Green Planet: Radiation and the Evolution of Photosynthesis (June 2023 Paper 3 Scientific Article): Edexcel SNAB A

10 questions · 30 marks · about 36 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · A level Paper 3 · June 2023 · Q8(a) · 1 mark

8 The scientific article you have studied is adapted from a chapter in the book *Oxygen*.

Use the information from the scientific article and your own knowledge to answer the following questions.

(a) The mass of 'carbon turned into sugars by photosynthesis' is a measure of the gross productivity of photosynthetic organisms (paragraph 2).

Write an equation that describes the relationship between total carbon turned into sugar and the carbon turned into sugar that becomes available to primary consumers.

(1)

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Question 2 · A level Paper 3 · June 2023 · Q8(b) · 1 mark

(b) Name one product, other than ATP and oxygen, produced by the light dependent reactions of photosynthesis (paragraph 4).

(1)

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Question 3 · A level Paper 3 · June 2023 · Q8(c) · 3 marks

(c) Explain why cells use 'chemical energy in the form of ATP' (paragraphs 4 and 5).

(3)

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Question 4 · A level Paper 3 · June 2023 · Q8(d) · 4 marks

(d) Describe how 'plant photosynthesis converts carbon dioxide from the air into simple organic molecules' (paragraph 5).

(4)

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Question 5 · A level Paper 3 · June 2023 · Q8(e) · 4 marks

(e) Devise an investigation to show that in chloroplasts, the oxygen for photosynthesis comes from water and not carbon dioxide (paragraphs 6 and 7).

(4)

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Question 6 · A level Paper 3 · June 2023 · Q8(f) · 4 marks

(f) Explain how chloroplasts are adapted for their role in photosynthesis (paragraphs 9 and 10).

(4)

Question 7 · A level Paper 3 · June 2023 · Q8(g) · 3 marks

(g) Explain how energy of the electrons passed along an electron transport chain 'is used to power the synthesis of ATP' (paragraph 10).

(3)

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Question 8 · A level Paper 3 · June 2023 · Q8(h) · 3 marks

(h) Explain how 'tiny changes' in chlorophyll molecules could result in a change in the wavelength of light absorbed (paragraphs 12 and 13).

(3)

Question 9 · A level Paper 3 · June 2023 · Q8(i) · 4 marks

(i) The structure of the oxygen-evolving complex is similar to that of catalase, 'it looks as if it evolved from two catalase enzymes lashed together' (paragraph 17).

Explain how proteomics and genomics could be used to support the suggestion that the oxygen-evolving complex evolved from catalase.

(4)

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Question 10 · A level Paper 3 · June 2023 · Q8(j) · 3 marks

(j) Sketch a graph to compare the effect of substrate concentration on the rate of reaction of catalase and peroxidase (paragraphs 19 and 20).

Include suitable units in the labels for each axis.

(3)



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Mark schemes

Question 1 · A level Paper 3 · June 2023 · Q8(a) · 1 mark

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

Question 2 · A level Paper 3 · June 2023 · Q8(b) · 1 mark

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

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Question 3 · A level Paper 3 · June 2023 · Q8(c) · 3 marks

Question number	Answer
8(c)	An explanation that makes reference to three of the following: • contains {phosphate / P-O-P} bonds (1) • that when hydrolysed {releases / provides supplies} energy (1) • description of how energy is used (1) • ATP {immediate source of energy /releases energy rapidly} (1)

Additional guidance	Mark
ALLOW contain high energy bonds ALLOW hydration of released phosphates releases energy ALLOW (hydrolysis) is exothermic IGNORE ATP -> ADP + Pi IGNORE energy is produced e.g. to {form / break} bonds / form {carbohydrates / sugars} / used in light independent reactions / for metabolic reactions e.g. quickly hydrolysed	(3)

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Question 4 · A level Paper 3 · June 2023 · Q8(d) · 4 marks

Question number	Answer
8(d)	A description that makes reference to four of the following: • CO_2 combined with RuBP (1) • by RUBISCO (1) • forming molecules of GP (1) • each GP is converted to GALP using ATP and reduced NADP (1) • GALP used to form {glucose / hexose sugars} (1)

Additional guidance	Mark
ALLOW with ribulose bisphosphate ALLOW glycerate 3-phosphate ALLOW glyceraldehyde 3-phosphate ALLOW NADPH / $NADPH_2$ for reduced NADP IGNORE other molecules	(4)

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Question 5 · A level Paper 3 · June 2023 · Q8(e) · 4 marks

Question number	Answer
8(e)	An answer that makes reference to four of the following: • isolate chloroplasts (1) • incubate (chloroplasts) in solution of iron ferricyanide (1) • identification of one abiotic factor to control (1) • place chloroplasts in the light (1) • collect (and test) gas produced / observe decolourisation of DCPIP (1)

