

Mark Scheme (Results)

Summer 2023

Pearson Edexcel GCE
In Biology A (9BN0 02)
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	Mark
1 (a)(i)	The only correct answer is C metaphase A is incorrect as centromeres and spindle fibred do not join in anaphase B is incorrect as centromeres and spindle fibres do not join in interphase D is incorrect as centromeres and spindle fibres do not join in telophase	[1]

Question Number	Answer	Mark
1 (a)(ii)	The only correct answer is C prophase A is incorrect as the nuclear envelope does not start to break down in interphase B is incorrect as the nuclear envelope does not start to break down in metaphase D is incorrect as the nuclear envelope does not start to break down in telophase	[1]

Question Number	Answer	Mark
1 (a)(iii)	The only correct answer is C prophase A is incorrect as chromatids are not first visible in interphase B is incorrect as chromatids are not first visible in metaphase D is incorrect as chromatids are not first visible in telophase	[1]

Question Number	Answer	Additional Guidance	Mark
1 (b)	An explanation that makes reference to three of the following: • swapping of {alleles / genetic material} (1) • between non-sister chromatids (1) • of a {homologous pair of chromosomes/ bivalent} (1) • resulting in different combinations of alleles (1)	ALLOW swapping {sections of DNA / genetic information } ALLOW between maternal and paternal chromosomes	**[3]**

Question Number	Answer	Mark
2(a)	The only correct answer is - D the sugar in both eukaryotic and prokaryotic DNA is deoxyribose A is incorrect prokaryotic DNA is not linear and human DNA is not circular B is incorrect prokaryotic DNA is not located in a membrane-bound nucleus C is incorrect the base thymine is not replaced by uracil in the prokaryotic DNA	**[1]**

Question Number	Answer	Additional Guidance	Mark
2 (b)(i)	A description that makes reference to the following: • a group of genes / a section of DNA (1) • (controlled by a single) {operator/ promotor} / that are transcribed together (1)	ALLOW two marks for operator and group of genes associated with it	**[2]**

Question Number	Answer	Additional Guidance	Mark
2(b)(ii)	A description that makes reference to three of the following: • lactose allows the lac operon to function (1) • RNA polymerase can now bind to promoter (region) / repressor (molecule) no longer binds to operator (1) • allowing {transcription / mRNA to be synthesised} (1) • so enzymes involved in {metabolising / breaking down} lactose are made (1)	ALLOW lactose binds to repressor ALLOW lactase / (β) galactosidase produced	**[3]**

Question Number	Answer	Mark
3 (a)	The only correct answer is A - elastic and attaches bone to bone B is incorrect as ligaments do not attach muscle to bone C is incorrect as ligaments are elastic D is incorrect as ligaments are both elastic and attach bone to bone	**[1]**

Question Number	Answer	Additional Guidance	Mark
3 (b)	An answer that makes reference to the following: • {no change / very little change} for each age group that had surgery (1) • the {20-29 age group had the greatest percentage / 50+ age group had the smallest percentage} who underwent surgery (1) • percentage undergoing surgery decreased as age increased from the 20-29 age group (1)	ALLOW 10-19 age group showed greatest variation from 2013-2018 ALLOW reference to fewer people playing sports such as football above the age of 29 / more people playing sport up to the age of 29	**[3]**

Question Number	Answer	Additional Guidance	Mark
3 (c)(i)	• 0.005 : 1		**[1]**

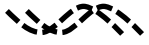
Question Number	Answer	Additional Guidance	Mark
3 (c)(ii)	An explanation that makes reference to the following: • larger opening / slower recovery time (1) • access for (more) {pathogens / bacteria} / (therefore) more time for { pathogen entry / bacteria entry / infection }	 ALLOW converse for keyhole surgery ALLOW converse for keyhole surgery	**[2]**

