Pearson Edexcel

Mark Scheme (Results)

November 2021

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)	An answer that makes reference to: • no (in row two) (1) • some (in row five) (1)		**(2)**

Question Number	Answer	Additional guidance	Mark
1(b)	An explanation that makes reference to three of the following: • (because) there are {more similarities / fewer differences} between the Archaea and the Eukaryota (1) • (because) there are {fewer similarities / more differences} between the Archaea and the Bacteria (1) • two similarities between Archaea and Eukaryota (from table) described (1)	ALLOW correct number of similarities / differences for Archaea and Eukaryota ALLOW correct number of similarities / differences for Archaea and Bacteria e.g. not inhibited by streptomycin/ methionine required for starting protein synthesis / transcription factors required for transcription	**(3)**

	• (so) the more recently they have evolved from a common ancestor (1)		

Question Number	Answer	Additional Guidance	Mark
2(a)	A description that makes reference to the following: • (produces non-identical gametes due to) independent assortment (of chromosomes) (1) • crossing over between (non-sister) chromatids (of homologous chromosomes) (1)	ALLOW description of independent assortment e.g. random which chromosome of each pair moves to which pole ALLOW description of crossing over e.g. swapping of alleles between (non-sister) chromatids	**(2)**

Question Number	Answer	Additional guidance	Mark
2(b)	An explanation that makes reference to the following: • cortical granules fuse with the egg cell (surface) membrane (1) • releasing {contents / enzyme} that {harden / thicken} zona pellucida (1)	ALLOW exocytosis ALLOW alter the polarity of the egg cell surface membrane	**(2)**

Question Number	Answer	Additional guidance	Mark
2(c)	An explanation that makes reference to the following: • there are more genes than there are chromosomes (1) • linkage relates to genes (for different characteristics) located on the same (non-sex) chromosome (1) • sex-linkage relates to genes on the {sex / X / Y} chromosome (1)	ALLOW many genes on each chromosome	**(3)**

Question Number	Answer	Additional guidance	Mark
3(a)	A description that makes reference to two of the following: • polysaccharide made up of many monosaccharide components (1) • joined together by {condensation reactions / glycosidic bonds} (1) • (only)1-4 glycosidic bonds present / no 1-6 glycosidic bonds present (1)	ALLOW chain of glucose molecules	**(2)**

Question Number	Answer	Additional guidance	Mark
3(b)	An explanation that makes reference to the following: • hydrolysis / description of hydrolysis (1) • of glycosidic bonds (1)		**(2)**

Question Number	Answer	Additional guidance	Mark
3(c)	An answer that makes reference to the following: • 0.5 probability for being { same sex / female} (1) • person 1 is heterozygous for MPS 1 (1) • (therefore) person 2 has a 0.75 probability of having same phenotype as person 1 for MPS 1 (1) • therefore probability of being female and not having MPS 1 will be 0.375 (1)	ALLOW 50% for 0.5 ALLOW detail of proof of phenotype of person 1 e.g. does not show condition therefore has to have one dominant allele but (at least) one daughter has condition so received a recessive allele from person 1 ALLOW carrier for heterozygous ALLOW 75% for 0.75 ALLOW $^{3}/_{8}$ or 37.5% for 0.375	**(4)**

Question Number	Answer	Additional guidance	Mark
4 (a)	An answer the makes reference to four of the following: • both have same volume (1) • animal A has a larger surface area (1) • animal A has a larger surface area to volume ratio (1) • so sufficient (surface area in animal A) for diffusion (1) • distance to cells in centre of A is shorter than for B allowing {quicker/sufficient} diffusion / shorter diffusion distance (in A) (1)	ALLOW both have a volume of 64 mm^3 ALLOW converse ALLOW figures given (e.g. 168 mm^2 v 96 mm^2) or difference given as 72 mm^2 ALLOW {168:64 / 2.6:1} compared to {96:64 / 1.5:1} ALLOW converse ALLOW converse	**(4)**

Question Number	Answer	Additional guidance	Mark
4(b)	An explanation that makes reference to three of the following: • less oxygen available for aerobic respiration (1) • deoxygenated blood mixes with oxygenated blood (1) • therefore reducing the concentration of oxygen in the blood circulating in the body (1) • because some deoxygenated blood {does not leave right ventricle / is transferred to the left ventricle / does not go to the lungs / goes to the respiring tissues} (1)	ALLOW lack of oxygen leads to (some) anaerobic respiration ALLOW some oxygenated blood {does not leave left ventricle / is transferred to the right ventricle / does not go to the respiring tissues / goes to the lungs}	**(3)**

