GCE

Biology A

H420/03: Unified 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
BOD	Benefit of Doubt
CON	Contradiction
	Cross
ECF	Error Carried Forward
GM	Given Mark
	Extendable horizontal wavy line (to indicate errors / incorrect science terminology)
I	Ignore
	Large dot (various uses as defined in mark scheme)
	Highlight (various uses as defined in mark scheme)
NBOD	Benefit of the doubt not given
	Tick
^	Omission Mark
BP	Blank Page
L1	Level 1 answer in Level of Response question
L2	Level 2 answer in Level of Response question
L3	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	A = (permanent / temporary) vacuole ✓ B = <u>nucleolus</u> ✓	2	**ALLOW** vacule **DO NOT ALLOW** nucleus
		Ii	(x)14000 / 1.4 x 10^4 ✓✓	2	If the answer is incorrect, award one mark for a correct calculation not rounded to 2 s.f. (e.g. 0.02 / 0.0000014 = 14285.71429 20000 / 1.4 = 14285.71429) **ALLOW** 0.019/0.0000014 = 13571.428 **or** 0.021/0.0000014 = 15000 for 1 mark
		iii	no, shading / cross hatches / AW ✓ add, a scale / magnification ✓ add a title ✓	2 max	**Mark first two improvements described** e.g. only use outlines **IGNORE** references to labels or annotations and the use of a pencil (because this is mentioned in the question stem) **IGNORE** drawing should take up half a page / no overlapping lines / use continuous lines
		iv	place stain at edge of sample (not the centre) ✓ lower cover slip at an angle / use mounted needle ✓ use blotting paper to, remove excess stain / pull stain through ✓ use more than one stain (to improve contrast) ✓	2 max	**Mark as prose** **IGNORE** use forceps / lay sample flat **ALLOW** place stain at side of sample **ALLOW** stated angles given e.g. 45^o **ALLOW** 'tissue/paper towel' instead of 'blotting paper' **ALLOW** ensure stain covers whole sample
	b		*No waxy cuticle*	3	

Question			Answer	Marks	Guidance
			idea that water loss is not a problem / wax production wastes energy /AW ✓ *Stem tissue contains air spaces* buoyancy / (allows it to) float / increases gas exchange / more light near surface of water / AW✓ *Thin, flexible stem* less support needed / plant is supported by water / can move more (in water) without breaking / AW ✓		**ALLOW** does not impede flow of materials through cell wall / shorter diffusion distance / easier gas exchange / faster gas exchange / gas exchange more efficient e.g. less likely to be damaged / not damaged by, water currents / aquatic animals
2	**a**	**i**	naked mole rats, have a lower body temperature / AW ✓ naked mole rats use, **more** behavioural responses / use **fewer** physiological responses (to thermoregulate) / described ✓ (core) body temperature of naked mole rats, is not maintained within a narrow(er) range / changes (with environmental temperature) ✓ no fur / hair , to trap layer of (insulating) air / for insulation ✓	**2 max**	*Assume 'they' or 'it' refers to naked mole rats* **ORA** for other mammals **IGNORE** 'mammals are endotherms and mole rats are ectotherms' **ALLOW** 'most mammals are 37^{o}C and naked mole rats are 30-32^{o}C' e.g. 'they huddle together when temperature falls whilst mammals shiver' or ' they move to cooler parts when temperature rises whilst mammals sweat' **IGNORE** 'naked mole rats body temperature matches environmental temperature' **IGNORE** ref to no subcutaneous fat layer / no sweat glands **ALLOW** 'no hair so cannot trap heat'

