

Mark Scheme (Results)

October 2020

Pearson Edexcel GCE
In Biology A Salters Nuffield (9BN0)
Paper 02: 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.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication
Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Answer	Mark
1(a)(i)	The only correct answer is **D** – all of his introns plus all of his exons ***A*** *is incorrect because it does not describe the genome of the adult male* ***B*** *is incorrect because it does not describe the genome of the adult male* ***C*** *is incorrect because it does not describe the genome of the adult male*	**(1)**

Question Number	Answer	Mark
1(a)(ii)	The only correct answer is **D** – yes for animal, bacterium and plant ***A*** *is incorrect because animals and bacteria can also be genetically modified and be a source of a gene* ***B*** *is incorrect because animals can be genetically modified and be a source of a gene* ***C*** *is incorrect because plants can be genetically modified and be a source of a gene*	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)	A description that makes reference to three of the following: • (DNA) helicase to {unzip DNA / break hydrogen bonds} (1) • RNA polymerase involved in {making mRNA / transcription of gene} (1) • { joining nucleotides together / forming phosphodiester bonds } (1) • enzymes { join amino acids together / form peptide bonds } (1)	ALLOW (DNA) helicase involved in unwinding DNA (to allow transcription) ALLOW: H bonds for hydrogen bonds	**(3)**

Question Number	Answer	Additional Guidance	Mark
2(a)	A description that makes reference to four of the following: Respiratory minute volume: • find the difference in peak to trough volume (to give the tidal volume) (1) • find ventilation rate (1) • multiply the tidal volume by ventilation rate (1) Oxygen consumption • difference in volume of one { peak / trough } compared to a subsequent one (1) • description of time calculation to produce a value per minute (1)	ALLOW reference to troughs instead of peaks e.g. count the number of peaks in a stated time and convert to per minute / count how many peaks in one minute ALLOW: breathing rate for ventilation rate e.g. divide by time between the two { peaks / troughs } and multiply by 60	**(4)**

Question Number	Answer	Additional Guidance	Mark
2(b)	An answer that makes reference to two of the following: • level of fitness / physical activity (1) • body mass (1) • exposure to the same environmental conditions (1)	ALLOW same level of exercise / duration of exercise ALLOW same weight	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(a)	An explanation that makes reference to four of the following: • IAA diffuses from the tip of the coleoptile (1) • (therefore) can be taken up by cells in zone of elongation (1) • which causes cells to elongate (1) • details of action in zone of elongation (1) • (therefore) causes the coleoptile to { grow towards the light / increase in height } (1)	e.g. leads to lowering of the pH in the cellulose cell wall ALLOW: positive phototropism IGNORE: bend for growth	**(4)**

Question Number	Answer	Mark
3(b)(i)	The only correct answer is **D** – phytochrome change is P_R to P_{FR} and speed of change is rapid ***A*** *is incorrect because phytochrome does not change from* P_{FR} *to* P_R *in light and the process is rapid* ***B*** *is incorrect because phytochrome does not change from* P_{FR} *to* P_R *in light* ***C*** *is incorrect because the conversion is not slow*	**(1)**

Question Number	Answer	Mark
3(b)(ii)	The only correct answer is **B** – a photosensitive pigment ***A*** *is incorrect because phytochrome is not a form of opsin* ***C*** *is incorrect because phytochrome is not an isomer of retinal* ***D*** *is incorrect because not a type of cytochrome*	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(b)(iii)	An answer that makes reference to one of the following: • (seed) germination / flowering (1)	ALLOW chlorophyll synthesis / leaf development / stops growth e.g. falling leaves	**(1)**

Question Number	Answer	Additional Guidance	Mark
4(a)	An explanation that makes reference to the following: • washing with disinfectant will kill any microorganisms (1) • drying to { reduce chance of germination / decrease enzyme action } (1) • therefore preventing { decay / infection / damage } to the seeds (1)	ALLOW bacteria and / or fungi ALLOW: for long term storage	**(3)**

Question Number	Answer	Mark
4(b)	The only correct answer is **B** – a group of several different cell types, each type working together ***A*** *is incorrect because it is not a description of an organ* ***C*** *is incorrect because it is not a description of an organ* ***D*** *is incorrect because it is not a description of an organ*	**(1)**

Question Number	Answer	Additional Guidance	Mark
4(c)	• correct calculation of number of seeds in the sample (1) • correct calculation of percentage that germinated (1) • therefore the remaining seeds are viable (as germination was greater than 75%) (1)	Example of calculation (1000 ÷ 50) x 3 = 60 seeds (1g = 20 seeds) (48 ÷60) x 100 = 80% (80% without working gains 2 marks)	**(3)**

