



Mark Scheme (Results)

Summer 2019

Pearson Edexcel GCE
In Biology Spec B (9BI0) Paper 01
Advanced Biochemistry, Microbiology and
Genetics

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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.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:

- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.

() means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.

ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

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	Additional Guidance	Mark		
1(a)					
	Component	Component found in a molecule of			
		both DNA and mRNA	DNA but not mRNA	mRNA but not DNA	neither DNA nor mRNA
	Adenine	X	☐	☐	☐
	Hydrogen bonds	☐	X	☐	☐
	Pentose sugar	X	☐	☐	☐
	Uracil	☐	☐	X	☐

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	An explanation that makes reference to two of the following: • {DNA / fragments} {are negatively charged / have a phosphate group} (1) • therefore the {DNA / fragments} move {when a potential difference is applied / towards the positive electrode} (1) • {smaller / lighter} fragments move further / {larger / heavier} fragments move shorter distance (1)	ACCEPT current / charge / voltage / electric field towards (positive) anode ACCEPT small fragments faster / larger fragments slower	

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	7 / 7.0 / 8 / 8.0 / 9 / 9.0 (kb)		

Question Number	Answer	Additional Guidance	Mark
2(a)	B monosaccharide disaccharide	A is incorrect because sucrose is a disaccharide C is incorrect because glucose is a monosaccharide D is incorrect because glucose is a monosaccharide and sucrose is a disaccharide	

Question Number	Answer	Additional Guidance	Mark
2(b)(i)	- values read from graph per unit time and converted back from logs - subtraction of each pair and division done	(7.6=) 39 810 717 and (6.6=) 3 981 072 and (3.0=) 1000 or (4.2=) 15849 15 / 10 / 10.04 ACCEPT 1.9 / 1.92 / 2 / 82.5 / 82.54 / 83 for 1 mark if slopes of graph used but no mention of the exponential growth rate constant (<i>k</i>)	

	OR exponential growth rate constant (k) calculated and used	ACCEPT k values calculated (3.820598 / 3.82 and 1.99335548 / 1.99) for 1 mark and k sucrose divided by k glucose = 1.9 / 1.92 / 2 for 2 marks	
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Question Number	Answer	Additional Guidance	Mark
2(b)(ii)	An explanation that makes reference to the following: (lag phase longer as) {sucrose has to be broken down / enzymes to breakdown sucrose had to be synthesised} (1) (reproduction faster) because sucrose has more {sugar / monosaccharides / energy} (1)	ACCEPT converse for glucose ACCEPT sucrase ACCEPT sucrose made of glucose and fructose / sucrose is a disaccharide and glucose is a monosaccharide	

Question Number	Answer	Additional Guidance	Mark
2(b)(iii)	a line that continues to go up after 8 hours and then levels off (around) 16 hours without dropping	Log₁₀ cell number per cm³ bacteria grown in sucrose bacteria grown in glucose	

Question Number	Answer	Additional Guidance	Mark
3(a)	B <i>Puccinia</i>	A is incorrect because <i>Plasmodium</i> is a protist that causes malaria C is incorrect because <i>Salmonella</i> is a bacteria that causes food poisoning D is incorrect because <i>Staphylococcus</i> is a bacteria that causes food poisoning	

Question Number	Answer	Additional Guidance	Mark
3(b)	An explanation that makes reference to three of the following: • (stem rust) fungus {takes up / uses} {nutrients / glucose / amino acids} (1) • less {glucose to form starch / amino acids to form protein} (1) • (stem rust) fungus interferes with vascular tissue (1) • consequence of damaged vascular tissue (1)	ACCEPT glucose for respiration (by the plant) e.g. weakened stems , less magnesium ions for chlorophyll, less sucrose to transport to roots	

Question Number	Answer	Additional Guidance	Mark
3(c)	An answer that makes reference to three of the following: - because {meiosis / sexual reproduction / basidiospore production} results in {genetically different fungi / variation} (1) - because of {crossing over / random assortment / independent assortment} (1) - because of mutation (in the DNA) (1) - the {asexual cycle / production of uredinospores} results in more stem rust fungus that plants are not resistant to (1)	ACCEPT recombinants ACCEPT only in the context of causing variation DO NOT ACCEPT meiosis causes mutation ACCEPT clones of stem rust fungus that plants are not resistant to	

Question Number	Answer	Additional Guidance	Mark
4(a)(i)	B matrix	A is incorrect because crista are folds in the membrane C is incorrect because stroma is in chloroplasts D is incorrect because thylakoids are in chloroplasts	

