CAMBRIDGE
International Education

Cambridge International AS & A Level

BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **May/June 2025**

MARK SCHEME

Maximum Mark: 60

Published

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

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Generic Marking Principles

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- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

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- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
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Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

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Annotations

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	working towards marking point
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O	or reverse argument
PAG	point already given
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SEEN	point has been noted, but no credit has been given or blank page seen

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;	separates marking points
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R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
AW	alternative wording (where responses vary more than usual)
Underline	actual word given must be used by candidate (grammatical variants accepted)
Max	indicates the maximum number of marks that can be given
Ora	or reverse argument
Mp	marking point (with relevant number)
Ecf	error carried forward
I	ignore

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Question	Answer	Marks
1(a)	*macromolecule* (both are) large / AW, molecules / size / (molecular) mass **;** **A** composed of, many / AW, atoms **I** composed of more than one molecule *polymer* composed of, many / three or more / more than two / repeated / repeating, subunits / units / monomers / residues / alpha glucose **;** **A** many of the same / similar / chain of … *for repeated* **I** molecules	**2**
1(b)(i)	**1** α- / alpha-, glucose molecule on left with –OH on C1 facing downwards **;** **2** α- / alpha-, glucose molecule on right with –OH on C4 facing downwards **;** **ecf** if a single same mistake is made in both, e.g. no –H on C5 **3** involvement of water **;** must be above or alongside arrow **R** if below	**3**
1(b)(ii)	glycosidic **;** **A** glucosidic **I** incorrect detail of the bond, e.g. β- / beta- / α- / alpha-,1, 6	**1**
1(b)(iii)	hydrolysis **;**	**1**

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Question	Answer	Marks
2(a)	*any **two** from:* *cilia* (composed of) microtubules / not composed of microfilaments / not composed of actin (fibres) **;** **R** if microvilli have microtubules 9+2, arrangement / pattern / structure (in horizontal section) **;** AVP **;** e.g. *ref. to* component proteins – e.g. tubulin / dynein (cilia) extend from / attach to, a basal body / basal body at base **R** centrioles	**2**
2(b)	number of microvilli (over the surface of the cell) **;** **I** amount / quantity	**1**
2(c)	mitochondrion **;** synthesises / makes / produces / provides, ATP for, active transport / active uptake / endocytosis / exocytosis **;** **I** absorption **A** provides energy *if no ATP* **A** any other suitable function of an epithelial cell in the small intestine e.g. synthesis of, enzymes / carrier proteins / mucus **or** movement of organelles within cell	**2**
2(d)	*no ora for this question* *organisation for one mark* linear, chromosome / DNA **A** straight **or** DNA associated with, histones / histone proteins / basic proteins **;** **A** *ref. to* chromatin *distribution for one mark* DNA, contained in nucleus / surrounded by nuclear envelope / surrounded by nuclear membranes **;** **A** *ref. to* DNA in nucleolus	**2**

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Question	Answer	Marks
3(a)(i)	**1** change in, absorbance / rate of reaction, <u>and</u> (then), reaches a time when there is no further change / reaches a plateau / reaction stops / absorbance becomes constant **;** **A** *for change* absorbance increases, in Fig. 3.2 / for dopa oxidase, and decreases, in Fig. 3.3 / for neutrase **A** decrease in rate of reaction **R** if rate of reaction increases **2** due to change in (intensity / shade, of) colour (of reaction mixture) **;** **3** due to, collisions between substrate and enzyme / enzyme-substrate complexes form(ing) / product being made **;** **4** *idea that, no / little, change in absorbance* because, all / most, of the substrate is used up / AW **;** **A** substrate is limiting factor **I** reactants are used up	**3**
3(a)(ii)	*any **two** from:* **1** can take, quantitative / numerical, readings / results **;** **2** *idea that* can use values from the colorimeter to plot graph(s) **;** **3** can take readings continuously/do not have to take samples **;** **I** continuous data **4** results are not subjective/no judgements made by eye/no bias in the results/AW **;** **A** results are objective/more accurate **I** precise **5** can determine / AW, <u>rates</u> of reactions **;** **6** AVP **;** e.g. *ref. to* use of, standards / calibration curve, to obtain actual concentrations e.g. can detect, small differences in, colour / cloudiness / AW	**2**
3(b)(i)	V_{max} = 80 (μmol mg^{-1} min^{-1}) <u>and</u> half V_{max} = 40 (μmol mg^{-1} min^{-1}) **;** **A** 80 and 40 / horizontal lines shown at 80 and 40 on Fig. 3.4 K_m = 0.014 mmol dm^{-3} / 14 μmol dm^{-3} **;** *unit must be given on answer line or in working* **A** in range 0.012 to 0.016 mmol dm^{-3}	**2**
3(b)(ii)	*any **two** from:* lower concentration of substrate to reach (½) V_{max} / AW **;** **A** faster rate at, the same concentration / lower concentration VpSP37 has a higher <u>affinity</u> for its substrate (than the other enzymes) **; ora** explained **;** e.g. better fit between substrate and active site / AW **;** **I** ESCs formed more efficiently / any *ref. to* cost, etc.	**2**

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Question	Answer	Marks
4(a)(i)	RNA polymerase **;**	**1**
4(a)(ii)	*any **two** from:* *accept for either cap or poly(A) tail or both* **1** protects mRNA from being, broken down / degraded / damaged, by enzymes **;** **A** protects mRNA from enzyme action **2** prevents mRNA molecules joining together **;** **A** prevents ends of a mRNA molecule joining **3** helps to, direct / move, mRNA, through nuclear pores / to ribosome(s) / to leave nucleus / to cytoplasm **;** **4** required to start, translation / assembly of amino acids at ribosome **;** **A** helps / allows / AW, (mRNA) attachment to ribosome(s) **R** refs to start and stop codons **5**, **6** AVP **;;** e.g. makes sure 5' end enters ribosome first / AW	**2**
4(a)(iii)	*any **three** from:* **1** gene / RNA, splicing **;** **A** primary transcript splicing **R** DNA splicing / mRNA splicing / genetic splicing **2** introns removed **;** **3** exons, attached together / joined up **;** **R** extrons **4** shortens / AW, the RNA molecule **;** **5** removal of non-coding sequences / only keeping the coding sequences **;** **A** non-coding regions / AW **A** non-coding introns **R** non-coding / coding, genes **6** AVP **;** e.g. rearranging exons / alternative splicing **I** annealing *ref. to* phosphodiester bonds forming between RNA nucleotides / AW *ref to* spliceosome	**3**
4(b)(i)	(at the) ends / AW **;** **A** at the ends of, DNA / chromatids **I** sides / edges	**1**

