Pearson
Edexcel

Mark Scheme (Results)

Summer 2019

Pearson Edexcel Advanced Level in Biology (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.
- In questions marked with an **asterisk** (*), marks will be awarded for the ability to structure answers logically showing how the points are related or follow on from each other where appropriate.

Question Number	Answer	Mark
1(a)(i)	***The only correct answer is B*** 3 and 4 only ***A*** *is incorrect because 1 and 2 do not transport charged molecules or ions across membranes* ***C*** *is incorrect because 1 and 2 do not transport charged molecules or ions across membranes and 4 does transport* ***D*** *is incorrect because 1 and 2 do not transport charged molecules or ions across membranes*	**(1)**

Question Number	Answer	Mark
1(a)(ii)	***The only correct answer is D*** 1, 2, 3 and 4 ***A*** *is incorrect because 3 and 4 also have both these regions* ***B*** *is incorrect because 1 and 2 also have both these regions* ***C*** *is incorrect because 4 also has both these regions*	**(1)**

Question Number	Answer	Mark
1(a)(iii)	D - x 5 000 000 ***The only correct answer is D*** *– (2.5 ÷ 5) x 10^7* *A is incorrect* *B is incorrect* *C is incorrect*	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)	An explanation that makes reference to the following: • hydrophilic region (of phospholipid) orientated towards water (1) • (and) hydrophobic regions away from the water (1) • (but need the two layers as) { water-based / aqueous } solution either side of the cell membrane (1)	ALLOW phosphate head / polar region ALLOW hydrocarbon chain / fatty acid tails e.g. separating tissue fluid from cytoplasm	**(3)**

Question Number	Answer	Additional Guidance	Mark
2(a)(i)	<table><tr><th>Type of scan</th><th>Can be used to identify the tumour</th></tr><tr><td>CT</td><td>✓</td></tr><tr><td>MRI</td><td>✓</td></tr></table>	DO NOT ACCEPT HYBRID tick/cross	**(2)**

Question Number	Answer	Mark
2(a)(ii)	**The only correct answer is A** - blood flow ***B*** *is incorrect because fMRI does not measure brain activity by detecting bone density* ***C*** *is incorrect because fMRI does not measure brain activity by detecting dopamine release* ***D*** *is incorrect because fMRI does not measure brain activity by detecting lactic acid production*	**(1)**

Question Number	Answer	Mark
2(a)(iii)	***The only correct answer is A*** - CT ***B*** *is incorrect because fMRI does not use X-rays* ***C*** *is incorrect because MRI does not use X-rays* ***D*** *is incorrect because PET does not use X-rays*	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(b)	A description that makes reference to two of the following: • (PET makes use of) radioactive { tracers / markers / glucose } (1) • (PET scan detects) { emission of positrons / production of gamma rays } (1) • provides 3D image (1)	ALLOW radionuclides	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(a)	• correct use of Hardy-Weinberg equation (1) • correct calculation of allele frequencies (1) • correct probability of heterozygote frequency calculated (1)	<u>Example of calculation</u> $p^2+2pq+q^2= 1$ q = 0.020 and p = 0.980 2pq = 2 x (0.98 x 0.02) 3.92% / 3.9% / 0.0392 / 0.039 ALLOW $\frac{49}{1250}$ as a fraction for probability Correct answer with no working gains full marks ALLOW 2 marks for correct allele frequencies alone	**(3)**