Question Number	Answer	Additional Guidance	Mark
4(a)(ii)	An explanation that makes reference to the following: - because the resolution of the microscope used for P is {lower / worse} (1) - to distinguish {the small distance between the two membranes / the membranes as separate structures} (1)	ACCEPT converse for Q throughout DO NOT ACCEPT magnification ACCEPT (inter membrane) space can be seen between membranes / the inner and outer membrane can be seen/ two lines can be seen	

Question Number	Indicative content
*4(b)	Answers will be credited according to candidates' 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: • membranes both made of phospholipid bilayer with embedded proteins • lipid content is the phospholipid bilayer • phospholipids needed for {fluidity / compartmentalisation} • higher protein : lipid ratio in the inner membrane / more protein compared to lipid in the inner membrane • protein content equals lipid content in outer membrane • role of inner membrane is oxidative phosphorylation / chemiosmosis / synthesise ATP • inner membrane contains proteins involved in electron transport • inner membrane contains ATPase channels • movement of protons through ATPase channels results in ATP formation • proteins in outer membrane to allow pyruvate to pass through

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 description of membrane structure 1 mark = 2 points 2 marks = 3 points
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 between the two membranes and their lipid and protein content 3 marks = explanation of ATPase or electron transport proteins or outer membrane 4 marks = explanation of two from ATPase, electron transport proteins, outer membrane
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. The explanation shows a well-developed and sustained line of scientific reasoning which relates named protein molecules to the high protein content of the inner membrane 5 marks = explanation of ATPase, electron transport proteins and outer membrane 6 marks = clear, accurate account of oxidative phosphorylation

Question Number	Answer	Additional Guidance	Mark
5(a)(i)	{methyl group / CH ₃ } added to a {base (cytosine or adenine) / cytosine / adenine / CpG site}	DO NOT ACCEPT between cytosine and guanine ACCEPT A for adenine, C for cytosine, G for guanine	

Question Number	Answer	Additional Guidance	Mark
5(a)(ii)	A description that makes reference to the following: • {zygote / morula} are totipotent stem cells as they give rise to all cell types (1) • {blastocyst / inner cell mass} contains pluripotent cells that give rise to the cells of the embryo (and not the extra embryonic tissue) / most cell types (1) • cells in the developing embryo are multipotent as they become only some cell types (1)	ACCEPT references to early and late stages of development if clear from description which stages are being referred to ACCEPT cleavage cells ACCEPT {trophoblastic cells / cells around the outside of the blastocyst} as they become extra embryonic tissue N.B. If correct description given for 2 or more types of stem cell but no reference to embryo, award 1 mark	

Question Number	Answer	Additional Guidance	Mark
5(a)(iii)	An explanation that makes reference to two of the following: • level of DNA methylation increases after the blastocyst stage} (1) • because genes {switched off / silenced / inactivated / cannot be transcribed / cannot be expressed} (1) • causing cells to become {specialised / differentiated} (1)		

Question Number	Answer	Additional Guidance	Mark
5(b)	An explanation that makes reference to two of the following: • because they are (fully) differentiated cells (1) • therefore genes needed (for other cell types) are (permanently) {switched off / silenced} (1) • therefore proteins needed by other cell types cannot be produced (1)	ACCEPT specialised ACCEPT not able to express certain genes	

Question Number	Answer	Additional Guidance	Mark
6(a)	An explanation that makes reference to two of the following: - MHC needed if endothelial cells were to {present antigen / be antigen presenting cells} (1) - antigen binds to MHC molecules (1) - MHC-antigen complex involved in activation of T helper cells (1)	ACCEPT antigens presented on MHC ACCEPT MHC-antigen complex binds to (CD4) receptor on T helper cells	

Question Number	Answer	Additional Guidance	Mark
6(b)	An explanation that makes reference to two of the following: - because stops DNA replication in endothelial cells (1) - dividing cells {take up / use} the (radioactive) thymidine (1) - so that any radioactive thymidine uptake will be by the T cells (only) (1)	N.B. 'They' or 'cells' refers to the endothelial cells ACCEPT DNA synthesis uses thymidine ACCEPT only T cell division can be measured	

Question Number	Answer	Additional Guidance	Mark
6(c)	An explanation that makes reference to the following: - to remove any thymidine (not taken up) (1) - which would result in an over estimate of the {number of T cells / thymidine present} (1)	ACCEPT {inaccurate / not valid} result for the T cells	