Question Number	Answer	Mark
4 (c) (i)	**The only correct answer is D - 5** ***A*** *is not correct because oxygen has to travel across both sides of a cell in the alveolus wall plus both sides of the capillary wall cell as well as across the cell surface membrane of a red blood cell. This summates to 5, not 2.* ***B*** *is not correct because oxygen has to travel across both sides of a cell in the alveolus wall plus both sides of the capillary wall cell as well as across the cell surface membrane of a red blood cell. This summates to 5, not 3.* ***C*** *is not correct because oxygen has to travel across both sides of a cell in the alveolus wall plus both sides of the capillary wall cell as well as across the cell surface membrane of a red blood cell. This summates to 5, not 4.*	**(1)**

Question Number	Answer	Mark
4(c)(ii)	**The only correct answer is B (diffusion)** ***A*** *is not correct because oxygen does not enter a red blood cell by active transport* ***C*** *is not correct because oxygen does not enter a red blood cell through facilitated diffusion* ***D*** *is not correct because oxygen does not enter a red blood cell through osmosis*	**(1)**

Question Number	Answer	Mark
5(a)	The only correct answer is A - the ventricles contract, atrioventricular valves close and semilunar valves open *B is incorrect because the AV valves do not open* *C is incorrect because the ventricles do not relax* *D is incorrect because the semilunar valves do not close*	**(1)**

Question Number	Answer	Additional Guidance	Mark
5(b)(i)	• correct value for percentage increase	11.3 / 11.32 (%)	**(1)**

Question Number	Answer	Additional guidance	Mark
5(b)(ii)	An answer that makes reference to four of the following • details of the procedure (1) • record heartbeat before and after placing in regular or decaffeinated coffee (1) • controlled variable for the coffee (1) • reference to controlled variables (1) • use of a suitable statistical test to compare the results (1)	 e.g. use of a microscope / method of counting / allowing acclimatisation ALLOW ref to heartbeat for *Daphnia* in water and coffee e.g. concentration or volume e.g. temperature / length of time to count heartbeat / same species	**(4)**

Question Number	**Answer**	**Additional guidance**	**Mark**
5(c)	An explanation that makes reference to the following • high blood pressure causes damage to the endothelium of the arteries (1) • inflammatory response / build-up of cholesterol leads to the formation of an atheroma (1) • plaque develops and narrows the lumen of the artery (1)		**(3)**

Question Number	Answer	Additional guidance	Mark
6(a)(i)	An explanation that makes reference to three of the following: • (DNA) ligase (joins the two genes) (1) • by joining phosphate to sugar / forming phosphodiester bonds (1) • by condensation reactions (1) • description of role of active site of enzyme (1)		**(3)**

Question Number	Answer	Mark
6(a)(ii)	**The only correct answer is D restriction endonuclease** ***A*** *is not correct because DNA polymerase catalyses the formation of new DNA strands* ***B*** *is not correct because RNA ligase joins sections of RNA* ***C*** *is not correct because RNA polymerase catalyses the formation of pre-mRNA*	**(1)**

Question Number	Answer	Additional guidance	Mark
6(a)(iii)	An explanation that makes reference to the following: • so that only bacteria with the antibiotic resistance gene survive (1) • therefore, these bacteria will also have the gene for spider silk (1)		**(2)**

Question Number	Answer	Additional guidance	Mark
6(a)(iv)	An answer that makes reference to two of the following: • IAA to cause cell elongation (1) • detail of how IAA affects plant cells (1) • to grow plants that produce spider silk (1)	ALLOW alters pH of cell wall / makes cellulose cell wall more plastic / effect on transcription ALLOW stimulates roots to grow	**(2)**

Question Number	Answer	Additional guidance	Mark
6(a)(v)	An answer that makes reference to the following: • mass per acre per year for goats (1) • correct calculation of difference in mass of spider silk produced (1) • correct percentage increase (1)	Example of calculation 10 x 12 = 120 (kg per acre per year) 218-120 = 98 (kg per acre per year) 81.66 / 81.7 / 82 (%) Correct answer with no working gains full marks	**(3)**

Question Number	Answer	Additional guidance	Mark
6(b)	An answer that makes reference to the following: • transfer of antibiotic-resistance gene to other microorganisms (1) • a reason associated with health (1)	e.g. pathogenic bacteria developing resistance to antibiotics	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(a)(i)	A description that makes reference to the following: • fast twitch fibres have {no / few} mitochondria present / slow twitch fibres have many mitochondria (1) • fast twitch fibres have {no / few} capillaries present / slow twitch fibres have many capillaries present (1)		**(2)**

