# GCE

# Biology A

## H420/02: Biological diversity

A Level

# Mark Scheme for June 2024

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

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

9. 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.

10. 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 **18(b)(i)** and **20(b)(i)**.

11. **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 |

12. **Subject Specific Marking Instructions**

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

| Annotation | Meaning |
|---|---|
| ***I*** | 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.

## Other subject-specific instructions

- Use **CON** when a correct response is associated with a piece of clearly incorrect science within the same statement and award no mark.
- For questions in which the command word is ‘suggest’, ignore incorrect responses and credit a correct response wherever it occurs
- Accept mis-spellings that are phonetically identical unless otherwise indicated
- All marks are stand-alone unless otherwise stated in Guidance
- Bracketed words. The words in brackets are there to ‘set the scene’ and indicate the context in which the answer is expected. They do not need to appear. Award the mark as long as the statement in the brackets is not contradicted.
- Solidus (/): A solidus indicates alternative ways that a mark might be gained for a given Mark Point.

- In questions involving calculations, where a candidates answer is not covered by the mark scheme, assume one mark less than the maximum available for a single error.
- Use of the comma in a mark point: This indicates that some information from either side of the comma or commas is needed. It is used in conjunction with the solidus.
- In some cases the Guidance column may indicate examples of wording or terms that are acceptable (ALLOW) or that should be ignored (IGNORE). In the case of IGNORE read on (or previously) to see if something creditworthy appears later in the response.
- Underlining
  - solid underline. The word or part of word underlined is required but minor mis-spellings are acceptable as long as the word is clearly the same
  - wavy underline. This indicates that, while the word underlined is not precisely needed, alternative responses need to be closely related in meaning or be a clear description.
- *idea of.* This is used as a prefix to marking points where there may be a fairly wide range of responses which cover the essence of the required response. This often requires examiner judgement. For '*idea of*' marking points, a wide range of wording is acceptable. The mark is to be awarded for the *idea*.

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| **1** | | | B ✓ | **1** | 1.1 | |
| **2** | | | D ✓ | **1** | 1.1 | |
| **3** | | | B ✓ | **1** | 2.2 | |
| **4** | | | B ✓ | **1** | 1.1 | |
| **5** | | | C ✓ | **1** | 1.1 | |
| **6** | | | B ✓ | **1** | 1.1 | |
| **7** | | | C ✓ | **1** | 1.2 | |
| **8** | | | A ✓ | **1** | 2.8 | |
| **9** | | | D ✓ | **1** | 2.8 | |
| **10** | | | D ✓ | **1** | 1.2 | |
| **11** | | | C ✓ | **1** | 1.1 | |
| **12** | | | A ✓ | **1** | 1.2 | |
| **13** | | | D ✓ | **1** | 1.2 | |
| **14** | | | C ✓ | **1** | 1.1 | |
| **15** | | | C ✓ | **1** | 1.1 | |

