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GCE A LEVEL – BIOLOGY UNIT 3 QUESTION PACK

1074 (Legacy BY4) + 1075 (Legacy BY5) · New spec Unit 3 Topic 2 · A2 unit, first sat 2017, 90 marks, 2h paper

REVISE

.wales

BIOLOGY – UNIT 3 · PHOTOSYNTHESIS – LIGHT REACTIONS & CHLOROPLAST

3.2 Photosynthesis – chloroplast structure, light-dependent stage, photolysis, photophosphorylation

Ultrastructure of the chloroplast (grana, thylakoids, stroma), the absorption and action spectra of chlorophyll, photosystems I and II, non-cyclic and cyclic photophosphorylation, photolysis of water, and the production of ATP and reduced NADP for use in the Calvin cycle.

LEGACY 2008 SPECIFICATION

Estimated time for entire question pack: ~1 h 57 min

Derived from the legacy BY4 / BY5 papers' pace of ~1.3 min/mark, padded for long-prose answers (73 marks over 6 questions).

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains every question from the legacy WJEC BY4 (and BY5, where relevant) papers (2008 modular spec, 2011–2017) that maps onto new-spec A2 Unit 3 Topic 2 (3.2).

Questions are ordered by source paper date.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working – quality of written communication will affect marks. A calculator is allowed. Diagrams included in answers must be fully annotated.

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Q	Source	Max	Mark	Q	Source	Max	Mark
1	BY4 Jun 13 Q3	10		4	BY4 Jun 17 Q7	11	
2	BY4 Jun 14 Q5	13		5	BY4 Jan 12 Q3	14	
3	BY4 Jun 16 Q2	9		6	BY4 Jan 14 Q7	16	
Total						73	

Photosynthesis – Light Reactions & Chloroplast – what the new spec asks

WJEC GCE A Level Biology (from 2015) · Unit 3: Energy, Homeostasis & the Environment · Topic 3.2.

Chloroplast structure

- Outer + inner membranes; stroma fluid matrix.
- Thylakoid membrane stacks form grana.
- Photosystems & ETC embedded in thylakoid membrane.

Photosystems

- Pigments arranged in light-harvesting complexes.
- PSI absorbs at 700 nm (P700), PSII at 680 nm (P680).
- Antenna pigments funnel energy to reaction-centre chlorophyll.

Non-cyclic photophosphorylation

- Z-scheme: PSII → ETC → PSI → NADP⁺.
- Produces ATP (via chemiosmosis) and reduced NADP.
- Photolysis of water replaces electrons in PSII (O₂ released).

Cyclic photophosphorylation

- Uses PSI only – electrons cycle back to PSI.
- Produces ATP only, no NADPH and no O₂.
- Boosts ATP when Calvin cycle demands extra.

Photosynthesis – Light Reactions & Chloroplast in one page

Quick-reference notes – revisit before each question.

Chloroplast

Outer + inner membranes;
intermembrane space.
Thylakoids stacked in grana,
embedded in stroma.
Pigments + ETC + ATP synthase on
thylakoid membrane.

Photolysis

Water split in PSII: $2\text{H}_2\text{O} \rightarrow 4\text{H}^+ + 4\text{e}^- + \text{O}_2$.
Electrons replace those lost from
P680.
 O_2 is the by-product released into the
air.

Z-scheme (non-cyclic)

PSII (P680) \rightarrow ETC \rightarrow PSI (P700) \rightarrow
NADP⁺.
Generates ATP + reduced NADP.
Drives the Calvin cycle.

Cyclic

Uses PSI only; electrons cycle back.
Makes ATP only.
Tops up ATP when Calvin cycle short.

Chemiosmosis (chloroplast)

