



Rewarding Learning

**ADVANCED
General Certificate of Education
2022 RESERVE SERIES**

Biology

Assessment Unit A2 2

assessing

Biochemistry, Genetics and Evolutionary Trends

[ABY21]

TUESDAY 28 JUNE, MORNING

**MARK
SCHEME**

General Marking Instructions

Introduction

The main purpose of the mark scheme is to ensure that examinations are marked accurately, consistently and fairly. The mark scheme provides examiners with an indication of the nature and range of candidates' responses likely to be worthy of credit. It also sets out the criteria which they should apply in allocating marks to candidates' responses.

Assessment objectives

Below are the assessment objectives for Biology.

Candidates should be able to demonstrate:

- AO1** Knowledge and understanding of scientific ideas, processes, techniques and procedures.
- AO2** Apply knowledge and understanding of scientific ideas, processes, techniques and procedures:
- in a theoretical context
 - in a practical context
 - when handling qualitative data
 - when handling quantitative data.
- AO3** Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to:
- make judgements and reach conclusions
 - develop and refine practical design and procedures.

Quality of candidates' responses

In marking the examination papers, examiners should be looking for a quality of response reflecting the level of maturity which may reasonably be expected of a 17 or 18-year-old which is the age at which the majority of candidates sit their GCE examinations.

Flexibility in marking

Mark schemes are not intended to be totally prescriptive. No mark scheme can cover all the responses which candidates may produce. In the event of unanticipated answers, examiners are expected to use their professional judgement to assess the validity of answers. If an answer is particularly problematic, then examiners should seek the guidance of the Supervising Examiner.

Positive marking

Examiners are encouraged to be positive in their marking, giving appropriate credit for what candidates know, understand and can do rather than penalising candidates for errors or omissions. Examiners should make use of the whole of the available mark range for any particular question and be prepared to award full marks for a response which is as good as might reasonably be expected of a 17 or 18-year-old GCE candidate.

Awarding zero marks

Marks should only be awarded for valid responses and no marks should be awarded for an answer which is completely incorrect or inappropriate.

Marking Calculations

In marking answers involving calculations, examiners should apply the 'own figure rule' so that candidates are not penalised more than once for a computational error. To avoid a candidate being penalised, marks can be awarded where correct conclusions or inferences are made from their incorrect calculations.

COVID-19 Context

Given the unprecedented circumstances presented by the COVID-19 public health crisis, senior examiners, under the instruction of CCEA awarding organisation, are required to train assistant examiners to apply the mark scheme in case of disrupted learning and lost teaching time. The interpretation and intended application of the mark scheme for this examination series will be communicated through the standardising meeting by the Chief or Principal Examiner and will be monitored through the supervision period. This paragraph will apply to examination series in 2021–2022 only.

/ denotes alternative points
 ; denotes separate points
comments on mark values are given in bold
comments on marking points are given in italics

AVAILABLE
MARKS

Section A

- | | | | |
|---|--|---------------------------------|----|
| 1 | <p>(a) Amplify/copy;
hydrogen;
annealing/complementary binding;
thermostable/heat-stable;</p> | [4] | 5 |
| | <p>(b) 512;</p> | [1] | |
| 2 | <p>(a) (i) Adenine;</p> <p>(ii) Label clearly indicating terminal phosphate bond;</p> <p>(iii) Phosphorylation;</p> | [1]
[1]
[1] | 5 |
| | <p>(b) Any two from:</p> <ul style="list-style-type: none"> • active transport • synthesis, e.g. of neurotransmitter (named example) • mechanical work, e.g. detachment of myosin heads (named example) • glycolysis | [2] | |
| 3 | <p>(a) In radial symmetry the body can be divided into two identical halves by any plane that goes through the central axis;
in bilateral symmetry the body can be divided into two identical halves on each side of a central axis (there are left and right sides);</p> <p>(b) (Stinging cells on) tentacles arranged around the central gut;
allowing feeding in all directions/other appropriate response;</p> <p>(c) Dorso-ventral flattening increases surface area:volume/decreases diffusion distance;
allowing more diffusion of oxygen to tissues/enabling more tissue respiration/to allow increased rate of named metabolic activity;</p> <p>(d) Any two from:</p> <ul style="list-style-type: none"> • cnidarian sac-like gut/platyhelminth branched gut • cnidarian has smaller volume mass of metabolic tissue/platyhelminth has a greater volume mass of metabolic tissue • other appropriate response (OAR) <p>(e) Any two from:</p> <ul style="list-style-type: none"> • through gut/gut shows regional specialisation • metameric segmentation/self-contained segments • SA:V ratio of metabolic tissue is increased/coelomate • other appropriate response | [2]
[2]
[2]
[2]
[2] | 10 |

