Photosynthesis (5.2.1): OCR A Level Biology Exam Questions by Topic

17 questions · 45 marks · about 54 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · A level Paper 3 · June 2017 · Q1(b)(ii) · 2 marks

(ii) State the precise location of photosynthetic pigments in a chloroplast.

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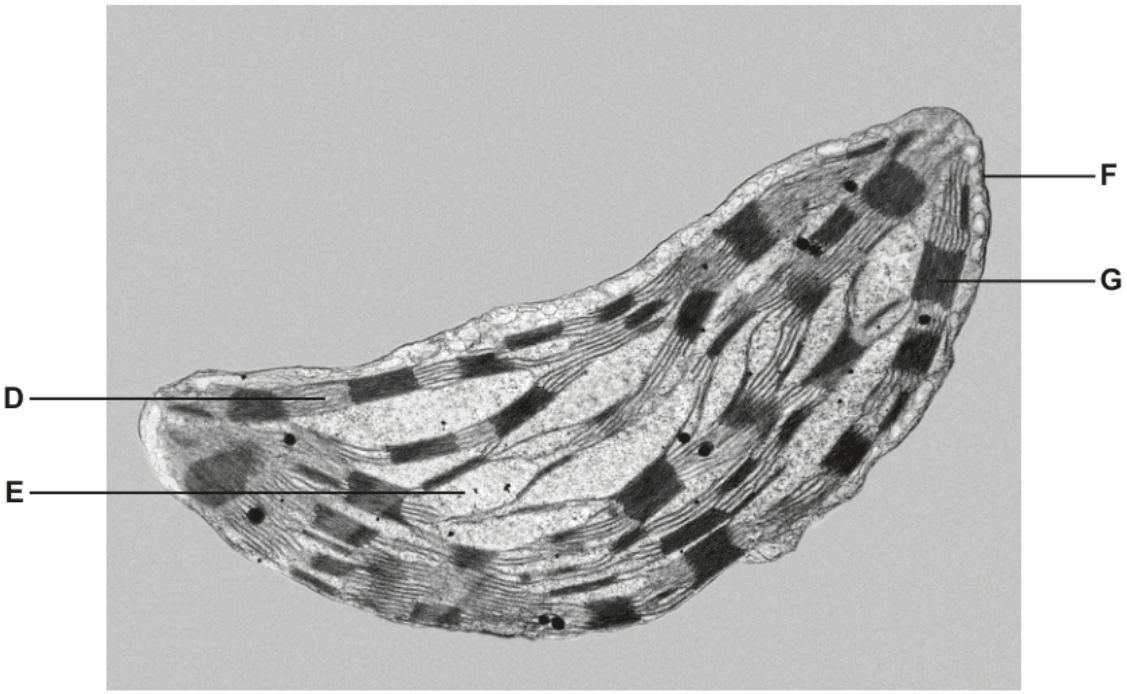
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..... **[2]**

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Question 2 · A level Paper 1 · June 2022 · Q22(a) · 4 marks

22 (a) The image is a transmission electron micrograph (TEM) of a chloroplast.



Complete the table using the letters from the TEM which identifies the structure or function. Each letter may be used once, more than once or not at all.

Structure or function	Letter
Chloroplast envelope	
Site of light independent reactions	
Inter-granal lamellae	
Contains starch grains and lipid droplets	

[4]

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Question 3 · A level Paper 1 · June 2025 · Q16(a)(ii) · 2 marks

(ii) Identify **one** similarity and **one** difference between the structures of chloroplasts and the structures of mitochondria.

Similarity .....

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Difference .....

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[2]

Question 4 · A level Paper 1 · June 2018 · Q17(a)(i) · 4 marks

17 (a) Chromista are photosynthetic protoctists that live in water.

Chromista are different from other photosynthetic organisms because they contain the pigment chlorophyll *c*.

Chlorophyll *c* is not found in plants.

(i) Outline the importance of photosynthetic pigments in photosynthesis.

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..... **[4]**

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Question 5 · A level Paper 1 · June 2018 · Q17(a)(ii) · 1 mark

(ii) The wavelengths of light absorbed by chlorophyll *c* are different from those wavelengths absorbed by chlorophyll *a* and chlorophyll *b*.

Suggest why Chromista need pigments that are different from those of other photosynthetic organisms.

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..... **[1]**

Question 6 · A level Paper 1 · June 2022 · Q22(b) · 5 marks

(b) Complete the sentences using the most appropriate terms.

