CAMBRIDGE INTERNATIONAL AS & A LEVEL BIOLOGY · 9700

BIOLOGY



EXAM QUESTION PACK

13 PHOTOSYNTHESIS

SCORE	PERCENTAGE
/	%

STEMUP

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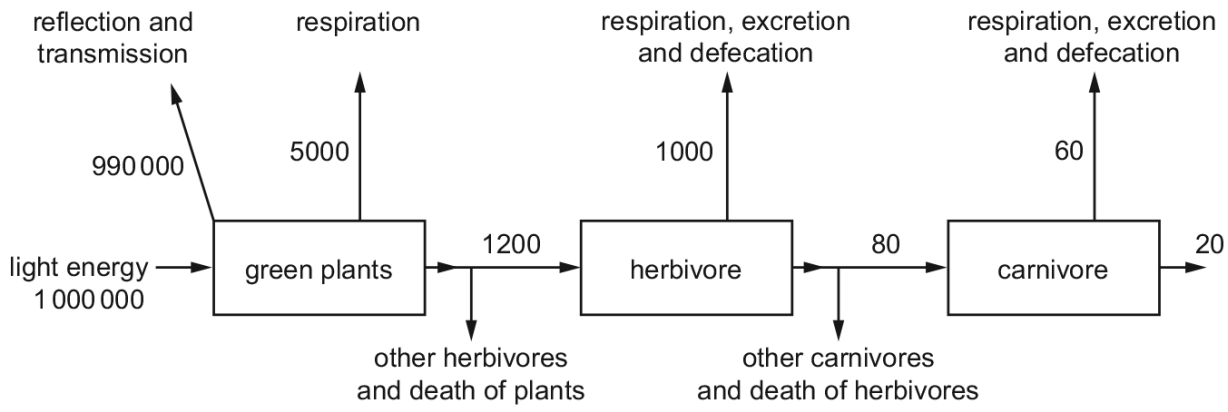
Chapter 13

Photosynthesis

13.1 Photosynthesis as an energy transfer process

1606. 9700_w15_qp_11 Q: 39

The diagram shows the flow of energy through a food chain. Figures are in $kJ\,m^{-2}\,year^{-1}$.



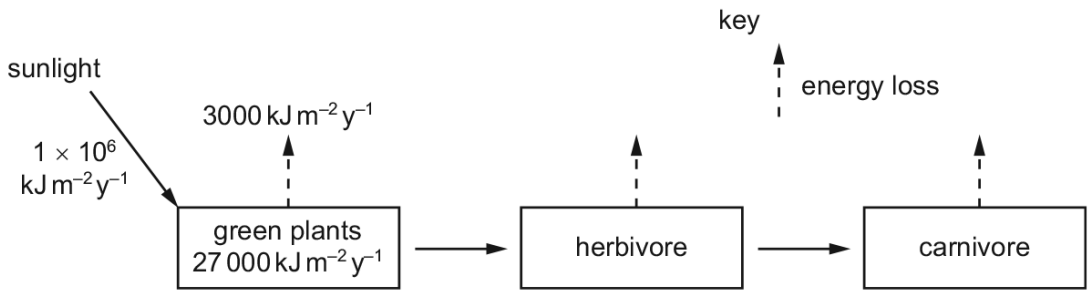
What percentage of light energy is available to the herbivore?

A 0.12 % **B** 0.38 % **C** 0.50 % **D** 1.00 %

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1607. 9700_w15_qp_12 Q: 39

The diagram shows the flow of energy through a food chain.



What percentage of the energy is used by the green plants for photosynthesis?

A 0.03% **B** 0.30% **C** 2.70% **D** 3.00%

1608. 9700_w15_qp_13 Q: 39

The table shows the results of a field study of four species in a food chain in an area of woodland.

species	number of individuals	biomass of one individual / arbitrary units	energy value per unit mass / arbitrary units
R	10 000	0.1	1.0
S	5	10.0	2.0
T	500	0.002	1.8
U	3	300 000.0	0.5

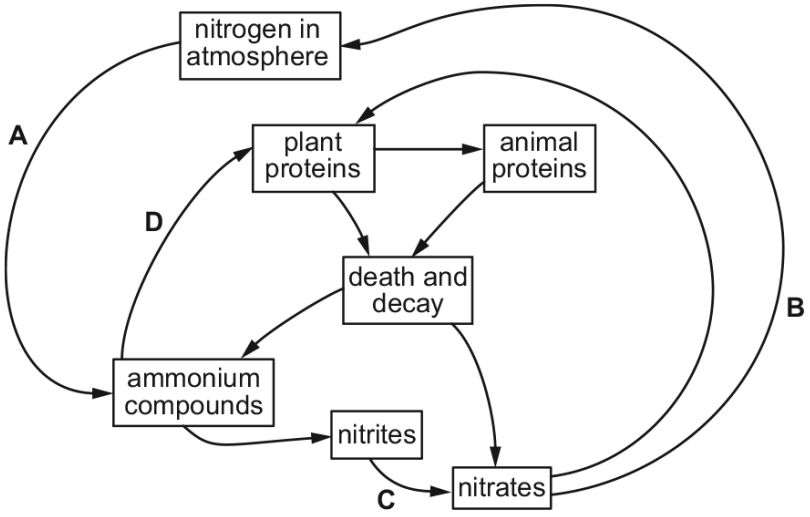
What is the energy flow in the food chain?

	from → to			
A	R	T	S	U
B	S	T	R	U
C	U	R	S	T
D	U	S	T	R

1609. 9700_w15_qp_13 Q: 40

The diagram shows a simplified nitrogen cycle.

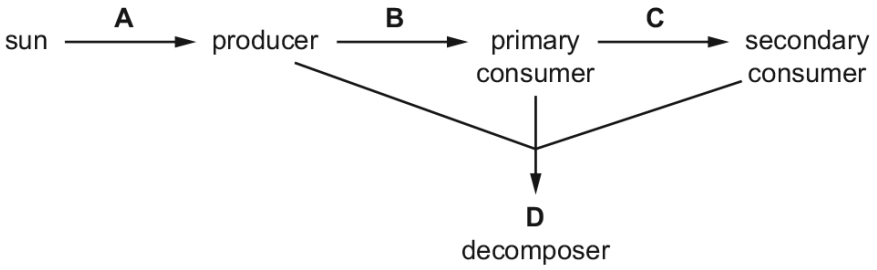
Which arrow represents the activity of nitrogen-fixing bacteria?



13.2 Adaptations for photosynthesis

1610. 9700_s15_qp_12 Q: 38

At which stage of a food chain in a tropical grassland is the energy transfer least efficient?



Chapter 12

Photosynthesis

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12.1 Photosynthesis as an energy transfer process

242. 9700_w15_qp_21 Q: 6

Fig. 6.1 is a food web.

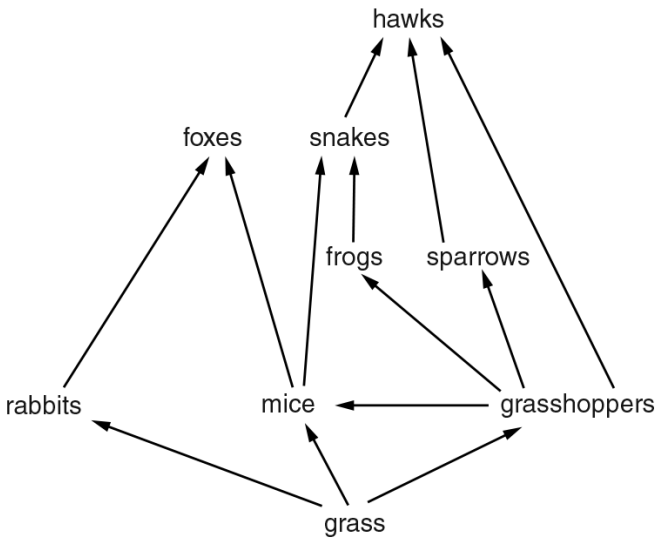


Fig. 6.1

(a) From the food web in Fig. 6.1, name:

(i) the producer

..... [1]

(ii) an organism feeding only as a primary consumer.

..... [1]

(iii) The hawks are top predators.

Name **one other** top predator shown in Fig. 6.1.

..... [1]

(b) Name the processes in the nitrogen cycle in which the following changes occur:

nitrate ions ⟶ nitrogen gas

.....

ammonium ions ⟶ nitrate ions

.....

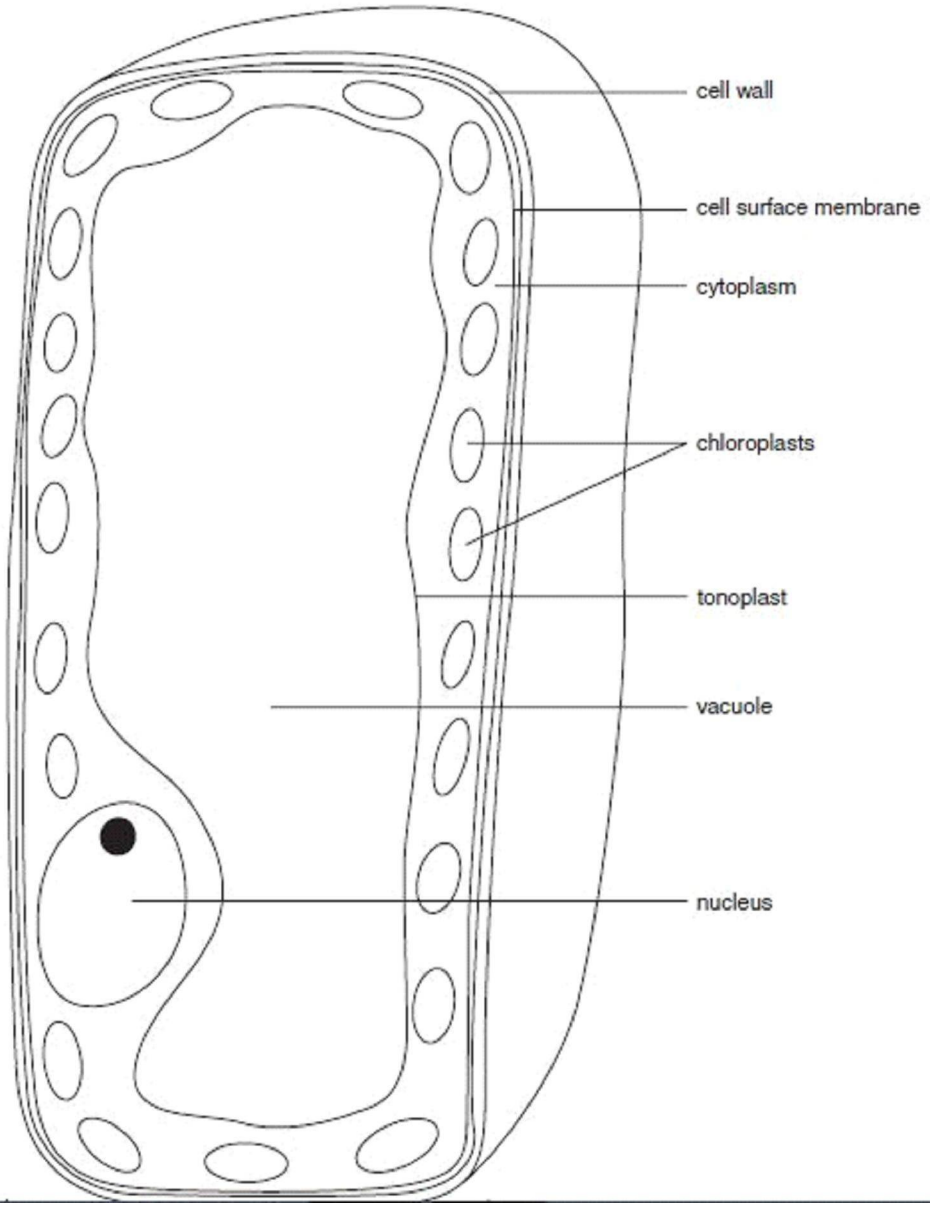
nitrogen gas ⟶ ammonium ions.

..... [3]

[Total: 6]

Q1.

1 Fig. 1.1 is a diagram of a palisade cell from a dicotyledonous leaf.



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(a) Describe how these cells are arranged in the leaf.

.....

.....

.....[2]

(b) With reference to Fig. 1.1, explain how the structure of this cell is related to its function in photosynthesis.

.....

.....

.....

.....[3]

Fig. 1.2 is a diagram of an electron micrograph of part of a chloroplast showing thylakoid membranes.

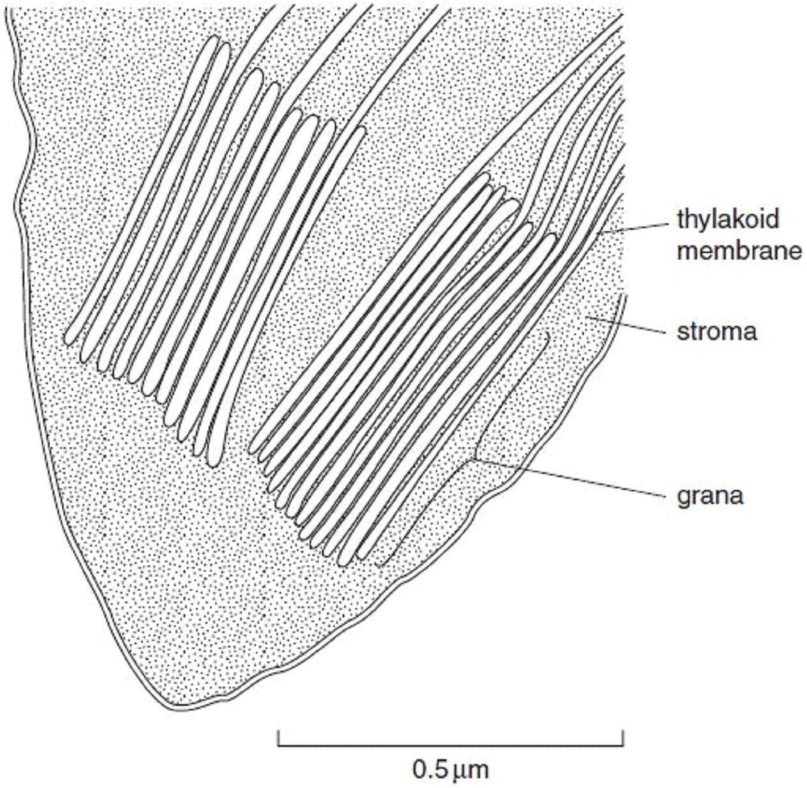


Fig. 1.2

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(c) Describe the role of the thylakoid membrane in photosynthesis.

.....

.....

.....

.....

.....[4]

(d) Describe how carbon dioxide is fixed in the stroma.

.....

.....

.....[2]

[Total : 11]

Q2.

4 Fig. 4.1 is a diagram of a section through the undersurface of a dicotyledonous. leaf.

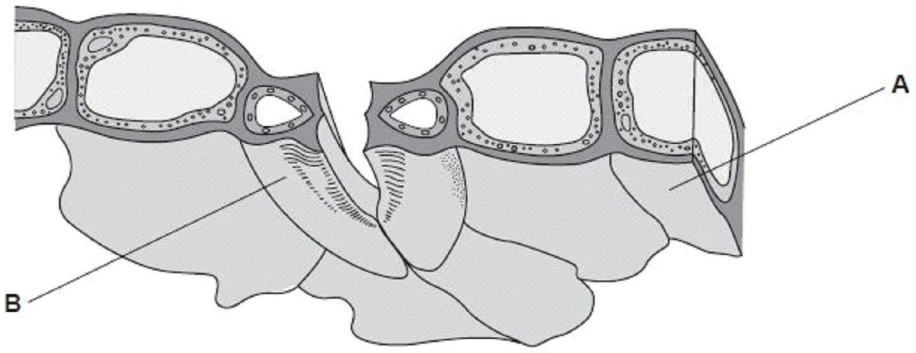


Fig. 4.1

(a) Name the cells **A** and **B**.

A .....

B .....[2]

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(b) Explain the role of the pore shown, in relation to photosynthesis in the leaf.

.....

.....

.....

.....

.....

.....[4]

(c) With reference to Fig. 4.1, list two visible features of the cell **B** that allows the pore to open and close.

feature 1 .....

.....

feature 2 .....

.....[2]

[Total: 8]

Q3.

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5 Fig. 5.1 shows the main stages of the Calvin cycle.

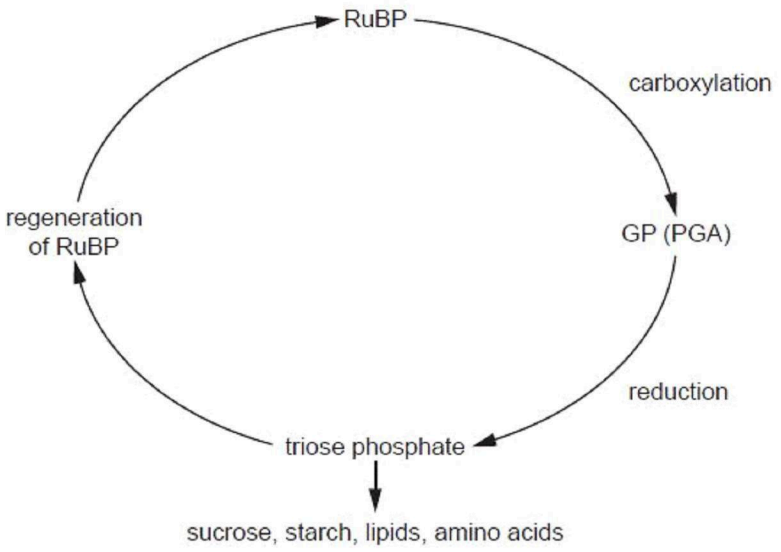


Fig. 5.1

(a) State precisely where the Calvin cycle occurs in plant cells.

.....[1]

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(b) Describe how carbon dioxide is fixed in the Calvin cycle.

.....

.....

.....[2]

(c) Explain how the products of photophosphorylation are used in the Calvin cycle.

.....

.....

.....

.....[3]

(d) Explain what initially happens to the concentration of RuBP and GP if the supply of carbon dioxide is reduced.

RuBP .....

.....

GP .....

