

GCE

Biology B

H422/02: Scientific literacy in biology

Advanced GCE

Mark Scheme for June 2019

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Annotations

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
()	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Marking Annotations

Annotation	Use
	Benefit of Doubt
	Contradiction
	Cross
	Error Carried Forward
	Given Mark
	Extendable horizontal wavy line (to indicate errors / incorrect science terminology)
	Ignore
	Large dot (various uses as defined in mark scheme)
	Highlight (various uses as defined in mark scheme)
	Benefit of the doubt not given
	Tick
	Omission Mark
	Blank Page
	Level 1 answer in Level of Response question
	Level 2 answer in Level of Response question
	Level 3 answer in Level of Response question

Subject-specific Marking Instructions

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

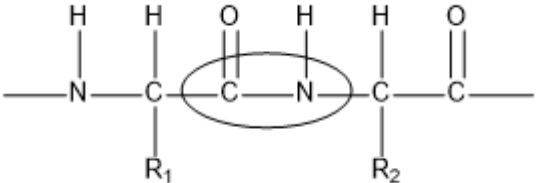
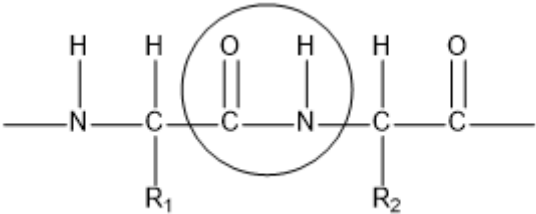
You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

Question			Answer	Marks	Guidance
1	(a)	(i)	1. sequence of, DNA / nucleotides / bases, that code for a polypeptide ✓ 2. a gene variant ✓	2	Mark the first answer. If an additional answer is given that is incorrect, then = 0 marks ALLOW protein /amino acid sequence for 'polypeptide' ALLOW different versions of the same gene
		(ii)	1. <u>founder</u> (s) effect ✓ 2. <u>genetic bottleneck</u> ✓	2	Mark the first answer. If an additional answer is given that is incorrect, then = 0 marks
		(iii)	1. small / decreasing , gene pool ✓ 2. limited number / loss, of <u>alleles</u> ✓	2	
	(b)		Label cells with fluorescent marker ✓ (fluorescence attached to) antibodies ✓ (antibodies bind to) <u>antigens</u> on (white blood) cells ✓ (alternative) fluorescent DNA probe ✓ counts / sorts, cells (with genetic variant) ✓	4 max	IGNORE red blood cells IGNORE fluorescent marker binds to antigens ALLOW section of DNA for 'DNA probe'
	(c)		base / nucleotide, substitution ✓ mRNA codon changes OR different amino acid (attached) ✓	3 max	ALLOW named bases ALLOW glutamic acid changed to valine ALLOW different primary structure

Question			Answer	Marks	Guidance
			changes haemoglobin, (tertiary) structure / (3D) shape ✓ (abnormal) haemoglobin, clumps / crystallises (clumping) at low O₂ concentration ✓ (only present in) homozygous recessive individuals ✓		IGNORE mutations in haemoglobin protein IGNORE red blood cells clump together ALLOW H^S H^S for 'homozygous recessive'
	(d)		<i>advantages of the IMF approach:</i> (may) give a more accurate diagnosis ✓ treat / intervene, earlier ✓ identify people (at risk) who do not have family history OR removes worry for people that do have a family history ✓ <i>disadvantages of IMF approach:</i> results of the MGUS screening may give false positives ✓ more expensive (than pedigree analysis) ✓	4 max	ALLOW ora throughout ALLOW prevents / cures, myeloma