Question Number	Answer	Mark
4(d)	The only correct answer is **D** - pyruvate ***A*** *is incorrect because carbon dioxide is not a product of glycolysis* ***B*** *is incorrect because glucose is not a product of glycolysis* ***C*** *is incorrect because oxygen is not a product of glycolysis*	**(1)**

Question Number	Answer	Additional Guidance	Mark
5(a)	An answer that makes reference to the following: • simpler nervous system / does not feel pain (1)	ALLOW – feels less pain	**(1)**

Question Number	Answer	Additional Guidance	Mark
5(b)(i)	An answer that makes reference to one of the following: • { identify / remove } any anomalies (1) • to calculate a mean / can make valid comparisons (1)	ALLOW to gain more repeatable data ALLOW outliers for anomalies ALLOW produce / form for calculate	**(1)**

Question Number	Answer	Additional Guidance	Mark
5(b)(ii)	An explanation that makes reference to the following: • (because time is required) for the alcohol to be absorbed (1) • (because time is required) for acclimatisation (1)	ALLOW getting used to the new conditions / overcoming stress of being moved	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(c)	An answer that makes reference to the following: • alcohol concentrations between 0.00 and 0.17 mol dm^{-3} (1) • controlling one biotic variable (1) • controlling one abiotic variable (1) • determine the concentration at which the *Daphnia* show a decrease in heart rate (1) • use of microscope to count heart beats of *Daphnia* (1)	e.g. age, size, sex, species of *Daphnia,* e.g. temperature, volume of alcohol ALLOW the concentration at which the mean heart rate drops below 221 beats per minute	**(5)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>6(a)</td><td>
<table>
<tr><th>Description of adaptation</th><th>Type of adaptation shown by the wasp</th></tr>
<tr><td>(knocking its body to signal food)</td><td>Behavioural (1)</td></tr>
<tr><td>(the stinger)</td><td>Anatomical (1)</td></tr>
</table>
</td><td></td><td>(2)</td></tr>
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Question Number	Answer	Additional Guidance	Mark
6(b)	A description that makes reference to four of the following: • the structure of the enzyme is determined by the sequence of amino acids (1) • { tertiary structure / globular shape } provides an active site (1) • active site complementary to { (part of) phospholipid / ester bond } (1) • to break { ester bonds / bonds between glycerol and fatty acids } (1) • relevant detail concerning bonding { within the enzyme molecule / between enzyme and substrate } (1)	ALLOW primary structure for sequence of amino acids e.g. hydrophilic R groups / hydrophobic R groups	**(4)**

Question Number	Answer	Additional Guidance	Mark
6(c)(i)	An answer that makes reference to two of the following: • modifies proteins (1) • forms vesicles (1) • removes (some) water from the protein / concentrates the { protein / glycoprotein } (1)	e.g. addition of carbohydrate to protein / formation of glycoprotein ALLOW processes protein IGNORE folds protein e.g. lysosomes / secretory vesicle / vesicle in synaptic knob ALLOW packages proteins into vesicles	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(c)(ii)	An explanation that makes reference to three of the following: • (for phase 1) – to make sure the phospholipase inhibitor is not harmful (1) • (for phase 2) – to see if it is effective in { treating the condition / preventing allergic reactions to wasp venom } (1) • (for phase 3) – to gather much data / data for statistical tests / to look for rare side effects (1) • to test for side effects in { phase 1 / phase 2 } (1)	ALLOW finding safe dosage ALLOW reference to how the drug is absorbed / metabolised ALLOW double blind trials to compare effectiveness with a placebo / previous drug	**(3)**

Question Number	Answer	Additional Guidance	Mark
7(a)(i)	An explanation that makes reference to two of the following: • time is required for heat to warm the blood (1) • because of the layer of insulation in the skin (1) • because it takes time for the warm blood to circulate (1)	ALLOW it takes time for warm blood to reach the fingertip	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(a)(ii)	• maximum difference in temperature divided by time (1) • correct answer with units (1)	Example of calculation (32.0 - 27.5) ÷ 3 1.5 ºC min^{-1} OR 1.5 ºC per minute OR 1.5 ºC / minute ALLOW 32.0 – 27.4 to give 1.53 for 2 marks Correct answer no working with units gains full marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(a)(iii)	An explanation that makes reference to five of the following: • thermoreceptors detect increase in temperature (1) • description of role of hypothalamus in heat loss mechanism (1) • (therefore more) impulses are sent along the sympathetic { nerves / nervous system } (1) • which leads to constriction of shunt vessels (1) • therefore causing vasodilation (of arterioles) (1) • so more warm blood flows near the skin surface (1)	e.g. thermoreceptors in the hypothalamus detect temperature increase OR reference to role of heat loss centre / thermoregulatory centre in co-ordinating mechanisms of heat loss ALLOW so more warm blood in capillaries ALLOW radiation of heat energy from the skin	**(5)**

