# GCE

# Biology A

## H420/03: Unified biology

Advanced GCE

# Mark Scheme for Autumn 2021

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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 |

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>1</td><td>a</td><td></td><td>(A =) spiracle ✓<br>(B =) trachea ✓</td><td>2</td><td>2.3</td><td>ALLOW spiracles<br>DO NOT ALLOW tracheoles<br>ALLOW chitin (rings) / taenidia / tracheal tube / tracheae</td></tr>
<tr><td></td><td>b</td><td>i</td><td><table><tr><th></th><th>Mouth closes</th><th>Buccal cavity floor lowers</th><th>Operculum opens</th><th>Oxygen diffuses into capillaries</th></tr><tr><td>Water moves into the buccal cavity</td><td></td><td>✓</td><td></td><td></td></tr><tr><td>Water moves across the gills and out of the buccal cavity</td><td>✓</td><td></td><td>✓</td><td>✓</td></tr></table>All 4 columns correct ✓✓</td><td>2</td><td>1.2</td><td>3 columns correct = ✓</td></tr>
<tr><td></td><td></td><td>ii</td><td>remove operculum / described (rather than cutting up the ventral side) ✓<br>use pins to hold fish (rather than a hand) ✓<br>remove gills and observe under a microscope ✓</td><td>1 max</td><td>3.3</td><td>IGNORE ‘remove gills’ unqualified<br><br>IGNORE ‘use a microscope’ unqualified</td></tr>
<tr><td></td><td>c</td><td>i</td><td>60 ($cm^3$) ✓</td><td>1</td><td>2.2</td><td>1.44 $dm^3$ = 1440 $cm^3$<br>1440 / 24 = 60</td></tr>
<tr><td></td><td></td><td>ii</td><td>inbreeding / AW, reduces genetic diversity ✓<br><br>(more) homozygous recessive alleles (for CPF) ✓<br><br>idea of allele for CPF linked to gene for desirable trait (so inherited together) ✓</td><td>1 max</td><td>2.5</td><td>ALLOW ‘inbreeding creates smaller gene pool’<br>ALLOW ‘more homozygous recessive genotypes (for CPF)’<br>ALLOW (leads to) inbreeding depression e.g. ‘CPF gene on same chromosome as (named) desirable trait ‘</td></tr>
</table>

