

# Mark Scheme (Results)

## Summer 2022

Pearson Edexcel GCE
In Biology A Salters Nuffield (9BN0)
Paper 2: Energy, Exercise and Coordination

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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 | Additional Guidance | Mark |
|---|---|---|---|
| **1(a)(i)** | A description that makes reference to two of the following:<br><br>• the valves are open { when atria contract / atrial systole / when blood pressure greater in atria (than ventricles) } (1)<br><br>• the valves close { when ventricles contract / during ventricular systole/when pressure greater in ventricles (than atria) } (1)<br><br>• valves prevent backflow of blood into the atria during ventricular systole (1) | ALLOW valves open to allow blood to flow from atria to ventricles<br><br>ALLOW tendons prevent valves from inverting during ventricular systole | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
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|---|---|---|---|
| **1(a)(ii)** | An explanation that makes reference to the following:<br><br>• { larger lumen / less muscle (in walls) / thinner walls } (1)<br><br>• explanation { larger lumen as blood pressure lower / less muscle because contraction not needed to push blood back to the heart } (1) | IGNORE valves<br><br>ALLOW thinner walls linked to lower blood pressure | **(2)** |

| Question Number | Answer | Mark |
|---|---|---|
| **1(b)(i)** | • D thromboplastin<br><br>*The answer is not A as fibrin is not released from platelets*<br><br>*The answer is not B as prothrombin is not released from platelets*<br><br>*The answer is not C as thrombin is not released from platelets* | **(1)** |

| Question Number | Answer | Mark |
|---|---|---|
| **1(b)(ii)** | • C thrombin | **(1)** |

| | | |
|---|---|---|
| | *The answer is not A as fibrinogen is not the enzyme that converts the soluble plasma protein into an insoluble protein*<br><br>*The answer is not B as prothrombin is not the enzyme that converts the soluble plasma protein into an insoluble protein*<br><br>*The answer is not D as thromboplastin is not the enzyme that converts the soluble plasma protein into an insoluble protein* | |

| Question Number | Answer | Mark |
|---|---|---|
| **2(a)** | • Diagram C<br><br>*The answer is not diagram A because the labelled regions do not match the descriptions*<br><br>*The answer is not diagram B because the labelled regions do not match the descriptions*<br><br>*The answer is not diagram D because the labelled regions do not match the descriptions* | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(b)(i)** | A description that makes reference to the following:<br><br>• due to more activity (1)<br><br>• an increase in { oxygenated blood / blood flow } to this region (1)<br><br>• fMRI signals { reflected / not absorbed } by oxygenated blood (1) | <br><br>ALLOW increased aerobic respiration<br><br>ALLOW oxyhaemoglobin or oxygen-rich blood for oxygenated blood<br><br>ALLOW oxyhaemoglobin or oxygen-rich blood for oxygenated blood | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(b)(ii)** | A description that makes reference to three of the following<br><br>• (using both provides information on) function (PET) and structure (1)<br><br>• PET scan shows areas that are {more (metabolically) active / dividing more } (1)<br><br>• CT scan gives {location / size} (1)<br><br>• each scan uses a different technique / techniques described (1) | ALLOW reference to 3D images (with PET and CT)<br><br>e.g. CT uses X-rays and PET radioactively labelled metabolite such as glucose | **(3)** |

| Question Number | Answer | Mark |
|---|---|---|
| **3(a)(i)** | • D validity<br><br>*The answer is not A as controlling the variety of mice does not improve data accuracy*<br><br>*The answer is not B as controlling the variety of mice does not improve data precision*<br><br>*The answer is not C as controlling the variety of mice does not improve data reliability* | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(a)(ii)** | An answer that makes reference to the following:<br><br>• there is no difference in { the number of offspring born / fertility } { if genetically modified or not / if supplied drug K or not / between the treatments } | IGNORE 'significant'<br>ALLOW between the groups | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(a)(iii)** | An answer that makes reference to the following:<br><br>• { the GM mice / group P } had very few offspring (1)<br><br>• therefore raised HDL levels lead to reduced fertility (1)<br><br>• {non-GM mice / group R } had fewer offspring than {group Q / GM mice given drug K } (1)<br><br>• suggesting that HDL levels below a certain concentration reduce fertility (1) | ALLOW GM mice had fewest offspring<br><br>ALLOW converse<br><br>ALLOW converse<br><br>ALLOW – some HDL required for fertility | **(4)** |

