Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/42**

Paper 4 A Level Structured Questions **March 2020**

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 March 2020 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

[Turn over

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 marking point
R	reject
A	accept
I	ignore
AVP	any valid point
AW	alternative wording (where responses vary more than usual)
ecf	error carried forward
underline	actual word underlined must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument

Question	Answer	Marks
1(a)(i)	**A** – microvilli **;** **A** brush border **B** – tight junction **;**	**2**
1(a)(ii)	**C** – label to membrane of microvilli **;** **D** – label to cell surface membrane of any pct cell on side closest to blood capillary up to tight junction **;**	**2**
1(b)	25 200 × 99.4 ÷ 100 (= 25 048.8) **;** **A** any equivalent valid working (25 200 – 25 048.8 =) 151 / 151.2 **;**	**2**
1(c)	1 glucose oxidase, oxidises / converts, glucose to gluconic acid and hydrogen peroxide **;** **A** gluconolactone for gluconic acid 2 peroxidase catalyses the reaction between hydrogen peroxide and, chromogen / colourless compound, to produce a coloured compound **;**	**2**

Question	Answer	Marks
2(a)(i)	*any **three** from:* 1 primer DNA anneals to, single-stranded DNA / denatured DNA **;** 2 using complementary base pairing **;** 3 formation of hydrogen bonds (between primer DNA and TREC DNA) **;** 4 allows, *Taq* polymerase / DNA polymerase, to bind **or** starting point for, *Taq* polymerase / DNA polymerase, to attach **;** 5 ref. to specificity **;** e.g. only binds to TREC DNA	**3**
2(a)(ii)	*any **two** from:* 1 PCR product means TRECs present / ora **;** 2 if PCR detects TRECS, then T-lymphocytes are developing normally / ora **;** 3 TRECs, do not form / are in small numbers, in children with SCID / ora **;** 4 (detection of) PCR product means child does not have SCID **;**	**2**

Question	Answer	Marks
2(b)(i)	*any **three** from:* 1 contribution (to the identification of children with SCID) by screening programme increased (from 2010 to 2016) **;** 2 contribution (to the identification of children with SCID) by family history decreased and infection decreased (from 2010 to 2016) / AW **;** 3 between 2012 and 2013 the screening programme became the method with the highest percentage contribution **;** 4 by 2016 nearly all cases of SCID were diagnosed by the screening programme **;** 5 comparative figures to support any of marking points 1 to 4 **;** 6 AVP **;** e.g. some children diagnosed with SCID as a result of infection (despite screening) in 2010 the biggest contribution to diagnosing SCID was through infections	**3**
2(b)(ii)	*any **two** from:* 1 early, diagnosis / treatment / AW **;** 2 does not rely on family knowing about family history of SCID **;** 3 prevents child with SCID from developing several infections before diagnosis **;** 4 removes worry if not present **;**	**2**

Question	Answer	Marks
2(c)	*any **three** from:* 1 isolate / obtain, functional / normal, ADA allele **;** **A** gene throughout 2 insert allele into virus (vector) **;** I ref. to plasmid 3 remove, stem cells / T-lymphocytes / target cells **;** 4 insert, allele / gene / virus, into, stem cells / T-lymphocytes / target cells **;** 5 return, stem cells / T-lymphocytes / target cells, to body **;** 6 AVP **;** e.g. ref. to retrovirus / lentivirus ref. to difficulty in finding suitable donor for bone marrow transplant	**3**
2(d)	*any **three** from:* 1 (retrovirus / lentivirus) can insert, viral DNA / healthy allele, randomly into (host) DNA **;** 2 may cause, cancer / side effects / allergic response **;** 3 inserted, allele / DNA, may be inactivated **or** inserted, allele / DNA, may inactivate another (host) gene **;** 4 virus may not enter, target cells / T-lymphocytes **or** virus may enter non-target cells **;** 5 AVP **;** e.g. ref. to safe / clean, conditions required to produce virus ineffective immune response against virus	**3**

Question	Answer	Marks
3(a)(i)	1 different forms / variations, of, the same / a, gene **;** 2 due to different DNA, base / nucleotide, sequence **or** resulting in different, polypeptide / protein, produced **;**	**2**
3(a)(ii)	*any **three** from:* 1 example of, gene interaction / epistasis **;** 2 (allele **R** may code for) an enzyme in pigment production pathway **;** 3 (allele **R** may code for) co-factor to, activate enzyme / block inhibitor **;** 4 (allele **R** may code for) transcription factor **;** 5 (by) binding to, enhancer / promoter **;** 6 (which) promotes transcription / allows binding of RNA polymerase / allows mRNA to be made **;** 7 AVP **;** e.g. protein that causes transcription factor complex formation	**3**