Question			Answer					Marks	Guidance																									
	(e)		<table><tr><th>Feature</th><th>Trans- cription only</th><th>Trans- lation only</th><th>Both</th><th>Neither</th></tr><tr><td>C pairs with G</td><td></td><td></td><td>✓</td><td></td></tr><tr><td>A pairs with T</td><td>✓</td><td></td><td></td><td></td></tr><tr><td>Phospho- diester bonds are made</td><td>✓</td><td></td><td></td><td></td></tr><tr><td>Peptide bonds are made</td><td></td><td>✓</td><td></td><td></td></tr></table>					Feature	Trans- cription only	Trans- lation only	Both	Neither	C pairs with G			✓		A pairs with T	✓				Phospho- diester bonds are made	✓				Peptide bonds are made		✓			4	Mark the first answer. If an additional answer is given that is incorrect, then = 0 marks ALLOW crosses or any other unequivocal symbol as alternative to ticks.
Feature	Trans- cription only	Trans- lation only	Both	Neither																														
C pairs with G			✓																															
A pairs with T	✓																																	
Phospho- diester bonds are made	✓																																	
Peptide bonds are made		✓																																

Question			Answer	Marks	Guidance
2	(a)	(i)		1	ALLOW 
		(ii)	condensation ✓	1	Mark the first answer. If an additional answer is given that is incorrect, then = 0 marks IGNORE polymerisation
	(b)	(i)	1. to <u>hydrolyse</u> , peptide bonds / protein / peptide ✓ 2. to avoid contamination (with amino acids from skin) ✓	2	IGNORE reference to microorganisms
		(ii)	$R_f = \frac{(45)}{(88)} = 0.51$ ✓ Correct identification = methionine ✓	2	ALLOW answer in range 0.50 – 0.52 (2 d.p.) ALLOW ECF from incorrect R_f value

Level 3 (5–6 marks) A comprehensive explanation that describes the role of phagocytes and mast cells in the body's non-specific defence mechanisms, with reference to first defence <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) A simple explanation for the role of phagocytes and mast cells in the body's non-specific defence mechanisms. OR A detailed explanation for the role of phagocytes or mast cells in the body's non-specific defence mechanisms. <i>There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) A simple explanation for the role of phagocytes or mast cells in the body's non-specific defence mechanisms. <i>There is an attempt at a logical structure with a line of reasoning. The information is, in the most part, relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6	Indicative scientific points may include <i>Pathogenic bacteria, fungi, virus in first defence</i> Barrier AMP destroy pathogen before , entry (into intestines, respiratory tract etc) / can spread Skin / mucus NK cells APC's / dendritic cells Complement proteins Acidic pH (of vagina) <i>Mast cells</i> inflammation vasodilation / redness swelling /increased blood flow / oedema histamine / serotonin / prostaglandins <i>Phagocytes</i> macrophages / neutrophils aggregation attracts phagocytes cytokines engulf pathogen phagolysosome / phagosome, formation (hydrolytic) enzymes destroy pathogen monocyte differentiation IGNORE reference to the specific immune response
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Question			Answer	Guidance
	(d)	(i)	(sperm can't) reach the, oviduct / fallopian tube ✓ (so) fertilise a <u>secondary oocyte</u> ✓	
		(ii)	0.47 ✓✓	Correct answer = 2 marks even if no working shown. If answer is incorrect then award 1 mark if; <i>answer not to 2 sig figs:</i> 0.469 <i>q² / p²:</i> 0.22 ✓ (<i>incorrect q² or p²</i>)
		(iii)	(heterozygotes) have a selective advantage OR No effect on heterozygotes ✓	IGNORE ref to IVF ALLOW only affects homozygous recessive