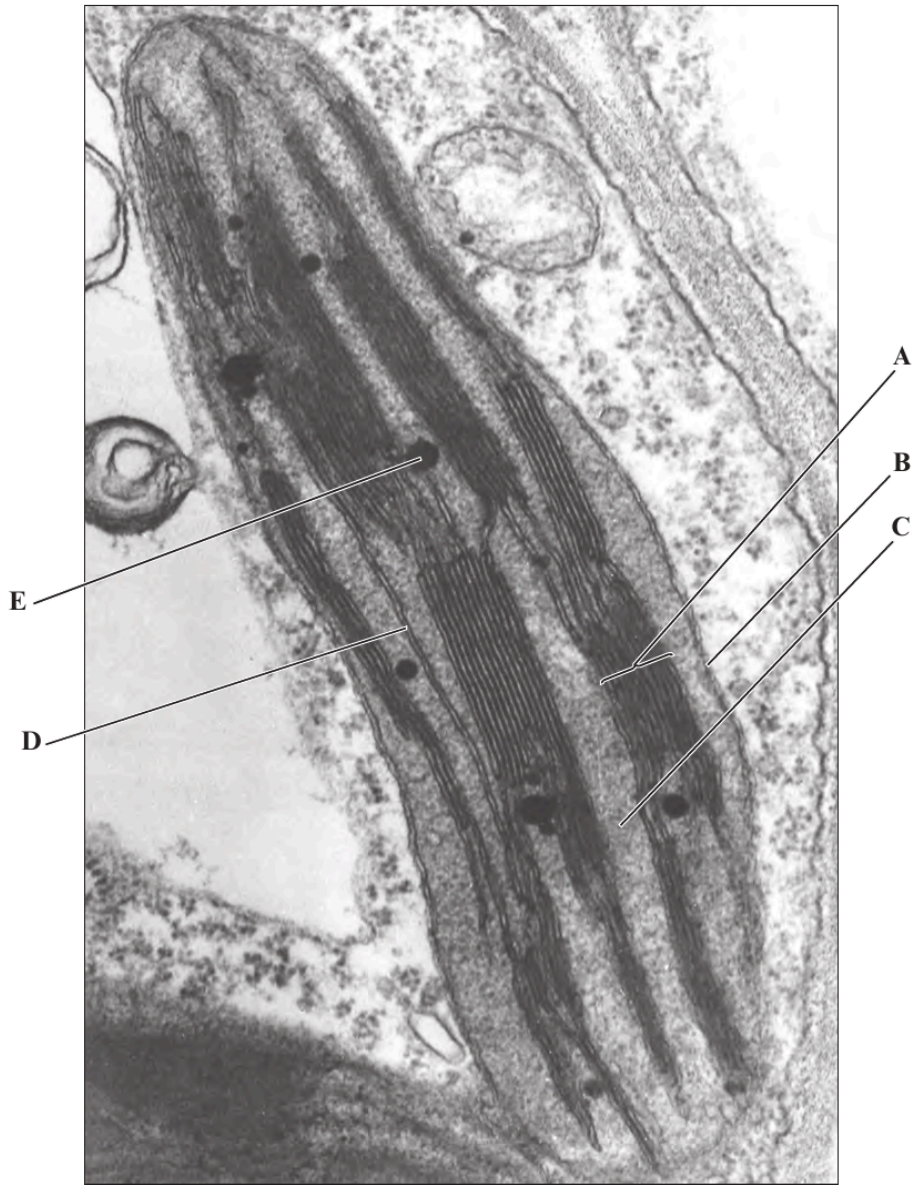
H^+ pumped into thylakoid space.
Flow out through ATP synthase makes
ATP.
Same principle as mitochondrial
chemiosmosis.

Pigments

Chlorophyll a (blue-green) absorbs 430
& 662 nm.
Chlorophyll b, carotenoids extend
absorption range.
Antenna pigments funnel energy to
reaction centre.

3. The electron micrograph below shows part of a palisade cell, including one chloroplast.

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- (a) Choose a letter or letters from the electron micrograph above that indicate [3]
- (i) one granum,
 - (ii) parts of the chloroplast where photosynthetic pigments are located,
 - (iii) where reactions of the Calvin cycle occur.

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(b) The Calvin cycle involves the conversion of inorganic carbon dioxide into useful organic compounds.

(i) Explain how carbon dioxide is used in the production of glycerate-3-phosphate. [2]

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(ii) Describe how glycerate-3-phosphate is converted to triose phosphate. [3]

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(c) (i) State why only some of the triose phosphate produced by the Calvin cycle can be used to produce hexose phosphate. [1]

