



ADVANCED
General Certificate of Education
2019

Biology

Assessment Unit A2 2

assessing

Biochemistry, Genetics and Evolutionary Trends

[ABY21]

THURSDAY 13 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.

Types of mark schemes

Mark schemes for tasks or questions which require candidates to respond in extended written form are marked on the basis of levels of response which take account of the quality of written communication.

Other questions which require only short answers are marked on a point for point basis with marks awarded for each valid piece of information provided.

Levels of response

In deciding which level of response to award, examiners should look for the 'best fit' bearing in mind that weakness in one area may be compensated for by strength in another. In deciding which mark within a particular level to award to any response, examiners are expected to use their professional judgement.

The following guidance is provided to assist examiners.

- **Threshold performance:** Response which just merits inclusion in the level and should be awarded a mark at or near the bottom of the range.
- **Intermediate performance:** Response which clearly merits inclusion in the level and should be awarded a mark at or near the middle of the range.
- **High performance:** Response which fully satisfies the level description and should be awarded a mark at or near the top of the range.

Quality of written communication

Quality of written communication is taken into account in assessing candidates' responses to all tasks and questions that require them to respond in extended written form. These tasks and questions are marked on the basis of levels of response. The description for each level of response includes reference to the quality of written communication.

For conciseness, quality of written communication is distinguished within levels of response as follows:

- Level 1: Quality of written communication is basic.
- Level 2: Quality of written communication is good.
- Level 3: Quality of written communication is excellent.

In interpreting these level descriptions, examiners should refer to the more detailed guidance provided below:

Level 1 (Basic): The candidate makes only a limited selection and use of an appropriate form and style of writing. The organisation of material may lack clarity and coherence. There is little use of specialist vocabulary. Presentation, spelling, punctuation and grammar may be such that intended meaning is not clear.

Level 2 (Good): The candidate makes a reasonable selection and use of an appropriate form and style of writing. Relevant material is organised with some clarity and coherence. There is some use of appropriate specialist vocabulary. Presentation, spelling, punctuation and grammar are sufficiently competent to make meaning clear.

Level 3 (Excellent): The candidate successfully selects and uses the most appropriate form and style of writing. Relevant material is organised with a high degree of clarity and coherence. There is widespread and accurate use of appropriate specialist vocabulary. Presentation, spelling, punctuation and grammar are of a sufficiently high standard to make meaning clear.

/ 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)** Template (strand); [1]
(b) 18; [1]
(c) Joins ribonucleotides together (in the correct sequence); [1]
(d) Nucleus; [1]

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2 (a)

Stage	Net number of ATPs produced
Glycolysis	2
Link reaction	0
Krebs cycle	2
Electron transport chain	34

[All correct = [2]; 2/3 correct = [1] [2]

- (b) (i)** Cristae; [1]
(ii) Electrons occupy progressively lower energy levels in each carrier;
 electrons lose energy as they are passed along the chain;
 at two/three points, sufficient energy given out to produce ATP; [3]
(iii) Electrons cannot be removed from cytochromes (cytochromes remain
 reduced);
 as hydrogen/electrons cannot combine with oxygen; [2]
(c) Glycolysis can only occur with carbohydrate;
 so (additional) ATP can be produced without oxygen involvement only
 when carbohydrate is respired; [2]

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- 3 (a) Any **two** from:
- crossing over during the formation of gametes
 - independent assortment of chromosomes of gametes
 - random nature of gametes combining in fertilisation
- [2]
- (b) Different types of alleles present with each in excess of 1%/frequency of each allele too high to be explained by (recent) mutation; [1]
- (c) (i) Allele I^O is most frequent/I^B least frequent/same order of frequency; [1]
- (ii)

Category	European country	African country	Differences	Differences ²	$\frac{\text{Differences}^2}{\text{European allele frequency}}$
I ^A	460	298	162	26 244	57.05
I ^B	210	198	12	144	0.69
I ^O	1330	1504	-174	30 276	22.76

