

GCE

Biology A

Unit **H420A/03**: Unified biology

Advanced GCE

Mark Scheme for June 2017

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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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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Annotations

Annotation	Meaning
DO NOT ACCEPT	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ACCEPT	Answers that can be allowed
()	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

Subject-specific Marking Instructions**INTRODUCTION**

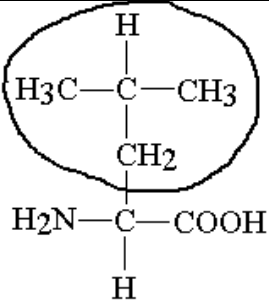
Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- 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	 <p style="text-align: center;">✓</p>	1	ACCEPT any shape or mark that indicates the R group unambiguously
		ii	solubility / <u>adsorption</u> / interactions with the stationary phase, similar / same / AW ✓ R/ functional / residual, groups, similar / AW ✓	1 max	ACCEPT leucine <i>slightly</i> more soluble / interacts <i>slightly</i> less with stationary phase ACCEPT both more soluble than Y IGNORE size/ charge
		iii	a mark shown on the diagram at 1.5 cm from the origin ✓✓✓	3	Correct answer = 3 marks (indicated by 3 ticks on diagram) even if no working shown ACCEPT a mark in the range 1.4 -1.6 cm ACCEPT centre of dot on or within guidelines Max 2 for calculation if mark not drawn on the diagram within this range, OR if two dots drawn and second dot incorrect Marks for seeing in calculation: $(R_f \text{ of Y}) = 2.5 / 5 = 0.5 /$ $(R_f \text{ of Y}) = 25 / 50 = 0.5 \checkmark$ $(R_f \text{ of Z}) = 0.5 - 0.2 = 0.3 \checkmark$ ALLOW ECF for R_f value of Y $(\text{Distance moved by Z}) = 0.3 \times 5 = 1.5 /$ $(\text{Distance moved by Z}) = 0.3 \times 50 = 15 \checkmark$ ALLOW ECF for R_f value of Z

Question		Answer	Marks	Guidance
	b i	silica (gel) ✓	1	ACCEPT aluminium oxide/ alumina/ cellulose/ zirconium oxide / silicon dioxide DO NOT ACCEPT paper/ silicon / aluminate IGNORE plastic / perspex
	ii	photosystems ✓ (in) thylakoid (membranes) ✓	2	ACCEPT antenna complex/ reaction centre / light harvesting , clusters / systems IGNORE grana ACCEPT lamellae (membranes)
	c	1. separates by (relative) , <u>adsorption</u> / solubility / interaction with the stationary phase in TLC and (separates) by size in electrophoresis ✓ 2. TLC separates non - charged particles and electrophoresis (only) separates charged particles ✓ 3. electricity, used for electrophoresis / not used for TLC ✓ 4. buffer solution, used for electrophoresis / not used for TLC ✓ 5. dyes used in TLC OR radioactive / fluorescent , tags / nucleotides, used in electrophoresis ✓ 6. <i>Idea of</i> electrophoresis is , automated / computerised / uses laser scanning (to analyse sequence) / TLC is not automated ✓	3 max	Read as prose and look for any three correct mp's for mp1 and 2 IGNORE separates by size of charge on molecule ACCEPT mass/ length for size ACCEPT electrophoresis uses, current / voltage / charge / (named) electrode(s)

