Rewarding Learning

ADVANCED
General Certificate of Education
2019

Life and Health Sciences

Assessment Unit A2 5

assessing

Genetics, Stem Cell Research and Cloning

[AZ051]

THURSDAY 6 JUNE, AFTERNOON

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.

					AVAILABLE MARKS
1	**(a)**	**(i)**	Chargaff; Base equivalence/A=T and C=G/described; **or** Franklin/Wilkins; X-ray crystallography/X-ray photograph/image of DNA/enabled Watson and Crick to describe structure of DNA as double helix;	[2]	
		(ii)	A: Hydrogen bonds; B: Phosphate; C: Nucleotide; D: Phosphodiester bond/covalent bond/sugar phosphate backbone;	[4]	
		(iii)	Cytosine = guanine = 23%; Adenine and thymine both = (100 – 46) ÷ 2 = 27%; Adenine 27% Cytosine 23% Thymine 27%	[3]	
		(iv)	Any **two** from: • RNA is single stranded, DNA is double stranded • RNA sugar is called ribose, DNA sugar is deoxyribose • RNA has the base uracil while DNA has the base thymine	[2]	11
2	**(a)**		E, A, D, B. E (in first box) [1]; B (in final box) [1]; A (in second box)/D (in third box) [1]	[3]	
	(b)	**(i)**	Semi-conservative theory [1] Conservative theory [1] Fragmentation theory/dispersive [1]	[3]	
		(ii)	Semi-conservative theory [1] Meselson and Stahl [1]	[2]	8
3	**(a)**	**(i)**	Any **two** from: • Undifferentiated/non specialised; • Can replicate to form new stem cells; • Can differentiate into specialised cells/a specialised cell/can form any cell in body; • Undifferentiated cell found among differentiated cells (niche)	[2]	
		(ii)	Any **two** from: • Embryonic stem cell can develop into any cell type in body/(totipotent); • Adult stem cell can only develop into limited range of cell types/(pluripotent); • Embryonic stem cells can reproduce indefinitely in culture;	[2]	
	(b)	**(i)**	Pancreatic cells/β cells	[1]	
		(ii)	Secrete insulin/cells produce insulin in the patient/patient no longer has to inject insulin/to help regulate glucose levels	[1]	6

				AVAILABLE MARKS
4	**(a)**	**(i)**	Any **two** from: • sticky/thick mucus [1] • less oxygen taken into blood/shortness of breath/increased diffusion distance/less efficient gas exchange [1] **or** • sticky/thick mucus • chest infections/mucus traps microbes/bacteria/viruses [1] [2]	
		(ii)	Moves/separates the (**fragments**) of DNA [1] according to size/smaller fragments travel further [1]; [2]	
		(iii)	Ian is a carrier/normal and mutated allele; [1] Denise is not a carrier/normal alleles/no chance of passing on faulty allele; [1] Probability of having a child with cystic fibrosis is 0 [1] [3]	
	(b)	**(i)**	Any **two** from: • Undergo genetic testing for *BRCA* mutations; • Warn woman of **risk** of developing cancer/chance of having mutation; • Enable early/regular/enhanced screening; • Enable early treatment; • Advise of risk of passing a mutation to children • Query whether *BRCA* mutations identified in sister or aunt [2]	
		(ii)	Any **one** from: • Other factors may contribute to the onset of (breast/ovarian) cancer/any other appropriate response • Other genes that may prevent her from developing this cancer (reference to suppressor genes) • Not activated [1]	10
5	**(a)**	**(i)**	Enzyme A: Restriction (endonuclease) Enzyme B: (DNA) Ligase [2]	
		(ii)	Any **two** from: • Cut at same base sequence; • Produce sticky ends/sticky ends joined (secured); • Idea of complementary bases/complementary shape of sticky ends; • To insert gene into plasmid [2]	
		(iii)	Any **one** from: • Factor VIII • Human serum albumin • Factor IX • Any other appropriate response [1]	

(b) **Maximum four** points from:

- Increase in blood sugar level detected by pancreas;
- Insulin released;
- Glucose uptake by cells increased;
- Glucose converted to glycogen;
- Glycogen stored in the liver/muscle;
- Increased respiration/more respiration;
- Lowers blood glucose levels;
- 120 down to 88 (or difference 32)
- At 2 hours blood glucose is below starting point/92 ± 4 vs 88 ± 4
- Blood glucose levels peaked at 120

Maximum four points from:

- Starting blood glucose concentration higher in person with diabetes
- Starting blood glucose for person with type 2 diabetes is 136 and for a person without diabetes is 92/44 difference (136 – 92)
- Maximum blood glucose concentration is higher in person with diabetes
- Maximum in diabetes 200 and in person without diabetes is 120/80 difference (200 – 120)/or difference 200 – 136 = 64 vs 120 – 92 = 28
- Blood glucose concentration does not return to starting value in person with diabetes (over 5 hours) and person without diabetes returns to starting value at 2 hours/longer to reduce blood glucose for diabetic
- Maximum blood glucose reached sooner in non diabetic (or converse)

Level of response	Marking criteria	Marks
Excellent	Candidates give **seven to eight** points from the indicative content. Presentation, spelling, punctuation and grammar are excellent.	**[7]–[8]**
Very good	Candidates give **five to six** points from the indicative content. Presentation, spelling, punctuation and grammar are highly competent to make the meaning clear.	**[5]–[6]**
Good	Candidates give **three to four** points from the indicative content. Presentation, spelling, punctuation and grammar are sufficiently competent to make the meaning clear.	**[3]–[4]**
Basic	Candidates give **one or two** 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]

