Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/42**

Paper 4 A Level Structured Questions **May/June 2023**

MARK SCHEME

Maximum Mark: 100

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 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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.

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.

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.

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

Question	Answer	Marks
1(a)(i)	*any **one** from:* *glucose* is activated / made reactive **;** becomes unstable **;** cannot leave cell **;** energy level increased **;** concentration gradient maintained **;**	**1**
1(a)(ii)	*any **one** from:* carrier / acceptor / provider, of, hydrogen (atoms) / electrons **or** provider of H ions **and** electrons **; R** H ions alone used for redox reactions **;** used to reduce, ethanal / pyruvate **;**	**1**
1(a)(iii)	substrate-linked / substrate level **;**	**1**

Question	Answer	Marks
1(b)	*any **three** from:* 1 (inner) mitochondrial membrane impermeable (to pyruvate) **;** 2 carrier (protein) **; A** symport / MPC (mitochondrial pyruvate carrier) 3 lower concentration of pyruvate outside mitochondrion **ora** **or** against concentration gradient **;** 4 oxygen available **;** 5 ATP / energy **;**	**3**
1(c)	*any **three** from:* 1 decarboxylation **; A** description 2 dehydrogenation / oxidation, (of pyruvate) **; A** description 3 reduced NAD produced **;** 4 formation of, acetyl coenzyme A / acetyl CoA **;**	**3**

Question	Answer	Marks
2(a)	haploid is one (complete) set of chromosomes **;** diploid is two (complete) sets of chromosomes **;** *if only comparative statement = max 1* e.g. haploid is n chromosomes and diploid is 2n haploid is half the number of chromosomes as diploid / AW	**2**
2(b)	*prophase I* chromosomes / chromatin, condense / shorten / fatten **I** DNA **or** homologous chromosomes pair up / bivalents form **or** crossing over / synapsis / chiasmata formation **;** *metaphase I* homologous (pairs of) chromosomes / bivalents, line up on the, equator / metaphase plate **or** random / independent, assortment, of homologous (pairs of) chromosomes / bivalents **;** *anaphase I* chromosome(s) / one of each pair of chromosomes, moves (to pole / end of cell) **;** *telophase I* chromosomes reach the opposite, poles / centrosomes / centrioles / end of cell **or** chromosomes decondense / chromatin formation / chromosomes become diffuse **;**	**4**
2(c)	<u>cytokinesis</u> **;**	**1**

Question	Answer	Marks
3(a)(i)	discontinuous **;**	**1**
3(a)(ii)	*any **two** from:* 1 mutation **A** description **or** (formation of a) new allele **;** 2 change in, environment / selection pressure **; A** description 3 cross pollination / cross breeding / hybridisation **;** 4 new allele combination / codominant alleles together **;**	**2**
3(a)(iii)	*any **three** from:* *both types* 1 (inter)breed to produce fertile offspring / not reproductively isolated **;** 2 occupy the same niche **;** 3 same / similar, morphology / physiology / biochemistry **;** **A** description **I** fruit shape 4 have, similar / same, genes / DNA sequences / genomes **;** 5 similar / same, proteins / amino acid sequences **;**	**3**

Question	Answer	Marks
3(b)	*any **five** from:* 1 (populations) can produce many offspring / AW ; 2 genetic variation occurs (in populations) / described ; 3 *ref.* mutations / sexual reproduction / gamete formation / random fertilisation ; 4 *ref.* competition qualified ; e.g. mates / food / resources 5 *ref.* selection pressure ; 6 some individuals have advantageous, adaptations / phenotype / traits / AW ; 7 (so) they, survive / reproduce / have a selective advantage ; 8 (so) pass on their advantageous allele(s) ; 9 (so) the (advantageous) allele frequency increases ;	**5**