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| | | iii | *idea of* compare genomes of, dog breeds / individual dogs ✓<br><br>*idea of* identify, alleles / genotypes / base sequences (in WHTs), that are present (only) in dogs with CPF ✓<br><br>*idea of* identify dogs that are carrying (the allele for) CPF ✓<br><br>(use of) computational biology / bioinformatics, to link genes with CPF ✓<br><br>*idea of* linking DNA sequences to specific proteins (i.e. proteomics) ✓ | **2 max** | 2.5 | e.g. 'compare DNA of dogs with and without CPF'<br>e.g. 'identify, allele / gene, that causes CPF'<br><br>e.g. 'can identify mutated protein from DNA sequence' |
| | | iv | weakened / dead / inactivated, (parvo)virus ✓<br><br>antigens from the (parvo)virus ✓<br><br>mRNA to produce(parvo)virus proteins ✓ | **1 max** | 2.1 | **IGNORE** 'dormant form of virus'<br>**ALLOW** 'attenuated form of virus'<br>**ALLOW** viral coat proteins |
| | | v | memory cells have, reduced in number / AW ✓ | **1** | 2.5 | **ALLOW** to produce more memory cells (to improve immunity)<br>**DO NOT ALLOW** 'no memory cells left' |
| | | | | | | |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 2 | a | | ***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.***<br><br>***In summary:***<br>*Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)*<br>*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.*<br>*Then, award the higher or lower mark within the level, according to the* ***Communication Statement*** *(shown in italics):*<br>o *award the higher mark where the Communication Statement has been met.*<br>o *award the lower mark where aspects of the Communication Statement have been missed.*<br><br>• ***The science content determines the level.***<br>• ***The Communication Statement determines the mark within a level.*** | | | |
| | | | **Level 3 (5-6 marks)**<br>Describes in detail, with no major errors, the stages of mitosis in all three cells.<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>Describes, with few errors or omissions, the stages of mitosis in all three cells.<br>**OR**<br>Describes in detail, with no major errors, at least two cells.<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>Describes the stages of mitosis, with some errors, in at least one cell.<br>**OR**<br>Describes stages of mitosis with no link to cells in question | **6** | 2.5<br>2.7 | **Indicative scientific points (including details in bold) may include (but are not limited to):**<br><br>*Cell C:*<br>• Prophase<br>• Chromosomes condense<br>• Chromosomes have become visible (but are unordered)<br>• Nuclear envelope and nucleolus have disappeared<br><br>*Cell D:*<br>• (Early) anaphase<br>• Spindle fibres are shortening<br>• Chromatids are separating and are being pulled to opposite sides of the cell |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| | | | *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. | | | *Cell E:*<br>• (Late) telophase<br>• Chromatids have been pulled to opposite sides of the cell<br>• A new cell membrane is visible down the centre of the cell<br>• Cytokinesis/ the cell is beginning to divide |
| | **b** | **i** | *idea that* (some) cells contain incorrect number of chromosomes ✓ | **1** | 3.1 | e.g. cells do not contain the diploid number of chromosomes / cells contain different numbers of chromosomes |
| | | **ii** | G1 (checkpoint) **AND** *idea that* cells (with damaged DNA) should be stopped from entering the S phase ✓<br><br>G1(checkpoint) **AND** *idea that* this is the point where DNA damage is checked ✓ | **1** | 3.1 | **DO NOT ALLOW** G2 (as if this was not working both replication and mitosis would occur) |
| | **c** | | *Binary fission has*<br><br>chromosome(s) do not condense prior to separation ✓<br><br>no lining up of chromosomes, in pairs / across equator ✓<br><br>no separation of chromosomes into chromatids ✓<br><br>chromatids not joined at centromere ✓<br>no, centrioles / spindle fibres ✓<br>one large chromosome rather than several smaller chromosomes ✓<br><br>(replication of) circular DNA / plasmid(s) ✓ | **2 max** | 2.5 | **Mark as continuous prose**<br>**ALLOW** ora throughout<br>**IGNORE** ref to nuclear membrane disappears<br>**ALLOW** 'no lining up of DNA across equator'<br>**ALLOW** 'no separation of chromatids'<br>**DO NOT ALLOW** 'no chromosomes being pulled to opposite sides of cell' |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| | d | i | *'For' statement:*<br><br>no lag phase (is shown) ✓<br>no (clear), stationary / death / decline, phase ✓<br><br>*idea that* decrease between day 3 and 4 is not typical of standard growth curve ✓<br><br>*'Against' statement:*<br>*idea that* lag phase may be present but day 0 data are not shown ✓<br><br>exponential / log / rapid growth, phase present (between day 1 and 2) ✓<br><br>*idea that* stationary / death / decline, phase may occur later ✓<br><br>*General point*:<br>*idea that* presence of limited nitrate is responsible for the (non-standard) growth curve ✓ | **4 max** | 3.1 | **ALLOW** clear descriptions of stages of growth curve e.g 'there is no fall in number of cells at end of growth curve'<br><br>e.g. 'lag phase may occur between day 0 and day1'<br><br>**ALLOW '**growth rate increases (between days1-5) but then rate of growth slows down'<br><br>e.g. 'reduction in nitrate could lead to fall in cell numbers between day 3 and 4' / 'as nitrate levels fall bacterial cell numbers are still increasing' |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| | | ii | **FIRST CHECK ON ANSWER LINE**<br>**If answer = 2.5 x $10^6$ award 3 marks**<br><br>$10^{4.7}$ = 50,118.72336 ✓<br><br>x 50 (= 2,505,936.168) ✓<br><br>standard form = 2.5 x $10^6$ ✓ | **3** | 2.4 | **ALLOW any value between $10^{4.5}$ and $10^{4.8}$**<br>**i.e. 1.6 - 3.2 x $10^6$ award 3 marks**<br>**ALLOW** 31,622.7766 – 63,095.73445<br>**ALLOW** any correct rounded value<br><br>This mark should be awarded to 'x50' seen anywhere in the working, regardless of the value being multiplied<br>This mark should be awarded for correctly converting to standard form, regardless of the value being converted as **ECF**<br>**MAX 2** for correct answer not converted to standard form |
| | | iii | serial dilution ✓<br>*idea of*<br>grow colonies (on agar plate) and count number of colonies ✓<br>*idea of* scale up /multiply up, count (to estimate population size) ✓ | **2 max** | 2.7 | <br><br>**ALLOW** *idea of* flow cytometry / described |
| | **e** | | Short /AW ✓<br>pollutants / contaminants ✓<br><br>metabolites ✓ | **3** | 1.1 | <br>**ALLOW** pollution / contamination / waste / oil /solvents /pesticides / benzene / plastics / chemicals<br><br>**IGNORE** impurities / faeces / toxins / bacteria / pathogens |
| **3** | **a** | | *callose…*<br>(has) 1-3 and 1-6 glycosidic bonds ✓<br><br>(is) branched ✓<br><br>(is) helical ✓<br><br>*idea of* alternate glucose molecules are not rotated 180° ✓ | **2 max** | 2.1 | <br>**ALLOW** cellulose (has only) 1-4 glycosidic bonds<br>**ALLOW** cellulose is, not branched / straight chains<br>**ALLOW** cellulose is not helical<br>**IGNORE** callose is more compact<br>**ALLOW** *idea of* alternate glucose molecules rotated 180° in cellulose |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| | b | | ***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.***<br><br>***In summary:***<br>*Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)*<br>*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.*<br>*Then, award the higher or lower mark within the level, according to the* ***Communication Statement*** *(shown in italics):*<br>o *award the higher mark where the Communication Statement has been met.*<br>o *award the lower mark where aspects of the Communication Statement have been missed.*<br><br>• ***The science content determines the level.***<br>• ***The Communication Statement determines the mark within a level.*** | | | |
| | | | **Level 3 (5-6 marks)**<br>A valid plan for testing the effect of temperature on callose production, including details of control variables **and** some details of callose measurement.<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>A valid plan, with some details, for testing the effect of temperature on callose production, including **either** details of control variables **or** some details of callose measurement.<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>A plan that mentions observing callose production **or** controlling variables. | | 3.3<br>3.4 | **Indicative scientific points may include (but are not limited to):**<br><br>*General experimental details to improve validity*:<br>• a suitable range of temperatures (e.g. 0, 10, 20, 30, 40° C)<br>• a suitable sample size or the idea of repeats (e.g. 50 plants)<br>• idea of a baseline measure of callose levels before the experiment<br><br>*Control variables*:<br>• same species / size / genetics of plant (e.g. using cloned plants)<br>• light intensity and duration (e.g. 12 hours of light and 12 hours of dark) |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| | | | *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. | | | • pH / nutrients / water regime (e.g. using the same soil and water supply)<br>• maintaining aseptic conditions and monitoring infections (and removing infected plants from the experiment)<br><br>*Callose observation*:<br>• use a microscope<br>• take tissue samples<br>• standardise the size and location of tissue samples<br>• take samples from different sites<br>• use of stain (e.g. aniline blue)<br>• immunofluorescence |