.....[3]

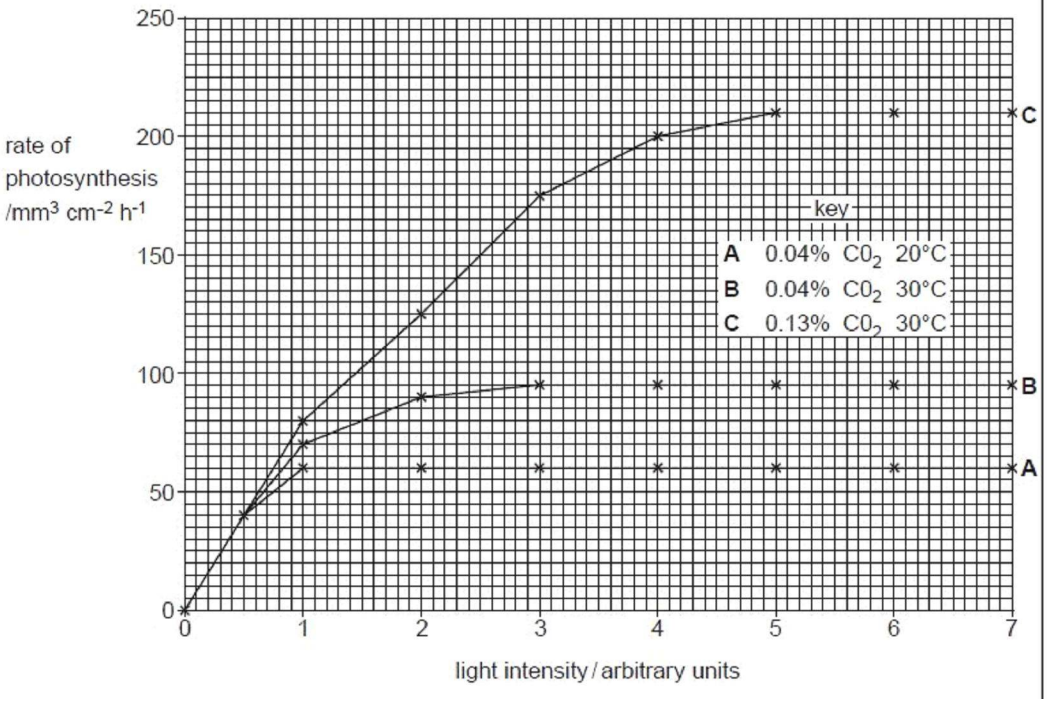
[Total: 9]

Q4.

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Use

2 Fig. 2.1 shows the results of experiments investigating the effect of different light intensities on the rate of photosynthesis of cucumber plants measured as mm^3 CO_2 uptake per cm^2 leaf area per hour. The experiments were carried out at two different temperatures and two different carbon dioxide concentrations.



(a) With reference to Fig. 2.1,

(i) describe the shape of curve **A**,

.....

.....

.....

.....

.....

.....[3]

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(ii) explain the reasons for the difference between curves **B** and **C**.

.....

.....

.....

.....

.....

.....

.....[4]

(b) Suggest **two** ways in which a commercial grower of cucumbers may increase the yield of the growing crop.

1 .....

.....

2 .....

.....[2]

[Total: 9]

Q5.

7 **(a)** An **absorption** spectrum is a graph of the absorption of different wavelengths of light by a photosynthetic pigment.

An **action** spectrum is a graph of the rate of photosynthesis at different wavelengths of light.

Fig. 7.1 shows the absorption spectra of chlorophyll a and chlorophyll b as well as an action spectrum.

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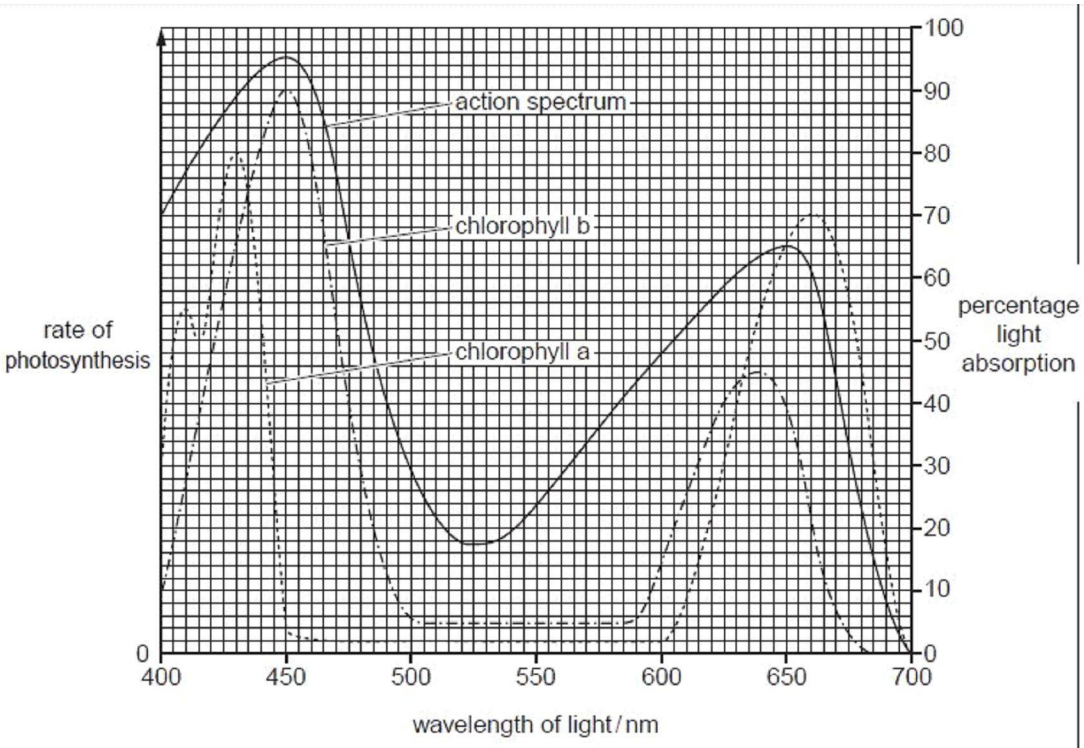


Fig. 7.1

With reference to Fig. 7.1,

(i) compare the **absorption** spectra of chlorophyll a and chlorophyll b,

.....

.....

.....

.....

.....

.....

..... [3]

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(ii) explain the shape of the **action** spectrum,

.....

.....

.....

.....

.....[3]

(iii) explain why plants appear green .

.....

.....

.....

.....[2]

(b) Fig. 7.2 is an electron micrograph showing a section through part of a chloroplast.

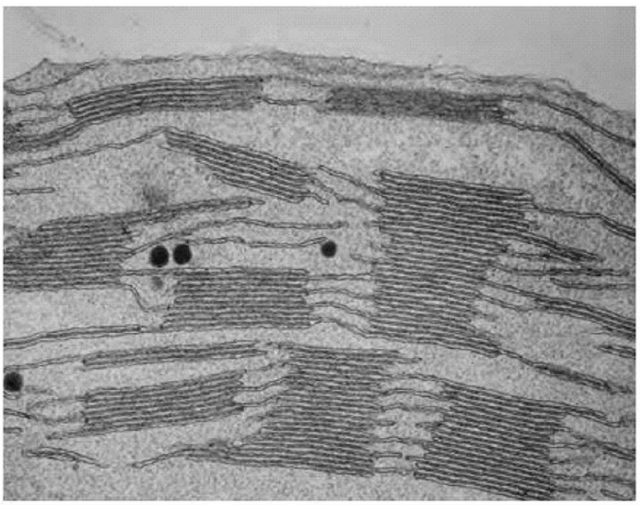


Fig. 7.2

On Fig. 7.2, draw label lines and use the letters **W** and **Y** to identify the following structures:

- **W** where the light-independent reactions occur
- **Y** where chlorophyll is found [2]

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(c) Explain why increasing the concentration of carbon dioxide may increase the rate of production of carbohydrates at high light intensities.

Exa

.....

.....

.....

.....

.....

.....

.....

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.....

.....

.....[5]

[Total: 15]

Q6.

8 (a) Fig. 8.1 shows a scanning electron micrograph of a section through a leaf of the Christmas rose, *Helleborus niger*.

For Examiner Use



Fig. 8.1

Name **M** and **N**.

M .....

N ..... [2]

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(b) Gases leave and enter the leaf through pores called stomata.

Describe **and** explain how a stoma is opened.

.....

.....

.....

.....

.....

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..... [6]

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(c) Fig. 8.2 outlines the main reactions in the light-dependent stage of photosynthesis.

For Examiner Use

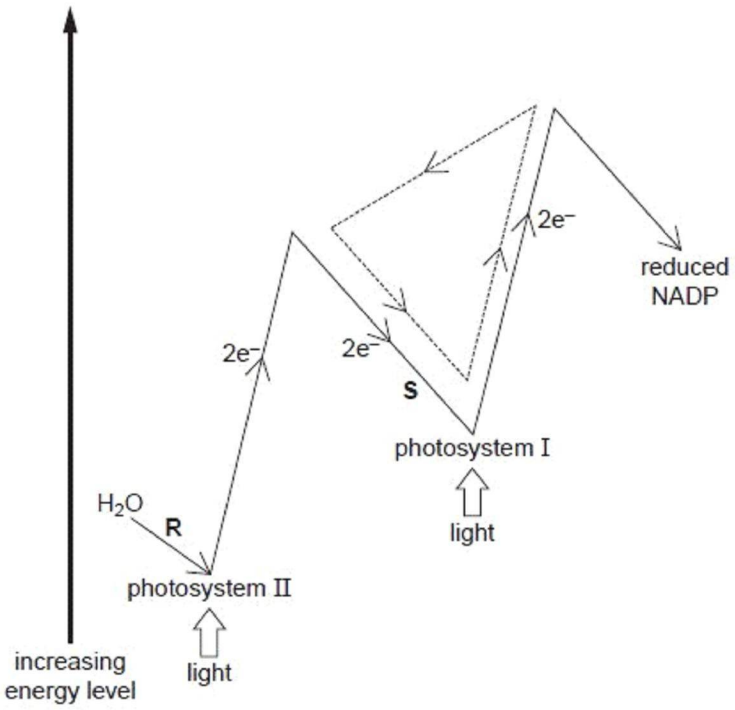


Fig. 8.2

(i) Name the process shown by the dotted arrows (⇢).

..... [1]

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(ii) Describe what happens to water at **R**.

.....

.....

.....

..... [2]

(iii) State the product formed as electrons flow along **S**.

..... [1]

(iv) Explain briefly the role of reduced NADP in the **light-independent stage**.

.....

.....

.....

..... [2]

[Total: 14]

Q7.

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4 Fig. 4.1 is a photomicrograph of a transverse section through the leaf of a C4 plant.

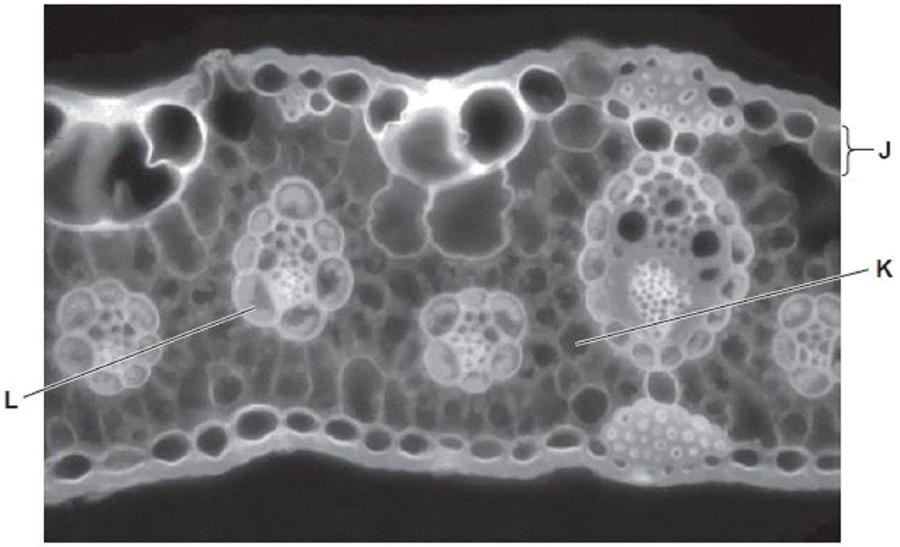


Fig. 4.1

(a) (i) Identify structures **J** to **L**.

J .....

K .....

L ..... [3]

(ii) Outline how this leaf anatomy adapts the plant for high rates of carbon fixation at high temperatures.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

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(b) Sorghum is a C4 plant and *Sorghum bicolor* is a major food crop in dry tropical regions. The leaves of *S. bicolor* are covered with a layer of wax made up of a mixture of esters and free fatty acids, with a melting point of 77–85 °C. Waxes from the leaves of non-tropical plants tend to have melting points lower than this. For example, wax from the bayberry, *Myrica* sp., has a melting point of 45 °C. E

Suggest how the wax on sorghum leaves helps the plant to survive in dry, tropical regions.

.....

.....

.....

..... [2]

(c) An investigation was carried out into the response of sorghum to being kept at a low temperature for a short period of time. Soybean plants, which are better adapted than sorghum for growth in subtropical and temperate climates, were used for comparison.

Plants of sorghum and soybean were kept at 25 °C for several weeks and then at 10 °C for three days. The temperature was then increased to 25 °C again for seven days. Day length, light intensity and carbon dioxide concentration were kept constant throughout.

The uptake of carbon dioxide, as mg CO_2 absorbed per gram of leaf dry mass, was measured

- at 25 °C before cooling
- on each of the three days at 10 °C
- for seven days at 25 °C.

The results are shown in Table 4.1.

Table 4.1

plant	carbon dioxide uptake / mg CO_2 g^{-1}				
	at 25 °C, before cooling	at 10 °C			at 25 °C (mean over days 4 to 10)
		day 1	day 2	day 3	
sorghum	48.2	5.5	2.9	1.2	1.5
soybean	23.2	5.2	3.1	1.6	6.4

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(i) Compare the **changes** in carbon dioxide uptake in sorghum and soybean during the three days at 10 °C.

For Examin Use

.....

.....

.....

..... [2]

(ii) During the cooling period, the ultrastructure of the sorghum chloroplasts changed. The membranes of the thylakoids moved closer together, eliminating the spaces between them. The size and number of grana became reduced.

Explain how these changes could be responsible for the low rate of carbon dioxide uptake by sorghum even when returned to a temperature of 25 °C.

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 15]

Q8.

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8 **(a)** Fig. 8.1 shows the effect of temperature on the rate of photosynthesis of a plant at a constant light intensity and a carbon dioxide concentration of 0.03%.

For Examiner's Use

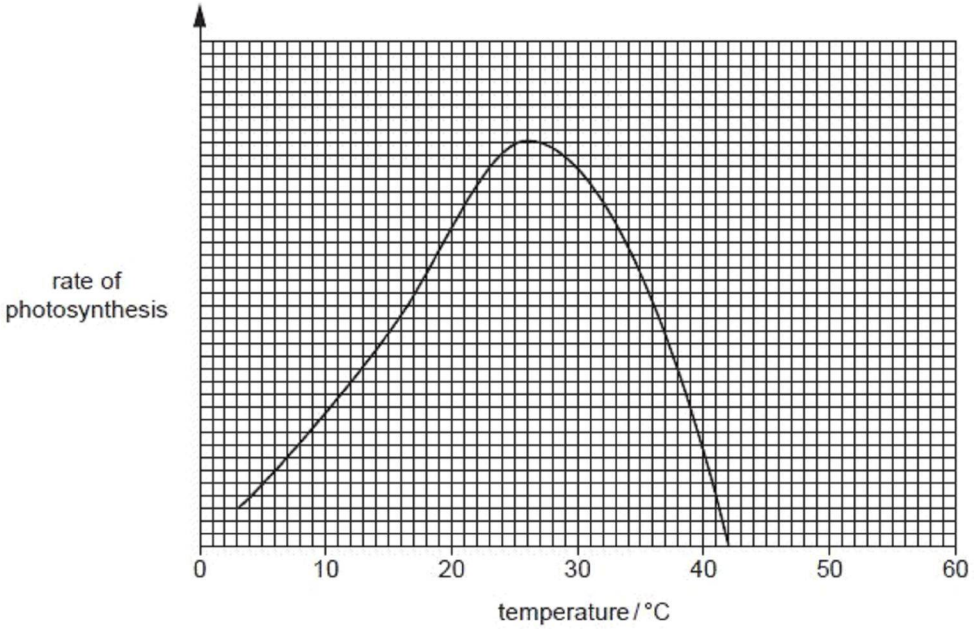


Fig. 8.1

(i) Suggest and explain why the rate of photosynthesis of the plant decreases to zero just above 40 °C.

.....

.....

.....

.....

.....

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.....

.....

..... [5]

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(ii) Draw, **on Fig. 8.1**, the likely curve if the same experiment were carried out on a C4 plant, such as sorghum.

Give reasons to explain your curve.

.....

.....

.....

.....

.....

.....[3]

(b) Experiments were carried out to determine the effect of light intensity on the rate of photosynthesis of a species of the unicellular protoctist, *Chlorella*. A cell suspension of *Chlorella* was used.

- The suspension of *Chlorella* was illuminated at a light intensity of 5 lux for 20 seconds.
- The carbon dioxide uptake by *Chlorella* was measured at the end of the 20 second period of illumination.
- The experiment was repeated at 10, 13 and 15 lux.
- The suspension was maintained at a temperature of 20 °C.

Table 8.1 shows the results of the experiments.

