



*Rewarding Learning*

**ADVANCED**  
**General Certificate of Education**  
**2022 Reserve Series**

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## **Life and Health Sciences**

**Assessment Unit A2 5**

*assessing*

**Genetics, Stem Cell Research and Cloning**

**[AZ051]**

**FRIDAY 1 JULY, AFTERNOON**

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**MARK  
SCHEME**

## General Marking Instructions

### Introduction

Mark schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

### The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of students in schools and colleges.

The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes, therefore, are regarded as part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

### 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.

			AVAILABLE MARKS
<b>1</b>	<b>(a)</b> Meiosis;	[1]	4
	<b>(b)</b> Gametes/sperm and ova; chromosomes; genetically;	[3]	
<b>2</b>	<b>(a) (i)</b> Pancreas;	[1]	7
	<b>(ii)</b> Diabetes;	[1]	
	<b>(b) (i)</b> Humulin;	[1]	
	<b>(ii)</b> Human insulin gene has been used to produce the GE insulin; therefore the insulin produced is human insulin/if not produced by GE will differ from human insulin;	[2]	
	<b>(iii)</b> Any <b>two</b> from: <ul style="list-style-type: none"> <li>• larger quantities being made</li> <li>• low production costs</li> <li>• fewer ethical or religious issues</li> </ul>	[2]	
<b>3</b>	<b>(a) (i)</b> Nucleotide correctly circled;	[1]	11
	<b>(ii)</b> Cytosine;	[1]	
	<b>(iii)</b> Thymine base (is in DNA but not in RNA);	[1]	
	<b>(iv)</b> Ribose sugar/single strand/three types of RNA;	[1]	
	<b>(b) (i)</b> Conservative;	[1]	
	<b>(ii)</b> Semi-conservative;	[1]	
	<b>(iii)</b> Any <b>five</b> from: <ul style="list-style-type: none"> <li>• unzipping/unwinding of the double helix/two strands are separated</li> <li>• by the breaking of hydrogen bonds</li> <li>• by DNA helicase</li> <li>• free nucleotides combine with the template strands</li> <li>• by base pairing</li> <li>• DNA polymerase</li> <li>• joins adjacent nucleotides together</li> </ul>	[5]	
	<b>4 (a)</b> Produce different types of cells (or by example);	[1]	
	<b>(b)</b> Obtain stem cells (from human skin); Switch on/stimulate genes responsible for producing type(s) of cells required;	[2]	
	<b>(c)</b> In older people stem cells divide at a much slower rate (or converse); so it takes longer to produce new bone (or other) cells (or converse);	[2]	

- 5 (a) (i) Pea; [1]
- (ii) aaRR and aaRr; [1]
- (b) (i)
- |    |      |      |      |      |
|----|------|------|------|------|
|    | AR   | Ar   | aR   | ar   |
| AR | AARR | AARr | AaRR | AaRr |
| Ar | AARr | AArr | AaRr | Aarr |
- [2] for gametes; [2] for correct offspring  
[1] for 1/2 errors in offspring [4]
- (ii) Walnut – 6;  
Pea – 2; [2]
- (iii) Both sets of parental gametes would need to contain recessive alleles only/(in any cross) at least one set of parental gametes had at least one dominant allele; [1]
- (iv) aaRR and aaRR;  
and aaRR and aaRr [2]
- (c) Epistasis; [1]

AVAILABLE  
MARKS

12

- 6 (a) The fastest speed has increased over the last 100 years; [1]  
Any **three** from:
- although not an exact correlation;
  - the fastest runners were selected/the slowest runners were not selected;
  - selected runners were bred;
  - this was repeated many times;
  - with the result that the horses became 'genetically' faster [3] [4]
- (b) Genes with the desired quality are introduced (into the target organism); only requires one generation (traditional breeding requires many generations); introduced genes may introduce new genetic combinations not previously present; traditional breeding can only edit/combine genetic material already present; [4]
- (c) Any **two** from:
- ethical/religious issues
  - lack of understanding
  - unknown consequences
  - produce allergies
  - designer babies
  - other appropriate response [2]

10

- 7 (a) (i) Mucus (in the lungs) traps microbes causing infections/restricts the removal of microbes (by coughing)/other appropriate response; [1]
- (ii) 3 (allow 6 if both strands of the DNA are considered); [1]
- (iii)  $0.04 \times 0.04 = 0.0016$ ;  
 $0.0016 \times 0.25$ ;  
 $0.0004/0.04\%/1$  in 2500; [3]

(b) **Indicative content**

**Processes**

- repairing defective gene
- replacing the faulty gene with a normal one
- adding a normal gene and leaving the defective one in position
- can put gene into vector/aerosol or other appropriate discussion