Question			Answer	Marks	Guidance																		
3	(a)		<table><tr><th>Feature</th><th></th><th>Description</th></tr><tr><td rowspan="3">The active site of MMP contains a Zn²⁺ ion that is required for substrate binding.</td><td></td><td>Primary structure</td></tr><tr><td></td><td>Secondary structure</td></tr><tr><td></td><td>Tertiary structure</td></tr><tr><td rowspan="2">The enzyme contains a β-pleated sheet and three α-helices.</td><td></td><td>Competitive inhibition</td></tr><tr><td></td><td>Cofactor</td></tr><tr><td colspan="2">The amino acid histidine occurs in three places in the sequence making up the active site of all MMPs.</td><td></td></tr></table>	Feature		Description	The active site of MMP contains a Zn ²⁺ ion that is required for substrate binding.		Primary structure		Secondary structure		Tertiary structure	The enzyme contains a β-pleated sheet and three α-helices.		Competitive inhibition		Cofactor	The amino acid histidine occurs in three places in the sequence making up the active site of all MMPs.			3	1 mark for each correct joining line
Feature		Description																					
The active site of MMP contains a Zn ²⁺ ion that is required for substrate binding.		Primary structure																					
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The enzyme contains a β-pleated sheet and three α-helices.		Competitive inhibition																					
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The amino acid histidine occurs in three places in the sequence making up the active site of all MMPs.																							
	(b)	(i)	there is no (significant) difference (in MMP activity) between grade III tumours and all other groups ✓	1	ALLOW the difference (between grade III tumour activity and other groups) is due to chance																		
		(ii)	there is less than, 0.01% / 0.0001, <u>probability</u> that the differences in activity (between the two groups / grade III and other tumours) are due to <u>chance</u> ✓	1	ALLOW <0.01% for 'less than 0.01%'																		

Question			Answer	Marks	Guidance
		(iii)	yes Y1 the activity is significantly greater in, grade III / the most malignant, tumours ✓ Y2 <u>positive correlation</u> (between MMP activity and severity of breast cancer) ✓ No N1 activity is, the same in grade II and benign / lower in grade I than benign ✓ N2 other factors may be involved OR N2 correlation does not imply causation ✓	3 max	ALLOW severity of breast cancer increases as activity of malignant grade tumour increases.

Question	Answer	Marks	Guidance
(c)	<i>Competitive inhibitor</i> (Marimastat) binds to / blocks , the <u>active site</u> of, MMPs / proteases / enzyme ✓ (this) prevents / competes with, binding of, substrate / proteins ✓ OR <i>Non-competitive inhibitor</i> Marimastat binds to allosteric site of, MMPs / proteases / enzyme ✓ (therefore) changes (3D) <u>shape</u> of <u>active site</u> ✓	2	

Question			Answer	Marks		Guidance
4	(a)		1. to ensure the algae are photosynthesising (at a constant rate) OR to allow the, algae / suspension, to equilibrate ✓ 2. to prevent the suspension from overheating OR to prevent denaturation of (photosynthetic) enzymes ✓ 3. to kill the, algae / cells OR to stop the (photosynthetic) reactions ✓	3		ALLOW light dependent stage / LDR , of photosynthesis 3. ALLOW stop photosynthesis for 'stop the reactions'
	(b)	(i)	ribulose-bisphosphate carboxylase (oxygenase) ✓	1		ALLOW RUBISCO / rubisco
		(ii)	GP produced first as radioactivity present by 2 seconds. ✓ TP produced, second / after GP, as radioactivity present by 10 seconds ✓ amino acids AND sucrose AND sugar phosphates are produced, last / from TP, as radioactivity present by 30 seconds ✓	3		ALLOW any correct alternative name for GP and/or TP throughout. ALLOW s for seconds
	(c)		because CO ₂ reacts with, RuBP /	2		

Question			Answer	Marks		Guidance
			ribulose bis-phosphate / 5C compound ✓ the first reaction produces an, unstable / 6C, compound that breaks down to form two 3-C compounds ✓			
	(d)	(i)	465.6 / 466 ✓✓	2		Correct answer = 2 marks even if no working shown. If answer is incorrect then award 1 mark if; <i>max uptake per m²:</i> 8.0 x 0.97 / 7.76 <i>max uptake in 1 min:</i> 8.0 x 60 / 480 <i>incorrect calculated value for</i> x 60 <i>max uptake per m²</i>
		(ii)	there is no net (named) gas exchange ✓ (the rate of) photosynthesis and respiration are equal / compensation point ✓	1 max		
	(e)		<u>vernalisation</u> ✓ (cold and moist conditions) promote, transcription / expression, of genes (associated with flowering) ✓	2		ALLOW production of transcription factors for 'promote transcription of genes'.
	(f)		chrysanthemums are , short day / long night , plants ✓ P _{fr} is converted (slowly) to P _r during darkness ✓	3 max		