Carbon fixation occurs in the Calvin cycle when CO_2 combines with the five-carbon molecule ..... . This forms an unstable six-carbon molecule that immediately breaks down into two molecules of ..... . These are reduced to triose phosphate using ..... and ..... that are formed in the light-dependent stage of photosynthesis. Triose phosphate is used to form hexose phosphates which can be converted to ..... for transport elsewhere in the plant. **[5]**

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22 Plants are capable of synthesising a variety of molecules from the products of the light-independent stage of photosynthesis.

Fig 22.1 summarises these processes.

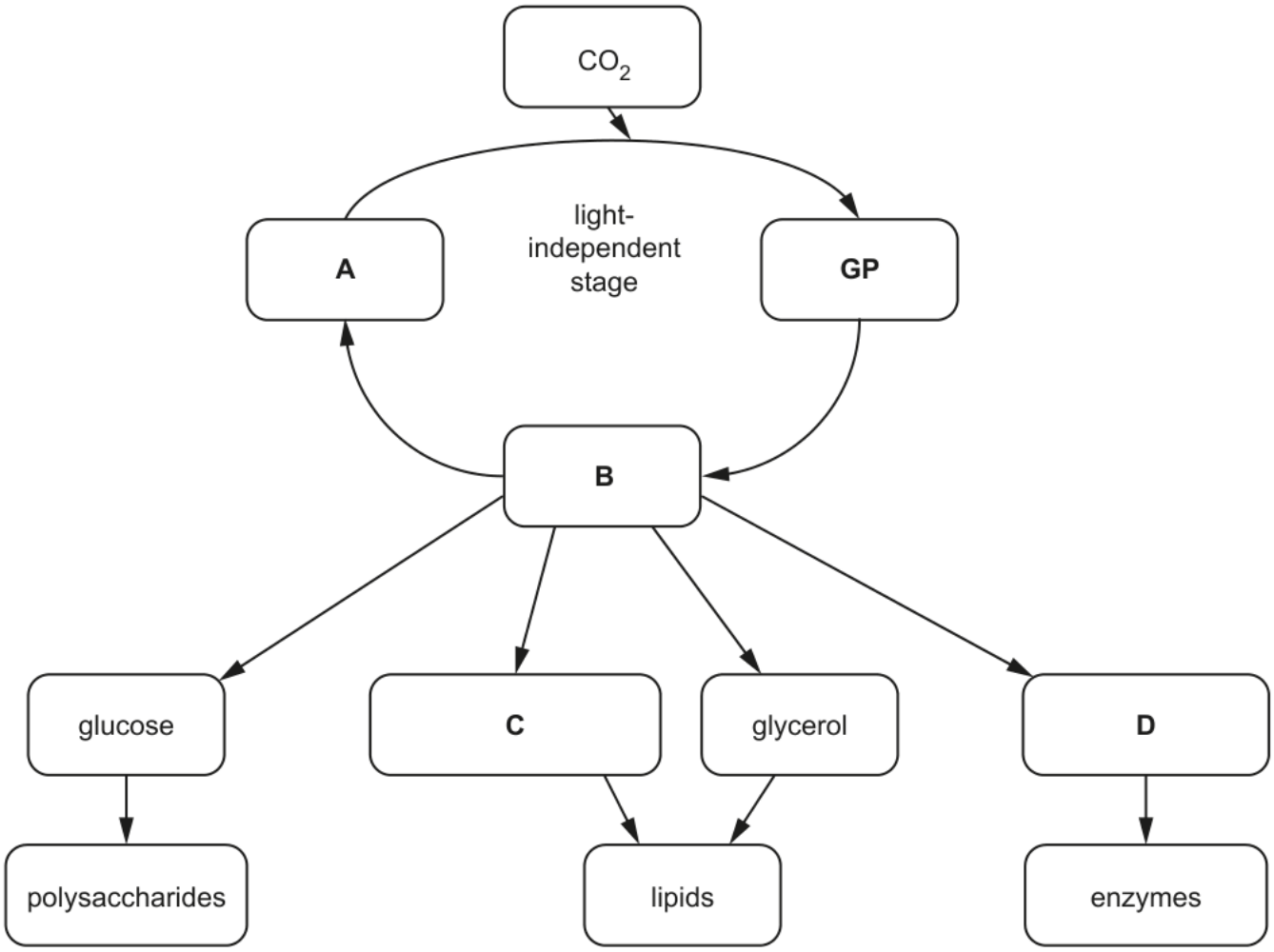


Fig. 22.1

(a) Identify the molecules represented by the letters **A**, **B**, **C** and **D** in Fig. 22.1

A .....

