PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

# BIOLOGY



## MARK SCHEME

TOPIC 1: BIOLOGICAL MOLECULES

ENZYMES

| SCORE | PERCENTAGE |
| --- | --- |
| /100 | % |

STEMUP

# These questions belong to Pearson Edexcel, not to us.

The examination questions and mark schemes in this pack were written and published by Pearson Edexcel. They are past assessment materials, reproduced here so that students can revise from them.

## What we do not own

STEMUP is not affiliated with Pearson Edexcel and does not own, and makes no claim to own, any of the question or mark scheme material in this pack. Pearson has not endorsed, approved or been involved in the production of it. Pearson, Edexcel and the qualification titles used here belong to their respective owners and appear for identification only.

## Where to find the originals

Pearson publishes its past papers and mark schemes free of charge. Always check the current specification at qualifications.pearson.com before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

## Mark Scheme

Q1.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | An explanation that contains three of the following:<br><br>• higher kinetic energy so more enzyme-substrate complexes formed (1)<br><br>• at very high temperatures the **rate decreases** due to denaturation (1)<br><br>• because of bond changes in the enzyme altering the active site (1)<br><br>• so substrate no longer fits active site (and rate of product formation decreases) | Accept higher kinetic energy increases rate of collisions (between enzyme and substrate)<br><br>Accept at temperatures above the optimum the rate decreases due to denaturation<br><br>Accept changes to tertiary structure change the shape of the active site<br>Accept bonds break in the enzyme altering the active site<br>Do not accept peptide bonds<br><br>Accept substrate longer complementary to active site | **Exp (3)** |

Q2.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **(i)** | An answer including two of the following variables with suitable methods of control:<br>• appropriate named variable (1)<br>• description of how the variable is controlled (1)<br>• appropriate named second variable (1)<br>• description of how second variable is controlled (1) | eg<br>• volume of hydrogen peroxide / accept stated volume<br>- measuring cylinder / syringe / pipette (to measure same volume)<br>• concentration of hydrogen peroxide / accept stated concentration<br>– dilute / make up solution to same % concentration / use of stock solution<br>• temperature / accept stated temp<br>- flask in **thermostatically controlled** waterbath / accept descriptions<br>• pH / accept stated pH<br>– buffer in flask | **Exp (4)** |

| Question Number | Answer | Additional Guidance | | Mark |
|---|---|---|---|---|
| **(ii)** | Initial rate of reaction calculated (1) | Answer uses **seconds** | 0.33 $cm^3 s^{-1}$ | **Grad (1)** |
| | | **Accept:** values in range: | 0.28 to 0.35 $cm^3 s^{-1}$ | |
| | | **Accept:** $cm^3/s$ : $cm^3$ per second | | |
| | | Answer uses **minutes** | 19.8 $cm^3 min^{-1}$ | |
| | | **Accept:** values in range | 16.8 to 21.0 $cm^3 min^{-1}$ | |
| | | **Accept:** $cm^3/min$ : $cm^3$ per min | | |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (iii) | An explanation including the following<br>• {hydrogen peroxide / substrate} is {converted to products / used up} (1)<br>• so less substrate to collide with the enzyme (1) | Accept {hydrogen peroxide / substrate} becomes a limiting factor<br>Accept concentration of {hydrogen peroxide / substrate} decreases<br>Accept less substrate so fewer enzyme-substrate complexes form | **Exp (2)** |

Q3.

| **Question Number** | **Answer** | **Additional Guidance** | **Mark** |
|---|---|---|---|
| | An explanation including three of the following<br>• As more potato is added more oxygen is produced because more enzyme is present (1)<br>• increase in volume of oxygen expected as surface area increases (1)<br>• {volume of oxygen produced / graph / rate of reaction} may level off as substrate {is not in excess / is used up} (1) | Accept rate of reaction would increase because there is **more enzyme** available<br>Accept increased rate of reaction expected as surface area increases<br>Accept at a higher number of cubes, concentration of hydrogen peroxide may be a limiting factor | **Exp (3)** |

Q4.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (i) | An explanation that makes reference to the following:<br>• citrate binds to another site on the enzyme, activating theenzyme (1)<br>• so that the structure of the enzyme is changed (1)<br>• so that active site binds more effectively to the substrate (1)<br>• an increase in fatty acyl CoA molecules inhibits the substratebinding to the active site (1)<br>• due to competitive inhibition (1) | Accept citrate and fatty acyl CoAmolecules act together to regulate the activity of the enzyme | (5) |
| (ii) | An explanation that makes reference to two of thefollowing:<br>• fewer fatty acids will be made (1)<br>• so that less fat is stored (1)<br>• because the enzyme is being inhibited despite beingactivated by citrate (1) | Allow (less fat stored so) fatreserves used | (2) |

