



*Rewarding Learning*

**ADVANCED**  
**General Certificate of Education**  
**2023**

---

**Biology**

**Assessment Unit A2 2**

*assessing*

**Biochemistry, Genetics and Evolutionary Trends**

**[ABY21]**

**FRIDAY 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.

/ 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**

| <b>Term</b>        | <b>Definition</b>  |
|--------------------|--|
| Gene               | <b>Length of chromosome/DNA coding for a protein/polypeptide;</b>        |
| Allele             | <b>Alternate forms of the same gene;</b>                                 |
| <b>Homozygous;</b> | Both alleles of a gene are the same.                                     |
| <b>Locus;</b>      | The position of a gene on a chromosome.                                  |
| Phenotype          | <b>Expression of the genotype (in association with the environment);</b> |

[5]

5

**2 (a) (i)** RNA polymerase; [1]

**(ii)** Arrow to the right; [1]

**(iii)** Any **four** from:  
 • hydrogen bonds broken between DNA strands  
 • free ribonucleotides  
 • use complementary base pairing  
 • joining to the template strand  
 • adjacent ribonucleotides are joined by phosphodiester bonds [4]

**(b)** Introns (non-coding) removed/excised;  
 exons/coding RNA are spliced/joined; [2]

8

|          |  |    | AVAILABLE MARKS |
|----------|--|----|-----------------|
| <b>3</b> | <p><b>(a) (i)</b> Analysis of DNA from crime scene/infection diagnosis/paternity cases/target gene involved in gene technology/OAR; [1]</p> <p><b>(ii)</b> Time 1.25 hrs;<br/>1.25 × 40 = 50 cycles; [2]</p> <p><b>(b)</b> Taq polymerase is thermostable (or by description); therefore no requirement to replace polymerase at end of each cycle; complete process is faster/more cost efficient; [3]</p> <p><b>(c) (i)</b> Y: primer; [1]</p> <p><b>(ii)</b> Any <b>two</b> from:</p> <ul style="list-style-type: none"> <li>• prevents reannealing of DNA strands</li> <li>• DNA must be double stranded for replication/copying to begin/initiates replication/provides substrate for polymerase</li> <li>• brackets DNA sections to be copied [2]</li> </ul>   | 9  |                 |
| <b>4</b> | <p><b>(a) (i)</b> Any <b>two</b> from:</p> <ul style="list-style-type: none"> <li>• small amount of energy is released</li> <li>• single reaction</li> <li>• easily transported [2]</li> </ul> <p><b>(ii)</b> Any <b>two</b> from:</p> <ul style="list-style-type: none"> <li>• prevents hydrogen/electrons joining with oxygen;</li> <li>• since electron/hydrogen carriers remain reduced;</li> <li>• prevents (ATP formation by) oxidative phosphorylation; [2]</li> </ul> <p><b>(b)</b> Release of the myosin head (and reorientation) from actin binding site; [1]</p> <p><b>(c) (i)</b> At the start of exercise most ATP is supplied by phosphocreatine system;<br/>anaerobic respiration then supplies ATP as phosphocreatine system reduces supply of ATP;<br/>aerobic respiration then supplies ATP production (as anaerobic production reduces) as exercise continues/ATP produced by aerobic respiration generates ATP for a sustained period; [3]</p> <p><b>(ii)</b> Creatine phosphate system produces ATP very rapidly/creatine phosphate stored in muscle cells is rapidly used up;<br/>anaerobic respiration due to limited availability of oxygen (due to intensity of exercise)/glycolysis is shorter pathway/produces ATP faster; [2]</p> <p><b>(d)</b> Allows regeneration/reoxidation of NAD;<br/>so allowing dehydrogenation reactions to continue; [2]</p> | 12 |                 |

|            |  |  | AVAILABLE MARKS |    |   |     |
|------------|--|--|-----------------|----|---|-----|
| <b>5</b>   | <b>(a)</b>   | <b>(i)</b> A: thylakoid labelled;<br>B: stroma labelled;   | [2]             | 13 |   |     |
|            |  | <b>(ii)</b> Double membrane surrounding organelle;   | [1]             |    |   |     |
|            | <b>(b)</b>   | <b>(i)</b> Any <b>three</b> from: <ul style="list-style-type: none"> <li>• large numbers of accessory pigments</li> <li>• absorption of light over a range of wavelengths</li> <li>• tightly packed</li> <li>• allowing resonance energy transfer</li> <li>• ordered arrangement on thylakoid</li> </ul>                       | [3]             |    |   |     |
|            |  | <b>(ii)</b> (Light energy absorbed) resulting in photoactivation/electron excitement/raised to higher energy level/electron emission; passed to electron acceptor molecule; pass down an electron carrier chain;   | [3]             |    |   |     |
|            |  | <b>(iii)</b> PSII electrons replace those emitted from PSI; Photolysis (by description) as electron source to replace those of PSII;   | [2]             |    |   |     |
|            | <b>(c)</b>   | Any <b>two</b> from: <ul style="list-style-type: none"> <li>• reduces impact of low light intensity as a limiting factor;</li> <li>• light dependent reaction can proceed at a faster rate (than with fewer accessory pigment molecules);</li> <li>• resulting in increased production of glucose/organic molecules</li> </ul> | [2]             |    |   |     |
|            |  | <b>6</b>   | <b>(a)</b>      |    |   |     |
|            |  |  | <b>(i)</b>      |    | Aerobic: oxygen produced as a by-product of photosynthesis, Motile: bacteria will accumulate in/move to regions of higher oxygen concentration; | [2] |
|            | <b>(ii)</b> The <b>rate</b> of photosynthesis; which occurs at different wavelengths of light;                                   |  |                 |    | [2]   |     |
|            | <b>(iii)</b> The 95% confidence limits overlap at these wavelengths  | [1]  |                 |    |   |     |
| <b>(b)</b> | Wide confidence limits indicate lower reliability; since the results are more variable larger standard deviation/standard error; | [2]  | 7               |    |   |     |