B .....

C .....

D .....

[4]

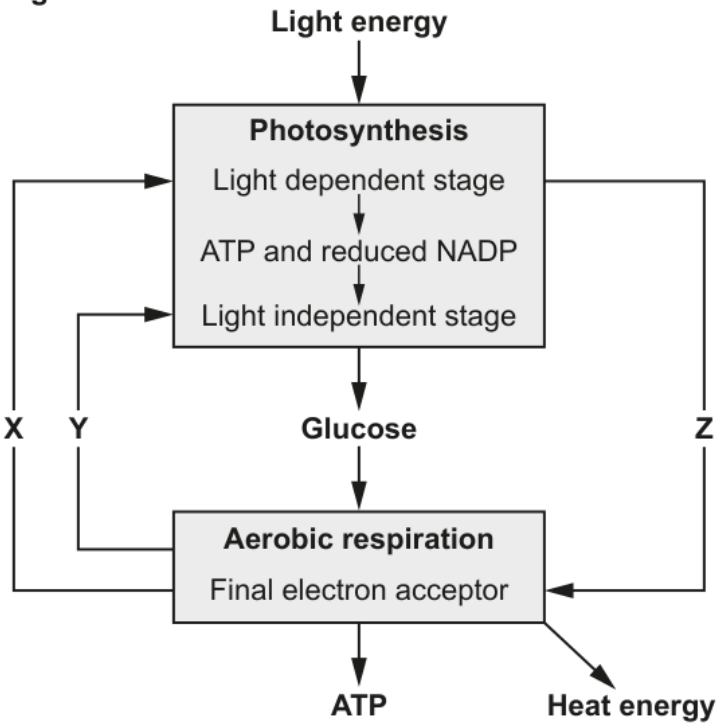
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Question 8 · information from earlier in the question

17

(a) **Fig. 17.1** shows the relationship between photosynthesis and aerobic respiration.

Fig. 17.1



(i) Identify the molecules labelled **X**, **Y** and **Z** in **Fig. 17.1**.

X .....

Y .....

Z .....

[2]

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Question 8 · A level Paper 1 · June 2024 · Q17(a)(ii) · 3 marks

(ii) Use the information in **Fig. 17.1** to explain how plants are able to survive in a sealed glass container, such as a terrarium or bottle garden, for many months or even years.

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..... **[3]**

Turn over

Question 9 · information from earlier in the question

3 Genetic modification and selective breeding can be used to improve the characteristics of crop plants, such as maize.

(a) In high light intensity, photosystem II absorbs excess light energy.

A process called nonphotochemical quenching (NPQ) converts the excess light to heat energy.

NPQ can continue when light intensity is no longer in excess. This makes photosynthesis inefficient.

Scientists genetically modified (GM) crop plants to limit NPQ.

The scientists exposed unmodified plants and GM plants to a period of high light intensity followed by lower light intensity. The scientists then compared the rate of NPQ and the rate of carbon dioxide (CO_2) fixation in unmodified plants and GM plants.

Some of the results are shown in the table.

Time after decrease in light intensity (s)	Rate of NPQ (arbitrary units)		Rate of CO_2 fixation (mmol CO_2 m^{-2} s^{-1})	
	Unmodified plant	GM plant	Unmodified plant	GM plant
0	1.00	1.00	26	26
150	0.35	0.25	11.5	13.2

(i) State **one** dependent variable in this investigation.

..... **[1]**

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Question 9 · A level Paper 3 · June 2023 · Q3(a)(ii) · 2 marks

(ii) Explain the effect of genetic modification on the rate of CO_2 fixation after 150 seconds of low light intensity.

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..... **[2]**

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(c) Algae are single-celled photosynthetic organisms.

An investigation was carried out into the effect of CO_2 concentration on the concentrations of ribulose bisphosphate (RuBP) and glycerate 3-phosphate (GP) present in algae.

Algae were grown in a solution containing a high concentration of CO_2. The concentration of CO_2 was then reduced.

RuBP and GP concentration were measured for 2 minutes before and 3 minutes after the reduction in CO_2 concentration.

The results are shown in Fig. 17.2.