Question	Answer	Marks
3(b)	*parental genotypes:* **RrTt** × **RrTt ;** *parental gametes:* (**RT**) (**Rt**) (**rT**) (**rt**) × (**RT**) (**Rt**) (**rT**) (**rt**) **;** *results of cross:* **;** **;** *phenotypic ratios:* 9 purple : 3 red : 4 white **;**	**5**

	(**RT**)	(**Rt**)	(**rT**)	(**rt**)
(**RT**)	**RRTT** purple	**RRTt** purple	**RrTT** purple	**RrTt** purple
(**Rt**)	**RRTt** purple	**RRtt** red	**RrTt** purple	**Rrtt** red
(**rT**)	**RrTT** purple	**RrTt** purple	**rrTT** white	**rrTt** white
(**rt**)	**RrTt** purple	**Rrtt** red	**rrTt** white	**rrtt** white

Question	Answer	Marks
4(a)	$(q^2) = 1437/2936 = 0.489$ q = square root of 0.489 = 0.700 **or** 0.699 **;** p = 1 – 0.700 = 0.300 **(or** p = 1 – 0.699 = 0.301) $(p^2) = 0.300^2 = 0.090$ **or** $(p^2) = 0.301^2 = 0.091$) **;** (0.090 × 2936 or 0.091 × 2936) = 264 / 265 / 266 / 267 **;** one mark for calculation of q or q^2, one mark for calculation of p or p^2 and one mark for answer **A** ecf	**3**
4(b)	*any **two** from:* 1 population is large **;** 2 no migration (into or out of the population) **;** 3 random mating occurs **;** 4 undergoes sexual reproduction / ora **;** 5 organism is diploid **;** 6 no selection **;** 7 no mutation **;**	**2**

Question	Answer	Marks
4(c)	*any **four** from:* 1 artificial selection / humans apply selection pressure ; 2 remove dark brown, *O. mykiss* / rainbow trout, from breeding population / ora ; 3 breed, *O. mykiss* / rainbow trout, with shiny blue-silver appearance ; 4 over several generations ; 5 using offspring with shiny blue-silver appearance ; 6 frequency of shiny blue-silver allele increases ; 7 only shiny blue-silver allele passed on to offspring ;	**4**
4(d)	*any **two** from:* 1 gene **/** allele, for, faster growth rate / growth hormone / larger sized salmon, (inserted) ; 2 ref. to promoter from another species (also inserted) ; 3 growth occurs, all year round / not just in spring and summer ; 4 GM salmon, grow faster / grow larger / reproduce more ;	**2**

Question	Answer	Marks
5(a)	DNA that contains genetic material from two different <u>organisms</u> / DNA from two different <u>sources</u> ;	1
5(b)	*any **two** from:* 1 marker (gene) ; 2 to identify, transformed bacteria / bacteria that have taken up plasmid ; 3 detected, under UV light / because GFP fluoresces ;	2
5(c)	blunt / AW ; **A** not sticky	1
5(d)(i)	*Xho*I ; *Sal*I ;	2
5(d)(ii)	 5′CTCAGATCTCGAGCTCAAGCTTCGAATTCTGCAGTCGACGGTACCGCGGGCCCGGGATCC 3′ 3′GAGTCTAGAGCTCGAGTTCGAAGCTTAAGACGTCAGCTGCCATGGCGCCCGGGCCCTAGG 5′ ; ; one mark for each end	2
5(d)(iii)	*any **one** from:* 1 *idea that* there was not a single type of restriction site present on either side of the gene / these were the only restriction sites close to the start and end of the gene ; 2 AVP ;	1
5(d)(iv)	(DNA) ligase ;	1

Question	Answer	Marks
6(a)	class **;** family **;**	**2**
6(b)	*any **three** from:* 1 low genetic variation **;** **A** ref. to small gene pool 2 low hybrid vigour / inbreeding depression **;** 3 low heterozygosity / high homozygosity **;** 4 more chance of harmful recessive alleles, being expressed / coming together **;** 5 AVP **;** e.g. gene pool may not be representative of original population	**3**
6(c)	**A** increase, decrease or stay the same as long as the candidate has given a valid explanation based on the food web *sea urchins:* e.g. increase in numbers **because** predator / sea otter, absent **;** *animal plankton:* e.g. decrease in numbers **because** increase in molluscs **;** *crabs:* e.g. decrease in numbers **because** increase in numbers of large fish **;**	**3**

Question	Answer	Marks
6(d)	*any **three** from:* 1 ref. to requiring additional oxygen than normal **;** 2 ref. lactate (build up) **;** 3 (oxygen required for) conversion of lactate to, pyruvate / glycogen **;** **R** lactate broken down 4 ref. to oxygen debt / EPOC **;** 5 reoxygenation of, haemoglobin / myoglobin **;** 6 AVP **;** e.g. replenishment of ATP	**3**
6(e)	*any **four** from:* 1 myosin is a fibrous protein **;** 2 (has) globular heads / ATPase **;** 3 AVP **;** e.g. 15 nm diameter / M lines 4 actin is a globular protein **;** 5 ref. to tropomyosin / troponin **;** 6 binding site for myosin head **;** 7 AVP **;** e.g. 7 nm diameter / Z lines	**4**

