ;	**2**
(c)(ii)	*any three from:* less oxygen in inhaled air / AW ; **A** less oxygen taken up from alveoli low(er) saturation of haemoglobin (with oxygen) ; **A** Hb for haemoglobin **A** haemoglobin carries less oxygen *must be the context of oxygen* **R** saturation, with air / carbon dioxide haemoglobin has lower affinity for oxygen ; (so) more haemoglobin required (so more red blood cells) / (more red blood cells) so more haemoglobin ; AW compensation / compensates ; **A** so same, volume / quantity / amount, of oxygen reaches body cells (compared to lower altitude)	**3**

(d)	*any four from:* **1** (alleles have) different nucleotide sequences ; **A** different base sequences **2** base substitution / substitution of a base ; **A** T replaced by A **3** (alleles have) different mRNA codons ; **A** altered mRNA codon **R** altered genetic code **4** (results in) one amino acid change **or** change from, glutamic acid / glutamate / glu, to, valine / val **or** changed primary structure ; **A** changed sequence of amino acids **R** *if implies whole sequence changes* **5** AVP ; e.g. Hb^A = CTC and Hb^S = CAC (on template strand) **A** Hb^A = GAG and Hb^S = GTG (on non-template strand) **or** Hb^A = CTT and Hb^S = CAT (on template strand) **A** Hb^A = GAA and Hb^S = GTA (on non-template strand) *this is **not** also mp2* *ref. to* amino acid substitution at position 6 (*this is **not** also mp4*) **A** 6th, codon / triplet, changed **6** changed, (β-globin / Hb) tertiary structure ; **A** polypeptide / (Hb molecule) quaternary structure **R** β-globin / polypeptide **7** *ref. to* loss of globular structure / hydrophobic amino acid faces outside (instead of towards centre) ; **A** described e.g. (val) amino acid with hydrophobic R-group instead of (glu) amino acid with hydrophilic R-group *accept hydrophilic / polar, amino acid* *accept hydrophobic / non polar, amino acid*	**4**
(d)	**8** sticky (haemoglobin) molecule formed / forms fibres with other haemoglobin molecules ; **9** oxygen taken up less easily / less oxygen carried by haemoglobin / AW ; **A** β-globin takes up oxygen less easily / AW **10** AVP ; (sickle cell) haemoglobin / β-globin, less soluble / AW **I** insoluble	

201. 9700_s19_ms_23 Q: 3

(a) *one mark each row* — **4**

cell structure	*V. cholerae*	epithelial cell from the human intestine
cell wall	✓	✗
cell surface membrane	✓	✓;
ribosomes	✓	✓;
large permanent vacuole	✗	✗;
organelles surrounded by a double membrane	✗	✓;

(b) — **5**

I better sanitation unqualified
I *ref. to* unclean water

any five from :

ref. to treat drinking water ;
A clean / sterilised / chlorinated / safe / bottled / boiled
A *ref. to* water treatment plants
provide sewage treatment plants ; **A** treat waste water / containment of sewage / provide latrines (in temporary camps) ;
ref. to keeping sewage and (drinking) water sources separate ;
A examples e.g. avoid swimming downstream of sewage outlets
avoid defaecating near rivers used for washing
water treatment plants upstream of sewage disposal
bury faeces

ref. to vaccination / providing vaccines ;

ref. to education in ways to prevent spread ;

ref. to (encourage) hand washing ;

ref. to food hygiene ; e.g. use of clean cooking utensils / covering food to prevent flies landing / washing food in treated water / cook food thoroughly / peel fruit and vegetable washed in (suspected) contaminated water

discourage use of human faeces for fertiliser / use fertiliser other than human faeces / do not irrigate plant food with contaminated water;
control breeding of, vectors / flies ;

rapid diagnosis ;
rapid treatment (for earlier recovery to minimise risk of spreading) ;
ref. to oral rehydration, salts / therapy ;
use of antibiotics ;
ref. to isolation / quarantine ;

(c)(i) — **2**

to, bind / attach / AW, HIV / virus / pathogen, to, host cell / T-lymphocyte / T-cell ;
(because it) binds / is complementary, to, CD4 receptor proteins / AW ;

ref. to binding leads to, entry of virus into cell / endocytosis / fusion of viral envelope with host cell (surface) membrane ;

(c)(ii) — **2**

ref. to less cytokine (released) ; *in context of fewer helper T-lymphocytes*

any one from:

(so) fewer B-lymphocytes divide by mitosis / AW ; **A** humoral response decreased

(so) fewer B -lymphocytes stimulated to differentiate into plasma cells / AW ;

(so) fewer plasma cells to, produce / secrete antibodies ;

202. 9700_m18_ms_22 Q: 2

(a)(i)	bone marrow ;	1
(a)(ii)	*accept points from a diagram* *max **three** from:* 1 detection / recognition ; e.g. detects (named type of) pathogen recognises, (foreign) antigens / antibodies complexed to antigens has receptors (for antigens) 2 engulfs / envelops, pathogen / bacterium / AW ; **A** phagocytosis occurs **A** endocytosis occurs **A** pseudopodia form 3 forms, vacuole / vesicle / phagosome ; 4 ref. to lysosome fusion ; 5 ref. to hydrolytic / digestive, enzymes ; **A** named examples **A** hydrolases 6 ref. to antigen presentation ; 7 AVP ; e.g. (response is) non-specific / innate	3
(a)(iii)	*any **one** valid suggestion from:* produces inhibitors for / deactivates, lysosomal enzymes ; escapes out of phagosome ; forms resistant spore / is resistant to digestive enzymes ; AVP ; e.g. suggestion of macrophage malfunction	1
(b)	*any **three** from:* 1 production of mucus by, mucous glands / goblet cells ; 2 sticky / AW, mucus **or** mucus traps, pathogens / bacteria / microorganisms ; 3 mucus acts as a barrier (to prevent entry) ; 4 mucus increases distance to reach cells ; 5 cilia on ciliated epithelial cells ; **A** ciliated epithelium 6 cilia, waft / move, mucus / AW ; 7 *idea that* (contaminated) mucus is moved, away from alveoli / away from lung tissue / towards back of mouth / AW ;	3
(c)	*any **one** suggestion from:* blood / plasma / circulatory system ; lymph / lymph system ; within, neutrophils / macrophages / phagocytes ; **A** white blood cells / leucocytes	1
(d)	*any **one** from:* from infected, cows / cattle ; eating contaminated, meat / beef (from infected cattle) ; drinking, raw / unpasteurised, milk (from infected cows) ;	1

(e)	*any **two** from:* increases chances of, killing / AW, all bacteria ; **I** will kill all bacteria (unqualified) **A** will kill all bacteria if bacteria are, susceptible / not resistant if bacteria are resistant to one antibiotic, then still susceptible to other antibiotics / AW ; reduces chance of mutations arising / (if bacteria susceptible) mutations unlikely to occur against all antibiotics ; AVP ; e.g. antibiotic can be stopped because of side effects idea that more effective because different antibiotics will work on different targets (in the bacteria)	**2**
(f)	*any **two** from:* overall trend for both is increase ; rate of increase in cases of MDR-TB greater than rate of increase in cases of TB / AW / ora ; ref. to fluctuations / detail of fluctuations / periods of decrease ;	**2**
(g)	*any **three** from:* *overall increase in TB cases:* 1 ref. to problems with people living in, poorly ventilated accommodation / close proximity to each other / AW ; 2 vaccination programmes not able to prevent increase / herd immunity insufficient / AW ; *decrease / numbers fairly constant:* 3 ref. to (some) success of, prevention / treatment programme ; **A** described examples *increase in MDR-TB:* 4 people fail to finish course of treatment for normal TB / AW ; 5 ref. to ease of transmission of TB means easy to transmit *MDR-TB ;* *decrease in 2014 for MDR-TB:* 6 suggestion for decrease ; e.g. better, surveillance / cooperation, in completion of drug therapy more successful antibiotics used people better educated about preventing spread *for either increase in TB cases or increase in MDR-TB:* 7 qualified ref. to link between, HIV / HIV/AIDS, and TB ; 8 less money available for, longer drug treatment / vaccination, by, health authorities / governments ; 9 AVP ; e.g. balance between new cases and successfully treated cases means problem still exists in prevention ref. to changes in population size ref. to improvements in data collection ref. to immigration	**3**

203. 9700_s18_ms_21 Q: 5

(a)	*five from:* **A** 'cells' for 'lymphocytes' throughout 1 ref. to antigen presentation ; **A** macrophage presents antigen 2 recognition / binding (in context of B-, or T-lymphocytes) ; e.g. cell surface receptor specific to toxoid / clonal selection **A** immunoglobulin / antibody on surface of B-lymphocytes 3 T-lymphocytes or B-lymphocytes, divide by mitosis / clonal expansion ; 4 (some) plasma cells, formed / AW ; **R** if in context of T-lymphocytes 5 antibody molecules / antibodies, secreted / produced / released ; **R** if in context of T-lymphocytes 6 T helper cells secrete, cytokines / interleukins ; 7 ref. to action of cytokines / interleukins ; e.g. to stimulate, humoral response / B-lymphocytes / to stimulate macrophages / angry macrophages 8 formation of memory cells ; *only in context of B- / T-lymphocyte activation*	**5**
(b)(i)	*three from:* 1 failure to distinguish between self and non-self / AW ; 2 specific B-,lymphocytes / cells, are not destroyed (during development) ; 3 antibodies are produced against, cell surface / ACh, receptors on, muscle cell / neurones / nerve cells ; 4 antibodies, bind to / block, receptors ; **A** antibody–antigen, binding / complex *if receptors already given* 5 AVP ; any detail related to the disease e.g. (chemical) transmitter molecules / acetylcholine, cannot bind (to receptor) impulses are not transmitted across synapse / neurones cannot send impulses ref. to causing, muscle weakness / muscle fatigue ref. to neuromuscular junction does not function	**3**
(b)(ii)	*two from:* so immune response, occurs all the time / recurs ; (defective) B-lymphocytes still being produced / AW ; **I** T (helper) cells **A** not destroyed / remain plasma cells / B-lymphocytes, continue to release antibodies against receptors ; memory cells / immunological memory, present ; receptors are always present (on neurones / nerve cells) ; AVP ; e.g. no cure	**2**

204. 9700_s18_ms_22 Q: 3

(a)	**A** antibiotic for penicillin throughout *three from:* 1 (penicillin) weakens / AW, the cell wall ; **I** punches holes / holes made 2 (penicillin) acts, on growing cells / when cell wall being synthesised (during growth) ; 3 inhibits / binds to / AW, enzymes / transpeptidases (for cross linkage formation) ; **I** ref. to synthesis of peptidoglycan 4 prevents formation of cross, links / linkages (between, peptidoglycan / murein, molecules) / AW ; *suggestions why antibiotic is less effective on Gram negative* 5 outer membrane, prevents / interferes with / protects from / AW, entry (of penicillin) ; **A** idea of, more difficult / further, to reach peptidoglycan layer 6 proteins in outer membrane may pump out antibiotic ; **A** presence of efflux pumps 7 enzymes may be present (in periplasm) to degrade antibiotic / AW ; 8 suggestion that antibiotic cannot cross hydrophobic region of (outer) membrane ; 9 AVP ; e.g. proportionately, less / lower concentration of, penicillin reaches murein for, enzyme / transpeptidase, inhibition	**3**
(b)(i)	ATP not required ; **A** (metabolic) energy not required	**1**
(b)(ii)	*four from:* 1 channel protein ; **A** pore protein / has a pore / has a channel 2 channel / pore, can form from polypeptides **or** (protein) has quaternary structure ; 3 hydrophilic R-groups, on amino acids lining channel / face inwards (towards channel) ; **A** hydrophilic, lining / channel **A** water-filled, channel / AW **A** idea that passage is through hydrophilic region of protein 4 allows facilitated diffusion ; **A** diffusion alone if in context of through the protein but **R** if via phospholipid bilayer 5 increases permeability for, movement of water / osmosis ; **I** faster 6 no (specific) binding sites / (channel) not specific / not selective / allows more than one type of substance through / AW ; 7 globular ; 8 AVP ; e.g. ref. to hydrophobic part of protein, faces / interacts with, hydrophobic, region / core / fatty acid tails ref. to hydrophilic parts of, protein / polypeptide, extend into, external environment / periplasm / aqueous regions / AW	**4**