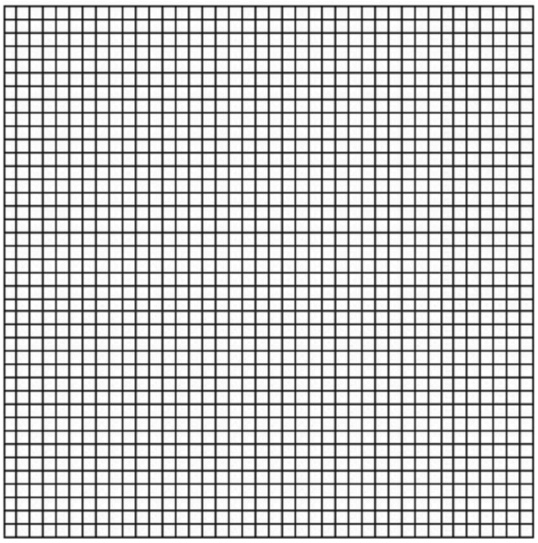
Table 8.1

light intensity / lux	total CO_2 uptake after 20 seconds / µmol	rate of photosynthesis / µmol s^{-1}
5	36	1.8
10	84	
13	104	
15	120	

(i) Complete Table 8.1. [1]

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(ii) Use the data in the table to plot a graph on the grid below to show the effect of light intensity on the rate of photosynthesis.



[3]

(iii) With reference to photosynthesis, state what is meant by a limiting factor.

.....

.....

.....

.....

.....[2]

(iv) State the limiting factor in these four experiments.

.....[1]

[Total: 15]

Q9.

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8 Fig. 8.1 shows a diagram of a stoma, its guard cells and adjacent epidermal cells.

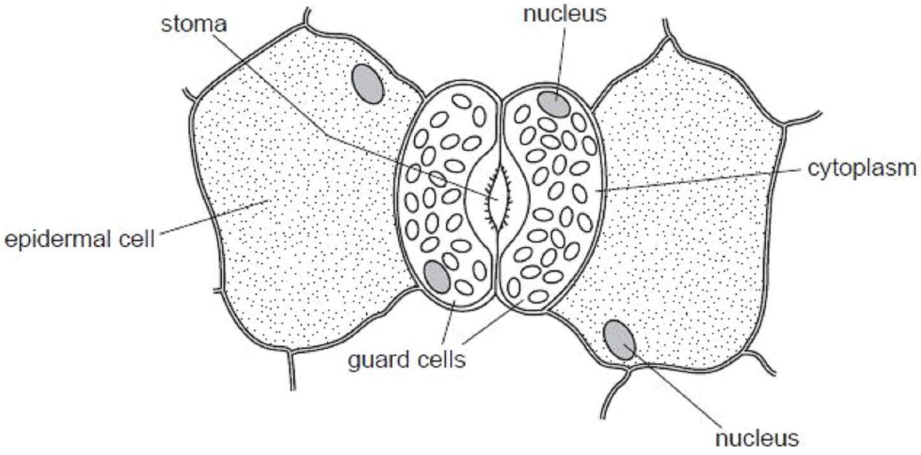


Fig. 8.1

(a) Guard cells have chloroplasts while epidermal cells do not have chloroplasts.

State **one other** difference, visible in Fig. 8.1, between guard cells and epidermal cells.

.....

.....[1]

(b) During stomatal closure:

(i) state precisely where abscisic acid (ABA) binds

.....[1]

(ii) identify the ion that diffuses from the guard cells to epidermal cells

.....[1]

(iii) compare the relative water potential of the guard cells with that of epidermal cells

.....[1]

(iv) describe the change in volume of the guard cells.

.....[1]

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(c) The following experiment was carried out to investigate the effect of light intensity on the rate of photosynthesis of a water plant, *Elodea*.

- *Elodea* was cut into three pieces, each 10 cm long.
- Each piece of *Elodea* was placed in a glass tube, containing 0.5% sodium hydrogencarbonate solution, which was then sealed with a bung.
- Tube **A** was placed 10 cm away from a lamp.
- Tube **B** was placed 5 cm away from a lamp.
- Tube **C** was placed in a dark room.
- An oxygen sensor was used to measure the percentage of oxygen in the solutions at the start of the experiment and again at 5, 10 and 20 minutes.

The results are shown in Fig. 8.2.

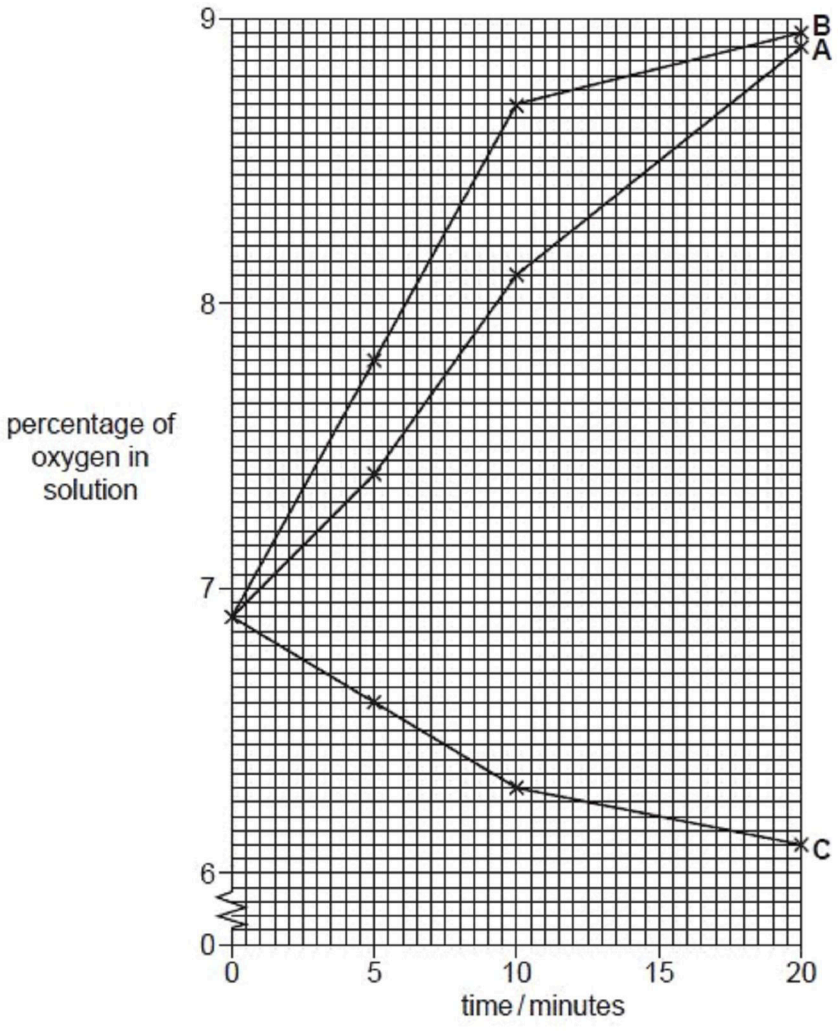


Fig. 8.2

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(i) State why sodium hydrogencarbonate solution was used.

.....

.....[1]

(ii) Calculate the mean rate of oxygen production for tube **A** for the 20 minutes of the experiment.

Show your working.

answer .....[2]

(iii) Compare the results for tubes **A** and **B**.

.....

.....

.....

.....[2]

(iv) Explain the results for tube **C**.

.....

.....

.....

.....[2]

(v) Suggest what factor, which may have an effect on the rate of photosynthesis, was **not** taken into account in this experiment.

.....[1]

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(d) Fig. 8.3 shows the relationship between the light-dependent and light-independent reactions in a chloroplast.

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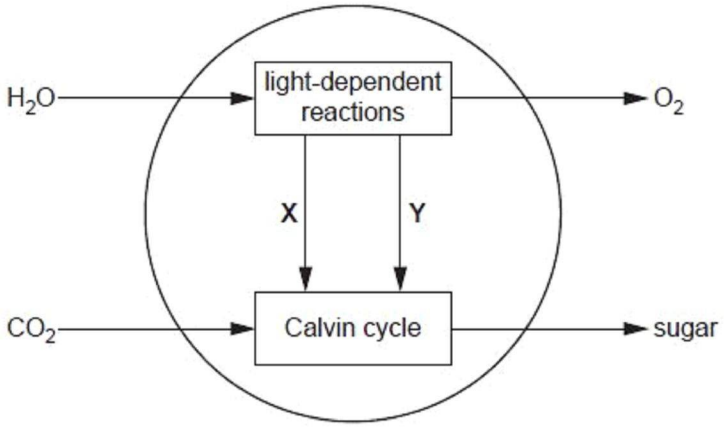


Fig. 8.3

Name the substances **X** and **Y** in Fig. 8.3.

X .....

Y .....[2]

[Total: 15]

Q10.

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1 **(a)** Fig. 1.1 shows a transverse section through a dicotyledonous leaf.

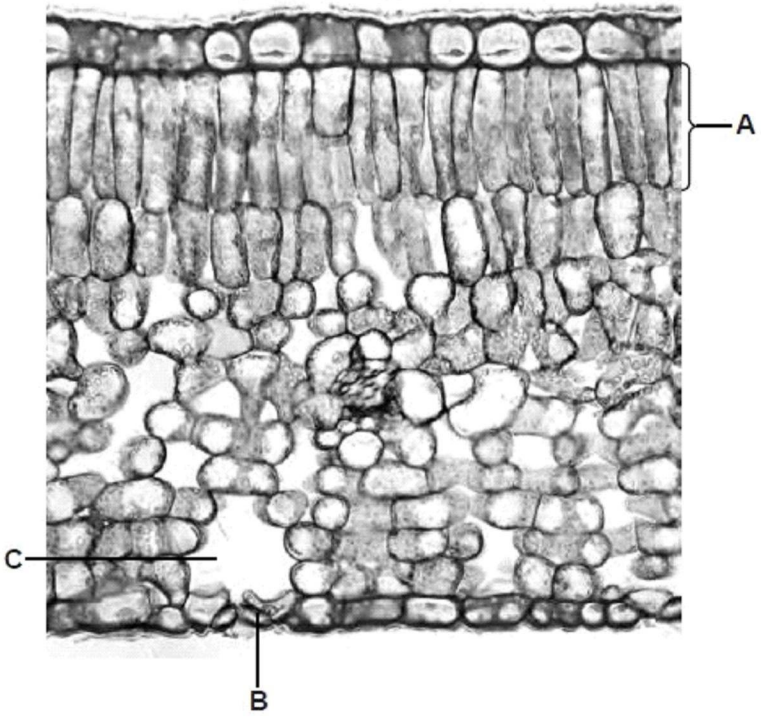


Fig. 1.1

Name **A**, **B** and **C**.

A .....

B .....

C .....

[3]

(b) The leaf is the main photosynthetic organ in most plants. For the light-independent stage of photosynthesis to occur, carbon dioxide must be present.

(i) Describe how carbon dioxide enters the leaf.

.....

.....

.....

..... [2]

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(ii) Name the compound that combines with carbon dioxide in the light-independent stage in a C3 plant.

..... [1]

(iii) Outline the role of reduced NADP in the light-independent stage.

.....

.....

.....

..... [2]

[Total: 8]

Q11.

1 (a) A student investigated the effects of temperature and light intensity on the rate of photosynthesis of an aquatic plant.

Fig. 1.1 shows the results of the investigation.

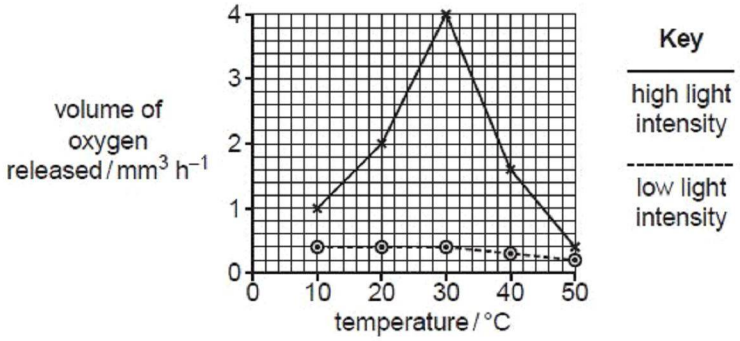


Fig. 1.1

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With reference to Fig. 1.1:

(i) describe the results of the investigation

.....

.....

.....

.....

.....

.....

.....

..... [3]

(ii) suggest explanations for the results for high light intensity **above 30 °C**.

.....

.....

.....

.....

..... [2]

(b) (i) Name the process in the light-dependent stage of photosynthesis that produces oxygen.

..... [1]

(ii) Name the photosystem involved in the production of oxygen in the light-dependent stage.

..... [1]

(iii) Explain why the volume of oxygen released from the plant does not give a true rate of photosynthesis.

.....

.....

..... [1]

[Total: 8]

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Q12.

1 Fig. 1.1 shows the changes in concentration of a 3C compound, glycerate phosphate, GP, and a 5C compound, ribulose bisphosphate, RuBP, extracted from samples taken from actively photosynthesising green algae in an experimental chamber when the light source was turned off.

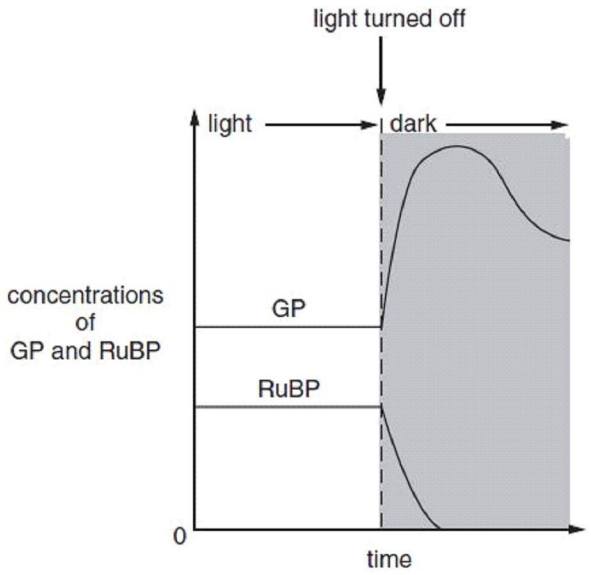


Fig. 1.1

(a) With reference to Fig. 1.1, describe what happens after the light source was turned off to the concentration of

(i) GP;

.....

.....

.....[2]

(ii) RuBP.

.....

.....[1]

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(b) Explain, with reference to the Calvin cycle, the reasons for these observed changes in

(i) GP;

.....

.....

.....[2]

(ii) RuBP.

.....

.....

.....[2]

(c) State the two products of photophosphorylation that drive the Calvin cycle.

1. .....

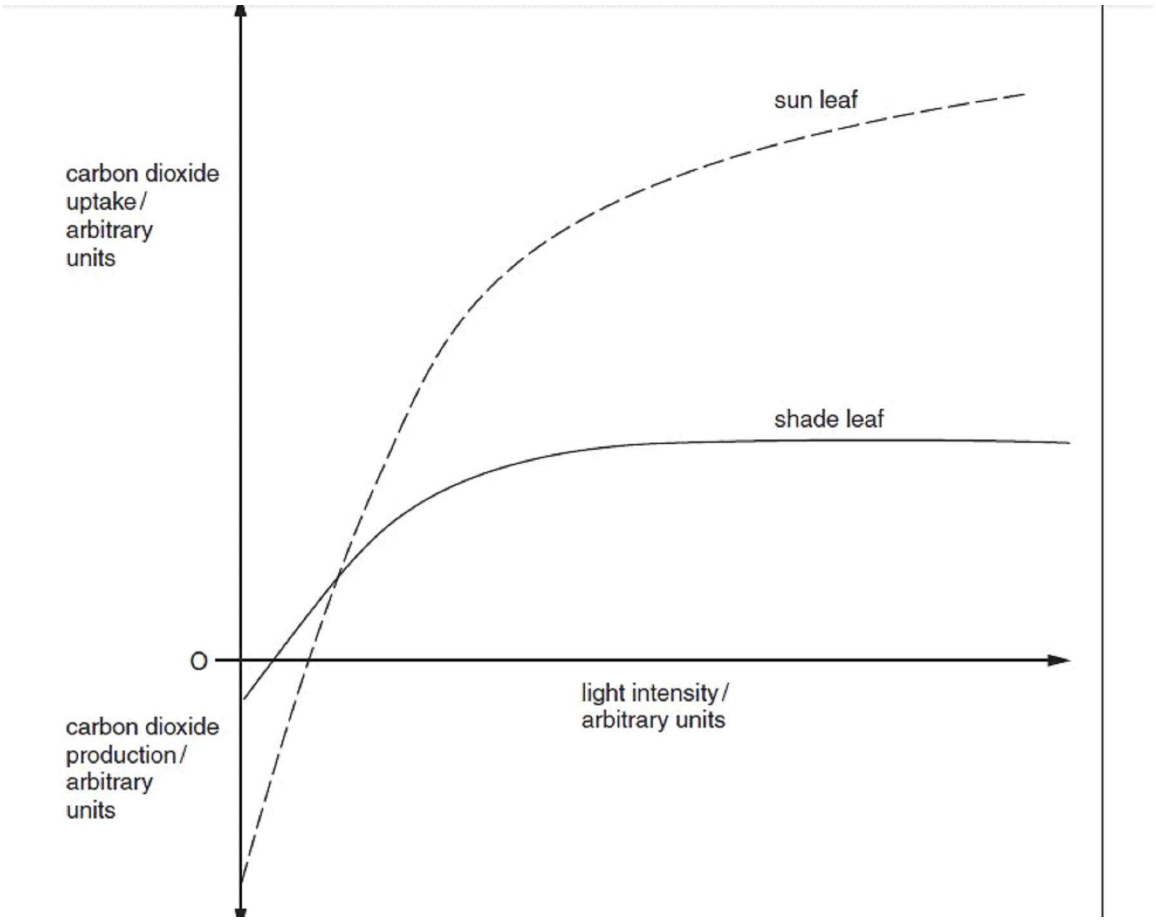
2. .....[2]

[Total : 9]

Q13.

1 Large trees produce sun leaves on the outside of the canopy and shade leaves inside the canopy. Fig. 1.1 shows the rate of carbon dioxide uptake or production of a sun leaf and a shade leaf when exposed to increasing light intensity.

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sun leaf
carbon dioxide uptake / arbitrary units
shade leaf
O
light intensity / arbitrary units
carbon dioxide production / arbitrary units

(a) With reference to Fig. 1.1, describe three ways in which the sun and shade leaf differ in their response to increasing light intensity.

1 .....

.....

2 .....

.....

3 .....

.....[3]

(b) Explain why the carbon dioxide uptake levels off in the shade leaf as the light intensity increases.

.....

.....

.....

.....[3]

(c) The results shown in Fig. 1.1 were taken at a temperature of 20 °C.

