Pearson Edexcel

Mark Scheme (Results)

November 2021

Pearson Edexcel GCE
In Biology A Salters Nuffiled (9BN0)
Paper 3: General and Practical Applications in Biology

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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 explanation that makes reference to the following: • magnesium is needed to make chlorophyll (1) • because chlorophyll is required for photosynthesis (1) • because shoots need (chlorophyll) to carry out photosynthesis to grow (1)	ALLOW required to replace organic molecules stored in seed that have been used up	Choose an item. (2)

Question number	Answer	Additional guidance	Mark
1(b)	An answer that makes reference to the following: • (IAA) produced in the tip of the shoot (1) • (IAA) accumulates on the dark side of the shoot (1) • (IAA) stimulates cell elongation (1) • causing the shoot to grow towards the light source (1)	ALLOW a diffusion gradient is established / IAA diffuses to the opposite side of the shoot ALLOW low concentrations of IAA inhibit cell elongation on the light side ALLOW plant ALLOW bend	Choose an item. (4)

Question number	Answer	Additional guidance	Mark
2(a)(i)	An explanation that makes reference to two of the following: • (pre-)mRNA splicing / post-transcriptional modification (1) • different exons removed (1) • (therefore) producing different {sequences of amino acids / mRNA sequences} (1)	 ALLOW the exons can be joined in different sequences ALLOW (the acetylcholinesterase) gene is made up from several exons and introns IGNORE producing different primary structure	Choose an item. (2)

Question number	Answer	Additional guidance	Mark
2(a)(ii)	An explanation that makes reference to three of the following: • {hormones / signal molecules / chemical signals} bind to receptors found only in some {tissues / cells} (1) • regulating a {transcription factor / repressor molecules} (1) • {transcription factor / repressor molecule} binds to the promotor region of the (acetylcholinesterase) gene (1) • therefore switching {on / off} transcription (1)	 ALLOW epigenetic changes occur in some tissues ALLOW only act on some {tissues / cells} ALLOW {allowing / preventing} binding of RNA polymerase	Choose an item. (3)

Question number	Answer	Additional guidance	Mark
2(b)(i)	An explanation that makes reference to three of the following: • acetylcholinesterase breaks down acetylcholine (1) • inhibitor prevents break down of acetylcholine (1) • so more (acetylcholine) is available to bind to post-synaptic {membrane / receptors} (1) • therefore compensating for the {reduced production of acetylcholine / loss of acetylcholine producing neurones} (1)	ALLOW blocks acetylcholinesterase ALLOW inhibiting acetylcholinesterase maintains higher concentrations of acetylcholine (in synapse) (1)	Choose an item. (3)

Question number	Answer	Additional guidance	Mark
2(b)(ii)	An answer that makes reference to the following: • concentration between 25 and 50 μmol dm^{-3} (1) • concentration having greatest inhibitory effect (1) • but having no effect on cell viability (1)	ALLOW any value between 25 and 50 ALLOW suitable description of effect e.g. reduces enzyme activity by {more than 50% / 60% / 2.4 a.u. ALLOW viability remains at 100%	Choose an item. (3)

Question number	Answer	Additional guidance	Mark
3(a)(i)	• correct values taken from the graph (1) • correct percentage decrease (1)	200 and 90 ((200 – 90) ÷ 200) x 100 = 55%	Choose an item. (2)

Question number	Answer	Additional guidance	Mark
3(a)(ii)	An answer that makes reference to the following: • the larger the dose the greater the decrease in heart rate (1) • reducing the heart rate reduces the cardiac output (1) • therefore, reducing the supply of blood to the muscle (1) • increasing the dose has a greater effect on males than females (1)	ALLOW at very low dose there is little change in heart rate IGNORE oxygen / nutrients / body ALLOW comparison of decrease in males and females e.g. 56% decrease in males and 53% decrease in females	Choose an item. (4)