| Question Number | Answer | Mark |
|---|---|---|
| **3(b)** | • C 2 only<br><br>*The answer is not A as exocytosis occurs in both sperm and egg*<br>*The answer is not B as 50% of sperm will have less DNA*<br>*The answer is not D as 50% of sperm will have less DNA* | **(1)** |

| Question | Answer | Mark |
|---|---|---|

| Number | | |
|---|---|---|
| **3(c)** | • D 4<br><br>*the answer is not A as 1 is the acrosome and this is not the site of glucose phosphorylation*<br><br>*the answer is not B as 2 is the nucleus and this is not the site of glucose phosphorylation*<br><br>*the answer is not C as 3 is a mitochondrion and this is not the site of glucose phosphorylation* | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(a)(i)** | • calculation of heart rate per minute (1)<br><br>• percentage above 100 beats per minute (1) | Example of calculation<br><br>60 ÷ 0.5 = 120<br><br>20%<br><br>Full marks for correct answer without working | **(2)** |

| Question Number | Answer | Mark |
|---|---|---|
| **4(a)(ii)** | • C that the atrioventricular node (AVN) delays depolarisation<br><br>*The answer is not A because Z is not the time of atrial contraction*<br><br>*The answer is not B because Z is not the time it takes for the A-V valves to open*<br><br>*The answer is not D because Z is not the time that the ventricles are contracting* | **(1)** |

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| **Question Number** | **Answer** | **Additional Guidance** | **Mark** |
| **4(b)** | An explanation that makes reference to three of the following:<br><br>• acetylcholine was not broken down (as quickly) (1)<br><br>• therefore {maintaining / increasing} the concentration of acetylcholine in the synaptic gap (1)<br><br>• so able to compete with the poison (1)<br><br>• and so able to bind to receptors (on cell surface membrane of cells of the SAN) (1) | ALLOW acetylcholine remains in the synaptic gap | **(3)** |

| **Question Number** | **Answer** | **Additional Guidance** | **Mark** |
|---|---|---|---|

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|---|---|---|---|
| **4(c)** | A description that makes reference to the following:<br>• antagonistic (interaction) of muscles (1)<br>• in the iris (1)<br>• radial muscles contract and circular muscles relax (1) | | **(3)** |

| Question Number | Answer | Mark |
|---|---|---|
| **5(a)** | • A 1 only<br>*The answer is not B as these do not summate to the maximum that can be exhaled (the vital capacity)*<br>*The answer is not C as these do not summate to the maximum that can be exhaled*<br>*The answer is not D as these do not summate to the maximum that can be exhaled (the vital capacity)* | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|

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| **5(b)(i)** | An answer that makes reference to four of the following:<br><br>• select people with different thorax sizes (1)<br><br>• select people who are similar in other respects (1)<br><br>• one relevant variable controlled (1)<br><br>• measurement of tidal volume from spirometer trace (1)<br><br>• measure breathing rate as number of {peaks / troughs} in a set time (1) | <br><br>ALLOW with or without the adaptation, who lived at high altitude and low altitude<br><br>e.g. same age, same fitness level, same sex<br><br>e.g. temperature, same level of previous activity, data collected when subjects were at rest<br><br>ALLOW difference in peak to trough volume gives tidal volume<br><br>ALLOW – measure breathing rate by counting number of breaths in a set time | **(4)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|