Question			Answer	Marks	Guidance
2	a	i	secondary quaternary primary tertiary	2	All 4 correct ✓✓ 2 or 3 correct ✓
		ii	other foods have , same / similar , <u>antigen</u> ✓ <i>idea that</i> the antigen is a short sequence of amino acids (so may be common to more than one polypeptide) ✓ variable region / binding site, (of antibody) is not specific (to gliadin antigens) ✓ antibody binds to ,T lymphocyte / mast cell ✓ mast cell releases histamine (causes inflammation) ✓	2 max	DO NOT ACCEPT active site ACCEPT binding site is complementary to, more than one molecule/ substances other than gliadins IGNORE Antibody can bind to, range of structures / foods ACCEPT attaches to
	b	i	1.(at start) respiration is <u>anaerobic</u> / glucose converted into ethanol ✓ 2.respiration, decreases rapidly /stops , once glucose used up ✓ 3.ethanol used (as a carbon source) once glucose has been consumed ✓ 4.aerobic respiration (of ethanol) ✓ 5.(because) acetyl Co A used in Krebs cycle ✓ 6.respiration stops when, ethanol / respiratory substrate, has been used up ✓	3 max	ACCEPT oxygen is needed for the metabolism of ethanol

Question	Answer	Marks	Guidance
ii	<p>(use) aseptic techniques / avoid contamination ✓</p> <p>provide (sources of) nutrients / respiratory substrates ✓</p> <p>(incubate at) suitable temperature ✓</p> <p>use (pH) buffer ✓</p> <p>agitation / stirring / shaking ✓</p>	2 max	<p>Mark first two suggestions given</p> <p>ACCEPT a description of an aseptic technique ACCEPT sterile techniques</p> <p>ACCEPT a specific example of a nutrient</p> <p>ACCEPT optimum temperature / right temperature / a specific, appropriate temperature (15- 35°C) IGNORE keep temperature constant / low temperature/ monitor temperature / control temperature</p> <p>ACCEPT maintain optimum pH / right pH / a specific, appropriate pH (4-7) IGNORE keep pH constant / monitor pH / control pH</p> <p>ACCEPT mixing IGNORE ref to aeration / oxygen supply / sparging</p>
iii	<p>3.75 ✓</p> <p>$\times 10^5$ ✓</p>	2	<p>One mark awarded for a correct calculation with the wrong number of significant figures or not in standard form (e.g. 375000 , 375×10^3 , 3.8×10^5)</p>

Question	Answer	Marks	Guidance
iv	<p><i>Yes because...</i> a suitable, range / intervals, of temperatures have been chosen ✓ volume controlled ✓ temperature , controlled / maintained ✓ repeats, to identify anomalies / outliers ✓ same yeast suspension used ✓</p> <p><i>No because...</i> availability of, oxygen/ nutrients / yeast concentration, not controlled ✓ pH is not be controlled at start of experiment ✓</p> <p><i>idea of pH change would not be an accurate measure of respiration rate ✓</i></p> <p>no time reference (to calculate rate) ✓</p> <p>no control (sample) ✓</p>	3 max	<p>Max 2 for statements supporting only one view</p> <p>IGNORE large / wide, range of temperatures</p> <p>IGNORE repeats exclude anomalies</p> <p>ACCEPT 'better to collect (volume of) carbon dioxide produced' / 'It is better to use a respirometer' (implies pH change not accurate) 'because some CO₂ would diffuse into the air'</p>
v	<p>difference (between the means), is not significant / can be explained by chance (at $p = 0.05$) ✓</p>	1	<p>ACCEPT null hypothesis / H₀, can be accepted</p> <p>DO NOT ACCEPT null hypothesis / H₀ can be rejected</p> <p>ACCEPT the results are not significantly different ($p = 0.05$)</p>

Question			Answer	Marks	Guidance
3	a	i	anatomical ✓	1	<p>Mark the first answer only. If additional incorrect answer given, then 0 marks</p> <p>ACCEPT anatomy</p>
		ii	<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p><i>In summary:</i> <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.) 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></p> <p><i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i></p> <ul style="list-style-type: none"> ○ <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> <p>• The science content determines the level. • The Communication Statement determines the mark within a level.</p> <p><i>A level annotation should be used where all marks for a level have been achieved eg for 6 marks L3</i></p> <p><i>If a candidate has achieved 5 marks then they have reached level 3 but with one mark omitted e.g L3</i> </p> <p><i>The same principal should be applied to level 2 and level 1</i> <i>No marks (0) should have a cross</i></p>		