(b)(iii)	*two from:* translation, cannot / does not, begin / occur **or** polypeptide / protein, synthesis, cannot occur / decreases ; **I** ompF not made **A** chain of amino acids **R** transcription does not occur so translation does not occur **R** if in context of mutation or enzyme inhibition mRNA cannot attach to, ribosome / small subunit / ribosomal subunit ; (first) tRNA (with UAC anticodon) / tRNA carrying met, cannot bind (to START codon) ;	**2**
(c)(i)	(composed of) many / chain of / polymer of / AW, monosaccharides / sugar monomers / sugar units ; **A** glucose, molecules / residues **A** more than two / many sugars further detail ; e.g. carbohydrate may be, branched / unbranched *in context of polysaccharide* macromolecule *in context of polysaccharide* glycosidic bonds *in context of between sugar monomers* (sugar monomers) joined by condensation reactions	**2**
(c)(ii)	*three from:* 1 specificity / specific (in correct context) ; 2 (B / T, -) lymphocytes have receptors complementary to antigen ; **A** immunoglobulins / antibody *as receptors for B-lymphocyte* **A** surface molecules *as receptors for T-lymphocytes* 3 (different) antigens, stimulate / activate / AW, (different) B-lymphocytes / T-lymphocytes ; **A** antigens stimulate an immune response 4 *idea that* different antibodies, synthesised / produced / AW, for different (O) antigens / O polysaccharides / lipopolysaccharides ; 5 memory cells will, not respond to different antigen / only respond to same antigen / AW ; 6 different O-antigens can, be composed of different sugars ; **A** can have different shapes	**3**

(a)	*two from* (loss of ions) increases / AW, water potential within cell ; **ora, A** Ψ for water potential, **I** *ref. to* solutes / solute potential water moves out of cell, down water potential gradient / from high(er) to low(er) water potential ; **R** from high to low water potential gradient (out) by <u>osmosis</u> / through the partially permeable membrane ; **A** selectively permeable membrane **I** osmotic gradient	**2**
(b)	*four from* *capillary side sodium ions* 1 sodium ions out (of cell), by active transport / with use of ATP ; **A** sodium ions pumped out 2 (so) lowers concentration of sodium ions within cell **or** sodium ion concentration gradient, set up / maintained ; *intestinal lumen sodium ions and glucose* 3 sodium ions enter by facilitated diffusion ; **A** diffusion / high to low concentration, through, SGLT1 / cotransporter **I** glucose enters by facilitated diffusion 4 glucose, cotransported with sodium ions into cell (through SGLT1) ; **A** sodium ions cotransported with glucose **A** glucose enters by secondary active transport, **A** *idea of* glucose only able to enter if moving with sodium ions (i.e. sodium drives the process) 5 (cotransport means) glucose enters against concentration gradient ; *capillary side glucose* 6 glucose out of cell (towards capillary) by <u>facilitated</u> diffusion ; **A** by diffusion if stated through, membrane protein / GLUT2 *water uptake from lumen* 7 (higher concentrations of) sodium ions / glucose / solutes, within cell lowers water potential ; 8 water follows, sodium ions / glucose / solutes (osmotically) **or** so water enters cell (down water potential gradient) ; *must have idea that it follows inward movement of solutes*	**4**
(c)	*any one valid e.g.(if not stated artery or vein, assume vein)* high(er) pressure of artery (will not allow drip) **or** artery may be deeper to reach to insert needle for drip / easier to find vein **A** vein more, visible / superficial **or** greater risk / more complications / greater blood loss, associated with intra arterially AW	**1**
(d)	*one from* no / reduced, polypeptide / protein, synthesis **or** <u>mRNA</u> not translated / no translation / reduced translation ; **A** detail of translation e.g. tRNA cannot bind **R** DNA not translated no / few, enzyme-catalysed reactions ;	**1**
(e)(i)	*three from* 1 volume / AW, decreases over time for all groups ; 2 *compared to no antibiotic* antibiotic groups, steep(er) / faster, decrease to, 32 / 48 hours ; 3 *idea that* diarrhoea, stops / is 0 dm^3, at / after, 64 hours, for one dose 1 g / **A**, **or**, multiple dose / **C** ; **A** recovers after 64 hours / AW 4 after 48 hours, one dose 2 g / **B**, fluctuation / decreases then (slight) increase then decrease / AW ; 5 no antibiotic / **D**, higher volumes diarrhoea than antibiotics (to approx. 110h) **or** no antibiotic / one dose 2 g / **B**, took 128 hours (for diarrhoea) to, reach 0 dm^3 / stop ; 6 multiple dose / **C**, higher volumes than, **A** (all readings) / **B** (to 48 hours) **ora or A** has steepest decrease *in context of 16–32 hours or overall*	**3**

(e)(ii) — **2**

alternative ways to refer to decrease in volumes of diarrhoea may be in terms of recovery, destroying bacteria, decreasing loss of glucose and salts

two from

support treatment
there is a difference between antibiotic and no antibiotic treatment **or** fast(er) decrease in volume of diarrhoea with antibiotics / AW **or** (generally) faster recovery with antibiotics ; **I** *ref. to* one dose 2 g

use of Fig. 4.3 to support ;
e.g.
use (1 dose) 1 g or multiple dose
time, to recover / reach 0 dm^3, is halved
use of numerical data from Fig. 4.3

does not support treatment
(in all cases) volume decreased to, same level / zero **or** all patients recovered ;

use of Fig. 4.3 to support ;
e.g.
by 128 hours all patients 0 dm^3
one dose of 2 g same trend from 112 hours as no antibiotic
one dose of 2 g patients relapse after 64 hours
one dose of 2 g took 128 hours (for recovery)

not able to say
limited information available / small number of patients ;

ref. to one dose of 2 g antibiotic ; e.g. does not reach 0 dm^3 until same time as no antibiotic
also see arguments above – allow once only here or for does not support

(f) — **2**

answer may be from point of view of single dose or multiple dose
allow AW – note mp 3 is for starting with susceptible bacteria and mp 4 is for starting with resistant bacteria

penalise once if use virus throughout

	single dose	multiple dose	
1	easier to be sure patient has taken complete dose	course may not be completed	;
2	if (bacteria are all susceptible and) treatment completed, all bacteria killed / no reservoir of bacteria	treatment may not be completed so some (susceptible) bacteria survive	;
3	(susceptible so) no bacteria survive to, mutate / become resistant	(bacteria replicating so) increased chance of, mutation / becoming resistant	;
4	*idea that* (if resistance is already present) single stronger dose has greater chance of killing resistant bacteria	weaker dose spread over time, resistant bacteria, more likely to survive / have less chance of being killed	;
5	(if all killed with single dose) *idea that* resistance not transferred (if all killed) e.g. no vertical / horizontal, transmission *this could be suggested as follow up to mp 2 / 4*	if resistant / if develop resistance, this could be transferred **A** vertical / horizontal, resistance	;
6	AVP e.g. one dose may mean, no / less, antibiotic enters environment (in faeces) (more effective so) bacteria passed out for shorter time, so reduces risk of transmission (of pathogen) *idea that* multiple low dose antibiotics may increase mutagenesis *suggestion that* if resistant and not killed by antibiotic, there may be less of an effect on (good) gut bacteria with single dose		;

(g) — **3**

three from

1 *ref. to* different antigens (in context of, flagellum / whole cell / toxin) ; **A** *ref. to* epitopes instead of antigens

2 specificity ; *in correct context (B-lymphocytes / plasma cells / antibodies /antigen binding sites)*

3 detail of B-lymphocytes ; e.g. specific B-lymphocytes activated (by each different antigen) **A** clonal selection form plasma cells that release specific antibody, **A** B-lymphocytes release specific antibody

4 detail of antibody ; **I** *ref. to* receptor
e.g. antibody complementary (shape) to antigen, antigen binding sites on antibody, variable regions different for each antibody

(h) passive natural / natural passive ; — **1**

206. 9700_w17_ms_23 Q: 3

(a)	(cell) thin / squamous / flat / pavement ; **R** cell wall **I** one cell thick short distance for, diffusion of (named) gases / gas exchange ; **A** diffusion between (air in) alveolus and (blood in) capillary	**2**
(b)	*two from* phosphate / 'heads', are, polar / hydrophilic **and**, fatty acids / hydrocarbon chains / 'tails', are, non-polar / hydrophobic ; **A** hydrophilic / polar, heads **and** hydrophobic tails tails, face away from fluid *or* water / project into air ; **A** diagram heads form hydrogen bonds with water ; *max 1 if answer is about a bilayer*	**2**
(c)	*three from* 1 prevention of infections (of, gas exchange system / named part) ; **A** in context of a named disease (TB, pneumonia, influenza) 2 prevent (named) pathogen entering, rest of body / blood ; 3 *idea that macrophages* patrol / move around / AW, alveoli / lungs ; 4 (carry out) phagocytosis / endocytosis ; **A** are phagocytes 5 engulf / remove / destroy / kill / digest , pathogens ; 6 macrophages are, antigen presenting cells / APCs ; **A** description of antigen presentation **A** part of the immune system 7 AVP ; e.g. reduce excess surfactants **I** *ref. to* mucus	**3**
(d)(i)	*two from* breakdown / AW, elastin / elastic fibres / elastic tissue ; makes a pathway, to alveolus / through alveolar wall ***or*** goes through alveolar wall ***or*** to reach, respiratory tract / gas exchange surface / air space ; to reach, pathogens / site of infection, in alveoli / AW / implied ;	**2**
(d)(ii)	*three from* 1 no / less, inhibition of elastase ; 2 too much / more, elastin / AW, is broken down ; 3 *ref. to* lack of elastin so, no / less, recoil (during expiration) ; 4 alveoli, over expand / overstretch / increase in size ; 5 alveoli burst ;	**3 max**

207. 9700_s16_ms_21 Q: 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]

(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]

208. 9700_s15_ms_21 Q: 2

(a) (i) **X** – (ciliated) epithelium ;
Y – red blood cell / erythrocyte ; [2]

(ii) cilia beat to move mucus (up the bronchiole / towards the mouth / away from the lungs / AW) ;
mucus as a barrier to entry into (epithelial) cells ;
mucus traps, pathogens / bacteria / microbes ; *accept in context of goblet cells*
capillary / blood vessel, brings, phagocytes / macrophages (to engulf bacteria) ; [max 3]

(b) (i) **J** – phagocytosis / endocytosis / described in terms of engulfing *or* forming phagosome ; [1]

(ii) digestion of bacteria / described ;
to destroy bacteria / pathogen ; **A** to prevent spread through the body
antigen, presentation / display on cell surface ;
idea of selection of specific, B cells / T cells ;
A recognition / binding of / activation of, appropriate B / T cells [max 2]

(c) **1** faster ;
in context of whole secondary response

2 memory cells;
in context of production during the first response

3 *idea that* there are many more cells specific for this pathogen ;

4 (so) increases chances of encountering pathogens more quickly / AW ;
5 fast(er) production of, B lymphocytes / plasma cells / antibodies / helper (T) cells / cytotoxic T cells / cytokines ;
6 greater concentration of antibodies (in, blood / lymph) *or* greater numbers of, B / plasma, cells ;
A more, antibodies / plasma cells / B cells

7 pathogen, removed / killed, faster ;
8 person does not become ill / no symptoms ;
A pathogen does not, spread through the body / infect cells / AW [max 3]

(d) (i) little / no / slower / weak, immune response ;
stated function of T-lymphocytes, does not occur / occurs slowly ;
e.g. release of cytokines / stimulating macrophages / stimulating B cells / killing infected cells
high susceptibility to infectious diseases ;
R 'fighting disease' [max 1]

(ii) pathogen **not** recognised, as non-self / foreign ;
pathogen is recognised as self ; **A** non-foreign
ignore antigen concealment [max 1]

(iii) no, antibodies / plasma cells / memory (B) cells, produced ;
no humoral response ;
no antigen presentation by B cells ; [max 1]

[Total: 14]

209. 9700_w15_ms_21 Q: 5

(a) Morbillivirus ; [1]

(b) *must have one ref. to either infected or uninfected to gain max*
aerosol, infection / route ; **A** droplet infection **I** *ref. to* contact
infected person, sneezes / coughs / talks / spits, to release airborne droplets;
inhaled by, uninfected / healthy, person ; [max 2]

(c) RNA nucleotides ;
contains uracil ; **A** no thymine
ribose (instead of deoxyribose) ;
no (double) helical structure ;
AVP ; e.g. small enough to pass through nuclear pores ; [max 2]