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|---|---|---|---|
| **5(b)(ii)** | An explanation that makes reference to four of the following:<br><br>• (by) differentiation (1)<br><br>• (due to) certain stimuli (1)<br><br>• (which causes) {some genes/ gene for haemoglobin} to be activated / some genes to be deactivated (1)<br><br>• {mRNA / haemoglobin} produced from activated genes (1)<br><br>• removal of nucleus / produce a biconcave shape (1) | ALLOW some genes switched on / switched off<br>IGNORE genes being turned on / off | **(4)** |

| Question Number | Answer | Mark |
|---|---|---|
| **6(a)(i)** | • C -60 millivolts<br><br>*The answer is not A as – 80 millivolts is the maximum hyperpolarisation*<br><br>*The answer is not B as – 70 millivolts in the resting potential*<br><br>*The answer is not D as + 40 millivolts is the action potential* | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(a)(ii)** | An explanation that makes reference to the following:<br><br>• voltage gated sodium ion channels open and sodium ions {diffuse into /move in } from outside the cell (1)<br><br>• (therefore causing an) increase in sodium ion concentration (1)<br><br>• voltage gated potassium ion channels open and potassium ions {diffuse out / move out} from the inside (1)<br><br>• (therefore causing an) decrease in potassium ion concentration at or after { 7 milliseconds / 40 mV } (1) | ALLOW sodium gates for voltage gated sodium ion channels<br><br>ALLOW decrease in potassium ion concentration with repolarisation | **(4)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(a)(iii)** | An explanation that makes reference to three of the following:<br><br>• potassium ions (continue) leaving the {axon / cytoplasm} (1)<br><br>• (therefore) preventing another depolarisation occurring / it is the refractory period (1)<br><br>• allowing time for the neurone to reset (1)<br><br>• so that nerve impulses travel in one direction only (1) | ALLOW voltage gated potassium ion channels remain open<br><br>ALLOW prevents an action potential from being generated<br><br>ALLOW time to return to resting potential | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(b)** | A description that makes reference to<br><br>• vesicles fuse with {motor endplate / presynaptic membrane} releasing acetylcholine (1)<br><br>• (acetylcholine crosses the synapse) by diffusion (1) | ALLOW neurotransmitter is released from the presynaptic neurone by exocytosis<br><br>ALLOW moves down the concentration gradient | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(a)(i)** | An explanation that makes reference to:<br><br>• heat is {released / generated} (1)<br><br>• (due to) increased respiration (1) | ALLOW heat energy or thermal energy | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
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| **7(a)(ii)** | An answer that makes reference to four of the following: | | **(4)** |

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| | • core temperature increases more when humidity is high (during exercise) (1)<br><br>• therefore body temperature not as well controlled at higher humidity (1)<br><br>• in low humidity there is no body temperature rise { after 35 minutes / above 37.7°C} (indicating thermoregulation) (1)<br><br>• however no investigation carried out on low temperature with high humidity (1)<br><br>• comment on quality of the design of investigation (1) | ALLOW converse<br><br>Examples: Only nine athletes involved, investigation only done on one occasion per condition, exercise only carried out for 50mins | |

