

# Mark Scheme (Results)

## Summer 2023

Pearson Edexcel GCE
In Biology 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.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1(a)(i)** | • (calcium) pectate (1) | **IGNORE** middle lamella<br>**DO NOT ACCEPT** any other molecule | (1) |

| Question Number | Answer | Mark |
|---|---|---|
| **1(a)(ii)** | **The only correct answer is C**<br><br>***A** is incorrect because statements 1 and 2 are correct and statement 3 is incorrect*<br><br>***B** is incorrect because statements 1 and 2 are correct and statement 3 is incorrect*<br><br>***D** is incorrect because statements 1 and 2 are correct and statement 3 is incorrect* | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1(b)** | An explanation that makes reference to four of the following:<br><br>• (decrease in concentration) due to $K^+$ {leaving (cell) / being used in synthesis of correct named molecule} **AND** (increase in concentration) due to $K^+$ being taken up (by cell) (1)<br><br>• ions decrease {by (facilitated) diffusion / move down a concentration gradient} (1)<br><br>• ions taken up by active transport (1)<br><br>• (in aerobic conditions) oxygen available for aerobic <u>respiration</u> (1)<br><br>• aerobic respiration generates (more) {ATP / energy} (1) | **PIECE TOGETHER**<br><br>**ACCEPT** active transport cannot take place in anaerobic conditions<br><br>**ACCEPT** converse<br><br>**ACCEPT** converse | (4) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(a)** | An explanation that makes reference to the following:<br><br>• not Bacteria as Archaea do not have a peptidoglycan cell wall (1)<br><br>• not Eukaryota as these organisms {have 70S ribosomes / do not have a nucleus} (1) | **IGNORE** refs to gram negative and gram positive bacteria<br>prokaryotes<br>**DO NOT ACCEPT** if wrong reason given as well<br><br>**ACCEPT** do not have 80S ribosome<br>**IGNORE** refs to other membrane-bound organelles<br>**DO NOT ACCEPT** if wrong reason given as well | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(b)(i)** | An answer that makes reference to three of the following:<br><br>• (two enzymes) because enzymes found in different locations (1)<br><br>• pH is different / their substrates are found in different locations (1)<br><br>• (two enzymes) because their substrates are different (1)<br><br>• therefore their <u>active site</u> will be different {shape / structure} (1)<br><br>• {similar structure / both are AK enzymes / both are kinases} because both {are transferring phosphate / have similar roles (1) | **IGNORE** incorrect explanations of what the enzymes are doing with ATP and GTP<br><br>**ACCEPT** enzymes cannot move between mitochondria and cytoplasm<br><br>**ACCEPT** ATP in cytoplasm and GTP in mitochondria<br><br>**ACCEPT** because one uses ATP and the other uses GTP | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(b)(ii)** | An explanation that makes reference to two of the following:<br><br>• Archaea {do not have mitochondria / only have cytoplasm} so do not need two enzymes (1)<br><br>• {pH / temperature} of Archaea different to human's (1)<br><br>• Archaea's enzymes need to be able to {bind / fit} to {two substrates / both ATP and GTP} (1)<br><br>• {genetic code / (DNA) base sequence} is different<br>**OR**<br>different primary structure (1) | **ACCEPT** need to form ESCs with different substrates<br>**NB** ref to induced-fit may access this point provided in the context of substrate | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(a)** | • (a group of similar) cells that perform a similar function (1) | | (1) |

| Question Number | Answer | Mark |
|---|---|---|
| **3(b)** | | (3) |

| **Statement** | **Type of tissue** | | | |
|---|---|---|---|---|
| | both xylem and phloem | xylem only | phloem only | neither xylem nor phloem |
| Contain sieve plates | ☐ | ☐ | X | ☐ |
| Have cellulose in the cell walls | X | ☐ | ☐ | ☐ |
| Has mitochondria | ☐ | ☐ | X | ☐ |