Describe briefly how increasing the temperature to 25 °C would affect the results in the sun leaf.

.....

.....

.....

.....[3]

[Total : 9]

Q14.

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1 Fig. 1.1 shows the arrangement of photosystems, protein complexes containing chlorophyll molecules, on the thylakoid membrane of a plant chloroplast.

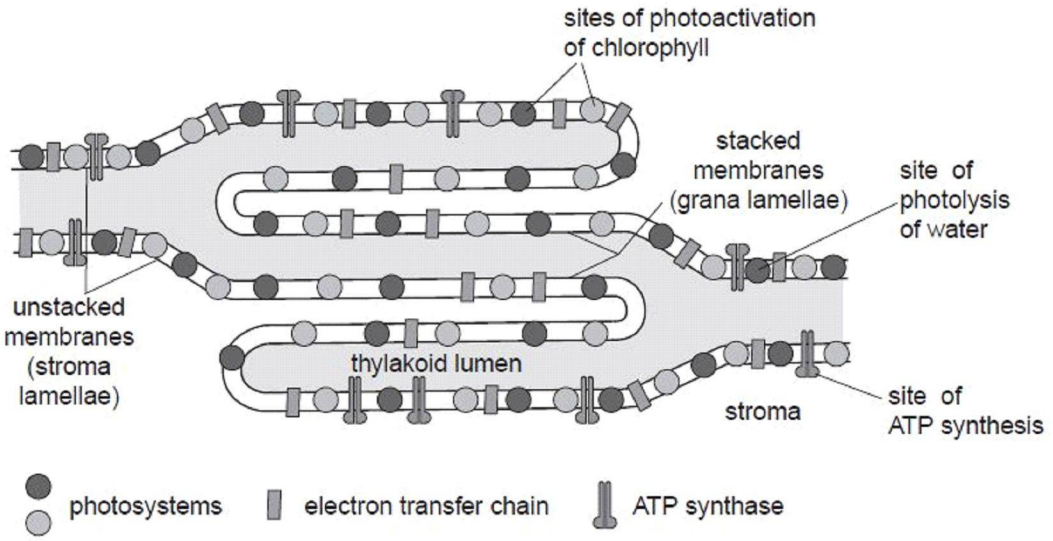


Fig. 1.1

(a) Describe the photoactivation of chlorophyll.

.....

.....

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.....

.....[3]

(b) Explain how the photolysis of water occurs.

.....

.....

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.....[3]

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(c) Outline how ATP is formed in the chloroplast.

.....

.....

.....

.....

.....[3]

(d) Suggest an advantage of having photosystems, the electron transport chain and ATP synthase as part of the thylakoid membrane.

.....[1]

[Total : 10]

Q15.

9 In the majority of photosynthetic organisms, fixation of carbon dioxide occurs in the Calvin cycle.

Fig. 9.1 is an outline of this cycle.

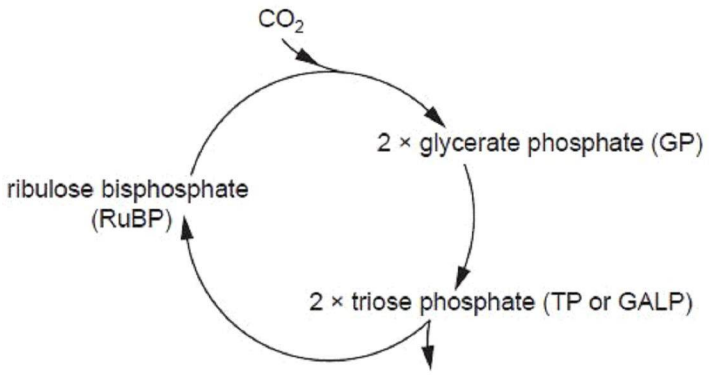


Fig. 9.1

(a) State,

(i) the name of the five carbon sugar in the cycle

.....[1]

(ii) the name of the enzyme that fixes carbon dioxide

.....[1]

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(iii) where in the chloroplast the Calvin cycle occurs

.....[1]

(iv) the name of another compound that is produced in the light-dependent stage of photosynthesis that is used in the Calvin cycle.

.....[1]

(b) Fig. 9.2 shows the changes in the relative concentrations of RuBP and GP produced in the Calvin cycle before and after a light source is switched off. All other conditions are constant.

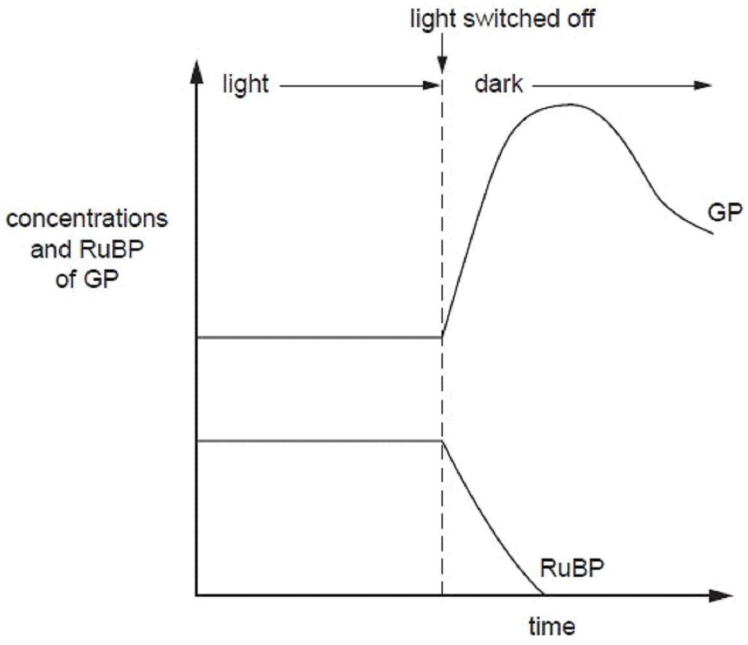


Fig. 9.2

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Explain the changes in the relative concentrations of RuBP and GP **after** the light source is switched off.

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 8]

Q16.

8 **(a)** Fig. 8.1 shows the results from two experiments carried out to investigate the effect of light intensity and carbon dioxide concentration on the rate of photosynthesis.

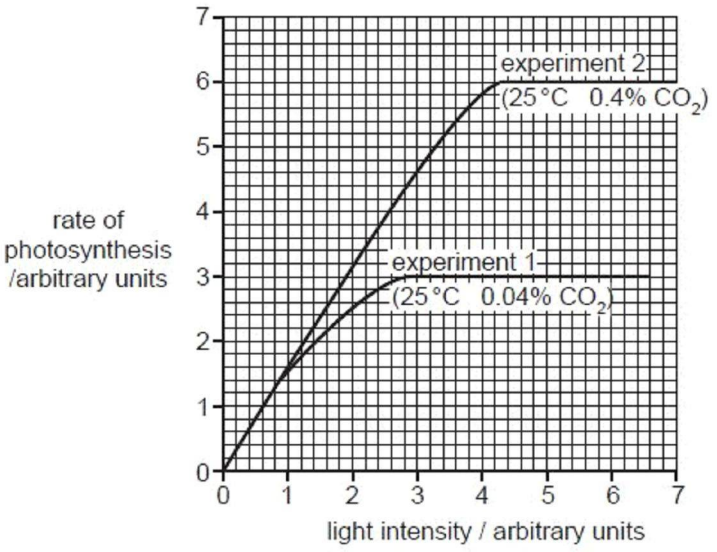


Fig. 8.1

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(i) Describe **and** explain the results shown in Fig. 8.1 for **experiment 1**.

.....

.....

.....

.....

.....

.....[3]

(ii) Describe **and** explain the difference between the results for experiment 1 **and** experiment 2.

.....

.....

.....

.....

.....

.....[3]

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(b) The optimum temperature for many plants living in temperate regions is approximately 25 °C.

Explain why the rate of photosynthesis in these plants decreases at temperatures above 25 °C.

.....

.....

.....

.....

.....

.....

.....

.....

.....[5]

[Total: 11]

Q17.

8 **(a)** In the majority of plants the leaf is the main photosynthetic organ.

List four ways in which the structure of a dicotyledonous leaf is adapted for gas exchange.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

..... [4]

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In an experiment to investigate the effect of light intensity on the rate of photosynthesis, the following procedure was carried out.

- Discs were cut, using a cork borer, from the photosynthetic tissue of the brown alga, *Fucus serratus*, a common seaweed of rocky shores.
- Ten discs were placed in each of four beakers containing 50 cm^3 of sea water. The discs are denser than sea water and therefore initially sink to the bottom of the beaker.
- Each beaker was illuminated with a bench lamp placed at different distances, *d*, from the beaker.
- With time the discs began to rise to the surface of the water.
- The time, *t*, in minutes, at which the fifth disc from each batch reached the surface was recorded.
- The rate of photosynthesis was determined by calculating 1000 / *t*.

A student's set of results is shown in Table 8.1.

Table 8.1

distance of beaker from lamp, *d* / cm	light intensity $1/d^2$	time for fifth disc to reach the surface *t* / min	rate of photosynthesis 1000 / *t*
5	0.04	23	43.5
10	0.01	36	27.8
15	0.004	52	19.2
20	.....	88	11.4

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(b) Calculate the value for light intensity when the distance between beaker and lamp was 20 cm.

Record the value in the space in Table 8.1.
[1]

(c) Explain why the discs rise to the surface after being illuminated for a length of time.

.....

.....

.....

.....

.....

.....[3]

(d) Using the data in Table 8.1, describe the relationship between light intensity and the rate of photosynthesis.

.....

.....

.....

.....[2]

(e) The student found that there was no increase in the rate of photosynthesis when two lamps were placed 5 cm from the beaker.

Suggest why there was no increase in the rate of photosynthesis.

.....

.....

.....

.....[2]

[Total: 12]

Q18.

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8 **(a)** In flowering plants, the light-dependent reactions are carried out by photosynthetic pigments which fall into two categories: primary pigments and accessory pigments.

Outline the role played by accessory pigments in the light-dependent reactions.

.....

.....

.....

..... [2]

(b) Photosynthetic pigments are arranged in photosystems. There are two photosystems, PSI and PSII. PSI takes part in cyclic photophosphorylation but PSII does not.

Outline the differences between cyclic and non-cyclic photophosphorylation.

.....

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.....

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..... [4]

(c) The rate of photosynthesis is affected by several environmental factors. Fig. 8.1 shows the effect of temperature on the rate of photosynthesis.

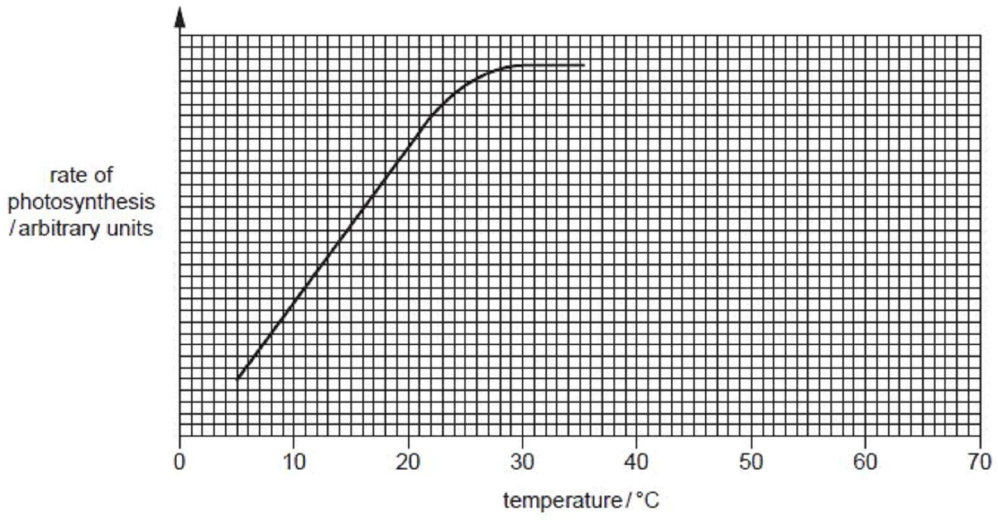


Fig. 8.1

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(i) Explain why the rate of photosynthesis levels out at 30 °C.

Ex

.....

.....

.....

..... [2]

(ii) On Fig. 8.1 continue the curve to indicate what would happen to the rate of photosynthesis if the temperature was increased to 70 °C. [1]

(iii) Explain why you have continued the curve in this way.

.....

.....

.....

..... [2]

(d) A palisade mesophyll cell is adapted to carry out photosynthesis. The table below lists some of the adaptations of a palisade mesophyll cell.

Complete the table to show how these adaptations help the cell to carry out photosynthesis.

adaptation	how the adaptation helps photosynthesis
thin cell wall	....
cylindrical shape	....
large vacuole	....
chloroplasts can be moved within the cell	....

[4]

[Total: 15]

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Q19.

8 **(a)** The rate of photosynthesis at different wavelengths of light can be measured and plotted as a graph. This is called an action spectrum and is shown on Fig. 8.1.

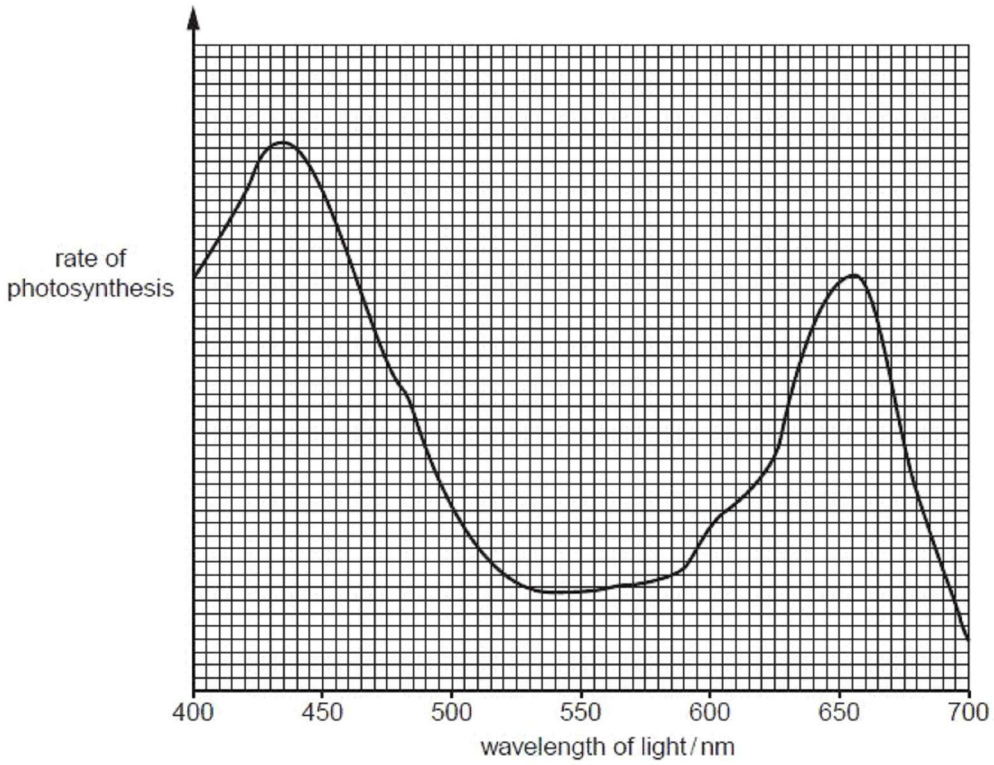


Fig. 8.1

Describe and explain the effects of different wavelengths of light on the rate of photosynthesis.

.....

.....

.....

.....

.....

.....

.....

..... [4]

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(b) (i) Name two products of the light-dependent stage of photosynthesis that are used in the light-independent stage.

1. .....

2. ..... [2]

(ii) Describe how these two products are used in the light-independent stage of photosynthesis.

.....

.....

.....

.....

.....

..... [3]

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(c) The rate of photosynthesis is affected by factors other than the wavelength of light. These factors may act as limiting factors.

Explain what is meant by the term *limiting factor*.

.....

.....

.....

..... [2]

(d) Carbon dioxide concentration in the atmosphere may be a limiting factor in photosynthesis.

Describe how carbon dioxide reaches the photosynthetic cells in a leaf.

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 15]

Q20.

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7 **(a)** An experiment was carried out into the effect of light of different colours on photosynthesis.

- 15 leaf discs from the same plant were obtained.
- Five sealed test-tubes were set up, each containing three leaf discs in hydrogencarbonate indicator solution.
- Hydrogencarbonate indicator solution changes colour at different pH values.
- At the start of the experiment the indicator solution in all five test-tubes was orange-red.
- Four of the test-tubes were illuminated by light of a specific colour.
- The test-tubes were illuminated for the same length of time.
- The fifth test-tube was covered in black paper and was a control.

The results are recorded in Table 7.1.

Table 7.1

colour of light	final colour of hydrogencarbonate solution
white	purple
blue	purple
green	orange-yellow
red	purple
control – no light	yellow

When the pH increases, the indicator becomes purple and when the pH decreases, the indicator turns yellow.

(i) Explain the results for the leaf discs illuminated by blue light.

.....

.....

.....

.....[2]

(ii) Explain why the indicator in the control went yellow.

.....

.....

.....

.....[2]

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(b) Cyclic and non-cyclic photophosphorylation take place in the light-dependent stage of photosynthesis.

(i) Describe the role of accessory pigments in photophosphorylation.

.....

.....

.....

.....[2]

(ii) Write a balanced equation that summarises photolysis.

.....[1]

(iii) State **precisely** the location of photosynthetic pigments within a chloroplast.

.....[1]

[Total: 8]

Q21.

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7 The light-dependent stage of photosynthesis takes place on the thylakoids of the chloroplast.

Fig. 7.1 shows some of the components involved in the light-dependent stage.