$\chi^2 = 80.5$; [1]

- (iii) 2;
p < 0.001; [2]
- (iv) The differences in allele frequencies for the two countries are (very highly) significant; [1]
- (v) In certain regions a particular allele could give a selective advantage/
selective advantage explained/separate mutations in different regions
and limited mating between regions/other appropriate response; [1]

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- 4 (a) (i) Removing the gene of interest from (human) DNA producing a break in a plasmid (with complementary 'sticky ends' to the DNA to be inserted); [1]
- (ii) Treating disease (e.g. killing cancer cells or treating bacterial infections)/vector; [1]
- (b) (i) $(1\,800\,000 - 17\,000) \div 1\,783\,000 \times 100 = 10\,488.235;$
10 000%; [2]
- (ii) Fewer restrictions/more acceptable to society/other appropriate response; [1]
- (c) (i) In the mature plant (grown from the small section) more of the cells will contain the inserted gene (or converse);
as the cells produced following the tissue culture stage will carry the inserted gene/a higher proportion of cells in tissue culture can have the desired gene inserted/the mature plant will be produced by cell division from the small section; [2]
- (ii) Following gene transfer the plant tissue is treated with herbicide;
only those plants/tissue sections resistant to the herbicide carry the desirable gene; [2]
- (iii) Higher percentage of transgenic plants;
reduced public opposition linked to concern about herbicide tolerance genes escaping into the wild/development of herbicide tolerant weeds; [2]
- (d) (i) Any **two** from:
 - many developing countries/famine-stricken countries have dry soils
 - increases food production (in these countries/globally)
 - other appropriate response, e.g. extend the range over which crops can grow
[2]
- (ii) Loss of habitat/crops more costly to produce/transfer of herbicide tolerance genes to weeds/may not self-seed, so new seeds need to be bought each year; [1]

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5 (a) (i)

	B	b
B	BB	Bb
b	Bb	bb

Normal Batten disease
 3 : 1;

[2]

(ii) Individuals with Batten disease are selected against/less likely to have offspring; [1]

(b) (i) Certain traits are more likely to occur in males/a particular sex; [1]

(ii) X^hX^h and X^hY ; [1]

(iii) For a female to have the condition she must have inherited an allele from each parent; the condition/allele is rare so the chance of both parents carrying the allele is remote; [2]

(c) Male – BX^hBY ;
 Female – $BX^H BX^h bX^H bX^h$; [2]

(d) (i) Polygenic;
 with many genes wide variety of phenotypes possible; [2]

(ii) Skin colour is influenced by the environment/is not purely genetic; [1]

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6 (a) (i) Heritable modifications of the genome/variations in gene activity that do not involve changes to the DNA base sequence; [1]

(ii) Any **four** from:
 • gene activity decreases as percentage of CG sequences methylated increases
 • at highest percentages there is zero activity/gene is switched off
 • methylation involves methyl group attaching to cytosine
 • (gene activity decreases as a result of) reduced transcription
 • example of mechanism by which transcription may be reduced, e.g. RNA polymerase cannot bind [4]

(iii) Histone modification; [1]

(iv) Genes will only be switched on/expressed in those cells where the protein produced is normally present/required; less wastage of resources; [2]

(b) (i) Active genes transcribed into mRNA/mRNA translated to make protein; [1]

(ii) Any **three** from:
 • mRNA is added to the microarray
 • mRNA binds to complementary sequence in a well
 • fluorescent or chemiluminescent tags present on mRNA
 • increasing colour/fluorescence indicates increasing hybridisation/ gene expression [3]