Additional guidance	Mark
ALLOW use Hill reaction / experiment ALLOW add iron ferricyanide e.g. temperature / light intensity / volume or concentration of reagent ALLOW record time for DCPIP to decolourise ALLOW measure volume of oxygen produced	(4)

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Question 6 · A level Paper 3 · June 2023 · Q8(f) · 4 marks

Question number	Answer
8(f)	An explanation that makes reference to four of the following: • large surface area of thylakoid (membrane) (1) • thylakoid (membrane) contain photosynthetic pigments to absorb light (1) • thylakoid (membrane) enables photophosphorylation (1) • stroma contains enzymes for light independent reaction (1) • stroma contains {DNA / ribosomes} to produce {enzymes / proteins} involved in photosynthesis (1)

Additional guidance	Mark
ALLOW grana / granum with large surface area ALLOW increases for large ALLOW contains {chlorophyll / photosystems} to absorb light ALLOW example e.g. contain electron transport chain molecules / enable generation of a proton gradient / contain ATP synthase ALLOW example of enzyme ALLOW to produce a named protein e.g chlorophyll / electron transfer chain protein	(4)

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Question 7 · A level Paper 3 · June 2023 · Q8(g) · 3 marks

Question number	Answer
8(g)	An explanation that makes reference to three of the following: • by photophosphorylation (1) • (transfer of) electrons releases energy (1) • that is used to {pump / move} protons into the thylakoid (space / lumen) (1) • protons {diffuse / move back down concentration gradient} through ATP synthase (1) • which forms ATP from ADP and inorganic phosphate (1)

Additional guidance	Mark
IGNORE reference to mitochondria ALLOW H^+ for proton DO NOT ALLOW diffuse DO NOT ALLOW pumped ALLOW which phosphorylates ADP	(3)

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Question 8 · A level Paper 3 · June 2023 · Q8(h) · 3 marks

Question number	Answer
8(h)	An explanation that makes reference to the following: • change in the {3D structure / tertiary structure / bonds formed} (1) • changes shape of (chlorophyll) light absorbing region (1) • changing the quantity of energy needed to {release / excite} an electron (1)

Additional guidance	Mark
ALLOW change in amino acid sequence / primary structure ALLOW so wavelength of light absorbed {decreases / correct stated change in wavelength} e.g. 870 to 716 / 716 to 680 / 870 to 680 IGNORE unqualified change in wavelength of light absorbed	(3)

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Question 9 · A level Paper 3 · June 2023 · Q8(i) · 4 marks

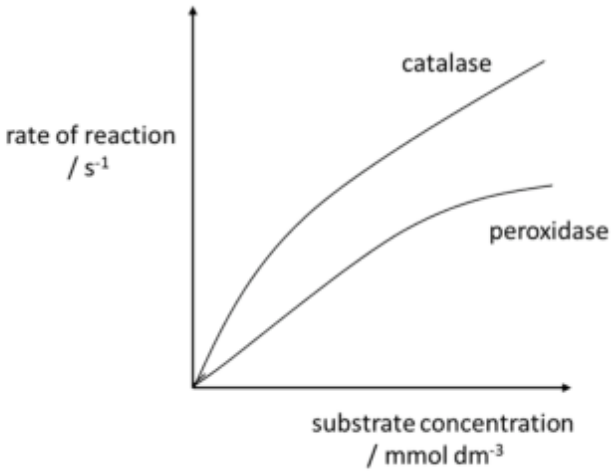
Question number	Answer
8(i)	An explanation that makes reference to the following: • compare the amino acid sequences (in catalase and the oxygen evolving complex) (1) • compare the base sequences of the {DNA / genes} (for catalase and the oxygen evolving complex) (1) • in organisms from different stages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

Additional guidance	Mark
ALLOW primary structure ALLOW converse ALLOW similar sequences in catalase and oxygen-evolving complex support the suggestion	(4)

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Question 10 · A level Paper 3 · June 2023 · Q8(j) · 3 marks

Question number	Answer
8(j)	• two lines one for catalase and one for peroxidase with slope for catalase steeper than that for peroxidase (1) • axes correct and labelled (1) • suitable axis units (1)

Additional guidance	Mark
e.g. x- axis {substrate / peroxide / H_2O_2} concentration e.g. y-axis rate of oxygen production / rate of reaction e.g x-axis {g cm^{-3} / mol dm^{-3}/ vol / %} e.g. y-axis {g s^{-1} / mol s^{-1} / mol dm^{-3} s^{-1} / s^{-1}} ALLOW any units of mass, moles and time IGNORE a.u. e.g. gains all three marks 	(3)

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