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Question	Answer	Marks
4(b)(ii)	*any **three** from:* **1** allows DNA replication to, occur many times **;** **2** allows (some) cells to carry out, many / continuous / repeated, mitoses / cell cycles / cell divisions **;** **I** cell replication **3** prevents the loss of, genes / genetic information **;** **A** prevents loss of coding sequences **I** loss of DNA **I** prevents loss of genetic material **4** AVP **;** e.g. prevents fusion of chromosome ends prevents ends of chromosomes being recognised as damaged	**3**
4(c)	*any **four** from:* **1** mutation in a gene **;** **2** *leads to* uncontrolled / unregulated, mitosis / cell division **;** **3** proto-oncogene to oncogene **;** **A** *ref. to* oncogene in correct context (without the proto-) **4** *ref. to* tumour suppressor gene(s) **;** **A** in context of 'switched off' **5** *idea that* normal (named) checkpoints do not function **;** **A** not checked during (named) stage of cell cycle **A** bypass checkpoints / checkpoints not used **6** mass of, abnormal / non-functional / damaged, cells formed **;** **A** irregular / abnormal, mass of cells **I** undifferentiated **7** AVP **;** e.g. supplied with blood vessels cells do not carry out, apoptosis / programmed cell death cancer cells ignore stop signals from other cells / have no contact inhibition	**4**

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Question	Answer	Marks
4(d)	*any **five** from:* *melanoma cell releases cytokines* **1** cytokines stimulate, clonal expansion / division (by mitosis), of, T-lymphocytes / B-lymphocytes **;** **A** T-cells / B-cells **A** T-helper cells / T-killer cells **2** cytokines stimulate (action of), macrophages / phagocytes **;** **A** form angry macrophages **3** cytokines act as cell-signalling molecules **;** *melanoma cell releases antigens* **4** antigens stimulate, clonal selection of (specific) B-lymphocytes / T-lymphocytes **;** **A** B- / T-, lymphocytes (with receptors / immunoglobulins / antibody) that are complementary to antigen **A** T-cells / B-cells **A** T-helper cells / T-killer cells **5** antigens, stimulate / AW, B-lymphocytes to divide (by mitosis) to form plasma cells **;** **A** clonal expansion of B-lymphocytes to form plasma cells **A** if cytokines stated instead of antigens **6** plasma cells, secrete / release / produce, antibodies **;** **7** antibodies mark cancer cells for destruction by, T-killer cells / macrophages / phagocytosis **;** **8** killer cells, release / AW, perforin / granzymes / toxins / hydrogen peroxide / hydrolytic enzymes, to kill / destroy, (cancer) cells **;** **A** description of how cell is killed e.g. breaks open / makes holes, in cell surface membrane **9** AVP **;** e.g. proteins released from melanoma cell act as <u>non-self antigens</u>	**5**

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Question	Answer	Marks
5(a)	*any **two** from:* **1** most water (in xylem) goes to the leaves taking (dissolved) phosphate ions with it **;** **2** xylem tissue does not extend into, growing points / shoot tips / root tips **;** **3** higher demand for phosphate ions in leaves (for photosynthesis) **;** **4** water and phosphate ions are transported upwards in the xylem (not down to root tips) **;** **5** phosphate ions are absorbed in area above root tips (so don't go down) **;** **A** transport to root tips involves movement in phloem **6**, **7** AVP **;;** e.g. correct ref to blockage by, endodermis / Casparian strip / suberin (apoplast pathway) not all phosphate ions cross cell (surface) membrane of endodermal cells (symplast pathway) phosphates may be stored in (vacuoles of cells in), roots / stems phosphate ions are used in the root for making, ATP / nucleotides / AW	**2**
5(b)	*any **four** from:* **1** phosphate ions transported in the phloem move, out of the leaf / into stem **;** **2** (group B data suggests that) phloem transports (some of) phosphate ions downwards **;** **3** phosphate ions can move from phloem to xylem **;** **4** waxed paper prevents movement (between phloem and xylem) **; ora** **5** data in support of difference between waxed and unwaxed in the same sample area **;** e.g. in S1 1% in xylem in A as opposed to 5% in xylem in B / <u>percentage</u> in xylem always higher in group B **6** some phosphate ions may transfer to surrounding cells in the stem **;** **7** much of the phosphate may not have left the leaf / much of the phosphate has been transported away from the leaf in the hour **;** **8** AVP **;** e.g. some may travel upwards in the phloem but no data not clear that results show phosphate ions transported upwards in xylem *ref. to* anomalous results / results not conclusive not all phosphate ions injected are accounted for	**4**

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Question	Answer	Marks
6(a)(i)	haem (group) **;** **I** Fe^2 **I** prosthetic group	**1**
6(a)(ii)	(iron in haem group) combines / binds, with (one) oxygen (molecule) **;** **A** carries / transports / attaches, oxygen **A** 'bonds with' if stated as iron ion / Fe^{2+} / ferrous ion **R** oxygen atom / 2 or more oxygens **R** carbon dioxide binds	**1**
6(a)(iii)	more than one <u>polypeptide</u> (chain) **;** **A** 2 or more **R** more than 2 / many / multiple **A** haemoglobin has four <u>polypeptides</u> **I** amino acid chain	**1**
6(b)(i)	accept values within the range 10–14 <u>kPa</u> **;** **A** as a range or as a single figure	**1**
6(b)(ii)	accept any <u>range</u> between 1–6 <u>kPa</u> **;** **A** within range 0–6 kPa **R** a single figure *ref. to* (steep) decrease in percentage saturation of haemoglobin as pO_2 decreases **;** **R** increasing saturation **A (**oxy)haemoglobin, dissociates / releases its oxygen **A** haemoglobin has a low affinity for oxygen	**2**

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6(b)(iii)	*units – kPa and % – must each be used once* **1** (dissociation) curve shifts to the right **;** **I** curve shifts downwards / graph if given for curve **2** (percentage) saturation (of haemoglobin) decreases (as pCO_2 increases) **;** **A** decrease affinity of Hb for O_2 **3** comparative data quote giving percentage saturation at the same pO_2 and at two different values of pCO_2 **;** **A** percentage of oxygen released **4** *any ref. to* difference between position of curves, e.g. large difference in percentage saturation in middle of the range / little difference at high pO_2 **;**	**3**
6(b)(iv)	Bohr, shift / effect **;**	**1**
6(b)(v)	*any **two** from:* supplies more oxygen (to respiring tissues) **;** **A** more oxygen is released / AW **I** quicker / faster **I** haemoglobin releases oxygen more readily *idea that* allows oxygen to be supplied to, (named) tissues / cells, to meet demand / as demand increases **;** (maintains) aerobic respiration **;**	**2**

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1(a)	**X** = (large / permanent) vacuole **;** **Y** = tonoplast **; A** vacuolar membrane **Z** = nucleus **;**	**3**
1(b)	*if correct named cells are given, allow as a tissue if plural, otherwise ignore e.g.* ***I** cortex cell* ***A** cortex cells* **I** root hair cell *at start* and, xylem / vascular bundle / stele, *at end* **I** cell structures epidermal (tissue) / epidermis cortical (tissue) / cortex **A** parenchyma endodermal (tissue) / endodermis pericycle any three in correct sequence **;;** *if incorrect tissue(s) included with a correct full sequence of three, max 1 mark* *only two tissues stated but are in correct sequence allow one mark* *three tissues stated but not in correct sequence, and no incorrect tissues, allow one mark*	**2**
1(c)	*any **three** from*: cellulose, (molecules / fibres), hydrophilic / allow adhesion of water (molecules) **;** *idea that* arrangement of cellulose (fibres) gives spaces (for water flow) **;** AW e.g. many gaps freely permeable / not impermeable, (to water) **;** **A** *idea of* few obstacles to, water, movement / flow e.g. (cell walls) not selective / allow continuous movement of water / allow water to move at a high rate / allow all water to pass through / (offer) path of least resistance *ref. to* hydrogen bonding **;** *in correct context* e.g. cellulose molecules form hydrogen bonds with water molecules **I** hydrogen bonds between cellulose molecules hemicellulose / pectin, hydrophilic **;**	**3**

