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Edexcel

# Mark Scheme (Results)

## Summer 2024

Pearson Edexcel Advanced Level GCE
In Biology B (9BI0)
Paper 1: 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

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1(a)** | <table><tr><th rowspan="2">**Statement about blood vessels**</th><th colspan="4">**Type of blood vessel**</th></tr><tr><th>both capillaries and veins</th><th>capillaries only</th><th>veins only</th><th>neither capillaries nor veins</th></tr><tr><td>Endothelial cells</td><td>☒</td><td>☐</td><td>☐</td><td>☐</td></tr><tr><td>Valves</td><td>☐</td><td>☐</td><td>☒</td><td>☐</td></tr></table> | | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1(b)** | An explanation that makes reference to two of the following:<br>• (blood) fluid is forced through capillary wall (1)<br>• due to high hydrostatic pressure (in arterial end) (1)<br>• due to narrowing of the arteries (1) | **ACCEPT** pores/gaps in the capillary | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(a)** | **The only correct answer is A**<br><br>**B** is incorrect because hydrolysis splits bonds<br><br>**C** is incorrect because galactose is not a component of sucrose<br><br>**D** is incorrect because galactose is not a component of sucrose and hydrolysis splits bonds | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(b)** | An answer that makes reference to three of the following:<br><br>Similarities:<br><br>• both contain α glucose (1)<br><br>• both contain glycosidic bonds (1)<br><br>Differences:<br><br>• amylose has 1 – 4 (glycosidic) bonds only but amylopectin has both 1 – 4 and 1 – 6 (glycosidic) bonds (1)<br><br>• amylose is helical but amylopectin is branched (1) | **NB** both contain glucose joined by α glycosidic bonds = 2 marks<br><br>**ACCEPT:** Coiled/unbranched for amylose | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(a)** | An explanation that makes reference to two of the following:<br><br>• because viruses can only bind to {one type / limited number of types} of cell (1)<br><br>• due to receptors on {their capsid / the surface of the cells} (1)<br><br>• because they cannot replicate without host cell | **ACCEPT** specific cells bind | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(b)(i)** | An explanation that makes reference to three of the following:<br><br>• because time was needed for the {(viral) DNA / (viral) RNA} to enter the cell (1)<br><br>• because time needed for {nucleic acid / protein} synthesis (1)<br><br>• because time needed for assembly of viruses (1)<br><br>• numbers only increase once (host) cells have been lysed (1) | **ACCEPT** genetic material<br><br>**ACCEPT** time for transcription or translation | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(b)(ii)** | • correct values read from the graph (1)<br><br>• correct answer given to 3 sig figs (1) | 70 : $\log_{10}$ 7<br>50 : $\log_{10}$ 5.7<br><br>10 000 000 – 501 187 = 9 498 813 = 9 500 000 more particles /or<br>10 000 000 ÷ 501 187 = 19.95 = 20.0 x<br>7 – 5.7 = 1.3 = 20.0 x<br><br>9500000 = 2 marks<br>9498813 = 1 mark | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(a)** | An answer that makes reference to the following:<br><br>• (carbon) carbon dioxide<br><br>• (hydrogen) water<br><br>• (oxygen) carbon dioxide | **1 or 2 correct = 1 mark**<br>**All 3 correct = 2 marks**<br><br>**IGNORE** $CO_2$, $H_2O$ | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(b)** | **The only correct answer is D**<br><br>**A** is incorrect because both photolysis occurs on thylakoid membrane and the pigments are embedded in the thylakoid membrane<br><br>**B** is incorrect because photolysis occurs on thylakoid membrane<br><br>**C** is incorrect because the pigments are embedded in the thylakoid membrane | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(c)(i)** | An explanation that makes reference to three of the following:<br><br>• because carbon dioxide has already been fixed (1)<br><br>• acetate used to form {GALP / glucose / organic molecules} (1)<br><br>• and store {organic molecules / named organic molecule} as biomass (1)<br><br>• acetate can be used in respiration | (Acetate) generates amino acids/proteins for growth | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(c)(ii)** | An answer that makes reference to one of the following:<br><br>• can be grown anywhere (indoors) because no need for {sunlight / nutrients / water} (1) | can be grown where daylight is limited/ at any time of year so higher yield/can be grown day or night so increased yield | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(a)** | **The only correct answer is D**<br><br>**A** is incorrect because (245 000 – 49735) ÷ 245 000 = 0.797, 0.797 × 100 = 79.7<br><br>**B** is incorrect because (245 000 – 49735) ÷ 245 000 = 0.797, 0.797 × 100 = 79.7<br><br>**C** is incorrect because (245 000 – 49735) ÷ 245 000 = 0.797, 0.797 × 100 = 79.7 | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(b)(i)** | **The only correct answer is D**<br><br>**A** is incorrect because both have peptidoglycan in their cell wall (1) and a Gram negative bacteria has a thinner cell wall (3) S. aureus is gram positive so statement 2 is incorrect<br><br>**B** is incorrect because both have peptidoglycan in their cell wall (1) and a Gram negative bacteria has a thinner cell wall (3)<br><br>**C** is incorrect because both have peptidoglycan in their cell wall (1) and a Gram negative bacteria has a thinner cell wall (3) S. aureus is gram positive so statement 2 is incorrect | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(b)(ii)** | **The only correct answer is A**<br><br>**B** is incorrect because *S aureus* releases exotoxins whilst it is alive<br><br>**C** is incorrect because *S aureus* releases exotoxins whilst it is alive<br><br>**D** is incorrect because *S aureus* releases exotoxins whilst it is alive | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(c)** | **The only correct answer is A**<br><br>**B** is incorrect because a vaccine is artificial and the antigens contained stimulate an immune response<br><br>**C** is incorrect because a vaccine is artificial and the antigens contained stimulate an immune response<br><br>**D** is incorrect because a vaccine is artificial and the antigens contained stimulate an immune response | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(d)(i)** | An explanation that makes reference to three of the following:<br><br>• few T helper cells at start as delay whilst antigen is being presented (1)<br><br>• some T helper cells present as they have been activated and are beginning to divide (1)<br><br>• large number of T helper cells by day 2 due to clonal expansion (1)<br><br>• drop in number after 21 days as T helper cells have {died / moved out of the lymph nodes} (1) | **IGNORE** descriptions of the immune response not linked to time<br><br>**ACCEPT** description of clonal selection linked to increase<br><br>**ACCEPT** large number due division by mitosis | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(d)(ii)** | An explanation that makes reference to three of the following:<br><br>• no antibodies in control mice as they had not been exposed to antigen before (1)<br><br>• Rapid production of antibodies in vaccinated mice due to secondary immune response (1)<br><br>• immediate increase in antibodies in vaccinated mice as they had memory cells present as a result of the vaccine (1)<br><br>• therefore rapid increase in plasma cells to release antibodies (1) | Mouse must undergo primary immune response (which takes time)<br><br>**ACCEPT** converse | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(a)** | **The only correct answer is C**<br><br>**A** is incorrect because there is no cytoplasm in mitochondria<br><br>**B** is incorrect because mitochondrial DNA is found in the matrix<br><br>**D** is incorrect because mitochondria do not have a nucleus | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(b)** | **The only correct answer is A**<br><br>**B** is incorrect because circular DNA has two more phosphodiester bonds than linear DNA with the same number of pentoses<br><br>**C** is incorrect because mitochondrial DNA is circular<br><br>**D** is incorrect because mitochondrial DNA is circular | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(c)** | An explanation that makes reference to four of the following:<br><br>• position 1 : only the daughter has inherited this DNA from the mother (1)<br><br>• position 2 : (genes located in) this DNA is common to all people (1)<br><br>• position 3 : daughter and son 1 have inherited this DNA from their father but son 2 has not (1)<br><br>• position 4 : this could be mitochondrial DNA as it is found in the mother and all children (1)<br><br>• position 5 : this could be the mitochondrial DNA of the father as it is not present in any of the children (1) | **IGNORE** references to how the bands form<br><br>Must refer to DNA in band at least once | (4) |