Question number	Answer	Additional guidance	Mark
3(b)	An explanation that makes reference to the following: • beta-blockers reduce blood pressure (1) • therefore reducing the risk of {atherosclerosis / heart disease / CVD} (1)	 ALLOW prescribed to people with {high blood pressure / irregular heart beat / anxiety} ALLOW because high blood pressure can {cause atherosclerosis / damage the endothelium} ALLOW heart attack	 (2)

Question number	Answer	Additional guidance	Mark
3(c)	An answer that makes reference to four of the following: • adrenaline carried in the blood (1) • (acts on the) sinoatrial node (1) • increasing the frequency of impulses {produced by the SAN / that spread across the heart} (1) • increasing the rate at which the heart contracts	 ALLOW increases the frequency of {action potentials / depolarisations} in the SAN ALLOW atria / ventricles ALLOW increasing heart rate	 (4)

Question number	Answer	Additional guidance	Mark
4(a)	An answer that makes reference to three of the following: • as temperature increase less lipoprotein lipase mRNA is produced (1) • resulting in reduced lipoprotein lipase activity (1) • (as temperature increases) triglyceride concentrations increase and fatty acid concentrations decrease (1) • (because) triglycerides are not being broken down into fatty acids (1)	ALLOW converse arguments	(3)

Question number	Answer	Additional guidance	Mark
4(b)(i)	An answer that makes reference to the following: • the ratio of the rate of an enzyme reaction taking place at temperatures differing by 10 (°C or K).	ALLOW description ALLOW equation	Choose an item. (1)

Question number	Answer	Additional guidance	Mark
4(b)(ii)	An answer that makes reference to five of the following: • description of how two suitable temperatures will be controlled (1) • provide excess triglyceride (1) • control concentration of lipoprotein lipase (1) • measure concentration of {triglyceride / fatty acids } at stated time intervals (1) • find initial rates (1) • description of how Q10 can be determined (1)	e.g use two water baths with a 10 degree temperature difference / use water baths at 5 and 15 °C ALLOW more than two if they include a 10 °C difference ALLOW use lipoprotein lipase at a limiting concentration ALLOW enzyme in place of lipoprotein lipase ALLOW determine pH at set time intervals ALLOW colorimeter to measure cloudiness of milk / lipid solution ALLOW draw tangent to curve to find rate e.g. rate at T+10 ÷ rate at T	Choose an item. (5)

Question number	Answer	Additional guidance	Mark
5(a)(i)	An answer that makes reference to two of the following: • food availability (1) • interspecific competition (1) • predation (1) • disease (1)	IGNORE time of year / availability of resources ALLOW grazing / migration IGNORE competition unqualified or competition between birds	Choose an item. (2)

Question number	Answer	Additional guidance	Mark
5(a)(ii)	• correct expected value (1) • correct values for observed minus expected squared (1) • correct answer (1)	26 ÷ 2 = 13 $(16 – 13)^2 = 9$ and $(10 – 13)^2 = 9$ 1.38 ECF for incorrect expected value ALLOW one mark for 2.25 / 3.6	Choose an item. (3)

Question number	Answer	Additional guidance	Mark
5(a)(iii)	An answer that makes reference to the following: • cutting down trees decreases the number of bird species in both forests (1) • the decrease is significant (at p=0.05) in forest A (1) • the decrease was not significant (at p=0.05) in forest B (1)	 ALLOW decreases species richness ALLOW less than {5% / 0.05 probability} reduction in forest A due to chance ALLOW more than than {5% / 0.05 probability} reduction in forest B due to chance ALLOW 1 mark chi squared value was {greater than the critical value for forest A / less than critical value for forest B} with no reference to p value or significance	Choose an item. (2)

Question number	Answer	Additional guidance	Mark
5(b)(i)	A description that makes reference to two of the following: • replacing trees that have been cut down (1) • {remove / cut down} older trees (1) • replace with {seedlings / young / rapidly growing} trees (1)	 ALLOW coppicing IGNORE allow trees to fully grow	Choose an item. (2)