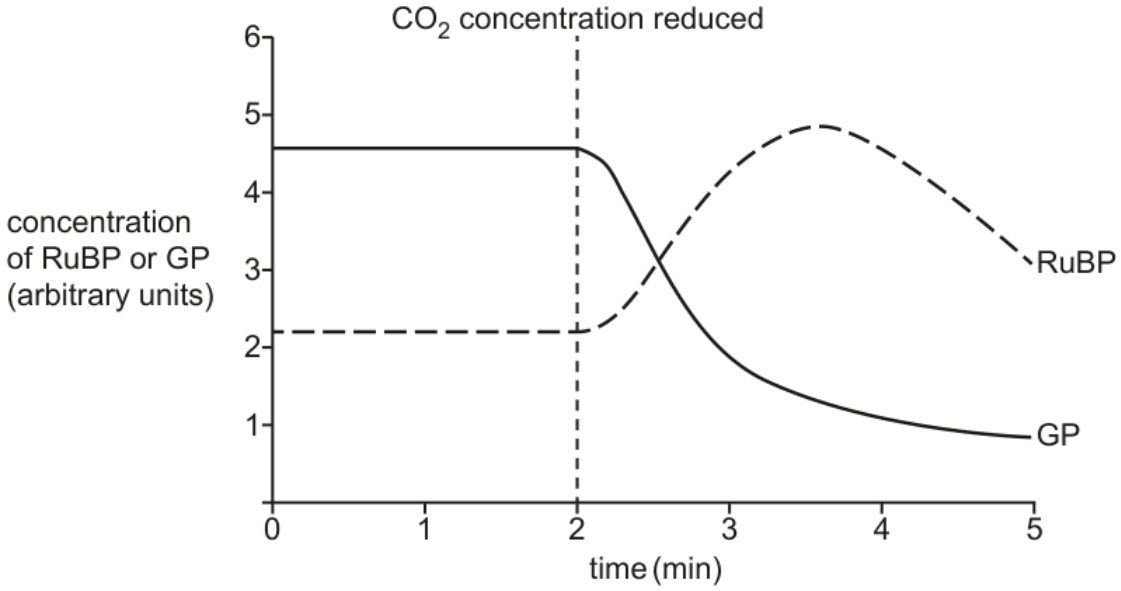


Fig. 17.2

Describe and explain the effect of reducing the CO_2 concentration on the concentration of RuBP and GP in the algae.

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[1]

Table 5.1

(b) Light intensity is one factor that affects the rate of photosynthesis.

Fig. 5.1 shows how the rate of photosynthesis varies with light intensity in two plants: a fern species, *Dicksonia antarctica*, and maize, *Zea mays*.

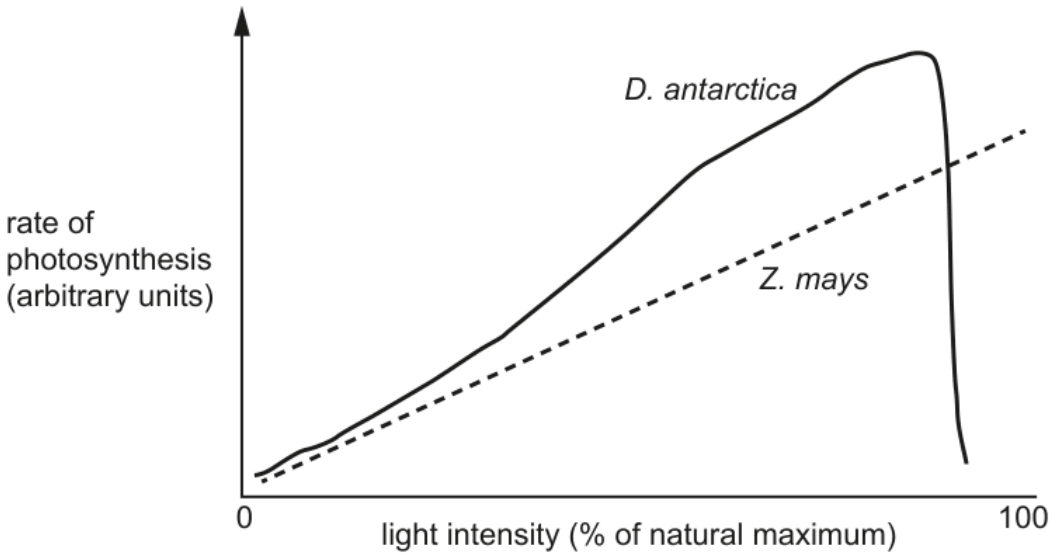


Fig. 5.1

What can you conclude from **Fig. 5.1** about the habitat of *D. antarctica* compared to the habitat of *Z. mays*?