| Question Number | Answer | Mark |
|---|---|---|
| **3(c)(i)** | **The only correct answer is D**<br><br>***A*** *is incorrect because fructose is a monosaccharide*<br><br>***B*** *is incorrect because glucose is a monosaccharide*<br><br>***C*** *is incorrect because lactose is not found in plants* | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(c)(ii)** | • 14 / 14.3 / 14.29 (cm $hr^{-1}$) | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(c)(iii)** | A description that makes reference to three of the following:<br><br>• by mass flow / as a solution (flowing through the phloem) (1)<br><br>• {sugars / sucrose} {loaded / pumped / actively transported} into phloem {in the leaf / at the source} (1)<br><br>• {sugars / sucrose} {move out / diffuse} (out of phloem) into {sink tissues / roots / storage sites / named storage site} (1)<br><br>• description of how water enters phloem at source **and** leaves at sink (1)<br><br>• (sugars / contents) move to region of lower hydrostatic pressure (in the phloem) (1) | **ACCEPT** mass transport / dissolved in water<br>**IGNORE** hypothesis<br>**DO NOT ACCEPT** cohesion / adhesion / osmosis / active transport / diffusion / apoplast / symplast<br><br>**DO NOT ACCEPT** glucose<br><br>**DO NOT ACCEPT** glucose, but only penalise once pumped out / by active transport<br><br>**DO NOT ACCEPT** diffusion<br><br>**DO NOT ACCEPT** diffusion | (3) |

| Question Number | Answer | Mark |
|---|---|---|
| **4(a)** | **The only correct answer is A**<br><br>***B*** *is incorrect because TMV does not have an envelope*<br><br>***C*** *is incorrect because lambda phage is a DNA virus and does not have an envelope*<br><br>***D*** *is incorrect because TMV does not have an envelope and lambda phage is a DNA virus and does not have an envelope* | (1) |

| Question Number | Answer | Mark |
|---|---|---|
| **4(b)** | **The only correct answer is C**<br><br>***A*** *is incorrect because influenza is predominantly transmitted by respiratory droplets and only a few cases by contaminated surfaces*<br><br>***B*** *is incorrect because influenza is predominantly transmitted by respiratory droplets*<br><br>***D*** *is incorrect because influenza is predominantly transmitted by respiratory droplets* | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(c)** | An explanation that makes reference to three of the following:<br><br>• (because it takes time) for {enough / large number of / other} cells to be damaged (by viruses) (to cause the symptoms) (1)<br><br>**Any TWO from:**<br><br>• (because time taken) for attachment to host cell (1)<br><br>• (because time taken) for {penetration / infection} of host cell with {virus / RNA / genetic material} (1)<br><br>• (because time taken) for synthesis of RNA (from RNA) (1)<br><br>• (because time taken) for synthesis of proteins (1)<br><br>• (because time taken) for {assembly of (new) viruses /viral components to be put together} (1) | **IGNORE** refs to retroviruses and latency throughout<br>**NB must be a ref to a time delay for all 3 marks to be awarded**<br><br>**ACCEPT** for {enough / large number of} virus particles to be produced to infect other cells<br>for {the immune system to be activated / an immune response to occur}<br><br>**DO NOT ACCEPT** DNA<br><br>**DO NOT ACCEPT** DNA<br><br>**IGNORE** replicated / produced | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(d)(i)** | • 1 : 0.30 / 1.00 : 0.30 (1) | **ACCEPT** 3.35 : 1 / 3.35 : 1.00 | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(d)(ii)** | An explanation that makes reference to the following:<br><br>• because the antibiotics will not work as viruses are not {living / cells} (1)<br><br>• (and unnecessary usage) will act as a selection pressure to {cause / increase} antibiotic resistance (in bacteria) (1) | **DO NOT ACCEPT** viruses are dead<br>**IGNORE** antibiotics only target cell wall / viruses do not have a cell wall<br><br>**ACCEPT** description of selection pressure e.g. resistant bacteria will survive and non-resistant ones will not<br>**DO NOT ACCEPT** immune<br>causes mutation | (2) |