Question Number	Answer	Additional Guidance	Mark
6(d)(i)	An explanation that makes reference to the following: - to determine any passive uptake of radioactive thymidine / to see if T cells take up thymidine without antigen present (1) - to show that antigen is stimulating the T cells (to divide) (1)	ACCEPT to compare the thymidine with and without antigen ACCEPT to see the effect of antigen (on T cells)	

Question Number	Answer	Additional Guidance	Mark
6(d)(ii)	An explanation that makes reference to three of the following: • endothelial cells are best at presenting Con A (and MBP) / Con A (and MBP) are presented (1) • endothelial cells are least effective at presenting OVA (and PPD) / OVA (and PPD) are not presented (1) • because there is very little difference between antigen and {no antigen / control} (1) • because {error bars for Con A and MBP are not overlapping / error bars for OVA and PPD are overlapping} with the control (1)	N.B. Con A (and MBP) have the highest level of thymidine and OVA (and PPD) the least = 1 mark if no other marks awarded	

Question Number	Answer	Additional Guidance	Mark
7(a)	An explanation that makes reference to the following: - because {cholesterol / fatty acids} are hydrophobic (so cannot be carried in bloodstream) (1) - phospholipid tails are hydrophobic so {cholesterol / fatty acids} can be carried inside lipoprotein (1) {protein / phospholipid heads} in lipoprotein are hydrophilic (enabling transport in bloodstream) (1)	ACCEPT non-polar ACCEPT non-polar ACCEPT polar	

Question Number	Answer	Additional Guidance	Mark
7(b)(i)	- substitution of values into equation - answer given to 3 or 4 sig figs	$\frac{4}{3} \times \pi \times 11 \times 11 \times 11 / 5572.453$ 5570 / 5572 ACCEPT 5580 / 5575 for 1 mark	

Question Number	Answer		Mark
7(b)(ii)	An explanation that makes reference to two of the following: • because (in the LDL) there is less protein (contained in a larger volume) (1) • because the protein is denser than the phospholipid (in the LDL) (1) • (the LDL has) {a larger hole in the middle / fewer molecules in relation to its size} (1)	ACCEPT converse statements for HDL ACCEPT types of protein in HDL are denser than the types in LDL	

Question Number	Answer	Additional Guidance	Mark
7(b)(iii)	An explanation that makes reference to four of the following: • because cholesterol is a risk factor (1) • (because of raised LDLs) more cholesterol in the blood (1)		

	• {cholesterol / plaque / atheroma} builds up in (walls of) artery (1) • reducing the flow of blood to the heart {tissue / cells} (1) • therefore lack of oxygen for (aerobic) respiration (in heart cells) (1)		
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Question Number	Answer	Additional Guidance	Mark
8(a)(i)	• length of scale line given in μm • magnification calculated	1.7×10000 / 17000 1.7×10^3 / 0.0017×10^6	

Question Number	Answer	Additional Guidance	Mark
8(a)(ii)	width of GM aperture divided by width of non-modified aperture	In the range of 1.3 to {4 / 4.0} to no more than 1 decimal place DO NOT ACCEPT with units or %	

Question Number	Answer	Additional Guidance	Mark
8(b)(i)	A description that makes reference to the following: • (μmol) carbon dioxide used / {oxygen / GP / GALP / glucose} made (1) • (m^{-2}) is the area of the {leaf / open stomata} (1) • (s^{-1}) in one second (1)	ACCEPT example e.g. measure for 120 seconds and divide by 120	

Question Number	Answer	Additional Guidance	Mark
8(b)(ii)	An explanation that makes reference to three of the following: • increase in light intensity increases photosynthesis (1) • increase is greater in GM plants because the wider aperture will result in a more {gas exchange / uptake of carbon dioxide} (1) • therefore {light-independent reactions / Calvin cycle / carbon fixation} is faster (1) • rate levels off when {another factor / carbon dioxide concentration / temperature} becomes rate limiting (1)	ACCEPT GM plants photosynthesise faster than non-GM ACCEPT carbon dioxide not limiting the rate of {light-independent reactions / Calvin cycle / carbon fixation}	