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Question	Answer	Marks
1(d)(i)	rough ER site of, protein / enzyme, synthesis and smooth ER site of, lipid / sorgoleone, synthesis **;** **A** protein modification **A** lipid storage (barley plant), higher proportion of rough ER / lower proportion of smooth ER **or** (sorghum plant), higher proportion of smooth ER / lower proportion of rough ER **;**	**2**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(d)(ii)</td><td>
student X to max 3
(mechanism could be) exocytosis ;
R diffusion / facilitated diffusion see ecf below

plus max two details from:
for, bulk transport / larger quantities ;
idea that may be too large to exit cell (by other mechanisms) ; A are large molecules
presence of, (small) Golgi bodies ; A presence of Golgi body
ref. to vesicles as, Golgi / secretory, vesicles ; A description e.g. packaging into vesicles
vesicles, move to / fuse with, cell (surface) membrane ;

ecf if, diffusion / facilitated diffusion, stated as the mechanism:
move down a. concentration / diffusion, gradient ;
A move from high to low concentration

student Y to max 3 check one of three different options (A enzymes for acid phosphatases and vice versa)
option 1
enzymes, facilitated diffusion <u>and</u> sorgoleone, (simple / passive) diffusion ;

plus two marks for all information in table correct ;;
<table>
<tr><td>enzymes</td><td>sorgoleone</td></tr>
<tr><td>hydrophilic / are not hydrophobic / polar / AW</td><td>hydrophobic / not hydrophilic / non-polar / AW</td></tr>
<tr><td>pass through, transport / membrane / carrier, proteins AW
A channel protein</td><td>cross hydrophobic core / between fatty acid tails / phospholipid bilayer AW</td></tr>
</table>
if two marks not gained, one mark for a correct row or correct column
</td><td>4</td></tr>
</table>

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Question	Answer	Marks
1(d)(ii)	***option 2*** sorgoleone exocytosis and enzyme facilitated diffusion **;** *plus* one additional point about exocytosis **;** detail from enzyme column (shaded dark grey) **;** ***option 3*** enzymes exocytosis and sorgoleone diffusion **;** *plus* one additional point about exocytosis **;** sorgoleone column (shaded light grey) **;**	

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>any two from:
amino acids with hydrophilic R groups to, exterior / outside, (of molecule)
A facing, watery / aqueous, environment / cytosol / cytoplasm
or
amino acids with hydrophobic R groups to, interior / centre / AW, (of molecule) ;
A hydrophilic / hydrophobic, amino acids
must see amino acids somewhere in text to allow hydrophobic / hydrophilic ideas soluble (in water / cytoplasm / cytosol) ;
A forms colloidal suspension physiological / metabolic / dynamic, (role) ;
I functional unless qualified e.g. functional, for example haemoglobin carries oxygen has a functional role / functional, not structural
AVP ; e.g. non-repetitive / irregular, sequence(s) of amino acids

ref. to two or more bond types holding (3D) shape / tertiary structure / quaternary structure in place, but
R if peptide bonds listed</td><td>2</td></tr>
<tr><td>2(b)</td><td>
<table>
<tr><td>chloride ion / Cl^-;
I glucose</td></tr>
<tr><td>carbaminohaemoglobin ;</td></tr>
<tr><td>hydrogencarbonate (ion) ;
A HCO_3^-</td></tr>
<tr><td>oxyhaemoglobin ;</td></tr>
<tr><td>hydrogen ion(s) ;
A H^+ / proton</td></tr>
</table>
</td><td>5</td></tr>
</table>

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Question	Answer	Marks
3(a)	positions of H and OH for C1 and C4 are other way round / AW **;** can award from a diagram **A** H should be up on C1 and C4 **A** OH should be down on CI and C4	**1**
3(b)	*conclusion 1 there are non-reducing and reducing sugars in the carrots* (all have) fructose/galactose/glucose, which, is / are, reducing (sugar(s)) **and** sucrose, which is non-reducing (sugar) **;** **A** sucrose is non-reducing and all the others are reducing (sugars) **A** fructose / galactose / glucose, reacts with Benedict's solution **and** sucrose does not **R** if another sugar in addition to sucrose is stated as non-reducing *conclusion 2 there are monosaccharide and disaccharide sugars in the carrots* (all have) fructose / galactose / glucose, which, is / are, monosaccharide(s) and sucrose, which is a disaccharide **;** **R** if another sugar in addition to sucrose is stated as disaccharide *conclusion 3 the carrots have the same patterns of results* (yes) all have order of content as (highest) fructose, glucose, sucrose and galactose **;** **A** all have fructose as highest content and galactose as lowest content **I** data quotes	**3**
3(c)	starch / amylose / amylopectin / cellulose / hemicellulose / pectin / inulin **;**	**1**

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Question	Answer	Marks
3(d)	*allow other AW for assimilates e.g. sugars / sucrose / other named sugars / amino acids / organic compounds* *allow named locations for growing areas e.g. developing shoots / developing leaves / buds / seeds* *ignore 'nutrients' as AW for assimilates but allow ecf* acts as source (only), after dormant period/in second year of growth and is a sink in the first year of growth **;** **I** during dormant period one detail of source **;** e.g. *idea that* assimilates are mobilised for transfer e.g. starch to sugars for transport assimilates, loaded / AW, into phloem (tissue) source is starting area of, translocation / transport of assimilates source, provides assimilates for growing areas one detail of sink **;** e.g. of, growth / development storage e.g. energy store / assimilates converted for storage / storage of substances receives assimilates transported, in phloem sap / in phloem tissue / photosynthates receives assimilates from, source / leaves / sites of synthesis / photosynthetic tissue	**3**
3(e)	*any **two** from:* has RNA (as genetic material), not DNA / so does not need transcribing / so transcription does not occur **;** (viral) RNA, acts as mRNA / is sequence of mRNA codons **;** AW (viral) RNA can be used (directly) for translation **;** **A** description of translation e.g. to form, amino acid chain / polypeptide **I** for synthesis of proteins attach to ribosomes and make, polypeptide / protein *ref. to single– / double–, stranded is neutral*	**2**

