GCE

Biology A

H420/03: Unified biology

A Level

Mark Scheme for June 2024

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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.

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **number of required** standardisation responses.

   YOU MUST MARK 5 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the RM Assessor messaging system, or by email.

5. **Crossed Out Responses**
   Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

   Rubric Error Responses – Optional Questions
   Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

Multiple Choice Question Responses
When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).
When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses
When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)
Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth **two or more marks**)
If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)
Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add an omission mark or 'seen' to confirm that the work has been seen.

7. Award No Response (NR) if:
   - there is nothing written in the answer space

   Award Zero '0' if:
   - anything is written in the answer space and is not worthy of credit (this includes text and symbols).

   Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM Assessor **comments box** is used by your team leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

9. If you have any questions or comments for your team leader, use the phone, the RM Assessor messaging system, or e-mail.

10. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

11. For answers marked by levels of response:
    Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.
    Once the level is located, award the higher or lower mark:
    The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.
    The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.
    In summary:
    The skills and science content determines the level.
    The communication statement determines the mark within a level.

    Level of response questions on this paper are **3(c)(ii)** and **5(a)**.

12. **Annotations**

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

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
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

13. **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)	flagellum ✓	1	**ALLOW** flagella **ALLOW** phonetic spelling e.g flagela, flaegella **DO NOT ALLOW** undulipodia/ undulipodium (*as found in eukaryotic cells only)*
1	(a)	(ii)	0.1 – 10 (µm) ✓	1	**ALLOW** any single value in the range *(from knowledge of prokaryote size not working from a magnification)*
1	(b)	(i)	mix (each dilution) ✓ replace (micro)pipette tips between each transfer ✓ repeat the plating (at least three times) and calculate a mean ✓ take photo of final plate so colonies can be counted ✓ reduce the number of, dilutions / transfers (to reduce random error) ✓	2 max	**mark as prose** **ALLOW** stir / shake (test tube before plating) **ALLOW** replace pipettes between each transfer / sterilise pipette between dilutions **IGNORE** 'repeat the experiment' (*as this suggests starting with a new population so does not improve accuracy)* **ALLOW** 'use more than one agar plate and calculate the mean' **IGNORE** 'average' **IGNORE** general ref to aseptic technique e.g. use sterile, water /agar

Question			Answer	Marks	Guidance
1	(b)	(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.1 x 10^7 award three marks** (22 x 10^5 =) 2,200,000 ✓ x 5 (= 11,000,000) ✓ (standard form =) 1.1 x 10^7 ✓	3	*If answer is incorrect,* ***ALLOW ECF*** *within working for max 2 marks* ***If answer = 11,000,000 award 2 marks*** **ECF** from step 1 (e.g. 220,000 x 5 = 1,100,000) **ECF** from steps 1 and 2 (e.g. 1,100,000 in standard form = 1.1 x 10^6) (The third marking point is awarded for the correct use of standard form based on their calculation) **DO NOT ALLOW** incorrect use of standard form e.g. 11000000x10^1 **ALLOW** alternative calculation with same **ECF** from step1 or steps 1 and 2 (22 x 10^4 =) 220,000 ✓ x 50 (cm^3) (= 11,000,000) ✓ (standard form =) 1.1 x 10^7 ✓

Question			Answer	Marks	Guidance
1	(c)		1.short life cycle / fast growth rate ✓ 2.simple nutrient requirements ✓ 3.can be maintained at (relatively) low temperatures ✓ 4.few ethical concerns ✓ 5.qualified reason why it is costs less ✓	2 max	**Mark as prose** **ALLOW** reproduce / replicate / multiply, quickly / fast **ALLOW** many produced in a short period of time **ALLOW** divides rapidly **IGNORE** short lifespan **ALLOW** 'does not require many nutrients' **IGNORE** simple / few, requirements for growth **ALLOW** 'does not require high temperatures' (for growth) **ALLOW** no, (animal) welfare issues / ethical concerns **e.g.** does not take up much space / uses cheaper substrates / uses wastes as substrates / uses cheap food example 'can be kept at low temperatures which is cheaper' = mp 3 and 5 'does not use many nutrients so it reduces cost' = mp 2 and 5