| **Question Number** | Answer | Additional Guidance | **Mark** |
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| **7(a)(iii)** | An answer that makes reference to three of the following:<br><br>• both decrease (1)<br><br>• both reach the same temperature {by 70 minutes after running /after 120 minutes} (1)<br><br>• greater decrease for the warm and humid conditions (1)<br><br>• greater rate of cooling for those in warm humid conditions (1) | ALLOW rate of cooling linear for cool and low humidity but non-linear for warm and high humidity | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(b)(i)** | • calculate a difference in the number of neutrophils (1)<br><br>• calculation of difference in number of neutrophils per athlete either in blood or per kilogram (1)<br><br>• calculation of number of fewer neutrophils in the blood per kilogram (1) | Example of calculation:<br><br>$0.15 \times 10^6 = 150\,000$<br>OR<br>$(3.57 \div 70) - (3.42 \div 70) = 0.002142$<br><br>In blood - $150\,000 \times 5000 = 750\,000\,000$<br>OR<br>per kg - $150\,000 \div 70 = 2142.86$<br><br>$750\,000\,000 \div 70 = 10\,714\,286$<br>OR<br>$2142 \times 5000 = 10\,710\,000$<br><br>ALLOW $11 \times 10^6$ or $1.1 \times 10^7$ or $0.11 \times 10^8$<br><br>ALLOW ECF - 2 marks for 10.7 or 10.71<br><br>Correct answer with no working gains full marks. | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(b)(ii)** | • there are fewer neutrophils and the activity is reduced | | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| 8(a) | A<br><br>Plasmid DNA is: double-stranded<br>Chromosomal DNA is: double-stranded | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| 8(b)(i) | • two correctly identified organelles | e.g. smooth endoplasmic reticulum / SER/ sarcoplasmic reticulum / (secretory) vesicles / lysosomes / acrosome / cortical granules / vacuole<br><br>IGNORE nucleus, mitochondria, chloroplast, or ribosome, centriole | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(b)(ii)** | An explanation that makes reference to five of the following:<br><br>• pancreatic cells have more rER (1)<br><br>• (more rER) for the synthesis of protein (1)<br><br>• pancreatic cells have more Golgi apparatus (1)<br><br>• (more Golgi apparatus) for the modification of protein (1)<br><br>• (more) {vesicles/lysosomes} produced by {pancreatic cells / Golgi apparatus} (1)<br><br>• (vesicles) as the pancreas secretes (more) {protein / glycoprotein} (1) | ALLOW converse – liver cells have less rER<br><br>ALLOW more folding of protein / package more protein, production of {enzymes / hormones / insulin}<br><br>ALLOW converse – liver cells have less Golgi apparatus<br><br>ALLOW description of modification given such as addition of carbohydrate, production of glycoprotein, concentrates protein<br><br>ALLOW releases a named protein such as insulin or digestive enzymes | **(5)** |

| Question Number | Answer | Additional Guidance | Mark |
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| **8(c)** | • height of the six cisternae and distance between the six cisternae found (1)<br><br>• correct addition and conversion to micrometres (1) | Example of calculation<br>(6 x 15) = 90<br>plus (5 x 25) = 125<br><br>0.215 (µm)<br><br>215 gains one mark<br><br>Correct answer with no working gains full marks. | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(d)** | An explanation that makes reference to three of the following:<br><br>• decreases betalain concentration (in the cells) (1)<br><br>• due to betalain {diffusing out / moving down a concentration gradient} (1)<br><br>• (because) the alcohol increases membrane permeability (1)<br><br>• membrane {lipids/ phospholipids} dissolve in alcohol (1) | IGNORE reference to cell wall | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9(a)(i)** | An explanation that makes reference to the following:<br><br>• the parents were {heterozygous / had a dominant and a recessive allele} as the offspring had both yellow and non-yellow coats (1)<br><br>• (because the parents had yellow coats) the recessive allele was for non-yellow coat (1) | ALLOW parents were carriers | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9(a)(ii)** | <table><tr><td>offspring with a yellow coat</td><td>offspring with a non-yellow coat</td></tr><tr><td>1199.25</td><td>399.75</td></tr></table><br>1 mark for each predicted number | ALLOW 1199 for 1199.25<br><br>ALLOW 400 for 399.75 | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9(a)(iii)** | An explanation that makes reference to the following :<br><br>• ratio is 2 : 1 rather than 3 : 1 (1)<br><br>• random fertilisation (1)<br><br>• due to no homozygous dominant individuals surviving / homozygous dominant is lethal (1) | ALLOW description of random fertilisation | **(3)** |

| Question Number | Answer | Mark |
|---|---|---|
| ***9(b)** | 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>For DNA<br>• Double stranded so more stable<br>• Allows for a template strand<br>• Larger as includes promotor / site for transcription factors to bind<br><br>For mRNA<br>• Ribose rather than deoxyribose <u>and</u> uracil rather than thymine<br>• Smaller as not bound to other genes / fewer bases (minimum of 396)<br>• So can {exit the nucleus / move through the nuclear pore}<br>• Single-stranded<br>• So {bases / codon} exposed to (tRNA's with) complementary anticodons / bases can bind<br>• Amino acids {brought/joined} in the correct sequence | **(6)** |