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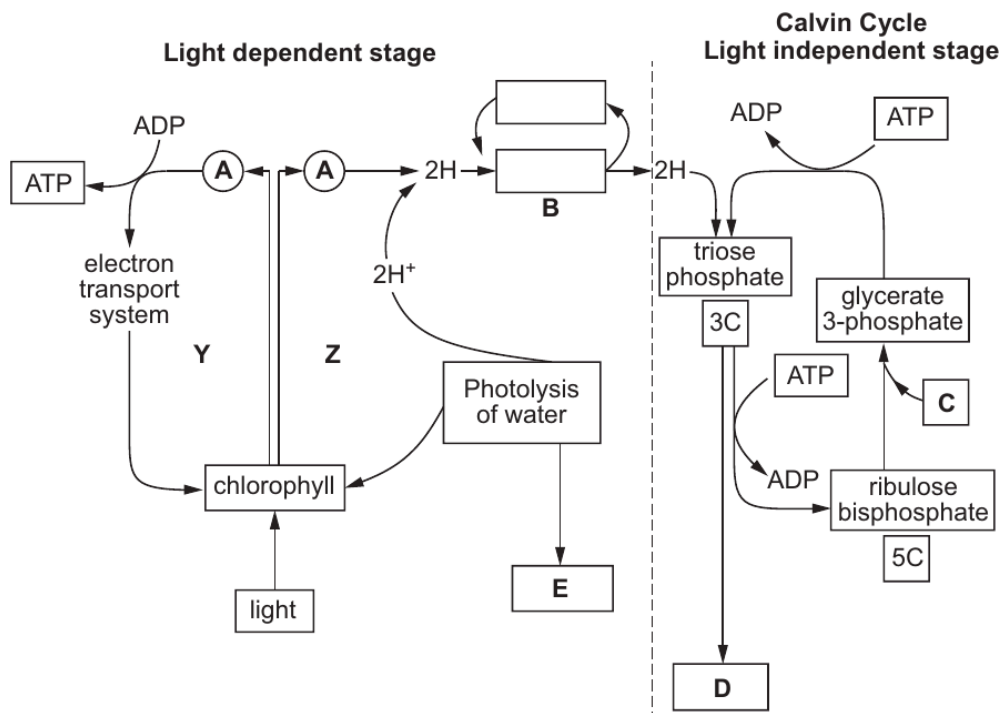
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(ii) Suggest how many times the Calvin cycle must occur to produce one molecule of glucose. [1]

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5. The diagram below shows the events involved in photosynthesis.



- (a) (i) Name stages **Y** and **Z** in the light dependent stage. [1]
Y
- Z**
- (ii) What is represented by circles **A**? [1]

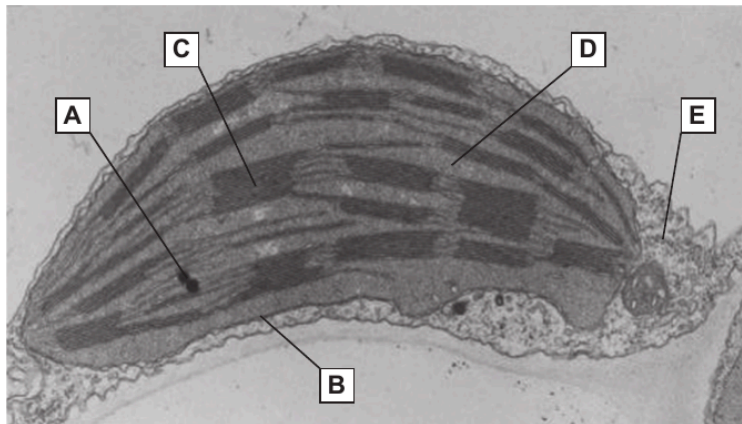
- (iii) Complete the boxes above to show the reactions occurring at point **B**. [1]
- (iv) What is being produced at **E**? [1]

- (v) Name the molecule entering at **C**. [1]

- (vi) What compound is produced at **D**? [1]

(b) The photomicrograph below is of a chloroplast.

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Using the letters on the photomicrograph, complete the following table.

[4]

Area	Letter	Name of region
Where the light dependent stage occurs		
Where the light independent stage occurs		

(c) Plants take up minerals from the soil. These are combined with the products of the light independent stage to produce other molecules needed by the plant.

Give **three** examples of minerals taken up from the soil and state what molecules are produced when each example combines with the products of the light independent stage. [3]