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Question	Answer	Marks
4(a)	*Mycobacterium tuberculosis* **;** *must be spelled correctly*	**1**
4(b)	1 (infected), person, coughs / breathes (out) / talks / sneezes / AW, and (uninfected) person, inhales / inspires / breathes in **;** 2 aerosol infection / aerosol transmission / droplet infection / droplet transmission *must be a term* **or** organism / pathogen / bacteria / *M. tuberculosis*, in, airborne droplets / droplets in air **;** **A** contaminated airborne droplets / contaminated droplets in air **A** *ref. to* airborne droplets from an infected person transmits the pathogen **I** infected droplets / infected airborne droplets / droplets of air / air droplets *max 1 if another mode of transmission also given as a choice* *max 1 if correct description of Mycobacterium bovis given e.g. drinking contaminated (unpasteurised) milk* ***or*** *eating contaminated meat (from cattle)*	**2**
4(c)	antibiotic **;** **I** examples **I** antibacterial	**1**
4(d)	label line and label to: bronchus **;** bronchiole **;** blood vessel **;** **R** if blood vessel is stated as a capillary	**3**

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Question	Answer	Marks
4(e)	*any **five** from:* *gas exchange and overall health to max 4* 1 fewer, bronchioles / alveoli / alveolar capillaries **or** granuloma / described, causes, damage / lesions / airway lumen to decrease / AW **;** **A** takes up lung space **I** blocks airways 2 consequence **;** e.g. less air enters alveoli / reduced surface area (for gas exchange) *context is fewer alveoli (fewer capillaries)* fewer red blood cells / less haemoglobin, to take up oxygen *(granuloma)* causes (partial) air blockage / prevents alveolar function / AW suggestion that cells in the granuloma take up oxygen 3 many immune system cells / dead cells / debris / AW, hinders gas exchange **;** *this is not the same as mp8* 4 less oxygen, reaches tissues / to the (rest of) body (in circulation) **;** 5 consequence **;** e.g. tiredness / fatigue / less mobile increases blood pressure / strain on heart rapid breathing / causes breathlessness **A** difficulty breathing **I** affects breathing *prevent development TB elsewhere in body to max 4* 6 infected (lung) cells / pathogen, prevented from entering, circulation / bloodstream **;** 7 granuloma acts to, confine / localise / isolate, pathogen **;** **A** description of cells within granuloma acting as the barrier 8 many / surrounded by / AW, cells of the immune system / named **;** **I** white blood cells e.g. lymphocytes / plasma cells / phagocytes / macrophages / neutrophils / multinucleated giant cells *note: many macrophages in a giant cell is not mp7* 9 other detail of immune response stimulated **;** e.g. antigen presentation antibody formation (against *M. tuberculosis*) phagocytosis of, infected cells / pathogen cytokine release 10 AVP **;** e.g multinucleated giant cells, more effective as a large cell / increase chance of detecting pathogen result of immune response prevents, population increase / bacteria reproducing / AW another detail of immune response	**5**

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Question	Answer	Marks
5(a)	antigen(s) **;** **I** self– / non-self	**1**
5(b)	*any **three** from: using bone marrow stem cells* 1 (origin from bone marrow so) haematopoietic/results (only) in production of blood cell types **;** **I** multipotent **A** specialise / differentiate, into red blood cells 2 able to produce genetically identical cells **;** 3 (retain ability to) divide (continuously) / carry out mitosis / go through cell cycles **;** **I** reproduce / replicate 4 (so) large numbers (of red blood cells) can be produced **;** **A** can, produce stem cells / self-renew **R** can differentiate into stem cells 5 can avoid passing on diseases / AW **;** *from the blood sample* 6 less invasive than extraction from bone marrow **;** AW **ora** 7 immobilisation method used to collect the stem cells is, only possible if in blood / easy / easier (than extraction from bone marrow) **; ora** 8 AVP **;** e.g. can replace blood taken as a sample by a transfusion easily genetically modified can be modified to avoid rejection	**3**

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Question	Answer	Marks
5(c)	*any **three** from:* 1 no toxic effects (in recipient) **;** 2 should not stimulate an, allergic/immune, response (in the recipient) **;** **A** not rejected 3 does not carry any pathogens / AW **;** **A** no risk of infection / named example **A** screening (of blood product) not required *allow* safe to use *if mp1, 2 or 3 not gained* 4 long shelf life / long-lasting **;** **A** easy to store 5 can transport oxygen **;** **A** idea of improved ability to carry / transport / deliver, oxygen 6 soluble, in blood **or** idea of able to circulate easily in blood **;** 7 used for all blood types / specific to particular blood types **;** 8,9 AVP **;;** e.g. can carry out other functions of blood fast production / large quantities / mass production acceptable to be used by people because of, ethical / cultural / religious, reasons AW	**3**

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Question	Answer	Marks
6(a)	curve drawn to the right of original, same shape and lower maximum rate of reaction, passing through plot of 0.055 to 0.06 mmol dm^{-3} on x-axis **;** *must start branching away before third plot point at 2au* **R** S-shaped / sigmoid curve K_m = 0.055 to 0.06 mmol dm^{-3} **;** *allow ecf if no curve drawn and printed curve used* *incorrect K_m but standard curve for non-competitive inhibition drawn, allow 2 marks if their K_m is correct* *if competitive curve drawn and K_m is correct from their curve allow* ecf *1 mark*	**2**
6(b)	*start codon* triplet of / three, (RNA / DNA) bases / nucleotides (begins translation), qualified e.g. coding for, methionine / first amino acid first codon attaching to ribosome **or** (codon to begin translation is) AUG (for RNA) **or** TAC (for DNA transcribed strand) **or** ATG (for DNA non-transcribed strand) **;** *stop codon* triplet of / three, (RNA / DNA) bases / nucleotides, (ending translation), qualified **;** *codon meaning only needed once* e.g. does not code for amino acid stops, chain elongation / addition of amino acids allows / AW, polypeptide to detach (from ribosome) recognised by releasing factors **or** (codon to end translation) UAG UAA / UGA (for RNA) **or** ATC / ATT / ACT (for DNA transcribed strand) **or** TAG / TAA / TGA for DNA non-transcribed strand) *if more than one codon given, all must be correct*	**2**

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Question	Answer	Marks
6(c)(i)	(each) detection antibody attached to a (different) toxin **;** *allow one antibody attached to two toxins (astride)* **A** at least one detection antibody attached **R** if one detection antibody attached directly to immobilised antibody **R** if unattached detection antibody shown	**1**
6(c)(ii)	*any **one** from:* bind, to different, locations / sites / AW, on toxin **;** AW **A** bind different, epitopes / antigenic determinants detection antibody has, HRP / enzyme (attached) **; ora** *ignore similarity of both bind toxin to award if stated detection antibody has enzyme* capture antibody is immobilised **; ora**	1

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Question	Answer	Marks
6(c)(iii)	*allow enzyme for HRP* *allow 'lighter' for 'paler'* *assume ref. to colour is blue-green* *any **four** from;* 1 colorimeter measures, absorption of light (by reaction mixture) **;** **A** transmission of light (through reaction mixture) 2 low(er) intensity of / pale(r), colour gives low(er), (colorimeter) reading / measurement / absorbance **;** **ora** for transmission **A** ***or*** *idea that* different intensities of colour, gives different absorbances *allow example* 3 low(er), intensity of colour / absorbances, indicates low concentration **;** **A** *idea that* different, intensities of colour / absorbances, indicate different concentrations *allow example* 4 will get different absorbance readings for low toxin positive result compared with negative result **;** AW **A** would get same reading as blank if negative result (positive does not give same reading as blank) **A** not relying on by-eye judgement (between colourless and very pale blue-green) **A** colorimeter not subjective **A** by-eye judgment may not detect a slight colour change (colourless to very pale blue-green) ***no** ora for statement colorimeter detects a slight colour change (must compare with by-eye)* 5,6 AVP **;;** e.g. *ref. to* use of, standards / calibration curve, to obtain actual concentrations *ref. to* use of, stop / acid, so only initial rate of reaction occurs low concentration of HRP so low quantity of, TMB / substrate, oxidised **A** less products formed **ora** low quantity of, oxidised TMB gives a, light(er) (blue-green) colour / minimal colour change **ora** low concentration of toxin results in, a low quantity of detection antibody binding / most detection antibody washed away	**4**