| Question number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(d)(i)** | • substitution (1) | **ACCEPT** transition<br><br>**DO NOT ACCEPT** insertion / addition / deletion / subtraction / chromosome mutation / frameshift / inversion / duplication/ replacement | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(d)(ii)** | An explanation that makes reference to two of the following:<br>• the cytosine will not bind with the adenine (1)<br>• therefore the hydrogen bonds will not form (1)<br>• so {the left hand loop will open up / other bonds may form} (1) | **ACCEPT** tRNA will be a different shape | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(d)(iii)** | An explanation that makes reference to two of the following:<br>• the tRNA may not be able to bind with the ribosome (1)<br>• and therefore not hold the amino acid in place (1)<br>**OR**<br>• the amino acid may not be able to bind to the tRNA (1)<br>• and therefore {this amino acid cannot be / fewer of these amino acids} brought to the ribosome (1)<br>**OR**<br>• the anticodon may not be able to bind to the codon on the mRNA (1)<br>• and therefore the amino acid will not be held in place (1) | | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(a)(i)** | A description that makes reference to two of the following:<br>• during glycolysis (1)<br>• glucose is converted to pyruvate (1)<br>• by substrate level phosphorylation (1) | **ACCEPT** anaerobic respiration | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(a)(ii)** | An explanation that makes reference to the following:<br>• because the proton gradient would be shallower (1)<br>• so protons would flow through the ATP synthase more slowly (1)<br>• therefore less energy for the phosphorylation of ADP (1) | **ACCEPT** electrochemical/chemiosmotic gradient<br>**IGNORE** fewer protons<br>**ACCEPT** less ADP + Pi converted to ATP | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(b)(i)** | • length from head to tail in photo in cm ÷ 12 (1) | 40-42 mm<br>40 = 0.33x 41 = 0.34 x 42= 0.35 x | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(b)(ii)** | • 0.8 : 1 (1) | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(c)(i)** | An explanation that makes reference to two of the following:<br>• To attract the birds to be caught (1)<br>• so that respiration would not be limited by energy source (1)<br>• to make the investigation valid (1) | so that all birds had plenty to eat | (2) |