Q5.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | An explanation that makes reference to four of the following:<br>• because 30 °C is an appropriate temperature for one species and provides enough oxygen for the other species<br>**(1)**<br>• because if the temperature was above {30 / 40} °C there would be less oxygen dissolved in it<br>**(1)**<br>• so there would not be enough oxygen for {respiration / metabolism / ATP production}<br>**(1)**<br>• because if the temperature was above {25 / 30} °C the enzymes would be denaturing<br>**(1)**<br>• because the temperature was below {25 / 30} °C the enzymes would not have enough {kinetic energy / collisions / enzyme substrate complexes}<br>**(1)** | **Accept** because 30 °C satisfies the requirements of both fish<br>**Do not accept** start to denature<br>**Accept for 1 mark** 30 °C is close to the optimum temperature for the enzymes | **(4)** |

Q6.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (i) | A description that makes reference to four of the following:<br>• sample taken from the female genital tract (1)<br>• bacteria grown on {selective / indicator} media (1)<br>• bacteria grown on media containing different types of antibiotics (1)<br>• use of {antibodies / DNA profiling} (1)<br>• using {Gram staining / cell shape / colony shape / colony colour} (1) | | (4) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (ii) | An explanation that makes reference to three of the following:<br>• because they grow on the skin cells preventing pathogenic bacteria from doing so (1)<br>• because they use the glycogen so less {glucose / energy / glycogen} available for the pathogenic bacteria (1)<br>• because they produce lactic acid which inhibits the growth of pathogenic bacteria (1)<br>• because the low pH denatures the enzymes of the pathogenic bacteria (1) | **ACCEPT** below optimum pH | (3) |

Q7.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **(i)** | A calculation that makes reference to the following:<br>• correct tangent to the curve (1)<br>• correct measurement of the y axis and x axis distances (1)<br>• correct calculation of gradient (1) | **Accept** a straight line that must through or between 19.0 mg $cm^{-3}$ or 24.0 mg $cm^{-3}$ at 30 s.<br>**TE** for mark points 2 and 3 from wrong tangent<br>**TE** for mark point 3 for correct gradient calculation with no tangent (y ÷ x)<br>Example of calculation:<br>21.0 / 30 = 0.70 mg $cm^{-3}$ $s^{-1}$<br>(accept range of between 0.63 mg $cm^3$ $s^{-1}$ to 0.80 mg $cm^3$ $s^{-1}$)<br>Correct answer with no working gains full marks | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (ii) | A explanation that makes reference to two of the following:<br>• active site (of enzyme) {shape / structure} changes (1)<br>• because {$H^+$ ions / acid} {affects ionic bonds / affects hydrogen bonds} (of enzyme) (1)<br>• so {substrate/ monophenol} no longer fits / binds (1) | **Accept** {shape / structure} of monophenol changes so it no longer fits active site<br>**Accept** because $H^+$ ions / bind to monophenol<br>**Accept** E/S complexes do not form | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (iii) | An explanation that makes reference to two the following:<br>• tropolone is similar in {shape / structure} to monophenol (1)<br>• tropolone acts as a competitive inhibitor / binds in the active site (1)<br>• so it prevents {binding of monophenol / enzyme substrate complexes forming} decreasing the {rate of reaction / production of quinone / enzyme activity}(1) | | **(2)** |

Q8.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (i) | An answer that makes reference to two of the following:<br>• less needed for same sweet effect (1)<br>• therefore less {energy / calorie} intake (1)<br>• therefore less risk of appropriate named health benefit (1) | **e.g.** reduced obesity / (type 2) diabetes / tooth decay / heart disease / atherosclerosis / high blood pressure / CVD / CHD | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | • 0.066 to 0.074 | **DO NOT ACCEPT** 0.06° | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (iii) | An answer that makes reference to the following:<br>• with and without magnesium ions (1)<br>• use same {volume / stated $cm^3$ / concentration} of isomerase enzyme (1)<br>• use excess {glucose / substrate} (1)<br>• control {temperature / pH} (1)<br>• repeat to {calculate mean / calculate average / standard deviation / standard error / recognise anomalies} (1) | **ACCEPT** same mass<br>**DO NOT ACCEPT** if in list | **(5)** |

