# Mark Scheme (Results)

## November 2021

Pearson Edexcel GCE In Biology A Salters Nuffield (9BN0) Paper 1: The Natural Environment and Species Survival

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## General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

| Question Number | Answer | Mark |
|---|---|---|
| **1(a)** | **The only correct answer is A absorbs infrared radiation reflected by the surface of the Earth**<br><br>***B*** *is incorrect because it does not absorb ultraviolet*<br><br>***C*** *is incorrect because it does not reflect infrared*<br><br>***D*** *is incorrect because it does not reflect ultraviolet* | **(1)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **1(b)** | Chloroplast | | **(1)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **1(c)** | An explanation that makes reference to two of the following:<br><br>• GPP – R = NPP (1)<br><br>• {organic molecules / glucose} used in respiration to provide energy (1)<br><br>• because the more {organic molecules / glucose } used in respiration, the less is available for the production of biomass (1) | ALLOW word equation or rearranged equation<br><br>ALLOW more respiration results in less biomass | **(2)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **1(d)** | An explanation that makes reference to the following<br><br>• carbon dioxide produced by burning wood replaces that absorbed by the trees (1)<br><br>• trees absorb carbon dioxide (from the atmosphere) for photosynthesis (1)<br><br>• new trees are grown to replace those that are cut down (1)<br><br>• therefore no net increase in carbon dioxide (1) | ALLOW converse<br><br>ALLOW fix carbon<br><br>ALLOW carbon neutral | **(4)** |

| Question Number | Answer | Mark |
|---|---|---|
| **2(a)** | **The only correct answer is B polymerase chain reaction**<br><br>***A*** *is not correct because it is not profiling*<br><br>***C*** *is not correct because it is not RNA*<br><br>***D*** *is not correct because it is not translation* | **(1)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **2(b)** | An explanation that makes reference to four of the following<br><br>• restriction { enzymes / endonucleases } used to cut DNA (from modern humans and Neanderthals) into fragments (1)<br><br>• DNA samples are loaded onto (agarose) gel (1)<br><br>• {electric current is passed through / potential difference is applied across} the gel (1)<br><br>• markers are added to visualise the bands (1)<br><br>• the position of the bands produced can be compared (1) | ALLOW use of fluorescent dyes | **(4)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **2(c)** | An explanation that makes reference to the following<br><br>• by comparing the {location / number of} bands produced by the two types of DNA (1)<br><br>• similarities would indicate interbreeding (in the past) (1) | ALLOW a description eg looking whether the bands are next to each other | **(2)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **3(a)** | An answer that makes reference to the following<br><br>• Hardy-Weinberg equation stated (1)<br><br>• correct calculation of frequency of homozygous recessive individuals (1)<br><br>• correct calculation of frequency of dominant and recessive alleles (1) | Example of calculation<br><br>$p^2 + 2pq + q^2 = 1.0$<br><br>$q^2 = 102 \div 200 = 0.51$<br><br>Dominant allele = 0.29<br>Recessive allele= 0.71<br><br>**Correct answer with no working gains full marks** | **(3)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **3(b)(i)** | An explanation that makes reference to three of the following<br><br>• many of the elephants with tusks were killed (for their ivory) / large percentage of population do not have tusks (1)<br><br>• elephants without tusks were more likely to survive and breed (1)<br><br>• therefore passing on alleles for not having tusks (1)<br><br>• increasing the frequency of homozygous recessives in the population (1) | ALLOW converse | **(3)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **3(b)(ii)** | A description that makes reference to the following<br><br>• calculate the {allele frequencies/ number of dominant and recessive alleles} (in the population in Mozambique) (1)<br><br>• (regular) sampling over a period of time (1) | | **(2)** |

| Question Number | Answer | Mark |
|---|---|---|
| **4(a)(i)** | **The only correct answer is B – a diploid zygote**<br><br>***A*** *is incorrect because it is not a gamete*<br><br>***C*** *is incorrect because it is not haploid*<br><br>***D*** *is incorrect because it is not haploid* | **(1)** |