| Question Number | Indicative content | Mark |
|---|---|---|
| ***7(c)(ii)** | **Graph 1** (volume of mitochondria)<br><br>• great tits have larger volume of mitochondria than blue tits<br>• blue tits have more mitochondria than coal tits<br>• error bars do not overlap between autumn and winter so differences are significant<br>• because bigger birds need to produce more ATP for flying<br>• coal tits are smaller so need less ATP<br>• all three birds increase their number of mitochondria in the winter<br>• by division<br>• because more heat needs to be generated to keep warm in the colder season<br>• greater volume needed in winter because more leaked respiration<br><br>**Graph 2** (respiration producing ATP)<br><br>• coal tits respire faster than blue tits and great tits<br>• because they have fewer mitochondria<br>• no significant difference between blue tits and great tits<br>• there is no difference in rate of respiration in great tits between autumn and winter<br>• the rate of respiration decreases in winter in blue tits and coal tits<br>• because they need to {produce more heat / switch to leaked respiration}<br>• as they have a larger surface area : volume ratio<br>• and therefore lose more body heat<br>• if switch to leaked respiration is made there is a smaller proton gradient<br>• therefore less respiration to make ATP<br><br>**Graph 3** (leaked respiration)<br>• Rate of leaked respiration is faster in all three species in winter<br>• rate of leaked respiration is faster in coal tits than blue tits<br>• rate of leaked respiration is similar in great tits than blue tits<br>• there are no error bars so cannot say if any differences are significant<br>• because leaked respiration produces more heat | (6) |

| | | |
|---|---|---|
| | • needed for coal tits because they have a larger surface area : volume ratio<br>• and therefore lose more body heat | |

| | | | Additional guidance |
|---|---|---|---|
| Level 0 | 0 | No awardable content | |
| Level 1 | 1-2 | An explanation may be attempted but with limited interpretation or analysis of the scientific information and with a focus on mainly just one piece of scientific information. The explanation will contain basic information, with some attempt made to link knowledge and understanding to the given context. | Simple descriptions of the data<br><br>1 mark = a description relating to one graph<br>2 marks = a description for three graphs |
| 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 and lines of scientific reasoning, with some structure. | Some explanation of the data<br><br>3 marks = explanation for one of the graphs<br>4 marks = explanation for two of the graphs |
| Level 3 | 5-6 | An explanation is made that 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 is clear and logically structured. | Detailed explanation of the data<br><br>5 marks = explanation of two graphs and discussion of error bars<br>6 marks = explanation of all three graphs and both size and seasonal variation discussed |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(a)** | An explanation that makes reference to the following:<br><br>• if AR is too early then there will not be the enzymes available for fertilisation (1)<br><br>• and it will not be able to digest through the zona pellucida/jelly coat (1)<br><br>• if AR is too late then {the egg/sperm (cell) may have died / the sperm have swam past the egg (cell)} (1) | | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(b)** | | | (4) |