Question Number	Answer	Additional Guidance	Mark
4(a)	An answer that makes reference to the following: Similarity • (both) look for any genetic condition (so parents can make informed decisions) (1) Differences • PGD before implantation / amniocentesis after implantation (1) • (increased) risk of miscarriage with amniocentesis (1) • embryo tested in PGD / amniotic fluid tested in amniocentesis (1)	ALLOW testing occurs earlier in PGD / amniocentesis occurs during pregnancy ALLOW {reduced /no} risk of miscarriage with PGD ALLOW selecting embryo for implantation in PGD ALLOW cells from the 'amniotic fluid'	**[4]**

Question Number	Answer	Additional Guidance	Mark
4(b)	A description that makes reference to two of the following: • selecting one embryo over another / loss of a potential life (1) • risk of identifying other conditions / selecting for other characteristics (1) • {costly / emotional strain } as not always accurate (1)	ALLOW issues concerning discarding of spare embryos ALLOW 'designer baby' argument ALLOW 'false positives' for 'not always accurate'	**[2]**

Question Number	Answer	Additional Guidance	Mark
4(c)	An explanation that makes reference to three of the following: • (produces) sticky mucus (1) • (which) { blocks / reduces } flow of {pancreatic juice / enzyme from pancreas } (1) • (so) reducing digestion (1) • {blocks / reduces } flow of bile (1)	ALLOW: thick/thicker/viscous mucus ALLOW: blocks / reduces lumen diameter of pancreatic duct ALLOW a named enzyme ALLOW: food not digested, food not broken down ALLOW: blocks / reduces lumen diameter of bile duct	**[3]**

Question Number	Answer	Additional Guidance	Mark
5(a)	• width of the bacterium calculated (1) • width of DNA calculated (1) • answer given in standard form (1)	<u>Example of calculation</u> 0.5µm / 0.0005mm / 5×10^{-1} µm / 5×10^{-4} mm 0.002 µm 2.0×10^{-3} ECF – ALLOW 1 mark for 2 or 2.0 as the answer ALLOW 2 marks for 2.0×10^{-6} in the working or answer Correct answer with no working gains full marks	**[3]**

Question Number	Answer	Additional Guidance	Mark
5(b)(i)	Conservative: 1 x  and 3 x  (1) Semi-conservative – 1st replication:  and  (1) Semi-conservative – 2nd replication: 2 x  and 2 x  (1)		**[3]**

Question Number	Answer	Additional Guidance	Mark
5(b)(ii)	An explanation that makes reference to two of the following: • doubling of the DNA (1) • with each original DNA strand acting as a template (onto which a new strand is formed) (1) • (so) (each double-stranded) DNA formed contains one original strand of DNA and one new strand of DNA (1)	ALLOW marks for annotated diagram ALLOW two double helices formed ALLOW reference to {template / sense and antisense} strands from original DNA	**[2]**

Question Number	Answer	Additional Guidance	Mark
5(c)	An explanation that makes reference to three of the following: • less thromboplastin (released from fewer platelets) (1) • (so less/slower) prothrombin converted to thrombin (1) • (so less/slower) {fibrinogen converted to fibrin / fibrin formed} (1) • fewer platelets to be trapped in the fibrin mesh (1)	ALLOW less thrombokinase ALLOW: slower formation of fibrin ALLOW: slower blood clotting / cascade reduced ALLOW: smaller platelet plug formed / slower platelet plug formation	**[3]**

Question Number	Answer	Additional Guidance	Mark
6(a)(i)	An answer that makes reference to the following: • reduced NAD and ATP	ALLOW NAD_{red}, $NADH_2$, NAD2H, NADH + H^+ for reduced NAD	**[1]**

Question Number	Answer	Additional Guidance	Mark
6(a)(ii)	A description that makes reference to two of the following: • it would be used in anaerobic respiration (1) • reduced NAD provides hydrogen (1) • reduced to { lactate / lactic acid } (1)	ALLOW mark for anaerobic respiration ALLOW binds with hydrogen from reduced NAD ALLOW converted for reduced	**[2]**

