

Mark Scheme (Results)

Summer 2023

Pearson Edexcel GCE
In Biology A Salters Nuffield (9BN0)
Paper 03: 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 two of the following: • to pump blood around blood vessels (1) • enabling mass transport (1) • therefore overcoming the limitations of diffusion (1)	 IGNORE to move blood IGNORE to move blood around the body ALLOW a description e.g. 'needed to carry oxygen to where it is used' e.g. 'organism is too large for {substances/gases/glucose} to diffuse directly to organs' / distance for diffusion is too great ALLOW surface area to volume ratio too small for diffusion	(2)

Question number	Answer	Additional guidance	Mark
1(b)(i)	An answer that makes reference to the following: • (heart / cardiac muscle) is myogenic (1)	 IGNORE references to impulses / electrical signals	(1)

Question number	Answer	Additional guidance	Mark
1(b)(ii)	An explanation that makes reference of the following: • the {pacemaker / SAN / sinoatrial node} is in the right atrium (1) • (left atrium) cannot contract without impulses from the SAN (1)	 ALLOW depolarisation is initiated in the right atrium ALLOW no longer attached to the SAN ALLOW left atrium does not receive impulses needed to stimulate {contraction / beating}	(2)

Question number	Answer	Additional guidance	Mark
1(b)(iii)	An explanation that makes reference to two of the following: • (heart / muscle cells) run out of oxygen (1) • (aerobic) respiration stops (1) • (heart / muscle cells) stop making ATP (1)	 ALLOW heart (muscle) does not have a blood supply (from the lungs) ALLOW anaerobic respiration takes place ALLOW resulting in accumulation of lactic acid	(2)

Question number	Answer	Additional guidance	Mark
2(a)	• finding r^3 (1) • correct volume of neutrophil (1) NB Check table and clip below table	Example of calculation 125 / 5 x 5 x 5 / 5^3 / $(^{10}/_{2})^3$ 523 / 524 / 523.8 / 523.6 / 523.3 ALLOW 39 / 39.3 for both marks (from 1/8th volume given for monocyte) Correct answer with no working gains full marks	(2)

Question number	Answer	Additional guidance	Mark
2(b)(i)	An answer that makes reference to the following: • {engulfing / ingesting / endocytosis} of {pathogen / cell debris / bacteria / virus / fungi / microbes}	IGNORE foreign bodies / cell unqualified	(1)

Question number	Answer	Additional guidance	Mark
2(b)(ii)	An explanation that makes reference to the following: • (monocytes / macrophages) {phagocytose / digest / break down} {virus / pathogen} (1) • (monocytes / macrophages) present {virus / antigens} to T cells (1) • (produce) cytokines involved in the immune response (1)	ALLOW both can phagocytose {virus / pathogen} ALLOW converse for neutrophils ALLOW examples of role of cytokines e.g. activate B cells	(3)

Question number	Answer	Additional guidance	Mark
3(a)	• correct length (1) NB watch out for incorrect 6.0	Example of calculation 108 ÷ 1.8 = 60 (mm)	(1)

Question number	Answer	Additional guidance	Mark
3(b)(i)	• correct change calculated (1) • correct percentage decrease (1)	Example of calculation 9.6 - 2 = 7.6 ALLOW 7.4 / 7.5 79 ALLOW 77.9 to 79.2 Correct answer with no working gains full marks	(2)

Question number	Answer	Additional guidance	Mark
3(b)(ii)	An explanation that makes reference to three of the following: • as time increased number of bites decreased (1) • because the stickleback are unable to get to the brine shrimps (1) • therefore they have become **habituated** (1) • to avoid wasting energy (1)	ALLOW up to 6 minutes the number of bites (per minute) decreases IGNORE over time fish stopped biting at the brine shrimp ALLOW because stimulus was not rewarded ALLOW fish realises it cannot {eat / get to} the shrimp IGNORE description of mechanism of habituation IGNORE reference to brine shrimp no longer being a threat	(3)