Question			Answer	Mark	Guidance
2	(a)			4 max	***Only award Explanation mark if linked to correct Improvement***
			I: large(r) sample size / AW ✓		e.g. 'generate more (than 10) coordinates' e.g. 'carry out study twice (in grassland/shrubs/bushes and grassland)'
			E: more representative / better representation (of populations / area) / AW ✓		e.g. 'higher chance of samples being taken from all three areas' / 'more, accurate / valid, estimate of population size' / '(otherwise) might not cover all, species / biodiversity (in area)' **IGNORE** ref to accuracy / validity unqualified
			I: stratified sampling / described ✓		**IGNORE** 'quota sampling'
					e.g. 'divide area into three zones and take random samples in each zone, with the number of samples proportional to the area of the zone' / 'sample from all three regions on map'
			E: avoids missing, species / populations (in different areas / in river / on one side of river) ✓		**ALLOW** more representative / better representation (of area) **ALLOW** (because) different areas have different species

Question			Answer	Mark	Guidance
			I: use frame <u>quadrat</u> (rather than point quadrat) / described ✓ E: less likely to miss (rare) species **or** easier to measure, tall plants / shrubs / bushes **or** less likely to harm small animals **or** more representative / better representation (of population / area) / AW ✓ I: use (a number of) transects (from bank into grassland) E: more representative of population / AW **or** less likely to miss (rare) species ✓ I: ref to sampling at different times of the year E: more representative of population / AW **or** less likely to miss species (growing at different times of the year) ✓		**ALLOW** phonetic spelling e.g. quadrrat, quadratte e.g. 'use a quadrat with squares' **ALLOW** 'as there is an environmental gradient from the river'

Question			Answer	Mark	Guidance
2	(b)	(i)	mammals greater, threat / %, from human exploitation / AW **OR** birds smaller, threat / %, from human exploitation / AW ✓ mammals smaller, threat / %, from, climate change / pollution / AW **OR** birds larger, threat / %, from, climate change / pollution / AW ✓ mammals have, similar / slightly lower, threat / %, from, habitat degradation / invasive species / AW ✓ **OR** birds have, similar / slightly higher, threat / %, from, habitat degradation / invasive species / AW ✓	2 max	**ALLOW** 'vulnerable', 'susceptible', 'sensitive', face more', 'affected more' in place of 'threat' **ALLOW** refs to **qualified** data quote e.g. human exploitation has 37% threat in mammals but **only** 16% in birds' / 'mammals more, threat from / affected by, human exploitation / hunting' e.g. 'mammals have less threat from climate change and pollution' e.g. 'pollution is twice the threat for birds compared to mammals'
2	(b)	(ii)	*Supports* 1 lowest (% threat) for reptiles and amphibians **and** mammals / AW ✓	4 max	**ALLOW** '**all** other categories for reptiles and amphibians **and** mammals have a greater threat / higher % (than climate change) '

Question			Answer	Mark	Guidance
			2 threatens fewer than 11 -13% (of species / populations) in **all**, (four) groups / animals / AW ✓		**ALLOW** any value in this range e.g. 'highest % of populations affected by climate change is 12%'
			3 *ref to* absolute number of species assessed being high enough to be representative ✓		e.g. '3789 species are assessed is a large enough sample to be representative'
			does not support ***(max 3)*** 4 small proportion of (of total) species assessed ✓		**ALLOW** 'only 3,789 of the millions of animal species were assessed' / 'not assessed every species' **IGNORE** 'small sample size'
			5 sample was not random (because species were selected from the Red List) ✓		
			6 threat categories overlap / described ✓		**ALLOW** examples (e.g. 'human exploitation / climate change, can cause habitat loss')
			7 many species are threatened by more than one factor ✓		
			8 effects of climate change (on biodiversity) yet to be felt / climate change impact will increase in future / AW ✓		e.g. 'data is (8 years) old, climate change has had a greater impact since then'
			9 AVP ✓		e.g. 'can't be generalised to all animals' / 'no statistical analysis carried out' / 'only vertebrates were studied' / 'no plants included'