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			AVAILABLE MARKS
7	(a)	A species is a group of individuals of common ancestry that closely resemble each other, and are normally capable of interbreeding to produce fertile offspring; [1]	
	(b)	(i) Habitats divided by lava flows; so that populations are separated; <i>Drosophila</i> are poor fliers; so less likely to move between geographical locations/cross geographical barriers; [4] (ii) (Allopatric) speciation takes many years to occur so the older the island the more opportunities for speciation; through mutation/lava flows splitting habitats; older islands are likely to have more diverse habitats so more opportunities for natural selection to act; [3]	
	(c)	Basic body plan that is easily adapted; have evolved into most available habitats, e.g. water, land and air; or produce large numbers of offspring; contributing to more opportunities for mutation; or have evolved a wide range of mouthparts/have larval and adult forms; contributing to less competition for food; [2]	10
8	(a)	(i) True roots; which can penetrate the substratum to reach water; or waterproof cuticle; to reduce water loss by cuticular transpiration/evaporation; or fine control over stomata; to reduce water loss by transpiration/evaporation; [2] (ii) Thickened walls; with lignin; [2]	
	(b)	(i) Trees reach greater height than ferns; height : width ratios are greater in ferns; height : width ratios are more variable in ferns; [3] (ii) The greater width allows the trees to achieve greater heights/more stability at greater heights; giving them competitive advantage/able to photosynthesise at higher rates; [2]	
	(c)	Similarity – both have a hydrostatic skeleton; Difference – hydrostatic skeleton in Cnidaria based on external medium/ within enteron (gut) whereas in Annelida it is internal fluids/within coelom; [2]	11
Section A			82

Section B

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9 (a) Indicative content

- in the light-dependent stage light is harvested over a range of wavelengths
- in the thylakoids of the chloroplasts
- in two different photosystems (photosystems II and I)
- chlorophyll *a* molecules become excited/photoactivated and lose electrons
- electrons replaced by the splitting of water/photolysis
- electrons pass through a series of carriers (at progressively lower energy levels)
- at certain stages in ETC there is sufficient energy to make ATP/ photophosphorylation
- (in PSI) electrons replaced from PSII/electron transport chain
- electrons combine with hydrogen ions from photolysis
- to form hydrogen
- that combines with NADP to make NADPH
- ATP and NADPH used in the light-independent reaction
- in the stroma of the chloroplast
- carbon dioxide combines with RuBP to form 2 molecules of glycerate phosphate
- catalysed by rubisco
- NADPH used to reduce the glycerate phosphate to form triose phosphate
- using energy from ATP
- 1/6 of triose phosphate converted to glucose (and other compounds) with 5/6 recycled to form RuBP

Band	Response	Mark
A	Candidates use the most appropriate specialist terms to clearly describe and explain how plants utilise light energy to make glucose using a minimum of ten points of indicative content. Spelling, punctuation and grammar are excellent and the form and style are of a high standard.	[9]–[12]
B	Candidates use appropriate specialist terms to clearly describe and explain how plants utilise light energy to make glucose using a minimum of six points of indicative content. Spelling, punctuation and grammar are good and the form and style are of a high standard.	[5]–[8]
C	Candidates partially describe and explain how plants utilise light energy to make glucose using a minimum of one point of indicative content.	[1]–[4]
D	Response not worthy of credit.	[0]

[12]

(b) Indicative content

- in shady positions, light is expected to be a limiting factor
- broad leaves provide greater surface area for absorption of light
- thin leaves have fewer cell layers for light to penetrate
- darker leaves contain greater amount of chlorophyll/other pigments for light absorption
- at top of canopy, carbon dioxide availability expected to be limiting factor
- greater stomatal density allows more intake of carbon dioxide

Band	Response	Mark
A	Candidates use the most appropriate specialist terms to clearly explain how leaves are adapted for low and/or high light levels 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]
B	Candidates use appropriate specialist terms to clearly explain how leaves are adapted for low and/or high light levels 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]
C	Candidates partially explain how leaves are adapted for low and/or high light levels using a minimum of one point of indicative content.	[1]–[2]
D	Response not worthy of credit.	[0]

[6]

Section B

Total

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100