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CAMBRIDGE
International Education

Cambridge International AS & A Level

BIOLOGY **9700/23**

Paper 2 AS Level Structured Questions **May/June 2025**

MARK SCHEME

Maximum Mark: 60

Published

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

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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PUBLISHED

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘List rule’ guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	correct point or mark awarded
	correct awarding one mark from marking point or marking group 1. similar numbered ticks are used for marking point or marking groups 2, 3, 4 etc.
	incorrect point or mark not awarded
	working towards marking point
	information missing or insufficient for credit
	used to highlight part of an extended response
	used to highlight part of an extended response
	allow or accept
	benefit of the doubt given

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Annotation	Meaning
CON	contradiction in response, mark not awarded
ECF	error carried forward applied
I	incorrect or insufficient point ignored while marking the rest of the response
IRRL	irrelevant material that does not answer the question
NBOD	benefit of doubt was considered, but the response was decided to not be sufficiently close for benefit of doubt to be applied
O	or reverse argument
PAG	point already given
R	incorrect point or mark not awarded
SEEN	point has been noted, but no credit has been given or blank page seen

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
I	ignore
( )	the word / phrase in brackets is not required, but sets the context
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
AVP	alternative valid point

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Question	Answer	Marks
1(a)(i)	**A** = endodermal (cell) **;** **B** = xylem vessel element **;** **A** vessel elements **A** xylem elements **I** xylem	**2**
1(a)(ii)	(has cells that can) divide continuously by mitosis **;** *idea that* forms cells that can, differentiate / AW, into cells in, vascular tissue / xylem (tissue) / phloem (tissue) **;** (for) repair / growth, of, vascular tissue / xylem / phloem **;** divide to maintain pool of procambial cells **;**	**1**

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Question	Answer	Marks
1(b)	*mark as pairs (adaptation A + explanation E), max two pairs* **A** thick (waxy) cuticle **;** **E** increased / long, diffusion distance for water <u>vapour</u> **or** *idea of* (greater) impermeability to, water <u>vapour</u> **;** **A** needle-shaped / narrow / AW, leaves **;** **E** low surface area to volume ratio, qualified **;** e.g. less transpiration / AW *allow **ecf** if adaptation is spines* **A** multilayered epidermis / hypodermis **;** **E** increased diffusion distance for water <u>vapour</u> **;** **A** low stomatal density **; A** few(er) stomata (per unit area) **A** small(er) stomata **E** less, transpiration / diffusion of water vapour out of the plant (because most water loss is via stomata) **; I** evaporation **A** sunken stomata **; A** other examples e.g. stomata in, grooves / crypts / chambers **A** trichomes / (stomatal) hairs**;** **A** rolled / curled, leaves **;** *for above three mps* **E** maintains humid air around stomata / reduced water potential gradient / (creates) still / non-moving, air **;** **I** concentration gradient AVP **;;** e.g. **A** midday closure of stomata **E** close at times when transpiration is highest / AW **A** close packing of mesophyll cells / fewer (intercellular) air spaces **E** reduces evaporation from mesophyll **A** stomata open at night **E** lowers transpiration as, higher humidity / lower temperature **A** lighter gray / pale coloured, leaves **E** reflect light to keep temperature cooler	**4**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)(i)</td><td>4 / four ;</td><td>1</td></tr>
<tr><td>2(a)(ii)</td><td>COOH group bonded to the top carbon ;

NH_2 group bonded to the top carbon ;

A with or without lines indicating bonds within functional groups
R if atoms other than C and N are shown bonded to the carbon</td><td>2</td></tr>
<tr><td>2(b)</td><td><table><tr><th>description</th><th>level of protein structure</th></tr><tr><td>in some conditions, four melittin polypeptides can bind to each other</td><td>quaternary ;</td></tr><tr><td>a melittin polypeptide consists of a sequence of 26 amino acids</td><td>primary ;</td></tr><tr><td>alpha helices are formed at each end of a melittin polypeptide</td><td>secondary ;</td></tr></table></td><td>3</td></tr>
<tr><td>2(c)</td><td>produces a, pore / gap / channel / opening / AW, (in cell surface membrane) ;
A forms a channel protein

ref. to phospholipids / phospholipid bilayer ; e.g. displaces / disrupts / separates, phospholipids</td><td>2</td></tr>
</table>

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Question	Answer	Marks
2(d)	*any **four** from*: **1** binding / attachment / joining / AW, of cell fragment to, (phagocyte cell surface) receptors / (phagocyte) membrane **;** *endocytosis / phagocytosis* **2** (cell surface) membrane, surrounds / AW, cell fragment **or** pseudopodia, surrounds / form round / AW, cell fragment **or** (phagocytic) cell, envelops / engulfs, cell fragment **;** **3** membrane fusion / (phagocytic), vacuole pinches off / AW **or** phagocytic vacuole formed **;** *allow vacuole if phagocytosis stated* **A** phagosome formed **A** vesicle for vacuole *break down cell fragments* **4** lysosome (containing enzymes), fuses / AW, with phagocytic vacuole **;** **A** phagolysosome formed **5** fragment broken down by, hydrolytic / digestive, enzymes **;** **R** lysosome digests **6** named enzyme and product **or** two named enzymes **;** AVP **;** *idea of* opsonisation of / antibody binding to, cell fragment	**4**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)</td><td>
<table>
<tr><th>feature</th><th>prokaryotic cell</th><th>eukaryotic cell</th></tr>
<tr><td>circular DNA</td><td>✓</td><td>✓</td></tr>
<tr><td>80S ribosomes</td><td>X</td><td>✓</td></tr>
<tr><td>a cell diameter of 20 μm</td><td>X</td><td>✓</td></tr>
</table>

one mark per correct row

if no marks gained, check correct column for 1 mark
</td><td>3</td></tr>
<tr><td>3(b)</td><td>allow enzyme for protein
any three from:
protease (produced by S. epidermidis) is, secreted / released ;
A protease is an extracellular enzyme

protease breaks down proteins (needed for survival) specific to S. aureus ; AW
explanation ; e.g. protease active site complementary to substrate (of S. aureus)
protease complementary to substrate and form enzyme-substrate complexes

protease breaks down, protein in biofilm / (biofilm) polymers ;
idea that without biofilm the S. aureus cannot remain attached to skin cells ;

other example of S. aureus protein broken down ;
e.g. cell membrane proteins / receptors / binding sites