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..... **[2]**

Turn over

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Question 12 · A level Paper 3 · June 2018 · Q3(b) · 2 marks

(b) Photosynthesis occurs in two stages: the light-dependent stage and the light-independent stage. The light-independent stage is affected by temperature more than the light-dependent stage.

Explain why temperature has a greater effect on the rate of the light-independent stage.

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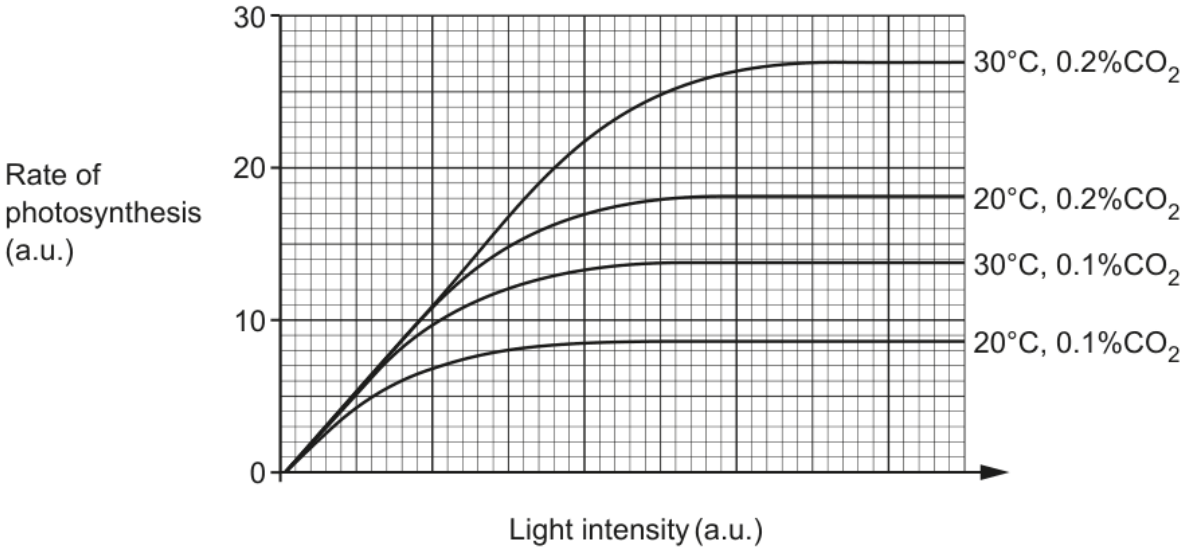
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Question 13 · A level Paper 1 · June 2025 · Q19(c)(i) · 2 marks

(c) The graph shows the effect of light intensity on the rate of photosynthesis at two temperatures and two CO_2 concentrations.



(i) Explain the evidence from the graph that shows that CO_2 concentration is a limiting factor in these experiments.

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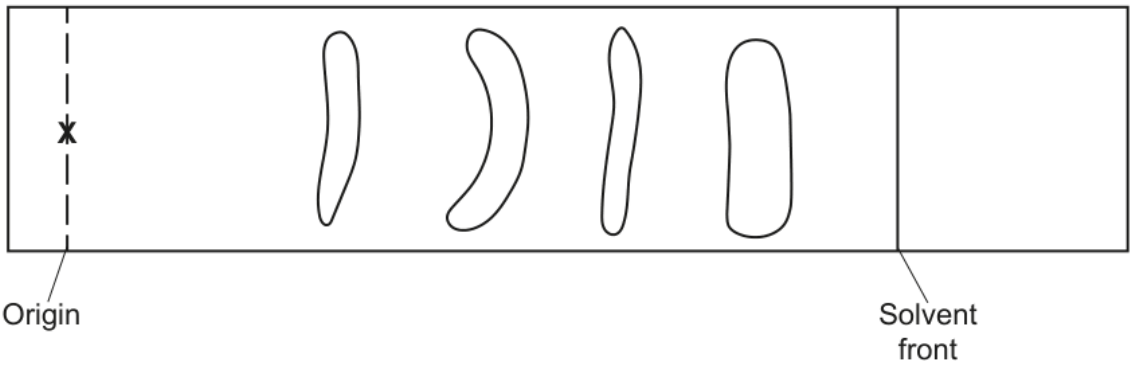
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Question 14 · A level Paper 1 · June 2025 · Q16(b)(i) · 3 marks

(b) A student used thin layer chromatography (TLC) to separate the photosynthetic pigments in a chloroplast extract.