Q9.

| Question Number | Acceptable Answer | Additional Guidance | Mark |
|---|---|---|---|
| **(i)** | non-competitive (inhibition) | | **(1)** |

| Question Number | Acceptable Answer | Additional Guidance | Mark |
|---|---|---|---|
| **(ii)** | An answer that makes reference to the following:<br><br>• appropriate assembly of reaction mixture: copper ions added to cellulose and cellulase (1)<br><br>• use of control with cellulose, cellulase and no copper ions (1)<br><br>• details of steps taken to control two relevant variables (1)<br><br>• use of colorimeter to obtain quantitative measure of the dependent variable (1)<br><br>• calculation of mean results from repeat data (1) | <u>Allow other controls e.g.</u><br>With copper ions, cellulose and no cellulase /<br>With copper ions, cellulase and no cellulose<br>Allow filtering, drying and weighing the precipitate | **(5)** |

Q10.

| Question Number | Answer | Mark |
|---|---|---|
| (i) | The only correct answer is A hydrogen only<br><br>*B is incorrect because ionic bonds are not involved in the secondary structure*<br><br>*C is incorrect because disulfide bonds are not involved in the secondary structure*<br><br>*D is incorrect because ionic bonds are not involved in the secondary structure* | 1 |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (ii) | An explanation that makes reference to three of the following:<br><br>• {tyrosinase active / melanin made} in cooler regions (1)<br><br>• tyrosinase denatures / {hydrogen / ionic} bonds break (in warm / light regions) (1)<br><br>• active site changes shape / tertiary structure changes (1)<br><br>• no enzyme substrate complexes form / tyrosine does not bind (to tyrosinase / enzyme) (1) | **ACCEPT** converse throughout<br><br>**ACCEPT** enzyme for tyrosinase for all mark points<br><br>**ACCEPT** optimum temperature is cool / low | 3 |

Q11.

| Question Number | Acceptable Answer | Additional Guidance | Mark |
|---|---|---|---|
| | An explanation that makes reference to the following:<br><br>• (a mutation results in) a different sequence of amino acids (1)<br><br>• therefore different R groups / side chains (1)<br><br>• resulting in changes to { ionic / hydrogen bonding / disulphide bridges } (1)<br><br>• change in shape of active site causing a change in enzyme activity (1) | | **(4)** |

Q12.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | An explanation that makes reference to four of the following:<br><br>• as temperature increases up to 10°C hatching increases and then decreases (1)<br><br>• enzyme activity affects {hatching / development / growth}<br><br>(1)<br><br>• (below 10°C ) increase in temperature increases {kinetic energy / enzyme-substrate complexes / successful collisions between enzyme} (1)<br><br>• (above10°C) temperature too high denatures enzymes (1)<br><br>• higher temperature results in less dissolved oxygen available<br><br>(1) | Piece together<br><br>**ACCEPT** converse<br><br>**DO NOT ACCEPT** starts to denature<br>**ACCEPT** shape of active site changed | **(4)** |

Q13.

| Question Number | Acceptable Answer | Additional Guidance | Mark |
|---|---|---|---|
| **(i)** | An explanation that makes reference to the following:<br><br>• (as) wavelength of light decreases, rate of photosynthesis increases (1)<br><br>• because the data show a greater colour change at shorter wavelengths of light, indicating faster $CO_2$ uptake (by alga) (1) | ACCEPT converse throughout | **(2)** |

| Question Number | Indicative content |
|---|---|
| * **(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.<br><br>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.<br><br>• the trend of the results is opposite in the two repeats: results are not reliable<br>• variables such as organism and indicator are controlled whereas variables such as temperature and light intensity are not controlled<br>• colour changes judged by eye are qualitative and not precise<br>• fastest rate is seen with the last filter used, therefore temperature may be responsible for change in rate<br>• experiment left for 30 minutes, other additional times would give extra information about the rate<br>• coloured indicator may affect the wavelengths of light reaching the algae<br>• the algae will be respiring and producing $CO_2$, which complicates measurement of the rate of photosynthesis<br>• rate of respiration is assumed to be constant, but this may not be the case<br>• changes in temperature or pH may alter the activity of the enzymes responsible for photosynthesis<br>• conclusion that the experiment is invalid / not measuring effect of wavelength on photosynthesis |

| Level | Marks | Descriptor |
|---|---|---|
| Level 0 | **0** | No awardable content |
| Level 1 | **1-3** | Limited scientific judgement made with a focus on mainly one aspect. A few strengths or weaknesses identified.<br><br>A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but supported with limited evidence. |
| Level 2 | **4-6** | Scientific judgements are made through the application of relevant evidence, referring to both methods and trends in results. Both strengths and weaknesses are identified.<br><br>A conclusion is made with reference to more than one piece of evidence, demonstrating links to biological knowledge and understanding. |
| Level 3 | **7-9** | Scientific judgements are made through detailed analysis and interpretation of relevant evidence including trends in results and several aspects of methodology. Both strengths and weaknesses are identified in both methods and results.<br><br>A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding and drawing upon several strands of evidence. |

Q14.