Question	Answer	Marks
4(a)	Bacteria **and** Archaea **;**	**1**
4(b)	*any **four** from:* 1 obtain (specific restriction endonuclease) gene, qualified **;** e.g. gene extracted from the, DNA / genome, of E. coli / bacteria gene synthesised from the mRNA of E. coli / bacteria gene synthesised from nucleotides 2 PCR to make more copies of, gene / DNA **;** 3 cut a plasmid, with a restriction enzyme / to give sticky ends **;** 4 combine / mix / join, gene with plasmid using ligase **;** 5 add plasmid to, E. coli / bacteria **; A** transformation of E. coli 6 use marker genes to, select / identify, bacteria / E. coli, with recombinant plasmids **;** 7 *ref.* culture bacteria / use fermenter **;** 8 *ref.* extraction / purification (of enzyme) **;** 9 AVP **;** e.g. heat shock / calcium ions / electroporation (detail mp5) complementary sticky ends anneal / make phosphodiester bonds (detail mp4)	**4**

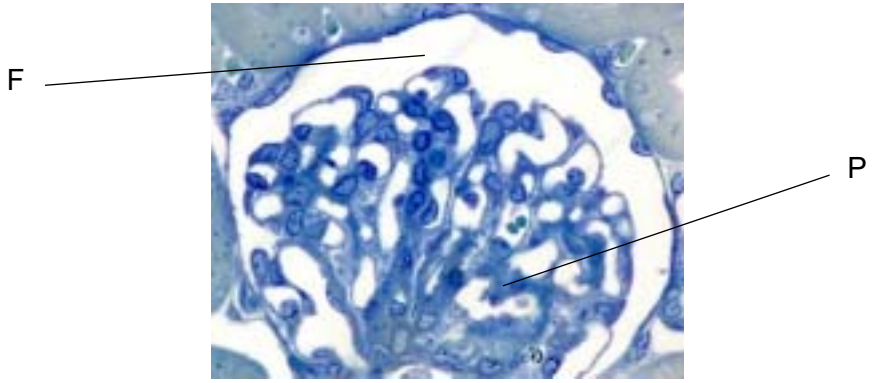
Question	Answer	Marks
4(c)	*any **three** from:* 1 (data stored is) a large amount of, amino acid / nucleotide / base / DNA, sequences **;** 2 share data / access data quickly **;** 3 compare (amino acid / nucleotide / base / DNA) sequences **;** 4 use to, predict / visualise / model, the structure of the enzyme **;** 5 identify restriction endonuclease to use **or** find / discover, new restriction endonucleases **;**	**3**

Question	Answer	Marks
4(d)	*any **four** from:*	**4**

feature	electrophoresis	chromatography	
1 separation role	both – are separating techniques **or** both – involve movement of substances		;
2 molecule separated	DNA / RNA / proteins	pigments / named pigment / amino acids	;
3 medium	gel / named gel	paper / glass / silica gel / named medium	;
4 separated by	(electric) current / electric field / electricity	solvent / named solvent	;
5 separated due to	charges / polarity / lengths / mass	solubilities / mass	
	both – separate by mass		;
6 visualisation using	dyes / ethidium bromide / UV light	different colours of pigments / dyes not added / UV light not used	
	both - dyes can be added (if TLC)		;
7 identification by	use, DNA ladder / known length of DNA **or** use of DNA probe	use R_f value	
	both - use of, references / known values		;

Question	Answer	Marks
5(a)(i)	$q^2 = 0.6$ **or** $q = \sqrt{0.6}$ **or** q = 0.775 **or** p = 0.225 **;** 2pq = 2 × 0.225 × 0.775 **or** 0.35 **;** *allow ecf from mp1* 35 % **;** *allow ecf from mp2*	**3**
5(a)(ii)	*any **four** from:* 1 no migration **or** no flow of, alleles / genes, into / out of, the population **;** 2 population is isolated / described **;** e.g. separated by geographical barrier **I** *ref to* island alone 3 random mating is occurring **;** 4 rats move around island / AW **;** 5 large population **;** 6 rats have high reproductive rate / no predators **;** 7 rats are diploid **;** 8 have two different alleles (for the gene) / heterozygous **;**	**4**