| Question | | | Answer | Marks | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 16 | (a) | | identifying / AW , genetic diseases / disease risk / evolutionary relationships / disaster victims ✓<br><br>classifying organisms / evidence for evolution ✓<br><br>(as part of) breeding programmes ✓ | 1 max | 1.1 | *Mark the first answer*<br>**ALLOW** identifying , siblings / ancestry<br>**IGNORE** to see if people are related (as could be paternity)<br>**IGNORE** medical , diagnosis / screening (for non-genetic diseases)<br>**IGNORE** investigating , genetics / research / mutations<br>**IGNORE** organ transplants / personalised medicine |
| | (b) | (i) | polymerase chain reaction ✓ | 1 | 1.1 | |
| | (b) | (ii) | **X** (represents) denaturation / strand separation / breaking of H-bonds ✓<br><br>**Y** (represents) annealing / primers added (to DNA) ✓<br><br>**Z** (represents) synthesis of a new strand / addition of nucleotides (to new DNA strand) ✓ | 3 | 1.2 x 2<br>2.6 x 1 | **X IGNORE** $H^+$-bonds<br><br>**Z ALLOW** synthesis / extension / elongation (of DNA strand)<br>**Z ALLOW** description of forming a complementary strand<br>**Z IGNORE** bases **/** replication |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **(b)** | **(iii)** | optimum (temperature for enzyme) ✓<br><br>Taq polymerase allows high(er) rate , of DNA replication / AW ✓<br><br>(enzyme) obtained from , thermophilic / AW , organisms ✓<br><br>enzyme is able to withstand high(er) temperatures (than normal DNA polymerase) ✓ | **3 max** | **2.5 x 2**<br><br>**2.6 x 2** | **ALLOW** Taq polymerase allows fast(er) rate of reaction<br><br>**ALLOW** e.g., from bacteria that live in hot springs<br><br>**ALLOW** doesn't denature at such high temperatures / thermostable<br>**ALLOW** optimum is higher than other forms of DNA polymerase |
| | | **(iv)** | (initial) sample is small / AW ✓ | **1** | **2.6** | **ALLOW** not much DNA to begin with<br>**IGNORE** to amplify the sample / to get a big enough sample |
| | **(c)** | **(i)** | double peaks / they , are heterozygous / have different alleles ✓<br><br>single peaks , are homozygous / have the same allele ✓ | **2** | **2.2** | **IGNORE** genes / coding<br><br>**ALLOW** VNTR length as AW for allele<br><br>*If no other mark awarded*<br>**ALLOW** 1 mark for using the terms 'homozygous' and 'heterozygous' (not linked to peaks) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | **(ii)** | *claim is supported because…*<br>**1** (DNA profiles) are identical / match / AW ✓<br><br>**2** probability / chance , of 2 people having identical profiles is very low / AW ✓<br><br>*however…*<br>**3** (6 is) a low number of , loci / peaks ✓<br><br>**4** … so they could have been , closely related / AW ✓<br><br>**5** could be identical twins ✓ | **3 max** | **3.2**<br>**3.2**<br><br>**3.2**<br>**3.1** | *Assume correct context unless answer contradicts it*<br><br>**1 ALLOW** are the same<br>**1 IGNORE** similar / same number of base pairs<br><br>**2 ALLOW** very low likelihood / near impossibility , that 2 people would have matching profiles<br>**2 IGNORE** so they probably come from the same person<br><br>**3 ALLOW** only 6 genes were tested<br>**3 ALLOW** 17 loci are needed in court<br>**3 IGNORE** small sample<br><br>**4 ALLOW** only if mp 3 has been **AWARDED** |

| Question | | | Answer | Mark | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 17 | (a) | | **1** use <u>pipette</u> to place blood on <u>slide</u> ✓<br>**2** (place blood) near one end (of slide) ✓<br>**3** use (2nd) slide / cover slip , to spread / AW , blood across slide ✓<br>**4** slide / cover slip , at an angle ✓<br>**5** AVP ✓ | **3 max** | **1.2 x 1**<br>**3.3 x 2** | **CREDIT** answers from an annotated diagram<br>**IGNORE** staining<br>**3 ALLOW** smear as AW for spread<br>**5 CREDIT** allow to (air) dry |
| 17 | (b) | (i) | <u>erythrocyte</u> ✓ | **1** | **1.1** | **ALLOW** spelling that is phonetically loosely equivalent |

| Question | | | Answer | Mark | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 17 | (b) | (ii) | **1** single cell<br>**and**<br>two parts to nucleus<br>**and**<br>broadly circular ✓<br><br>**2** clear continuous (single) lines (on nuclear and cell surface membranes)<br><br>**and**<br><br>≥ 45 mm horizontal diameter ✓<br><br>**3** ruled label lines (touching feature) ✓<br><br>**4** nucleus<br>**and**<br>cytoplasm / cytosol<br>**and**<br>cell (surface) / plasma , membrane labelled ✓<br><br>**5** colour of any of above mentioned (as annotation) ✓ | **4 max** | **3.3** | **1 DO NOT CREDIT** if anything obviously incorrect has been drawn<br><br>**2 IGNORE** minor errors if it is clear candidate has attempted to draw continuous lines<br><br>**3 DO NOT CREDIT** arrows / label lines that cross<br><br>**4 DO NOT CREDIT** nuclei<br>**4 IGNORE** nuclear , membrane / envelope<br>**4 IGNORE** lysosomes<br>**4 DO NOT CREDIT** any other labelled structures<br><br>**5 ALLOW** e.g., nucleus is darker<br>**5 DO NOT CREDIT** if shading has been used |