Question Number	Answer	Additional Guidance	Mark
7(b)	An answer that makes reference to three of the following: • the water has an uneven distribution of charge (making it a dipole) (1) • so water forms hydrogen bonds with other water molecules (1) • (and) it requires a lot of { heat / thermal } energy to break these bonds (1) • and allow water to evaporate (taking the heat energy with it) / high latent heat of evaporation (1)	ALLOW description of dipole ALLOW – a lot of heat energy is required to evaporate water	**(3)**

Question Number	Answer	Additional Guidance	Mark
8(a)	An explanation that makes reference to three of the following: • { cell surface membrane / sarcolemma } contains voltage-gated channels to allow depolarisation (of muscle fibre) (1) • many mitochondria for { (aerobic) respiration / to supply ATP } (1) • presence of { myofibrils / actin and myosin } (1) • (myofibrils) allow contraction (of muscle) (1)	ALLOW T tubules to allow depolarisation to be transferred to sarcoplasmic reticulum / sarcoplasmic reticulum { stores / releases } calcium ions ALLOW description of interaction of actin and myosin for contraction	**(3)**

Question Number	Answer	Mark
8(b)	The only correct answer is **A** – CT uses X-rays that can cause mutations in the DNA of muscle fibres ***B*** *is incorrect because mutations do not occur in protein* ***C*** *is incorrect because CT does not use magnets* ***D*** *is incorrect because CT does not use magnets and mutations do not occur in protein*	**(1)**

Question Number	Answer	Additional Guidance	Mark
8(c)(i)	• correct values for p and q (1) • value for 2pq calculated (1) • correct number of people calculated (1)	Example of calculation p = 0.9975 and q = 0.0025 OR p= 0.9976 and q = 0.0024 ALLOW opposite values for p and q 2pq = 0.0048 to 0.0050 319 200 to 332 500 Correct answer with no working gains full marks	**(3)**

Question Number	Answer	Additional Guidance	Mark
8(c)(ii)	An explanation that makes reference to three of the following: • because the allele for LGMD2A may undergo mutation (1) • because gene flow may cause alleles to be lost or gained from the population (1) • due to { natural selection / (changed) selection pressure } (1) • because people with the condition may not have children (1)	ALLOW random mutations to allele ALLOW: immigration / emigration ALLOW confers an advantage / disadvantage	**(3)**

Question Number	Answer	Additional Guidance	Mark
8(d)	An explanation that makes reference to the following: • more males die as more have the condition (1) • (therefore) { sex-linked / X-linked } condition / { gene / allele / mutation } carried on the X chromosome (1) • more common in males as only require one copy of { gene / allele /affected X chromosome } / less common in females as require two copies (1) • because the condition is more severe in males than in females (1)	ALLOW males only need one copy of recessive allele to { inherit condition / show condition / show phenotype } ALLOW different effect of hormones in males and females	**(4)**

Question Number	Answer	Additional Guidance	Mark
9(a)(i)	An explanation that makes reference to three of the following: • nicotine similar in shape to acetylcholine (1) • increases permeability of membrane to sodium ions / changes shape of { receptors / channel proteins } (1) • nicotine causes the depolarisation of the post-synaptic membrane (1) • depolarisation reaches threshold level (1)	ALLOW { sodium ion / Na^+ } channels open ALLOW sodium ions { diffuse / move down concentration gradient } into the neurone	**(3)**

Question Number	Answer	Additional Guidance	Mark
9(a)(ii)	An answer that makes reference to the following: • (calcium ions cause) vesicles (containing noradrenaline) to fuse with { cell (surface) membrane / presynaptic membrane } (1)	ALLOW (calcium ions cause) vesicles to release noradrenaline through exocytosis	**(1)**

Question Number	Answer	Additional Guidance	Mark
9(b)(i)	• calculation of { largest difference in concentration / largest value at 0 minutes and smallest value at 30 minutes } (1) • calculation of rate of decrease in nicotine concentration per minute (1)	Example of calculation (35.0 + 9.3) / 44.3 and (24.1 – 5.6) / 18.5 25.8 ÷ 30 = 0.86 Correct answer without working gains full marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
9(b)(ii)	An answer that makes reference to two of the following: • percentage change greater for { the lower concentration of / 0.1 mg } nicotine (1) • a higher concentration causes a positive (percentage) change whilst the lower concentration leads to a negative (percentage) change (1) • correct calculation of percentage change for both rat groups (1)	2.08% for { 1.0 mg nicotine / group A } and 6.25% for { 0.1mg nicotine / group B }	**(2)**