This is the result of the TLC.



(i) Calculate the R_f for the most soluble pigment.

Give your answer to **2** significant figures.

Distance travelled = ... mm

R_f = ...

[3]

Question 15 · A level Paper 1 · June 2025 · Q16(b)(ii) · 2 marks

(ii) The student noticed that the spots were very faint and thought that there might be other pigments present in the mixture that were too faint to be seen.

Describe how the student could increase the intensity of the spots using the same chloroplast extract.

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..... **[2]**

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Question 16 · information from earlier in the question

19 (a) The Hill reaction is a model system used to study the light-dependent stage of photosynthesis. It uses a blue dye, DCPIP, which is colourless when reduced.

A student was provided with the following method:

- Cut three small spinach leaves into small pieces and place in a mortar containing 20 cm^3 of 0.5 mol dm^{-3} sucrose solution.
- Homogenise by grinding vigorously.
- Filter the mixture and pour the filtrate into a centrifuge tube.
- Centrifuge at high speed for 5 minutes.
- Gently pour the supernatant (liquid part) into a clean tube labelled A.
- Resuspend the pellet (sediment) in 20 cm^3 of pH 7.0 buffer.
- Add 5 cm^3 of resuspended pellet to each of tubes labelled B – D.
- Boil tube B for 5 minutes and then cool.
- Add 10 cm^3 DCPIP solution to each of tubes A – E.
- Transfer tube C to a dark cupboard.
- Observe colour of the tubes after 5 minutes.

The table shows the results of the experiment.

	Tube A	**Tube B**	**Tube C**	**Tube D**	**Tube E**
Contents	supernatant	resuspended pellet	resuspended pellet	resuspended pellet	distilled water
Boiled for 5 minutes	no	yes	no	no	no
DCPIP	yes	yes	yes	yes	yes
Illumination	light	light	dark	light	light
Colour after 5 minutes	blue	blue	blue	colourless	blue

(i) State the name of the final electron acceptor in the light-dependent stage of photosynthesis.

..... **[1]**

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Question 16 · A level Paper 1 · November 2021 · Q19(a)(ii) · 2 marks

(ii) DCPIP is reduced in the Hill reaction.

Suggest and explain the function of DCPIP in the Hill reaction.

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..... **[2]**

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Question 17 · information from earlier in the question

22 (a) A scientist used a respirometer to investigate the rate of respiration and photosynthesis of maize in different light intensities.

- The scientist placed ten maize seedlings in a respirometer and kept it in the dark for three hours.
- The respirometer contained soda-lime to remove any CO_2 produced by the seedlings.
- The scientist placed ten maize seedlings in a separate respirometer without soda-lime and placed it in different light intensities for three hours at a time.

Light intensity (lux)	Distance moved by fluid in respirometer (mm)
0	–3.7
1020	–0.8
1510	0.0
1700	1.2
2000	2.9

Table 22.1

(i) The diameter of the capillary tubing was 0.1 mm.

The volume of a cylinder can be calculated using the following formula:
volume of cylinder = $\pi r^2 l$

Calculate the **rate of oxygen uptake** by the seedlings in the dark. Give your answer to **two** significant figures. Show your working.

Answer = ... $mm^3 h^{-1}$ **[3]**

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Question 17 · A level Paper 1 · June 2018 · Q22(b) · 2 marks

(b) The scientist made the following claim:

> These results suggest that, in maize seedlings, the rate of photosynthesis only exceeds the rate of respiration when the light intensity is above 1510 lux.

Use the data in Table 22.1 to explain why the scientist made this claim.

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..... **[2]**

Turn over

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Mark schemes

Question 1 · A level Paper 3 · June 2017 · Q1(b)(ii) · 2 marks

ii	photosystems ✓ (in) thylakoid (membranes) ✓	2	**ACCEPT** antenna complex/ reaction centre / light harvesting , clusters / systems **IGNORE** grana **ACCEPT** lamellae (membranes)

Question 2 · A level Paper 1 · June 2022 · Q22(a) · 4 marks

22 (a)

Structure or function	Letter
chloroplast envelope	**F** ✓
site of light independent reactions	**E** ✓
inter-granal lamellae	**D** ✓
contains starch grains and lipid droplets	**E** ✓

4	1.1, 2.1	**DO NOT ALLOW** more than one letter for each response

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Question 3 · A level Paper 1 · June 2025 · Q16(a)(ii) · 2 marks