AVP ; e.g. S. aureus cells need substances from biofilm for survival</td><td>3</td></tr>
</table>

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Question	Answer	Marks
3(c)(i)	*allow, bacteria / pathogens / microorganisms, for S. aureus* secrete / produce / AW, mucus / mucin **;** mucus, traps *S. aureus* cells ***/*** acts as a barrier (to reach cells) **;** **R** virus	**2**
3(c)(ii)	ciliated epithelial cell **;** **A** ciliated epithelium cell **I** ciliated cell	**1**
3(d)(i)	*any **three** from*: prevent formation of crosslinks / cross bridges, (between peptidoglycan chains) **;** *if not gained, allow **ecf** for vancomycin difference* stop / prevent, synthesis / repair, of cell wall **;** *differences* penicillin, binds to / is an inhibitor of, enzyme(s) / transpeptidase(s) (that catalyse formation of cross links) **; ora** vancomycin, binds to / acts on / AW, peptidoglycan / cross link, components **;** **ora** *idea that* vancomyin, blocks access to peptidoglycan component / may prevent binding of enzyme that joins peptidoglycan subunits together **;** *if no marks gained because of incorrect knowledge of pencillin mechanism of action, allow one mark as **ecf** for an answer incorporating a feature of vancomycin mechanism of action shown on Fig. 3.2*	**3**

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Question	Answer	Marks
3(d)(ii)	*any **three** from*: **1** prescribing / take, antibiotics only when (absolutely) necessary **;** **A** examples e.g**.** do not use for viral infections do not use as preventative medicine **2** make sure, correct / effective, antibiotic(s), prescribed / used **;** **A** only use antibiotic for the prescribed condition **3** complete course / follow instructions for use **;** **A** *ref. to* DOTS **4** use other antibacterials **or** develop new, drugs / antibiotics **;** **5** reduce / control, antibiotics in, agriculture / animals used for food **;** **6** *ref. to* break transmission cycle / described example **;** e.g. vaccines good hygiene in hospitals quarantine **7,8** AVP **; ;** e.g check / improve / AW, knowledge of, healthcare professionals / public, qualified report patterns of antibiotic resistance / AW *ref. to* monitor to check if antibiotic is effective **;** *ref. to* WHO Global Plan to End TB vary antibiotic treatment use a number of different antibiotics at the same time limit / prevent, antibiotics being sold *context is control by prescription*	**3**

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Question	Answer	Marks
4(a)(i)	*any **one** from:* (membrane) fluidity will increase / AW **;** increase in (lateral) movement of phospholipids (in bilayer) **;** AVP **:** e.g. increase in passage of, polar molecules / ions, across membrane easier to fuse with other membranes	**1**
4(a)(ii)	*idea that* (greater membrane fluidity) makes it easier for lysosomes to fuse with, vacuoles / vesicles / phagosomes / endosomes / membranes (of other organelles) **;** *allow **ecf** on fluidity decreases in **Q4(a)(i)** e.g. makes more impermeable to prevent hydrolytic enzymes exiting*	**1**
4(b)(i)	K_m = 120 **;** unit = μmol dm^{-3} **;**	**2**
4(b)(ii)	*any **four** from*: *differences* **1** rate of reaction is lower at pH 4.5, throughout / at all substrate concentrations / AW **; ora** **2** V_{max} / plateau, is 2.8 (at pH 4.5) v 5.9 (at 5.9) pmol min^{-1} **;** **3** V_{max} is reached at a lower substrate concentration with pH 4.5 **; A ora** **A** data 330–400 μmol dm^{-3} compared with 700 μmol dm^{-3} *explanations to max 3* *at pH 4.5 / lower pH* **4** fewer enzyme-substrate complexes form **;** **5** tertiary structure of enzyme / shape of active site, changes / AW **;** **6** (at pH 4.5) active site shape becomes less complementary to substrate **;** **7** detail **;** e.g. increased presence of hydrogen ions has an effect on, R-group interactions / ability to lower activation energy / ability to bind substrate **8** suggestion that pH 5.9, is / is closer to, the optimum pH **; ora**	**4**

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Question	Answer	Marks
5(a)	*any **three** from*: allows DNA replication to, occur many times / AW **;** allows (some) cells to carry out, many / continuous / repeated, mitoses / cell cycles / cell divisions **;** **I** cell replication prevents the loss of, genes / genetic information (from ends of chromosomes) **;** **ora** **A** prevents loss of coding sequences **I** prevents loss of, DNA / genetic material AVP **;** e.g. prevents fusion of chromosome ends prevents ends of chromosomes being recognised as damaged	**3**
5(b)(i)	U U A G G G **;**	**1**
5(b)(ii)	leucine **;** glycine **;** **ecf** on asparagine and proline	**2**
5(b)(iii)	*any **one** from*: increase in number of different proteins produced **;** **A** increase in number of different enzymes produced **A** increase in the number of different mRNA molecules in the cell *ref. to* ability of cell to, become differentiated / become specialised / take on particular function **;** increase in growth of cell (in preparation for mitosis) **;** production of cell organelles (in preparation for mitosis) **;** AVP **:**	**1**

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Question	Answer	Marks
6(a)	*any **five** from*: **1** inject (non-self / foreign / specific) antigen into small mammal **;** **A** named e.g. mouse **2** *ref. to* leave time for immune response to occur (over several weeks) **;** **A** immune response described **3** remove splenocytes from the spleen (of mice) **;** **A** plasma cells / B-lymphocytes / B-cells, *for splenocytes* **4** fuse, splenocytes / AW, and, myeloma / tumour / cancer, cells **;** **5** screen and select hybridoma cells **;** **6** clone selected hybridoma cells **;** **7** AVP **;** e.g. use of fusogen / polyethylene glycol separate hybridoma cells into separate wells *ref. to* HAT medium *ref. to* humanising monoclonal antibody	**5**
6(b)	**T** / **S** **;** **Q** **;** **R** **;**	**3**
6(c)	right atrium **;** Purkyne , tissue / fibres **;** **A** Purkinje, tissue / fibres **A** Bundle of His ventricular systole **;**	**3**

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CAMBRIDGE
International Education

Cambridge International AS & A Level

BIOLOGY **9700/24**

Paper 2 AS Level Structured Questions **May/June 2025**

MARK SCHEME

Maximum Mark: 60

Published

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

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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PUBLISHED

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘List rule’ guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	correct point or mark awarded
	correct awarding one mark from marking point or marking group 1. similar numbered ticks are used for marking point or marking groups 2, 3, 4 etc.
	incorrect point or mark not awarded
	working towards marking point
	information missing or insufficient for credit
	used to highlight part of an extended response
	used to highlight part of an extended response
	allow or accept
	benefit of the doubt given

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Annotation	Meaning
CON	contradiction in response, mark not awarded
ECF	error carried forward applied
I	incorrect or insufficient point ignored while marking the rest of the response
IRRL	irrelevant material that does not answer the question
NBOD	benefit of doubt was considered, but the response was decided to not be sufficiently close for benefit of doubt to be applied
O	or reverse argument

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
I	ignore
( )	the word / phrase in brackets is not required, but sets the context
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
AVP	alternative valid point