Question	Answer	Marks
5(b)	*any **three** from:* 1 new allele initially found in heterozygotes **;** *dominant advantageous allele* 2 (new) dominant allele is, expressed in heterozygote / always expressed **;** 3 selection can act on individuals with dominant allele straight away / AW **;** *recessive advantageous allele* 4 (new) recessive allele is not expressed, in heterozygote / due to dominant allele **or** recessive allele only expressed in homozygous recessive (genotype) **;** 5 selection can only act on individuals who are homozygous recessive **;** 6 it takes time for homozygous recessive (genotype) to occur / AW **;**	**3**

Question	Answer	Marks
6(a)		**2**
6(b)(i)	$\frac{118-52}{60}$ **or** $\frac{118-52}{69}$ **or** $\frac{118-52}{51}$ **;** 1.1 **or** 1.0 **or** 1.3 **;** $cm^3\ min^{-1}\ y^{-1}$ **;** **A** $cm^3\ min^{-1}$ / year **A** year(s) $^{-1}$ **R** yr or yrs or mins	**3**

Question	Answer	Marks
6(b)(ii)	*any **three** from:* 1 high(er), hydrostatic / blood, pressure causes higher GFR **; ora** 2 water / solute, potential gradient between glomerulus and Bowman's capsule affects GFR **;** 3 kidney disease / named, decreases GFR **;** e.g. damage to nephron or basement membrane / cancer 4 dehydration / lower water potential of blood, decreases GFR **; ora** 5 high altitude decreases GFR **; ora** 6 drugs / named, affects GFR **;** e.g. diuretics / beta blockers / vasodilators / NSAIDS / ACE inhibitors 7 larger difference between afferent arteriole lumen and efferent causes higher GFR **; ora**	**3**

Question	Answer	Marks
6(c)	*any **seven** from:* 1 Na^+, actively transported / pumped, out of cells **;** 2 Na^+ enter blood **;** 3 Na^+ concentration in cells decreases **or** Na^+ concentration gradient (between pct lumen and cytoplasm) / described **;** 4 Na^+ enter cells from, filtrate / lumen **;** 5 by facilitated diffusion **;** 6 cotransport of, glucose / amino acids **; I** secondary active transport 7 water potential of cells decreases **;** 8 water enters cells from (filtrate / lumen) by, osmosis / down the water potential gradient **;** 9 glucose / amino acids, leave cells by, (facilitated) diffusion / described **;** 10 glucose / amino acids, reabsorbed **or** move into , tissue fluid / blood **;** 11 AVP **;** e.g. other named ions reabsorbed	**7**

Question	Answer	Marks
7(a)	*any **four** from:* 1 respiration rate decreases / less ATP produced **;** 2 reduces activity of (named) enzymes / description **;** 3 reduces movement of, Ca^{2+} / Na^{+} / ACh / neurotransmitter **;** 4 (*in neuromuscular junction*) less / no, acetylcholine broken down acetylcholine remains attached to receptors acetylcholinesterase, less active / inactive **;** 5 (*in sarcomere*) fewer / no, Ca^{2+} bind to troponin fewer / no, cross bridges formed fewer / no, power stokes **;** 6 (*in sarcomere*) less / no, detachment of myosin heads (from actin) fewer / no, cross bridges broken ATPase / myosin head, less active / inactive hydrolysis of ATP, slower / stops **;** 7 AVP **;** e.g. shivering / reduced blood flow to muscle / energy diverted for thermoregulation (*idea*)	**4**

Question	Answer	Marks
7(b)	*any **three** from:* 1 Na^+ channels don't open **A** Na^+ do not, diffuse / move, into neurone **or** stay open **;** **A** Na^+ always, diffuse / move, into neurone 2 (axon) membrane, cannot be depolarised **or** (axon) membrane stays depolarised **;** 3 no action potentials, generated / transmitted (along motor neurone) **or** continuous action potentials, generated / transmitted (along motor neurone) **;** 4 Ca^{2+} does not enter presynaptic knob / vesicles not stimulated to move / no ACh release (at neuromuscular junction) **or** Ca^{2+} always enters presynaptic knob / vesicles always stimulated to move / ACh continually released (at neuromuscular junction) **;** 5 consequence e.g. paralysis / described or continued muscle contraction **;**	**3**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(a)(i)</td><td>
any two from:

1 higher rate of activity (of rubisco) in GM rice (throughout) ;

2 (low CO_2 concentrations) rate of activity for both increases ;

3 comparative figures – GM and non-GM at one CO_2 concentration ;
<table>
<tr><td rowspan="2">atmospheric CO_2 concentration / mg dm^{-3} ±5</td><td colspan="2">rate of activity of rubisco / arbitrary units</td></tr>
<tr><td>non-GM rice ±0.05</td><td>GM-rice ±0.05</td></tr>
<tr><td>0</td><td>0.7</td><td>0.80</td></tr>
<tr><td>100</td><td>1.8</td><td>2.70</td></tr>
<tr><td>200</td><td>2.4</td><td>3.95</td></tr>
<tr><td>280</td><td>2.6</td><td>4.15</td></tr>
<tr><td>300</td><td>2.6</td><td>4.15</td></tr>
<tr><td>400</td><td>2.6</td><td>4.30</td></tr>
<tr><td>500</td><td>2.6</td><td>4.45</td></tr>
<tr><td>600</td><td>2.6</td><td>4.55</td></tr>
</table>
</td><td>3</td></tr>
</table>

Question	Answer	Marks
8(a)(i)	*plus* *levels off because:* 4 carbon dioxide <u>concentration</u> no longer limiting **or** light <u>intensity</u> limiting **or** temperature limiting **or** rubisco active sites saturated (with carbon dioxide) **or** less RuBP available **;**	
8(a)(ii)	active site **;** **A** allosteric site	**1**
8(b)(i)	carbon (dioxide) fixation **;** **A** carboxylation	**1**
8(b)(ii)	reduction / hydrogenation **;**	**1**
8(b)(iii)	6 / 5 **;**	**1**
8(b)(iv)	*any **two** from: list rule* 1 hexose / named **;** e.g. glucose / fructose 2 disaccharide / named **;** e.g. sucrose / maltose 3 starch / cellulose **;** 4 amino acids **;** 5 glycerol / fatty acids **;**	**2**

Question	Answer	Marks
9(a)	glands ; cell surface membrane / plasma membrane ; **A** liver (cells) second messenger / cAMP ; **A** enzyme cascade / phosphorylation of enzymes / signalling cascade (striated) muscles ; collecting duct ; homeostasis ;	**6**
9(b)(i)	1 insulin, produced / released ; 2 increase in uptake of glucose into cells ; 3 detail of uptake ; e.g. increase permeability of cell surface membrane (to glucose) / GLUT added to cell surface membrane 4 increase / stimulates, respiration of glucose (in cells) / phosphorylation of glucose ; 5 (stimulates) glycogenesis / conversion of glucose to lipids ;	**3**
9(b)(ii)	*ref.* glucagon ;	**1**

Question	Answer	Marks
10(a)	*any **three** from:* 1 safe location **or** protected from, predators / hunters / poachers **;** 2 research qualified **;** e.g. disease control / into diet / behaviour 3 raise funds **;** 4 work with local, communities / governments or conservation projects **;** 5 education / raise awareness **;** 6 medical / veterinary / health, (care) **;**	**3**
10(b)	*any **four** from:* 1 unnatural environment / described **; ora** 2 effect of captivity on fertility **;** 3 refuses to mate **;** 4 low availability of suitable mates / AW **; ora** 5 stress / pressure **;** 6 AVP **;** e.g. zoo capacity / zoos control number they breed	**4**
10(c)	**A** – fertilisation occurs / sperm or semen added **;** **B** and **C** – surrogacy / described **;** cryopreservation / described **;**	**3**