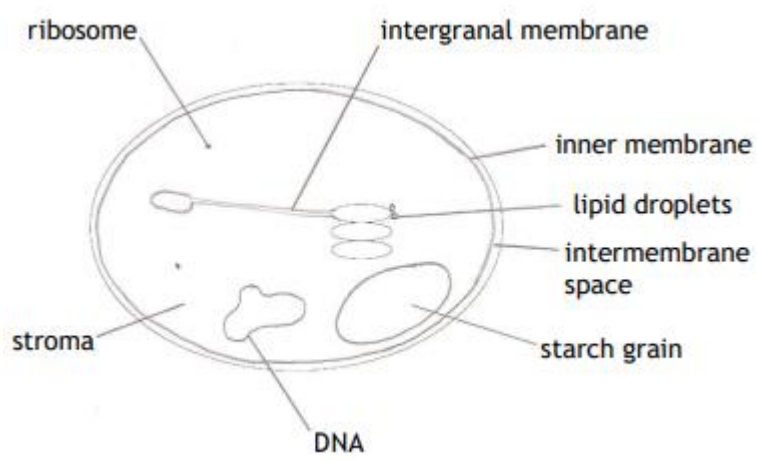
| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(a)** | **The only correct answer is B**<br><br>***A** is incorrect because injection of antibodies is passive*<br><br>***C** is incorrect because injection of antibodies is artificial and passive*<br><br>***D** is incorrect because injection is artificial* | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(b)(i)** | • $6 \times 10^3$ / $6.0 \times 10^3$ / 6 000 (1) | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(b)(ii)** | An answer that makes reference to three of the following:<br><br>• time taken to agglutinate decreases with increase in antibody concentration (1)<br><br>• credit comment about lack of error bars (in graph 1) (1)<br><br>• antibody {reduces / prevents} sperm from escaping (1)<br><br>• concentration of antibody does not affect the percentage of sperm escaping (1)<br><br>• credit comment about overlapping error bars (in graph 2) (1) | **IGNORE** attempts to explain data<br><br>**ACCEPT** inverse (proportional) relationship<br>(weak) negative correlation<br><br>**ACCEPT** significant / valid<br>**IGNORE** reliable / accurate / precise<br><br>**ACCEPT** significant / valid<br>**IGNORE** reliable / accurate / precise | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(b)(iii)** | An explanation that makes reference to three of the following:<br><br>• because antibodies have (more than one identical) binding sites (1)<br><br>• antibodies are specific to (one) antigen (1)<br><br>• (bind head and flagellum) there may be the same {antigen / antibody-binding site} on both the head and the flagellum (1)<br><br>• (only bind head or flagellum) there may be different {antigen / antibody-binding site} on the head and the flagellum (1)<br><br>• because there may be (three) different types of antibody present (in the contraceptive) (1) | **NB** careful with the term 'variable region' as it is used for the antigen-binding site<br><br>**ACCEPT** on all parts of cell<br>tail to mean flagellum | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(c)** | An explanation that makes reference to the following:<br><br>• because at low concentrations the collision between antibody and {antigen / sperm} {will take longer / are less frequent} (1)<br><br>• because at high concentrations there may be insufficient antibodies (1) | **ACCEPT** chances of attaching are lower<br><br>**ACCEPT** lower antibody : sperm<br>**IGNORE** too many sperm cells unless qualified with a comment relating to antibody<br>limiting factor unless qualified | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(a)(i)** | A drawing that labels three of the following:<br><br>• DNA (loop) (1)<br><br>• stroma (1)<br><br>• starch {grain / granule} (1)<br><br>• inner membrane / envelope (1)<br><br>• inter membrane space (1)<br><br>• intergranal membrane / (stromal) lamellae / intergranal thylakoid (1)<br><br>• (small / 70S) ribosome (1)<br><br>• lipid droplets<br><br>**IGNORE** thylakoid membrane / lumen of thylakoid / grana<br>drawing quality, unless completely wrong e.g. strand of DNA | **DO NOT ACCEPT** if drawn as linear DNA<br><br>**DO NOT ACCEPT** stoma<br><br><br><br><br>**NB**<br>1 correct + 1 or 2 wrong = 1 mark<br>1 correct + 3 wrong = 0 marks<br>2 correct + 1 wrong = 2 marks<br>2 correct + 2 or 3 wrong = 1 mark<br>3 correct + 1 wrong = 2 marks<br>3 correct + 2 wrong = 1 mark<br>3 correct + 3 wrong = 0 marks | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(a)(ii)** | • length measured and converted to µm / length measured and actual chloroplast length converted into same units (1)<br><br>• (magnification given to 2 significant figures, with no units) 27 000 (1) | 80 000 / 81 000 / 82 000 + 3<br>80 / 81 / 82 + 0.003<br>8.0 / 8.1 / 8.2 + 0.0003<br><br>80 000 ÷ 3 = 26,666.66<br>81 000 ÷ 3 = 27,000<br>82 000 ÷ 3 = 27,333.3333<br><br>ECF figures of 27 given but wrong order of magnitude<br><br>**NB**<br>Correct answer with no working = 2 marks<br>Correct answer with too many sig figs = 1 mark<br>Figures of 27 given