Cambridge International Examinations
Cambridge Pre-U Certificate

BIOLOGY **9790/03**

Paper 3 Case Study and Synoptic Essay **May/June 2016**

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 will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **9** printed pages.

Notes:

The following abbreviations may be used in mark schemes:

;	separates marking points
/	alternative and acceptable answers for the same marking point
allow / accept / **A**	answers that can be accepted
ignore / **I**	statements that are irrelevant – applies to neutral answers
AW / owtte	credit alternative wording / or words to that effect
ecf	error carried forward
(words)	bracketed words that are not essential to gain credit
<u>words</u>	underlined words must be present to gain credit
max	indicates the maximum number of marks that can be given
ORA	or reverse argument
AVP	any valid point – marking points not listed on the mark scheme but which are worthy of credit

Section A – Case Study

1 (a) 1 description of mutation **;**
   2 change in, codon(s) / amino acid(s) in protein **;**
   3 incorrect transcription / incorrect mRNA processing **;**
   4 change in CFTR protein / change in channel protein **;**
        A no protein produced
        I shape unqualified
   5 CFTR may not reach the (cell surface) membrane **;**
   6 <u>chloride</u> ion transport across membrane reduced **;**
   7 ion concentration in cells increases **;**
        A decrease in, solute potential / water potential / ORA
        A reduced water potential gradient
   8 less, movement of water / osmosis (down water potential gradient), out of cells **;**

   9 AVP **;**   e.g. CFTR protein degradation   **[max 5]**

(b) 1 ref. to disadvantage / reduced chance of survival **;**
   2 reduced chance of reproduction and passing on allele(s) **;**
   3 ref. to selection pressure **;**
   4 low allele frequency **;**
   5 most inherited diseases are caused by recessive alleles **;**
   6 low chance of two carriers mating **;**
   7 allele(s) only expressed in people who are homozygous (recessive) **;**
   8 many novel mutations unique to individuals **;**
   9 AVP **;**   e.g. ref. to sex linkage / sexual selection / lethal allele
                  ref. to genetic screening   **[max 3]**

(c) $1/30 \times 1/30 = 1/900$ probability of two carriers being the parents of a newly-born child **;**
   1/4 probability of such a child being homozygous recessive, so overall probability =
   $1/4 \times 1/900 = 1/3600$ **;**
   A 0.028 / 2.8%   **[2]**

   [Total: 10]

2 (a) 1 water loss depends on, density / activity / AW, of CFTR protein (channels) **;**
   2 people heterozygous for the *ΔF508* allele may have, fewer functional CFTR proteins / reduced CFTR function **;**
   3 fewer binding sites for cholera toxin / binding of toxin has no effect **;**
   4 reduced chloride ion, concentration gradient / movement out **;**
   5 effects of cholera reduced **;**
        e.g. less water lost
   6 heterozygous advantage **;**
   7 *ΔF508* allele carriers more likely to survive cholera / ORA **;**
   8 AVP **;**   **[max 5]**

(b) (i) **accept** use of figures

    1   prostaglandin stimulation increased chloride secretion in **both** carriers and controls **;**

    2   CF patients unaffected / AW **;**

    3   (significantly) more chloride secretion in carriers and controls than in CF **;**

    4   ref. to statistical significance/error bars **;** **[max 3]**

(ii) 1   mimics effect of cholera **;**

    2   dangerous / unable / unethical, to give cholera toxin **;**

    3   unethical to use cholera patients **;**

    4   prostaglandin (concentration) can be controlled **;**

    5   AVP **;**   e.g.prostaglandin not affected by immune system **[max 2]**

(iii) 1   comment on lack of statistical data for 1994 **;**

    2   1994 study measures water loss but 2000 study measures chloride secretion **;**

    3   1994 study lacks date for homozygous recessives **;**

    4   mice were subjects in 1994 and humans were subjects in 2000 **;**

    5   may not be able to compare mice with humans **;**

    6   cholera toxin used in 1994, but prostaglandins used in 2000 **;**

    7   prostaglandins may not act in same way as cholera toxin **;**

    8   1994 study supports idea of heterozygous advantage / 2000 study shows no heterozygous advantage **;**

    9   AVP **;**

   10 AVP **;**

           e.g. mice respond to mutation differently / ORA

                mice respond to cholera differently / ORA

                ref. to numbers of subjects **[max 5]**

[Total: 15]

3 (a) 1   selection for the allele in the past / heterozygotes at selective advantage in the past **;**

    2   heterozygotes do not show CF symptoms **;**

    3   insufficient selective disadvantage to eliminate subsequently **;**

    4   not much time since eradication of cholera to eliminate recessive allele **;**

    5   AVP **;**

    6   AVP **;** **[max 2]**

(b) 1   thermoregulation needed in hot countries for survival **;**

    2   heterozygotes, unable / less able, to sweat **;**

    3   heterozygotes at a selective disadvantage / ref. to over-heating **;**

    4   unknown advantage may maintain allele at low frequency **;**

    5   AVP **;** **[max 3]**

[Total: 5]

Section B – Synoptic Essay

Breadth   **Maximum 3 marks**

Mark	Descriptors
	Candidate has:
3	given a balanced account including most of the relevant topic areas and selected a wide range of facts, principles, concepts and/or examples pertinent to the title
2	given a fairly balanced account including some of the relevant topic areas and selected many of the appropriate facts, principles, concepts and/or examples pertinent to the title
1	given an account including a few of the relevant topic areas and selected some of the appropriate facts, principles, concepts and/or examples pertinent to the title
0	given an account that relies on one topic area alone and selected only a few of the appropriate facts, principles, concepts and/or examples pertinent to the title