Question	Answer	Marks
7(a)	site 1 – thylakoid / granum ; site 2 – stroma ;	**2**
7(b)	**A** – oxygen ; **B** – reduced NADP / ATP ; **C** – reduced NADP / ATP ; **D** – carbon dioxide ; **B** and **C** must be different 4 correct = 3 marks 3 correct = 2 marks 1 or 2 correct = 1 mark	**3**

Question	Answer	Marks
7(c)	*any **three** from:* 1 cell wall (production / support) **and** cellulose **;** 2 respiration **and** named, monosaccharide / disaccharide **;** 3 energy store **and** fatty acids / lipids / starch **;** 4 protein synthesis **and** amino acids **;** 5 AVP **;** e.g. storing genetic information **and** nucleic acids / nucleotides use of lipids in cell surface membrane	**3**

Question	Answer	Marks
8(a)	*any **three** from:* 1 substrate / acetylcholinesterase / Ach, cannot bind (to active site) **;** 2 no / few, enzyme substrate complexes form **;** 3 (in competitive inhibition) ref. to inhibitor complementary to active site **;** 4 (in competitive inhibition) inhibitor binds to active site / inhibitor blocks active site **;** 5 (in non-competitive inhibition) inhibitor binds to, allosteric site / description **;** 6 (binding of inhibitor to allosteric site) causes change to, 3-D shape / tertiary structure / active site **;**	**3**
8(b)	*any **three** from:* 1 acetylcholinesterase / Ach, remains attached to receptors (on post-synaptic membrane) **or** acetylcholinesterase / Ach, not broken down **;** 2 Na^+ continues to diffuse into post-synaptic neurone / (voltage-gated) sodium ion channels remain open **;** 3 postsynaptic membrane remains depolarised / repolarisation of postsynaptic membrane does not occur **;** 4 continuous transmission of action potentials **;** 5 AVP **;** e.g. synaptic fatigue paralysis	**3**
8(c)	*any **one** from:* 1 add compound to, bind to / degrade, the inhibitor (and prevent it binding to the active site of acetylcholinesterase) **;** 2 (use compound to) stimulate production of acetylcholinesterase **;**	**1**

Question	Answer	Marks
9(a)	*any **eight** from:* *meiosis:* 1 chiasma / crossing over ; 2 between non-sister chromatids ; 3 of, homologous chromosomes / bivalent ; 4 in prophase 1 ; 5 exchange of, genetic material / alleles / genes / DNA ; 6 linkage groups broken ; 7 new combination of alleles ; 8 random / independent, assortment of, homologous chromosomes / bivalents (at equator) ; 9 (during) metaphase 1 ; 10 random / independent, assortment (of, sister chromatids / chromosomes) at metaphase 2 ; 11 possible chromosome mutation ; *fertilisation:* 12 random mating ; 13 random, fusion / fertilisation, of gametes ;	**8**

Question	Answer	Marks
9(b)	*any **seven** from:* *albinism (max 4):* 1 caused by recessive (allele) ; 2 (mutant allele) affects production of tyrosinase / causes production of faulty tyrosinase ; 3 results in, absence / reduced production of, melanin ; 4 pale / white, hair or skin ; 5 pink eyes ; 6 increases susceptibility to, sunburn / skin cancer ; *haemophilia (max 4):* 7 caused by recessive (allele) ; 8 factor VIII / factor IX, not produced ; 9 gene / allele, is carried on X chromosome ; 10 sex-linked ; 11 prevents / reduces, clotting of blood ; 12 description of symptoms ; e.g. excessive bleeding bleeding into joints large bruises internal bleeding	**7**

Question	Answer	Marks
10(a)	*any **six** from:* 1 area marked out as a grid ; 2 co-ordinates obtained using a random number generator ; 3 quadrats used ; 4 placed at random co-ordinates ; 5 ref. to size of quadrat ; 6 species identified within quadrat ; 7 % cover / count number within quadrat ; 8 Braun Blanquet / other named, scale ; 9 repeat sampling ; 10 AVP ; e.g. large sample size means calculated method of calculating abundance and richness	**6**

Question	Answer	Marks
10(b)	*any **nine** from:* 1 habitat loss ; 2 deforestation ; 3 named cause ; e.g. clearing land for, housing / agriculture / transport / industry 4 habitat fragmentation / description ; 5 named example ;e.g. palm oil plantations in SE Asia 6 climate change / global warming / description ; 7 named cause ; e.g. greenhouse gases 8 pollution / description ; 9 named example ; e.g. fertilisers / toxins / plastic 10 over exploitation of resources / description ; 11 named example ; e.g. overfishing / hunting / animal trade 12 invasive alien species / description ; 13 named example ; e.g. grey squirrel in Europe	**9**