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td></td><td>c</td><td></td><td>
<table>
<tr><th>Type of pathogen</th><th>Pathogen has membrane-bound organelles</th><th>Pathogen has cell wall</th><th>Example of a disease affecting plants</th></tr>
<tr><td>fungus</td><td>yes</td><td>yes</td><td>black sigatoka</td></tr>
<tr><td>bacterium</td><td>no</td><td>yes</td><td>ring rot</td></tr>
<tr><td>virus</td><td>no</td><td>no</td><td>tobacco mosaic (virus) / TMV</td></tr>
</table>
One mark per correct row; all correct = ✓✓✓</td><td>3</td><td>1.1</td><td>ACCEPT any other correct examples of viral diseases in plants</td></tr>
<tr><td></td><td>d</td><td></td><td>example of chemical defence ✓<br><br>example of physical defence ✓</td><td>1 max</td><td>1.1</td><td>e.g. (production of) pheromones / poisons / toxic compounds / named examples (phenols, tannins, alkaloids, Bt toxin)<br>e.g. folding in response to touch / thorns/ spines</td></tr>
<tr><td></td><td>e</td><td></td><td>insects (may) develop resistance ✓</td><td>1</td><td>2.1</td><td>ALLOW ‘insects become resistant’<br>DO NOT ALLOW references to immunity<br>DO NOT ALLOW insecticides cause mutations leading to resistance</td></tr>
<tr><td>4</td><td>a</td><td></td><td>(carry out) Benedict’s test / described ✓<br><br>(if test for reducing sugar negative) boil with (dilute) HCl and (re)test (with Benedict’s) ✓</td><td>2</td><td>2.7</td><td>ALLOW ‘add Benedict’s (solution)’</td></tr>
</table>

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td></td><td>b</td><td>i</td><td>
<table>
<tr><th>Description of amino acid</th><th>Name of amino acid</th><th>Justification</th></tr>
<tr><td>Converted to pyruvate with the fewest changes</td><td>Alanine</td><td>(Both have) 3 carbon atoms / Same number of carbon atoms</td></tr>
<tr><td>Converted to alpha-ketoglutarate with the fewest changes</td><td>Glutamic acid</td><td>(Both have) 5 carbon atoms / Same number of carbon atoms</td></tr>
<tr><td>The amino acid with the highest respiratory quotient (RQ)</td><td>Aspartic acid</td><td>Highest proportion of oxygen atoms (in its structure) / lowest proportion of C-H bonds (relative to other bonds)</td></tr>
</table>
First row correct ✓<br>Second row correct ✓<br>Aspartic acid ✓<br>Aspartic acid explanation ✓</td><td>4</td><td>3.1</td><td>ALLOW (both have) 3C atoms<br>DO NOT ALLOW ‘same number of C and, H / O, atoms’<br><br>IGNORE ‘both have 2 carboxyl groups’<br><br>ALLOW (both have) 5C atoms<br>DO NOT ALLOW ‘same number of C and, H / O, atoms’</td></tr>
<tr><td></td><td></td><td>ii</td><td>decarboxylation / carbon dioxide produced ✓<br>dehydrogenation / hydrogen removal / reduced NAD produced / reduced FAD produced✓<br>ATP produced ✓<br>succinyl co-A / succinate / fumarate / malate / 4 C intermediate, produced ✓</td><td>2 max</td><td>1.2<br>2.5</td><td>ALLOW mp’s from correct equations</td></tr>
</table>