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| (i) | An explanation that makes reference to five of the following:<br>• (cyanide) changes tertiary structure / changes active site / substrate no longer fits {active site / enzyme} (1)<br>• therefore transport of {electrons / hydrogen ions} stops (1)<br>• carrier(s) cannot be reduced (1)<br>• (so that) ATP manufacture stops / less ATP made (1)<br>• muscles {cannot contract / go into spasm} / breathing stops / heart stops (1)<br>• any other named biological process that requires ATP stops eg active transport (1) | | (5) |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| (ii) | • mass of cyanide that kills = 10 mg (1) | 1 x 10 = 10 mg | |
| | • mass of cyanide inhaled per minute | 0.24 mg $dm^{-3}$ x 15 = 3.6 (mg per minute) | |
| | • time taken to inhale lethal dose (1) | 10 ÷ 3.6 = **2.78** minutes (3sf) | |
| | OR | | |
| | • mass of cyanide that kills = 10 mg (1) | 1 × 10 = 10 mg | |
| | • volume that provides lethal dose (1) | 10 ÷ 0.24 = 41.67 ($dm^3$) | |
| | • time taken to inhale lethal dose (1) | 41.67 ÷ 15 = **2.78** minutes (3sf) | (3) |

Q15.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (i) | An answer that makes reference to the following:<br><br>One from:<br><br>• (increase in) rates are same up to 30 to 32 (mg $dm^{-3}$) / at 13 (µg $s^{-1}$) (1)<br><br>• both reduce rate up to 30 to 32 (mg $dm^{-3}$) / at 13 (µg $s^{-1}$) (1)<br><br>Then:<br><br>• B stops increasing but A continues to increase (1) | | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (ii) | An explanation that makes reference to the following<br><br>• inhibitor B because reaction does not reach rate without inhibitor (1)<br><br>• because it binds to {enzyme / allosteric site} (1)<br><br>• changes {active site} (1) | **ACCEPT** levels off / plateaus / stays the same / does not maximum rate<br><br>**DO NOT ACCEPT** binds to active site | (3) |

Q16.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | An explanation that makes reference to two of thefollowing:<br><br>• an inhibitor of the bacterial enzyme may not affect thehuman one (1)<br><br>• description of effect of treatment eg fatty acids not madeso {less respiration / bacteria die} (1)<br><br>• so that there will be fewer side effects if used as atreatment for infections (1) | Allow enzymes are specific<br><br>Allow is an effective antibiotic | **(2)** |

Q17.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | An explanation that makes reference to the following:<br><br>• clotting takes longer at low temperature due to {low kinetic energy / fewer enzyme-substrate collisions} (1)<br><br>• clotting time is least at {body/optimum} temperature (1)<br><br>• (clotting takes longer) at {temperatures above 37°C / high temperatures} (because) enzymes are denatured (1) | Accept clotting takes less time as temperature increases because {kinetic energy increases / more enzyme-substrate collisions} | **(3)** |

Q18.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | An explanation that makes reference to the following:<br>• {hydrolysis / breaking} of peptide bonds (1)<br>• by protease (1) | | (2) |

Q19.

| Question Number | Answer | Mark |
|---|---|---|
| | An explanation that makes reference to the following:<br>• it is the initial rate of reaction (1)<br>• substrate / hydrogen peroxide is in excess / not limiting / substrate / hydrogen peroxide decreases / becomes limiting (1) | (2) |

Q20.

| Question Number | Answer | Mark |
|---|---|---|
| | An explanation that makes reference to three of the following:<br>• catalase / enzyme {denatured / change to tertiary structure} (1)<br>• because {hydrogen / ionic / disulfide} bonds are broken (1)<br>• {shape} of active site changed (1)<br>• therefore no longer {binds / fits / attaches} to {substrate / hydrogen peroxide} / no enzyme substrate complexes (1) | (3) |