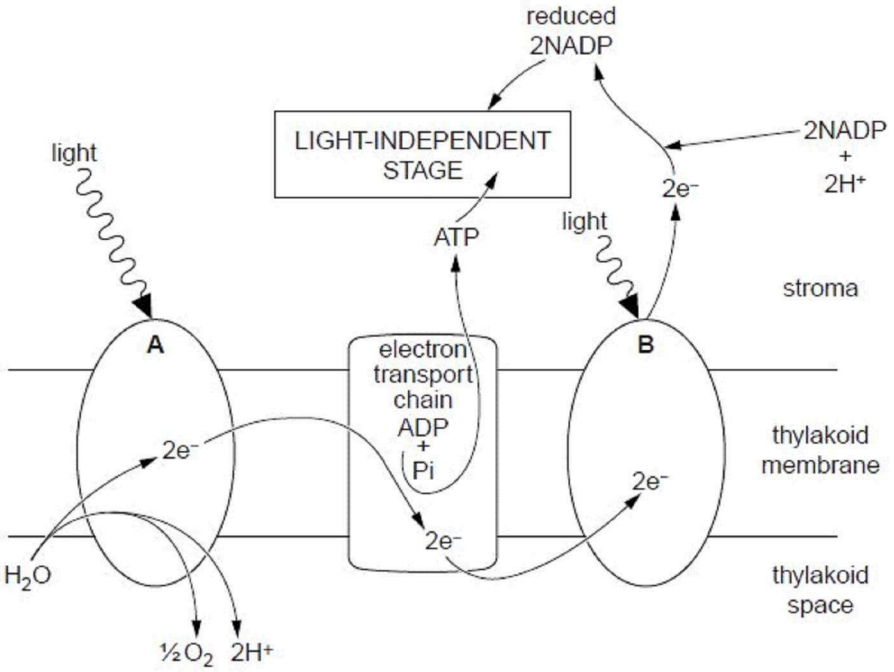


Fig. 7.1

(a) With reference to Fig. 7.1, identify structures **A** and **B**.

A .....

B .....[2]

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(b) Describe the roles of the following substances in the light-independent stage of photosynthesis:

E

(i) RuBP

.....

.....

.....

.....[2]

(ii) reduced NADP

.....

.....

.....

.....[2]

(iii) ATP.

.....

.....

.....

.....[2]

[Total: 8]

Q22.

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1 **(a)** The unicellular green alga, *Chlorella*, a photosynthetic protoctist, was originally studied for its potential as a food source. Although large-scale production proved to be uneconomic, the many health benefits provided by *Chlorella* mean that it is now mass produced and harvested for use as a health food supplement.

Fig. 1.1 shows cells of *Chlorella*.

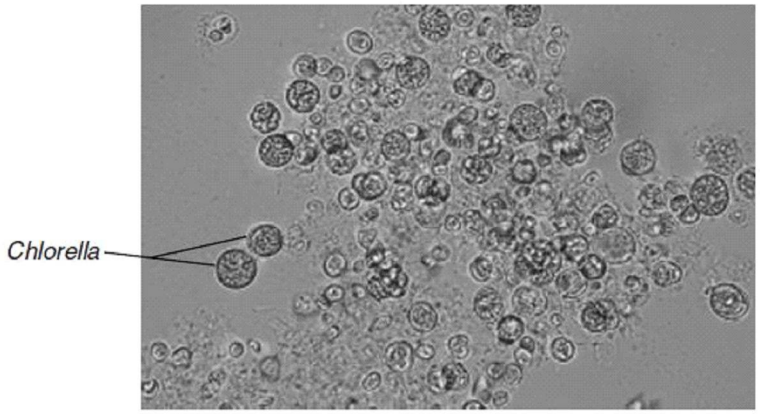


Fig. 1.1

In one study into the productivity of *Chlorella*, carbon dioxide concentration was altered to investigate its effects on the light-independent stage of photosynthesis.

- A cell suspension of *Chlorella* was illuminated using a bench lamp.
- The suspension was supplied with carbon dioxide at a concentration of 1% for 200 seconds.
- The concentration of carbon dioxide was then reduced to 0.03% for a further 200 seconds.
- The concentrations of RuBP and GP (PGA) were measured at regular intervals.
- Throughout the investigation the temperature of the suspension was maintained at 25 °C.

The results are shown in Fig. 1.2.

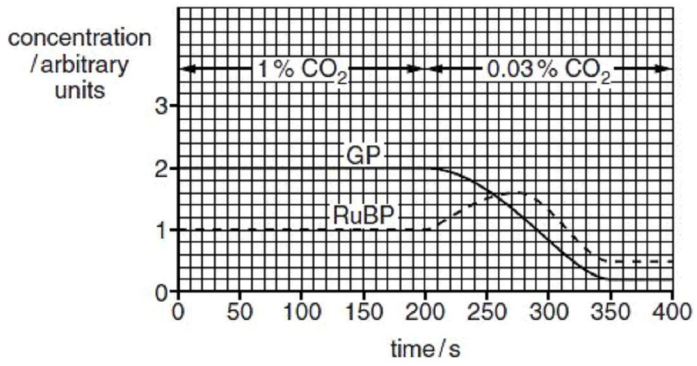


Fig. 1.2

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(i) State **precisely** where in the chloroplast RuBP and GP are located.

.....[1]

(ii) Explain why the concentration of RuBP changed between 200 and 275 seconds.

.....

.....

.....

.....

.....

.....[2]

(iii) Calculate the rate of decrease per second in the concentration of GP between 200 and 350 seconds.

Show your working and give your answer to **two decimal places**.

answer ..... arbitrary units per second [2]

(b) Explain how the decrease in the concentration of GP leads to a decreased harvest for commercial suppliers of *Chlorella*.

.....

.....

.....

.....

.....

.....[2]

[Total: 7]

Q23.

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1 (a) Fig. 1.1 is an electron micrograph of a chloroplast from a maize leaf cell.



Fig. 1.1

Indicate below which of **X**, **Y** or **Z** contains:

transport proteins .....

pigments ..... [2]

(b) A chloroplast also contains DNA.

Suggest the functions of DNA in **this** organelle.

.....

.....

.....

.....

.....

.....[2]

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(c) Changes in the atmospheric carbon dioxide concentration, light intensity and temperature alter the rate of photosynthesis. These three factors directly affect different stages of photosynthesis.

Complete the table below using a tick (✓) if the factor **directly** affects the stage or a cross (✗) if it does not affect the stage.

factor	stage	✓ or ✗
carbon dioxide concentration	Calvin cycle	.....
	photolysis	.....
light intensity	Calvin cycle	.....
	photolysis	.....
temperature	Calvin cycle	.....
	photolysis	.....

[3]

[Total: 7]

Q24.

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8 **(a)** Fig. 8.1 shows some of the reactions that take place inside a palisade mesophyll cell.

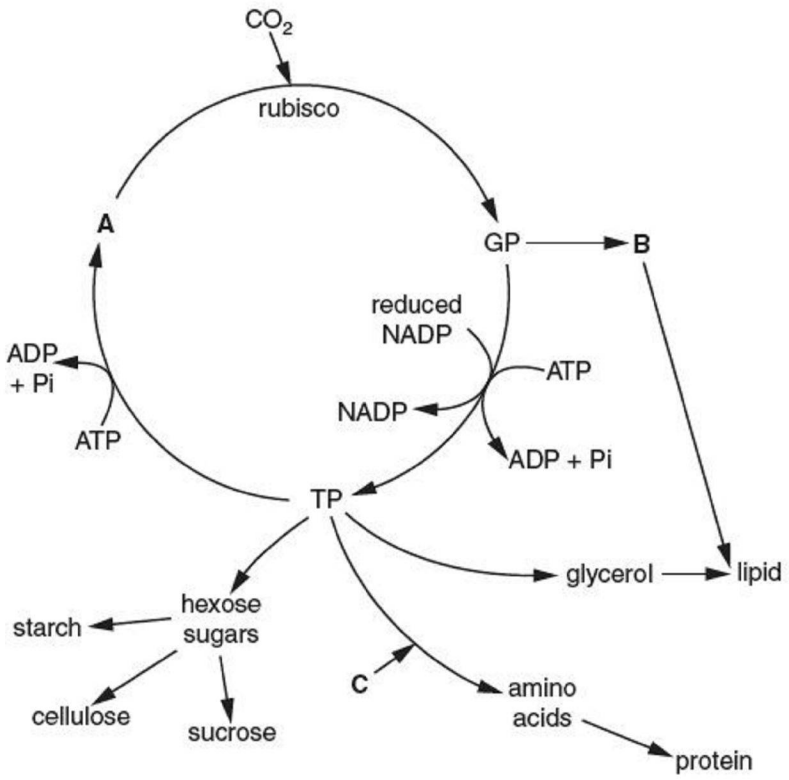


Fig. 8.1

(i) Identify substances **A**, **B** and **C**.

A .....

B .....

C ..... [3]

(ii) Name precisely the process that produces reduced NADP.

.....[1]

(iii) Name the type of reaction that takes place to produce starch from hexose sugars **and** name the type of bonds formed.

reaction .....

bond .....[2]

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(iv) Describe how carbon dioxide reaches the inside of a palisade mesophyll cell from the external atmosphere.

.....

.....

.....

.....

.....

.....

.....[3]

(b) The optimum pH for the activity of rubisco is pH8.

Explain why the illumination of chloroplasts leads to optimum pH conditions for rubisco.

.....

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.....

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.....

.....

.....

.....

.....[3]

[Total: 12]

Q25.

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8 **(a)** Fig. 8.1 is a diagram of a palisade cell from a leaf.

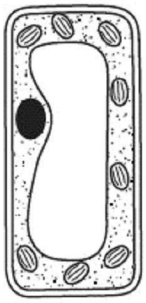


Fig. 8.1

Using label lines and the letters **X**, **Y** and **Z**, identify a structure in Fig. 8.1 that:

- contains RuBP – **X**
- is fully permeable – **Y**
- is made mainly of phospholipids – **Z** [3]

(b) An experiment was carried out to investigate the effect of light intensity on the rate of photosynthesis in an aquatic plant using the apparatus shown in Fig. 8.2.

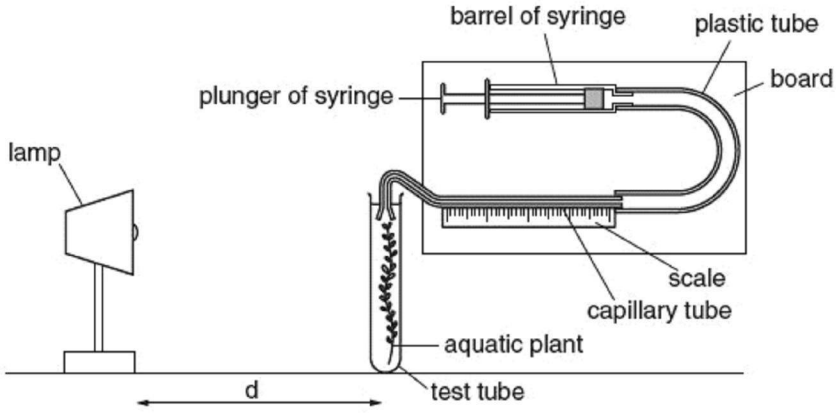


Fig. 8.2

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As photosynthesis took place, the oxygen produced formed a bubble of gas which moved along the scale in the capillary tube. The distance moved by the bubble in a fixed period of time was used to calculate the rate of photosynthesis.

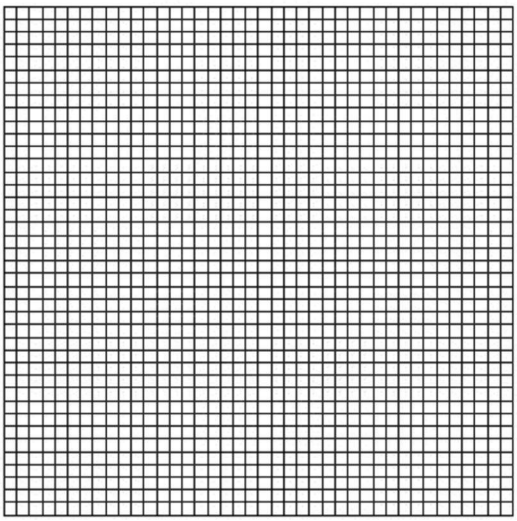
The light intensity was varied by altering the distance, d, between the lamp and the photosynthesising plant.

The results are shown in Table 8.1.

Table 8.1

light intensity / arbitrary units	rate of photosynthesis / arbitrary units
50	50
100	100
125	110
150	115
200	120
300	120

(i) Using the data in Table 8.1, draw a graph to show the relationship between light intensity and the rate of photosynthesis.



[3]

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(ii) **Explain** the shape of the graph you have drawn, with reference to limiting factors.

.....

.....

.....

.....

.....

.....

.....

.....[3]

(c) Fig. 8.3 shows the absorption spectra of the photosynthetic pigments of a flowering plant.

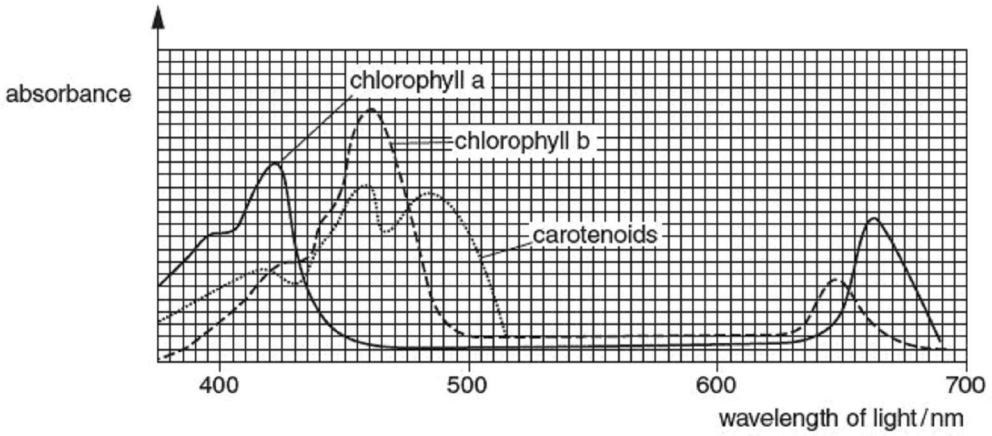


Fig. 8.3

(i) Name the accessory pigment(s) shown in Fig. 8.3.

.....

.....[1]

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(ii) Outline the role of the accessory pigments in photosynthesis.

.....

.....

.....

.....

.....

.....

.....[3]

(iii) Very little light of wavelength 550 nm is absorbed by the photosynthetic pigments.

State what happens to most of this light.

.....

.....[1]

(iv) A graph can also be drawn to show the relationship between the wavelength of light and the rate of photosynthesis.

State the name of this type of graph.

.....[1]

[Total: 15]

Section B

1.

7 (a) Outline the main features of the Calvin Cycle. [9]

(b) Explain the role of NADP in photosynthesis. [6]

[Total: 15]

2.

10 (a) Describe the structure of a chloroplast. [9]

(b) Explain how the palisade mesophyll cells of a leaf are adapted for photosynthesis. [6]

[Total: 15]

3.

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9 **(a)** Explain how the palisade mesophyll cells of a leaf are adapted for photosynthesis. [8]

(b) Outline the light-independent stage of photosynthesis. [7]

[Total: 15]

4.

9 **(a)** Describe the structure of photosystems and explain how a photosystem functions in cyclic photophosphorylation. [8]

(b) Explain briefly how reduced NADP is formed in the light-dependent stage and how it is used in the light-independent stage. [7]

[Total: 15]

5.

10 **(a)** Describe how non-cyclic photophosphorylation produces ATP and reduced NADP. [9]

(b) Outline the steps of the Calvin cycle. [6]

[Total: 15]

6.

10 **(a)** Describe the photoactivation of chlorophyll **and** its role in **cyclic** photophosphorylation. [8]

(b) Explain briefly how reduced NADP is formed in the light-dependent stage and how it is used in the light-independent stage. [7]

[Total: 15]

7.

10 **(a)** Explain how the physiology of the leaves of a C4 plant, such as maize, is adapted for efficient carbon fixation at high temperatures. [7]

(b) Describe how, in photosynthesis, light energy is converted into chemical energy, in the form of ATP. [8]

[Total: 15]

8.

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6 **(a)** Describe how the structure of a dicotyledonous leaf is related to its functions in photosynthesis. [7]

(b) Discuss the effects that variations in carbon dioxide concentration and light intensity have on the rate of photosynthesis. [8]

9.

10 **(a)** Describe the structure of photosystems and explain how a photosystem functions in **cyclic** photophosphorylation. [9]

(b) Explain briefly how reduced NADP is formed in the light-dependent stage of photosynthesis and is used in the light-independent stage. [6]

[Total: 15]

10.

10 **(a)** Describe how the structure of a chloroplast is related to its functions. [9]

(b) Describe how you would separate chloroplast pigments using chromatography. [6]

[Total: 15]

11.

10 **(a)** Explain how the palisade mesophyll cells of a leaf are adapted for photosynthesis. [7]

(b) Describe the structure of photosystems **and** explain how a photosystem functions in ***cyclic*** photophosphorylation. [8]

[Total: 15]

12.

10 **(a)** Describe the arrangement and location of chloroplast pigments **and** discuss their effect on absorption spectra. [8]

(b) Describe the part played by auxins in apical dominance in a plant shoot. [7]

[Total: 15]

13.

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10 **(a)** Outline the process of the photolysis of water **and** describe what happens to the products of photolysis. [10]

(b) Describe the roles of gibberellins in stem elongation. [5]

[Total: 15]

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1. Nov/2018/Paper_41/No.7

(a) Fig. 7.1 is a transmission electron micrograph of a chloroplast.

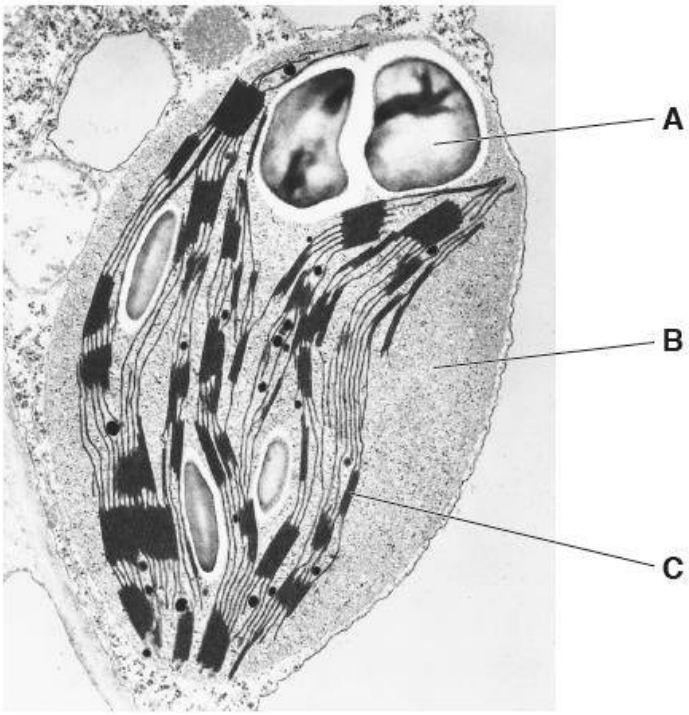


Fig. 7.1

Many compounds and structures involved in photosynthesis are located in a chloroplast.