| Question | | | Answer | | Mark | AO Element | Guidance |
|---|---|---|---|---|---|---|---|
| 17 | (b) | (iii) | | **FIRST CHECK ON ANSWER LINE**<br>**If answer = 8.0 (± 0.3) µm award 3 marks** | 3 | 2.8 | *Where an answer is not obviously covered by the mark scheme, a single error should mean that only one of the marking points is not credited, e.g.,* '82' or '0.79' = 2 marks (mp 1 and mp 3). |
| | | | **1** | *correctly reading the diameter with the graticule and mapping this measurement onto the stage micrometer*<br>diameter = 8.0 (± 0.3 divisions) / 0.008 (mm) ✓ | | | **AWARD** this mark for any answer where the first 2 significant figures are in the range 77 to 83 |
| | | | **2** | *converting units*<br>0.008 mm = 8.0 (µm) ✓ | | | **AWARD** this mark if the final answer is between 5 and 10 (µm) |
| | | | **3** | *using correct number of significant figures.*<br>answer in µm to 2 significant figures ✓ | | | **AWARD** this mark if the final answer given to 2 significant figures |

| Question | | | Answer | Mark | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 18 | (a) | (i) | family ✓ | 1 | 2.1 | |
| 18 | (a) | (ii) | **1** all / they , are different genera ✓<br><br>**2** Tasmanian devil **and** quoll **and** dunnart are in same , family / (taxon) A ✓<br><br>**3** (Dasyuridae species) share more recent common ancestor (with one another than with thylacine or numbat) ✓ **ora**<br><br>**4** all in the same order so likely to have (phylogenetic) relationship ✓ | 3 max | 2 x 2.1<br>1 x 3.1 | **CREDIT** scientific names<br><br>**1 ALLOW** all / they , are different species<br><br>**2 ALLOW** thylacine **and** numbat do not share a family with the others<br><br>**3 ALLOW** share , closer / next , common ancestor<br>**3 ALLOW** more / most , closely related<br>**3 ALLOW** more genetically similar (or higher level descriptions thereof)<br>**3 IGNORE** DNA<br><br>**4 IGNORE** DNA |
| 18 | (a) | (iii) | none are in , Thylacinidae / the thylacine's family ✓<br><br>*idea that* further information is required ✓ | 2 | 3.1 | **ALLOW** e.g., DNA sequences not available / classification based on observable features (rather than molecular evidence) |
| 18 | (a) | (iv) | no / absence of , cell wall<br><br>**AND**<br><br>no / absence of , chloroplasts ✓ | 1 | 2.1 | **DO NOT CREDIT** wrong answers<br>Answers can be in any order but both required for 1 mark.<br><br>**IGNORE** heterotrophic / lysosomes / glycogen granules / centrioles / centrosomes |

| Question | | | Answer | Mark | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 18 | (b) | (i)* | Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.<br><br>**Level 3 (5–6 marks)**<br>Explains in detail how gene sequencing **AND** bioinformatics **AND** computational biology are used in the production of synthetic proteins.<br><br>*There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.*<br><br>**Level 2 (3–4 marks)**<br>Explains how gene sequencing **AND** bioinformatics are used in the production of synthetic proteins.<br><br>**OR**<br><br>Explains how gene sequencing **AND** computational biology are used in the production of synthetic proteins.<br><br>**OR**<br><br>Explains how bioinformatics **AND** computational biology are used in the production of synthetic proteins.<br><br>*There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*<br><br>**Level 1 (1–2 marks)**<br>Mentions how gene sequencing **OR** bioinformatics **OR** computational biology are used in the production of synthetic proteins.<br><br>*There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.*<br><br>**0 marks**<br>*No response or no response worthy of credit.* | 6 | 2.5 | **Indicative points may include**<br><br>*Principle*<br>• computational biology can use bioinformatics to make predictions about the structure and function of a synthetic protein using DNA sequences<br>• involves genetic modification of organisms<br><br>*Gene sequencing*<br>• determines order of bases<br>• order of bases linked to order of amino acids<br>• order of amino acids is protein primary structure<br>• DNA sequence can be inferred from, and implies, protein primary structure<br><br>*Bioinformatics*<br>• stores and organises large amounts of data<br>• databases of<br>○ DNA and amino acid sequences<br>○ protein structures<br>○ metabolic pathways<br>• facilitates fast retrieval and sharing of information<br>• algorithms and statistical tests<br><br>*Computational biology*<br>• needed for analysis of large amounts of data<br>• rapid processing of data<br>• prediction of amino acid sequences<br>• modelling of protein structure or function<br>• algorithms and statistical tests<br><br>QWC<br>*Award the communication mark if the candidate is able to communicate relevant ideas clearly without confusing terms such as bases and amino acids*. |