but wrong order of magnitude = 1 mark | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(b)** | An explanation that makes reference to four of the following:<br><br>• (contain) {photosystems / PSI / PSII / chlorophyll / named pigment} so that {light / photons} can be absorbed (1)<br><br>• (contain) electron {carrier proteins / carriers / transport chain} so that {reduced NADPH is formed / hydrogen is pumped into thylakoid (space) / so that a series of redox reactions can take place} (1)<br><br>• (contain) ATP synthase so that hydrogen ions can pass through (1)<br><br>• membranes {enclose a space / form a barrier} so that hydrogen ions can accumulate (1)<br><br>• membranes are the site of {photolysis / chemiosmosis / photophosphorylation} (1) | **ACCEPT** ETC<br><br>**ACCEPT** ATPase<br><br>**ACCEPT** membranes trap hydrogen ions<br>protons<br><br>**ACCEPT** compartmentalisation / description of | (4) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(c)(i)** | • RUBISCO / ribulose bisphosphate carboxylase / ribulose bisphosphate oxygenase | **ACCEPT** ribulose biphosphate carboxylase / ribulose biphosphate oxygenase<br>RUBISCO in capitals / lowercase / mixture | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(c)(ii)** | An explanation that makes reference to two of the following:<br><br>• keep the thylakoids and enzymes close together (1)<br><br>• so that products of the light-dependent stage {are not lost / can collide with enzymes more frequently} (1)<br><br>• because enzymes need to be in solution to function (1) | **ACCEPT** other terms meaning close e.g. nearby, constant contact, touching, small distance<br>{products / named products} of light-dependent stage needed in {light-independent stage / Calvin cycle / carbon fixation / by enzymes}<br><br>**ACCEPT** easier for collisions to occur | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(a)** | • $7 \times 10^4$ | **ACCEPT** $7.0 \times 10^4$ | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(b)(i)** | • number of guanine and cytosine bases given as 317 203 092<br><br>**OR**<br><br>number of thymine bases given as 204 202 736<br><br>**OR**<br><br>number of adenine and thymine bases given as 408 405 472<br><br>• number of guanine bases calculated as 158 601 546 | Correct answer with no working get 2 marks | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(b)(ii)** | • one set of correct figures {selected / calculated} for Yap hadal snailfish (1)<br><br>• 85.8 (%) (1)<br><br>**OR**<br><br>• one set of correct figures {selected / calculated} for Mariana hadal snailfish (1)<br><br>• 85.6 (%) (1) | 14 750 / 12 685 / 2 092<br><br>*85.816949152542372881355932203 39*<br><br>14 783 / 12 658 / 2 125<br><br>*85.625380504633700872623959954001*<br><br>1 mark if {incorrect rounding / too many dps given in answer}<br>ECF correct % for correct numbers {used / added up} from diagram wrongly | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(b)(iii)** | A description that makes reference to three of the following:<br><br>• All four fish {share the same (original) common ancestor / came from the same species} (1)<br><br>• Yap hadal and Mariana snailfish are <u>most closely-related</u> / the zebrafish is the <u>least closely-related</u> (1)<br><br>• Yap hadal and Mariana snailfish evolved from the same {species / common ancestor} (1)<br><br>• The common ancestor of the {Yap hadal snailfish / Mariana snailfish} {evolved from / had} the same common ancestor as the Tanaka's snailfish (1)<br><br>• Zebrafish are the <u>most distantly-related</u> because they diverged from the others {about 240 million years ago / the longest time ago} (1) | **NB IGNORE** years given unless contradictory<br><br>**ACCEPT** had the most recent common ancestor<br>Tanaka's snailfish is <u>closer-related</u> to the zebrafish than the other snailfish as they have the closest common ancestor<br><br>**ACCEPT** evolved from the same species<br><br>**ACCEPT** the three snailfish are <u>more closely related</u> as they share a (more) recent common ancestor | (3) |