Question Number	Answer	Mark
3(b)(i)	The only correct answer is B - 2.5 x Q *The only correct answer is B because 50% of the base pairs are A-T with 2 hydrogen bonds and 50% C-G with 3 hydrogen bonds making a mean of 2.5 x Q* *A is incorrect because 2.0 x Q is only correct if all base pairs were A-T* *C is incorrect because it assumes that each base in a pair has 4 hydrogen bonds and all the base pairs are A-T* *D is incorrect because it assumes that each base in the A-T base pair has 4 hydrogen bonds and each base in the G-C has 6 hydrogen bonds*	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(b)(ii)	An explanation that makes reference to two of the following: • (different mutations) will have different effects on the protein produced (1) • chloride ion transport affected by the extent of changes to the (CFTR) protein (1) • varying the { stickiness / thickness } of the mucus (1)	ALLOW absence of protein / different { folding / tertiary structure / shape } of the protein ALLOW faulty CFTR protein has less impact on chloride ion transport than a missing CFTR protein	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(a)(i)	An explanation that makes reference to two of the following: • chemoreceptors detect a change in { carbon dioxide / pH } (1) • the cardiovascular control centre { receives impulses from chemoreceptors / sends impulses to the heart } (1) • (therefore impulses are transmitted) along the parasympathetic { nerve / nervous system / nerve pathway } to the SAN (reducing heart rate) (1)	ALLOW cardiac control centre ALLOW cardiovascular control centre sends impulses to the SAN ALLOW vagus nerve	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(a)(ii)	A description that makes reference to the following: • thermoreceptors detect a decrease in temperature (1) • { hypothalamus / thermoregulatory centre } sends fewer impulses to sweat glands (1)		**(2)**

Question Number	Answer	Additional Guidance	Mark
4(b)	An explanation that makes reference to three of the following: • (increased exercise results in) wear (and tear) of { joints / cartilage / tendons / ligaments } (1) • (therefore leading to) joint damage (1) • suppression of immune system (1) • (therefore leading to) increased risk of infection (1)	 e.g. arthritis or a named injury e.g. reduced { T cell numbers / antibody production } e.g. appropriate infection such as upper respiratory tract infections, cold, influenza	**(3)**

Question Number	Answer	Mark
5(a)	***The only correct answer is A*** **-** *actin* ***B*** *is incorrect because the myosin binding site is not found on sarcoplasmic reticulum* ***C*** *is incorrect because the myosin binding site is not found on tropomyosin* ***D*** *is incorrect because the myosin binding site is not found on troponin*	**(1)**

Question Number	Answer	Additional Guidance	Mark
5(b)	An answer that makes reference to three of the following: Differences: • only actin has a tertiary structure (1) • collagen has three chains whereas an actin (filament) has one chain (1) Similarities: • both are made up of (a sequence of) amino acids joined together by peptide bonds (1) • both have a secondary structure / both have { more than one polypeptide chain / a quaternary structure } (1)		**(3)**

Question Number	Answer	Additional Guidance	Mark
5(c)(i)	A description that makes reference to the following: • { P / troponin } changes shape (1) • causing { Q / tropomyosin } to move away from the myosin-binding sites (on actin) (1)	 ALLOW P binds with calcium ions ALLOW Q is displaced away from myosin binding sites	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(c)(ii)	An explanation that makes reference to three of the following: • (primary structure) determines interaction between {amino acids / R groups} (1) • (primary structure) determines { folding / tertiary structure } (1) • (therefore) affecting the shape of the active site (1) • (active site is) complementary to ATP (1)	 e.g. bonds formed between R groups ALLOW 3D shape ALLOW ATP fits active site	**(3)**

Question Number	Answer	Mark
6(a)(i)	***The only correct answer is C*** - there is no change in the percentage of cells carrying out mitosis from the tip to the start of zone 2. ***A*** *is incorrect as it is the alternate and not the null hypothesis* ***B*** *is incorrect as the null hypothesis must refer to mitosis and not interphase* ***D*** *is incorrect as the null hypothesis must refer to mitosis and not interphase*	**(1)**

Question Number	Answer	Additional Guidance	Mark
6(a)(ii)	An answer that makes reference to five of the following: • samples from different regions of zone 1 / samples from zone 1 and (start of) zone 2 (1) • details of root tip squash procedure (1) • use of an appropriate named stain (1) • detail of how to assess percentage of cells undergoing mitosis (1) • use of a named appropriate statistical test (1) • comparison of calculated value to critical value (to accept or reject the student's hypothesis) (1)	e.g. correct use of hydrochloric acid, maceration procedure, squashing to produce single layer of cells e.g. toluidine blue, (ethanoic) orcein e.g. number of cells with visible chromosomes compared to the total or use of mitotic index e.g. Spearman's rank correlation, or (Student's) T test (to compare two different regions)	**(5)**