| Question | | | Answer | Mark | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 18 | (b) | (ii) | *idea of* unknown consequences ✓<br><br>(named) ethical issues ✓ | 1 | 2.5 | <br><br>**IGNORE** tampering with nature / not natural / designer babies / animal welfare<br>**ALLOW** creating bioweapons |
| 18 | (c) | (i) | thylacine has lowest , genetic diversity / proportion of heterozygous gene loci ✓<br><br>antechinus **and** dunnart (and wombat) / three species with highest (genetic) diversity , have least concern ✓<br><br>species with more genetic variation are less vulnerable ✓<br>**ora** | 2 max | 3.2 | **CREDIT** scientific names<br><br>**ALLOW** all least concern species except wallaby have high genetic diversity<br>**ALLOW** all species with genetic diversity above 0.0017 have least concern<br><br>*Needs to be a general statement about a pattern inferred from the table*<br>**ALLOW** there is a correlation between genetic diversity and conservation status<br>**ALLOW** the higher the genetic variation the lower the concern |
| 18 | (c) | (ii) | koala is vulnerable but (tammar) wallaby is least concern / AW **ora** ✓<br><br>(tamar) wallaby is least concern but has (relatively) low genetic diversity / koala's genetic diversity is (relatively) high but it is vulnerable ✓ | 1 max | 3.2 | **CREDIT** scientific names<br>**ALLOW** any working that communicates the point, e.g. species with genetic diversity 0.0013 has higher concern than 0.0007<br><br>**ALLOW** AW for describing conservation status |

| Question | | | Answer | Mark | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 19 | (a) | (i) | a weakened / attenuated / dead , form of (polio) virus ✓ | 1 | 2.1 | **ALLOW** fragments / antigens , of virus<br>**IGNORE** DNA / RNA<br>**IGNORE** small amount / dormant / antibodies<br>**IGNORE** cells |
| 19 | (a) | (ii) | **1** involved in clonal selection ✓<br>**2** (cell surface) receptors (on T-cell) bind to , antigens / (named) APCs ✓<br>**3** produce / release , interleukins / cytokines ✓<br>**4** (T-helper cells / interleukins) stimulate phagocytosis ✓<br>**5** (T-helper cells / interleukins) , stimulate clonal expansion ✓<br>**6** T-killer cells destroy infected cells ✓<br>**7** differentiate into T-memory cells ✓<br>**8** T-memory cells allow rapid , secondary / AW , response ✓ | 4 max | 1.2 | **1 IGNORE** activation (of T-helper cells)<br>**5 ALLOW** cause , mitosis / proliferation / division , of , T/ B , cells<br>**5 ALLOW** activate , B / T-killer , cells<br>**8 ALLOW** description, e.g., T-memory cells rapidly produce T-killer cells if pathogen returns<br>**8 IGNORE** produce antibodies more quickly<br>**IGNORE** regulator cells |

| Question | | | Answer | Mark | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 19 | (b) | (i) | **FIRST CHECK ON ANSWER LINE**<br>**If answer = 85 or 84.9 (%) award 2 marks**<br><br>*correct reading from graph and subtraction*<br>3440 − 520<br>= 2920 ✓<br><br>*correct calculation*<br>2880 x 100 = 84.7 ✓<br>3400 | **2** | **2.2** | **ALLOW** any answer in the range 82 to 86<br>**ALLOW** 1 mark for 80 or if correct answer given to more than 3 significant figures<br>**IGNORE** sign<br><br>If answer is incorrect, **ALLOW** 1 mark for **either** of the following:<br><br>*correct answer to…*<br>3380–3600 − 500–600 =<br><br>**or**<br><br>*candidate's values substituted into the following equation*<br>change x 100 = correctly processed answer<br>original |
| 19 | (b) | (ii) | uptake might not have been , immediate / high in 1956 ✓<br><br>some cases in 1956 might have occurred before vaccine introduction / 1957 was first full year of vaccine ✓ | **2** | **3.2** | *Mark as prose*<br>**ALLOW** more people would have had the vaccine by then / time needed to get all children vaccinated / slow distribution<br><br>**ALLOW** vaccine might have been introduced towards the end of 1956<br><br>**IGNORE** vaccine takes time to have affect |
| 19 | (b) | (iii) | use a log(arithmic) scale ✓ | **1** | **3.3** | |