Question Number	Answer	Mark
7(a)(ii)	**The only correct answer is B – contracted and relaxed** ***A*** *is not correct because the flexor in the leg would be relaxed* ***C*** *is not correct because the flexor in the arm would not be relaxed and the flexor in the leg would not be contracted* ***D*** *is not correct because the flexor in the arm would not be relaxed*	**(1)**

Question Number	Answer	Mark
7(b)(i)	**The only correct answer is A - ligaments only** ***B*** *is not correct because the tendons do not join bones to bones in the elbow joint* ***C*** *is not correct because the tendons do not join bones to bones in the elbow joint* ***D*** *is not correct because the ligaments do join bones to bones in the elbow joint*	**(1)**

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Question Number	Answer	Mark
7(b)(ii)	**The only correct answer is D rows 3 and 4** ***A*** *is not correct because the tendons showing a change is not a change in genotype* ***B*** *is not correct because the tendons also show a physiological adaptation* ***C*** *is not correct because the tendons showing a change is not a change in genotype*	**(1)**

Question Number	Answer	
***7(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. **Indicative content** **Valid because:** • {sufficient replicates / 12 individuals} used and a mean calculated • All same gender • Means of both heart rate and blood lactate agree with conclusion • Spread of data (standard deviation / error bars) between cycling and running does not overlap **Not valid because:** • Insufficient / only 12 individuals involved • Insufficient detail relating to the athletes e.g. they maybe athletes that focus on different sports/ have done more than one previous triathlon / more experienced • The three disciplines are always done in the same order / different distances covered • Spread of cycling data (standard deviation / error bars) for blood lactate overlaps with swimming • As no time allowed to recover between sports, some of blood lactate shown for cycling could have been produced during swimming • Agree or not agree with conclusion	**(6)**

			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.	Considers one area only e.g. comparing mean data or spread of data only Conclusion based on only one set of data or only one sport considered e.g. cycling is most demanding
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.	Considers both a valid and an invalid aspect e.g. relevance of spread of data for lactate concentrations overlap in some cases or elements of the study Conclusion given that takes both valid and invalid aspects into account
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.	Considers both a range of valid and invalid aspects A conclusion based on a range of considered evidence

Question Number	Answer	Mark
8(a)(i)	**The only correct answer is B Q – the Krebs cycle occurs in the matrix** ***A*** *is not correct because the Krebs cycle does not occur in the intermembrane space* ***C*** *is not correct because the Krebs cycle does not occur on the crista* ***D*** *is not correct because the Krebs cycle does not occur at the outer mitochondrial membrane*	**(1)**

Question Number	Answer	Mark
8(a)(ii)	**The only correct answer is C – R which labels a crista** ***A*** *is not correct because oxidative phosphorylation does not occur in the intermembrane space* ***B*** *is not correct because oxidative phosphorylation does not occur in the matrix* ***D*** *is not correct because oxidative phosphorylation does not occur at the outer mitochondrial membrane*	**(1)**

Question Number	Answer	Additional guidance	Mark
8(a)(iii)	An answer that makes reference to the following: • length measured and units (converted correctly) (1) • image size divided by actual size to calculate magnification (1)	Example of calculation e.g. 70mm – 70 000 µm e.g. 70 000 ÷ 0.5 = 140 000 x 140 000 Correct answer with no working gains full marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
8(b)(i)	An answer that makes reference to two of the following: • pyruvate (1) • oxygen (1) • reduced NAD / ADP (1)		**(2)**

Question Number	Answer	Additional guidance	Mark
8(b)(ii)	An explanation that makes reference to four of the following: • to stop H^+ diffusing out (of mitochondrion) / into cytoplasm (1) • (therefore) maintaining a high concentration (of H^+) in the intermembrane space (1) • so {hydrogen ions / protons / H^+} can move down {concentration / electrochemical} gradient (1) • (by) chemiosmosis (1) • to synthesise ATP (1)	ALLOW moves out for diffuses out ALLOW enabling/allowing/establishing for maintaining	**(4)**

Question Number	Answer	Additional guidance	Mark
8(c)	An answer that makes reference to four of the following: • selection of two temperatures that are not above the optimum temperature (1) • named variable kept constant (1) • record the distance travelled by the coloured liquid in a set time (1) • description of how to calculate rates (1) • data collected during the initial rate of reaction / before a factor (other than temperature) becomes limiting (1)	ALLOW: below a temperature that causes enzyme denaturing or not above optimum temp ALLOW any two temperatures between 10 and 40°C e.g. pH of solution, {sucrose/glucose} concentration, yeast {concentration / volume} ALLOW time taken for coloured liquid to travel a set distance e.g. by dividing distance travelled by time	**(4)**