(d) cell has no enzyme for RNA replication ;
ref. to enzyme specificity ;
RNA polymerase (in cell) uses DNA template / not RNA template / AW ; [max 2]

(e) *ref. to* recognition and activation by presence of antigen (on APCs / infected cells) ;
T helper and T killer, lymphocytes / cells ; **A** T cytotoxic
T helper
secrete cytokines ;
(cytokines) stimulate / AW, (specific) B-lymphocytes ; **A** humoral response
stimulate / AW, macrophages / phagocytes / phagocytosis / T killer response ;
T killer
kill infected cells ;
detail of killing ; e.g. perforin / H_2O_2
punching 'holes' in membrane
ref. to T lymphocytes become memory cells (for secondary immune response) ; [max 5]

[Total: 12]

(a) **I** *ref. to* other components of tobacco smoke that enter bloodstream

1 contains carbon monoxide and nicotine (which contribute) ;
R if tar also stated

contribution to atherosclerosis
2 damage to / AW, endothelium / (inner) lining / tunica intima / inner wall ;
A also as consequence of increased blood pressure *mp8*
3 increased accumulation of LDLs ; AW *in context of the vessel walls*
A cholesterol / lipids / lipoproteins / fats / triglycerides
4 inflammation ;
5 more / arrival of / attraction of, phagocytes / macrophages / monocytes / neutrophils ;
A leucocytes / white blood cells
A phagocytes, have increased adherence / 'stick' more, to lining
6 phagocytes engulf, LDLs / AW, and die (in situe)
or
formation of / presence, foam cells ;
7 (contributes to) formation of, atheroma / atheromatous plaque ; **A** plaque
I atherosclerosis

features that may have a consequential effect
8 one risk factor (caused by components of smoke) ;
one from:
increased blood pressure *must be in context e.g. adrenalin release owing to nicotine* **I** atheroma increases blood pressure
increased stickiness of platelets (promotes clotting)
thrombus formation / thrombosis / (blood) clotting
increased, (serum) cholesterol / triglyceride / LDL, concentration
decreased, HDL / 'good' cholesterol, concentration
increased, oxidation / reactivity / AW, of LDLs [max 3]

(b) **(i)** phagocytosis ; **A** act as phagocytes

engulf / attack / destroy / AW, pathogens / bacteria / microorganisms ;
A viruses
A act as, antigen presenting cells / APCs
I antigens / foreign organisms / organisms

remove / engulf / AW, foreign substances / dead cells / cell debris / AW ; [max 1]

(ii) *following inhalation* **I** *ref. to* contract / relax

1 alveoli / air sacs / lungs, over expand / over inflate / over stretch / AW ;

2 (alveoli have) no / poor, recoil ; **A** do not, rebound
A lungs do not, recoil / deflate properly

3 (alveoli / lungs) cannot return to normal size / remain, (fully) stretched ;
A do not, decrease in size after, stretching / inhalation / AW

4 alveoli / air sacs, do not push out air (effectively) / have trapped air / AW ;
I oxygen trapped [max 2]

(c) (i) biological catalyst / described ;
e.g. biological molecule / protein that, increases the rate of / catalyses
speeds up, a reaction
molecule that, increases the rate of / speeds up / catalyses, metabolic
/ biological / cell(ular) reaction

one of:
globular protein ;
remains unchanged (at end of reaction) / not used up (in reaction) ;
lowers the activation energy (of a reaction) ; [max 2]

(ii) *points can be gained from diagrams if not contradicted in written answer*

1 (shape of) substrate / elastin, complementary to (shape of) active site ;
R matching / same
A description e.g. substrate fits (into) active site
diagram – label active site + substrate (shapes must be complementary)

2 lock is, enzyme / elastase / active site, and key is, substrate / elastin ;

3 formation of, enzyme-substrate complex / ES complex / ESC ;
A successful collision between enzyme and substrate
A substrate, binds / AW, at / to, the active site
diagram – ESC no label required if following on from mp1

4 peptide fragments / peptides / products, released / formed ; **A** amino acids
diagram – allow without label if sequence clear and products shown

following points need to be annotated if shown on diagram

5 hydrogen / temporary, bonds form between, enzyme / active site, and substrate ;

6 detail of how Ea lowered ; *term Ea not required and points can be general*
strain on (peptide) bond
electron transfers
reactants held close for bond forming (i.e. water joining) [max 3]

(d) **(i)** **I** active site of A1AT changes shape / acts as non-competitive inhibitor
R if macrophage elastase stated

cannot bind / not complementary, to active site **;** **A** elastase / enzyme
H / temporary, bonds cannot form with active site **;**
no longer, prevents entry / binding, of substrate **;** **A** (so) substrate can bind [max 1]

(ii) *consequence must be correctly linked to an event*

1 neutrophil elastase, active / not inhibited / AW **;** **A** increase rate of reaction
2 (so) TIMP-1 inactivated **;** **A** other / macrophage elastase, inhibitor
3 (so) macrophage elastase, active / functioning / not inhibited / not regulated **;**
4 (so) more, macrophage and neutrophil / of both elastases, (to breakdown elastin) **;**
5 *ref. to* consequence **;** e.g. bursting alveoli / breakdown of alveolar walls / formation one large air sac / decrease in surface area for gas exchange [max 3]

(e) **1** mRNA, binds / AW, to ribosome **;** **A** ribosomal RNA **I** rRNA
A mRNA moves to ribosome
2 tRNA with amino acid (to / at, ribosome) **;** **A** aminoacyl / charged, tRNA
3 tRNA / anticodon, specific to an amino acid **;** **A** specific tRNA / anticodon for the amino acid
4 *ref. to* start codon; **A** $AUG^{(met)}$ / first codon is AUG / initiator tRNA **;**
5 (complementary) base pairing / binding, between anticodon and codon **;**
6 first and second tRNAs bind / two tRNAs bound (at a time)
or (tRNAs bring) amino acids, side by side / close **;**
7 peptide bond formation **;**
8 ribosome moves along, one codon / AW **;**
9 next (aminoacyl) tRNA arrives / amino acids added one at a time **;**
10 elastase / polypeptide, released when STOP codon reached **;**
A process continues until a STOP codon reached
11 AVP **;** e.g. *ref. to*, aminoacyl / A, site, and, peptidyl / P, site
small subunit (of ribosome) attaches to mRNA
aminoacyl tRNA synthetase binds amino acid to tRNA
ATP required for tRNA-amino acid binding
peptidyl transferase for peptide bond formation
ref. to, exit / E, site, on ribosome ribosome moves 5' to 3' [max 5]

[Total: 20]

211. 9700_w15_ms_22 Q: 4

(a) *ignore descriptions or further qualification*
no marks for each box if other mechanisms given

active transport ; **A** active uptake
exocytosis ; **I** bulk transport / secretion
diffusion ; **I** passive / simple **R** facilitated diffusion [3]

(b) **I** *ref. to* small increase in partial pressure causes more oxygen to associate
A pp / pressure, for partial pressures

1 this is the range of (partial) pressures occurring in respiring tissues ;
A (partial) pressures in respiring tissues are low
2 (for a) small / 1.6 kPa, decrease in partial pressure ;
3 (so) allows, large quantity of / more, oxygen to, be released / dissociate ;
A oxygen dissociates more, easily / readily
4 affinity of haemoglobin to oxygen decreases ;
in context of, as oxygen is released / as partial pressure decreases
5 data to support ; e.g. 60–62% to 28–30% / 30–32% difference [max 2]

[Total: 5]

212. 9700_m20_ms_22 Q: 5

(a)	**A** ref. to receptors (at neuromuscular junctions) for self-antigens *any **two** from:* 1 autoimmune disease ; 2 failure to distinguish self and non-self (antigens) ; **A** foreign for non-self 3 immune response / antibodies produced, against self-antigens ; 4 binding of (specific) antibody to self-antigen (on the external cell surface membranes of muscle cells) ; 5 faulty / AW, lymphocytes not destroyed ;	**2**
(b)	human immunodeficiency virus ;	**1**
(c)	*any **three** from:* *if T_h cell number is low:* 1 low T_h cells means increased risk of developing an infectious disease ; 2 low levels / less, cytokine, secreted / AW ; *role of cytokine:* 3 stimulates activity of macrophages / produces angry macrophages ; 4 stimulates, B-lymphocytes / plasma cells / humoral, response ; **A** activate B-lymphocytes 5 (so lower concentrations / less / no), antibody, produced / secreted ; 6 stimulates, T-cytotoxic / T-killer, cells ; 7 (so) fewer infected cells killed ; 8 more time for pathogens to, reproduce / spread ; 9 fewer memory cells (to fight future infection) ;	**3**
(d)(i)	*any **three** from:* *receiving treatment (max 2):* 1 percentage of people living with HIV receiving treatment increases ; 2 low rate of increase between 2000 and, 2003 / 2004 ; 3 data to support ; e.g. 3% / 4%, in 2000–2003, 45% in 2015 *deaths:* 4 increase in HIV / AIDS-related deaths to, 2004 / 2005, then decrease ; **A** peak in 2004 / 2005 5 data to support ; e.g. *two of:* start at 1.5 million, peak at 2 million, end at 1.2 million (2 of these)	**3**
(d)(ii)	*any **two** from:* 1 lack of trained personnel to deliver treatment ; 2 some people unwilling to take treatment ; 3 isolated areas / difficulty getting treatment to people ; 4 inability to, supply / produce, enough drugs ; 5 not all people living with HIV, know their status / have been diagnosed ; 6 AVP ;	**2**

213. 9700_s20_ms_21 Q: 5

(a)(i)	*Mycobacterium tuberculosis* or *Mycobacterium bovis* ;	1
(a)(ii)	*max1 if no reference to, infected / uninfected* airborne droplets, breathed / sneezed / AW, out by infected person ; breathed in / inhaled / inspired, by uninfected person ; **or** *in context of M. bovis only* contaminated meat / unpasteurised milk, from infected, cattle / cows ; ingested by uninfected person ;	2
(b)	*max 4 if no ref. to, (mature) B-lymphocytes / plasma cells, producing / secreting, antibodies* *any five from:* *ref. to* fusion of lysosomes releasing hydrolytic enzymes ; intracellular digestion / described ; e.g. hydrolysis of, (named) cell wall components / proteins / nucleic acids / lipids *ref. to* processing antigens to present on, cell surface membrane / cell surface ; **A** macrophage becomes an, antigen presenting cell / APC ; antigen, recognition / binding, by, B-lymphocytes / T-lymphocytes ; detail ; e.g. clonal selection / have receptors complementary to antigen / specificity of, B-lymphocytes /T- lymphocytes to (non-self) antigen ; **A** immunoglobulin / antibody as receptor for B-lymphocytes clonal, expansion / proliferation ; **A** described e.g. divides by mitosis to form a clone of cells B-lymphocytes, mature to / form, plasma cells that secrete antibodies ; T-helper cells release cytokines ; Cytokine action ; e.g. stimulates, humoral / B-lymphocyte, response	5
(c)	*any three from:* long-term immunity ; B and T memory cells remain in the body for, a long time / a lifetime ; memory cells for secondary (immune) response ; secondary response is faster / more effective (than primary immune response) ; (so) higher concentration antibodies / quicker production antibodies ; *Idea of* more (specific) memory cells in the body than (specific) lymphocytes before primary response ; increase chance that pathogen encountered more rapidly (to mount a response) ; AVP ; e.g. pathogen destroyed before symptoms of illness are caused	3
(d)	*any three from:* *Mycobacterium* / TB bacterium, is an intracellular parasite / lives inside host cells ; antibodies have no effect on bacteria inside cells ; only when bacteria are in the, plasma / tissue fluid ; *idea that* vaccination is not a global occurrence ; e.g. not part of vaccination programme in many countries only some countries have as part of their vaccination programme BCG is not very effective (for adults) / some people do not respond to BCG ; BCG does not have the same effectiveness across the world ; many countries, have no herd immunity / do have enough people that are immune, to prevent spread ; ref. *to* civil disturbance / AW, collapse of health services ; AVP ; *idea that* travellers / tourists / immigrants / displaced people, may be infected with TB and transmit it to host population (that does not have, a vaccination programme / herd immunity)	3