|   |   | AVAILABLE MARKS                  |
|---|---|----------------------------------|
| 7 | <p><b>(a) (i)</b> (Mature) mRNA is extracted from tissue; reverse transcriptase uses mRNA (as a template) to make cDNA; single strand of cDNA is converted to double stranded molecule (by DNA polymerase);</p> <p><b>(ii)</b> (Pancreas cells) produce insulin; indicating high mRNA copy;</p> <p><b>(iii)</b> Cut DNA at a specific base sequence; producing staggered (or blunt) ends;</p> | <p>[3]</p> <p>[2]</p> <p>[2]</p> |
|   | <p><b>(b) (i)</b> Vector</p> <p><b>(ii)</b> Thermal shock/calcium ions;</p> <p><b>(iii)</b> Growth of bacterial cells with tetracycline or ampicillin; those that have taken up the plasmids will be resistant to tetracycline; bacteria that have plasmids with insulin gene insert in ampicillin resistance gene cannot grow because the ampicillin gene is interrupted by insert;</p>      | <p>[1]</p> <p>[1]</p> <p>[3]</p> |
|   |   | 12                               |

- 8 (a) Dominance is an allelic interaction;  
Epistasis is a gene interaction; [2]

(b) Gametes: AB Ab aB ab AB Ab aB ab;

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

| F1 phenotypes | Ratio (number) |
|---------------|----------------|
| White         | 12             |
| Yellow        | 3              |
| Green         | 1              |

(c) (i)

| Phenotype | Observed (O) | Expected (E)   | O-E    | (O-E) <sup>2</sup> | $\frac{(O-E)^2}{E}$ |
|-----------|--------------|----------------|--------|--------------------|---------------------|
| White     | 2560         | 2550           | 10.00  | 100.00             | 0.039               |
| Yellow    | 620          | <b>637.50;</b> | -17.50 | <b>306.25;</b>     | <b>0.480;</b>       |
| Green     | 220          | 212.50         | 7.50   | 56.25              | 0.265               |
|           |              |                |        |                    | <b>Σ = 0.784;</b>   |

- (ii) 2 df; [4]
- (iii)  $0.90 > p > 0.50$ ; [1]
- (iv) There is no significant difference between observed and expected numbers of squash colours; [1]
- (v) The null hypothesis is accepted; [1]
- (vi) The results obtained suggest genes A and B indicate an epistatic interaction/results obtained fit the hypothesis that suggest the gene are linked epistatically; [1]

Section A

AVAILABLE  
MARKS

16

82

**9 Indicative content**

A minimum of two marks essential for each Phylum.

**Phylum: Cnidaria**

- radial symmetry
- allows feeding in all directions/filter feeder
- simple sac like gut/enteron/only one opening
- support is by hydrostatic skeleton/fluid filled enteron/aqueous medium
- OAR

**Phylum: Platyhelminthes**

- bilateral symmetry (*allow once for all phyla not cnidarians*)
- allowing development of head region (*allow once for all other phyla not cnidarians*)
- tube-like, branched gut
- although there is some specialisation there is a dense mass of metabolic tissue
- dorso-ventral flattening increases surface area:volume
- support is mainly by body tissue skeletal system absent)
- OAR

**Phylum: Annelida**

- metamerically segmented
- support provided by hydrostatic skeleton of segmented body cavities
- development of a one-way gut with mouth and anus
- allows regional specialisation/example of regional specialisation, e.g. crop/gizzard
- OAR

**Phylum: Arthropoda**

- possess a one-way gut showing regional specialisation
- basic body plan is suited to many feeding niches/by description
- a range of mouthpart types
- often larval form will have different food sources than adults of the same species
- OAR

**Phylum: Chordata**

- support by internal/jointed calcified skeleton
- spinal/vertebral column
- segmented muscle blocks
- possess one-way gut with a **high degree** of regional specialisation/**but to a much greater extent than other phyla**
- other associated systems, e.g. circulatory allow mass flow/transport.



| Band | Response  | Mark             | AVAILABLE MARKS |
|------|---|------------------|-----------------|
| 3    | Candidates use appropriate specialist terms to discuss the evolutionary development of feeding and support in the phyla using a minimum of <b>fourteen</b> points of indicative content. They must use good spelling, punctuation and grammar and the form and style are of a very good or better standard. | [14]–[18]        |                 |
| 2    | Candidates sometimes use appropriate specialist terms to discuss the evolutionary development of feeding and support in the phyla using a minimum of <b>eight</b> points of indicative content. They use satisfactory spelling, punctuation and grammar and the form and style are of a good standard.      | [8]–[13]         |                 |
| 1    | Candidates partially discuss the evolutionary development of feeding and support in the phyla using a minimum of <b>one</b> point of indicative content. They use limited correct spelling, punctuation and grammar and the form and style are of a basic standard.   | [1]–[7]          |                 |
| 0    | Response not worthy of credit.  | [0]              |                 |
|      |   | [18]             | 18              |
|      |   | <b>Section B</b> | <b>18</b>       |
|      |   | <b>Total</b>     | <b>100</b>      |