Question			Answer	Marks	Element
16	(a)	(ii)	**Similarities- max 1**	2	2.1
		1.	(both have) an envelope / double membrane / intermembrane space ✓		
		2.	(both have) (smaller / 70S) ribosomes / (circular) DNA ✓		
		3.	(both have) ETC (components) / ATP synthase ✓		
			Differences- max 1		
		4.	chloroplasts have, photosystems / (named) photosynthetic pigments ✓		
		5.	mitochondria have (membranes folded into) cristae ✓		
		6.	chloroplasts have, thylakoids / granum /grana / lamellae ✓		
		7.	mitochondria have matrix **and** chloroplasts have stroma ✓		

Guidance

read as prose throughout
IGNORE ref to starch
1 ALLOW 'outer and inner' for 'double'
ALLOW ora for **mp4-6**
e.g. mitochondria do not have photosystems

Question 4 · A level Paper 1 · June 2018 · Q17(a)(i) · 4 marks

17	(a)	(i)	(pigments) absorb , light / photons ✓ electrons , excited / raised to higher energy level ✓ accessory pigments pass energy to , reaction centres / primary pigments ✓ primary pigments , become oxidised / lose electrons / pass electrons to ETC ✓ for light dependent reaction / photophosphorylation ✓	**4 max**

ALLOW named accessory pigments
e.g. chlorophyll b / xanthophyll / carotenoids
ALLOW chlorophyll a for primary pigment

ALLOW for making , ATP / reduced NADP

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Question 5 · A level Paper 1 · June 2018 · Q17(a)(ii) · 1 mark

(ii)	*idea that* they have to absorb light of short (er) wavelengths ✓ *idea that* some wavelengths (of light) don't reach , depths / them ✓	**1 max**

ALLOW blue / blue-violet light
ALLOW wavelengths between 400 and 500nm
ALLOW high(er) frequency

e.g. some wavelengths of light may not reach *Chromista* if they are in deep water

Question 6 · A level Paper 1 · June 2022 · Q22(b) · 5 marks

22	**(b)**		RuBP / ribulose (-1,5-) bisphosphate ✓ GP / glycerate (3-) phosphate / G3P ✓ ATP ✓ NADPH / red(uced) NADP / $NADPH_2$ / $NADPH + H^+$ ✓ sucrose ✓

5	1.1	**ALLOW** (3-) phosphoglycerate / (3-) phosphoglyceric acid / 3PGA / 3PG / PGA **ALLOW** ATP and NADPH in either order

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Question 7 · A level Paper 1 · June 2019 · Q22(a) · 4 marks

22	(a)		**A** RuBP / ribulose bisphosphate ✓ **B** triose phosphate / TP ✓ **C** fatty acid(s) ✓ **D** amino acid(s) ✓	4

Mark first response on each line
IGNORE biphosphate

IGNORE named fatty acids / triglycerides / fats
IGNORE named amino acids
ALLOW polypeptide / protein

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Question 8 · A level Paper 1 · June 2024 · Q17(a)(ii) · 3 marks

17	(a)	(ii)			max 3
			1	*idea that* light (energy) is the only requirement from outside the terrarium / AW ✓	
			2	respiration provides carbon dioxide **and** water for photosynthesis **OR** photosynthesis provides glucose **and** oxygen for respiration ✓	
			3	water used for photolysis **OR** oxygen used as final electron acceptor (in respiration) ✓	
			4	carbon dioxide used for , light independent stage / Calvin cycle ✓	
			5	ATP (still) produced / energy provided , for (named) cell activities ✓	
			6	decomposing plant material provides (named) mineral ions ✓	

ALLOW O_2 for oxygen, H_2O for water, CO_2 for carbon dioxide and $C_6H_{12}O_6$ for glucose throughout

MP1 ALLOW e.g. as light (energy) can pass through glass for photosynthesis
MP1 ALLOW e.g. plants in glass containers will have access to light
MP2 IGNORE equations unqualified

MP5 ALLOW e.g. active transport / protein synthesis / active uptake of mineral ions
IGNORE produces energy
MP6 IGNORE nutrients

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3	**(a)**	**(ii)**	greater rate (of carbon fixation in GM plants) because , less light energy is converted to heat energy / lower NPQ rate / more energy remains as light ✓ (so) more electrons enter electron transport chain / AW ✓ more, ATP / NADPH / reduced NADP , generated for / supplied to , Calvin cycle (from light-dependent stage) ✓