Question Number	Answer	Mark
6(a)(iii)	The only correct answer is D A is the incorrect answer as some of the carbons are recycled in the Krebs cycle B is the incorrect answer as some of the carbons are recycled in the Krebs cycle C is the incorrect answer as the number of carbons in the Krebs cycle does not decrease to two	**[1]**

Question Number	Answer	Additional Guidance	Mark
6(b)	An explanation that makes reference to two of the following: • decrease in {pressure/volume} (in the tube) (1) • as oxygen {used / taken out of tube / taken up by maggots} (1) • as carbon dioxide released is absorbed by potassium hydroxide (1)		**[2]**

Question Number	Answer	Additional Guidance	Mark
6(c)	An answer that makes reference to five of the following: • suitable range of temperatures (1) • control of a relevant biotic variable (1) • record distance bubble travels in a set time / record time taken to travel a set distance (1) • judgement of optimum (1) • details of respirometer set up (1) • repeats at each temperature to calculate a mean value (1)	e.g. 5- 50° C Range to be at least 3 temperatures. e.g. age, species, mass or size of maggots IGNORE number of maggots e.g. note first temperature where distance bubble moves is less, so previous highest temperature to this is the optimum ALLOW temperature at which rate is highest e.g. use water baths, soda lime, time for organisms to acclimatise ALLOW average for mean	**[5]**

Question Number	Answer	Additional Guidance	Mark
7(a)	An explanation that makes reference to five of the following: • predominance of {type I / slow twitch} muscle fibres (1) • (long duration activity so) require muscle fibres that are slow to fatigue (1) • low level of anaerobic respiration reduces lactic acid build up (1) • {ATP needed over a longer time frame / (overall) more ATP needed} so provided by (more efficient process) {aerobic respiration / oxidative phosphorylation / chemiosmosis} (1) • high mitochondria concentration for (more) aerobic respiration (1) • {type II / fast twitch} muscle fibre allows runner to run faster (towards the end) (1)	ALLOW fatigue resistant ALLOW reduces cramp due to anaerobic respiration ALLOW converse ALLOW reduces oxygen debt	**[5]**

Question Number	Answer	Mark
7(b)(i)	The only correct answer is A none B is incorrect as ligase does not cut DNA, nor do viruses have plasmids C is incorrect as restriction enzymes do not add genes to the DNA of a cell in GM D is incorrect as the functional gene in the virus is not the vector	[1]

Question Number	Answer	Mark
7(b)(ii)	The only correct answer is B 4 A is incorrect as more than 2 phosphodiester bonds were hydrolysed C is incorrect as fewer than 8 phosphodiester bonds were hydrolysed D is incorrect as fewer than 16 phosphodiester bonds were hydrolysed	[1]

Question Number	Answer	Additional Guidance	Mark
7(b)(iii)	An explanation that makes reference to three of the following: • genetic modification has {only occurred in cells of the eye / not occurred in gametes} (1) • (person treated) has gametes with the allele for the condition (1) • {partner / other gamete} also supplies a recessive allele (1) • mutation occurs in gene of offspring (1)	ALLOW gametes not changed / not infected by virus ALLOW only cells in the eye have the functional gene ALLOW other parent may be a carrier ALLOW non-functional gene on X chromosome / condition sex-linked	**[3]**

Question Number	Answer	Mark
7(c)	The only correct answer is A differences in the genome between people B is incorrect medicines do not have the same effects on people C is incorrect similarities in the genome between people does not allow development of personalised medicine D is incorrect the genome does affect the activity of medicine	**[1]**

Question Number	Answer	Additional Guidance	Mark
8(a)	An explanation that makes reference to two of the following: • ATP required for sodium/potassium pumps (1) • to move ions against concentration gradient (1) • to maintain potential difference across axon membrane (1)	 ALLOW description of movement of sodium ions out and potassium ions into the axon ALLOW active transport ALLOW maintains resting potential	**[2]**