Using the labels **A**, **B** or **C**, complete Table 7.1 to show the location of four of these compounds or structures.

You may use each of the letters **A**, **B** and **C** once, more than once, or not at all.

Table 7.1

compound or structure	location
ATP synthase	……
rubisco	……
starch grain	……
phospholipid bilayer	……

[3]

(b) *Elodea canadensis* is an aquatic plant that lives submerged in freshwater.

Equal-sized plants of *E. canadensis* were exposed to different wavelengths of light for the same period of time. As each plant photosynthesised, the number of bubbles of oxygen leaving the plant was counted.

For each wavelength, the rate of oxygen production was calculated.

The results are shown in Fig. 7.2.

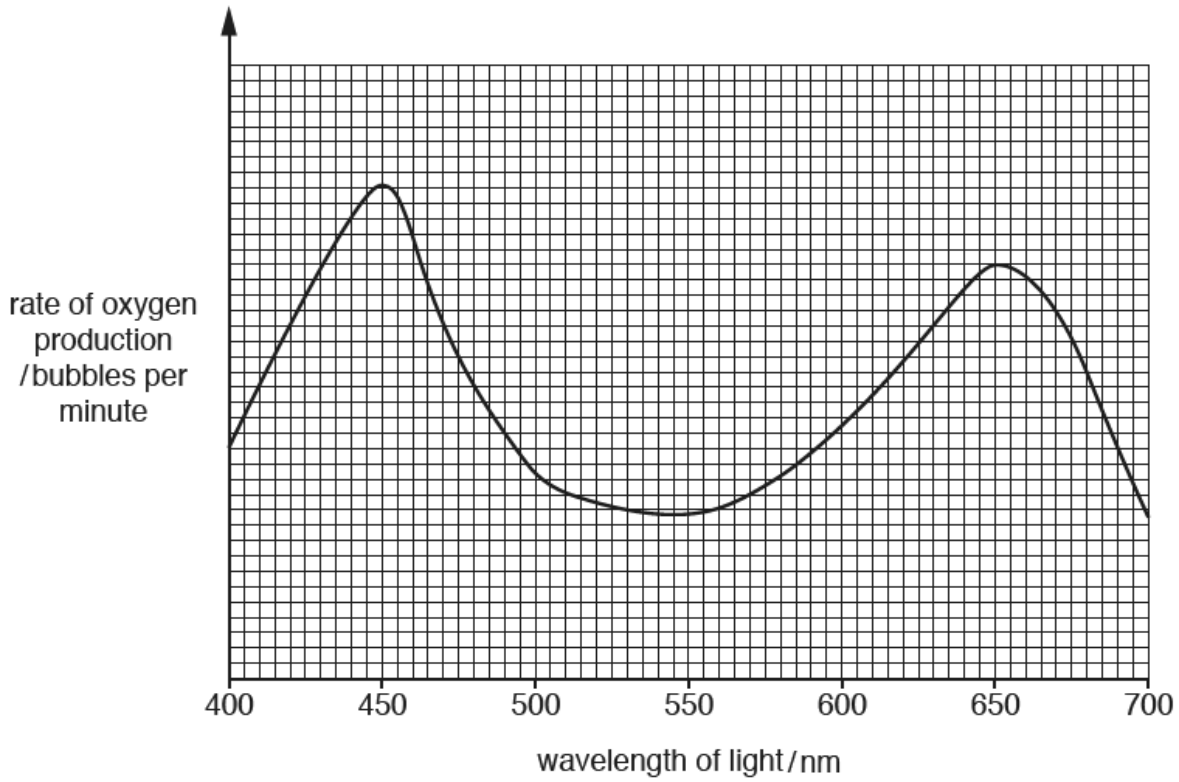


Fig. 7.2

Describe **and** explain the results shown in Fig. 7.2.

.....

.....

.....

.....

.....

.....

.....

.....[3]

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(c) Chlorophyll b, carotene and xanthophyll are known as accessory pigments. Describe the role of the accessory pigments in photosynthesis.

.....

.....

.....

..... [2]

[Total: 8]

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1. Nov/2019/Paper_41/No.5

(a) Fig. 5.1 shows the seaweed *Laminaria hyperborea*. This is a photosynthetic protoctist found in the coastal waters around Norway.

The seaweed is grown commercially to obtain the glucose polysaccharide called alginate. This is used in certain food products.

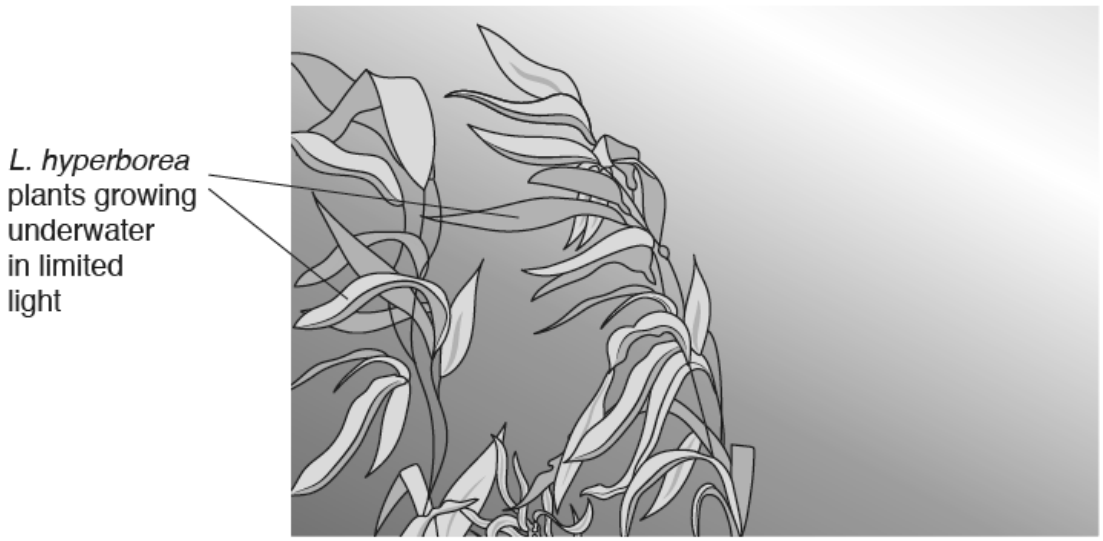


Fig. 5.1

An increase in carbon dioxide concentration in the atmosphere has resulted in higher concentrations of carbon dioxide in the ocean. This has caused a decrease in the pH of the ocean and has resulted in ocean acidification.

Scientists are studying seaweeds such as *L. hyperborea* because they absorb a large quantity of carbon dioxide during photosynthesis. This may help to increase the pH of the ocean and reverse ocean acidification.

(i) State where light absorption occurs in the chloroplasts of *L. hyperborea*.

..... [1]

(ii) Name **one** product of the light dependent stage of photosynthesis.

..... [1]

(iii) Outline the reactions occurring in the stroma that lead to the production of a polysaccharide, such as alginate.

The first sentence has been completed for you.

Carbon dioxide binds to RuBP.

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..... [4]

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(b) Laboratory experiments were carried out to investigate the effect of day length on the rate of photosynthesis in another marine autotroph, *Zostera marina*.

- The temperature was controlled at 4 °C.
- A low concentration of carbon dioxide dissolved in the water was used.
- The light exposure period (day length) was different for five groups of *Z. marina*.
- This was maintained for 10 days to allow *Z. marina* to adapt to these conditions.
- After 10 days, the rate of photosynthesis was measured for each group under the **same** controlled conditions.
- The experiment was repeated using five groups of *Z. marina* with a high concentration of carbon dioxide dissolved in water.

Table 5.1 shows the rate of photosynthesis for each group.

Table 5.1

day length /hours	rate of photosynthesis /arbitrary units	
	low carbon dioxide concentration	high carbon dioxide concentration
12	2.0	2.5
14	3.0	5.0
16	4.0	7.0
18	5.5	11.0
20	7.5	18.0

(i) With reference to Table 5.1, explain the difference in the rate of photosynthesis at high carbon dioxide concentration compared to low carbon dioxide concentration.

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..... [2]

(ii) With reference to Table 5.1, describe **and** explain the effect of increasing day length on the rate of photosynthesis for the *Z. marina* in high carbon dioxide concentration.

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..... [3]

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(c) In the laboratory, a seaweed was grown in water with different pH values. All other variables, including temperature and light, were standardised.

The mean rate of photosynthesis was calculated over a 24 hour period for each pH value.

The results are shown in Fig 5.2.

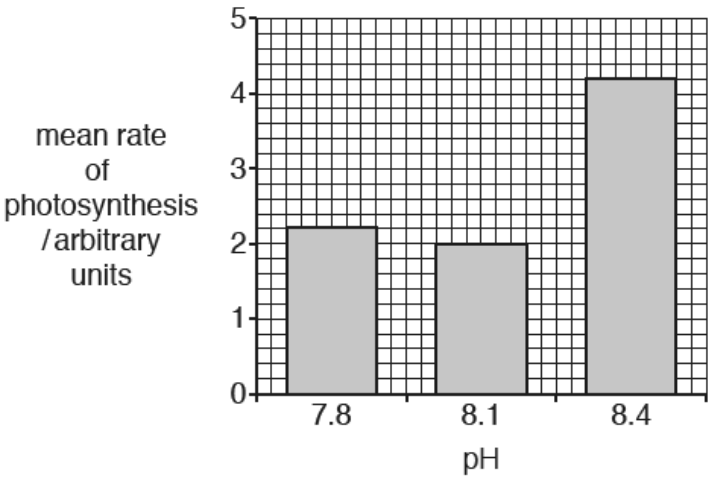


Fig. 5.2

(i) With reference to Fig. 5.2, explain the effect on the rate of photosynthesis when the pH increases from 8.1 to 8.4.

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..... [2]

(ii) The lower pH values on Fig. 5.2 represent ocean acidification.

Suggest why the results for the lower pH values do **not** fully support the idea that seaweeds can help to reduce ocean acidification.

.....

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..... [1]

[Total: 14]

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2. Nov/2019/Paper_42/No.5

(a) Fig. 5.1 shows the seaweed *Laminaria hyperborea*. This is a photosynthetic protoctist found in the coastal waters around Norway.

The seaweed is grown commercially to obtain the glucose polysaccharide called alginate. This is used in certain food products.

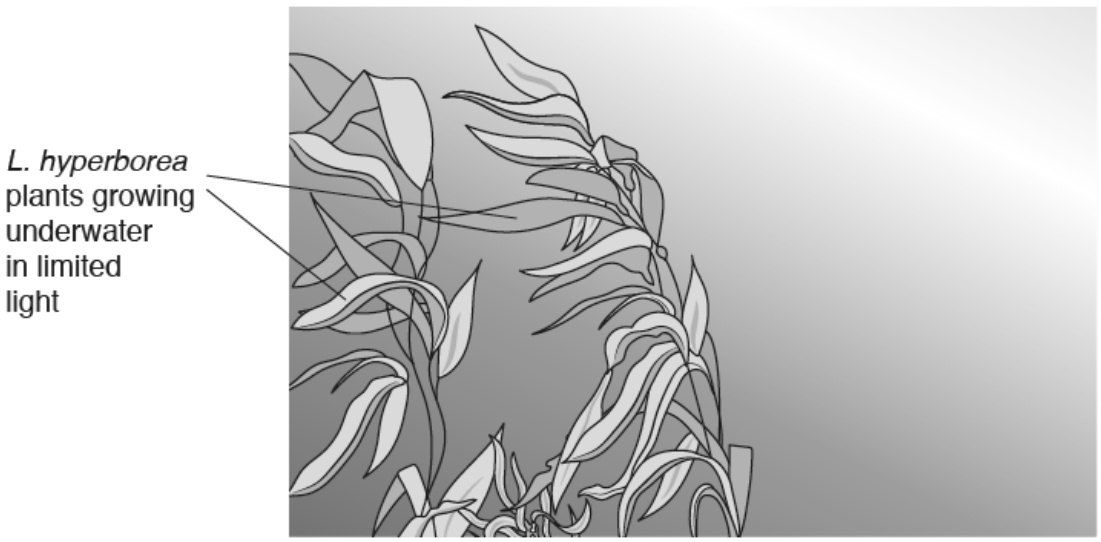


Fig. 5.1

An increase in carbon dioxide concentration in the atmosphere has resulted in higher concentrations of carbon dioxide in the ocean. This has caused a decrease in the pH of the ocean and has resulted in ocean acidification.

Scientists are studying seaweeds such as *L. hyperborea* because they absorb a large quantity of carbon dioxide during photosynthesis. This may help to increase the pH of the ocean and reverse ocean acidification.

(i) State where light absorption occurs in the chloroplasts of *L. hyperborea*.

..... [1]

(ii) Name **one** product of the light dependent stage of photosynthesis.

..... [1]

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(iii) Outline the reactions occurring in the stroma that lead to the production of a polysaccharide, such as alginate.

The first sentence has been completed for you.

Carbon dioxide binds to RuBP.

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..... [4]

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(b) Laboratory experiments were carried out to investigate the effect of day length on the rate of photosynthesis in another marine autotroph, *Zostera marina*.

- The temperature was controlled at 4 °C.
- A low concentration of carbon dioxide dissolved in the water was used.
- The light exposure period (day length) was different for five groups of *Z. marina*.
- This was maintained for 10 days to allow *Z. marina* to adapt to these conditions.
- After 10 days, the rate of photosynthesis was measured for each group under the **same** controlled conditions.
- The experiment was repeated using five groups of *Z. marina* with a high concentration of carbon dioxide dissolved in water.

Table 5.1 shows the rate of photosynthesis for each group.

Table 5.1

day length /hours	rate of photosynthesis /arbitrary units	
	low carbon dioxide concentration	high carbon dioxide concentration
12	2.0	2.5
14	3.0	5.0
16	4.0	7.0
18	5.5	11.0
20	7.5	18.0

(i) With reference to Table 5.1, explain the difference in the rate of photosynthesis at high carbon dioxide concentration compared to low carbon dioxide concentration.

.....

.....

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..... [2]

(ii) With reference to Table 5.1, describe **and** explain the effect of increasing day length on the rate of photosynthesis for the *Z. marina* in high carbon dioxide concentration.

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..... [3]

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(c) In the laboratory, a seaweed was grown in water with different pH values. All other variables, including temperature and light, were standardised.

The mean rate of photosynthesis was calculated over a 24 hour period for each pH value.

The results are shown in Fig 5.2.

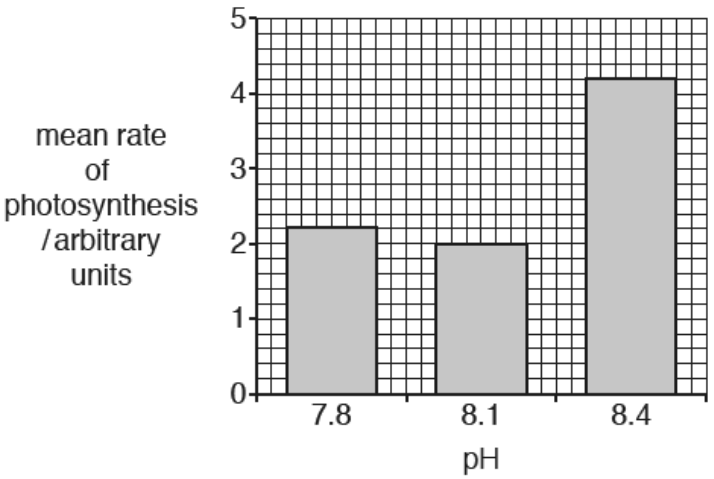


Fig. 5.2

(i) With reference to Fig. 5.2, explain the effect on the rate of photosynthesis when the pH increases from 8.1 to 8.4.

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.....

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.....

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..... [2]

(ii) The lower pH values on Fig. 5.2 represent ocean acidification.

Suggest why the results for the lower pH values do **not** fully support the idea that seaweeds can help to reduce ocean acidification.

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..... [1]

[Total: 14]

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3. Nov/2019/Paper_43/No.6

Mining may result in the release of heavy metal ions, causing pollution of lakes and rivers.

High concentrations of these heavy metal ions, such as cadmium (Cd^{2+}) and copper (Cu^{2+}), decrease the rate of photosynthesis in plants.

(a) Cadmium ions disrupt the function of photosystem II in chloroplasts.

(i) Name the part of the chloroplast where photosystem II is located.

..... [1]

(ii) Describe the role of photosystem II in the absorption of light.

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..... [3]

(b) An investigation was carried out into the effect of cadmium ion concentration on the aquatic, single-celled, photosynthetic protoctist, *Chlamydomonas reinhardtii*.

The activity of photosystem II was measured at different concentrations of cadmium ions.

- Four different concentrations of cadmium ions were used, 0, 1, 10 and 100 $\mu mol\,dm^{-3}$.
- *C. reinhardtii* was allowed to acclimatise in the dark before the experiment started.
- At time 0 min the light was switched on and the cadmium ions were added.
- At each concentration, the activity of photosystem II was measured over a period of 60 minutes.
- Each experiment was carried out under the same controlled conditions.

The results are shown in Fig. 6.1.