| Question Number | Indicative content |
|---|---|
| ***7(b)(iv)** | **Indicative content:**<br><br>**Aspect 1 : Isolation**<br>• common ancestor lived in same area<br>• example of allopatric speciation<br>• because in different trenches<br>• geographical barrier<br>• which is shallower water<br><br>**Aspect 2 : Selection pressures**<br>• conditions in two areas were different<br>• e.g. temperature, food, predators<br>• therefore different selection pressures / description of<br><br>**Aspect 3 : Natural selection story**<br>• two species evolved from the common ancestor they shared<br>• mutations occurred (in DNA)<br>• some giving rise to advantageous alleles<br>• new phenotypes enabling survival<br>• example of phenotype described<br>• survivors reproduced and passed down their alleles<br>• increase in allele frequencies<br><br>**Aspect 4 : Decrease in gene flow**<br>• gene flow reduced between two populations<br>• no longer interbreed together<br>• over time became two separate species as they cannot interbreed to produce fertile offspring<br>• as would have become reproductively isolated<br>• because {did not recognise mating behaviour / incompatible genitalia}<br><br>**Aspect 5 : Epigenetics**<br>• epigenetic modification occurred<br>• different genes became permanently switched off in the two species<br>• these changes were inherited |

**Level 1**

1 mark = any relevant comment

2 marks = demonstration of **some** understanding of **1** aspect

**Level 2**

3 marks = Good understanding of **1** aspect + **1** other aspect mentioned

4 marks = Good understanding of **2** aspects + **1** other mentioned

**Level 3**

5 marks = Good understanding of **2** aspects + **2** others mentioned

6 marks = Good understanding of **3** aspects + **1** other aspect mentioned which includes some specific detail relating to question scenario

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(a)** | A description that makes reference to four of the following:<br><br>• mRNA used (by macrophage in translation) to synthesise {(poly)peptide / protein / antigen / amino acid} (1)<br><br>• polypeptide {transported in RER / modified in Golgi / packaged in Golgi} (1)<br><br>• {antigen / protein} expressed on (macrophage) {surface of cell / membrane} (1)<br><br>• antigen attached to MHC (molecule) (1)<br><br>• binding of macrophage to T helper cells (1) | **IGNORE** ref to {viral antigens / reverse transcription} for mp 3, 4 and 5<br>**ACCEPT** mRNA is translated / translation of mRNA<br>**DO NOT ACCEPT** transcription<br><br>**DO NOT ACCEPT** mRNA attaches<br>**IGNORE** antigen moved towards membrane unless qualified that this is for presentation<br><br>**ACCEPT** macrophage binds to CD4 (antigen on T helper cells) | (4) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(b)** | An answer that makes reference to four of the following:<br><br>**Similarities:**<br><br>• both are active forms of immunity (1)<br><br>• both involve T helper cells (1)<br><br>• both involve cytokines (1)<br><br>• both result in the production of memory cells (1)<br><br>**Differences**<br><br>• antigen presentation in HIR is by {B cells (themselves) / antibody bound to B cells}<br>**AND**<br>in CMI the infected host cells present the antigen (1)<br><br>• {B cells / plasma cells} involved in the HIR but not in the C-MIR<br>**OR**<br>T killer cells involved in the C-MIR but not in the HIR (1)<br><br>• antibodies involved in HIR<br>**AND**<br>{not in the C-MIR / enzymes in C-MIR} (1)<br><br>• HIR involved in (cell-free) {antigens / pathogens} (and infected host cells and cancer cells)<br>**AND**<br>C-MIR involved with host-infected cells (1) | **NB do not piece together** except two adjacent sentences making single comparative point or comparative points linked between two sentences<br>**At least one similarity and one difference for full marks.**<br><br>**DO NOT ACCEPT** cytokinins<br><br>**IGNORE** types of memory cells, even if muddled up<br><br>**IGNORE** macrophages present antigen if mentioned in both but **DO NOT ACCEPT** if only mentioned in one<br><br>**ACCEPT** T cytotoxic cells<br>**ACCEPT** {B cells / plasma cells} involved in the HIR but T killer cells involved in the C-MIR<br>**IGNORE** T helper cells if mentioned in both but **DO NOT ACCEPT** if only mentioned in one<br><br>**ACCEPT** perforin | (4) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(c)** | An explanation that makes reference to the following:<br><br>• {chemicals / enzymes / perforins} (from T killer cells / CMI) will cause destruction of cancer cells (1)<br><br>• antibodies (from HI) will bind to the cancer cells / opsonisation of cancer cells (by antibodies) (1)<br><br>• therefore macrophages will engulf the cancer cells (as a result of the HIR) (1)<br><br>• and {enzymes break down the cancer cells / cancer cells are digested} (by phagocytes) (1) | **ACCEPT** in context of either primary or secondary immune response<br><br>**IGNORE** T killer cells bind to cancer cells<br><br>**IGNORE** agglutination<br>B cells produce antibodies<br>refs to pathogens<br>**DO NOT ACCEPT** antibodies destroy cancer cells<br>**ACCEPT** neutrophils / phagocytes | (4) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9(a)(i)** | **The only correct answer is A**<br><br>***B*** *is incorrect because electron transport chain is located on the inner membrane*<br>***C*** *is incorrect because electron transport chain is located on the inner membrane*<br>***D*** *is incorrect because electron transport chain is located on the inner membrane* | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9(a)(ii)** | An explanation that makes reference to the following:<br><br>• because the electron transport chain can no longer function (1)<br><br>• resulting in protein carriers / named carrier} becoming reduced (1)<br><br>• therefore cells can only respire anaerobically (1)<br><br>• therefore insufficient {ATP / energy} generated to sustain the fish (1) | **ACCEPT** {electrons transfer can no longer occur/ electrons cannot flow through the cytochromes} slower / less<br>**DO NOT ACCEPT** in context of no oxygen present<br><br>**ACCEPT** cannot become oxidised / {NAD / FAD} cannot be regenerated / redox reactions cannot occur<br><br>**ACCEPT** oxidative phosphorylation will be prevented / no protons pumped into intermembrane space /ATPase cannot synthesise ATP<br><br>**ACCEPT** a reason for fish not being able to survive e.g. {heart / muscles} to contract, active transport, metabolism, chemical reactions<br>lactic acid build up denaturing enzymes / stopping muscle contraction<br>**IGNORE** no energy for respiration<br>energy to swim too vague | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9(b)(i)** | • changes in {gene expression / phenotype} without a change in {base sequence / DNA / gene / genotype / genetic code} (1) | **ACCEPT** switching genes on or off<br>**DO NOT ACCEPT** mutation | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9(b)(ii)** | **The only correct answer is B**<br><br>***A** is incorrect because deletion mutation changes the base sequence*<br>***C** is incorrect because translation is the synthesis of a peptide chain*<br>***D** is incorrect because translocation affects the DNA base sequence* | | (1) |

