Rewarding Learning

ADVANCED
General Certificate of Education
2022

Biology

Assessment Unit A2 2

assessing

Biochemistry, Genetics and Evolutionary Trends

[ABY21]

THURSDAY 16 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 **(a)** **(i)** (Frequency/proportion of) homozygous recessive genotype; [1]

(ii) 2pq; [1]

(iii) Not diploid/divide rather than reproduce sexually/other appropriate response; [1]

(b) The sum total of genes/alleles in a population; [1] 4

2 **(a)** **(i)** Arthropoda; [1]

(ii) Jointed limbs/or by description; [1]

(b) **(i)** 4×10^6/four million; [1]

(ii) (Very small and) difficult to find/unexplored habitats (e.g. deep jungle)/ many in soil/small differences between species/some species very localised/other appropriate response; [1]

(iii) Ability to fly – escape ground-based predators/access food (e.g. nectar)/ easier to colonise new habitats/other appropriate response;
Small body size – requires small amounts of food/many can live in a small area/can live in difficult to access niches/other appropriate response; [2]

(c) Possess spinal column/notochord/(calcified) bones; [1] 7

				AVAILABLE MARKS
3	**(a)**	**(i)**	Cytoplasm; [1]	
		(ii)	6; [1]	
		(iii)	The NADH enters the mitochondrion; Any **three** from: • hydrogen/electrons pass through a series of carriers in the electron transport chain • electrons have progressively lower energy levels along the chain • electrons lose/release energy as pass along the chain • at 3 points sufficient energy given out/available to produce ATP [4]	
		(iv)	(2) ATP used to phosphorylate glucose/form fructose bisphosphate; [1]	
	(b)	**(i)**	NADH $\longrightarrow$ NAD added correctly; [1]	
		(ii)	Lactate can be further broken down (when oxygen available) to release energy; ethanol is toxic; [2]	
	(c)	**(i)**	Carbon dioxide produced divided by the oxygen consumed in respiration; [1]	
		(ii)	Carbon dioxide produced in pyruvate – ethanol stage; (in anaerobic respiration) ETC does not take place (no oxygen used); some aerobic respiration is taking place (so some O_2 utilised in ETC); [3]	14
4	**(a)**	**(i)**	X – thymine; Y – ribonucleotide/RNA nucleotide; [2]	
		(ii)	Uracil is only found on mRNA/mRNA formed rather than DNA; only one template strand/in DNA replication both strands act as template strands; [2]	
		(iii)	Joins RNA nucleotides/ribonucleotides together (by phosphodiester bonds); [1]	
	(b)	**(i)**	2%; [1]	
		(ii)	Bacteria/prokaryotes have zero/very low amounts of non-coding DNA; introns are non-coding (so cannot be present); [2]	
		(iii)	Provides a point of attachment to spindle fibres (during cell division)/ holds chromatids together; [1]	
	(c)	**(i)**	Cells are not specialised into specific cell types; [1]	
		(ii)	Cytosine; [1]	
		(iii)	Methylation ‘switches off’ (the mitosis-suppressing) genes; so cells undergo rapid/repeated division/preventing them stopping cells dividing out of control (and forming tumours); [2]	13

				AVAILABLE MARKS
5	**(a)**	**(i)**	Allows longer time for digestion/absorption; [1]	
		(ii)	Any **two** from: • ethical issues with killing young calves to obtain rennet • only a small amount can be obtained from each calf/genetic engineering can produce large quantities • chymosin is the most effective enzyme (rather than a mixture as in calves) [2]	
		(iii)	Plasmid cut using the same restriction enzyme used in obtaining chymosin gene (so as to provide complementary sticky ends); DNA ligase used to anneal chymosin gene with the plasmid; detail of method used to encourage uptake of recombinant plasmid into bacteria (e.g. heat shock); [3]	
	(b)	**(i)**	To know which type of restriction endonuclease to use (immediately adjacent to the MRS); [1]	
		(ii)	To decrease possibility of two individuals having the same genetic fingerprint/create a unique fingerprint; [1]	
		(iii)	Only a small amount of DNA may be available for analysis/genetic fingerprinting requires more DNA than is often available; [1]	
		(iv)	Investigating ancestral relationships/identifying human remains/ pedigree horse/pet confirmation/paternity disputes/other appropriate response; [1]	10

				AVAILABLE MARKS
6	**(a)**	The rate of photosynthesis at different wavelengths; [1]		
	(b)	**(i)** Different pigments absorb at different wavelengths; increases the overall amount of light absorbed; [2]		
		(ii) Combines with hydrogen ions; to form NADPH/reduced NADP (for use in the light-independent reaction); [2]		
		(iii) From PSII; [1]		
	(c)	**(i)** The light intensity/point at which carbon dioxide used in photosynthesis is the same as the carbon dioxide released in respiration/point at which the rates of photosynthesis and respiration are equal; [1]		
		(ii) As temperature increases the light intensity at the compensation point increases; particularly dramatic increase at higher temperature/above 30 °C; at lower temperatures rate of respiration increases slowly as temperature increases requiring only a small increase in light and photosynthesis rate to compensate; at higher temperatures the respiration rate increases dramatically as temperature increases requiring a large increase in light to increase photosynthesis rate enough to compensate; [4]		11