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Question	Answer	Marks
1(a)(i)	metaphase **;**	**1**
1(a)(ii)	telophase **;** **I** *ref. to* early / late	**1**
1(b)(i)	osmosis **;** *any **two** from:* water (molecules) move, down a water potential gradient / from high(er) to low(er) water potential / from less negative to more negative water potential **;** **A** ψ for water potential **I** *ref. to* concentration gradient across the cell (surface) membrane **;** passively / passive movement / no energy required / no ATP required **;**	**3**
1(b)(ii)	single (partially permeable) membrane / tonoplast **;** **A** membrane-bound / bound by a membrane **R** envelope / membranes / double-membrane bound **R** if tonoplast is also described as a wall contains <u>cell sap</u> **or** detail **;** e.g. (solution) containing dissolved (organic and inorganic) substances / AW water and other substances	**2**
1(c)	xylem drawn as cross or star <u>and</u> phloem drawn in areas between xylem **;** **R** if vascular bundles around the edge drawn centrally within whole section of root **;**	**2**

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Question	Answer	Marks
1(d)	*any **four** from:* **1** (because) presence of, sucrose / assimilates, causes water potential (inside phloem sieve tube) to, be lower / decrease / AW **;** **I** water potential <u>gradient</u> decreases **2** water enters, phloem (vessels) / sieve tubes, down a water potential gradient / by osmosis **;** **I** down a concentration gradient **I** higher water potential gradient to lower water potential gradient **3** increase in volume **;** *in context of within sieve tubes, at source / in roots* **4** (so) increase in / high(er), <u>hydrostatic</u> pressure **;** *must have hydrostatic once* **A** builds up **I** creates / forms **5** unloading / removal, of, sucrose / assimilates, at, sink / growing areas, lowers <u>hydrostatic</u> pressure **;** *context is water follows osmotically* **6** (mass flow / bulk flow / movement) down pressure gradient / from high(er) to low(er) pressure **;**	**4**

Question	Answer	Marks
2(a)	extracellular (enzyme) **;** **R** exocellular	**1**
2(b)(i)	arrow between O and CO on lower fatty acid residue **;**	**1**
2(b)(ii)	hydrolysis **;** ester **;**	**2**

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Question	Answer	Marks
2(c)	substrate / olive oil, concentration **;** for, lipase / the enzyme, to achieve, half, maximum rate (of reaction) / V_{max} (at a temperature of 37 °C) **;** **R** K_m is half, maximum rate of reaction / V_{max} *ref. to lipase / enzyme not needed if the context is correct* 'when the rate of reaction is half V_{max} , the olive oil concentration is 91.76 mmol dm^{-3}' *is two marks*	**2**

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Question	Answer	Marks
2(d)(i)	*any **four** from:* *accept activity for percentage enzyme activity throughout* *check for correct units – must be seen once* **1** optimum temperature i**s** 80 °C **;** **2** increasing temperature increases activity, up to, 80 °C / the optimum / the maximum **;** **I** constant increase **I** enzyme more active **R** if implied a continued increase throughout the temperature range *if mp not gained, allow extracted values:* from 25 °C to 80 °C, percentage / activity, from 57 to 100 **3** increased kinetic energy (of, substrate / enzyme, molecules) **;** **A** increased energy if movement stated **4** increase, in enzyme-substrate collisions / AW, (per unit time) **;** **A** increase in number of enzyme-substrate complexes *must be in context of only up to 80 °C* *allow **ecf** if mp2 rejected* **5** above, optimum / 80 °C, decrease in activity **;** ***ecf** for incorrect optimum* **A** percentage activity, from 100 to 55 / 56 *for decrease in activity* **6** partial (progressive) denaturation **;** **A** enzyme begins to denature **A** progressive denaturation **ora** enzyme not completely denatured **7** explanation of denaturation / partial denaturation **;** e.g. loss of, tertiary structure / shape of active site breakage of bonds between R-group breakage of two named bonds **A** fewer enzyme-substrate collisions *if mp4 not gained* **8** reason for, high optimum temperature / activity high at higher temperature **;** e.g. is a thermostable enzyme enzyme has more bonds **R** more peptide bonds enzyme more compact extracted from bacteria living in hot springs enzyme protected by other proteins	**4**

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Question	Answer	Marks
2(d)(ii)	*any **two** from:* active over a (much) narrower range of temperature **;** optimum of / maximum activity at / peaks at, 35 °C to 40 °C **;** steeper increase (from 25 °C) to optimum / maximum activity / peak and steeper decrease after optimum **;** decreases to, zero / 0, (percentage) activity (after optimum) **;** **A** becomes denatured when temperature higher than (approx. after) 40 °C **I** will be 0 percentage activity at 120	**2**

Question	Answer	Marks
3(a)(i)	actual length = $\frac{\text{image length / length of X–Y}}{\text{magnification}}$ **;** *can be a rearranged formula* *answer* 5.2 (µm) **;** *measured length 45 mm* **A** 5.0 / 5.1 / 5.3 / 5.4	**2**
3(b)	*any **one** from:* able to see, surface contours / topography / AW **;** not able to see thin section **;** **A** not able to see internal, features / details (appears as a) three-dimensional / 3D, image **;** **ora** not in 2D view good / greater, depth of field / AW **; ora**	**1**
3(c)	*any **one** from:* two / sister, chromatids present (in each chromosome) **;** **I** two identical DNA molecules centromere present (per chromosome)**;** it is at the (late) prophase / prometaphase / metaphase, stage of mitosis (which is after the S phase) **;**	**1**

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Question	Answer	Marks
4(a)	protoctist **;** **A** Protoctista **I** species names **I** eukaryote	**1**
4(b)	bulge in centre / swollen in centre / lost (full) biconcave shape **; ora** **A** misshapen / shape not regular	**1**
4(c)	*any **one** from:* (merozoites) break down (haemoglobin) to produce amino acids **;** (merozoites) use the amino acids for growth **;** **A** protein used for growth (merozoites) use the amino acids to synthesise other proteins **;** (merozoites) use the protein to provide energy **;** **I** use haemoglobin for energy AVP **;** e.g. red blood cells absorb water	**1**

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Question	Answer	Marks
4(d)		**4**

correct sequence	step
1	D ;
2	F ;
3	B
4	**H**
5	A ;
6	E
7	G ;
8	**C**

Question	Answer	Marks
4(e)	*any **four** from:* **1** *ref. to* folding / coiling, of polypeptide chain **;** *in correct context of formation of secondary / tertiary structure* **2** contains, α- / alpha-, helix / helices **or** β- / beta-, pleated sheets**;** **A** β- / beta-, pleats **R** beta-plates **CON** if add incorrect idea e.g. also contains glucose **3** interactions / bonds form, between, R-groups / side chains **;** **R** if linked to secondary structure **4** two or more named bonds (between R-groups) **;** **R** if peptide or other bonds included *two from* hydrogen bonds disulfide, bridges / bonds **I** covalent bonds ionic / electrostatic, bonds hydrophobic interactions **I** hydrophilic interactions **I** van der Waals forces **5** AVP **;** e.g. *ref. to* secondary structure random coil more detail of secondary structure e.g. H-bonds between (H of) N-H group and (O of) C=O group (of the polypeptide backbone) **A** amine / amino for NH and carboxyl for C=O (alpha-helix) pattern of H-bonds every, 3.6 amino acid (residues) / fourth amino acid / third or fourth amino acid (beta-pleated sheet) H-bonds between areas of polypeptide lying parallel more detail of tertiary structure bonds between R-groups e.g. ionic bonds between NH_3^+ and COO^- disulfide between sulfur atoms hydrophobic – between non-polar R-groups hydrogen – between oxygen atoms on C=O groups and hydrogen atoms on NH groups (of R-groups)	**4**