- 4 (a)** Any **three** from:
- geographical isolating mechanism (by description)
 - prevents interbreeding between two groups
 - different selection pressures experienced
 - allowing accumulation of genetic differences/mutations in populations
- [3]
- (b) (i)** Different forms can reproduce;
to produce viable/fertile offspring;
or
Genomes of different forms are sequenced;
high degree of similarity;
- [2]
- (ii)** As latitude north increases the percentage of white geese per colony increases (but there is little difference between colony A (80°) and B (74°));
over the 40 year period there has been a decrease in the percentage of white geese in colonies C, D and E/colonies further south/ lower latitudes;
- [2]
- (iii)** Because snow remains longer meaning white geese are camouflaged and will have a survival advantage;
survive to reproductive age;
will pass the allele for white form into subsequent generations so the proportion of the allele increases with time;
- [3]
- (c) (i)** Not sufficiently developed/wings not developed/other appropriate response;
- [1]
- (ii)** Stabilising;
- [1]

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- 5 (a)** Any **five** from the following:
- substrate level phosphorylation in matrix/electron transport chain on cristae/inner mitochondrial membrane
 - Krebs cycle generates 2ATP per glucose molecule (1ATP per cycle) by substrate level phosphorylation
 - hydrogen removed from Krebs intermediates
 - hydrogen/electrons passed along a series of carriers at progressively lower energy levels
 - O₂ is final hydrogen/electron acceptor
 - at certain points, enough energy is released to allow ATP to form
 - H accepted by NAD, 3 ATP produced/H accepted by FAD, 2 ATP produced
 - for one molecule of glucose, 34 ATP molecules are produced via electron transfer/oxidative phosphorylation (36 ATP in total) [5]
- (b) (i)** $3.3 \times 10^9 + 16\,569$;
3 300 016 569; [2]
- (ii)** Enzymes associated with Krebs cycle/respiratory chain/NADH dehydrogenase/cytochrome oxidase/cytochromes; [1]
- (iii)** Regulatory sequences/promotor regions/centromere/
other appropriate response; [1]
- (c) (i)** These cells require a lot of ATP;
less ATP results in reduced active transport; [2]
- (ii)** Functional mitochondrial DNA will be provided by the donor egg;
(since the mitochondrial DNA replicates independently of the nuclear DNA)
all cells descended from the zygote will have fully functional mitochondria; [2]
- (iii)** three individuals supply DNA to the embryo;
may cause ethical issues (by description); [2]

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		AVAILABLE MARKS
6	<p>(a) (i) Change to the genome of an organism (by description);</p> <p>(ii) Cell division/during replication or repair;</p>	<p>[1]</p> <p>[1]</p>
	<p>(b) (i) $q^2 = 532 - 369 = 163$ $163 \div 532 = \mathbf{0.31}$; $q = \sqrt{0.31} = \mathbf{0.56}$;</p> <p>$p = 1 - q = 1 - 0.56 = \mathbf{0.44}$;</p>	<p>[3]</p>
	<p>(ii) $2pq = 2 \times 0.56 \times 0.44 = 0.49$; $0.49 \times 532 = 262$; <i>(Consequential to values in (b)(i)).</i></p>	<p>[2]</p>
	<p>(c) Any two from:</p> <ul style="list-style-type: none"> • subsequent mutation giving rise to dark form • selection/predation depending on environment/differential survival • small population sampled • migration • mating not random 	<p>[2]</p>
		9

7 (a) Genotype AaBb × AaBb;

	AB	Ab	aB	ab	;
AB	AABB	AABb	AaBB	AaBb	
Ab	AABb	AAbb	AaBb	Aabb	
aB	AaBB	AaBb	aaBB	aaBb	
ab	AaBb	Aabb	aaBb	aabb	;

Genotype	Phenotype	Ratio
A_B_	Yellow smooth	9
A_bb	Yellow wrinkled	3
aaB_	Green smooth	3
aabb	Green wrinkled	1

;; [5]

(b) (i) In females both X chromosomes would need to have the DMD gene/ males only have one X chromosome so if the DMD gene is present it will be in phenotype; [1]

(ii)

	X ^D	X ^d
X ^D	X ^D X ^D	X ^D X ^d
Y	X ^D Y	X ^d Y

;;
X^dY is individual with DMD; [3]

(c) (i) Common, as the gene involved is very long; [1]

(ii) More bases involved so more chance of random mutations/other appropriate response; [1]