| Event | Presence of protein G | | Presence of protein G-P | |
|---|---|---|---|---|
| | Head region | Mid piece and flagellum | Head region | Mid piece and flagellum |
| Just before capacitation | ✓ | × | × | ✓ |
| During capacitation | ✓ | × | × | ✓ |
| Just before the AR | × | × | ✓ | ✓ |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(c)** | An explanation that makes reference to the following:<br>• DNA methylation {silences / switches off} a gene (1)<br>• Because is a form of epigenetic modification (1)<br>• therefore the gene cannot be transcribed / therefore no protein G will be produced (1)<br>• without protein G the timings of capacitation and AR will be wrong (1) | **ACCEPT** Transcription factors cannot bind to DNA<br>**ACCEPT** If AR not inhibited, AR will happen too soon | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(d)(i)** | An answer that makes reference to the following:<br>• genetically-modified (laboratory) mice (1)<br>• that have had the gene coding for protein G {inactivated / replaced} (1) | **ACCEPT** genes coding for protein G prevented from being expressed | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(d)(ii)** | A description that makes reference to three of the following:<br>• all female mice would have to be fertile (1)<br>• fertile males used as a control (1)<br>• pregnancy rate measured (1)<br>• Same species/age of mouse/diet (1) | **ACCEPT** Control group that have not had gene modified<br>**ACCEPT** Number of offspring produced | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9(a)(i)** | An explanation that makes reference to three of the following:<br><br>• because the embryo is increasing in cell number (1)<br><br>• all the cells are unspecialised (1)<br><br>• and have no genes switched on to produce the globin subunits (1)<br><br>• no yolk sac has developed yet (1) | **ACCEPT** Mitosis is occurring<br><br>**ACCEPT** Cells have not differentiated/are differentiating<br><br>**IGNORE** genes haven't been switched off | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9(a)(ii)** | An answer that makes reference to four of the following:<br><br>• the structure responsible for synthesising the globin subunits changes with time after fertilisation (1)<br><br>• the {embryo / fetus} contains gamma globin and either epsilon or beta globin (and some delta) (1)<br><br>• the baby has increasing levels of beta (and delta globin) and decreasing levels of gamma globin (1)<br><br>• yolk sac is responsible for synthesis of epsilon globin (1)<br><br>• the liver synthesises mainly gamma globin (1)<br><br>• bone marrow synthesises both components of adult haemoglobin (1) | **ACCEPT** Mainly gamma made before birth and mainly beta after birth<br><br>**ACCEPT** Liver synthesises gamma and beta<br><br>**ACCEPT** Bone marrow synthesises beta haemoglobin | (4) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9(a)(iii)** | • correct two values read from graph, subtracted and divided by 2.4 (1)<br><br>• answer given to 2 decimal places + (decrease in percentage of γ globin synthesised) per month / (%) $month^{-1}$ (1) | (84 – 32) ÷ 2.4 = 21.666667<br><br>21.67 $month^{-1}$ /month = 2 marks<br>21.66 $month^{-1}$ /month = 1 mark | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9(b)(i)** | • number of people without sickle cell disease calculated (1)<br><br>• ratio calculated (1) | 67 million – 15 000 = 66 985 000<br><br>4466:1 = 2 marks<br><br>66 985 000 : 15 000 = 4 465.6666666666666 : 1 | (2) |

| Question Number | Indicative content | Mark |
|---|---|---|
| ***9(b)(ii)** | **(1)Globin subunits and sickle cell disease :**<br>• sickle cell anaemia is caused by a mutation<br>• in the gene coding for the beta globin subunit<br>• which causes the red blood cells change shape<br>• and reduces the blood supply to cells of the body<br>• fetal haemoglobin contains gamma globin which is switched to beta globin at birth<br>**(2)BCL11A gene :**<br>• switch due to the presence of the gene product from the BCL11A gene<br>• if BCL11A switched off there will be no transcription<br>• therefore BCL11A will not be produced<br>• and therefore gamma globin will still be produced (fetal)<br>• which is not defective<br>• therefore red blood cells will no longer be sickle shaped<br>• haemoglobin affinity would be higher<br>**(3)Method used :**<br>• bone marrow stem cells used as these are the cells that produce haemoglobin in the fetus and the baby<br>• stem cells will divide by mitosis<br>• to produce genetically-identical cells<br>• that will all contain the modified BCL11A gene<br>• advantage of using own stem cells is that they will not cause an immune response when returned to body<br>• as there will not be any (foreign) antigens for the immune system to recognise<br>• and own stem cells will not be rejected<br>• wont need immunosuppressants<br>**(4)Ethics:**<br>• new technology so little evidence on effect<br>• e.g. that this will work in the long term<br>• e.g. there are no unanticipated changes<br>• relevant comment about cost<br>• changes will not be inherited<br>• painful to extract cells from patient | (6) |

| | | |
|---|---|---|
| | • may become cancerous<br>• Cells taken from patient not embryo<br>• Treatment would save lives<br>• If young, they cannot consent<br>• Who will the treatment be available to<br>• Don't know long term effects of GM | |

| | | | Additional guidance |
|---|---|---|---|
| Level 0 | 0 | No awardable content | |
| 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. | Limited discussion about the treatment/SCD/ethics<br><br>1 mark = one comment made from any section<br>2 marks = two comments made from any section |
| 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. | Limited links made between treatment and SCD<br><br>3 marks = basic understanding of approach used<br>4 marks = understanding of method |
| Level 3 | 5-6 | Demonstrates comprehensive knowledge and understanding by selecting and applying relevant biological facts / concepts. Consequences are discussed which supported throughout by sustained linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. | Extended links made between treatment and SCD<br><br>5 marks = aspects from 3 sections discussed including the ethical issues<br>6 marks = detailed discussion including both the ethical issues and the significance of using own stem cells |

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