Question Number	Indicative content
***9(b)(iii)**	Answers will be credited according to candidates' deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is relevant. Additional content included in the response must be scientific and relevant. Give examples of relevant biological knowledge and understanding: <u>Validating the statement</u> • Investigation involved rats inhaling nicotine which humans do during smoking • Rats are mammals so can extrapolate to humans <u>Not validating the statement</u> • Nicotine inhaled (for both nicotine concentrations) leads to vasoconstriction and then vasodilation and then returns to original diameter • Blood pressure for 1mg nicotine concentration increases and decreases but drops below original value • Presence of nicotine leads to noradrenaline release which increases heart rate • Blood pressure (for both nicotine concentrations) increases and decreases • No reference to rats inhaling smoke, only nicotine • Rats are not the same as humans • Sample size too small to make a valid statement <u>Comment</u> • whether agree or disagree with statement

			Additional guidance
Level 0	Marks	No awardable content	
Level 1	1-2	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	An answer that refers to just one piece of evidence – either lumen size or blood pressure Simple conclusion drawn from the evidence
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	An answer that refers to evidence concerning both lumen size and blood pressure Links made between lumen size, vasoconstriction and blood pressure
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. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	An answer that refers to data about vasoconstriction and vasodilation and links it to effect of nicotine on the release of noradrenaline and therefore on blood pressure Conclusion made considering validity of data collected from rats and how it can be applied to humans

Question Number	Answer	Mark
10(a)(i)	The only correct answer is **C** – number of carbon atoms in citrate is 6 and in succinate is 4 ***A*** *is incorrect because the number of carbons is not correct for either citrate or succinate* ***B*** *is incorrect because the number of carbons is not correct for either citrate or succinate* ***D*** *is incorrect because the number of carbons is not correct for either citrate or succinate*	**(1)**

Question Number	Answer	Mark
10(a)(ii)	The only correct answer is **B** – two hydrogen atoms ***A*** *is incorrect because oxygen is not transferred to FAD* ***C*** *is incorrect because oxygen is not transferred to FAD* ***D*** *is incorrect because water is not transferred to FAD*	**(1)**

Question Number	Answer	Additional Guidance	Mark
10(a)(iii)	An explanation that makes reference to two of the following: • so that hydrogen can be delivered to the electron transport chain (1) • to allow { ATP synthesis / chemiosmosis } (1) • to regenerate NAD (1)	ALLOW supply of { hydrogen ions / protons / electrons } to ETC ALLOW description of chemiosmosis ALLOW to keep Krebs cycle going / to allow conversion of citrate to succinate	**(2)**

Question Number	Answer	Mark
10(a)(iv)	The only correct answer is **A** – concentration of citrate and reduced FAD decreases ***B*** *is incorrect because the concentration of reduced FAD decreases rather than increases* ***C*** *is incorrect because the concentration of citrate decreases rather than increases* ***D*** *is incorrect because the concentration of citrate and reduced FAD decrease rather than increase*	**(1)**

Question Number	Answer	Additional Guidance	Mark
10(b)(i)	An answer that includes: • a line that shows a positive correlation with lung, liver and colon points below the line and breast, bladder and pancreas above the line		**(1)**

Question Number	Answer	Additional Guidance	Mark
10(b)(ii)	An explanation that makes reference to the following: • there is a correlation between age and level of DNA methylation (1) • as there is only a 5% likelihood of these results being produced by chance (1)	ALLOW converse, e.g. 95% probability that DNA methylation increases with age ALLOW as the calculated value is greater than the critical value at p=0.05	**(2)**

Question Number	Indicative content
*** 10(c) (iii)**	Answers will be credited according to candidates' deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is relevant. Additional content included in the response must be scientific and relevant. Give examples of relevant biological knowledge and understanding: • mutation is a change in the { base sequence in DNA / gene } / different amino acid sequence / primary structure of the enzyme succinate dehydrogenase • succinate dehydrogenase { less / non- } functional • succinate therefore accumulates • accumulation of succinate inhibits TET • therefore methyl groups not removed / increased methylation of DNA • affects transcription of a gene / therefore alters amount of product formed • greater methylation is of DNA is associated with increased risk of cancer

			Additional Guidance
Level 0	Marks	No awardable content	
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. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Only one point of basic information referred to: e.g. mutation results in more succinate, or high succinate and inhibition of TET, or less TET and more methylation of DNA
Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Link between high levels of succinate and inhibition of TET
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. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Links made to include all of these points: mutation leads to higher levels of succinate, which inhibits TET, therefore increasing DNA methylation, which increases risk of cancer Logical explanation of the reasons why a mutation in the enzyme succinate dehydrogenase can increase risk of developing cancer

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