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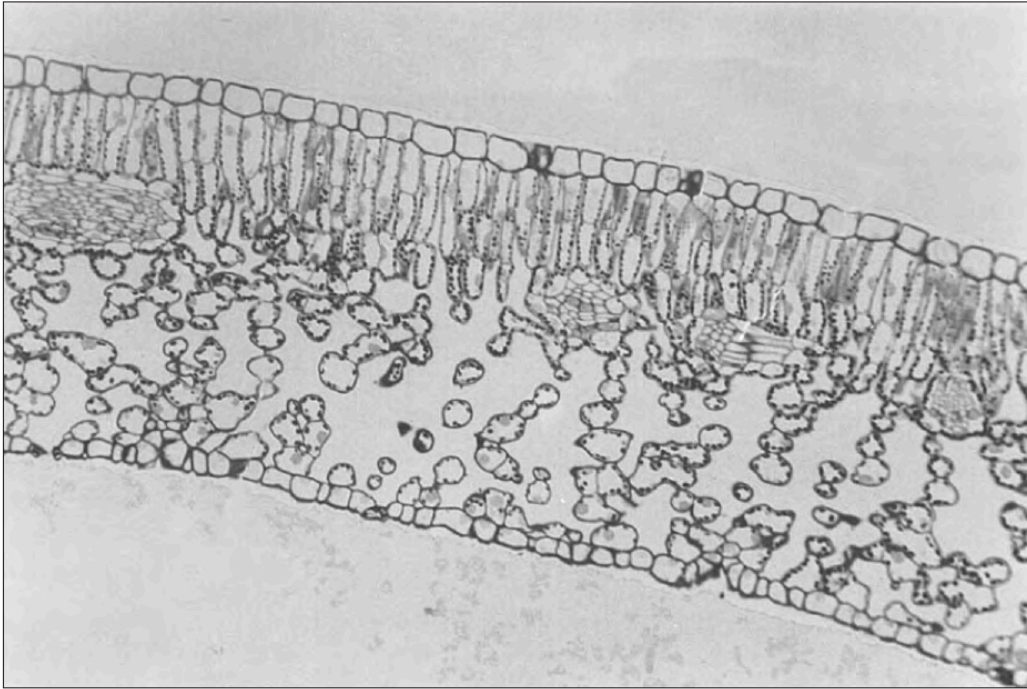
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2. Below is a leaf section as seen with a light microscope.



(a) **Indicate clearly with an arrow** on the photomicrograph above, the main site of photosynthesis. [1]

(b) Distinguish between an absorption spectrum and an action spectrum. [2]

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- (c) In part of the Calvin cycle, the carbon in carbon dioxide is incorporated into triose phosphate. Briefly describe **this** sequence of reactions. [4]

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- (d) How would you expect the pH of the thylakoid space of the chloroplast to differ from the stroma? Explain your answer. [2]

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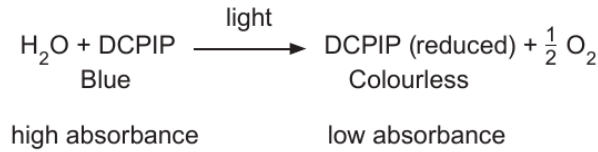
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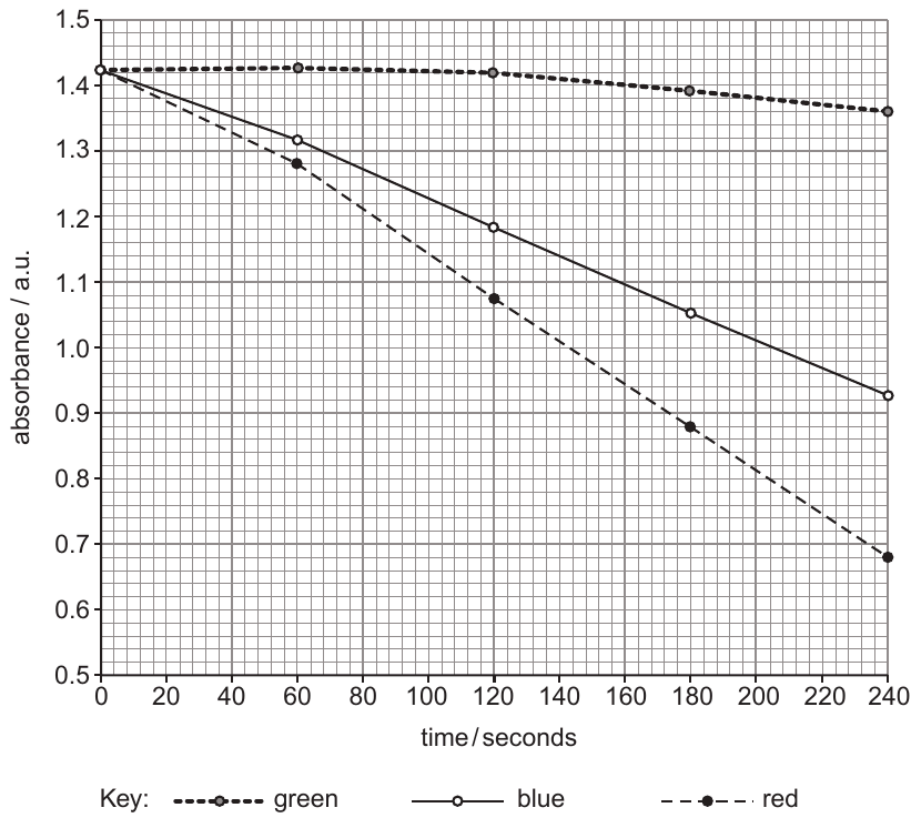
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7. Photolysis of water and the process of reduction can be demonstrated by using isolated chloroplasts suspended in an ice-cold buffered 2% sucrose solution, together with a chemical called DCPIP.