	<p>Level 3 (5-6 marks) Provides a full and accurate description of natural selection and describes the role of regulatory gene(s) and mentions a correct role of a structural gene.</p> <p><i>There is a well-developed line of reasoning, which is clear and logically-structured and uses scientific terminology at an appropriate level. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3-4 marks) Provides a description of natural selection with few errors or omissions and mentions a correct role of a structural gene (e.g. for fur colour / pigmentation)</p> <p><i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented in the most part relevant and supported by some evidence.</i></p> <p>Level 1 (1-2 marks) Provides an outline of natural selection</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks <i>No response or no response worthy of credit.</i></p>	6	<p>Indicative scientific points may include</p> <p><i>Natural selection</i></p> <ul style="list-style-type: none"> • mutations (e.g. of pigment gene, and of regulatory genes) • selection pressure of prey availability • the adaptation helped tigers hide from prey / ref to camouflage • striped tigers had a greater survival probability and were more likely to reproduce • beneficial alleles were passed on to the next generation • the allele frequency for the relevant genes would have increased with each generation • after many generations, all tigers within a population were striped <p><i>Roles of regulatory genes</i></p> <ul style="list-style-type: none"> • (regulatory) genes control, the pattern/ where pigments produced / expression of other genes • genes switched on or off during development (i.e. epigenetic changes / transcription factors)
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					<ul style="list-style-type: none"> • correct roles for epistasis – e.g. recessive epistasis preventing expression of pigment gene • ignore role of hox genes as not relevant • ignore 'genes for striped fur' or 'striped pattern' alone as this is neither a structural or regulatory gene role
	b	2 ✓✓✓		3	<p>Max 2 marks for calculation if answer not to one significant figure</p> <p>$(q^2 = 1 \text{ in } 10,000 = 0.0001)$ $q = 0.01 \quad \checkmark$ $(p = 1 - 0.01 = 0.99)$</p> <p>$2pq = 0.0198 \quad \checkmark$</p> <p>0.02 = 2 marks 1.98 = 2 marks</p>

Question		Answer					Marks	Guidance	
4	a	Type of bacteria	Location	Reactant	Product	Oxidation or reduction of nitrogen?	4	<p>AWARD one mark per correct column</p> <p>IGNORE references to oxygen in the reactant and product columns.</p> <p>DO NOT ACCEPT incorrect formulae or charge</p> <p>ACCEPT NH₃/ammonia for <i>Nitrosomonas</i> reactant</p>	
		<i>Rhizobium</i>	root nodules / leguminous roots	N ₂ and H ⁺ ions	NH ₃	reduction			
		<i>Nitrosomonas</i>	soil	NH ₄ ⁺ / ammonium ions / compounds	NO ₂ ⁻ / nitrites	oxidation			
		<i>Nitrobacter</i>	soil	NO ₂ ⁻ / nitrites	NO ₃ ⁻	oxidation			
		Denitrifying bacteria	soil	NO ₃ ⁻	N ₂ / nitrogen gas	reduction			
		✓	✓	✓	✓	✓			
	b	i	<p>1.cluster / iron / molybdenum / sulfur , are , cofactors / prosthetic groups ✓</p> <p>2.H₂ is a, competitive inhibitor / end product inhibitor ✓</p> <p>3.CO is a <u>non-competitive</u> inhibitor ✓</p> <p>4.(CO binds to allosteric site and) causes change in shape of active site ✓</p> <p>5.energy required (from ATP) ✓</p> <p>6.acidic conditions, are tolerated / increase reaction rate ✓</p>					4 max	<p>DO NOT ACCEPT coenzyme</p> <p>2. ACCEPT H₂ , competes /AW, with N₂ for the active site OR 'increase in H₂ will reduce the activity of the enzyme'</p> <p>3. ACCEPT CO acts as a cofactor (as candidates may be unfamiliar with CO)</p> <p>5. ACCEPT ATP required as process is active</p>