**Benefits and problems with treating CF by gene therapy**

- (if successful) can lead to normal lung function
- thus avoiding problems associated with mucus build up
- only lungs can benefit when using aerosols/digestive system unaffected by gene therapy treatment
- aerosol may not reach all parts of the lung/or fail to enter lung cells
- use of virus vector may cause allergies or unwanted immune responses
- repeat treatments may be necessary/new cells produced by the body will still contain the affected gene
- other appropriate response

Level of response	Marking criteria	Marks
Excellent	Candidates give <b>seven or more</b> points from the indicative content but must include at least two points from each section for balance. Presentation, spelling, punctuation and grammar are excellent.	[7]–[8]
Very good	Candidates give <b>five to six</b> points from the indicative content including points from both sections. Presentation, spelling, punctuation and grammar are very good.	[5]–[6]
Good	Candidates give <b>three to four</b> points from the indicative content. Presentation, spelling, punctuation and grammar are sufficiently competent to make the meaning clear.	[3]–[4]
Basic	Candidates give <b>one to two</b> points from the indicative content. There may be some errors in spelling, punctuation and grammar.	[1]–[2]
	Response is not worthy of credit	[0]

[8]

13

AVAILABLE  
MARKS

- 8 (a) (i) None of the parental generation have white eyes/if dominant there would be white eyes in every generation; [1]
- (ii) 1 –  $X^R Y$ ;  
2 –  $X^R X^r$ ;  
6 –  $X^r Y$ ; [3]
- (b) (i) 

	B	b
B	BB	Bb
b	Bb	bb

 ;  
Normal body colour: 3  
Darkened body colour: 1;  
[ratio can be represented in any suitable format] [2]
- (ii) Darkened body colour = ( $\frac{1}{4}$  or 25% or 1 in 4 of all flies) = 30; (ecf) [1]
- (iii) 

Category	Observed (O)	Expected (E)	(O-E)	(O-E) <sup>2</sup>	$\frac{(O-E)^2}{E}$
normal body colour	83	90	-7	49	0.54
darkened body colour	37	30	7	49	1.63

  
 $\chi^2 = 2.2$  [3]
- (iv) 1; [1]
- (v) between 0.500 and 0.100; [1]
- (vi) Results are a good fit to the ratio 3 : 1;  
the calculated p value is greater than 0.05/calculated  $\chi^2$  value (2.17) is less than the tabular  $\chi^2$  value at p = 0.05 (3.84)/no significant difference between observed and expected; [2]
- (c) (i) To prevent the mosquitoes from breeding/to reduce the number of mosquitoes;  
which will result in fewer infections of malaria; [2]
- (ii) Positive correlation between the percentage of people with malaria and the percentage of individuals with sickle cell trait;  
therefore, where catching malaria is more likely, more individuals have sickle cell trait and therefore are protected; [2]
- (iii) it will decrease. [1]

- 9 (a)  $20 \times 3 = 60$ ;  
 $\times 2 = 120$ ; [2]
- (b) Any **four** from:
- females with 42 or more CAG repeats developed Huntington's disease
  - males with 47 or more CAG repeats developed Huntington's disease
  - individuals with 42 or more CAG repeats developed Huntington's disease (max of 2)
  - individuals with 29 or fewer CAG repeats did not develop Huntington's disease
  - males and females are equally affected
  - it is not clear how individuals with 30 – 41 CAG repeats are affected from this data
  - the number of CAG repeats in this data ranges from 18–88
  - the number of CAG repeats in males ranges from 18–84
  - the number of CAG repeats in females ranges from 18–88 [4]
- (c) (i) Polymerase chain reaction/PCR; [1]
- (ii) To remove the section of CAG repeats/remove the huntingtin gene; [1]
- (iii) • an electric current;
- separates DNA fragments based on size/smaller fragments move further across the gel/larger fragments do not move as far;
  - DNA fragments are negatively charged so they move towards the positive electrode;
  - individuals with Huntington's disease do not move as far up the gel (or converse);
  - longer fragments/more repeats don't move as far (or converse) [5]
- (d) (i) 65; [1]
- (ii) Diagnosis could take place in individuals anytime from  $< 20$  to  $40 +$  ; higher numbers of CAG repeats resulted in earlier diagnosis (or converse); individuals diagnosed aged  $< 20$  tended to have significantly more CAG repeats than those diagnosed at a later age/the link between average number of CAG repeats and age at diagnosis was more gradual for those aged  $< 21$  to  $40 +$ ; [3]
- (e) **Advantage** – if shown to be negative will no longer have to worry they have Huntington's disease/or worry they could pass it on to their children/if shown they will develop Huntington's disease they can make arrangements for their family in time/can come to terms with knowledge that they will develop the disease/other appropriate response;
- Disadvantage** – if shown that they will develop the disease worry/anxiety will increase/may be unable to function normally following this knowledge/may be unable to cope with this knowledge/other appropriate response; [2]

**Total**

**AVAILABLE  
MARKS**

19

**100**