Question			Answer	Mark	Guidance
2	(c)		rotate the trees that are harvested ✓ (rotational) coppicing ✓ replant trees (rather than rely on natural regrowth) ✓ selective felling / described ✓	1 max	**Mark first answer given** **ALLOW** 'rotational felling' **ALLOW** pollarding **ALLOW** description (e.g. 'cut trees so that a stump remains near the ground') e.g. 'cut only the largest / oldest / most valuable / fastest growing, trees (each year) **ALLOW** 'strip felling' **IGNORE** clear felling **IGNORE** afforestation

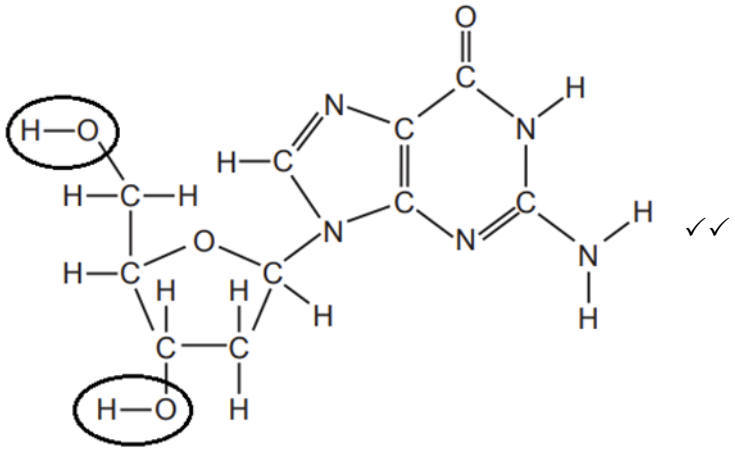
Question			Answer	Mark	Guidance
3	(a)		phloem ✓ differentiate ✓	2	**DO NOT ALLOW** 'phloem sieve tubes' **ALLOW** 'specialise'
3	(b)	(i)	*Safety precaution* cut away from the body **OR** *idea that* only one person at a time should work on the specimen **OR** use sharp, scalpel / scissors / knife / razor blade ✓ *Explanation* to avoid cuts / AW ✓ *Safety precaution* wash specimen / wash hands / wear gloves ✓ *Explanation* to avoid, infection (with plant pathogens) / allergic reaction / AW ✓	2 max	**Explanation mark can only be awarded if linked to relevant idea of safety precaution** *Examples 'be careful when using, a scalpel / sharp instruments, to avoid cutting yourself = 1 mark (no precaution but has explanation) 'wear goggles to prevent plant sap going into your eye' = 2 marks (safety precaution and explanation)* **IGNORE** 'be careful when using a scalpel' / 'take care when using sharp instruments' **ALLOW** 'take care when using a sharp, scalpel / scissors / knife / razor blade' **ALLOW** use forceps to hold plant tissue / use of, dissection board / glass tile / slate e.g. to avoid penetrating the skin' / 'to avoid stabbing, yourself / someone else' **ALLOW** wear eye protection

Question			Answer	Mark	Guidance
3	(b)	(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.17 award two marks** 15 (mm) / 90 **or** 0.166 ✓ (2 significant figures =) 0.17 (mm) ✓	2	**ALLOW** 1 mark if answer not given to 2 sig figs **ALLOW** any number of significant figures for mp1 **ALLOW ECF** from step 1 for an incorrect measurement divided by 90 **and** correctly rounded to 2 sig figs for **1 mark** e.g. 1.5(cm) / 90 = 0.0166 **and** = 0.017 for 1 mark
3	(c)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 28 / 28.3 award two marks** 1mm / 2 = 0.5 0.5^2 = 0.25 x π = 0.78539 x 18 = 14.137 ✓ x 2 = 28.274 = 28 mm^3 h^{-1} ✓	2	**ALLOW** 1 mark for correct answer not rounded to two or three significant figures (e.g. 28.27433, 28.2857, 28.26, 28.278) (depending on value of π used) **ALLOW** 1 mark for correctly working out volume of water lost in 30 minutes (to any number of sig figs (e.g.14.137165, 14.142855,14.13,14.139) (depending on value of π used) **ECF** if diameter rather than radius used to calculate volume (110 or 113) for 1 mark