Question		Answer	Marks	Guidance
	ii	<p>transport of oxygen, for respiration / to generate ATP (in <i>Rhizobium</i>) ✓</p> <p>removes(excess) oxygen so less inhibition (of enzyme / reaction) ✓</p> <p>removes CO to prevent inhibition (of nitrogenase) ✓</p>	2	<p>ACCEPT removes oxygen / creates anaerobic conditions, for nitrogen fixation</p> <p>IGNORE removes H₂ so more N₂ can bind (to active site)</p>
c	i	8550 (kJ m ⁻² yr ⁻¹) ✓✓	2	<p>AWARD one mark for 8 550 000 (J m⁻² yr⁻¹)</p> <p>OR</p> <p>AWARD one mark for 9 x 950 000</p> <p>OR</p> <p>AWARD one mark for 7600 (kJ m⁻² yr⁻¹)</p>
	ii	11 (%) ✓	1	<p>ACCEPT ECF from c (i)</p> <p>(look for 950(000) divided by answer to c(i) and a correct calculation to 2 sig figs)</p> <p>e.g. if calculated 7600 (kJ m⁻² yr⁻¹) then answer would be 13(%)</p>

Question			Answer	Marks	Guidance
5	a	i	<p>1. <u>antigens</u> on , neurones / nerve cell / Schwann cells / myelin sheath (activate immune system) ✓</p> <p>2. <u>antibodies</u> against , neurones / nerve cells / Schwann cells/ myelin sheath (are produced)✓</p> <p>3. phagocytes / neutrophils / macrophages / T(killer) cells, attack / break down, neurones / nerve cells / Schwann cells / myelin sheath ✓</p>	2	<p>For mp 1,2,and 3, IGNORE nerves ACCEPT oligodendrocytes / glial cells / cells in nervous system</p> <p>ACCEPT 'immune system fails to recognise <u>antigens</u> on , neurones / nerve cells/ Schwann cells / myelin sheath , as self '</p> <p>ACCEPT ' immune system recognises <u>antigens</u> on , neurones / nerve cells/ Schwann cells / myelin sheath , as, foreign/non self '</p> <p>IGNORE T helper cells / T memory cells IGNORE 'kill' cells</p>
		ii	<p>fewer / damaged , Schwann cells ✓</p> <p>no / less / incomplete / damaged, myelin (sheath) ✓</p> <p>no saltatory conduction ✓</p>	2 max	<p>IGNORE no / dead, Schwann cells ACCEPT oligodendrocytes / glial cells</p> <p>ACCEPT less insulation (on neurone)</p> <p>ACCEPT description of lack of saltatory conduction e.g. action potential travels along whole axon membrane</p> <p>IGNORE ref to axon size</p>

	<p>b</p> <p>i</p>	<p>(greater loss of) memory / thinking / cognition / speech / smell / sight / hearing</p> <p>AND (due to damage to) cerebrum / cerebral cortex ✓</p> <p>(greater loss of) balance / coordination</p> <p>AND (due to damage to) cerebellum ✓</p> <p>(greater loss of) feeding / sleeping patterns / temperature control / water balance</p> <p>AND (due to damage to) hypothalamus ✓</p> <p>(greater loss of)swallowing / bladder control / bowel movement / control of, heart rate / breathing rate</p> <p>AND (due to damage to) medulla oblongata / brain stem ✓</p>	<p>2</p>	<p>Mark as prose. Mark first two symptoms given only</p> <p>ACCEPT visual /olfactory / auditory (cortex) if linked to correct loss of speech /smell /sight ACCEPT corpus callosum if linked to loss of cognition / balance / memory / thinking</p> <p>ACCEPT (due to damage to) motor cortex</p>
	<p>ii</p>	<p>fewer / lower frequency / lower rate of, action potentials / impulses, reach NMJ ✓</p> <p>no/less, acetylcholine / ACh / neurotransmitter, released ✓</p> <p>no/less, (neurotransmitter) binding to (sarcolemma) receptors ✓ no/ less, depolarisation of, post-synaptic membrane / sarcolemma / T tubules ✓</p>	<p>2 max</p>	<p>DO NOT ACCEPT 'signals' / 'messages' / weaker action potentials IGNORE slower action potentials alone (as stated in previous question) ACCEPT takes longer for neurotransmitter to build up IGNORE less neurotransmitter produced ACCEPT fewer action potentials generated</p>