Question number	Answer	Additional guidance	Mark
3(c)	An answer that makes reference to four of the following: • place a breeding {pair of / male} (sticklebacks) in a tank (1) • allow fish to acclimatise (1) • introduce another male (1) • method of keeping (males) apart (1) • record number of attacks {at the sticklebacks / each minute} (1) • compare results using male with a red throat and without a red throat (1)	ALLOW red throat male for breeding male ALLOW control of sensible appropriate variable e.g. same age of fish / temperature /pH ALLOW use of {pictures / models} of fish e.g. use a glass tube / sheet of glass / adjacent tank ALLOW bites for attacks ALLOW observe duration of {biting / attack} IGNORE observe behaviour ALLOW compare results for breeding male and non-breeding male ALLOW compare results during breeding season and non-breeding season ALLOW compare competing male with a female	(4)

Question number	Answer	Additional guidance	Mark
4(a)	An explanation that makes reference to two of the following: • dipole allows water molecules to {form hydrogen bonds / bond with each other} (1) • {heat / energy} is used to break bonds (between water molecules) (1) • evaporation of water causes {cooling / removal of heat} (1)	 IGNORE strength of bonds ALLOW high latent heat of evaporation / high latent heat of vaporisation ALLOW evaporative cooling ALLOW sweat for water	(2)

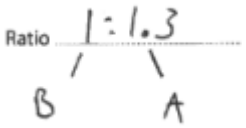
Question number	Answer	Additional guidance	Mark
4(b)	An answer that makes reference to the following: • (rate of) sweating increases with increasing (environmental) temperature (1) • (at any temperature) sweating is greater with exercise (than at rest) (1) • {no / little} difference between exercise and exercising (twice as) vigorously (on rate of sweating) (1) • increase in sweating begins at a lower (environmental) temperature during exercise (1)	ALLOW converse MP1 and MP2 ALLOW positive correlation described ALLOW description e.g. lowest rate of sweating when resting, higher rate of sweating during exercise ALLOW description e.g. {little/no} increase in sweating rate when resting until external temperature is above 34°C but starts to increase at 33^0C during exercise	(4)

Question number	Answer	Additional guidance	Mark
4(c)	A description that makes reference to four of the following: • by {homeostasis / a negative feedback response} (1) • thermoreceptors {in the skin / hypothalamus} detect a rise in temperature (1) • send impulses to the {heat loss centre / thermoregulatory centre / hypothalamus} (1) • {heat loss centre / thermoregulatory centre / hypothalamus} sends impulses to the sweat glands (1) • to increase sweat production (1)	IGNORE description of feedback response ALLOW liver / skeletal muscle IGNORE body ALLOW {heat loss centre / hypothalamus} coordinates motor response to sweat glands ALLOW to release of sweat	(4)

Question number	Answer	Additional guidance	Mark
5(a)(i)	• Schwann cell	ALLOW oligodendrocyte ALLOW phonetic spelling e.g. schwon / swan /shwann	(1)

Question number	Answer	Additional guidance	Mark
5(a)(ii)	A description that makes reference to the following: • provides (electrical) insulation (1) • enables saltatory conduction (1)	ALLOW prevents {diffusion / movement} of ions IGNORE reference to membranes ALLOW description of saltatory conduction ALLOW longer local circuits	(2)

Question number	Answer	Additional guidance	Mark
5(a)(iii)	A description that makes reference to five of the following: • sodium (ion) channels open (1) • (then) sodium ions **diffuse in** (1) • (causing) depolarisation of the membrane (1) • sodium (ion) channels close and potassium (ion) channels open (1) • (then) potassium ions **diffuse out** (1) • (causing) repolarisation of the membrane (1)	ALLOW into neurone / axon DO NOT ALLOW diffuse into membrane ALLOW out of neurone / axon DO NOT ALLOW diffuse out of membrane	(5)

Question number	Answer	Additional guidance	Mark
5(b)(i)	• 1.3 : 1 / 1.30 : 1 / 1 : 0.77 / 1 : 0.768	if answer refers to B : A allow 1 : 1.3 e.g. 	(1)