7 **(a)** An allele which is not expressed in the phenotype if a dominant allele is present/an allele which is only expressed in the phenotype if both alleles are recessive; [1]

(b) **(i)** 1 – X^bY;
4 – X^BY;
8 – X^BX^b; [3]

(ii) Sex-linked recessive; [1]

(c) HhRr (HR) (Hr) (hR) (hr) × Hhrr; (Hr) (hr);

	HR	Hr	hR	hr
Hr	HHRr	HHrr	HhRr	Hhrr
hr	HhRr	Hhrr	hhRr	hhrr

;

0.125/1 in 8 offspring not affected by either condition; [4]

(d) **(i)** The data are continuous/a normal distribution/there are no distinct categories; [1]

(ii) The mean for fur length in captivity is lower than in the natural habitat (or converse); [1]

(iii) Conditions in captivity are warmer/other appropriate response; [1] 12

AVAILABLE MARKS

				AVAILABLE MARKS
8	(a)	(i)	Transports water taken in by roots to the leaves/provides support necessary to extend above ground; [1]	
		(ii)	Any **two** from: • waterproof cuticle • fine control of stomata • true roots (to obtain water from substratum) [2]	
	(b)	(i)	Lysosomes; [1]	
		(ii)	Increase in oxygen usage up to day 30 then dramatic fall; (up to day 30) respiration rate increases due to cell building up lignin in walls/manufacturing hydrolytic enzymes; decrease due to release of hydrolytic enzymes; leading to destruction of cell contents (and therefore very little respiration taking place); [4]	
	(c)	(i)	Thicker wall/smaller lumen; [1]	
		(ii)	Support (only); very thick (lignified) walls so lumen too narrow for effective water transport; [2]	11
			Section A	**82**

Section B

AVAILABLE MARKS

9 (a) Indicative content

- gene mutations involving a single gene
- detail of gene mutations, e.g. base substitutions, deletions
- chromosome mutations involving whole chromosomes or large sections of a chromosome (several genes)
- crossing over during meiosis/gamete formation
- ensures that all gametes are unique (allow once)
- independent assortment during meiosis/gamete formation
- ensures that all gametes are unique (allow once)
- sexual reproduction involving cross-fertilisation/mixing of gametes

Band	Response	Mark
3	Candidates use the most appropriate specialist terms to clearly outline the main causes of variation in living organisms using a minimum of **five points** of indicative content. Spelling, punctuation and grammar are excellent and the form and style are of a high standard.	[5]–[6]
2	Candidates use appropriate specialist terms to outline the main causes of variation in living organisms using a minimum of **three points** of indicative content. Spelling, punctuation and grammar are good and the form and style are of a high standard.	[3]–[4]
1	Candidates partially outline the main causes of variation in living organisms using a minimum of **one point** of indicative content. Spelling, punctuation and grammar are satisfactory and the form and style are of a basic standard.	[1]–[2]
0	Response not worthy of credit.	[0]

[6]

(b) Indicative content

- selection as a process operating on genetic variation within a population
- natural selection favours particular phenotypes within a population
- favourable alleles increase in frequency through the generations (as a consequence of natural selection)
- fitness as those features that allow an organism to be adapted to its environment
- directional selection favours one extreme of the population and is most important in evolutionary change
- allopatric speciation important when populations are geographically isolated (as in oceanic islands)
- allows populations of a species to be reproductively isolated
- eventually leading to the formation of new species as a consequence of genetic divergence
- a small number of founder species will have colonised the islands
- A, B and C were formed longer ago than D and E so more time for habitat development/evolutionary change (or converse for D and E)
- the larger islands (A, B and C) have more habitats so have more niches and consequently more species (converse for D and E)
- A as the largest and oldest island (and most habitats) has most species
- also shorter distances between the islands (A, B and C) so less effective geographic isolation
- D and E less likely to have colonisation from A, B or C due to distances involved (or from each other) have the smallest number of species
- adaptive radiation

Band	Response	Mark
3	Candidates use the most appropriate specialist terms to clearly describe and explain how evolutionary change comes about and account for the distribution of species across the island group using a minimum of **nine points** of indicative content. Spelling, punctuation and grammar are excellent and the form and style are of a high standard.	[9]–[12]
2	Candidates use appropriate specialist terms to clearly describe and explain how evolutionary change comes about and account for the distribution of species across the island group using a minimum of **five points** of indicative content. Spelling, punctuation and grammar are good and the form and style are of a high standard.	[5]–[8]
1	Candidates partially describe and explain how evolutionary change comes about and account for the distribution of species across the island group using a minimum of **one point** of indicative content. Spelling, punctuation and grammar are satisfactory and the form and style are of a basic standard.	[1]–[4]
0	Response not worthy of credit.	[0]

[12]

Section B

Total

AVAILABLE MARKS
18
18
100