Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **October/November 2019**

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

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 descriptors 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.

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
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)(i)	**A** amino / amine group **;** **B** carboxyl (group) **; A** carboxylic acid	**2**
1(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**
1(b)(i)	label line to any area of the nucleus **;**	**1**
1(b)(ii)	correct formula **;** e.g. actual diameter = image length / magnification 15 (µm) **;**	**2**
1(b)(iii)	*any one valid suggestion* **;** e.g. *idea of* only very thin section of cell mitochondria found in other sections	**1**
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**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)(i)</td><td>Mycobacterium tuberculosis
or
Mycobacterium bovis ;</td><td>1</td></tr>
<tr><td>2(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>2(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>2b(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>
</table>

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Question	Answer	Marks
2(b)(iii)	*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 **;**	**4**

Question	Answer	Marks
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**
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**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)</td><td>A neutrophil ; A polymorphonuclear, leucocyte / granulocyte
B lymphocyte ;</td><td>2</td></tr>
<tr><td>4(b)(i)</td><td>
<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</td><td>2</td></tr>
<tr><td>4(b)(ii)</td><td>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</td><td>2</td></tr>
<tr><td>4(c)(i)</td><td>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</td><td>2</td></tr>
</table>

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Question	Answer	Marks
4(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**

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Question	Answer	Marks
5(a)	*two from* *ref.to* non-self / foreign (antigen) **;** ***one*** *from* activation / AW, of lymphocytes **;** *ref. to* specificity **;** *ref. to* immunological memory **;**	**2**
5(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**
5(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**
5(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**

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Question	Answer	Marks
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**
6(b)(i)	stops, cell cycle / mitosis / cell division / cell replication / AW **;**	**1**
6(b)(ii)	thymine only present in DNA / no thymine in RNA **;** uracil (nucleotide) replaces thymine (nucleotide) in transcription **;**	**1**
6(c)(i)	cytokinesis **;**	**1**
6(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**

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Question	Answer	Marks
1(a)	label line to phloem in one vascular bundle **;**	**1**
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**
1(c)(i)	epidermis / epidermal **;** **I** upper / lower	**1**
1(c)(ii)	eyepiece graticule **;** **I** stage micrometre	**1**
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**

Question	Answer	Marks
2(a)	EMRO and SEARO / Eastern Mediterranean and South-East Asia (Regions)	**1**
2(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**
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**

Question	Answer	Marks
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**
3(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><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(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>3(c)(ii)</td><td>carbonic anhydr<u>ase</u> ;
R carbon anhydrase / anhydrase</td><td>1</td></tr>
</table>

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Question	Answer	Marks
3(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**
3(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**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(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>4(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>

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Question	Answer	Marks
4(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**

Question	Answer	Marks
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**
5(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**
5(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**

Question	Answer	Marks
5(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**

Question	Answer	Marks
5(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**

Question	Answer	Marks
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**
6(b)	*Idea that,* mitosis / cell cycle / (DNA) replication / (cell) division, occurs in both cell types (continuously / regularly / AW) **;** **R** uncontrolled mitosis **R** meiosis	**1**
6(c)	induced fit **;**	**1**
6(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 <u>active site(s)</u> **;** 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**

Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

BIOLOGY **9700/23**

Paper 2 AS Level Structured Questions **October/November 2019**

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.

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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 descriptors 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.

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
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)(i)	haem ; **A** heme / prosthetic group **I** iron / iron ion / Fe / Fe^{2+} **I** porphyrin ring	**1**
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**
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**
1(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**

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Question	Answer	Marks
1(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**

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Question	Answer	Marks
1(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**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(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>2(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>2(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 <u>cytoplasm</u> 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>

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Question	Answer	Marks
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**

Question	Answer	Marks
3(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 <u>complementary</u> 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**

Question	Answer	Marks
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**
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**

Question	Answer	Marks
4(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**

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Question	Answer	Marks
4(c)(i)	**1** higher (hydrostatic) pressure of blood (at start of capillary) **;** **2** (pressure / ultra) <u>filtration</u> of blood **;** **3** (causing) leakage / movement out / pushing out, of <u>plasma</u> **;** **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**
4(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**

Question	Answer	Marks
5(a)	*two from* protein coat / capsid / capsomeres **;** nucleic acid / <u>DNA or RNA</u> (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**
5(b)	*three from* **1** drugs can be <u>inhibitors</u> (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**

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Question	Answer	Marks
5(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**

Question	Answer	Marks
5(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 <u>same</u> 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**
5(d)(ii)	across the placenta **;** **A** via umbilical cord in breast milk / colostrum / breast feeding / during lactation **;**	**2**

Question	Answer	Marks
6(a)(i)	nanometres / nm **;**	**1**
6(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**
6(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**

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Question	Answer	Marks
6(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 **;**	

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