Question Number	Answer	Additional Guidance	Mark
6(b)(i)	• amylopectin contains alpha glucose and cellulose contains beta glucose (1)	ALLOW { α / a } glucose and { β / b } glucose OR H and OH have been reversed on carbon 1	**(1)**

Question Number	Answer	Additional Guidance	Mark
6(b)(ii)	• hydrogen / H (bond)		**(1)**

Question Number	Answer	Additional Guidance	Mark
6(c)(i)	An explanation that makes reference to three of the following: • presence of different stimuli (1) • (therefore resulting in) different genes being { activated / deactivated / transcribed / expressed } (1) • so different proteins are made (1) • proteins produced determine { structure / function } of cells (1)	 e.g. transcription factors, chemical stimulus ALLOW different genes are switched {on / off} ALLOW ‘tissues’ for ‘cells’	**(3)**

Question Number	Answer	Additional Guidance	Mark
6(c)(ii)	An explanation that makes reference to three of the following: • xylem identified as { hollow / thick-walled / lacking cytoplasm } / stain used to identify { xylem tissue / lignin } (1) • sizes of cells measured using { eye piece graticule / stage micrometer } (1) • {length / width} of cells from both areas measured / several measurements made and then the means compared (1) • correct calculation by dividing image size by magnification (1)	e.g. stained with toluidine blue, safranin or phloroglucinol	**(3)**

Question Number	Answer	Mark
7(a)(i)	***The only correct answer is D because there is RNA in the cytoplasm, nucleus and mitochondria*** 1, 2 and 3 *A is incorrect because there is also RNA in the nucleus and mitochondria* *B is incorrect because there is also RNA in the nucleus* *C is incorrect because there is also RNA in the cytoplasm (as tRNA, mRNA or in ribosomes)*	**(1)**

Question Number	Answer	Additional Guidance	Mark
7(a)(ii)	An answer that makes reference to two of the following: • (lactate is) { oxidized to form / converted to } pyruvate (1) • (pyruvate is) converted to { glucose / glycogen } (1) • (pyruvate / glucose) used in respiration (1)	ALLOW glucose produced from the lactate ALLOW correct named stage e.g. glycolysis for glucose or link reaction for pyruvate	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(a)(iii)	An answer that makes reference to the following: • dipeptide correctly drawn with peptide bond (1) • water molecule released (1)		**(2)**

Question Number	Answer	Additional Guidance	Mark
7(b)	An explanation that makes reference to the following: • made up of { many / different } tissues (1) • carrying out several functions (1)	ALLOW named functions	**(2)**

Question Number	Answer	Mark
7(c)(i)	***The only correct answer C*** glycolysis, the Krebs cycle and the electron transport chain only *A is incorrect because ATP is also made in the Krebs cycle* *B is incorrect because ATP is also made in the electron transport chain* *D is incorrect because ATP is not made in the link reaction*	**(1)**

Question Number	Answer	Additional Guidance	Mark
7(c)(ii)	An explanation that makes reference to two of the following: • (because the breakdown of ATP) {donates phosphate to / phosphorylates} the glucose (1) • (ATP) supplies energy to break down the glucose (1) • to produce (phosphorylated) 3-carbon compounds (1)	ALLOW 'hexose' for 'glucose'. ALLOW production of fructose diphosphate ALLOW to make the glucose more reactive, activate the glucose e.g. for 3-carbon compounds: GALP / glyceraldehyde-3-phosphate / glycerate-3-phosphate / GP/ PGAL / G3P / GA3P / GADP / GAP / TP / triose phosphate	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(c)(iii)	An explanation that makes reference to three of the following: • receive hydrogen from reduced { NAD / FAD } / to allow reduced { NAD / FAD } to be oxidised (1) • break hydrogen into { protons / H^+ / hydrogen ions } and electrons (1) • electrons transferred by a series of redox reactions (1) • energy released is used to pump { hydrogen ions / protons / H^+ } into intermembranal space (1)	ALLOW NAD red / NADH + H^+ for reduced NAD and NAD or NAD^+ for oxidised NAD ALLOW e^- for electrons ALLOW a series of reduction and oxidation reactions ALLOW 'actively transported / moved into / moved up the concentration gradient' for	**(3)**