| Question Number | Answer | Mark |
|---|---|---|
| **4(a)(ii)** | **The only correct answer is D- mitosis to produce genetically identical cells**<br><br>***A*** *is incorrect because the division is not meiosis*<br><br>***B*** *is incorrect because the division is not meiosis*<br><br>***C*** *is incorrect because the cells are not genetically different* | **(1)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **4(b)(i)** | An answer that makes reference to the following<br><br>• a cell that has the ability to differentiate (1)<br><br>• into all cell types (1) | ALLOW specialise/give rise to | **(2)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **4(b)(ii)** | A description that makes reference to the following<br><br>• (chemical) signals cause some genes to be {activated/switched on} (1)<br><br>• only activated genes {are transcribed / produce mRNA} (1)<br><br>• (mRNA leads to) synthesis of specific proteins which cause cell modification (1) | ALLOW reference to {activators/transcription factors} and genes<br><br>ALLOW proteins determine the structure of the cell | **(3)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **4(c)** | An explanation that makes reference to three of the following<br><br>• DNA (in a chromosome) is wrapped around histones (1)<br><br>• {acetylation / modification} of the histone affects {binding of RNA polymerase / chromosome unwinding} (1)<br><br>• methylation of DNA affects { transcription of genes / production of mRNA } (1)<br><br>• therefore gene expression is altered (1) | ALLOW different proteins are synthesised | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5 (a)** | A description that makes reference to three of the following:<br><br>• description of role in protection (1)<br><br>• description of role in repopulation (1)<br><br>• description of role in education (1)<br><br>• description of role in research (1) | E.g. protection from poachers, hunting, vet care, administering medicines<br><br>E.g. increase numbers, breeding programmes, release back into the wild<br><br>E.g. conservation<br><br>E.g. Improving health, discovering better nutrition, breeding cycles, developing a genetic database | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5 (b)(i)** | A answer that makes reference to the following:<br>• the area inhabited by a particular { species / organism } (1) | | **(1)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **5 (b)(ii)** | An answer that makes reference to the following:<br><br>• biodiversity {measured / compared} using a diversity index (1)<br><br>• species richness (assessed) (1)<br><br>• genetic diversity of {populations / species} (1)<br><br>• presence of any {endemic / rare} species (1) | ALLOW count the number of different species in an area<br><br>ALLOW endangered species / species at risk of extinction | **(4)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **6(a)** | A description that makes reference to three of the following<br><br>• cell membrane is (mainly) phospholipids and protein (1)<br><br>• phospholipids form a bilayer (1)<br><br>• proteins float in the phospholipids / change position / fluid mosaic model (1)<br><br>• proteins may span the bilayer or be located in only one layer (1) | ALLOW proteins embedded in the phospholipid bilayer<br><br>ALLOW proteins may be intrinsic / extrinsic<br>IGNORE function of proteins such as carrier/ channel | **(3)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **6(b)** | An explanation that makes reference to the following<br><br>• oxygen enters the cells by diffusion (1)<br><br>• change in shape {reduces surface area to volume ratio / increases diffusion distance} (1)<br><br>• therefore gas exchange decreases / less oxygen enters the cells (1) | | **(3)** |