214. 9700_s20_ms_22 Q: 3

<table>
<tr><td>(a)</td><td>Mycobacterium tuberculosis ; A Mycobacterium bovis</td><td>1</td></tr>
<tr><td>(b)</td><td>any one from
live in an area that has cases of TB ;
recently returned from countries with TB ;
born in a country with TB ;
parents / grandparents whose origin country has TB ;
contact with a person who has TB ;
AVP ; e.g. ref. to compromised immune system
mother who is HIV-positive</td><td>1</td></tr>
<tr><td>(c)</td><td>any three from
decrease in incidence over time for all groups
or
decrease in incidence over time for low, lower middle, upper middle and plateau for high income group ;

one example of, large / AW, differences in incidence ;
e.g. between, upper middle income and, low / lower middle
between high income and, low / lower middle / low and lower middle ;
between upper middle and high ;

decrease in incidence with income group increase (for each year), generally / overall / except for 2015 / 2016 low to lower middle ;

low and lower middle similar incidence ;

data / manipulated data, to support any of above points ;</td><td>3</td></tr>
<tr><td>(d)</td><td>any two from
max 1 if no ref. to antigens
leprosy bacterium has similar (shaped) antigens ;
memory cells, recognise / bind, antigens on leprosy bacterium ;
anti-TB antibodies also bind to leprosy antigens ;
AVP ; e.g. similar / same, genes so synthesise similar proteins</td><td>2</td></tr>
<tr><td>(e)</td><td>any three from
<table><tr><th>artificial active</th><th>natural passive</th></tr><tr><td>deliberate / AW
A from medical staff</td><td>or not deliberate / from mother / in breast milk / across placenta ;</td></tr><tr><td>vaccine / (foreign) antigens in injection</td><td>or antibodies passed on ;</td></tr><tr><td>immune response</td><td>or no immune response ;</td></tr><tr><td>antibodies / memory cells produced</td><td>or no, antibodies / memory cells produced ;</td></tr><tr><td>longer lasting</td><td>or short-lived ;</td></tr><tr><td>protection not immediate</td><td>or immediate protection ;</td></tr></table></td><td>3</td></tr>
</table>

215. 9700_s20_ms_23 Q: 2

(a)	*allow mosquito for Anopheles throughout* *allow pathogen for Plasmodium throughout* *any three from* role of *Anopheles* in transmission cycle ; e.g. *Anopheles* is, a vector of *Plasmodium* / *Anopheles* passes *Plasmodium* from infected person to uninfected person *insecticide on nets and on surfaces* kills *Anopheles* before it can take blood from an infected person ; kills *Anopheles* before it can transfer blood with *Plasmodium* to uninfected person ; *presence of nets* protect people, when sleeping / at time when *Anopheles* is, active / feeding ; *general* prevent *Plasmodium* from completing its life cycle ; AW AVP ; *idea of* reducing population size of mosquitoes use of different insecticides on net and IRS to avoid insecticide resistance	**3**
(b)(i)	*any one from* increase in the use of ITN over time ; decrease in the use of IRS only ; proportion of population protected by ITN only has increased ;	**1**
(b)(ii)	*any one from* increase is not steep enough, to make a large enough difference / so disease will still be able to spread ; a large proportion of the population is still at risk, so people will still contract the disease ; **A** figures from Fig. 2.1 WHO targets may not be met, so hindering progress in the fight against malaria ; AW AVP ; e.g. suggests that the, provision of / distribution of / access to, ITN is not adequate ;	**1**
(b)(iii)	*any one suggestion from* ITN more effective in control than IRS ; more cost effective to provide ITN ; lack of personnel to carry out work required for IRS ; *ref. to* insecticide on net may be more effective at killing ; AVP ; e.g. outside agencies / AW, provide ITN but do not help with IRS	**1**
(c)	*any three from* higher concentration of antibodies ; faster production of antibodies ; because of presence of memory, B-lymphocytes / B cells ; higher numbers of specific B-lymphocytes, so increased chance of faster recognition / because of clonal expansion in first response ; AVP ; e.g. also more memory T-cells to stimulate B-lymphocyte response *ref. to* higher concentration antibodies in circulation remaining after recovery	**3**
(d)	*any two from* result of an autoimmune disease / AW ; antibodies produced against, self-antigens / antigens on body cells *or* antibodies bind to self-antigens / antigens on (own) body cells ; detail ; e.g. prevents functioning of muscle cells binds to receptors on muscle cells	**2**

(a)(i)	*any **three** from:* **I** heterochromatin / euchromatin envelope / two membranes / double membrane / inner and outer membrane ; nuclear pores ; **A** pores in nuclear envelope *for two marks* (outer surface of) outer membrane with ribosomes ; *ref. to* (outer nuclear) membrane continuous with RER ; **R** inner membrane AVP ; e.g. perinuclear space **A** intermembranous space pore complexes	**3**
(a)(ii)	*any **two** from:* resolution / resolving power, is, low / lower / poor / AW / 200 nm / 0.2 μm ; (**A** range 100–300 nm) **A** electron microscope has a higher resolution further detail ; e.g. ribosomes / ER, smaller than 200 nm can only see cell structures greater than (limit of) resolution cannot see structures smaller than 200 nm cell structures too small for the resolution (*needs ref. to resolution)* cell structures, too small to / do not, interfere with light waves ; AW	**2**
(b)	if letter used in more than one row, **R** these rows correct interphase knowledge G2 = **A**, S = **B**, G1= **blank** ; *cytokinesis* **blank** ; *prophase* **C** ; *anaphase* **E** ; *telophase* **D** ;	**5**
(c)	*any **three** from:* *large numbers of B-lymphocytes / plasma cells (in primary immune response)* **1** large quantity of (specific) antibody, produced / released **or** (large quantity of) antibody to form antibody-antigen complexes / to bind antigen (for phagocytosis) / AW ; *large numbers of memory B-lymphocytes so* **2** provide long term immunity / memory cells long-lived / provides immunological memory ; **A** remain in, circulation (for a long time) AW **3** able to produce fast(er), secondary (immune) response ; **A** second response will be fast(er) **A** immune response faster on second encounter (with antigen / pathogen) / AW **4** higher concentration / faster production, of antibodies (than primary response) ; **I** 'more' alone **5** person does not have, symptoms / become ill (of / from, same disease) ; **A** presence of same, pathogen / antigen, does not cause disease **6** AVP ; memory cells can (divide to) produce plasma cells more plasma cells present than primary response able to form more memory cells	**3**

(d)	*any* ***two*** *from:* immune response / antibodies produced, against, self antigens ; **I** immune system attacks self **A** autoimmunity / autoimmune disease *idea that* faulty B-lymphocytes not destroyed ; **A** *ref. to* T-lymphocytes *if in correct context* (specific) antibody, binds to / acts on / AW, self-antigen / receptor, on the (cell surface membranes of) muscle cells / at neuromuscular junction ; **A** antibody binds to acetylcholine receptors *ref. to* consequence to muscle cells ; e.g.(nerve) impulse conduction impaired action of transmitter substance hindered	**2**

217. 9700_m19_ms_22 Q: 3

(a)(i)	***accept*** *ora throughout* *any* ***four*** *from:* *(case) incidence:* 1 only Lao PDR increase in (case) incidence / AW ; 2 Papua New Guinea has greatest reduction ; 3 numerical data extracted from Fig. 3.1 to support ; *mortality (rate):* 4 all countries have a reduction ; 5 Cambodia greatest reduction **A** Cambodia **and** Lao PDR **or** Solomon Islands least reduction ; 6 numerical data extracted from Fig. 3.1 to support ;	**4**
(a)(ii)	*any* ***two*** *from:* nets prevent entry of, mosquito / *Anopheles* ; **A** in context of covering containers with water insecticide, kills / reduces number of, mosquitoes / *Anopheles* ; (female) mosquito / *Anopheles*, is vector / transmits parasite / AW ; feeds / takes blood meal, (mainly) at night / when people sleeping ; (helps to) break the transmission cycle ;	**2**
(b)(i)	*any* ***two*** *from:* 1 testing for the presence of different, antigens / (*Plasmodium*) proteins ; 2 antibodies are, specific / have specific shape ; **A** ref. to complementarity 3 different monoclonal antibodies have, different, variable regions / antigen binding sites ; 4 (pLDH / HRP-2 / *Plasmodium*) protein, binds to / complexes with, (monoclonal) antibody ;	**2**
(b)(ii)	*any* ***two*** *from:* (positive result of test strip 1) pLDH present, (so) the person, has malaria / is infected by *Plasmodium* ; **I** species names (negative result of test strip 2) HRP-2 not present, (so) the cause of malaria is not / the person is not infected by, *P. falciparum* ; (negative result of test strip 2) HRP-2 not present, (so) the person is infected by *Plasmodium* other than *P. falciparum* / AW ;	**2**

218. 9700_s19_ms_21 Q: 1

(a)	*any three from:* *secondary structure* **I** α-helix **1** (many) β-pleated / beta-pleated, sheets ; **R** 'B' **2** random structure / irregular structures / loops / beta turns / AW ; *tertiary structure* **3** folding / coiling, of, (each) polypeptide chain(s) / secondary structure ; **R** *idea of* polypeptide chains interacting (quaternary structure) **4** *ref. to* globular **A** description, e.g. spherical **I** circular / round **or** *ref. to* 3D, shape / structure ; **A** 3D arrangement	**3**
(b)(i)	**X –** site of synthesis of, (light and heavy) polypeptides ; **A** protein(s) **A** transport / modification, of, polypeptides / proteins **A** assembly of polypeptides / translation **R** answers that name the Golgi body **Y –** production of ATP ; **R** 'produce / create / AW, energy' **A** release of energy / provide energy	**2**
(b)(ii)	cell / membrane, fusion / AW ; **I** 'mix' (named) fusogen / hybridogen used ; e.g. polyethylene glycol / electrofusion / electric current **A** PEG for polyethylene glycol (between) plasma cell / (activated) B-lymphocyte / (activated) B-cell / splenocyte, **and**, tumour / cancer / myeloma, cell ; **R** β cells	**3**
(b)(iii)	*any three from:* **1** some mAbs act **directly** on target cells / some mAbs work **indirectly** to kill cells / mAbs do not damage other (non-target) cells ; **2** by binding to, specific / complementary, antigens/cell surface receptors ; **3** (named), drugs / radioactive isotopes, can be attached to mAbs ; **A** 'tagged' **I** labelled **4** enzymes can be attached to mAbs ; **5** so drug can be activated at site of action (linked to mp4) ; **6** bispecific mAbs attach two cells together ; **7** *ref. to* interrupting cell signalling ; **8** use of mAbs for passive immunity ; **A** described *in context of therapeutic antibody for treatment of disease* **9** stimulating / AW, immune system / phagocytes / macrophages / T-lymphocyes, to kill, cancer cells ; **10** name of a cancer or autoimmune disease that is treated with mAbs ;	**3**

219. 9700_w19_ms_21 Q: 2

<table>
<tr><td>(a)(i)</td><td>Mycobacterium tuberculosis
or
Mycobacterium bovis ;</td><td>1</td></tr>
<tr><td>(a)(ii)</td><td><table><tr><td>artificial active immunity</td><td>✓ ;</td></tr><tr><td>artificial passive immunity</td><td></td></tr><tr><td>natural active immunity</td><td></td></tr><tr><td>natural passive immunity</td><td></td></tr></table></td><td>1</td></tr>
<tr><td>(b)(i)</td><td>three from
changes the tertiary structure / shape of active site, of , enzyme / RNA polymerase ;
active site no longer complementary to, RNA nucleotides / substrate ; AW
RNA nucleotides not joined / mRNA not synthesised ; A transcription does not occur
translation prevented ; A described, I polypeptide / protein synthesis prevented
AVP ; ref. to other roles of RNA polymerase not occurring, e.g. does not bind to DNA, double helix does not unwind</td><td>3</td></tr>
<tr><td>b(ii)</td><td>two from
(from 2009 to 2013) overall increase in number of cases (of RR-TB and MDR-TB) ;
use of data to support overall trend ;
ref. to large increase between 2011 and 2012 / 2013
or
very little change between 2010 and 2011 ;</td><td>2</td></tr>
<tr><td>(b)(iii)</td><td>four from
overuse of, antibiotics / rifampicin
or
example of over use ; e.g. taking for viral infection, over prescribing for bacterial infection

people not completing course of antibiotics ;
reservoir of bacteria remains ;
ref. to mutation ;
any detail of the mutation ; e.g. protein produced has a changed binding site

bacteria with resistance, survive / selected for
or
only bacteria sensitive to antibiotic are, killed / selected against ; A antibiotic acts as a selection pressure

bacteria reproduce and pass on, gene / allele, for resistance to offspring
or
vertical (gene) transmission ;