DCPIP receives electrons, becoming reduced and turning from blue to colourless. This can be measured by recording the absorbance of light using a colorimeter.



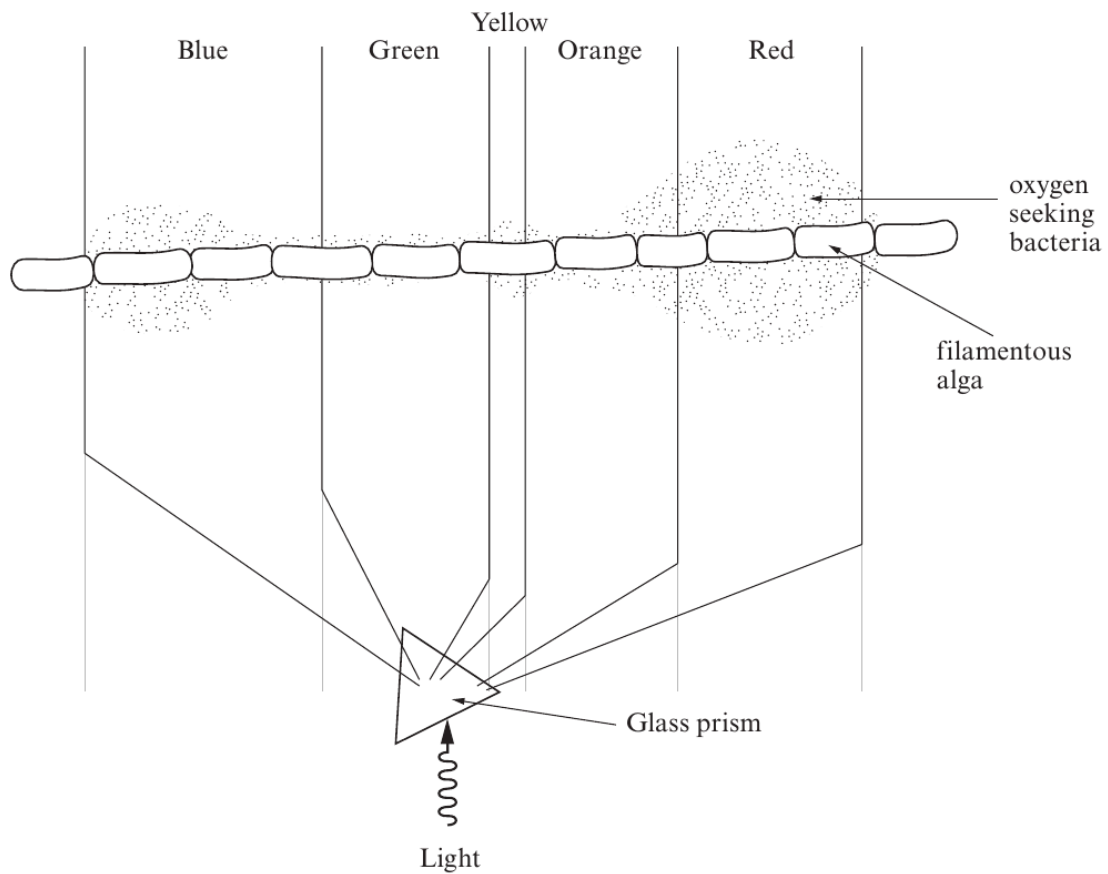
To investigate the effect of different wavelengths of light, coloured filters were placed between the light source and the reaction mixture. The intensity of light striking the reaction mixture was the same with all filters used. The results are shown below.



- (a) In this experiment DCPIP is the final electron acceptor. Name the usual final electron acceptor in the light dependent reactions. [1]

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3. A scientist called Engelmann set up an experiment using a filamentous alga (a single strand of photosynthetic cells joined end to end). The filamentous alga received light which had been passed through a glass prism which split the light into the different wavelengths. He used motile oxygen seeking bacteria to show which regions of the filamentous alga produced most oxygen.