Question Number	Answer	Additional guidance	Mark
9(a)	An answer that makes reference to the following: • as a control to compare with the muscle cells in space / to show that any change is due to {changes in gravity /being in space}	ALLOW as a control	**(1)**

Question Number	Answer	Additional guidance	Mark
9(b)(i)	An explanation that makes reference to two of the following: • there is {more than a 5% likelihood / less than 95% likelihood} (1) • therefore the rate of protein breakdown is the same {in space as it is on Earth / for groups 1 and 2} (1) • the calculated value is less than the critical value (at p=0.05) (1)	ALLOW: 'chance' for 'likelihood'	**(2)**

Question Number	Answer	Additional guidance	Mark
9(b)(ii)	A description that makes reference to three of the following: • (part) folded into a specific shape with a globular head (1) • that can bind to actin (1) • (myosin) has a site that can bind with ATP (1) • (part) straight to form a bundle with other myosin molecules (1)	ALLOW R groups arranged to bind with ATP	**(3)**

Question Number	Answer	
***9(c)**	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. **Evidence for muscle loss in low gravity:** No difference in protein breakdown But much less protein synthesis So overall there is a loss of muscle mass **Evidence against muscle loss:** Once subject to gravity again, protein synthesis significant / greater than if had not been in space **Quality of study:** Data only collected for 10 days in low gravity / not nine months of travel to Mars No data on gravity on Mars How good a model is a group of muscle cells compared with a muscle / astronaut In vitro versus in vivo studies **Consequences for the astronauts' muscles:** Conclusion given	**(6)**

			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.	An explanation that focuses one aspect such as during the space flight there will be a loss of muscle mass Uses suitable evidence such as there will be a reduction in protein synthesis when in low gravity
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.	An explanation that evaluates more than one aspect e.g. in addition to loss of muscle mass during the flight to Mars, more mass will be formed once on Mars Uses evidence about increased gravity on Mars compared to space and data supplied about protein synthesis once muscle cells returned to higher gravity situation
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.	Consideration is given to several aspects e.g. both muscle mass loss and gain as well as to the quality of the study

		The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Comparisons are made to the duration of time spent in space, comparing astronauts to human muscle tissue as well as change in muscle mass

Question Number	Answer	Additional Guidance	Mark
10(a)	An explanation that makes reference to the following: • increasing light intensity decreases the current (1) • because {rhodopsin is broken down / opsin is released} (1) • therefore, more opsin binds to the channel proteins in the outer segment (1) • sodium-gated voltage channels close (1) • {reducing / stopping} the influx of sodium ions / making membrane impermeable to sodium ions (1)	ALLOW opsin binds to the cell surface membrane / sodium-gated voltage channels ALLOW Na^+ channels / (non-specific) cation channels for sodium-gated voltage channels	**(5)**

Question Number	Answer	Additional guidance	Mark
10(b)(i)	A description that makes reference to the following: • calcium ions enter presynaptic neurone so vesicles with neurotransmitter can {move towards / fuse with presynaptic membrane} (1) • neurotransmitter molecules diffuse across the synapse (1) • neurotransmitter to bind with receptors on post synaptic membrane (on the brain cell) (1) • sodium ions diffuse into {brain cell / post-synaptic cell} leading to {a depolarisation / an action potential } (1)	ALLOW calcium ions enter presynaptic neurone leading to exocytosis of neurotransmitter from vesicles ALLOW named neurotransmitter such as acetylcholine, dopamine, noradrenaline ALLOW enter for diffuse	**(4)**

Question Number	Answer	Mark
10(b)(ii)	**The only correct answer is B - U – This is the site in the brain where the image is interpreted** ***A*** *is not correct because* T is not the site in the brain where the image is interpreted ***C*** *is not correct because V* is not the site in the brain where the image is interpreted ***D*** *is not correct because* W is not the site in the brain where the image is interpreted	**(1)**

Question Number	Answer	Additional guidance	Mark
10(c)	A description that makes reference to two the following: • fewer synaptic connections (1) • by neurones {associated with right eye / to right ocular dominance columns} (1) • left ocular dominance columns {expanded / contain more synapses} (to compensate) (1)	ALLOW fewer synapses ALLOW converse for right ocular dominance columns	**(2)**

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