Question number	Answer	Additional guidance	Mark
5(b)(ii)	An explanation that makes reference to the following: • relevant damage to cardiovascular system (1) • reduced {blood flow / oxygen supply / glucose supply} to (peripheral) nerves (1) • insufficient (aerobic) respiration takes place (so neurones die) (1)	ALLOW reasonable examples e.g. development of atherosclerosis / atheroma / oedema / reduced gas exchange in lungs e.g. nerve cells do not receive enough oxygen for respiration gets MP2 and 3	(3)

Question number	Answer	Additional guidance	Mark
6(a)	An explanation that makes reference to three of the following: • due to {chemical stimulus / transcription factors} (1) • activating specific genes (1) • resulting in synthesis of {proteins / enzymes} (1) • involved in the synthesis of melanin (1)	ALLOW (causing) differential gene expression ALLOW some genes are {activated /switched on} and some are {deactivated / switched off} ALLOW translation of mRNA to produce protein	(3)

Question number	Answer	Additional guidance	Mark
6(b)(i)	• **change** in the **base sequence** in the {**DNA / gene**}		(1)

Question number	Answer	Additional guidance	Mark
6(b)(ii)	An answer that makes reference to the following: • long fin is dominant (trait / allele) (1) • spots is a recessive (trait / allele) (1)	DO NOT ACCEPT answers referring to dominant recessive genes IGNORE reference to stripes and short fin phenotype	(2)

Question number	Answer	Additional guidance	Mark
6(c)(i)	An answer that makes reference to the following: • correct genotypes (1) • correct phenotypes (1)	<table><tr><td>DdNn</td><td>Ddnn</td><td>ddNn</td><td>ddnn</td></tr><tr><td>stripes and long fins</td><td>stripes and short fins</td><td>spots and long fins</td><td>spots and short fins</td></tr></table> ALLOW any order of letters in genotype	(2)

Question number	Answer	Additional guidance	Mark
6(c)(ii)	An answer that makes reference to the following: • correct O-E values (1) • correct $(O-E)^2 \div E$ values (1) • correct value for χ^2	Example of calculation ALLLOW evidence of finding difference e.g. 270-288 =-18 ALLOW evidence of finding $(O-E)^2 \div E$ values e.g. $(270-288)^2 \div 288$ for 2 marks 7.73 ALLOW any correctly rounded value between 7.7 and 7.729167 Correct answer with no working gains full marks	(3)

Question number	Answer	Additional guidance	Mark
6(c)(iii)	An answer that makes reference to two of the following: • the calculated value is less than {the critical value at 3 degrees of freedom / 7.82} (1) • the (observed) results are not (significantly) different from the expected results (1) • the two traits are inherited independently (1)	ALLOW less than the p=0.05 value at 3 degrees of freedom ALLOW consequential error if a different calculated value to 7.73 is quoted IGNORE reference to null hypothesis / Ho	(2)

Question number	Answer	Additional guidance	Mark
7(a)	A description that makes reference to two of the following: • (*M tuberculosis*) survive inside macrophages (1) • (*M tuberculosis*) {survive / remain dormant} in tubercles (1) • (*M tuberculosis*) {inhibit T helper cells / supress the (acquired) immune response} (1)	ALLOW description of how {*M tuberculosis* / bacteria} survive e.g. have thick waxy (coat / cell wall) / (macrophage) lysosomes cannot fuse with the (phagocytic) vacuole ALLOW antigen presentation {is disrupted / does not occur}	(2)

Question number	Answer	Additional guidance	Question number
7(b)(i)	• a **protein** that controls {the activation / transcription} of genes	ALLOW protein that binds with RNA polymerase to start transcription ALLOW protein that forms a transcription initiation complex to start transcription ALLOW binds to {operator / repressor / promoter} region IGNORE factor / molecule / chemical IGNORE reference to DNA methylation / histone acetylation	(1)