		‘pump’	

Question Number	Answer	Additional Guidance	Mark
8(a)	An answer that makes reference to three of the following: • development of prostate cancer increases as age increases (1) • under the age of 50, increasing age has no effect on development of prostate cancer (in all three countries) (1) • (increasing age has) less effect on the development of prostate cancer in Denmark than in Finland and Sweden (1) • over the age of 90 there is { little / no } change in the development of prostate cancer (1)	ALLOW positive correlation if appropriately qualified ALLOW lowest in Denmark and highest in Sweden ALLOW plateaus / levels off after the age of 90	**(3)**

Question Number	Answer	Additional Guidance	Mark
8(b)	• calculate death rate per 100 000 (1) • calculate proportion of 2.86 million (1)	<u>Example of calculation</u> 12.0 ÷ 100 000 = 0.00012 = 343 men Correct answer with no working gains full marks 343.2 scores one mark only	**(2)**

Question Number	Answer	Additional Guidance	Mark
8(c)(i)	An explanation that makes reference to the following: • (identical twins) have the same { genome / alleles / genotypes } (1) • (phenotypic) differences in identical twins will be due to environmental factors (1)	ALLOW genetically identical IGNORE same genes or DNA ALLOW to determine if environmental factors are affecting the development of prostate cancer	**(2)**

Question Number	Answer
8(c)(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 Investigation 1 • effects of age on probability of getting prostate cancer • effects due to country of origin – e.g. gene pool differences, or environmental differences Investigation 2 • effects of one lifestyle / one dietary factor on prostate cancer death rate • high sugar intake may lead to obesity, linked to higher risk of cancer Investigation 3 • genetic effects on risk of getting prostate cancer • probability is higher in identical twins that non-identical twins • suggests {genetic / inherited / familial} factors • example given e.g. both have a mutation in the DNA • as probability is at {0.4 / not 1.00} / {low / lower} correlation for non-identical twins suggests {not just due to inheritance / environmental factors} Overall evaluation • idea that it is multifactorial, interaction between genotype and environment • validity of investigations depends on sample size etc

Level	Mark	Descriptor	Additional Guidance
0	0	No awardable content.	
1	1 - 2	Limited scientific judgement made with a focus on mainly just one investigation. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	e.g. relationship between age and development of prostate cancer Basic conclusion from the data described.
2	3 - 4	A scientific judgement is made through the application of relevant evidence from the investigations. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	Discussion of evidence from at least two investigations. Conclusion drawn using evidence from studies discussed e.g. relationship between both age and sugar intake on prostate cancer. e.g. environmental effect as there is a greater incidence in some countries than others
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 for all the investigations A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	Evaluation of all three investigations. Links made between genotype and environment / lifestyle and phenotype. e.g. twin studies, sugar intake and obesity Link made between age and time of exposure to environmental factors. Reference to mutations and multifactorial nature of disease.