(alleles for resistance to antibiotics transferred by) horizontal (gene) transmission / described ;
frequency of resistance, gene / allele, increases in the bacterial population ;</td><td>4</td></tr>
</table>

220. 9700_w19_ms_21 Q: 4

(a)	**A** neutrophil ; **A** polymorphonuclear, leucocyte / granulocyte **B** lymphocyte ;	**2**
(b)(i)	<table><tr><th>substance</th><th>concentration in lymph compared to the concentration in blood</th></tr><tr><td>oxygen</td><td>lower</td></tr><tr><td>carbon dioxide</td><td>higher</td></tr><tr><td>red blood cells</td><td>lower</td></tr></table> three rows correct = 2 marks one row or two rows correct = 1 mark	**2**
(b)(ii)	*two from* immune response occurs (linked to antibody / cytokine production) ; increased concentration / production of / AW, of antibodies (which are protein) ; AVP ; e.g. cytokine production	**2**
(c)(i)	*two from* emits, impulses / waves of depolarisation / waves of excitation / AW ; at regular intervals / AW ; e.g. acts as a pacemaker spreads across the, atria / atrial muscles / AW **or** stimulates / AW, atrial, contraction / systole ; **A** initiates, heart beat / contraction of the heart	**2**
(c)(ii)	*three from* faster heart rate / increased rate of contraction (of ventricles) ; no, slowing / delay of, impulse / wave of excitation / AW, by AVN ; more impulses reaching the ventricle per unit time ; ventricles may contract before they are full ; irregular heart rate ; AVP ; e.g. may have no effect if only a small proportion of impulses pass through suggestion that ventricles may not contract from apex up	**3**

221. 9700_w19_ms_21 Q: 5

(a)	*two from* *ref.to* non-self / foreign (antigen) ; ***one** from* activation / AW, of lymphocytes ; *ref. to* specificity ; *ref. to* immunological memory ;	**2**
(b)(i)	*three from* (B-) lymphocytes respond / immune response, to self antigens (on muscle cell surface) / antibody produced by, B-lymphocytes / plasma cells ; **A** failure to distinguish between self and non-self antibody binds to receptor ; antibody has complementary shape to receptor ; **A** idea of specificity cell signalling molecule / neurotransmitter / AW, unable to bind to receptor ; reactions / AW, within cells, not triggered / described ;	**3**
(b)(ii)	*three from* active site of enzyme **Y** is, not (fully) complementary / partially complementary ; active site, moulds to fit / becomes fully complementary to, cell signalling molecule ; enzyme-substrate complex forms ; **A** ESC forms *ref. to* interaction between substrate and R groups of enzyme amino acids ; lowers activation energy ; products leave the active site ; enzyme molecule unchanged / able to be re-used ; AVP ; e.g. detail of how activation energy is lowered	**4**
(c)	*three from* **I** *statements about locating or diagnosis of disease* specific / targeted, therapy / treatment ; AW **A** only affects, one cell type in the body / B lymphocytes bind to / recognition of, receptors / antigens / CD20, on cell surface (of diseased cells) ; **A** in context of B lymphocytes or diseased cells monoclonal antibodies, are not recognised as foreign / do not trigger an immune response ; **A** *ref. to* humanisation of antibodies example of presence of monoclonal antibody stimulating the immune system / AW ; *in context of examples given* **A** stimulates phagocytosis / activates B-cells attach, radioactive substance / drug (to treat / kill, B lymphocytes / diseased cells) ; *must be in context*	**3**

222. 9700_w19_ms_22 Q: 5

(a)	**1** prevents formation of, cross links / cross linkages (between, peptidoglycan / murein, chains) ; **A** peptide cross links **A** links between, murein / polymer, chains **I** peptide bonds **I** formation of peptidoglycan **R** if cellulose chains stated **2** (penicillin) inhibits, transpeptidase action / enzyme involved in forming cross links ; **A** alternative correct names for transpeptidase **3** weakens cell wall ; **A** cell wall unable to withstand (turgor) pressure **A** cell wall loses strength **R** idea that penicillin, punches / makes, holes, to weaken **4** (cell), lysis / bursts / ruptures / AW (so bacterium killed) ; **5** acts, on growing bacteria / when bacteria are increasing in size (when cell wall needs to be synthesised) ; **I** growing, wall / peptidoglycan chains	**3**
(b)	*(Plasmodium / P.), ovale / falciparum / malariae / vivax ; correct spelling* **I** *if Plasmodium is written after the species name* *if more than one given, all must be correct*	**1**
(c)	*any one valid suggestion:* male does not, need protein for egg production / produce eggs ; **R** larvae **I** male does not reproduce male does not have mouthparts for piercing skin ; AW e.g. no 'needle' to pierce skin (to suck blood) adult male does not feed ; adult male feeds (only) on, plants / nectar ; blood is toxic to males ; can't detect presence of, humans / mammals ; male does not produce anticoagulant (for blood) ;	**1**

(d)	*accept mosquito or vector for Anopheles* *accept, pathogen / parasite, for Plasmodium* *max 2* **1** *idea that* individuals / people, taking antibiotics for bacterial diseases will pass on antibiotics to *Anopheles* when it feeds ; e.g. blood taken by *Anopheles* contains antibiotics **2** (so) antibiotics kill bacteria (in *Anopheles* gut) ; *must be in context of gut bacteria* **3** decreased / no, competition between, *Plasmodium* and (gut) bacteria (so more *Plasmodium* survives) ; **4** higher survival of *Plasmodium* makes effective (*Anopheles*) immune response more difficult ; AW *(so Anopheles more likely to pass on Plasmodium)* *max 2* **I** ref. to antibiotic resistance **5** use of antibiotics may increase, incidence / number of cases of, malaria ; **6** and **7** *two marks for* examples of what doctors need to consider ; e.g. need to balance antibiotic intake with increased risk of malaria transmission *idea that* do not want to stop people taking antibiotics / antibiotics needed to fight (bacterial) infections treat for malaria before giving antibiotics for (non-serious / non-life threatening) bacterial infections only prescribe antibiotics that have, no / low, impact on bacteria in *Anopheles* (gut) (consider) avoiding use of antibiotics to treat malaria **8** AVP ; e.g. need to research which antibiotics have this effect look for alternatives to antibiotics to treat bacterial infections	**3**

(e)	*any four from:* **1** (*Plasmodium*) is a, eukaryote / protoctist, so has many antigens ; **R** bacterium / virus, is a eukaryote **or** (*Plasmodium*) has many genes coding for (different) antigens ; **I** antigenic variation **2** *idea that* different *Plasmodium* species have different antigens ; **I** antigenic variation **I** strains *for species* **3** (*Plasmodium*) has different stages of life cycle (within human) with different antigens / shows antigenic variation ; **4** antigenic concealment / *Plasmodium* spends part of life cycle within host cells / AW ; **A** short time in blood plasma **A** spends time inside, red blood cells / liver cells **5** need to find the antigens that give the strongest immune response ; **6** need to, develop / use, more than one type of vaccine ; **A** cannot use only one type of vaccine **7** AVP ; e.g. mutations will give changed antigens need to find antigens present in, all / most, stages of life cycle *difficulties in producing a generic vaccine max 2* **8** costly to produce / need to keep costs low / developing countries need to be able to afford vaccine ; **9** needs to have a long shelf life / be stable / be easily stored (e.g. without cold storage) / AW ; **10** (immunity) needs to be long-lasting / aim to avoid boosters / need to develop a single dose vaccine ; AW	**4**

223. 9700_w19_ms_23 Q: 5

(a)	*two from* protein coat / capsid / capsomeres ; nucleic acid / DNA or RNA (core) ; **I** single- or double-stranded **A** 'DNA/RNA' **I** genetic material size given in nanometres / smaller than prokaryotes ; **I** small / very small / microscopic **I** acellular	**2**
(b)	*three from* **1** drugs can be inhibitors (of neuraminidase) ; *either* **2** (competitive inhibitor) so binds to active site *or* (non-competitive inhibitor) so binds to allosteric site / AW *or* (drugs may act by) breaking down / hydrolysing / denaturing, all / part of neuraminidase ; **A** changes active site **3** no / less, enzyme-substrate complexes formed ; **A** ESC **A** substrate not able to bind to enzyme **A** neuraminidase cannot bind to (host cell) receptor **4** receptor is (still) complementary to haemagglutinin ; **5** haemagglutinin becomes attached to, cell receptor / host cell (so newly formed virus does not leave the cells) ;	**3**
(c)	*four from* **1** antigen presentation ; *in correct context* **2** clonal selection / activation, of specific, B-lymphocytes / T-lymphocytes ; **A** B cells / T cells **3** (lymphocytes) divide by mitosis / undergo clonal expansion ; **4** B-lymphocytes, differentiate into / mature into / form / AW, plasma cells ; **5** antibodies secreted by plasma cells ; **6** T-helper cells secrete cytokines ; **7** cytokines stimulate / AW, B-lymphocytes / plasma cells / humoral response ;	**4**
(d)(i)	*max 2 (out of total three marks)* *advantages* *allow references to other pathogen types* **1** antibodies are provided to people immediately / no delay for plasma cells to secrete antibodies ; **A** immediate, immunity / protection **R** immediate (immune) response **2** antibodies, immediately neutralise toxins / prevent viruses entering cells ; **3** prevents disease (in the individual) / promotes quicker recovery ; **4** prevents spread of the pathogen through the population / prevents people dying ; **5** antibodies can be manufactured quickly in response to mutations that occur in virus / AW ; *max 2 (out of total three marks)* *disadvantages* **6** short-term / temporary (immunity) ; **7** no memory cells produced ; **8** can have infections of same pathogen again ; **9** allergic reaction / immune response, to the (non-human) antibodies given ; **10** *ref. to* cost qualified ; e.g. needs to be repeated / high cost of production of antibodies **11** AVP – for advantage (A) or disadvantage (D) ; e.g. (A) passive can be used for people who are malnourished / immunosuppressed e.g. (A) *ref. to* using a vaccine with a (live) pathogen that might give person the disease	**3**
(d)(ii)	across the placenta ; **A** via umbilical cord in breast milk / colostrum / breast feeding / during lactation ;	**2**

224. 9700_s18_ms_22 Q: 6

(a)	*three from:* same / similar, shape as, HMG CoA / substrate ; complementary (shape) to active site (shape) ; binds / attaches / fits into / active site (of, enzyme / HMG CoA reductase) ; HMG CoA / substrate, cannot bind (to active site) ; **A** no / few, enzyme/substrate complexes form mevalonic acid production, decreases / stops ; **I** product not made AVP ; e.g. increase in mevinolin concentration increases inhibition / ora	**3**
(b)	*two from:* *treatment of disease* **I** *statements about locating or diagnosis of disease* specific / targeted, therapy / treatment ; **A** specific to diseased, cells / tissue **A** examples bind to / recognition of, receptors / antigens, on cell surface (of diseased cells) ; kill the cell by stimulating the immune system / AW ; **A** correct immune responses e.g. stimulates phagocytosis / activates B-cells attach, radioactive substance / drug (to treat / kill diseased cells) / AW ; treat infectious diseases / bind to (antigens on) pathogens / recognition of antigens on pathogens ; **A** viruses **I** bacteria *unless stated that they cause disease* *allow examples such as treatment of ebola or rabies or tetanus (by immunising with antibody)*	**2**

225. 9700_s18_ms_23 Q: 3

(a)	*max 2 if only one section attempted* *three from:* *multilayered epidermis* reduces, cuticular transpiration / loss of water vapour through cuticle ; increases distance for diffusion (of water vapour to cuticle) ; ref. to protection from heat from sunlight and reduced evaporation (from spongy mesophyll cells) ; *stomatal crypts* creates area of moist air / AW ; **I** traps water minimises effect of, external air currents / wind ; reduces / less steep, water potential gradient (between intercellular air space and external environment) ; **A** water vapour potential gradient **A** diffusion gradient if referenced to water vapour ref. to only on lower surface / shaded, and reduced evaporation (from spongy mesophyll cells) ; **A** lower temperature reduces rate of diffusion of water vapour (out via stomata)	**3**
(b)	phloem sieve tube element(s) ; **A** phloem sieve tube (cells) **A** sieve elements **I** companion / transfer, cells	**1**
(c)	*allow named assimilates* *source* *in context of assimilates* site of synthesis ; **A** described e.g. photosynthesis in leaf / storage compound breakdown in roots *sink* *in context of, via phloem / from source / from leaf* **I** nutrients / substances, unqualifed *if assimilates / named assimilate, not stated when explaining source* site where assimilates are stored **A** described e.g. roots for storage of starch **or** area where, growth occurs / assimilates are used for growth **A** described e.g. growth in developing buds / growth of immature leaf **or** area that receives, assimilates / AW ; **A** area where sucrose unloaded **I** place that needs assimilates **I** place where assimilates are used, unless qualified	**2**
(d)(i)	change in the, sequence / AW, of, bases / nucleotides (in, the DNA / the gene / *cyFBP*) ;	**1**