Question Number	Answer	Additional Guidance	Mark
8(b)(i)	An explanation that makes reference to the following: • attaches to {myosin-binding site / actin} (1) • splits ATP / acts as an ATPase (1) • (myosin head) changes position (to move mitochondria on) (1)	ALLOW ATP split into ADP and Pi, ATP hydrolysed ALLOW myosin detaches from actin ALLOW myosin head changes shape (moving mitochondria)	**[3]**

Question Number	Answer	Additional Guidance	Mark
8(b)(ii)	• calculation of time to travel 9cm in seconds (1) • answer in hours (1)	<u>Example of calculation</u> 9cm = 90 000 μm ÷ 0.5 = 180 000 seconds Divided by 3 600 gives 50 hours ALLOW 1 mark for 0.5, 5 or 500 hours Correct answer with no working gains full marks	**[2]**

Question Number	Answer
***8(c)**	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. 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. Indicative content 1. **General** • Consideration of percentages in table – more lipid than protein in each, Schwann cells more lipid than motor neurone / percentages are not the same as importance • Many of lipids and proteins will have the same roles in both cell types. **2. Lipids** *(a) roles common to both:* • Phospholipids as a bilayer • Barrier to both polar and non-polar substances / Separates external and internal environment • So (most) movement must be through channel / carrier proteins • Allowing regulated movement / movement against the concentration gradient *(b) role of additional lipids in Schwann cells* • Part of myelin sheath / electrical insulation • Stops {ions / Na^+ / K^+} moving across (neurone) membrane • So no depolarisation where {Schwann cell / myelin} is present / depolarisation only occurs at nodes of Ranvier • Allows saltatory conduction / process described 3. **Proteins** *Role of additional protein in motor neurone* • Channel / carrier proteins / gated channel proteins • Na^+ / K^+ voltage-dependent gates / Ca^{2+} channels / Na^+ / K^+ pump • Role in allowing action potentials / resting potential in the axon 6 marks

Level 0	Marks	No awardable content	Additional guidance
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.	Basic comments on either lipids or proteins – reference to data in the table or their roles in cell surface membranes. Or lipids more important to Schwann cells and proteins to motor neurones Functions of motor neurones or Schwann cells described.
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.	Functions of both types of cell discussed related to cell membrane composition. Importance of lipids and proteins discussed. Channel and carrier proteins. Linking lipids to insulation of Schwann cells Proteins in terms of ion movement in motor neurone. Functions of motor neurones and Schwann cells described.
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Both types of cell discussed in detail linking function to structure of cell membrane Discussion of phospholipids in membrane structure / importance of lipids in allowing saltatory conduction /importance proteins in allowing action potentials to be generated.

Question Number	Answer	Mark
9(a)(i)	The only correct answer is C 9 A is incorrect as 9 individuals genotypes in this family tree can be identified B is incorrect as 9 individuals genotypes in this family tree can be identified D is incorrect as 9 individuals genotypes in this family tree can be identified	**[1]**

Question Number	Answer	Additional Guidance	Mark
9(a)(ii)	An explanation that makes reference to three of the following: • this (mutation) leads to a different {primary structure (of protein) / amino acid sequence} (1) • for the protein opsin (1) • (so) a {different / misfolded} tertiary structure of protein / altered shape of the protein (1) • (resulting in) more light of 280nm being absorbed (than 500nm) (1)	ALLOW different R group interactions ALLOW therefore less retinal binding to the protein	**[3]**

Question Number	Answer	Additional Guidance	Mark
9(b)	A description that makes reference to four of the following: • (in the dark) sodium ions moving {in through sodium ion channels / into the outer segment} (1) • sodium ions {removed / pumped out} at inner segment (1) • so rod cell depolarises (1) • causing { neurotransmitter / glutamate } to be released (1) • inhibits depolarisation in (adjacent) bipolar neurone (1)	CONVERSE for depolarisation of bipolar neurone (in the light): CONVERSE- sodium ions do not enter / are inhibited from entering the rod cell CONVERSE- rod cell hyperpolarises CONVERSE- inhibition of release of {neurotransmitter / glutamate } CONVERSE- bipolar neurone depolarised.	**[4]**