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| | • Removal of introns / post-transcriptional modification | |

| Level 0 | Marks | No awardable content | Additional guidance |
|---|---|---|---|
| Level 1 | 1-2 | An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information.<br><br>The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. | Basic description of differences between DNA and mRNA |
| Level 2 | 3-4 | An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.<br><br>The explanation shows some linkages and lines of scientific reasoning with some structure. | Reasons provided for differences in structure of DNA and mRNA. |
| Level 3 | 5-6 | An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.<br><br>The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. | Explanation for differences in the gene described and the mRNA – greater number of bases in DNA than in the mRNA.<br><br>Reference to removal of introns and post transcriptional changes to RNA before it is translated. |

| Question Number | Answer | Additional Guidance | Mark |
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| **10(a)** | An explanation that makes reference to the following:<br><br>• compressible / cushioning (1)<br><br>• to absorb shocks (1)<br><br>or<br><br>• smooth / slippery (1)<br><br>• to reduce friction / prevents bones rubbing together (1) | ALLOWS acts as a cushion/ padding | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
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|---|---|---|---|
| **10(b)(i)** | An answer that makes reference to:<br><br>• calculate mass of calcium ions in total soft tissue (1)<br><br>• calculate the mean mass of soft tissue in a human (1)<br><br>• calculate mass of calcium per gram of soft tissue (human) (1) | Example of calculation:<br><br>1% of 1000 g = 10 g<br><br>96 % of 80 kg = 76.8 kg or 76 800g<br><br>130.21 (µg $g^{-1}$) ALLOW 130.2 / 130<br><br>Correct answer with no working gains full marks. | **(3)** |

| Question Number | Answer | Mark |
|---|---|---|
| ***10(b)(ii)** | 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. | **(6)** |

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| | 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>***Relating to the data***<br>• Data compared in humans and one plant species<br>• Idea that concentration is not same as importance<br>• No evidence that more than one plant used<br><br>***Roles of calcium ions in plants and animals***<br>• Used for plant cell walls<br>• Detail of how used in plant cell walls: calcium pectate<br>• In humans used at synapse, muscle contraction, blood clotting, bone tissue<br>• Details of how used in synapse, muscle contraction, blood clotting<br><br>***Comments on study***<br>• Only one plant species used / this plant species may not be representative of all plant species<br>• Humans not necessarily representative of all animals | |

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| Level 0 | Marks | No awardable content | Additional Guidance |
| Level 1 | 1-2 | Limited scientific judgement made with a focus on mainly just one method, with a few strengths / weaknesses identified. | Basic description of role of calcium ions in plants and in animals. |

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| | | A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made. | OR<br><br>Basic conclusion or a comment on the data. |
| Level 2 | 3-4 | A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified.<br><br>A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made. | Details provided for roles of calcium ions in both animals and plants<br><br>Comparison of data e.g. more calcium ions in plant tissue than human tissue.<br>Only one species of plant considered |
| Level 3 | 5-6 | A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information.<br><br>A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made. | Details of roles of calcium ions in animals and plants.<br><br>Data compared. Higher concentration – but calculated value for humans was for soft tissue and not bones.<br><br>Evaluation of data provided – only from humans, not all animals. Data compared. Higher concentration – but calculated value for humans was for soft tissue and did not include bones. Idea that concentration is not the same as importance. |

| Question Number | Answer | Additional Guidance | Mark |
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| **10(c)** | An answer that makes reference to two of the following:<br><br>• glucose and galactose (1)<br><br>• joined by glycosidic bond (1)<br><br>• through a condensation reaction (1) | IGNORE alpha and beta<br><br>ALLOW with removal of a water molecule | **(2)** |

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