| Question | | | Answer | Mark | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 19 | (b) | (iv) | (because of virus in sewage) those in London / they are , more at risk / AW ✓ **ora**<br><br>vaccination rates , low(er) in London / high(er) outside London ✓<br><br>*idea that* vaccinating people outside London might be a waste of money ✓ | 2 max | 2.5 | **IGNORE** answers that discuss differences between children and adults<br><br>**IGNORE** ring / herd , vaccination<br><br>**ALLOW** vaccination rates already , high / >90%<br><br>**ALLOW** e.g. cheaper and more likely to make a difference<br>**IGNORE ‘**cheaper’ unqualified |

| Question | | | Answer | Marks | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 20 | (a) | (i) | **FIRST CHECK ON ANSWER LINE**<br>**If answer = 16.8 award 3 marks**<br><br>| | O | E | O−E | $(O-E)^2$ | $(O-E)^2/E$ |<br>|---|---|---|---|---|---|<br>| **A** | 44 | 40 | 4 | 16 | 0.4 |<br>| **O** | 56 | 40 | 16 | 256 | 6.4 |<br>| **S** | 20 | 40 | 20 | 400 | 10 |<br>✓ ✓<br><br>$\Sigma(O-E)^2/E$ = 16.8 / 16.80 ✓ | 3 | 2.4 | **CREDIT** working marks seen anywhere<br><br>**ALLOW** 1 mark for correct summation of candidate’s ‘$(O-E)^2/E$’ column<br><br>**ALLOW** 2 marks for…<br>• 17 / 16.800<br><br>**ALLOW** 2 marks for common errors with Expected numbers (**IGNORE s.f.**)<br>• 165.6 (E = 120)<br>• 16.4 (E = 44)<br>• 25.7 (E = 56) |

| Question | | | Answer | Marks | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 20 | (a) | (ii) | differences (between observed and expected) are significant ✓<br><br>(less than) 5% chance that (difference is) due to chance ✓<br><br>reject , null hypothesis / $H_0$ ✓<br><br>there is an association between tree species and wood sorrel population / AW ✓ | 3 max | 3.1 | **ALLOW ora** if candidate answer in (i) is below 5.991<br><br>**ALLOW** (>) 95% confident that (the difference is) not due to chance<br><br>**ALLOW** tree species affects wood sorrel<br>**ALLOW** wood sorrel less likely to grow near sycamore **ora** |
| 20 | (a) | (iii) | age / size / height , of tree ✓<br><br>gradient (of ground) ✓<br><br>density / AW , of surrounding trees ✓<br><br>*idea of* direction of sunlight ✓ | 2 max | 3.3 | **ALLOW** shading from adjacent trees<br>**IGNORE** light intensity unqualified<br><br>**ALLOW** e.g., whether they are all on the same side of a hill<br><br>**IGNORE** presence of other species<br>**IGNORE** all other variables |