Question Number	Answer	Additional Guidance	Mark
9(c)(i)	A description that makes reference to two of the following: • increased red light (due to a long day / short night) / limited exposure to far-red light (1) • phytochrome red converted to phytochrome far-red in the day / little conversion of far red form to red form during the (short) night (1) • {accumulation / high concentration} of phytochrome far red stimulates flowering (1)	ALLOW non active phytochrome for Pr and active phytochrome for Pfr ALLOW accumulation of phytochrome far red due to long days / short nights not long enough for Pfr to by converted back to Pr	**[2]**

Question Number	Answer	Additional Guidance	Mark
9(c)(ii)	An answer that makes reference to the following: • grow in conditions with different periods of time in light (per day) / range of hours in light (1) • control a relevant abiotic factor (1) • record whether plants flower or not (1)	ALLOW provided with more than 12 hours of light ALLOW grow at different times of the year} e.g. temperature, light intensity, water, soil factors	**[3]**

Question Number	Answer	Additional Guidance	Mark
10(a)(i)	• calculation of percentage (1)	(2.9 ÷ 7.6) x 100 = 38.16 / 38.2 / 38 (%)	**[1]**

Question Number	Answer	Additional Guidance	Mark
10(a)(ii)	• sugar mass per item (1) • correct number of biscuits (1)	<u>Example of calculation</u> 20.3 ÷ 4 = {5.075 / 5.08 / 5.1} ALLOW: % of recommended daily intake per item 23 ÷ 4 = {5.75 / 5.8} 18 (from 90 ÷ {5.08 or 5.1}) OR 18 (from 100÷ {5.75 or 5.8}) Correct answer with no working gains full marks	**[2]**

Question Number	Answer	Additional Guidance	Mark
10(a)(iii)	• calculate the RI using the biscuit data (1) • answer in standard form (1)	Example of calculation 700 x (100 ÷ 8) = 8 750 KJ or 8 750 000 (J) 8.75×10^6 (J) Correct answer with no working gains full marks	**[2]**

Question Number	Answer	Additional Guidance	Mark
10(b)(i)	A description that makes reference to two of the following: • increasing age increases incidence of CHD (1) • increasing BMI increases incidence of CHD (1) • greatest increase is due to increasing age (1)		**[2]**

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. 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. Indicative content 1. **Comment on design of study** • Comment on design of study Large cohort e.g only for the age range 55-74 /using a form could lead to over or under estimates /unreported incidents of CHD 2. **Comment on data** • Age-related data only for 5 year incidence whereas rest is for 20 years • Graphs give no information about the age of the women in the study • Reliability comment due to cohort size/longevity of study • Likelihood of CHD increases with increasing BMI (for all factors) and with age • Likelihood of CHD increases if smoke, do not drink alcohol, or/and are inactive (for all BMI levels) 3. **Discussion of relative likelihood of CHD occurring** • From table: increasing age appears to increase likelihood more than increasing BMI • From graphs: relative likelihood is greatest if a smoker (for all BMI's) and least for inactivity / data could be used (e.g. there is a 27% likelihood that a woman will have CHD at some point between the ages of 55-74 if she is a smoker with a BMI of 37.7 compared to a non-smoking, but inactive, woman of the same BMI)	**[6]**

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. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	Basic conclusion made from data concerning the effects of at least one lifestyle factor (smoking, inactivity, alcohol) on CHD incidence. A conclusion made: e.g. smoking / physical inactivity/ not drinking alcohol increases risk of CHD.
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.	At least 2 lifestyle factors discussed plus either BMI or age considered. Data from table or graphs discussed. Conclusion – e.g. greatest increase in risk comes from smoking, little increase in risk for being inactive compared to being active, risk increases with rise in BMI for all lifestyle factors.
Leve3	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.	All lifestyle factors, BMI and age to be considered. Data from table and graphs discussed Conclusion - e.g risk for smokers at lowest BMI doubles, whereas greatest percentage increase in risk is for smokers with the greatest BMI .

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