Question number	Indicative content
7(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** • Bullet points ○ STAT3 is involved in gene regulation of macrophages and T helper cells ○ The SNP1 and SNP2 {polymorphisms / mutations} are in non-coding part of gene • Table ○ (SNP1) AA and (SNP2) TT genotype are more common in people with TB ○ allow people with AA and TT genotype more likely to {have / be infected with} TB • Graph 1 ○ AA and TT genotypes are more common in people with severe TB than mild TB ○ error bars for TT do not overlap / error bars for AA do overlap • Graph 2 ○ white blood cells from people with AA genotype are less effective at killing mycobacteria ○ no results for SNP2 (polymorphism) ○ no error bars • Comments on the results ○ some results do not have error bars / some error bars overlap ○ effects are relatively small ○ data is incomplete / examples of missing data ○ no information about combination of SNP1 and SNP2 polymorphisms • Conclusions ○ these SNPs may affect synthesis of the transcription factor and not the function of the protein ○ genotype at SNP1 and SNP2 affects effectiveness of immune response to mycobacteria ○ macrophage (and T cell) activity affected ○ genotype at SNP1 and SNP2 affects susceptibility to infection/severity of infection

Level	Mark	Descriptor	Additional Guidance
0	**0**	No awardable content	Nothing credit worthy
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.	• One source of information • Two different sources of information or one source and one interpretation • Three different sources of information
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.	• Two different sources of information + one interpretation • Three different sources of information + one interpretation- some irrelevant / incorrect information • Three different sources of information + one interpretation
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. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	• Three different sources of information + two interpretation • Three different sources of information + three interpretation- some irrelevant / incorrect information • Three different sources of information + three interpretation

Sources of information:		Interpretation:	
• location of SNP sites • genotype prevalence table • genotype / severity graph • bacteria culture graph	(L) (T) (S) (B)	• comment on validity of the results • overall conclusion about AA / TT based on more than one source of information • consider role of STAT3 in immune response / macrophage activity in TB	(V) (C) (R)

Question number	Answer	Additional guidance	Mark
8(a)	• GPP = NPP + R NPP = GPP - R NPP + R = GPP GPP – R = NPP	ALLOW correct rearrangement of equation ALLOW net primary productivity for NPP gross primary productivity for GPP respiration for R	(1)

Question number	Answer	Additional guidance	Mark
8(b)	• reduced NADP	ALLOW NADPH / $NADPH_2$ / $NADPH+H^+$ IGNORE reference to electrons / e-	(1)

Question number	Answer	Additional guidance	Mark
8(c)	An explanation that makes reference to three of the following: • contains {phosphate / P-O-P} bonds (1) • that when hydrolysed {releases / provides supplies} energy (1) • description of how energy is used (1) • ATP {immediate source of energy /releases energy rapidly} (1)	 ALLOW contain high energy bonds ALLOW hydration of released phosphates releases energy ALLOW (hydrolysis) is exothermic IGNORE ATP -> ADP + Pi IGNORE energy is produced e.g. to {form / break} bonds / form {carbohydrates / sugars} / used in light independent reactions / for metabolic reactions e.g. quickly hydrolysed	(3)

Question number	Answer	Additional guidance	Mark
8(d)	A description that makes reference to four of the following: • CO_2 combined with RuBP (1) • by RUBISCO (1) • forming molecules of GP (1) • each GP is converted to GALP using ATP and reduced NADP (1) • GALP used to form {glucose / hexose sugars} (1)	ALLOW with ribulose bisphosphate ALLOW glycerate 3-phosphate ALLOW glyceraldehyde 3-phosphate ALLOW NADPH / $NADPH_2$ for reduced NADP IGNORE other molecules	(4)