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>6(c)</td><td>An answer that makes reference to the following<br><br>• correct genetic diagram used to determine genotypes of offspring (1)<br><br>• correct probability 0.5 linked to correct genotypes of offspring (1)</td><td>e.g.<table><tr><td></td><td>S</td><td>s</td></tr><tr><td>s</td><td>Ss</td><td>ss</td></tr><tr><td>s</td><td>Ss</td><td>ss</td></tr></table>Ss and ss<br><br>ALLOW 50% / ½ / 1 in 2</td><td>(2)</td></tr>
</table>

| Question Number | Answer | Mark |
|---|---|---|
| 7(a)(i) | **The only correct answer is C G (which is the xylem)**<br><br>***A*** *is not correct because E does not contain lignin*<br><br>***B*** *is not correct because F, which is phloem, does not contain lignin*<br><br>***D*** *is not correct because H is not xylem* | **(1)** |

| Question Number | Answer | Mark |
|---|---|---|
| 7(a)(ii) | **The only correct answer is B F (this is phloem)**<br><br>***A*** *is not correct because E is not phloem*<br><br>***C*** *is not correct because G is not phloem*<br><br>***D*** *is not correct because H is not phloem* | **(1)** |

| Question Number | Answer | Mark |
|---|---|---|
| 7(b)(i) | **The only correct answer is B - sclerenchyma fibres provide support**<br><br>***A*** *is not correct because it is not phloem*<br><br>***B*** *is not correct because it is not sieve tubes*<br><br>***D*** *is not correct because it is not xylem* | **(1)** |

| Question Number | Answer | Mark |
|---|---|---|
| 7(b)(ii) | **The only correct answer is A – phloem that transports organic solutes**<br><br>***B*** *is not correct because sclerenchyma does not transport water*<br><br>***C*** *is not correct because sieve tubes do not synthesise organic solutes*<br><br>***D*** *is not correct because it is not xylem* | **(1)** |

| Question Number | Answer | Mark |
|---|---|---|
| 7(b)(iii) | **The only correct answer is D - xylem vessel that transports water and mineral ions**<br><br>***A*** *is not correct because it is not phloem*<br><br>***B*** *is not correct because it is not a sclerenchyma fibre*<br><br>***C*** *is not correct because it is not a sieve tube* | **(1)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **7(b)(iv)** | An answer that makes reference to the following<br><br>• length of line correctly measured (1)<br><br>• correct conversion to μm (1)<br><br>• image size divided by actual size to give magnification (1) | Example of calculation<br><br>36mm ALLOW 37mm<br><br>36000 ALLOW 37000<br><br>36000/320 = 112.5<br>OR 37000/320 = 115.6<br><br>Correct answer without working gains full marks | **(3)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **7(c)** | An explanation that makes reference to three of the following<br><br>• nettle plants can be grown so they are renewable (1)<br><br>• (crude) oil (is non-renewable and) will run out (1)<br><br>• use of fibres from nettles will be available to future generations (1)<br><br>• clothing made of nettle fibres is biodegradable (1) | ALLOW description of renewable eg will not run out | **(3)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **8(a)** | • A substance which can {inhibit the growth / prevent multiplication} of bacteria | | **(1)** |

| **Question Number** | **Answer** | **Additional guidance** | **Mark** |
|---|---|---|---|
| **8(b)(i)** | An explanation that makes reference to three of the following<br>• ribosome shape is altered (1)<br>• mRNA is prevented from binding (to the ribosome) / causing change in tRNA binding (1)<br>• therefore translation cannot occur (1)<br>• { protein / polypeptide } is not synthesised (1) | ALLOW translation is affected / reduced / altered<br>ALLOW faulty protein produced | (3) |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **8(b)(ii)** | An answer that makes reference to two of the following<br><br>• bacteria have not been exposed to new antibiotics before / bacteria do not have mechanisms to make them resistant to the new antibiotics (1)<br><br>• bacteria have developed resistance (to other antibiotics) by { evolving / natural selection } (1)<br><br>• therefore there has been {no advantage to possessing a mutation to bypass the new antibiotic / no mutation present to give resistance } (1) | | **(2)** |