Question			Answer	Marks	Guidance
	a	ii	positive feedback, is when an initial (biological) change is, increased further / exaggerated / AW ✓ lower temperature reduces kinetic energy (of molecules) ✓ enzyme activity, slowed / reduced ✓ respiration rate / metabolism, slowed / reduced ✓ less (metabolic / internal) heat generated ✓ (so that body) temperature drops further ✓	**4 max**	e.g. 'it is when a change causes system to go further from, norm / optimum' 'it is when a decrease leads to a further decrease' **ALLOW** fewer successful collisions / fewer ESCs formed **IGNORE** enzymes stop working / no enzyme activity **ALLOW** the rate of reactions (in the body) is, reduced / slowed down **IGNORE** respiration stops **ALLOW** less heat, produced / created *'change causes system to go further from, norm / optimum and so a decrease in temperature leads to further decrease' = mp1 and 6*
	a	iii	False True True False ✓✓	**2**	**ALLOW** T and F for True and False **ALLOW** ticks and crosses for True and False (when unambiguous) All correct ✓✓ 2 or 3 correct ✓
	b	i	no, action potentials / (electrical) impulses (in response to acid stimulus) ✓ (along) sensory neurones / neurones to CNS ✓ (because) no / few, <u>voltage gated</u> (sodium) channels open ✓ less depolarisation (of receptor membrane) / fewer Na^+ ions move in ✓	**2 max**	**ALLOW** fewer, action potentials / (electrical) impulses, generated **ALLOW** neurones to brain **IGNORE** fewer sodium ion channels opened **DO NOT ALLOW** no depolarisation / no Na^+ ions move in

Question			Answer	Marks	Guidance
	b	ii	converts, chemical / stimulus, to action potential / electrical energy / electrical impulse ✓	1	**ALLOW** kinetic energy / pressure / temperature / mechanical energy / H^+ ions as examples of stimuli (as question states a pain receptor) **IGNORE** 'sensory information' / 'pain'
	c	i	positive correlation **or** the higher the body mass the, longer / higher, the lifespan ✓	1	**ALLOW** ' as body mass increases lifespan increases' **DO NOT ALLOW** 'increase in body mass **causes** them to live longer' **IGNORE** weight / size for mass
	c	ii	lifespan is greater than expected for its mass / AW ✓	1	**IGNORE** weight / size for mass **ALLOW** 'longer / higher / bigger, than expected'
	d	i	glycolysis / anaerobic respiration, can continue / AW✓ because, conversion of glucose to TP is not needed / lactate inhibition is irrelevant / AW ✓ ATP is produced when TP is converted to pyruvate ✓	2 max	**IGNORE** lactate pathway **ALLOW** description of glycolysis e.g. 'enzymes needed to convert fructose to triose phosphate are not inhibited by lactate'
	d	ii	low body temperature / slow metabolic rate ✓ less energy is spent on thermoregulation ✓	1 max	**ALLOW** low metabolic rate / fewer metabolic reactions **ALLOW** other plausible physiological adaptations e.g. **more** creatine phosphate stores / **more** able to buffer H^+ ions / **more** myoglobin / Hb has high**er** affinity for oxygen / dissociation curve shifted to left / bradycardia / **more** erythrocytes

3	a		physiological ✓	1	**ALLOW** biochemical / physiology / biochemistry **IGNORE** biological / genetic /chemical
	b		enterokinase, is an enzyme / converts trypsinogen to trypsin / described ✓ calcium ion / Ca^{2+}, is a cofactor (to trypsin)✓	2	**mark as prose** **ALLOW** enterokinase**,** modifies / activates / changes tertiary structure, of trypsinogen **ALLOW** calcium ion binding site formed by enterokinase **ALLOW** enterokinase is a catalyst **ALLOW** a description of a cofactor **ALLOW** calcium ion / Ca^{2+}, is a <u>non-competitive</u> inhibitor **DO NOT ALLOW** Ca^{2+} is a, prosthetic group / coenzyme

	c	**i**		**4 max**	*Read as prose as improvement mark could be found in explanation e.g. 'I; substrate concentration E; should be kept constant ' gets I mp* *Marks for explanation can be awarded if the linked improvement mark is attempted but not given*
			I: another named control variable (not mentioned in text) ✓		e.g. area of film / volume of pH buffer / source of trypsin thickness / volume / concentration, of, gelatine / substrate **IGNORE** amount
			E: *idea of* prevent other factors (other than temperature) affecting results ✓		e.g. thickness may affect rate of breakdown of gelatine
			I: *idea of* standardised method ✓		e.g. film is placed in the solution in the same way each time / measure time for set volume of gelatine to be broken down / use a thermostatically controlled water bath
			E: minimises experimental error ✓		**ALLOW** improves, accuracy / reproducibility/ repeatability / precision **IGNORE** improves reliability
			I: temperature intervals closer together ✓		**ALLOW** extend temperature range below 10^{o}C
			E: (gives a more) accurate estimate of optimum temperature ✓		**ALLOW** shows the optimum / best temperature (for trypsin) **ALLOW** improves precision **DO NOT ALLOW** improves, reproducibility /reliability
			I: control group / tube with no trypsin / tube with boiled trypsin ✓		
			E: to see if gelatine breaks down without trypsin (at different temperatures) / to allow comparison (with experimental data) ✓		**ALLOW** to show trypsin is needed to break down gelatine **ALLOW** to see if heat breaks down gelatine