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- 8 (a) (i) Any **two** from:
- lack true roots
 - lack vascular tissue/support by turgor
 - lack cuticle and stomata/poor control of water loss
- [2]
- (ii) Those plants that are less able to conserve water have thicker cell walls;
vascular plants must have other adaptations to prevent water loss such as extensive roots/water proof cuticle/stomatal control/named xerophytic adaptation/mosses lack other mechanisms to control water loss; (thicker cell walls tend to reduce water loss/aid water retention) [2]
- (b) (i) **X** RUBISCO;
Y glycerate phosphate/GP/phosphoglyceric acid/PGA;
Z reduced NADP/NADPH; [2]
(3 for 2, 2 for 1, 1 for 0)
- (ii) 1/6; [1]
- (iii) The products of the light-dependent reaction/NADPH and ATP are no longer made;
required to reduce and phosphorylate (by description) the intermediates of the light-independent stage/convert GP to TP; [2]
- (c) Suspension B is contaminated with mitochondria;
suspension A decolourises when in light indicating electron transfer is taking place, but does not decolourise in the dark indicating electron transfer has ceased;
suspension B decolourises faster in light suggesting (more chloroplasts or) mitochondrial electron transfer/B also decolourises in the dark but slowly indicating absence of chloroplast activity but mitochondrial activity continues; [3]
- (d) (i) CO₂ moves more slowly through the mesophyll in ferns;
so CO₂ entering through the stomata builds up in the sub-stomatal air spaces; [2]
- (ii) A small standard deviation of the mean (standard error) value shows that the sample means are close to the true mean/indicates reliability; [1]

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Section A

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Section B

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9 (a) Indicative Content

- chromosomal DNA is cut into fragments using restriction endonucleases (RE)
- these cut at specific base sequences/different REs recognise different sequences either side of the gene of interest
- the fragment required is identified (by probe)
- the fragment may have sticky ends or blunt ends/sticky ends are more useful as they allow joining of different sections of DNA due to unpaired complementary bases
- mRNA is isolated from cells actively expressing the desired gene
- reverse transcriptase is used to make a single stranded cDNA copy
- DNA polymerase is used to make a double stranded DNA molecule
- the amino acid sequence of the desired protein is determined
- allowing determination of the base sequence and polynucleotide synthesis
- a plasmid is a circular piece of bacterial DNA containing marker genes/acts as a vector
- a plasmid is cut using the same RE used to obtain gene/plasmid possesses same complementary sticky ends as gene
- gene and plasmid mixed and joined together using DNA ligase to form recombinant molecule
- host cells are encouraged to take up plasmids (calcium ions and temperature shock)
- when plant cells act as hosts the gene is inserted into a Ti plasmid
- the recombinant plasmid is introduced into *Agrobacterium tumefaciens* which readily invades plant tissue
- host plant cells must first have cell walls removed with cellulase to allow bacterial uptake
- other named insertion/vector example

Band	Response	Mark
3	Candidates use appropriate specialist terms to describe the processes involved in recombinant DNA technology using a minimum of nine points of indicative content. They use good spelling, punctuation and grammar and the form and style are of a very good or better standard.	[9]–[12]
2	Candidates sometimes use appropriate specialist terms to describe the processes involved in recombinant DNA technology using a minimum of five points of indicative content. They use satisfactory spelling, punctuation and grammar and the form and style are of a good standard.	[5]–[8]
1	Candidates partially describe the processes involved in recombinant DNA technology using a minimum of one point of indicative content. They use limited correct spelling, punctuation and grammar and the form and style are of a basic standard.	[1]–[4]
0	Response not worthy of credit.	[0]

[12]

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(b) Indicative Content

- gene therapy involves the insertion of a functional allele into cells affected by a particular genetic condition
- somatic-cell therapy targets only affected tissue
- that is easily accessible/by named example
- can be used at any stage in an individual's life
- germ-line therapy involves replacing the non-functional gene in the gametes or fertilised egg
- ensuring all cells in adult will have functional gene present and this is heritable
- this technique has ethical issues associated
- the main vectors used in somatic gene therapy include adenoviruses, retroviruses and liposomes
- introduced DNA may be incorporated into the host DNA or function as an independent unit/episome
- if enough donor DNA enters enough cells and is expressed then treatment is successful
- treatment can be less effective due to localisation to a particular tissue
- patients may develop infections, immune responses/immunity or allergies to the vectors used
- if the DNA acts as an episome, it is only functional for the lifespan of the cell and therefore regular repeated treatment is required

AVAILABLE MARKS

Band	Response	Mark
3	Candidates use appropriate specialist terms to discuss the major advantages and limitations of gene therapy using a minimum of five points of indicative content. They use good spelling, punctuation and grammar and the form and style are of a very good or better standard.	[5]–[6]
2	Candidates sometimes use appropriate specialist terms to discuss the major advantages and limitations of gene therapy using a minimum of three points of indicative content. They use satisfactory spelling, punctuation and grammar and the form and style are of a good standard.	[3]–[4]
1	Candidates partially discuss the major advantages and limitations of gene therapy using a minimum of one point of indicative content. They use limited correct spelling, punctuation and grammar and the form and style are of a basic standard.	[1]–[2]
0	Response not worthy of credit.	[0]

[6]

6

Section B

18

Total

100