Argumentation   **Maximum 3 marks**

Mark	Descriptors
	Candidate has:
3	developed and sustained a coherent argument throughout the essay leading to an appropriate conclusion showing insight
2	introduced an argument and partially developed it, so that some coherence is shown in the essay
1	shown evidence of an argument, with little development
0	shown no evidence of argumentation

Communication   **Maximum 2 marks**

Mark	Descriptors
	Candidate has:
2	organised and presented information clearly and used correct terminology in appropriate contexts
1	attempted to organise material and use some correct terminology, so that with re-reading the meaning becomes apparent
0	presented an unstructured answer with poor use of terminology

Spelling, punctuation and grammar   **Maximum 2 marks**

Mark	Descriptors
	Candidate has:
2	used spelling, punctuation and grammar accurately, with no more than very few errors
1	generally used spelling, punctuation and grammar accurately, but has made a number of significant errors
0	not used spelling, punctuation and grammar accurately

Scientific content   **Maximum 20 marks**

Mark	Descriptors
	The candidate:
20	• recalls and consistently uses all facts and principles (relevant to the essay); • shows sound understanding of all principles and concepts; • writes accurately with no major errors and very few minor errors; • gives comprehensive detail expected from the relevant learning outcomes, with evidence of relevant reading around the subject.
16	• recalls and consistently uses most facts and principles (relevant to the essay); • shows sound understanding of most principles and concepts; • writes accurately with no major errors and few minor errors; • gives full detail expected from the relevant learning outcomes.
12	• recalls and consistently uses some facts and principles (relevant to the essay); • shows sound understanding of some principles and concepts; • writes some material accurately with not more than one major error and some minor errors; • gives most detail expected from the relevant learning outcomes.
8	• recalls some facts and principles (relevant to the essay); • shows some understanding of some principles and concepts; • writes some material accurately with more than one major error or many minor errors; • gives some detail expected from the relevant learning outcomes.
4	• recalls a few facts and principles (relevant to the essay); • shows limited understanding of a few principles and concepts; • writes material that includes many errors, some of which may be major errors; • gives little detail expected from the relevant learning outcomes.
0	• recalls no relevant facts and principles; • shows no understanding of relevant principles and concepts; • writes irrelevant material or includes many major errors; • gives no detail expected from the relevant learning outcomes.

Expected content

For each of the questions, guidance is given as to the kind of content from the syllabus that may be appropriate to answering the question. Some candidates will include all of these areas and others may write in more detail about these or may include other relevant topics, in each case reflecting each candidate's reading-around the subject and personal research and other interests. Some topics, both in the candidates' answers and in the following expected content, may not be directly on the syllabus, but it is important to credit such responses where they are given and thus they are included here.

4   **'A human's genome is constant, whereas the proteome of a human is constantly changing.'**

Discuss this statement including reference to its medical implications.

Much of the content of this essay will come from Sections 1 and 2 of the syllabus:

- the nature of genes
- the human genome
- transcription
- translation
- protein synthesis
- the proteome.

The following learning outcomes are directly relevant:
- 1.3 (a), (b), (c), (g);
- 1.4 (a), (b), (c);
- 1.6 (a), (b), (c), (d), (e), (k), (l), (m), (n);
- 1.7 (h), (i);
- 2.2 (g), (h), (i), (j), (m).

Introduction: definitions of genome and proteome

Genomics:
nature of genes, DNA
introns, exons, promoters
post translational modification
one gene, one protein
mutations
variation
mitosis, stem cells
environmental factors, epigenetics

Proteomics:
protein synthesis
protein structure, amino acid R-groups
protein variety, classification of proteins
tertiary, quaternary structure
active site
enzymes: structure, specificity, function in cells
enzyme-catalysed reactions
cascade reaction
functions and examples of proteins in cells
protein phosphorylation
cell signalling

Medical implications:
gene target for drugs
genetic switches
drugs that affect proteins
protein interactions
protein markers for disease

5 **'The growth of a plant is genetically predetermined.'**

Discuss the extent to which this statement is true.

Much of the content of this essay will come from Section 4 of the syllabus:

- control of plant processes
- plant growth substances
- tropisms
- reproduction in plants
- plant genetics
- inheritance.

The following learning outcomes are directly relevant:
- 1.6 (a), (b), (c), (g), (h), (i), (k), (m);
- 4.3 (a), (b), (c);
- 4.4 (a)–(f).

Introduction: role and types of growth in plants

Genetic factors:
genes, alleles, genetic code
examples of genetically determined growth,
flower colour, height, leaf shape
mutation and genetic variation
sexual reproduction in plants, meiosis
adaptation
evolution and change

Growth factors:
gibberellins, auxins
functions of growth regulators in plants
cell growth, elongation
DELLA proteins
tropisms, phototropism
genetic coding of plant growth substances

Environmental factors:
environmental causes of variation in growth
example of factors – e.g. light, minerals
survival strategies

6 Discuss why the concept of the niche is so important in environmental studies.

Much of the content of this essay will come from Section 5 of the syllabus:

- defining a niche
- ecosystems and niche structure
- physiological adaptation
- behavioural adaptation
- distribution
- speciation.

The following learning outcomes are directly relevant.
- 5.1 (a)–(c), (e);
- 5.2 (a), (b), (d)–(i).

Introduction: definition of the niche

The niche concept:
habitat requirements
species functional role
biotic and abiotic factors
definition of ecosystems in terms of microhabitats
niche availability
species variability
species interactions
intraspecific competition
interspecific competition

Biodiversity:
maintenance of biodiversity
conservation, maintaining the niche
habitat size
SLOSS debate
biodiversity hotspots

New habitats:
succession
adaptive radiation
physiological adaptation
behavioural adaptation
niche isolation
allopatric speciation
sympatric speciation

Measuring the niche:
measurement of biotic factors
measurement of abiotic factors