3	(c)	(ii)	***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.***		
			Level 3 (5-6 marks) Detailed description of data to be collected **and** description of control variables **and** appropriate choice of statistical test. *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)** Detailed description of data to be collected **and** Description of control variables **or** appropriate choice of statistical test. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1-2 marks)** Description of data to be collected **or** description of control variables **or** appropriate choice of statistical test. *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 (but are not limited to):** *Data collected* • (appropriate) range of temperatures (e.g. 10, 15, 20, 25, 30, 35, 40, 45 °C) • detail of how temperature will be regulated (e.g. use of a climate-controlled room, thermostatically controlled chamber) (note a water bath is not appropriate in this experiment) • at least three repeats (at each temperature) • identify anomalies • calculate, means / standard deviation *Validity/controls* • area of leaf • humidity • light intensity • same plant • air movement • time • details of how to control these variables *Statistical test* • Spearman's rank / Pearson correlation coefficient (if comparing 5 or more temperature values) • *t*-test (if comparing two temperatures) or Mann-Whitney U test

3	**(d)**		*Adaptation* stomata, in pits / sunken / AW **or** hairs **or** curled / rolled, leaves /AW ✓ *Explanation* reduces air movement / increases humidity (around stomata) / AW **or** reduces water potential gradient (across stomata) / AW ✓ **OR** *Adaptation* curled / rolled, leaves / AW ✓ *Explanation* reduces surface area (exposed for transpiration) ✓	**2 max**	**Award 1 mark for adaptation and 1 mark for correctly linked explanation** **(only award the explanation mark if adaptation mark awarded)** **IGNORE** stomata on underside / lower surface e.g. leaves are curved **or** stomata face inwards **or** leaves reduced to spines / spikes / needles (as candidates not familiar with bell heather) e.g. 'to trap moist air' / reduces effect of wind / create a humid environment / trap water vapour **IGNORE** 'traps moisture' e.g. reduces water vapour, diffusion / concentration, gradient e.g. leaves are curved **or** stomata face inwards **or** leaves reduced to spines / spikes / needles (as candidates not familiar with bell heather)

			OR *Adaptation* thick waxy cuticle ✓ *Explanation* impermeable to water /AW ✓		 e.g. stops / reduces, water vapour escaping

Question			Answer	Mark	Guidance
4	(a)		 ✓✓	2	**One mark per correct circle** **ALLOW** circles around OH or H alone **ALLOW** clear, unambiguous mark other than a circle **DO NOT ALLOW** if circle encloses other parts of molecule e.g. CH_2 or O alone **If more than 2 circles drawn, -1 mark for each incorrect circle**
4	(b)		(produces) <u>ATP</u> to provide (chemical) energy / AW ✓ (DNA replication) requires <u>ATP</u> / AW ✓	1	**DO NOT ALLOW** 'produces energy' **ALLOW** requires <u>ATP</u> as it is an active process **ALLOW** 'because <u>ATP</u> is needed'

Question			Answer	Mark	Guidance
					e.g. need for ATP (in, DNA replication / to break bonds between bases / form phosphodiester bonds)
4	(c)	(i)	*(pH, would increase / become less acidic / more alkaline)* because protons move into, chloroplasts / AW ✓ by, diffusion / down a concentration gradient / AW ✓ (for) protons (to be pumped / moved) into thylakoid, lumen / space / AW✓	2 max	**If pH decreases / becomes more acidic / less alkaline = 0 marks** **ALLOW** H^+ / hydrogen ions for protons throughout **DO NOT ALLOW** H / hydrogen for protons throughout (but penalise only once) e.g. 'protons diffuse from high to low concentration into the chloroplasts' = 2 marks **ALLOW** electrochemical gradient for concentration gradient **IGNORE** 'along a concentration gradient' **IGNORE** active transport *(as energy provided by ETC)* **IGNORE** 'intermembrane' *(as confusing chloroplasts with mitochondria*)