AVAILABLE MARKS

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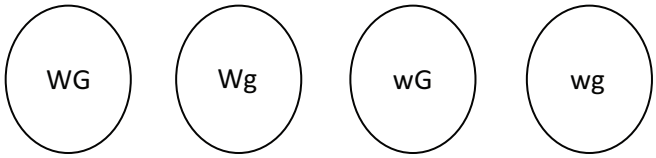
6 **(a)** **(i)** A length/section of DNA/short section of chromosome;
That codes for a particular trait/polypeptide (or protein)/codes for a characteristic [2]

(ii) Epistasis [1]

(b) **(i)**



[2]

	WG	Wg	wG	wg
WG	WWGG	WWGg	WwGG	WwGg
Wg	WWGg	WWgg	WwGg	Wwgg
wG	WwGG	WwGg	wwGG	wwGg
wg	WwGg	Wwgg	wwGg	wwgg

[2]

(ii) Phenotypic ratio:
12 white
3 yellow
1 green [3]

AVAILABLE MARKS

10

				AVAILABLE MARKS
7	(a)	(i)	• Temperature plotted on x-axis; • Scale selected to make best use of grid (must cover at least half of the grid in both dimensions); • Axes labelled appropriately including units; • Data accurately plotted for pH 5.0 with key/label; • Data accurately plotted for pH 6.0 with key/label; [5]	
		(ii)	Temperature: 55˚C; pH: 5.0 [2]	
		(iii)	60˚C [1]	
		(iv)	Any **two** from: • (Same) type of milk; • (Same) volume of milk; • (Same) source of rennet; • (Same) mass/amount of rennet; • (Same) amount of mixing/stirring; • Coagulation determination of milk constant; • Any other appropriate response; [2]	
		(v)	More intervals/smaller intervals/temperatures e.g. every 1–2˚C; [1] between 50˚C and 60˚C [1] [2]	
	(b)		Any **two** from: • Rennet changes bitterness of the cheese/taste of the cheese (or converse); • Chymosin meets global increase in demand for cheese/Chymosin mass produced meets increased demand for cheese/made in larger batches/higher yield produced; • Young calves no longer need to be killed to obtain rennet/calves not harmed; • Chymosin less expensive; • Fewer impurities in Chymosin; • Suitable for vegetarians; [2]	14

8 **(a)** Gene therapy involves **inserting** a functional gene/unmutated/ healthy gene [1];
By **repairing** the defective gene/replacing faulty gene with a normal one/ adding a normal gene [1] [2]

(b) Any **three** from:
1 Somatic cannot be inherited, germ line can be inherited;
2 Somatic introduces (functional) gene into body cells, germ line introduces (functional) gene into sperm/egg/zygote, embryo;
3 Somatic some cells have (functional) gene, germ line all cells have (functional) gene;
4 Somatic is short lived (temporary/needs repeating), germ line is long lived (permanent/does not need repeated);
5 Somatic legal/germ line illegal [3]

(c) Any **two** from:
- Reduce symptoms (for named disease e.g. cystic fibrosis, SCID, Parkinson's/Sickle cell anaemia)/cure disease/treat disease
- A better quality of life/described/improved mental health;
- Less medication/less admittance to hospital/less pressure on resources/ less treatment;
- Extend lifespan/saves lives; [2]

9 **(a)** **(i)** Locus [1]

(ii) 438/3; [1]
146 [1]
Correct answer only [2] [2]

(iii) Neither allele is dominant or recessive/alleles have equal dominance; [1]
Both alleles are expressed in the heterozygote [1] [2]

(iv) $Hb^S\ Hb^S$ [1]

(v)

	Hb^A	Hb^s
Hb^A	$Hb^A\ Hb^A$	Hb^AHb^s
Hb^s	Hb^AHb^s	$Hb^s\ Hb^s$

Correct gametes; [1] ecf
Correct cross; [1] ecf
$\frac{1}{4}$/25% probability [1] [3]

AVAILABLE MARKS

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(b) (i)

Category	Observed (O)	Expected (E)	(O – E)	$(O - E)^2$	$\frac{(O - E)^2}{E}$
homozygous and do not suffer from sickle cell anaemia	110	125	15	225	1.8
heterozygous for sickle cell anaemia	279	250	29	841	(3.4) 3.364
suffer from sickle cell anaemia	111	125	–14	196	(1.6) 1.568

Identifying expected as 125:250:125; [1]
Calculating $\frac{(O - E)^2}{E}$ correctly for each category; [3]
$\chi^2 = 6.732$ (6.73/6.7/6.8) [5]

(ii) 2 degrees of freedom (3–1); [1]

(iii) P between 0.050 and 0.010 ecf [1]

(iv) Any **two** from: ecf
- There is a significant difference between observed and expected ratios;
- Difference is not due to chance alone
- Reject the null hypothesis
- Does not fit 1:2:1 ratio [2]

(c) (i) Any **two** from:
- No sickle cell or malaria in Southern Africa
- Low to no sickle cell or malaria in North Africa;
- Areas of highest incidence of sickle cell only in areas where malaria does not occur;
- Other appropriate comparative observation [2]

(ii) there are no mosquitoes/no advantage to carrying the sickle cell gene/nobody carrying the gene for sickle cell anaemia/other appropriate point [1]

Total

AVAILABLE MARKS

21

100