6	<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p>In summary: <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.) 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. Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i></p> <ul style="list-style-type: none"> ○ <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> <p>• The science content determines the level. • The Communication Statement determines the mark within a level.</p> <p>A level annotation should be used where all marks for a level have been achieved eg for 6 marks L3</p> <p>If a candidate has achieved 5 marks then they have reached level 3 but with one mark omitted e.g L3  The same principal should be applied to level 2 and level 1 No marks (0) should have a cross</p>		
	<p>Level 3 (5-6 marks) Describes and explains some improvements to the method and the presentation.</p> <p><i>There is a well-developed line of reasoning, which is clear and logically-structured and uses scientific terminology at an appropriate level. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3-4 marks) Describes some improvements to the method and the presentation, and explains improvements to either method or presentation</p> <p><i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented in the most part relevant and supported by some evidence.</i></p> <p>Level 1 (1-2 marks)</p>	6	<p>Indicative scientific points may include <i>Method:</i></p> <ul style="list-style-type: none"> • sample sizes should be increased to improve the accuracy and repeatability of the results • same number of subjects for, smokers/non-smokers/gender, to make comparisons more valid • gender should be controlled/tested separately because heart rate may show an overall difference between genders • other subject factors (e.g. diet, exercise history, other health issues) should be controlled/taken into account because these can influence heart rate

		<p>Describes some improvements to either method and / or presentation.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks <i>No response or no response worthy of credit.</i></p>		<ul style="list-style-type: none"> • the level of smoking (e.g. casual vs 20 per day) should be controlled because this is likely to be a continuous variable rather than the discrete variable the student has implied • time of day should have been standardised because this may influence heart rate • subjects should have been given an exercise that required a particular intensity (e.g. treadmill running) because effort will have varied • more repeats before calculating mean to identify anomalies <p><i>Presentation:</i></p> <ul style="list-style-type: none"> • smokers and non-smokers should have been presented as separate columns to make comparisons easier • units should be include for the final two columns to show that the three heart rate measurements were made using the same method • the number of significant figures/decimal places should be the same for each measurement to standardise the level of precision • present data graphically to spot trends more easily • label heart rates as mean heart rates for clarity
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Question			Answer	Marks	Guidance
7	a	i	<i>Insects</i> many / branched, tracheae / tracheoles / tubes ✓ <i>Fish</i> many / AW , filaments / lamellae / plates✓	2	IGNORE many spiracles ACCEPT many / branched,vessels ACCEPT feathery filaments IGNORE folding with no reference to an increase in number e.g. primary lamellae folded but ACCEPT if primary lamellae, folded into / covered with, secondary lamellae / plates
		ii	oxygen is in short supply (in lugworm habitat) ✓ rate of diffusion is, insufficient / too slow (to meet needs) ✓ lugworms have a smaller surface area to volume ratio (than some worms) ✓ lugworms have a high(er) <u>metabolic</u> rate ✓	1 max	IGNORE Live in habitat where gas exchange difficult DO NOT ACCEPT no oxygen ACCEPT harder to get oxygen
	b		goblet ✓ noradrenaline ✓ diaphragm ✓ forced / conscious / active / voluntary ✓	4	ACCEPT phonetic spelling throughout ACCEPT norepinephrine
Total				70	

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