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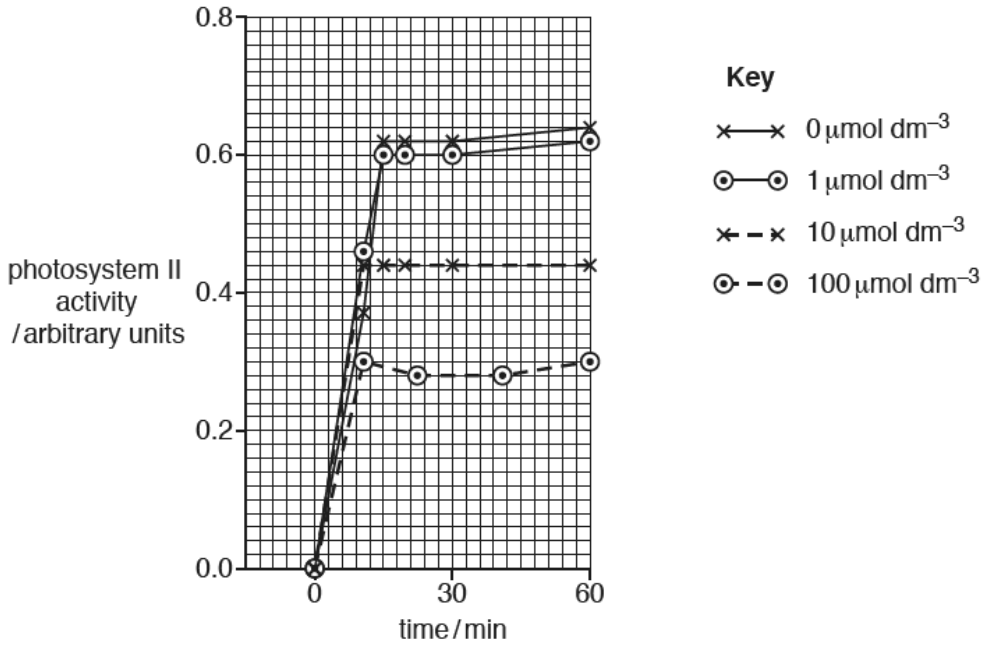


Fig. 6.1

Describe the effects of cadmium ion concentration on the activity of photosystem II, as shown in Fig. 6.1.

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..... [2]

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(c) Copper(II) ions (Cu^{2+}) inhibit the function of a proportion of the chlorophyll a present in single-celled, photosynthetic protoctists.

The concentration of functional chlorophyll a in these organisms was measured in two different months of the same year in an unpolluted lake and in a lake polluted with copper ions.

The results are shown in Table 6.1.

Table 6.1

lake	concentration of functional chlorophyll a / μg dm^{-3}	
	month **A**	month **B**
unpolluted	3.45	0.24
polluted with copper ions	1.79	0.24

(i) Describe **and** suggest explanations for the results shown in Table 6.1.

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..... [4]

(ii) Copper ions can replace other metal ions present in organic molecules.

Suggest how copper ions change the structure of chlorophyll a.

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..... [1]

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(d) Chromatography is a method that can be used to separate and identify different photosynthetic pigments in a chloroplast extract.

Describe how chromatography is used to identify chlorophyll a in an extract from chloroplasts.

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..... [4]

[Total: 15]

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4. June/2019/Paper_41/No.9(a)

(a) Explain what is meant by the term limiting factor **and** explain how knowledge of limiting factors is used to increase crop yields in glasshouses. [7]

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5. June/2019/Paper_41/No.10(b)

(b) Describe how you would carry out an investigation into the effect of wavelength of light on the rate of photosynthesis of a plant, using a redox indicator such as DCPIP. [8]

6. June/2019/Paper_43/No.9

(a) Describe how the structure of a chloroplast is related to its functions. [8]

(b) Describe how you would separate chloroplast pigments using chromatography. [7]

[Total: 15]

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7. Feb/2019/Paper_42/No.1

(a) The effect of light intensity on the rate of photosynthesis can be investigated using a cut shoot of a pond plant.

The apparatus used in the investigation is shown in Fig. 1.1.

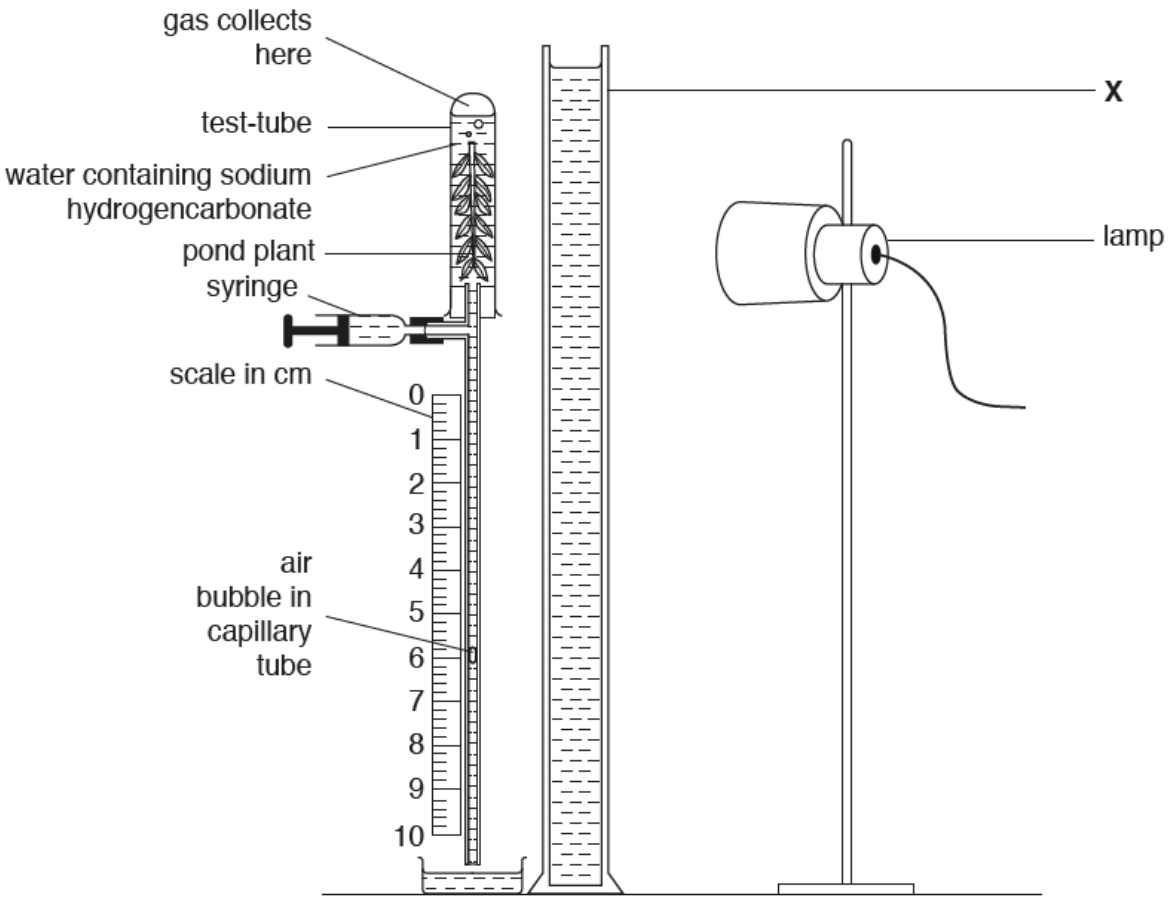


Fig. 1.1

The light intensity can be changed by placing the lamp at different distances from the pond plant.

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(i) Apparatus **X**, shown in Fig. 1.1, is a thin glass container filled with water.

Explain the function of apparatus **X**.

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..... [2]

(ii) Before completing the assembly of the apparatus shown in Fig. 1.1, sodium hydrogencarbonate is added to the water surrounding the pond plant in the test-tube.

Explain why sodium hydrogencarbonate is added to the water surrounding the pond plant in the test-tube.

.....

..... [1]

(iii) Name the gas collected in the test-tube.

..... [1]

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(b) The investigation was carried out with the lamp at distances of 10, 20, 30, 40 and 50 cm from the pond plant. For each of these distances, the air bubble in the capillary tube was initially positioned at 0 cm on the scale and, after 5 minutes, the distance moved by the air bubble was measured. The rate of movement of the air bubble was then calculated.

The results are shown in Fig. 1.2.

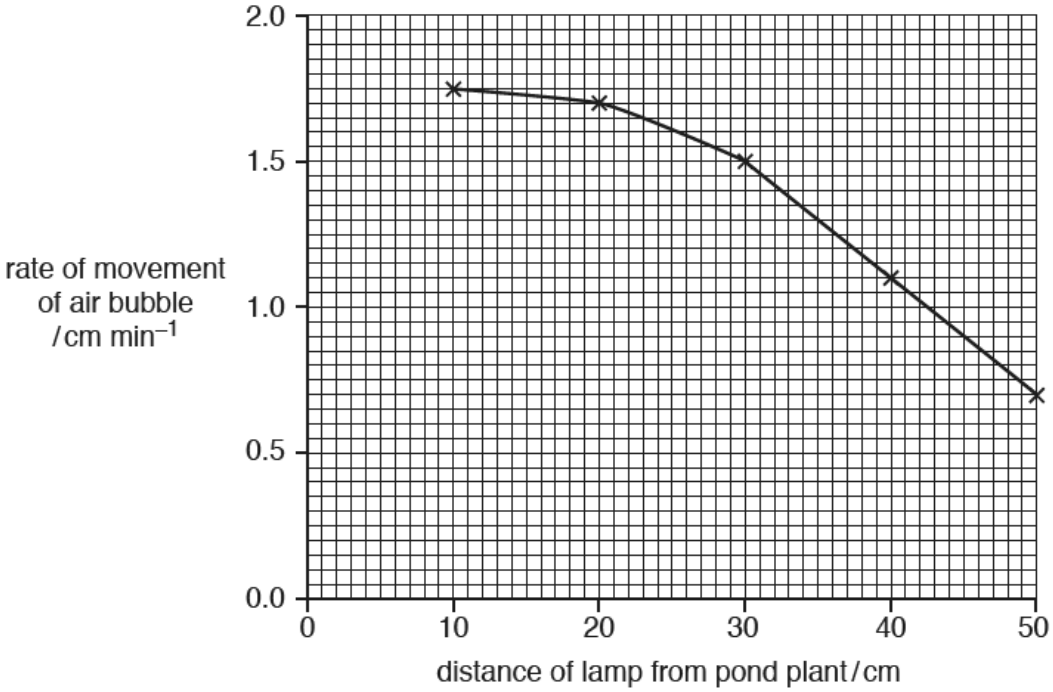


Fig. 1.2

(i) With reference to Fig. 1.2, describe the relationship between the rate of photosynthesis and **light intensity**.

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..... [2]

(ii) Further investigations showed that at distances of less than 10 cm, the rate of movement of the air bubble was the same as at 10 cm.

Explain why there was no change in the rate of movement of the air bubble at distances less than 10 cm.

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..... [2]

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(c) Some of the light energy absorbed by the pond plant is used in cyclic photophosphorylation.

Outline the process of cyclic photophosphorylation.

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..... [5]

[Total: 13]

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1. Nov/2021/Paper_41/No.2

(a) Cotton, *Gossypium hirsutum*, and false flax, *Camelina sativa*, are crop plants that are grown in different parts of the world.

Rubisco activase is an enzyme in the stroma of chloroplasts that is needed to maintain the activity of a second enzyme, rubisco.

Scientists measured the activity of rubisco activase in cotton and in false flax at a range of temperatures.

Fig. 2.1 shows the results.

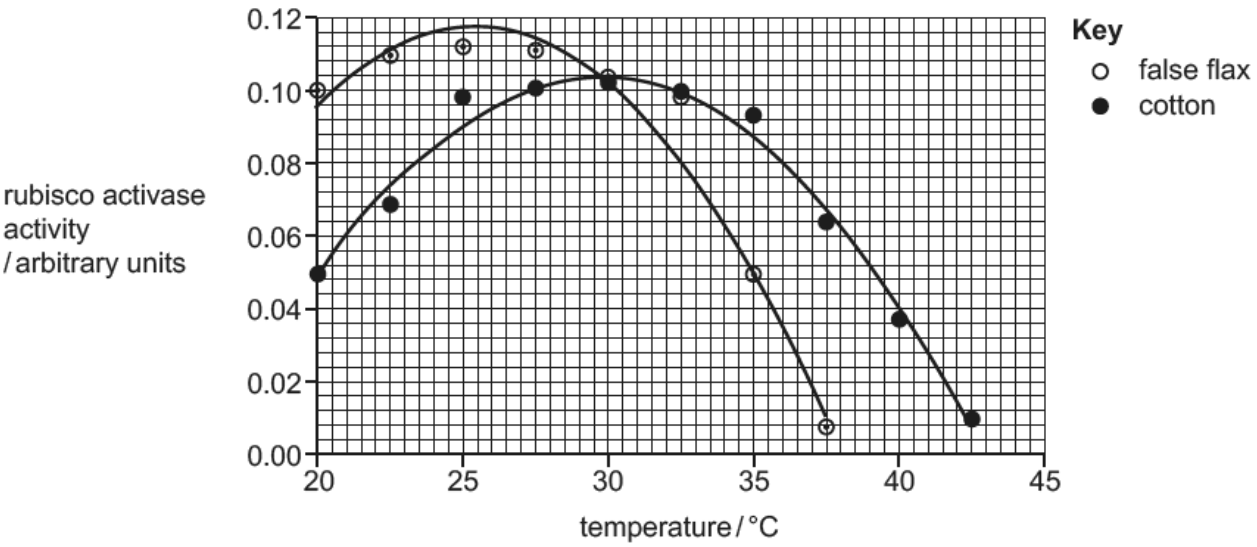


Fig. 2.1

(i) With reference to Fig. 2.1, compare the results obtained for cotton and false flax.

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..... [4]

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(ii) Suggest reasons for the differences shown in Fig. 2.1.

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..... [3]

(b) Rubisco enzymes from cotton and false flax are active at temperatures up to 45 °C and will denature at 45 °C.

Explain how the Calvin cycle is affected when rubisco denatures.

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..... [3]

(c) One goal of genetic engineering is to make crops that are heat tolerant. This means that crops can grow and produce a good yield at high environmental temperatures.

Use the information given in Question 2 to suggest **and** explain a way to improve the tolerance of a crop to high temperatures.

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..... [2]

[Total: 12]

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2. Nov/2021/Paper_41/No.9

(a) Describe **and** explain the mechanism by which guard cells open stomata. [7]

(b) Explain how the anatomy **and** physiology of the leaves of maize or sorghum are able to maximise carbon dioxide fixation at high temperatures. [8]

[Total: 15]

STEMUP.CO.UK

Photosynthesis – A2 9700 Biology June 2022

1. June/2022/Paper_41/No.2

(a) In eukaryotes, the cells of plants and photosynthetic protoctists contain chloroplasts.

Describe the relationship between the function of a chloroplast and its structure.

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..... [4]

(b) Outline the main features of cyclic photophosphorylation.

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..... [3]

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(c) Red algae are aquatic protoctists that are multicellular. The cells of red algae have chloroplasts containing photosynthetic pigments. Many red algae live in deep water.

Two of the accessory pigments of red algae chloroplasts are:

- phycoerythrin (appears red), often present in large concentrations
- phycocyanin (appears blue).

The first few metres of water nearest the surface absorb the red wavelengths of light. If the water also contains particles of organic material it absorbs blue wavelengths.

Fig. 2.1 shows absorption spectra of some pigments in red algae chloroplasts.

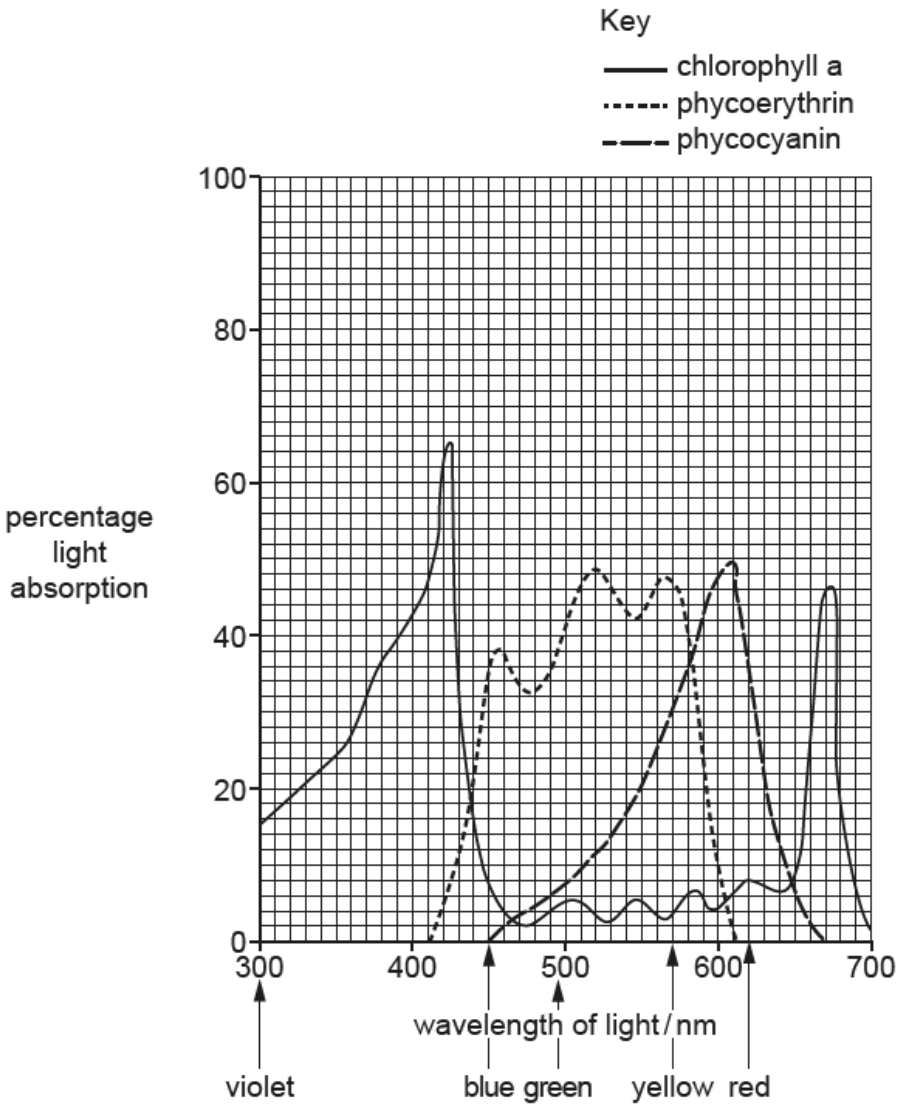


Fig. 2.1

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Describe the differences in the absorption spectra of the three photosynthetic pigments shown in Fig. 2.1 **and** explain how these differences help red algae to survive in deep water.