| Question Number | Answer | Mark |
|---|---|---|
| **8(b)(iii)** | Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.<br>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.<br><br>Indicative content<br><br>• prepare agar plates with bacterial cultures / bacterial lawn / seeded with bacteria – use bacteria that are resistant to other antibiotics<br>• prepare solutions of new antibiotic and penicillin<br>• place onto paper discs / into wells in the agar / prepare mast rings<br>• control time and temperature of incubation<br>• same concentration and volume of both antibiotics<br>• measure the area of inhibition<br>• repeat for effective antibiotics<br>• description of serial dilution of each antibiotic<br>• range of dilutions on each plate-one antibiotic per plate<br>• statistical test to determine which is the most effective<br>• repeat with different strains of resistant bacteria | **(6)** |

| Level | Marks | | Additional Guidance |
|---|---|---|---|
| 0 | 0 | No awardable content | |
| 1 | 1-2 | An explanation of how the investigation should be modified may be attempted but with limited analysis, interpretation and/or evaluation of the scientific information. Generalised comments made.<br><br>The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. | Preparation of agar plates<br>Method of adding antibiotic<br><br>Use of new antibiotic and penicillin<br>Measure zone of inhibition |
| 2 | 3-4 | An explanation of how the investigation should be modified will be given with occasional evidence of analysis, interpretation and/or evaluation of the scientific information.<br><br>The explanation shows some linkages and lines of scientific reasoning with some structure. | Incubated for stated time 24-72 hours<br>Incubated at stated temperature 25-37$^0$C<br>Method of culturing bacteria on agar plates/preparing a lawn<br><br>Repeats to calculate the mean<br>Larger zone of inhibition-more effective antibiotic |
| 3 | 5-6 | An explanation of how the investigation should be modified is given which is supported throughout by evidence from the analysis, interpretation and/or evaluation of the scientific information.<br><br>The explanation shows a well-developed and sustained line of scientific reasoning which is clear, coherent and logically structured. | Strain of bacteria known to be resistant to penicillin/other antibiotics<br>Same volume/concentration of both antibiotics<br><br>Several strains of resistant bacteria tested with new antibiotic<br>Preparation of serial dilutions for both antibiotics<br>Range of concentrations give minimum effective dose |