| Question number ***9(c)** | **Data :**<br>First generation fish<br>• male fish from environment with $H_2S$ have more DMRs than male fish from environment without $H_2S$<br>• female fish from environment with $H_2S$ have more DMRs than female fish from environment without $H_2S$<br>• number of DMRs increase up to a CpG density of 3 a.u. and then decrease<br>• the number of female DMRs and male DMRs show a similar pattern<br>• female fish have more DMRs than male fish<br>Second generation fish<br>• second generation fish show similar patterns of DMRs as the original fish<br>• but there are differences e.g. male fish showing more DMRs at a CpG density of 2 than {original fish / female fish}<br>• there are significant differences for the males at lower CpG densities, original females higher but 2nd gen females lower<br>**Lower level discussion points : recall of knowledge of epigenetics / experimental design :**<br>• DNA methylation of cytosine at CpG sites<br>• Methylations adds a $CH_3$<br>• DNA methylation causes silencing of genes<br>• by preventing transcription<br>• epigenetic modifications are {inherited / passed down}<br>• no details of experiment<br>• no statistical analysis<br>**Higher level discussion points :**<br>• the presence of $H_2S$ could be causing {DNA-methylation / epigenetic modification}<br>• but no indication of other differences in the water that could be causing this<br>• (wild) males could be less susceptible to DNA-methylation than female fish (so increase not so great) / genetic effects<br>• females have more methylation sites on second X chromosome<br>• female fish already more adapted to toxic environment<br>• DMRs have been retained by the second generation of fish<br>• and stable / retained even after $H_2S$ no longer present<br>• but it appears that the laboratory conditions are also causing more DMRs to be formed in male fish<br>• DNA methylation is a survival advantage<br>• fish with more DNA methylation are better adapted to $H_2S$<br>• as interruption to mitochondrial respiration is reduced / ETC can continue<br>• DNA methylation can stimulate gene expression<br>• so proteins synthesised that {inhibit $H_2S$ / provide an alternative to cytochrome c oxidase} |
|---|---|

**NB** IGNORE all values given unless clearly wrong

**Level 1 : Data commented on without any discussion**

1 mark = any relevant comment

2 marks = some comparison of data

**Level 2 : Some data discussed**

3 marks = 1 discussion point

4 marks = 2 discussion points

**Level 3 : Data discussed with some application of ideas**

5 marks = comparisons described + 3 discussion points, including at least one higher level point

6 marks = comparisons described + 4 discussion points, including at least one higher level point

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