Question			Answer	Marks		Guidance
			light, converts P_r to P_{fr} ✓ ratio of $P_{fr} : P_r$ / relative amounts of P_{fr} and P_r , determines when flowering occurs ✓			
5	(a)	(i)	C = glaucoma ✓ (increased pressure) damages optic nerve ✓ D = cataract ✓ lens (protein) becomes opaque ✓	4		ALLOW cloudy for 'opaque'
		(ii)	preventing / reversing , growth of (new) blood vessels into the, retina / macula / fovea ✓ (so) reduces / prevents, damage to, retina / macula / fovea ✓	2		ALLOW scarring for 'damage'
	(b)	(i)	convert <u>light</u> energy to <u>chemical</u> energy ✓	1		ALLOW electromagnetic energy for light energy

Question		Answer	Marks	Guidance										
	(ii)	<table><tr><td>Process in rod cell</td><td>Rest or Light</td></tr><tr><td>Rhodopsin is broken down to form opsin and <i>trans</i>-retinal</td><td>Light</td></tr><tr><td>Rod cell membrane is hyperpolarised</td><td>Light</td></tr><tr><td>Neurotransmitter is released by exocytosis from rod cell into the synaptic cleft</td><td>Rest</td></tr><tr><td>Sodium ion channels open</td><td>Rest</td></tr></table>	Process in rod cell	Rest or Light	Rhodopsin is broken down to form opsin and <i>trans</i> -retinal	Light	Rod cell membrane is hyperpolarised	Light	Neurotransmitter is released by exocytosis from rod cell into the synaptic cleft	Rest	Sodium ion channels open	Rest	2	3 correct = 2 marks 2 correct = 1 mark 1 or 0 correct = 0 marks
Process in rod cell	Rest or Light													
Rhodopsin is broken down to form opsin and <i>trans</i> -retinal	Light													
Rod cell membrane is hyperpolarised	Light													
Neurotransmitter is released by exocytosis from rod cell into the synaptic cleft	Rest													
Sodium ion channels open	Rest													
	(c)	(fault) on the X chromosome ✓ no corresponding <u>allele</u> on Y chromosome ✓ only one (faulty) <u>allele</u> needed for colour blindness (in males) ✓	2 max											

Question			Answer	Marks		Guidance
6	(a)	(i)	chromosome number is halved / <u>haploid</u> cells are produced from <u>diploid</u> cells ✓	1		DO NOT ALLOW diploid cell changes to haploid cell
		(ii)	translocation / non-disjunction ✓	1		ALLOW description
		(iii)	Down's / Turner's / Klinefelter's ✓	1		
		(iv)	somatic / body, cells divide by mitosis OR meiosis produces gametes ✓	1		DO NOT ALLOW meiosis occurs in gametes

Question		Answer	Marks		Guidance
	(b)*	Summary of instructions to markers: <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i> <i>Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i> ○ <i>award the higher mark where the Communication Statement has been met.</i> ○ <i>award the lower mark where aspects of the Communication Statement have been missed.</i> • The science content determines the level. • The Communication Statement determines the mark within a level.			