2 max	2.1 3.1	**ora** for unmodified plants **ALLOW** ref to figures for comparison of rates **ALLOW** 'light-independent stage' for Calvin cycle or a description of the Calvin cycle

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(c)	***GP*** **1** (concentration of) GP decreases ✓ **2** (GP decreases) because less CO_2 available to react with RuBP to produce GP ✓ ***RuBP*** *(2 max)* **3** (concentration of) RuBP increases **AND** then decreases ✓ **4** RuBP increases because it is not converted to GP ✓ **5** RuBP increases as it is still being produced from TP ✓
	6 RuBP decreases because less GP available to , regenerate / AW , RuBP ✓

3 max	2.3	**IGNORE** 6C intermediates **ALLOW** no / less , carbon (dioxide) fixation taking place **Max 2 from MPs 3,4, 5 and 6**

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Question 11 · A level Paper 3 · November 2021 · Q5(b) · 2 marks

b	*D. antarctica habitat*: lower (maximum) light levels ✓ *idea of* reason for lower (maximum) light levels ✓ *idea that* optimum rate of photosynthesis (in its habitat) is at a lower light intensity than that of *Z. mays* ✓

2 max	3.2	**ORA** *Z. mays habitat* **ALLOW** less available light / darker habitat / more shaded e.g more cloud cover / shorter day length / taller / competing, plants (shade fern) e.g. rate of photosynthesis is higher at lower light levels compared to *Z. mays*

Question 12 · A level Paper 3 · June 2018 · Q3(b) · 2 marks

	b		(light-independent stage is) controlled by (named) enzymes ✓	**2 max**	**IGNORE** no enzymes in light dependent stage **ALLOW** fewer enzymes in light dependent stage **ALLOW** Rubisco as named enzyme
			idea that higher temperature will increase, kinetic energy of enzyme molecules / number of successful collisions /ESCs formed / ora ✓		
			enzymes may be denatured at high temperatures / described ✓		

Question 13 · A level Paper 1 · June 2025 · Q19(c)(i) · 2 marks

Question			Answer	Marks	Element
19	(c)	(i)		2	2.2
		1	(rate) plateau shows light intensity is no longer limiting ✓		3.2
		2	higher rate, with increasing CO_2/ when CO_2 goes from 0.1% to 0.2% (at same temperature)✓ **ora**		

Guidance

1 IGNORE CO_2/ temperature, is limiting the rate
1 ALLOW (rate) remains constant / levels off, for 'plateaus'
1 ALLOW graph/line, plateaus

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Question 14 · A level Paper 1 · June 2025 · Q16(b)(i) · 3 marks

16	(b)	(i)	**Distance travelled = 91 mm, award 1 mark** distance travelled by most soluble = 91 (mm) ✓ **FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.83 award 2 marks** $R_f = 91 \div 109$ ✓ = 0.83 ✓	3	2.7	**ALLOW** +/- 0.5mm for each measured distance (soluble pigment and solvent front) **ALLOW** values of 87 **or** 95 **ALLOW 2 marks for** Rf value on answer line matches correct distance travelled answer (refer to table) to 2sf Rf value on answer line correct to 2sf with calculation expressed in cm e.g. *9.1÷ 10.9 = 0.83* incorrect soluble pigment distance measured

Question 15 · A level Paper 1 · June 2025 · Q16(b)(ii) · 2 marks

16	(b)	(ii)		**max 2**	3.3
		1.	allow/ leave, (existing) spot/ extract (at origin), to dry ✓		
		2.	(once dry) add, another spot / more extract, to, X / origin / original spot ✓		
		3.	evaporate (some) solvent from (original) extract ✓		

ALLOW dots for spots

2 ALLOW 'pigment**s**' for 'spots'
2 ALLOW origin line for 'origin'

Question 16 · A level Paper 1 · November 2021 · Q19(a)(ii) · 2 marks

19	(a)	(ii)	(final) electron acceptor ✓ replaces , NADP / the usual electron acceptor ✓ allows photolysis to continue ✓	**Max 2**	2.3

ALLOW proton / hydrogen (ion) acceptor

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	(b)	at 1510 (lux) the distance moved by the fluid (in respirometer) is , zero / 0 ✓ at 1510 (lux) rate of photosynthesis is equal to rate of respiration ✓ at 1510 (lux) there is no <u>net</u> change in volume in the respirometer ✓
		Total

2 max	'at 1510 (lux)' only needs to be mentioned **once** throughout **ALLOW** at 1510 (lux) compensation point has been reached
8	

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