(d)(ii)	*one valid suggestion that prevents polypeptide synthesis or prevents synthesis of functional enzyme:* *e.g.* no mRNA produced ; **A** transcription, does not / cannot, occur mRNA produced unable to attach to ribosome ; **A** translation, does not / cannot, occur no start codon on mRNA ; shortened polypeptide chain produced ; **A** ref. to STOP codon premature chain termination mutation / nonsense mutation ; polypeptide produced cannot fold to form, tertiary structure / active site ; **R** changes shape of active site preventing function polypeptide produced cannot form quaternary structure of protein ;	**1**
(e)(i)	*accept cell for lymphocyte throughout* *four from:* 1 (primary) immune response ; 2 cyFBPase / enzyme, is antigen ; 3 formation of, APC / antigen-presenting cell ; **A** antigens presented on surface of macrophages 4 antigen, recognition / binding (in context of B-, or T-lymphocytes) ; 5 detail ; e.g. clonal selection have receptors, complementary / specific, to, antigen / cyFBPase **A** immunoglobulin / antibody, as receptors for B-lymphocytes **A** surface molecules as receptors for T-lymphocytes 6 divide by mitosis / clonal expansion ; 7 (specific) B-lymphocytes form plasma cells ; 8 plasma cells, synthesise / secrete, specific antibody / antibody to cyFBPase ; 9 T-helper / Th, lymphocyte, secretes, cytokine / interleukin ; 10 stimulates, humoral / B-lymphocyte, response ;	**4**
(e)(ii)	no binding of (monoclonal) antibody to, antigen / cyFBPase / enzyme / AW ;	**1**
(f)	*two from:* (less cyFBPase / enzyme, so) less sucrose synthesised ; **A** no enzyme to synthesise sucrose less sucrose transported (source to sink) ; **A** less sucrose unloaded at sink ; ref. to less glucose for synthesis of starch / AW (on context of sucrose hydrolysis) ;	**2**

226. 9700_w18_ms_21 Q: 1

(a)	**A** trachea ; **A** windpipe **I** *ref.* to cartilage rings **B** bronchiole ; **I** respiratory / terminal , before bronchiole **C** alveoli ; **A** alveolus / air sac / alveolar sac	3
(b)	*any one from* lung cancer ; emphysema ; chronic bronchitis ; COPD ; cystic fibrosis ; AVP ; e.g. asthma *must be non-infectious*	1
(c)	*Plasmodium, falciparum / vivax / ovale / malariae* ;	1
(d)	*any three from* *pathogen* (because) four / several, different, causative species / AW, (with different antigens) ; (pathogen has) many antigens as it is eukaryotic / many genes coding for antigens ; *ref.* to mutation changing antigens ; pathogen has different stages of life cycle (within human) with different antigens ; **I** *ref.* to antigenic shift antigenic concealment / pathogen spends part of life cycle within host cells / AW ; **A** short time in blood plasma *vaccine* *ref.* to more than one type of vaccine needed ; suggestion that antigens used have not given the strongest immune response ; *vaccination programme* *ref.* to only trial programmes ; **A** programmes not global *ref.* to not achieving herd immunity / not enough people (successfully) vaccinated ; detail ; e.g. lack of willingness to be vaccinated lack of trained people to give vaccines poor nutrition and poor immune response	3
(e)	*allow* *mosquitoes / vectors, for Anopheles* *pathogen / parasite, for Plasmodium* *any four from (max 1 for list of factors without explanation)* *assume in context of comparison with area* **Q** *ref.* to a suitable climate for *Anopheles,* e.g. tropical / subtropical / hot and humid ; presence of *Anopheles* species which carry *Plasmodium* ; *ref. Anopheles* breeding sites present / (many) water sources (suitable for breeding) ; difficulty in controlling / lack of control, of *Anopheles* breeding sites ; AW, e.g. stagnant water not drained lack of / cannot afford, spraying with, insecticide / pesticide / repellents ; insecticide-resistant forms of *Anopheles* exist ; lack of / insufficient use of, mosquito nets ; mosquito nets not impregnated with insecticide ; lack of, artemisinin drugs / drugs to treat disease ; drug-resistant forms of *Plasmodium* exist ; idea of *Plasmodium* requiring temperatures of approximately 20 °C (in vector) ; **A** area **P** has temperature / conditions for survival of *Plasmodium* *ref.* to difficulties in diagnosing disease (so delay / no treatment) ; e.g. lack of diagnostic tests lack of trained personnel AVP ;; e.g. some countries in area **Q** have *Anopheles* but control is good, *ref.* to feature of *Anopheles* species present in area **P** feed at all times during the day feed only on humans good host for reproduction of *Plasmodium* poor education so people don't know how to protect themselves from malaria	4

227. 9700_w18_ms_21 Q: 4

(a)	correct formula ; (×) 1200 ; **A** 1171 (41 000 ÷ 35) 1229 **or** 1228.6 (43 000 ÷ 35) *max 1 if units given*	**2**
(b)(i)	*any two from* DNA , replication / AW ; **A** S phase **I** chromosome replication (early interphase) chromosome becomes two chromatids ; **A** described DNA checked for errors / errors in DNA repaired ; synthesis of, (growth) protein / enzymes (for growth) ; cell growth ; organelle synthesis ; centrioles replicate ; AVP ; e.g. *ref.* to checkpoint(s) nucleotide synthesis	**2**
(b)(ii)	*any two from* *ref.* target cells are endothelial cells ; VEGF / cell signalling molecule, binds / AW, to receptor ; **R** receptor cells *ref.* specificity (of receptors) / VEGF / cell signalling molecule, complementary to receptors ; suggestion of detail following binding ; e.g. triggers secondary messenger activates enzymes / enzyme cascade signal transduction phosphorylation events	**2**
(c)	*any four from* VEGF protein / antigen, injected into, mouse / small mammal ; time for immune response to occur ; **A** description of event in immune response plasma cells / B-lymphocytes / splenocytes, extracted from mouse ; plasma cells / AW, fused with, myeloma / cancer, cells ; (to produce) hybridoma cells ; clone hydridoma cells ; separate cells and culture in individual wells ; screen for cells secreting desired antibody ; hybridoma cells grown in large scale culture / AW ; AVP ; e.g. *ref.* to fusogen	**4**
(d)	*any one from* monoclonal antibodies identified, as foreign / non-self / act as an antigen ; (monoclonal antibodies) stimulate an, immune / allergic, response ; AVP ; e.g. (antibodies destroyed so) not enough antibody (to be effective)	**1**

228. 9700_w18_ms_22 Q: 4

(a)	*any three from* protein coat / capsid ; **I** protein layer nucleic acid ; DNA or RNA ; **R** in nucleus **I** in cytoplasm **I** *ref. to*, double / single, strand acellular / not made of cells ; **I** absence of named cell structures AVP ; e.g. *ref. to* capsomeres size 15 nm to 1000 nm *accept any in range* (some) are enveloped / have phospholipid bilayer **I** with glycoproteins	**3**
(b)(i)	one value in the range 64% – 68% ; *((940 000 – 980 000) ÷ (1 440 000 – 1 480 000))* □*100*	**1**
(b)(ii)	*allow women for pregnant women and therapy / treatment, for ART* *any three from* **1** (slight) decrease in (total) number of women living with HIV and (overall) increase in number of women living with HIV receiving ART ; **2** slight decrease / plateau / AW, between 2009 to 2010, in number of women living with HIV receiving, ART / therapy ; **3** proportion / percentage cover(age), of women receiving ART increases (in time period) ; **A** calculated values (approx. 13% to 66%) **A** number of women receiving ART increases more steeply than decrease in number of women living with HIV **4** data to support mp1 or 2 ; *mp1 two years and, two values / manipulated data, for either curve* *mp2 two values, 2009 compared to 2010* ***or*** *manipulated data* *allow* □*20 000 for extracted values*	**3**
(b)(iii)	*in context of pregnant and breastfeeding women who are living with HIV* *any three from* **1** *ref. to* mother to child transmission ; *in context of HIV transmission* **A** (because) HIV can be passed from mother to baby **A** decreases HIV transmission during, pregnancy / labour / birth / breastfeeding **A** reduces, number / proportion, of babies born with HIV (so fewer die) **I** stops transmission *(as this is in context of global transmission this implies in all cases)* **I** makes babies immune to HIV / AW or gives passive immunity *allow idea that ART may be passed across, placenta / breastmilk, to baby and so provide(short-term) protection against any HIV transmitted from mother* **2** reduces number of, HIV positive women becoming ill (with HIV/AIDS) /women with HIV/AIDS dying from the disease ; **A** opportunistic infections / named examples e.g. TB **3** example of reduces spread of HIV ; *in any correct context other than HIV mother to child* e.g. child may grow up without HIV and will not pass on mother less likely to pass on to partner **4, 5** examples of, social / economic, effect ;; e.g. (healthy women) can contribute to work force can be main carer if partner has died (*idea that* children not orphaned) overall financial savings e.g. if infants are not born with HIV then no lifelong ART required ART may be less costly than treating HIV/AIDS makes breastfeeding safer when no other options exist to feed babies HIV negative children will become next workforce generation all women throughout world receive same treatment	**3**
(c)(i)	(HIV) antigen / p24 ; **A** capsid protein / capsomere(s) / protein coat **R** HIV	**1**
(c)(ii)	(time needed) so, immune response / clonal expansion / production of B-lymphocytes / production of plasma cells, can occur ; **A** B-cells / splenocytes **R** plasma cells need to multiply **I** *ref. to* antibody production	**1**
(c)(iii)	*any one from* immortal / long-lived ; able to replicate / capable of cell division ; uncontrolled cell division, can grow / survive, in cell culture ; cannot grow on, HAT / hypoxanthine-aminopterin-thymidine / step **4**, (culture) medium ; **A** do not have gene coding for ability to grow on HAT	**1**
(c)(iv)	hybridoma ;	**1**
(c)(v)	*any one from* (check cells for) production / AW, (by hybridoma cells) of, anti-HIVp24 antibody / antibody against p24 ; **A** the antibody / monoclonal antibody **A** check cells, contain / have / AW, desired antibody / AW *idea that* only want cells that produce desired antibody / do not want cells that produce different antibodies / need to remove cells that don't produce the antibody ; waste of, money / resources, to culture other cells / if no antibody produced ;	**1**

229. 9700_w18_ms_23 Q: 6

<table>
<tr><td>(a)(i)</td><td>[A] C E D B F ;</td><td>1</td></tr>
<tr><td>(a)(ii)</td><td>I early and late except where indicated
<table><tr><th>event in the cell cycle</th><th>name of the stage in the cell cycle</th></tr><tr><td>DNA replication</td><td>interphase / S phase ;</td></tr><tr><td>division of centromeres</td><td>anaphase ;
R late anaphase</td></tr><tr><td>condensation of chromatin</td><td>prophase ;</td></tr><tr><td>contraction of spindle fibres</td><td>anaphase ;</td></tr><tr><td>organisation of chromosomes at the equator</td><td>metaphase</td></tr></table></td><td>4</td></tr>
<tr><td>(b)</td><td>I antibodies have receptors
any three from
1 clones / AW, of B/T cells consist of very few cells ;
AW = types of / specific / groups of
2 (mitosis occurs) during clonal expansion ;
3 many, B cells / plasma cells, to make antibodies ;
4 many, T-helper / T_h, cells to secrete, cytokines / lymphokines / interleukins ;
5 many, T-killer cells / T-cytotoxic cells, to kill, infected cells / cancer cells ;
6 memory cells are produced for, secondary response / faster response (when antigen encountered again) ;
A during a secondary infection (implying of the same pathogen)
7 need to make genetically identical cells ;</td><td>3</td></tr>
</table>