Question number	Answer	Additional guidance	Mark
5(b)(ii)	An explanation that makes reference to four the following: • less photosynthesis (1) • less carbon dioxide will be fixed / more CO_2 remains in the atmosphere (1) • because CO_2 is a greenhouse gas (1) • more (heat) energy trapped in the atmosphere (1) • more energy in the atmosphere increases (atmospheric) temperature (1)	Less can be implied from MP2 ALLOW more of the products of photosynthesis accumulate as new biomass than are released due to respiration IGNORE less carbon dioxide will be used IGNORE unqualified reference to greenhouse effect ALLOW increasing surface temperature of earth	Choose an item. (4)

Question number	Answer	Additional guidance	Mark
6(a)	A description that makes reference to four of the following: • extract mRNA for one form of the (tau protein) (1) • copy mRNA into DNA (1) • use restriction enzymes {to create sticky ends) / cut the DNA and a vector} (1) • {ligate / insert / integrate} the TAU DNA into the vector (DNA) (1) • introduce vector into {fertilised egg / embryonic stem / zygote / cells / neural cell stem cells} (1)	IGNORE cut / remove TAU gene from a human ALLOW synthesis DNA sequence for one form e.g. use code specific for one of the tau proteins ALLOW insert gene into fertilised egg cell / embryonic stem cell ALLOW egg cell fertilised after inserting gene	Choose an item. (4)

Question number	Answer	Additional guidance	Mark
6(b)	An answer that makes reference to the following: • as they age Drosophila climb {less high / more slowly} (1) • (the expression of) 0N3R or 0N4R further {reduce the height climbed / slow down} the Drosophila (1) • 033R has a greater effect than 0N4R (1)	ALLOW tau proteins / both tau proteins reduced height climbed ALLOW fly in place of climb ALLOW 033R affected the flies the most	Choose an item. (3)

Question number	Answer	Additional guidance	Mark
6(c)	An answer that makes reference to the following: • frequency is {the same / similar} for all flies at 10 days (1) • for older flies with {0N4R the error bars overlap with the control (1) • therefore 0N4R has {no / little} effect on the frequency of impulses (1) • for older flies 0N3R the error bars do not overlap with the control } (1) • therefore 0N3R decreases the frequency of impulses (1)	ALLOW length of time between impulses ALLOW frequency decreases from 220 to 190 impulses per second ALLOW length of time between impulses IGNORE unqualified length of time / increase ALLOW frequency decreased from 227 to 137 impulses per second ALLOW more significant / greatest effect ALLOW length of time between impulses IGNORE unqualified length of time / increase ALLOW effect was greater in older flies if MP2 to 5 not awarded	Choose an item. (4)

Question Number	Indicative content
7	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. • Mitosis for growth and repair • (Zygote to fetus) proliferation and differentiation • Meiosis for genetic variation • Production of gametes • Inheritance of alleles predisposing to genetic disease / some cancer • Mutations result in loss of control of cell division in cancers • Clonal amplification in immune system • Binary fission of bacterial cells • Some antibiotics work by inhibiting bacterial cell division

Level	**Mark**	**Descriptor**	**Additional guidance**
Level 0	Marks	No awardable content	
Level 1	1-3	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.	Use of factual information provided Give credit for use of different resources (bullet points, figure and table)
Level 2	4-6	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.	Linking / explaining information in terms of mitosis or meiosis Give credit for each clearly explained example
Level 3	7-9	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information.	Linking information provided to both meiosis and mitosis

		A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	Give credit for each clearly explained example.