| | | | |
|---|---|---|---|
| | | | Named statistical test eg T-test |

| Question Number | Answer | Mark |
|---|---|---|
| **9(a)** | **The only correct answer is D - RNA and reverse transcriptase**<br><br>***A*** *is incorrect because it is does not contain DNA*<br><br>***B*** *is incorrect because it is does not contain DNA*<br><br>***C*** *is incorrect because it does not contain DNA polymerase* | **(1)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **9(b)(i)** | A description that makes reference to three of the following:<br><br>• {glycoproteins / GP120} on the (surface of the) virus (1)<br>• bind to (CD4) receptors on the (surface of the) T (helper) cells (1)<br>• viral envelope fuses with cell membrane of T helper cell (1)<br>• viral RNA enters the cell (1) | ALLOW GP130<br><br>IGNORE capsid | **(3)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **9(b)(ii)** | An explanation that makes reference to the following<br>• ( lack of T helper cells ) reduces cytokine production (1)<br>• therefore reducing { cloning / activation } of B cells (1)<br>• reducing antibody production (1)<br>• there is an increased risk of opportunistic infections (1) | ALLOW reduced production of {B effector cells/plasma cells}<br>ALLOW example eg TB | **(4)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **9(c)(i)** | An answer that makes reference to two of the following:<br>• the protein is a receptor in the cell surface membrane of T helper cells (1)<br>• { glycoprotein / GP120 } is unable to bind with the (CD4) receptor (on the host cell) (1)<br>• viral RNA cannot enter the cell (1) | ALLOW the receptor that HIV binds to<br>ALLOW HIV cannot enter the cell | **(2)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **9(c)(ii)** | An explanation that makes reference to four of the following:<br><br>• stem cells (from the bone marrow) can differentiate into specialised cells (1)<br><br>• the stem cells will differentiate into T helper cells that { are resistant to HIV / have the mutated protein } (1)<br><br>• T helper cells are destroyed by HIV so the patient cannot produce an immune response (1)<br><br>• mutated (CD4) receptor prevents HIV entering the ( replacement ) T helper cells (1)<br><br>• T helper cells are not destroyed therefore { HIV is not present in the blood / AIDS does not develop } (1) | | **(4)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **10 (a)** | An answer that makes reference to<br><br>• correct method for calculation the change in value (1)<br><br>• correct answer (1) | <u>Example of calculation</u><br><br>405 ÷ 1.46<br><br>277.4 (ppm)<br>ALLOW 277<br>Correct answer without working gains full marks | **(2)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **10 (b)** | An explanation that makes reference to two of the following:<br><br>• plants show increase in height as the temperature increases (from $3^{o}C$ to $10^{o}C$) in this period (1)<br><br>• the rate of photosynthesis will increase ( in the Arctic plants ) as the temperature increases, leading to an increase in growth (1)<br><br>• the increase is greater in wet conditions because water is also needed for { photosynthesis / growth } (1) | | **(2)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **10(c)** | An answer that makes reference to four of the following:<br><br>• the light independent stage of photosynthesis is catalysed by enzymes / RUBISCO (1)<br><br>• activity of RUBISCO increases as the temperature increases (1)<br><br>• more carbon is fixed in the Calvin cycle (1)<br><br>• greater rate of production of { GP / GALP / glucose } (1)<br><br>• leading to increase to growth (1) | ALLOW RUBISCO is needed for the Calvin cycle<br><br>ALLOW more carbon dioxide reacts with RuBP<br><br>ALLOW more { GP / GALP / glucose } | **(4)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **10(d)** | Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.<br>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.<br><br>Indicative content<br><br>• Growth is greater in the temperate region than the Arctic region (at the present)<br>• Increase in global temperature could lead to an increase in growth in both regions<br>• rate of photosynthesis increases with an increase in temperature so growth could continue to increase<br>• increase likely to be greater in the polar climate zones that have a lower temperature<br>• temperature may not be the limiting factor in the current conditions<br>• photosynthesis may be limited by concentration of carbon dioxide or light intensity<br>• lack of carbon dioxide would limit the light independent stage<br>• light intensity would limit the light dependent stage<br>• if rate of photosynthesis does not increase, growth of plants would not increase<br>• link to activity of RUBISCO and effect of higher temperatures<br>• climate change linked to increase in carbon dioxide, which may also increase rate of photosynthesis<br>• effects of increase in temperature on life cycles of other organisms<br>• reference to increasing periods of drought<br><br>(6 EXP) | | |

| Level | Marks | | Additional Guidance |
|---|---|---|---|
| 0 | 0 | No awardable content | |
| 1 | 1-2 | Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made.<br>Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures.<br>The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context. | Statement about current growth eg growth in the temperate regions is higher than in the Arctic region/growth in the Arctic is higher when it is wetter<br><br>Statement about the effects of climate change eg climate change will lead to higher temperatures/changes in rainfall patterns<br><br>Growth of plants is likely to increase (in both areas) as global temperature increases |
| 2 | 3-4 | Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts.<br>Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures.<br>The discussion shows some linkages and lines of scientific reasoning with some structure. | Increase in temperature increases photosynthesis and therefore growth<br>Increase likely to be greater in the polar regions<br>Other factors may limit growth, eg light intensity, CO2 concentration, water<br>Changes in rainfall patterns such as drought/flooding may affect growth<br>Temperature in temperate regions may increase enough to denature enzymes, slowing growth |
| 3 | 5-6 | Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts.<br>Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. | Increased rate of growth may affect development<br>Impact on the food chain<br>Possible change in range for some species<br>Some of the current species may die out because they are not adapted to the temperature rise<br>Increase in $CO_2$ causing climate change may lead to an increase in photosynthesis and growth |

| | | | |
|---|---|---|---|
| | | The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. | Activity of RUBISCO increases at higher temperatures, increasing growth |