Question			Answer	Mark	Guidance
4	(c)	(ii)	*(ATP produced in 3 / pH 8 solution, but not 2 / pH 4 solution, because)*	2	**If ATP produced in 2 but not 3 or ATP production is, higher / highest, in 3 or more ATP produced in 3 than 2 = 0 marks** **ALLOW** H^+ / hydrogen ions for protons throughout **DO NOT ALLOW** H / hydrogen for protons throughout (but penalise only once)
			proton gradient between thylakoid (lumen / space) and solution 3 ✓		**ALLOW** electrochemical gradient for proton gradient **ALLOW** higher concentration of protons in thylakoid (lumen / space) than in solution 3 **ALLOW** no proton gradient / equal proton concentration, between thylakoid (lumen) and solution 2
			protons diffuse through ATP synthase (into solution 3) ✓		**ALLOW** no protons diffuse through ATP synthase into solution 2 **DO NOT ALLOW** 'pumped through by diffusion' **ALLOW** 'pass' / move / travel' for 'diffuse'

5	(a)		***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.***		
			Level 3 (5-6 marks) An answer that includes appropriate conclusions **and** an accompanying explanation *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)** An answer that includes an appropriate conclusion **and** an accompanying explanation. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1-2 marks)** An answer that includes an appropriate conclusion**.** *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 (but are not limited to):** • **C both types of diabetes are affected by the environment and genetics** • **E** because genetic influence alone would cause 100% of identical twin pairs to have diabetes • **E** because genetic influence alone would cause (approximately) 50% of non-identical twin pairs to have diabetes • **C environment appears to have more influence than genetics for both types** • **E** because (all four) percentages are low • **E** because if genetics and environment exerted a similar influence, we would expect 50% for identical twins / 25% for non-identical, and the percentages are all lower than these values • **C genetic component of type 2 might be higher than that of type 1** • **E** because percentages are higher for, both types of / non-identical / identical, twins with type 2 diabetes

					• **C conclusions drawn are limited / AW** • **E** different numbers of pairs of twins in each group / many more pairs of twins with type 2 diabetes looked at compared to type 1 diabetes / small overall sample size / no statistical analysis/ are both non identical twins the same sex / are all pairs of twins the same age • **E** assumption that twins both grew up in same environment / all pairs of twins were in similar environments / had similar diets or exercise

Question			Answer	Mark	Guidance
5	(b)		A = islet of Langerhans B = (branch of pancreatic) duct C = (named) blood vessel	3	**ALLOW** α-cell / β-cell **ALLOW** (intralobular) duct **ALLOW** artery / arteriole / vein / venule **ALLOW** red blood cell / erythrocyte **DO NOT ALLOW** capillary (contains too many erythrocytes) / incorrectly named blood vessel (e.g. hepatic artery)
5	(c)		all 5 data points plotted correctly (± half a square) ✓ (smooth) line of best fit ✓	2	 smooth continuous curve starting at point 1 and finishing at point 5 going through all 5 points **ALLOW** if goes between points 3 and 4 or misses either point 3 or point 4 **DO NOT ALLOW** ruled lines between points
5	(d)		quaternary / 4^{o} primary / 1^{o} tertiary / 3^{o} secondary / 2^{o}	2	**1 correct = 0 marks** **2 or 3 correct = 1 mark** **4 correct = 2 marks** **ALLOW** numbers 1,2,3,4 or 1ry, 2ry, 3ry, 4ry or terms first, second, third, fourth
5	(e)	(i)	culture heating / heat shock / electroporation ✓	1	**ALLOW** electric shock / electric pulse / virus (as a vector) / transfection / add calcium ions and heat **IGNORE** *Agrobacterium tumefaciens (as used to infect plant cells)* / electrofusion *(used to fuse 2 cells together)* / vector unqualified