230. 9700_m17_ms_22 Q: 2

(a)(i)	*Vibrio cholerae* ;	**1**
(a)(ii)	**A** 1 *cell structure:* ribosome ; **R** RER 2 *difference:* 70S / smaller / 18 nm v 80S / larger / 25–30 nm ; **B** 3 *cell structure:* DNA / chromosome ; **I** RNA 4 *difference:* circular / (closed) loop v linear OR no histone proteins / naked v histone proteins OR not surrounded by nuclear envelope v surrounded by nuclear envelope ; **A** in a nucleus v not in a nucleus **C** 5 *cell structure:* cell wall ; 6 *difference:* murein / peptidoglycan v cellulose ; **I** lignin	**6**
(b)	*two from* 1 caused by, a pathogen / a bacterium / *V. cholerae* ; 2 transmissible / AW OR reference to faecal-oral route ; 3 reference to reduced effectiveness of functions / AW ;	**2**
(c)	primary, secondary, tertiary ; **A** 1°, 2°, 3° quaternary ; **A** 4°	**2**
(d)	*three from:* 1 choleragen, fits into / complementary to, receptor / GM1 ; **A** complementary shape 2 membrane pinches in / invaginates / AW ; **A** engulfs / envelops 3 membrane fusion ; 4 (endocytotic) vesicle / vacuole, formed ; 5 ATP / energy, required ; ***A*** *points from an annotated diagram*	**3**
(e)(i)	*one from:* 1 portion that binds to cell ; 2 (antibodies produced) prevent binding to cell / prevent entry to cell ; 3 safer as not the toxic portion ; 4 A subunit, causes damage to cell / less safe / AW ; 5 AVP e.g. larger so more likely to provoke immune response / AW ;	**1**
(e)(ii)	*five from:* 1 vaccine contains (subunit B / bacterial) antigen(s) ; 2 primary immune response occurs ; 3 correct ref to B-lymphocytes / formation of plasma cells ; **A** B cells 4 secretion of, antibody / immunoglobulin (against cholera antigens) / antitoxins ; 5 T-helper lymphocytes secrete cytokine ; 6 (cytokine) increases humoral response / stimulates T-killer cells / stimulates macrophages ; 7 memory cell production ; 8 secondary (immune) response / response on further infection, is faster ; 9 higher levels of antibodies produced (during further infection) ; 10 active artificial immunity (against cholera) ; 11 AVP e.g. *idea* of specific antibody against each of the different vaccine antigens ;	**5**

231. 9700_s17_ms_21 Q: 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**
(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**
(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**
(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**
(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**

232. 9700_w17_ms_21 Q: 3

(a)(i)	B-lymphocyte / plasma cell ; **A** B-cell / white blood cell / lymphocyte / leucocyte / **R** beta / β, cells **R** T-lymphocyte / macrophage / neutrophil	**1**
(a)(ii)	*three from* **I** ref. to receptor 1 antibody complementary (shape) to antigen ; **I** matching shape 2 *idea that* variable regions different for each antibody ; 3 (specific) antigen / H / N, binding sites (on antibody) ; *if mp 2 and 3 not gained, allow one mark for antigen binding regions* 4 sequence of amino acids / primary structure, varies between antibodies / gives specificity ; 5 *ref. to* difference in, primary structure / amino acid sequence, leading to different, tertiary structure / 3-D shape ; 6 *ref. to* R group interactions between antibody and antigen ;	**3**
(b)(i)	*Vibrio cholerae* ; **I** bacterium	**1**
(b)(ii)	faecal–oral route ;; *if mode of transmission not named, allow description* *infected person* faeces / sewage, contaminates, (drinking) water / cooking utensils / vegetable plots / crops / food **A** diarrhoea *for faeces* **R** (human) waste unqualified **or** *ref. to* houseflies landing on contaminated faces ; *uninfected person* eating contaminated food / using contaminated utensils / drinking contaminated water ; **A** bacteria enters water in context of drinking **R** infected food or water **I** handling contaminated food *need ref. to contaminated once only*	**2**
(c)(i)	cell wall, breaks / damaged / AW **A** cell wall becomes thinner **or** cell wall weakened ; *plus one from* detail of change to cell wall e.g. cross links break down, quantity of murein / peptidoglycan, decreases **or** cell membrane, breaks / AW **or** increase in water in cell (so increase in turgor pressure) / AW ;	**2**
(c)(ii)	*two from* infect only, *V. cholerae* / cholera bacteria AW **or** do not, infect human cells / infect humans ; **A** do not harm human cells do not give side effects / allergic responses, (to humans) ; able to replicate inside *V. cholerae* (to produce more bacteriophage for treatment) ; *ref. to* remaining, active / infective / AW, with delivery method used / within gut ;	**2**
(c)(iii)	*antibiotics* only effective against bacteria / not effective against viruses **or** do not act on structures possessed by, (measles) virus / *Morbillivirus* **A** named structure e.g. protein coat **or** act on structures that viruses do not have **A** named structure e.g. murein cell wall **or** only act on, living / growing, cells **or** may not be able to reach virus inside (host) cell ; AW	**1**

233. 9700_w17_ms_23 Q: 4

(a)(i)	*Plasmodium* , *ovale* / *falciparum* / *malariae* / *vivax* ;	1
(a)(ii)	*Anopheles* / anopheline ;	1
(b)	*either* 1 numbers of cases have decreased in, all countries / Africa ***or*** number of deaths have decreased in, all countries / Africa ; 2 cases in Africa as a percentage of all countries decreases and, remains constant / reaches a plateau / (small) fluctuations / down + up + down ; 3 deaths in Africa as a percentage of all countries, remains constant / fluctuates (a little) ;	3
(c)	*three from* 1 example of control of breeding of, vector / mosquitoes ; e.g. drainage of stagnant water / sterile males / aerial spraying of insecticide / oil on water / fish in water / *ref. to* bacteria 2 example of reduction of contact between vector and humans ; e.g. bed nets (impregnated with insecticide) / insect repellents 3 earlier, identification of cases / treatment of malaria ; 4 use of (new) drugs to, prevent transmission / prevent spread / treat malaria; **A** development of new drugs for malaria 5 better, awareness of / education about, transmission / control methods ; 6 AVP ; e.g. targeting people at risk (e.g. pregnant women / high drug-resistant areas better screening of blood for transfusion **I** *better access to, healthcare / AW, without further qualification*	3
(d)	**A** mosquito for *Anopheles* *four from* 1 no vaccine ; **A** no effective vaccine 2 any problem in developing a vaccine ; e.g. *Plasmodium* is eukaryotic / antigens differ in different life stages / intracellular parasite / antigenic concealment / different stages in life cycle 3 drug resistance in *Plasmodium* ; 4 any example, e.g. chloroquine / artemisinins ; 5 insecticide resistance in *Anopheles* ; 6 any example, e.g. DDT / dieldrin / pyrethroids ; 7 *ref. to* conditions for breeding of *Anopheles* ; 8 problems with, funding research / AW ; 9 cost of, drugs / insecticides, to government / health authorities / individuals ; 10 people with HIV / AIDS are at high(er) risk than others ; 11 lack of knowledge / lack of education / 'fatalism' / AW ; 12 inaccessibility of some regions to healthcare ; 13 infected people not, identified / diagnosed ; 14 AVP ; e.g. migration of people with malaria to places without malaria (such as countries where it has been eliminated)	4

234. 9700_m16_ms_22 Q: 4

(a) *Morbillivirus*
aerosol / droplet, infection ;
A described, e.g. (from infected person) in, exhaled / airborne, droplets, and inhaled

idea of spread by touching an infected surface and putting fingers into mouth / nose ;
R contact *without qualification*

HIV
sexual intercourse / passed via semen / passed via vaginal fluids / AW ;
blood transmission ; **A** described, e.g. blood transfusion
sharing (contaminated), needles / syringes
accept transmitted in body fluids for one mark *if above two points not gained*

mother to, foetus / baby, transmission ;
A described, e.g. across placenta / during birth / breastfeeding

AVP ; e.g. ref. to measles mode of transmission leading to faster spread of disease / ora

[max 4]

(b) antibiotics (only) used against bacteria (and some fungi) ; **I** used in malaria

idea that antibiotics act at a cell structure not possessed by 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 ;

antibiotics act only on, living / growing, cells (viruses do not grow) ;

antibiotics do not act on, protein coat / capsid / capsomeres / viral envelope ;

[max 2]

(c) **(i)** phospholipid bilayer ;
proteins / glycoproteins / named ; **I** cholesterol

[2]

(ii) SLAM acts as a receptor ;
haemagglutinin / H / (viral) glycoprotein, binds to / fits into / complementary to, SLAM / receptor ;

fusion protein / F / (viral) glycoprotein, causes fusion (of envelope) to cell surface membrane ;
A (viral) envelope fuses with cell surface membrane
fusion releases nucleoprotein (and viral polymerase) ;

[max 3]

(iii) *in context of viral RNA*
replication of RNA / to make copies of genes / AW ;

transcription / production of mRNA ;
detail ; e.g. to make viral proteins ;

AVP ; e.g. *credit suggestion of,* RNA-dependent DNA polymerase / reverse transcriptase, to produce viral DNA

[max 2]

(d) (i) protein ; **A** polypeptide **A** glycoprotein [1]

(ii) immunise / inject / AW, mice / small mammals, with p24 / antigen ;
immune response occurs / leave for a number of weeks ; **A** description
harvest / collect / AW, splenocytes / B-lymphocytes / B-cells / plasma cells ;
fuse with, myeloma cells / cancer cells ; **A** tumour
form hybridoma cells ;
select for (hybridoma) cells secreting antibody against, p24 / antigen ;

[max 3]

[Total: 17]

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235. 9700_s16_ms_23 Q: 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]

(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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236. 9700_w16_ms_21 Q: 5

(a) (i) antigen binding site / variable region / V_H and V_L ; **A** F_V [1]

(ii) *four from*

1 *ref. to* monoclonal antibody, is recognised as, non-self / foreign ;
or
diseased cell (now) recognised as non-self / foreign ;

2 stimulates an immune response ;

max three suggestions from

3 recognition and binding by / activation of / AW, T-lymphocytes / B-lymphocytes / AW ; **A** clonal selection
A T- / B-, cell

4 *ref. to* specificity so healthy cells not destroyed ;

5 clonal expansion / mitosis ;

6 plasma cells (formed that) secrete antibody ; **A** B-lymphocyte

7 consequence ; e.g. antibody binds monoclonal antibody to lead to cell destruction

8 T-helper lymphocyte secretes cytokine, to activate macrophages / B-lymphocyte response / T-killer response ; AW
e.g. stimulates humoral response

9 T-killer / T-cytotoxic, releases, perforin to, punch holes in (cell) membrane / cause death of cell ; AW

10 detail of involvement of phagocytes / macrophages ;
e.g. receptor recognition of (monoclonal) antibody
engulf the diseased cells with monoclonal antibody attached / AW
A diseased cell (with monoclonal antibody) destroyed by phagocytosis [4]

(b) *one of*
failure to distinguish self and non-self (antigens) ; **A** foreign *for non-self*
immune response / antibodies produced, against self antigens ;

in context of lack of good health **R** does no harm [1]

[Total: 6]

237. 9700_w16_ms_22 Q: 5

(a) (i) *non-infectious to max 1*
not caused by a pathogen ; **A**
not, communicable / transmissible ; **A** not passed from one living, organism / person, to another AW

disease to max 1
R *if in context of an infectious disease*

abnormal condition (affecting an organism) / condition that reduces the effectiveness of the functions of the organism / lack of good health / AW ; [2]

(ii) *four from*

1 *ref. to* mutation ;

2 further detail ; e.g.
change in sequence of, nucleotides / bases, of, DNA / gene
tumour suppressor gene, switched off / stops functioning / alters / AW
formation of oncogene
proto-oncogene altered

3 uncontrolled, mitosis / cell division / cell replication ; AW

4 *ref. to* changes to checkpoints / coordination of cell cycle lost ;
A cell does not, receive / respond to, signals (to stop dividing)

5 loss of function / lack of differentiation / lack of specialisation / AW ;
allow loss of function idea if referring to the mass of cells

6 other detail of, tumour cell / cellular changes ;
e.g. immortal / no apoptosis / no programmed cell death
no contact inhibition / grows to invade healthy tissue / AW
more protein synthesised (for growth)
(release cell signalling molecules for) vascularisation / blood vessel formation
changed size compared to normal cell size
telomeres do not shorten / AW [4]

(b) (i) **A** = protoctist ; **A** protoctista, protist(a), protozoa(n), sporozoa(n)
B = bacterium ; **A** bacteria