Question Number	Answer	Additional Guidance	Mark
9(a)	An answer that makes reference to the following: • BMI calculation for 2017 (1) • interpretation of data for BMI (1)	26.51 / 26.5 ALLOW if written in the table (just) in overweight category	**(2)**

Question Number	Answer	Additional Guidance	Mark
9(b)(i)	A description that makes reference to two of the following: • being shown a cheeseburger increases saliva production (1) • repeated occasions results in less saliva production (1) • after six or more occasions there is less saliva produced than before being shown a cheeseburger (1)	ALLOW negative correlation appropriately qualified	**(2)**

Question Number	Answer	Additional Guidance	Mark
9(b)(ii)	• habituation		**(1)**

Question Number	Answer	Additional Guidance	Mark
9(b)(iii)	An explanation that makes reference to the following: • reduced permeability of presynaptic membrane to calcium ions / fewer calcium ions enter the pre-synaptic neurone (1) • (so fewer) vesicles { move towards / fuse with } the presynaptic membrane (1) • (therefore) less neurotransmitter binds to receptors on the post-synaptic membrane (1) • action potential may not occur in the post-synaptic neurone / membrane may not be depolarised (1)	ALLOW Ca^{2+} for calcium ions ALLOW calcium ion channels become less responsive ALLOW less exocytosis occurs at the presynaptic membrane ALLOW sodium ion channels not opening	**(4)**

Question Number	Answer	Additional Guidance	Mark
9(c)	A description that makes reference to three of the following: • sodium ions are pumped out of the { rod cell / inner segment } (1) • (in the light / when stimulated) sodium ions do not move back into rod cell (1) • (in the dark / when not stimulated) sodium ions can move back into the { rod cell / outer segment } (1) • (in the light / when sodium ions do not move back in) the rod cell is hyperpolarised / (in the dark / when sodium ions can move back in) the rod cell is depolarised (1)		**(3)**

Question Number	Answer	Additional Guidance	Mark
10(a)(i)	An explanation that makes reference to following: • the use of nandrolone reduces the (mean maximum percentage) recoil of the { aorta / artery } (1) and two from: • increased risk of damage to the endothelium of arteries (1) • inflammatory response / white blood cells accumulate (1) • build-up of { cholesterol / calcium salts / fibrous tissue } leads to formation of { atheroma / plaque } (1)		**(3)**

Question Number	Answer	Additional Guidance	Mark
10(a)(ii)	An answer that makes reference to three of the following: • nandrolone reduces the production of (both) proteins when exercise is allowed (1) • these proteins are involved in { ATP production / oxidative phosphorylation } (1) • nandrolone has no effect on ATP production if there is no exercise (1) • nandrolone reduces ATP production if exercise takes place (1)	ALLOW nandrolone has no effect on the production of the proteins in absence of exercise	**(3)**

Question Number	Answer	Additional Guidance	Mark
10(a)(iii)	An explanation that makes reference to the following: • without exercise the values for mRNA for Tfam overlap for groups with and without nandrolone (1) • as when exercise is carried out and nandrolone taken, the values for mRNA for Tfam overlap with no exercise and no nandrolone (1)	ALLOW overlap between groups P and Q ALLOW overlap between groups P and S	**(2)**

Question Number	Answer
***10(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. 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 Investigation 1 • comparison of data for no exercise/exercise without nandrolone: maximum recoil of {aorta / artery} is {higher / 23% greater} • discuss outcome of this difference as an advantage: so (oxygen-rich) blood can flow more rapidly (at the correct pressure) {from the heart / to the muscles} • less likely to get atherosclerosis / CVD / strokes Investigation 2 • comparison of data for P and R for both protein complexes: more present due to exercise • discuss advantageous outcome: so more {oxidative phosphorylation / ATP synthesis / chemiosmosis} so more ATP for muscle contraction / breaking of the bond between actin and myosin (in aorta wall) Investigation 3 • compare P and Q for mRNA coding for Tfam: more Tfam per cell so more mitochondria produced so more {respiration / ATP formed }

Level	Marks	Descriptor	Additional Guidance
0	0	No awardable content	
1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. 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.	Results of one investigation described e.g. comparing P and R groups General comments about production of ATP or respiration
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.	Results of at least two investigations considered Discussion of results of one of these investigations in terms of consequences
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.	Results of all three investigations discussed Discussion of the consequences of the data from the investigations in terms of respiration / ATP synthesis Links the consequences to muscle contraction

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