- (a) (i) Describe and explain the distribution of the bacteria. [3]

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(ii) Describe the process by which the alga produces oxygen. [5]

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(b) A suitable control would be to repeat the experiment without the prism. Suggest how the bacteria would then be distributed. [1]

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(c) (i) Give the name of the pigment found at the reaction centre. [1]

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(ii) Give the names of **two other** light absorbing pigments found in chloroplasts. [2]

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(iii) What is the advantage to a plant of having several different light absorbing pigments? [2]

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(Total 14 marks)

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7. Diuron is a weed-killer which is a very specific and sensitive inhibitor of photosynthesis. It blocks the electron carrier binding site on photosystem II. This stops the electron flow from where it is generated, in photosystem II, to the electron carrier. This reduces the ability of the plant to convert light energy into chemical energy.

Diuron only blocks electron flow from photosystem II. It has no effect on photosystem I or other reactions in photosynthesis, such as light absorption or carbon fixation in the Calvin cycle.

- (a) Explain the effects of Diuron on non-cyclic photophosphorylation and why cyclic photophosphorylation is not affected. [4]

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- (b) Suggest why a plant would die when the weedkiller Diuron is sprayed onto it. [3]

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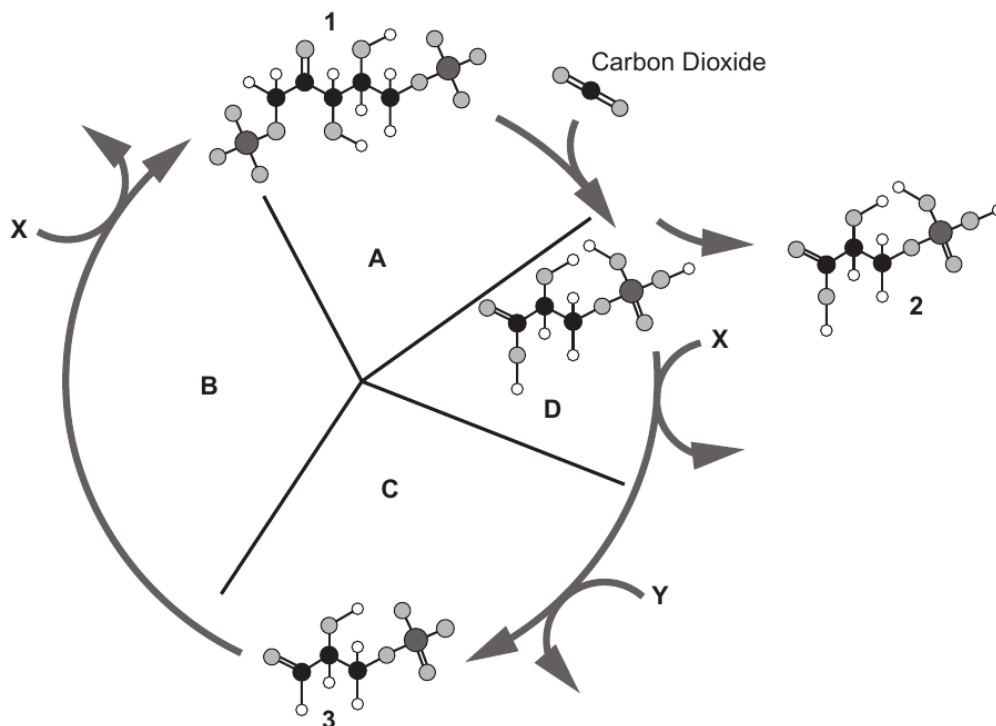
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(c) The Calvin cycle is shown below with some of the intermediate compounds drawn.

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(i) Name compounds **1**, **2** and **3** shown on the diagram above. [3]

1

2

3

(ii) What is the role of ribulose biphosphate carboxylase (RuBisCo) in the Calvin cycle? [1]

(iii) Name molecules **X** and **Y** shown on the diagram above. [2]

X

Y

(iv) Describe simply what is happening at **each** stage of the cycle indicated by **A**, **B** and **C** on the diagram above. [3]

A

B

C

16

END OF QUESTION PACK

6 questions · 73 marks · ~1 h 57 min

Source: WJEC BY4 + BY5 (2008 modular spec, 2011–2017)

Curated for WJEC Biology 2015 spec A2 Unit 3 – Topic 2 (3.2)

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