		ii	mm^2 / cm^2 **and** s^{-1} / min^{-1} ✓	**1**	**ALLOW** /s /min **DO NOT ALLOW** 'per' or 'sec' or 'minute'
		iii	*I agree / yes, because…* two mode values exist (for icefish trypsin) ✓ *I disagree / no, because…* outlier / anomaly, included in the mean (for human trypsin) ✓ median / mode, not / less, affected by outliers ✓	**2 max**	**IGNORE** references to decimal places
		iv	(Student's)(unpaired) t-test ✓ (they are) comparing **means** (of two data sets) / AW ✓	**2**	**IGNORE** standard deviation **DO NOT ALLOW** paired / dependent / related, t-test e.g. 'finding the difference between 2 means' **ALLOW** 'compare averages of 2 data sets'

4	**a**		(two years later T and B) memory cells produce a, stronger / larger / AW, response to antigens B and D ✓ (two years later, mutated virus) has less of / no longer has, antigens A and C ✓	**2**		**ALLOW** 'produce a secondary response to antigens B and D but not to A and C due to presence of memory cells' **IGNORE** 'faster response to antigens B and D' **ALLOW** antigens A and C, are mutated / have changed (shape) **IGNORE** 'virus has more antigens B and D than antigens A and C'

	b		***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*** ***In summary:*** *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):* ○ *award the higher mark where the Communication Statement has been met.* ○ *award the lower mark where aspects of the Communication Statement have been missed.* • ***The science content determines the level.*** • ***The communication statement determines the mark within a level.***			
			Level 3 (5-6 marks) Detailed explanation of variation from genes and environment, using examples. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated* **Level 2 (3-4 marks)** Explanation of variation from genes and environment, with few examples. *There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence* **Level 1 (1-2 marks)** Limited explanation of variation from genes or environment. *There is an attempt at a logical structure with a line of reasoning. The information is, in the most part, relevant.*	**6**		**Indicative scientific points may include (but are not limited to):** *Genes* • inherit genes that code for immune cells / antibodies (from parents) *examples: (B/T) lymphocytes, macrophages, etc* • different alleles code for different versions of immune cells/antibodies • ref. to gene segments recombining • alleles code for many different variable regions • reference to MHC alleles • mutation produces new alleles (for antigens / immune cells) • ref to autoimmune diseases *examples: lupus, arthritis, allergies, SCID* *Environment* • exposure to different pathogens determines immune response

			0 marks No response or no response worthy of credit.			*examples: measles, mumps, (produce) memory cells etc.* • vaccinations produce primary immune responses *examples:MMR, BCG,HPV, (produce) memory cells etc.* • reference to environmental influence on allergies *examples: pollen, hayfever, asthma, etc.* • poor diet can weaken immune system *examples: low levels of protein / vitamins, (reducing) antibodies* • reference to epigenetic changes *examples: as a result of diet, stress, chemical exposure* • (auto)immune diseases with an environmental component / trigger *example: AIDS*
	c		(DNL-Fab3) binds to, more than one type of antigen / different antigens (because it has different variable regions) ✓ (DNL-Fab3 is) unable to bind to immune cells (due to its lack of a constant region) ✓ (DNL-Fab3 can) bind to more antigens (due to having more than 2 binding sites) ✓ (DNL-Fab3 is) more flexible(due to having more hinge regions)✓	**2 max**		**IGNORE** refs to structural differences alone (e.g. heavy and light chains, number of binding sites, number of hinge regions, etc.) **IGNORE** pathogens **ALLOW** refs to more agglutination **IGNORE** pathogens
5	**a**		radius (of larva) = 0.8 mm **AND** (larvae) could (rely on simple diffusion) ✓✓	**2**		**ALLOW** calculator value (i.e. 0.79788456) or any correctly rounded value. **ALLOW** correct calculation with incorrect or no conclusion for 1 mark