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<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td></td><td>c</td><td></td><td>idea of establishment of $H^+$ ion gradient ✓<br><br>$H^+$ ions, flow down a concentration gradient / AW ✓<br><br>from intermembrane space to matrix ✓<br>through ATP synthase ✓<br>energy, provided / AW, to join ADP and Pi ( to form ATP) ✓</td><td>3 max</td><td>1.1</td><td>e.g. ‘ pumping protons into intermembranal space’<br>DO NOT ALLOW ‘$H^+$ ions pumped (from intermembrane space / through ATP synthase)<br><br>DO NOT ALLOW ‘energy produced to join ADP and Pi’</td></tr>
<tr><td></td><td>d</td><td></td><td>0 watts: (mainly) carbohydrates respired / AW ✓<br>50 watts: (more) fats / lipids /amino acids / proteins, respired /AW ✓<br><br>250 watts: (more) anaerobic respiration /AW ✓</td><td>3</td><td>3.1</td><td>ALLOW (mainly) glucose respired<br>DO NOT ALLOW ‘only, fats/amino acids / proteins, respired’</td></tr>
<tr><td>5</td><td>a</td><td></td><td><table><tr><th>Statement about amylose</th><th>True or False?</th></tr><tr><td>Amylose is soluble</td><td>False</td></tr><tr><td>Amylose is branched</td><td>False</td></tr><tr><td>Amylose is formed by condensation reactions</td><td>True</td></tr></table>All 3 correct = ✓</td><td>1</td><td>1.1</td><td></td></tr>
<tr><td></td><td>b</td><td></td><td>D. antarctica habitat:<br>lower (maximum) light levels ✓<br><br>idea of reason for lower (maximum) light levels ✓<br><br>idea that optimum rate of photosynthesis (in its habitat) is at a lower light intensity than that of Z. mays ✓</td><td>2 max</td><td>3.2</td><td>ORA Z. mays habitat<br>ALLOW less available light / darker habitat / more shaded<br>e.g more cloud cover / shorter day length / taller / competing, plants (shade fern)<br><br>e.g. rate of photosynthesis is higher at lower light levels compared to Z. mays</td></tr>
</table>

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| | c | i | **FIRST CHECK ON ANSWER LINE**<br>**If answer = 0.943 award 3 marks**<br><br>$\Sigma d^2 = 2$ ✓<br><br>$n(n^2 - 1) = 210$ ✓<br><br>$1 - (6 \times 2) / 210 = 0.943$ ✓ | **3** | 2.4 | **ALLOW** calculator value (0.942857) or any correctly rounded value<br><br>**ALLOW ECF** final answer if incorrect values used for $\Sigma d^2$ and / or $n(n^2 - 1)$ for mp3 |
| | | ii | significant positive correlation (at 0.05 confidence) ✓ | **1** | 3.1 | **ALLOW ECF** correct conclusion based on incorrect calculated value from **c(i)** |
| | | iii | no significant (positive) correlation ✓ | **1** | 3.1 | |
| | d | i | *idea of* little (visible) light available / plants absorb most light available / only certain wavelengths of light available underwater ✓<br><br>*idea of* it absorbs light, at different wavelengths, compared to aquatic plant species ✓<br><br>*idea of* absorbs wider range of wavelengths (compared to chlorophyll A alone) ✓ | **1** | 3.2 | e.g. 'longer wavelengths of light available in their aquatic environment'<br><br>e.g. 'able to use, far red / longer, wavelengths compared to aquatic plants'<br><br>e.g. 'able to absorb wavelengths of light that Chlorophyll A does not' |
| | | ii | Z ✓ | **1** | 2.8 | |
| | | | **Total** | **70** | | |

**OCR (Oxford Cambridge and RSA Examinations)**
**The Triangle Building**
**Shaftesbury Road**
**Cambridge**
**CB2 8EA**

**OCR Customer Contact Centre**

**Education and Learning**
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

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