| Question | | | Answer | Marks | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 20 | (b) | (i)* | Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.<br><br>**Level 3 (5–6 marks)**<br>Makes detailed comparisons between plant **AND** animal species in climax community **AND** pioneer community.<br><br>*There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.*<br><br>Level 3 responses must address some of the emboldened indicative points (or address ideas of equivalent value).<br><br>**Level 2 (3–4 marks)**<br>Makes comparisons between plant **AND** animal species in climax community **AND** pioneer community.<br><br>*There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*<br><br>**Level 1 (1–2 marks)**<br>Mentions some features of species in climax community and/or pioneer community.<br><br>*There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.*<br><br>**0 marks**<br>*No response or no response worthy of credit.* | **6** | **1.2 x 4**<br>**2.5 x 2** | **Indicative points may include**<br><br>*Pioneer community*<br>Plants<br>• small species with example<br>• **shorter life-cycle / fast growing**<br>• **seeds or spores**<br>o **large quantities produced**<br>o **can be dispersed long distances**<br>o **germinate rapidly**<br>• **self-pollinating / asexual reproduction**<br>• **able to tolerate extreme environments, e.g. xerophytic / able to fix nitrogen**<br><br>Animals<br>• few species (if any)<br>• mostly small species with example<br><br>*Climax community*<br>Plants<br>• more species than pioneer community<br>• larger species with example<br>• **unable to tolerate extreme environments**<br>• **require soil with ample water and minerals**<br>• **dominant species**<br>• **slow growing**<br><br>Animals<br>• larger species with example<br>• more **herbivore** species<br>• **carnivore species present**<br>• **longer food chains**<br><br>QWC<br>Award the communication mark to answers that include relevant material and make clear comparisons between climax and pioneer communities. |

| Question | | | Answer | Marks | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 20 | (b) | (ii) | (change in) soil / substrate ✓ | 1 | 1.2 | *Mark first answer*<br><br>**ALLOW** increased humus<br>**ALLOW** any feature of soil |
| 20 | (b) | (iii) | bare ground / rock / water / mud / sand / glacier / lava ✓ | 1 | 2.5 | **IGNORE** empty land<br>**DO NOT CREDIT** incorrect answers, e.g., soil |

| Question | | | Answer | Marks | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 21 | (a) | (i) | telophase ✓ | 1 | 2.7 | |
| 21 | (a) | (ii) | single area of dark (staining material) ✓<br><br>(individual) chromosomes not visible ✓<br><br>(nuclear material) not as dark ✓ | 2 max | 2.7 | **IGNORE** nuclear envelope visible<br><br>**ALLOW** one / a / the , nucleus visible<br>**IGNORE** present<br><br>**ALLOW** chromatids not visible<br>**IGNORE** thinner / in nucleus / not in two groups |
| 21 | (a) | (iii) | many dividing cells / cells undergo frequent mitosis ✓ | 1 | 3.3 | **IGNORE** meristem tissue |
| 21 | (b) | (i) | chromosomes / chromatin (fibres) , coil / condense ✓<br><br>spindle fibres form ✓<br><br>nucleolus disappears ✓ | 2 max | 2.5 | **ALLOW** chromosomes thicken<br>**IGNORE** DNA condenses<br>**IGNORE** ref to chromatids<br><br>**ALLOW** centrioles move to , poles / end of cell |
| 21 | (b) | (ii) | *In meiosis…*<br>only one chromosome from each homologous pair is present ✓ **ora**<br><br>sister chromatids not genetically identical / recombinants present (due to crossing over) ✓ **ora** | 1 | 2.5 | **ALLOW** chromosomes already condensed in meiosis<br>**IGNORE** bivalents / chromatids<br>**IGNORE** refs to haploid / diploid |

| Question | | | Answer | Marks | AO Element | Guidance |
|---|---|---|---|---|---|---|
| 21 | (c) | | **FIRST CHECK ON ANSWER LINE**<br>**If answer = 116 (min) award 2 marks**<br><br>*calculate proportion of cells undergoing mitosis*<br>(16/124 =) 0.129 ✓<br><br>*calculate time represented by that proportion of cells, convert to minutes **and** answer to 3 significant figures*<br>(0.129 x 900 =) 116 min ✓ | 2 | 2.5 | **ALLOW** 1 mark for 1.93 h or 1 h 56 min<br><br>**ALLOW** 1 mark for 0.129 or 12.9% |
| 21 | (d) | | nucleus ✓<br><br>cytokinesis ✓<br><br>synthesis / S ✓<br><br>DNA , damage / breaks ✓<br><br>second growth / $G_2$ ✓<br><br>resting phase / $G_0$ (phase) ✓ | 6 | 1.2 | **ALLOW** cell division<br><br>**IGNORE** correct DNA / mutation / errors<br><br>**ALLOW** second gap<br><br>**ALLOW** apoptosis |

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