Question Number	Answer	Additional Guidance	Mark
8(c)	An explanation that makes reference to three of the following: - because (faster photosynthesis will result in) more {GALP / glucose} produced (1) - to form a named plant molecule (1) - because transpiration stream will be faster (1) - therefore more mineral ions for named product (1)	ACCEPT biomass / other organic molecules more {oxygen / glucose} for ATP production e.g. Mg⁺⁺ for chlorophyll, nitrates for protein	
Question Number	Answer	Additional Guidance	Mark
8(d)(i)	D ATP is broken down into ADP and phosphate ions by a hydrolysis reaction	A is incorrect because ATP is broken down B is incorrect because ATP is broken down C is incorrect because condensation reactions form bonds	

Question Number	Answer	Additional Guidance	Mark
8(d)(ii)	A malate lowers the water potential of the cytoplasm	B is incorrect because increase in solute concentration raises water potential so water would leave the cells C is incorrect because starch has no osmotic effect D is incorrect because starch has no osmotic effect	

Question Number	Answer	Additional Guidance	Mark
8(d)(iii)	D The guard cells become larger and the inner wall of the guard cell is less flexible than the outer wall	A is incorrect because entry of water would make the cell more larger B is incorrect because entry of water would make the cell more larger C is incorrect because the stoma would not form if the inner wall was flexible	

Question Number	Answer	Additional Guidance	Mark
9(a)	An explanation that makes reference to five of the following: • DNA synthesis is needed for {mitosis / cell division} (1) • Dox prevents {DNA synthesis / DNA strands separating / promoters binding} (1) • because the strands are not available (for nucleotides to align) (1) • Dox prevents {transcription / transcription factors from binding} (1) • so no proteins synthesised (1) • repair enzyme will not be able to remove the drug (1)	ACCEPT without DNA synthesis the cell will remain in interphase ACCEPT mRNA cannot be made ACCEPT {cell cycle stops / cells destroyed} if damaged DNA is not repaired	

Question Number	Indicative content
*9(b)(i)	Answers will be credited according to candidates' 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. <u>Indicative content</u> • Dox decreases the concentration of (all) amino acids shown • largest actual decrease is glu and asp ($3.6 \mu\text{mol cm}^{-3}$) • smallest actual decrease is ser ($0.9 \mu\text{mol cm}^{-3}$) • relative decrease is least for pro (16.67%) • relative decrease is greatest for asp (85.71%) • data not available for all amino acids • polar and non-polar amino acids are affected • polar amino acids affected most (total $14.4 \mu\text{mol cm}^{-3}$ compared to total $11.7 \mu\text{mol cm}^{-3}$ / mean $2.4 \mu\text{mol cm}^{-3}$ compared to mean $1.95 \mu\text{mol cm}^{-3}$) • effect on non-polar amino acids is within a {narrower range for actual decrease / wider range for percentage decrease}

	Level 1 : comments on overall effect of Dox 1 mark = level 1 comment only 2 marks = level 1 comment backed up with figures / level 2 comment but no figures given Level 2 : comments on effect of Dox on polar and non-polar amino acids 3 marks = level 2 comment only / level 1 comment with a level 2 calculation (= actual decrease in concentration) 4 marks = level 2 comment backed up with a level 2 calculation Level 3 : comments about amino acids within the group of polar / non-polar amino acids 5 marks = level 3 comment / level 2 comment with a level 3 calculation (= percentage decrease in calculation) 6 marks = comment backed up with a level 3 calculation	
Level 0	Marks	No awardable content
Level 1	1-2	An answer 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 answer will contain basic information with some attempt to describe the data shown in the graph
Level 2	3-4	An answer will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The answer shows some linkages and lines of scientific reasoning with some structure between the graph and the different types of amino acids
Level 3	5-6	An answer is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The answer shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.

Question Number	Answer	Additional Guidance	Mark
9(b)(ii)	An explanation that makes reference to the following: - a decrease in some amino acids may mean that {certain proteins cannot be formed / less protein made} (1) - if these proteins are involved in heart muscle structure then it will be weaker (1) - these proteins may affect heart muscle function (1)	ACCEPT named example e.g. actin, myosin, collagen ACCEPT named example e.g. collagen, haemoglobin, myoglobin, cytochromes	

Question Number	Answer	Additional Guidance	Mark
9(b)(iii)	An explanation that makes reference to the following: - heart will not be able to pump as well (1) - so less {oxygenated blood / oxygen} will be delivered to the {cells / tissues / organs / named example} (1) - example of a consequence of this (1)	ACCEPT less carbon dioxide removed / lowers blood pH e.g. less aerobic respiration, build-up of lactic acid / fatigue / breathlessness	