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Question	Answer	Marks
4(f)	*any **four** from:* *allow MSP1 for antigen* **1** memory cells formed **;** *plus **three** from:* **2** detail of events occurring related to clonal selection leading to memory cell formation **;** e.g. phagocytosis of antigen leads to antigen presentation antigen recognition by / binding of antigen to, (specific B- / T-) lymphoctyes activation / growth, of (specific) lymphocytes triggers, humoral / cell mediated, response **I** *ref. to* stimulating events occurring after clonal expansion *for mp2* **'***MSP1 / antigen**, stimulates B-cell to divide' is mp2* ***not** mp3* **3** clonal expansion / increase in numbers by many mitoses (to form memory cells) **;** **4** (B- and T-) <u>memory cells</u>, long-lived / remain in circulation / AW **;** **I** kept in body **I** live longer *unless qualified that they are present when actual antigen is present* **5** presence of, merozoite / actual antigen / AW, produces a <u>secondary immune response</u> **;** **A** secondary response *if primary immune response introduced for mps1–3* *detail of why person, is immune / does not have symptoms of disease* **6** increased presence / great number, of (memory) lymphocytes increases chance of fast recognition (of antigen) AW **or** more / AW, of any two from, B-lymphocytes / plasma cells / T-helper cells / **A** B-cells T-killer cells *if only 'more B-cells and T-cells' stated, check for T-cells if Th and Tk types noted previously* **7** higher levels / faster production / AW, of antibody **;** **R** if produced by T-lymphocytes **8** AVP **;** e.g. binding of antibody to antigen prevents entry of merozoite into red blood cell T-helper cells to secrete cytokine / T-killer cells qualified *in context of secondary response*	**4**

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Question	Answer	Marks
4(g)	*any **three** from:* **1** stop female producing eggs by preventing access to blood meals **;** AW **2** example **;** e.g. use (mosquito) nets, at night / while sleeping / to prevent blood being taken wear clothes, that cover bare skin / as a barrier / AW insect repellents *allow* AW if qualified e.g. on body / on clothes insect sprays, qualified e.g. prevents mosquito landing on person to feed mosquito coils / AW must be qualified as a repellent / barrier **3** example of use of, insecticides / pesticides / named (to kill mosquitoes) **;** e.g. treat nets with insecticide / ITNs / insecticide-treated nets LLINs / long-lasting insecticide-treated (bed) nets indoor residual spraying / described **A** IRS use mosquito coils / insect repellents *allow once only* use of aerial sprays in, wetlands / AW **4** *ref. to* treat water to disrupt / AW, egg-laying, eggs, larvae / pupae **;** **5** example **;** e.g. remove bodies of water cover water tanks **I** cover rivers **A** ponds (spray) oil on, water / ponds / (small) lakes / swamps use biological control / predators / mosquitofish / other named **6** AVP **;** e.g. *ref. to* use of sterile males (irradiated or genetically modified) **I** sterile females use of drugs to kill *Plasmodium* in (female) mosquitoes **I** medicine	**3**

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Question	Answer	Marks
5(a)(i)	*'if qualified' = ref. to reduced, gas exchange/diffusion* *idea that* (ciliated epithelial cells),not thin enough / too thick / not flat / AW **;** **A** thicker / thick, if qualified *plus **one** from*: *context is movement of, O_2 / CO_2 / respiratory gases, across cells* diffusion too slow **;** AW **A** slow / slower, if qualified diffusion distance too great **;** **A** increases / increased, if qualified cilia, action / AW, may affect efficiency of gas exchange **;** **A** examples e.g. may use up oxygen (so less available for gas exchange) may affect role of surfactant	**2**
5(a)(ii)	*any **two** from:* mucus, wafted / moved, qualified **;** e.g. to / towards, mouth / (back of) throat away from, alveoli / gas exchange surface / lungs out of the air ways / upwards AW for *idea of* moving to back of throat **I** 'out of the body' / 'to the stomach' **R** if implied cilia are in the gut (for movement of mucus, cilia show) synchronous rhythm / metachronal rhythm **;** **A** described e.g. all move at once / wavelike action otherwise mucus (with pathogens) accumulates / AW, with consequence **;** e.g. increased risk of infection AW reduced flow of air AW **no** ora for this mp	**2**

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Question	Answer	Marks
5(b)	*any **four** from:* *allow O_2 for, oxygen / oxygen molecules* **I** *ref. to* damage to gas exchange system *as the person is stated as healthy* *suggestion that* **1** haemoglobin has higher affinity for, pollutants / named, than oxygen**;** **A** haemoglobin has decreased affinity for oxygen **2** pollutants (may) bind to haemoglobin, with consequence **;** e.g. so, fewer oxygen molecules bind / less oxygen binds fewer Hb binding sites available, for oxygen molecules / oxygen changes Hb shape / affects (R-group) bonds, so oxygen binding hindered **I** *ref. to* carbon dioxide **3** (pollutants) lower, proportion / partial pressure / concentration, of oxygen in (atmospheric / alveolar) air, so less, diffuses to blood / diffuses into capillary / enters red blood cells / binds to haemoglobin **;** **4** polluted air leads to less steep, diffusion / concentration, gradient between, alveolar air / alveolus, and, blood / capillary)**;** **A** smaller difference in concentration **5** pollutant, presence / binding, affects, haemoglobin allostery / cooperative binding / described **;** **ora** e.g. because without pollutant the first O_2 binding to Hb makes it easier to bind the next O_2	**4**

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Question	Answer	Marks
6(a)(i)	coronary (artery) **;**	**1**
6(a)(ii)	*slow rate of ventricular contraction* suggests that impulse generation / AW, (from SAN) is, slower rate / too slow **I** not at the correct rate **or** (SAN) initiating heartbeat / acting as pacemaker / setting heart rate, is, abnormal / faulty **;** described relationship between SAN and ventricles **;** e.g. SAN sends out, wave of excitation / electrical impulses / impulses / AW, across atria **I** signals **R** nerve impulses **R** electronic impulses / electricity impulses impulses reach ventricles (for contraction) through AVN	**2**
6(b)	(impulse via alternative pathway will) increase, heart rate / rate of ventricular contraction **;** *plus **one** from*: (because normally) AVN, delays / slows, impulse (conduction to ventricles) **;** **A** pathway does not have AVN, so not delayed ventricles, contract / in systole, too soon / prematurely **or** atria (still) contracting when ventricles (begin) contracting **;**	**2**

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