Question number	Answer	Additional guidance	Mark
8(a)	An explanation that makes reference to the following: • mate {males and females / individuals} from different populations (1) • if they do not produce fertile offspring the parents are different species (1)	ALLOW converse argument ALLOW they cannot breed together to produce fertile offspring gets both marks	Choose an item. (2)

Question number	Answer	Additional guidance	Mark
8(b)	An explanation that makes reference to four of the following: • when HIV infects a cell, its RNA is reverse transcribed (1) • the DNA produced is integrated into the DNA of the host cell (1) • CRISPR could be used to {delete / mutate / modify} the viral DNA (1) • therefore, preventing the synthesis of {new virus particles / new virus RNA} (1) • slowing the destruction of {white blood cells / T (helper) cells} (1)	ALLOW change structure / function of viral proteins ALLOW so virus particles cannot bind to / enter cells	Choose an item. (4)

Question number	Answer	Additional guidance	Mark
8(c)	A description that makes reference to the following: • growing same species of plant with and without the (CRISPR) deleted genes (1) • in similar {biotic / abiotic} conditions (1) • record a suitable dependent variable (1)	 ALLOW in controlled conditions e.g. plant damage by pests / number of pests on plants / frequency of pests visiting plants / requirement for pesticide	Choose an item. (3)

Question number	Answer	Additional guidance	Mark
8(d)	An explanation that makes reference to the following: • germline is the population of cells that give rise to gametes (1) • editing the germline results in changes in all gametes produced (1)	 ALLOW contain genetic material that is inherited ALLOW changes the genes in gametes	Choose an item. (2)

Question number	Answer	Additional guidance	Mark
8(e)	An explanation that makes reference to the following: • the RNA guide has a sequence of bases (1) • that are complementary to the (target) DNA sequence (1)		Choose an item. (2)

Question number	Answer	Additional guidance	Mark
8(f)	A description that makes reference to the following: • without a gene drive the expected outcome would be 50% heterozygous and 50% homozygous recessive offspring (1) • with a gene drive the proportion of homozygous recessive offspring would increase (1) • the stronger the gene drive the greater the proportion of homozygous recessive (1)	ALLOW a genetic cross diagram to show this	Choose an item. (3)

Question number	Answer	Additional guidance	Mark
8(g)	An explanation that makes reference to three of the following: • *Aedes aegypti* mosquito occupies its own niche (1) • if this species is eliminated the niche it occupied will become vacant (1) • other species (of mosquito) may evolve to occupy the niche (1) • these species may carry the virus (1)	ALLOW each species ALLOW other organisms / insects ALLOW Aedes aegypti is a vector / is not the disease causing organism	Choose an item. (3)

Question number	Answer	Additional guidance	Mark
8(h)	An answer that makes reference to two of the following: • PERVs (are retroviruses) present in the pig's genome (1) • PERV virus particles {are produced by / bud of from} the pig cells (1) • PERVs bind to membrane receptors (on human cells) (1) • PERVs insert their nucleic acid into the cells (1)	ALLOW pigs inherit the PERVs /retroviruses in their genomic DNA ALLOW membrane coated particles fuse with human cells ALLOW enter cells by endocytosis	Choose an item. (2)

Question number	Answer	Additional guidance	Mark
8(i)	An explanation that makes reference to three of the following: • pig genes are transcribed and translated to produce proteins (1) • the structure of (some of) these proteins will be different from those in humans (1) • these proteins will be recognised as foreign (1) • activating lymphocytes (1)	 ALLOW pig genes code for antigens ALLOW recognised as antigens ALLOW trigger a specific immune response	Choose an item. (3)

Question number	Answer	Additional guidance	Mark
8(j)	An explanation that makes reference to three of the following: • the same bacteria causes human plague and sylvatic plague (1) • antigens in the (human plague) vaccine are processed and presented to lymphocytes (in the black-footed ferret) (1) • therefore stimulating active immunity (to sylvatic plague) (1) • and producing memory cells (to these antigens) (1)	 ALLOW the bacteria causing human plague and sylvatic plague have the same antigens ALLOW enabling a secondary immune response	(3)

Question number	Answer	Additional guidance	Mark
8(k)	An answer that makes reference to the following: • (species) found only in one particular location (1)		Choose an item. (1)

Question number	Answer	Additional guidance	Mark
8(l)	An answer that makes reference to the following: • recessive		Choose an item. (1)

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