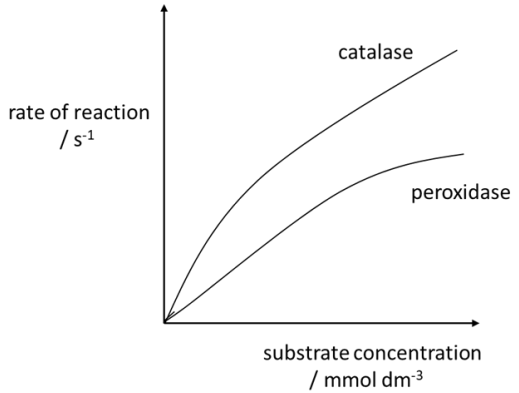
Question number	Answer	Additional guidance	Mark
8(e)	An answer that makes reference to four of the following: • isolate chloroplasts (1) • incubate (chloroplasts) in solution of iron ferricyanide (1) • identification of one abiotic factor to control (1) • place chloroplasts in the light (1) • collect (and test) gas produced / observe decolourisation of DCPIP (1)	ALLOW use Hill reaction / experiment ALLOW add iron ferricyanide e.g. temperature / light intensity / volume or concentration of reagent ALLOW record time for DCPIP to decolourise ALLOW measure volume of oxygen produced	(4)

Question number	Answer	Additional guidance	Mark
8(f)	An explanation that makes reference to four of the following: • large surface area of thylakoid (membrane) (1) • thylakoid (membrane) contain photosynthetic pigments to absorb light (1) • thylakoid (membrane) enables photophosphorylation (1) • stroma contains enzymes for light independent reaction (1) • stroma contains {DNA / ribosomes} to produce {enzymes / proteins} involved in photosynthesis (1)	ALLOW grana / granum with large surface area ALLOW increases for large ALLOW contains {chlorophyll / photosystems} to absorb light ALLOW example e.g. contain electron transport chain molecules / enable generation of a proton gradient / contain ATP synthase ALLOW example of enzyme ALLOW to produce a named protein e.g chlorophyll / electron transfer chain protein	(4)

Question number	Answer	Additional guidance	Mark
8(g)	An explanation that makes reference to three of the following: • by photophosphorylation (1) • (transfer of) electrons releases energy (1) • that is used to {pump / move} protons into the thylakoid (space / lumen) (1) • protons {diffuse / move back down concentration gradient} through ATP synthase (1) • which forms ATP from ADP and inorganic phosphate (1)	IGNORE reference to mitochondria ALLOW H^+ for proton DO NOT ALLOW diffuse DO NOT ALLOW pumped ALLOW which phosphorylates ADP	(3)

Question number	Answer	Additional guidance	Mark
8(h)	An explanation that makes reference to the following: • change in the {3D structure / tertiary structure / bonds formed} (1) • changes shape of (chlorophyll) light absorbing region (1) • changing the quantity of energy needed to {release / excite} an electron (1)	ALLOW change in amino acid sequence / primary structure ALLOW so wavelength of light absorbed {decreases / correct stated change in wavelength} e.g. 870 to 716 / 716 to 680 / 870 to 680 IGNORE unqualified change in wavelength of light absorbed	(3)

Question number	Answer	Additional guidance	Mark
8(i)	An explanation that makes reference to the following: • compare the amino acid sequences (in catalase and the oxygen evolving complex) (1) • compare the base sequences of the {DNA / genes} (for catalase and the oxygen evolving complex) (1) • in organisms from different stages in {evolution / phylogenetic tree} (1) • the further back in {evolution / the phylogenetic tree} the more similar the sequences will be (1)	ALLOW primary structure ALLOW converse ALLOW similar sequences in catalase and oxygen-evolving complex support the suggestion	(4)

Question number	Answer	Additional guidance	Mark
8(j)	• two lines one for catalase and one for peroxidase with slope for catalase steeper than that for peroxidase (1) • axes correct and labelled (1) • suitable axis units (1)	e.g. x- axis {substrate / peroxide / H_2O_2} concentration e.g. y-axis rate of oxygen production / rate of reaction e.g x-axis {g cm^{-3} / mol dm^{-3}/ vol / %} e.g. y-axis {g s^{-1} / mol s^{-1} / mol dm^{-3} s^{-1} / s^{-1}} ALLOW any units of mass, moles and time IGNORE a.u. e.g. gains all three marks  	(3)