						ALLOW ecf for correct conclusion drawn from incorrect calculation Award 0 marks for conclusion alone
	b	**i**	*the scientists need to know whether…* tomato plants produce methyl jasmonate ✓ natural concentrations are as high as experimental ones / AW ✓ methyl jasmonate increases, growth (rate) / cell division (rather than reducing herbivory) ✓ other plants respond in the same way (as tomatoes) ✓ the effect on the armyworm **population** / AW ✓ other insects respond in the same way ✓	**2 max**		**IGNORE** descriptions of improvements to method e.g. same growing conditions / effects of other herbivores / constant number of larvae **ALLOW** 'whether more methyl jasmonate produced after herbivory than before' **ALLOW '**need to carry out the investigation on other plant species' **ALLOW** how many herbivores died
		ii	methyl jasmonate increases the (final) mass (of tomato plants) ✓	**1**		**ALLOW** description of relationship e.g. 'as more methyl jasmonate applied mass of tomato plant increases' 'there is a positive correlation between methyl jasmonate and final mass'
		iii	methyl jasmonate (causes) increased cannibalism (among larvae above 0.1 mmol dm^{-3}) / AW ✓	**1**		**ALLOW** description of relationship e.g. 'as more methyl jasmonate larvae eat each other more' / 'there is a positive correlation between methyl jasmonate and cannibalism' **ALLOW** methyl jasmonate does not increase cannibalism below 0.1 mmol dm^{-3}

						ALLOW larvae have a tendency towards cannibalism even when no methyl jasmonate applied

6	**a**	**i**	***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*** ***In summary:*** *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):* o *award the higher mark where the Communication Statement has been met.* o *award the lower mark where aspects of the Communication Statement have been missed.* • ***The science content determines the level.*** • ***The communication statement determines the mark within a level.***		
			Level 3 (5-6 marks) Describes and explains advantages, using examples. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated* **Level 2 (3-4 marks)** Describes advantages, with some examples, but little explanation. *There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1-2 marks)** Describes some advantages, but with little or no explanation and few or no relevant examples. *There is an attempt at a logical structure with a line of reasoning. The information is, in the most part, relevant.* **0 marks** No response or no response worthy of credit.	**6**	**Indicative scientific points may include:** *Advantage*: low cost *Explanation*: many microorganisms require only low temperatures / few energy requirements / nutrients for growth are cheap (e.g. waste materials) *Advantage*: large numbers can be produced quickly / high yield of product *Explanation*: short generation time / reproduce quickly *Advantage*: better for the environment / less pollution *Explanation*: reduces use of land for food production / lower energy requirements *Advantage*: can be produced in many locations *Explanation*: not affected by climate / easy to control conditions *Advantage* : suitable food for vegans / more healthy food

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td>Explanation: low in cholesterol and high in protein or fibre / easy to genetically engineer to improve food quality

Examples (list not exhaustive)
• (Brewer's) yeast / for alcohol
• (Baker's) yeast / for bread
• Lactobacillus / for cheese / yoghurt
• Fusarium / for mycoproteins
• Pectinase / from A. niger / fungus / for fruit juice
• Aspergillus / yeast / for soya sauce
• fungal lactase / for lactose free milk</td></tr>
<tr><td></td><td>a</td><td>ii</td><td>
<table>
<tr><th>Statement</th><th>Batch</th><th>Continuous</th></tr>
<tr><td>Waste is removed during the fermentation process</td><td></td><td>✓</td></tr>
<tr><td>A fixed volume of nutrient medium is used</td><td>✓</td><td></td></tr>
<tr><td>Secondary metabolites are more likely to be produced</td><td>✓</td><td></td></tr>
<tr><td>The growth rate tends to be higher</td><td></td><td>✓</td></tr>
<tr><td>The culture is grown for a fixed period of time</td><td>✓</td><td></td></tr>
</table>
✓✓✓
</td><td>3</td><td>All 5 correct = ✓✓✓
4 correct = ✓✓
3 correct = ✓</td></tr>
<tr><td></td><td>b</td><td>i</td><td>50 ✓✓✓</td><td>3</td><td>If the answer is incorrect, award one mark for (1,000,000 / 20 =) 50000 / 5 x10^4</td></tr>
</table>

					and one mark for (50,000 / 10 =) 5000 / 5 x 10^3
		ii	*idea of* (with low colony numbers) small (random) differences (in plating) produce large errors when estimating / scaling ✓	**1**	**DO NOT ALLOW** assumes bacteria are equally distributed when removing the sample
	c		vectors ✓ spores ✓	**2**	
			Total	**70**	

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