	Level 3 (5–6 marks) A comprehensive response that covers the effects of alcohol AND evaluation of the evidence <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated</i> Level 2 (3–4 marks) A description of the effects of alcohol with an evaluation of the evidence. OR A detailed description of the effects of alcohol or comprehensive evaluation of the evidence <i>There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence</i> Level 1 (1–2 marks) A description of the effects of alcohol or evaluation of the evidence. <i>There is an attempt at a logical structure with a line of reasoning. The information is, in the most part, relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6	Indicative scientific points may include <i>Effects of alcohol</i> Ethanol crosses placenta Moderate drinking can cause language and speech problems (<i>Fetal Alcohol Syndrome / FAS</i>): damage to the CNS psychological or behavioural problems after birth learning difficulties other signs include facial features (small eye openings, thick upper lip) and growth deficiency Fetal liver is less able to detoxify ethanol <i>Evaluation of evidence</i> Advice is based on excessive drinking May not be valid to extrapolate to moderate drinking Individual women may respond differently Limited sample number Study may be biased Evidence, not long term / only recent No (conclusive) evidence between, light alcohol consumption and birth weight / light to moderate consumption and fetal alcohol syndrome.
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Question			Answer	Marks		Guidance															
7	(a)		pollen is produced in large amounts ✓ anthers / stigmas, hang outside the flower ✓	1 max		ALLOW in the air for 'outside the flower'															
	(b)		double fertilisation ✓ pollen tube delivers two, sperm cells / male gametes ✓ one, sperm cell / male gamete, fertilises egg cell to form embryo ✓ (nucleus of) other sperm cell fuses with (two) polar nuclei to form endosperm ✓	3 max																	
	(c)	(i)	parental genotypes: AaBb x aabb ✓ gametes: AB, Ab, aB, ab (and ab) ✓	2		ALLOW marks for correct information given in genetic diagram if candidate has not used the prompt lines. ALLOW ecf from incorrect parental genotypes															
		(ii)	<table border="1"><tr><td></td><td>AB</td><td>Ab</td><td>aB</td><td>ab</td></tr><tr><td>ab</td><td>AaBb</td><td>Aabb</td><td>aaBb</td><td>aabb</td></tr><tr><td></td><td>yellow, smooth</td><td>yellow, wrinkled</td><td>colourless, smooth</td><td>colourless, wrinkled</td></tr></table> genotype AND phenotype of offspring ✓ phenotypic ratio = 1 : 1 : 1 : 1 ✓		AB	Ab	aB	ab	ab	AaBb	Aabb	aaBb	aabb		yellow, smooth	yellow, wrinkled	colourless, smooth	colourless, wrinkled	2		ALLOW marks for correct information given in genetic diagram if candidate has not used the prompt lines. ALLOW ecf from incorrect gametes in 7ci
	AB	Ab	aB	ab																	
ab	AaBb	Aabb	aaBb	aabb																	
	yellow, smooth	yellow, wrinkled	colourless, smooth	colourless, wrinkled																	
		(iii)		3		ECF from phenotypic ratio given in 7cii															

			<table><tr><th>Phenotype</th><th>[O]</th><th>[E]</th><th>O-E</th><th>(O-E)²</th><th>(O-E)²/E</th></tr><tr><td>Smooth yellow</td><td>275</td><td>250</td><td>25</td><td>625</td><td>2.50</td></tr><tr><td>Wrinkled yellow</td><td>277</td><td>250</td><td>27</td><td>729</td><td>2.916</td></tr><tr><td>Smooth colourless</td><td>235</td><td>250</td><td>-15</td><td>225</td><td>0.90</td></tr><tr><td>Wrinkled colourless</td><td>213</td><td>250</td><td>-37</td><td>1369</td><td>5.476</td></tr><tr><td></td><td></td><td></td><td></td><td>$\chi^2 =$</td><td>11.792</td></tr></table> $\chi^2 = 11.79 / 11.8 \checkmark\checkmark\checkmark$	Phenotype	[O]	[E]	O-E	(O-E) ²	(O-E) ² /E	Smooth yellow	275	250	25	625	2.50	Wrinkled yellow	277	250	27	729	2.916	Smooth colourless	235	250	-15	225	0.90	Wrinkled colourless	213	250	-37	1369	5.476					$\chi^2 =$	11.792			Correct answer = 3 marks even if no working shown. If answer is incorrect then award 1 mark if; [E] column correct ✓ AND Award 1 mark if ; (O-E)² column correct ✓
Phenotype	[O]	[E]	O-E	(O-E) ²	(O-E) ² /E																																					
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				$\chi^2 =$	11.792																																					
		(iv)	there is <1% probability that the differences (between predicted and expected results) are, not significant / due to chance ✓	1		IGNORE ref to probabilities other than 0.01																																				
		(v)	OR there is a >99% probability that the difference is significant / not due to chance. ✓ there is <u>linkage</u> between the two <u>genes</u> (for colour and shape) ✓ the <u>genes</u> (for colour and shape) are on the same chromosome ✓	2		DO NOT ALLOW alleles for genes ECF for 7civ conclusion																																				

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