[2]

(ii) aerosol infection / droplet infection ; **A** described **A** airborne droplets
A direct contact ; **A** *description in this context,* e.g. body contact [1]

(iii) smallpox ; [1]

(iv) *Morbillivirus* ; [1]

(c) *three from*

1 vaccination, gives (active) immunity / stimulates an immune response ;
must be in context of active artificial immunity

2 detail ; e.g. primary immune response
clonal, selection / expansion (specific, B / T, lymphocytes)
formation of antibodies
formation of memory cells
artificial active (immunity)

3 secondary (immune) response, when, pathogen / antigen, present
or
presence of antigen / pathogen, gives, faster response / higher antibody production / AW ; **R** disease (for antigen / pathogen)

4 (effects of vaccination / immunity) long-lived / AW ;
A memory cells remain (in circulation) for a long time

5 herd effect ;

6 explained ; e.g. sufficient, (successfully) vaccinated / immune, so, susceptible / non-vaccinated, people protected

7 stops the transmission cycle ;
A less people with disease so reduces spread

8 AVP ; *ref. to* ring vaccination [3]

[Total: 14]

238. 9700_w16_ms_23 Q: 6

(a) *Morbillivirus* ; **A** *Morbilivirus / Morbili virus / morbillivirus* [1]

(b) *three from*
1 number of cases fluctuates (between 2008 to 2012 / in all years) ;
2 number of cases (much) higher in 2010 ;
3 epidemic lasted longer in 2010 ;
4 highest peak is 42 000 – 43 000 in 2010 ; **R** 45 000 **A** 30 000 – 35 000 in Africa
5 numbers are higher at beginning of each year (than at end) ;
6 five, outbreaks / peaks / epidemics / AW ; **A** four as no data before Jan 2008
7 numbers of cases in rest of world are greater than in Africa in every year except 2010 ; **ora** numbers of cases in Africa were less than in the rest of the world in every year except 2010 [3]

(c) **I** *the term primary immune response*
I *any ref. to, T cytotoxic / T killer cells*

four from
1 antigen presentation ;
2 clonal selection / described ;
3 clonal expansion / described ;
4 B-lymphocytes / B cells, develop / AW, into plasma cells ;
5 plasma cells, secrete / produce / AW, antibody ;
6 any correct ref. to T helper cells ; [4]

(d) **I** virus mutates / different strains *(as one vaccine is effective)*

two from
1 measles introduced by people who caught the disease when abroad ;
A any e.g. tourists / visitors / travellers / returning tourists / migrants / displaced people
2 *idea that* herd immunity, needs to be >90% / is not 100% ;
A herd immunity not achieved
3 some people in these countries have not been vaccinated ;
A too young to receive vaccine / refusal of vaccination / live in remote places / war zones / AW ;
4 some people do not respond to the vaccine ; **A** people have weak immune system / malnutrition
5 some people do not receive booster(s) ;
6 (reconstituted) vaccine is not thermostable / difficult to maintain the cold chain ; [2]

[Total: 10]

239. 9700_s15_ms_22 Q: 5

(a)

A *reverse wording for both* *mark vertically/one mark each correct column*			
description of event	**outcome for the individual**	**production of memory cells / yes or no**	**precise type of immunity acquired by individual**
individual **P** is injected with a live, weakened disease-causing organism	individual **P** does not become ill from the disease and has long-lasting protection from the disease	yes	artificial active
individual **Q** is exposed to a disease-causing organism and is immediately injected with a specific antibody	individual **Q** does not become ill from the disease but suffers from the disease a year later	no	artificial passive

[2]

(b) bone marrow ; **A** stem cells / myelocytes **I** white blood cell **[1]**

(c) **(i)** **1** healthy body cells, (recognised as) self / have self-antigens ; **A** non-foreign
2 cancer(ous) / tumour, cells, (recognised as) non-self / have non-self antigens ; **A** foreign
3 idea that changes occur to structure of cell surface membrane of, cancer(ous) / tumour, cells ;
4 phagocytes have receptors for, non-self / foreign, antigens **or** phagocytes have receptors for antibody complexed to non-self / foreign antigens ;
[max 2]

(ii) **1** uncontrolled / AW, mitosis / (mitotic) cell division / cell replication / cell cycle ;
either
2 one example of a change occurring in a healthy cell
e.g. proto-oncogene to oncogene
mutation of / switching of, tumour suppressor gene
uncontrolled growth
increase in growth proteins
shorter interphase (of cell cycle)
(rapid) DNA replication
cells do not respond to signals (from other cells)
or
further detail of tumour formation ;
e.g. cells immortal / no apoptosis / no programmed cell death
no contact inhibition / cells continue to grow when they contact other cells
cell cycle checkpoints not controlled
abnormal / AW, mass of cells formed
undifferentiated / unspecialised, cells / tissue / mass
cells do not function (as tissue of origin) **[2]**

[Total: 7]

240. 9700_s15_ms_23 Q: 3

(a) (endoplasmic reticulum / RER) has ribosomes ;
(ribosomes / RER) site of protein synthesis ;
antibodies are proteins ;
RER for, modification / transport / transport vesicle formation ; [max 2]

(b) 3000 ;; **A** 2933 / 3067 *if units given allow one mark only*
if incorrect allow one mark for correct length measured 44 / 45 / 46 mm and
knowledge of formula is correct (magnification = image length / actual length –
this can also be seen by workings e.g. 45 mm / 15 μm) but incorrect conversion
factor used for final calculation [2]

(c) Variola (virus) ; [1]

(d) memory cells produced (along with plasma cells) ;
to max 2
idea of greater number of (specific immune system) cells ;
(memory cells are) long(er) lived / remain in circulation ;
memory T and B cells ;
ref. to / detail of, faster secondary response (to give immunity) ; [max 3]

(e) *two relevant e.g.*
1 vaccine, thermostable / freeze-dried ; **A** *idea of* longer shelf-life / no wastage
2 virus did not mutate ; **A** pathogen / strain
3 same vaccine could be used everywhere ;
4 cheap to produce (in large quantities) ;
5 ease of production ;
6 used a live virus / vaccine gave a strong immune response ;
7 no need for boosters ;
8 ease of administration ; e.g. ref. to enthusiastic volunteers
needles could be, sterilised / re-used
9 high percentage cover / AW ;
10 ref. to ring vaccination / described ;
11 global effort / AW ; [2]

(f) artificial active / active artificial ; [1]

[Total: 11]

241. 9700_w15_ms_23 Q: 1

(a) **(i)** **A** – nuclear envelope ;
B – rough endoplasmic reticulum ; **R** RER / ER / smooth ER
C – (large sub-unit of) ribosome ; **A** ribosomal RNA, **R** rRNA [3]

(ii) **D** – transfer / t, RNA ; [1]

(iii) *at* **1** – transcription ;
A post-transcription modification / removal of introns
A DNA / gene, copied (to synthesise mRNA)
A genetic information copied
R DNA copied onto mRNA
R DNA code copied onto mRNA

at **2** – amino acid activation ;
A attachment / AW, of (specific) amino acid (to specific tRNA)

at **3** – translation / condensation of amino acids / formation of peptide bond(s) (between amino acids) ;
A codon-anticodon binding
I (poly)peptide synthesis [3]

(b) a protein combined with, a carbohydrate / sugars / AW ;
A protein with sugar
R protein with, glycogen / polysaccharide [1]

(c) *antibody molecule*
has (2) heavy and (2) light chains / two types of polypeptide / different types of polypeptide ;
idea that each different, polypeptide / chain, is coded for by a gene ;
ref. to gene coding for enzyme for carbohydrate attachment (to make the glycoprotein) ;
[max 2]

(d) *points can be taken from an annotated diagram*
1 variable region / Fab region, has antigen binding sites ;
2 *ref. to* specificity for binding antigen / complementary (shape) to the antigen ;
A *idea of* sequence of amino acids (on light and heavy chain) giving specific shapes
3 (IgG has) two (antigen) binding sites (per antibody molecule) ;
4 heavy chains / Fc / constant, region binds to (receptors on), phagocytes / named phagocyte ;
5 hinge region gives flexibility when binding to, antigen / pathogen / AW ;
6 disulfide bridges, give stability / hold chains together / AW ;
award on a diagram if bond and chains are labelled
7 AVP ; e.g. R groups bind to antigen
bind to antigen by, hydrogen bonding / ionic bonding
constant region gives antibody class / AW [max 4]

[Total: 14]

242. 9700_w15_ms_21 Q: 6

(a) (i) grass ; [1]

(ii) rabbit(s) / grasshopper(s) ; [1]

(iii) fox(es) ; [1]

(b) denitrification ;
nitrification ;
nitrogen fixation ; **A** Haber process [3]

[Total: 6]

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243. 9700_s16_ms_22 Q: 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]**

(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 and 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]**

(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]

244. 9700_s15_ms_22 Q: 6

(a) (i) (a) habitat ;
(a) population ;
producers / organisms ; **[3]**

(ii) (a) niche ;
(an) ecosystem ; **[2]**

(b) (i) *energy losses from*

1 reflection (from leaf surface) ;
2 idea that some light, passes through (leaf) / misses chloroplasts / strikes non-photosynthetic tissue ;
A suggestion that cell walls may not allow all of light through
3 heating plant ; **I** lost as heat to surroundings **A** converted to heat
4 evaporation ; **A** transpiration
5 not all light (reaching chlorophyll) is, the right wavelength (for photosynthesis) / AW / absorbed by chlorophyll ;
A idea that only a proportion of light energy is useable
A absorbed and, lost as phosphorescence / lost as luminescence / re-emitted
6 ref. to photosynthetic process inefficient ; **A** loss of heat energy during photosynthesis
7,8 AVP ;; e.g. ref. to photorespiration
ref. to factors that limit photosynthesis **[max 3]**

(ii) **1** increased production of / more, biomass / plant matter / named (e.g. carbohydrate / cellulose / starch / oils) ; **R** more plants **I** more crop **I** food
2 (so) more energy / more energy stores ;
A more chemical energy produced
A higher energy
A suggestion that high PE crop may be more energy dense
3 more crop / greater yield, per unit, area / volume / time ; **A** each year
4 idea of (comparatively) less space required (for growing) ;
5 ref. to supplying increasing demand for, food / fuel ;
6 more, profit (for farmers) / economic / AW ; **I** cheaper
7 AVP ; e.g. efficient use of carbon dioxide **[max 2]**

(iii) *credit all valid answers – this list is not exhaustive*

e.g. compound	**e.g. function of compound**
amino acids	production of proteins (for cell growth); **A** provide energy / for respiration
proteins	cell division / mitosis / increase in cell number / increase in, biomass or yield / (cell) membranes ; **A** reproduction **A** cell cycle **A** (tissue) repair **A** provide energy / for respiration
enzymes	synthesis of, macromolecules or organic molecules / anabolic reactions / for photosynthesis / for respiration ; **[max 2]** **A** named molecules e.g. carbohydrates / amino acids / proteins / lipids / nucleic acids
(organic / nitrogenous) bases	component / synthesis of, nucleotides component of, DNA / RNA / nucleic acids ;
nucleotides	component / synthesis of, DNA / RNA ;
DNA	ref. genes / genetic material / coded information / genetic information, (for protein synthesis) ;
RNA	ref. transcription / translation / protein synthesis ;
(some) phospholipids	(for cell) membranes ; **R** lipids
ATP	synthesis / anabolic reactions / active transport / translocation / described ; **A** provide energy for reactions
chlorophyll	photosynthesis / light (dependent) stage ;
NADP	(in) photosynthesis / light (dependent) stage ;
NAD	(involved in) respiration ;
FAD	(involved in) respiration ;
auxin	growth hormone / cell elongation / cell division ;
cytokinin	growth hormone / root growth ;

[Total: 12]

245. 9700_s15_ms_23 Q: 6

(a) (i) nitrification ; [1]

(ii) by bacteria ;
denitrification / reduction;
ref. anaerobic conditions ; **A** ref. to waterlogging [max 2]

(b) (i) *idea of* (unit made up of) biotic and abiotic, components ; AW
further detail ; interacting / functioning together ;
A *idea of* self-sustaining unit [2]

(ii) carries out photosynthesis / converts light (energy) to chemical energy ;
A (photo)autotrophic
synthesises (complex) organic compounds from inorganic, compounds;
(occupies) lowest / first trophic level ; **A** acts as a producer [max 1]

(iii) place where an organism lives ; **A** population / species / community [1]

[Total: 7]