Question			Answer	Mark	Guidance
5	(e)	(ii)	marker / reporter, genes (added to plasmid) ✓ gene for, antibiotic resistance / fluorescence / nutrient deficiency (added to plasmid) ✓	1 max	**ALLOW** use of PCR / DNA sequencing / pyrosequencing / use of electrophoresis **DO NOT ALLOW** 'add fluorescent, tag / dye'
5	(f)	(i)	(they can) differentiate into, specialised / specific, cells / AW ✓	1	**IGNORE** 'they are, undifferentiated / unspecialised unqualified **ALLOW** develop / change / divide / form, for differentiate **ALLOW** pluripotent / multipotent **IGNORE** totipotent e.g. 'they can specialise into, many / any, different types of cell' e.g. 'they can differentiate into, pancreatic / β, cells' **IGNORE** 'grow into / turn into, specialised cells'
5	(f)	(ii)	*idea that* type 1 diabetes is an autoimmune disease (so response against (any) β-cells would still occur) ✓	1	e.g. mistake **their own** new β-cells as foreign and attack them' **IGNORE** 'to stop the immune system attacking the cells' alone

Question			Answer	Mark	Guidance
6	(a)		1. remove meristem tissue from, shoot (tip) / root (tip) / leaf / (apical / axial) bud ✓	4 max	
			2.use aseptic techniques / described ✓		e.g. disinfect surfaces / work near Bunsen flame / use sterile scalpel / sterilise with, ethanol / sodium dichloroisocyanurate / bleach / sodium hypochlorite
			3.place (explant) in culture medium / described ✓		e.g. 'place on agar gel' *example* 'place on sterile nutrient medium' = mp2 and 3
			4.*ref to* use of **named** nutrient in culture medium ✓		e.g. amino acids for protein synthesis / phosphates for DNA or ATP / glucose or sucrose for respiration
			5.to allow cells to divide / to form a callus ✓		**ALLOW** 'allow cells to undergo mitosis'
			6.divide (callus) into smaller clumps (of cells) ✓		
			7. ref.(named) hormones / plant growth substances, to encourage differentiation / (shoot / root) growth / AW ✓		e.g. auxins / cytokinins, for specialisation **IGNORE** ref to hormones for mp7 if they are added before the callus forms
			8.transfer (plantlet) to, soil / compost ✓		

Question			Answer	Mark	Guidance
6	(b)		*disease* ring rot ✓ *type of pathogen* bacteria ✓ **OR** *disease* (potato / late) blight ✓ *type of pathogen* protoctista ✓	2 max	**The mark for pathogen can only be awarded when it is correctly matched with the disease** **ALLOW** other correct pairs to those listed **ALLOW** brown rot / blackleg / pink eye / common scab ✓ **ALLOW** protista / protoctist / phonetic spelling e.g.protocotist etc. **ALLOW** *disease* black dot / (common / yellow) rust / early blight / powdery mildew / dry rot ✓ *type of pathogen* fungus✓ **OR** *disease* (potato) leaf roll, (potato) leaf mosaic ✓ *type of pathogen* virus ✓ **IGNORE** tomato / tobacco mosaic **IGNORE** black sigatoka *(as it is a disease of bananas not potatoes*)

Question			Answer	Mark	Guidance
6	(c)	(i)	bulb ✓ split / divide / cut, (bulb / corm / tuber) **and**, plant / repot / AW ✓	2	**ALLOW** corm / tuber (*as not familiar with lily plant)* **IGNORE** rhizomes **ALLOW** 'remove bulb scale' for 'split bulb'
6	(c)	(ii)	runner ✓ roots / shoots, form (away from parent plant) **or** runner between plant(let) dies / described ✓	2	**ALLOW** stolon / horizontal stem e.g. 'runners, detach / break down / breaks **IGNORE** 'by asexual reproduction / vegetative propagation' (*as not a description*)

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