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..... [7]

[Total: 14]

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2. June/2022/Paper_41/No.9

(a) Stomata are involved in both transpiration and photosynthesis in plants.

Fig. 9.1 is a diagram of an open stoma, its guard cells and surrounding epidermal cells.

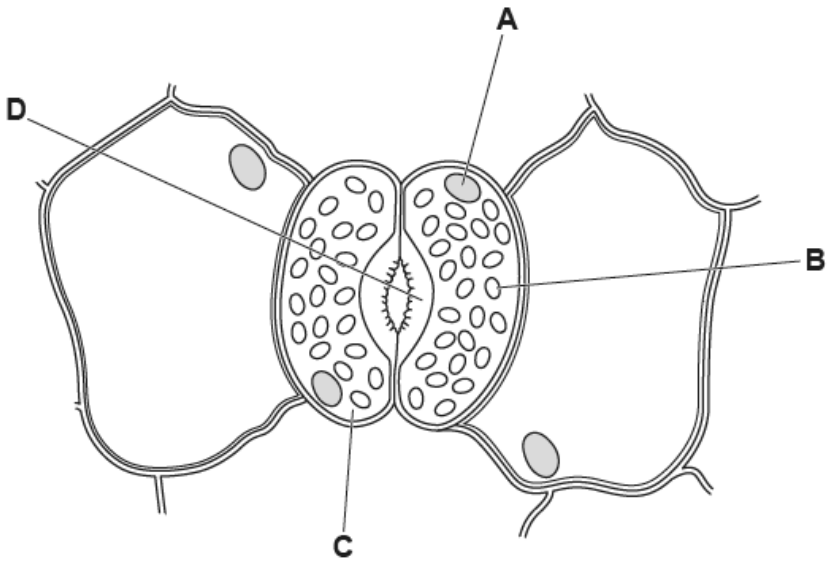


Fig. 9.1

Complete Table 9.1 by choosing the correct letter from Fig. 9.1 to match the feature stated in Table 9.1.

Each letter may be used once, more than once or not at all.

Table 9.1

letter	feature
.....	location of Calvin cycle
.....	made mainly of cellulose

[2]

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(b) The opening and closing of stomata are due to changes in environmental conditions. Hydrogen ions (H^+) and potassium ions (K^+) are involved in the opening of stomata.

Describe how hydrogen ions and potassium ions are involved in the opening of a stoma.

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..... [4]

[Total: 6]

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3. June/2022/Paper_42/No.2

(a) Photosynthesis is affected by many environmental factors.

(i) Explain why light intensity can be a limiting factor in photosynthesis.

.....

.....

..... [2]

(ii) The concentration of carbon dioxide (CO_2) can also be a limiting factor. It has an effect on the Calvin cycle in the light-independent stage of photosynthesis.

Ribulose bisphosphate (RuBP), triose phosphate (TP) and glycerate 3-phosphate (GP) are three important molecules in the Calvin cycle.

Fig. 2.1 shows how the concentration of GP changes when the concentration of CO_2 is reduced from 0.04% (atmospheric) to 0.008%.

Complete Fig. 2.1 by sketching the lines for RuBP and TP when the concentration of CO_2 is reduced from 0.04% to 0.008%.

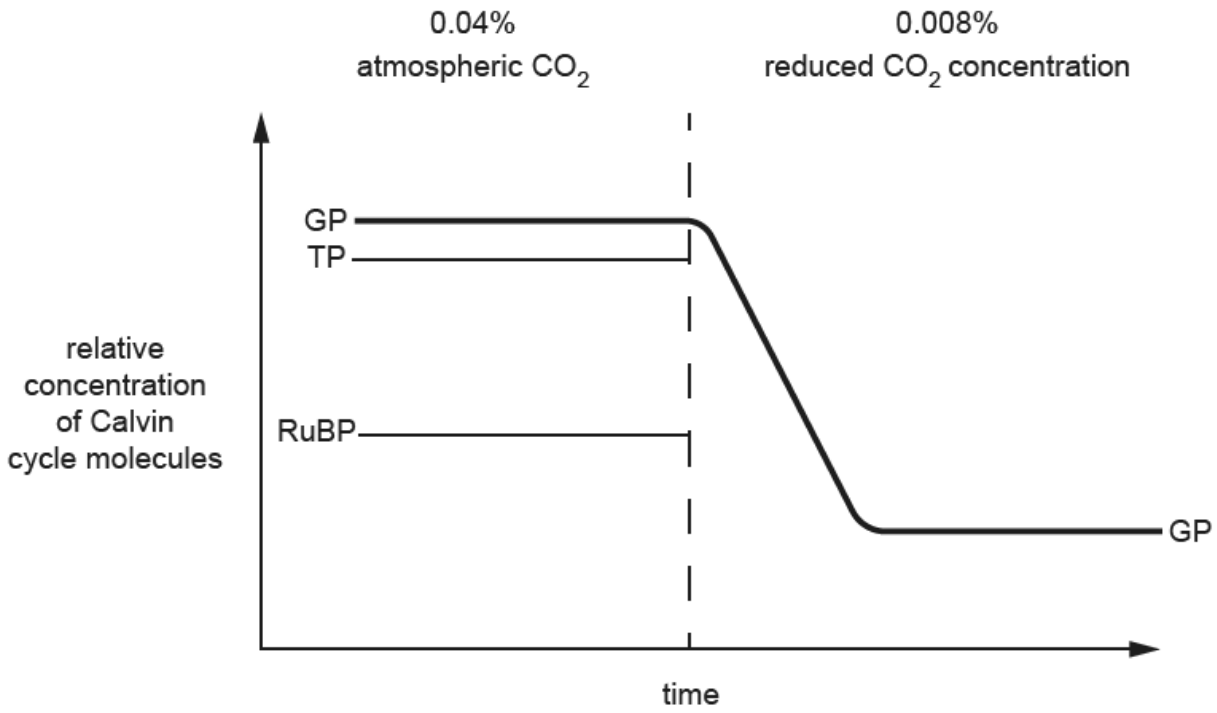


Fig. 2.1

[2]

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(iii) In very dry conditions, CO_2 concentration can become the main limiting factor of photosynthesis in plants.

Explain how very dry conditions cause CO_2 concentration to become the main limiting factor of photosynthesis in plants.

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..... [3]

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(b) A factor that can limit the rate of photosynthesis is the rate of regeneration of RuBP.

Sedoheptulose-1,7-bisphosphatase (SBPase) is an enzyme in the Calvin cycle that controls the rate of regeneration of RuBP. SBPase is coded for by the gene *SBPase*.

In an experiment, wheat plants were genetically modified to make more SBPase by introducing the *SBPase* gene from another grass species, *Brachypodium distachyon*. The resulting GM wheat plants were named Sox4.

- Wild type plants (not GM) and Sox4 plants were grown in a greenhouse.
- Light intensity, CO_2 concentration and temperature were kept constant.
- Mature plants were removed and dried to measure the biomass.

Fig. 2.2 shows the mean plant biomass for the wild type plants and GM Sox4 plants.

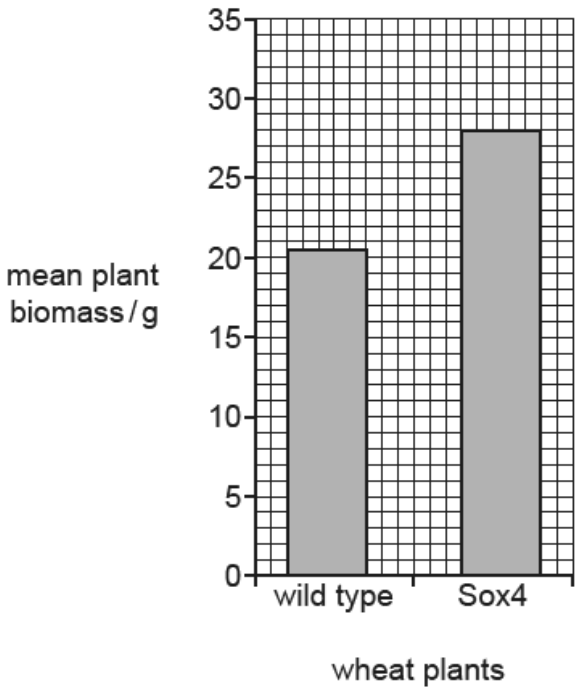


Fig. 2.2

(i) Calculate the percentage change in mean plant biomass when Sox4 plants are grown compared to wild type plants.

Show your working.

percentage change = ... % [2]

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(ii) Suggest **and** explain why Sox4 plants have a different mean plant biomass than wild type plants.

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..... [4]

(iii) Some soils may be deficient in nitrates.

Suggest how nitrate deficiency could limit the quantity of SBPase made by Sox4 plants.

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..... [2]

[Total: 15]

STEMUP.CO.UK

4. June/2022/Paper_43/No.2

Photosynthesis is an energy transfer process that results in the production of carbohydrate. It has two stages: the light-dependent stage and the light-independent stage.

Cyclic photophosphorylation and non-cyclic photophosphorylation are essential pathways in photosynthesis that occur in the light-dependent stage.

(a) (i) Describe the similarities and differences between cyclic photophosphorylation and non-cyclic photophosphorylation.

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..... [4]

(ii) Explain why herbicides that prevent cyclic photophosphorylation and non-cyclic photophosphorylation stop carbohydrate being produced in the chloroplast.

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..... [2]

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(b) The rate of regeneration of RuBP in the Calvin cycle is known to limit the rate of photosynthesis.

Sedoheptulose-1,7-bisphosphatase (SBPase) is an enzyme in the Calvin cycle that controls the rate of regeneration of RuBP. SBPase is coded for by the gene *SBPase*.

In an experiment, wheat plants were genetically modified to make more SBPase by introducing the *SBPase* gene from another grass species, *Brachypodium distachyon*. The resulting GM wheat plants were named Sox4.

- Wild type plants (not GM) and Sox4 plants were grown.
- A leaf from the wild type plant was placed in a sealed glass vessel.
- The carbon dioxide (CO_2) concentration in the vessel was increased so that the intercellular air spaces also had an increase in CO_2 concentration.
- The other environmental conditions were kept constant.
- The rate of fixation of CO_2 was measured for the leaf.
- The experiment was repeated with a leaf from a Sox4 plant.

Fig. 2.1 shows the rate of fixation of CO_2 by the leaves of wild type plants and Sox4 plants when the intercellular air space CO_2 concentration was increased.

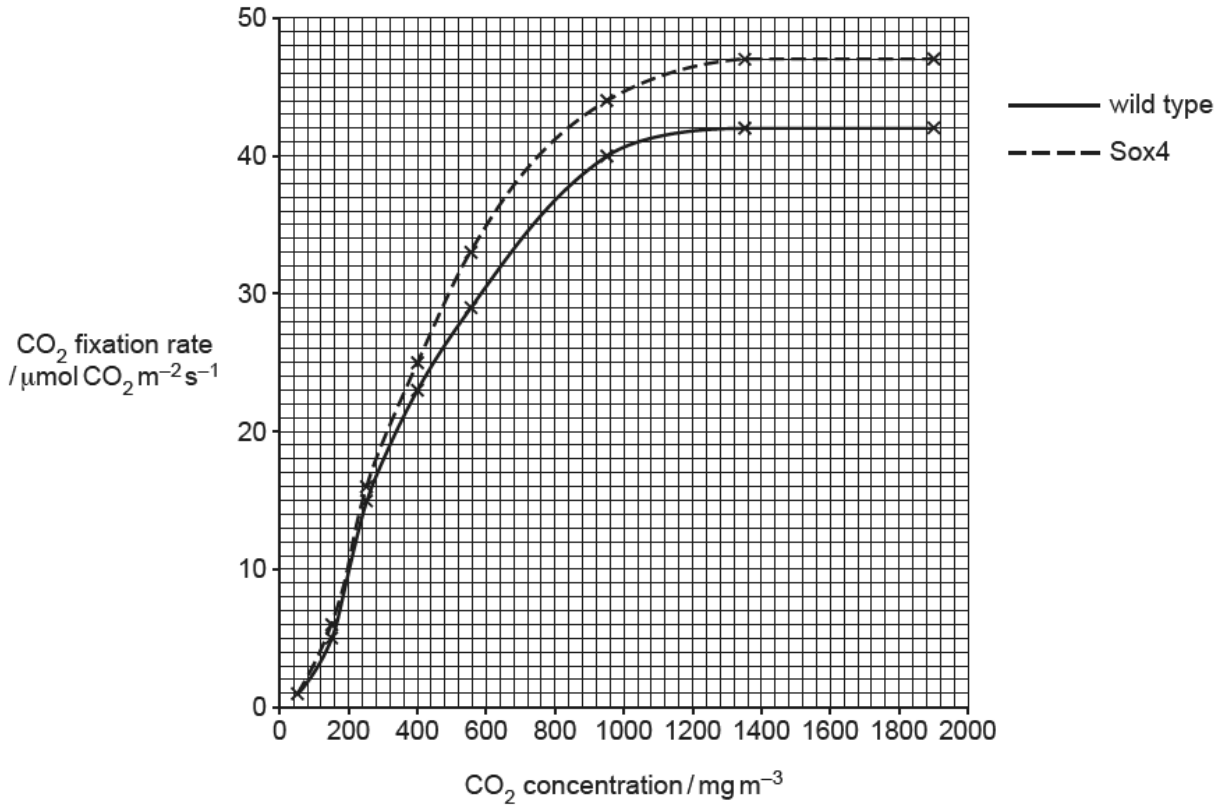


Fig. 2.1

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(i) With reference to Fig. 2.1, describe **and** explain the results shown by the **wild type** plants.

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..... [4]

(ii) With reference to Fig. 2.1, describe **and** suggest explanations for the differences in the rate of fixation of CO_2 between wild type plants and Sox4 plants.

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..... [3]

[Total: 13]

STEMUP.CO.UK

5. June/2022/Paper_43/No.3

(a) ATP is synthesised from ADP and P_i in a phosphorylation reaction.

State the **two** different ways in which this phosphorylation reaction occurs in aerobic respiration.

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..... [2]

(b) Coenzymes are important in all four stages of aerobic respiration.

Describe **and** explain the role of the coenzymes NAD and FAD in aerobic respiration.

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..... [6]

(c) The enzyme pyruvate dehydrogenase catalyses the link reaction. Pyruvate dehydrogenase is inhibited when the ratio of acetyl coenzyme A to coenzyme A increases.

Suggest the importance of this inhibition to the functioning of the cell.

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..... [2]

[Total: 10]

STEMUP.CO.UK

Photosynthesis – A2 9700 Biology Nov 2022

1. Nov/2022/Paper_41/No.2

Photosynthesis is an important energy transfer process.

(a) Name **one** chloroplast pigment.

.....

..... [1]

(b) Explain the relationship between the **absorption** spectrum of the main chloroplast pigments in a species of plant and the **action** spectrum for photosynthesis for that species.

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..... [2]

(c) Explain why temperature can be a limiting factor of photosynthesis.

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..... [3]

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(d) Outline how the light-independent stage of photosynthesis leads to the production of carbohydrates such as starch in plant leaves.

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..... [3]

[Total: 9]

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(a) Photosynthesis is an energy transfer process that takes place in chloroplasts of plant cells.

(i) Fig. 3.1 shows a diagram of a chloroplast.

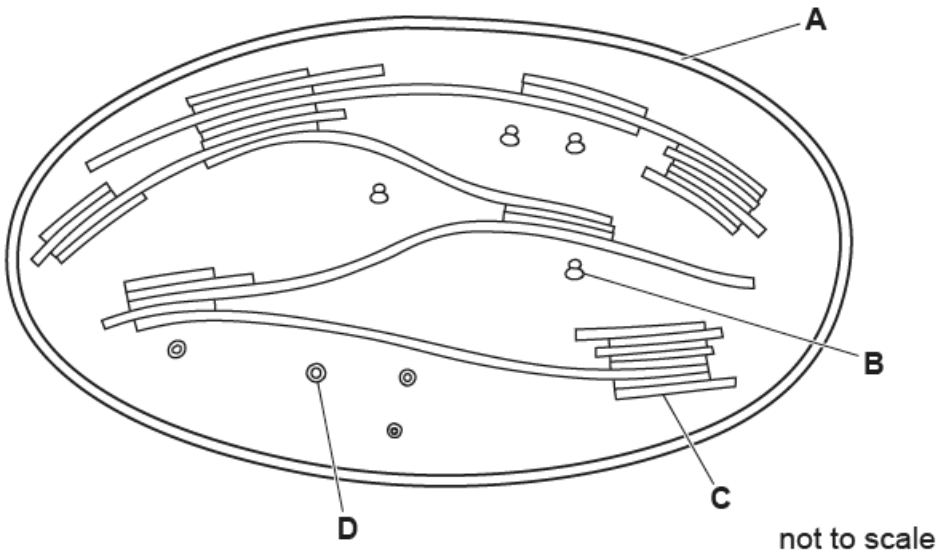


Fig. 3.1

Using the letters **A**, **B**, **C** or **D**, identify the structure that:

- contains genes that code for some of the enzymes used in photosynthesis

.....

- is the site of synthesis of some of the enzymes used in photosynthesis.

.....

[2]

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(ii) Explain how grana are adapted for their specific role in photosynthesis.

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..... [4]

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(b) An experiment was carried out to investigate the effect of changing light conditions on the pH of the chloroplast stroma. Scientists followed pH changes in chloroplast stroma using fluorescent chemicals that can be used as pH indicators.

- Chloroplasts were isolated from cells.
- A suspension of chloroplasts was prepared and kept in the dark for 180 seconds.
- The chloroplasts were exposed to a period of light of fixed intensity for 240 seconds, then returned to dark conditions.
- The pH of chloroplast stroma was continuously measured and recorded.

Fig. 3.2 shows the results of this experiment.

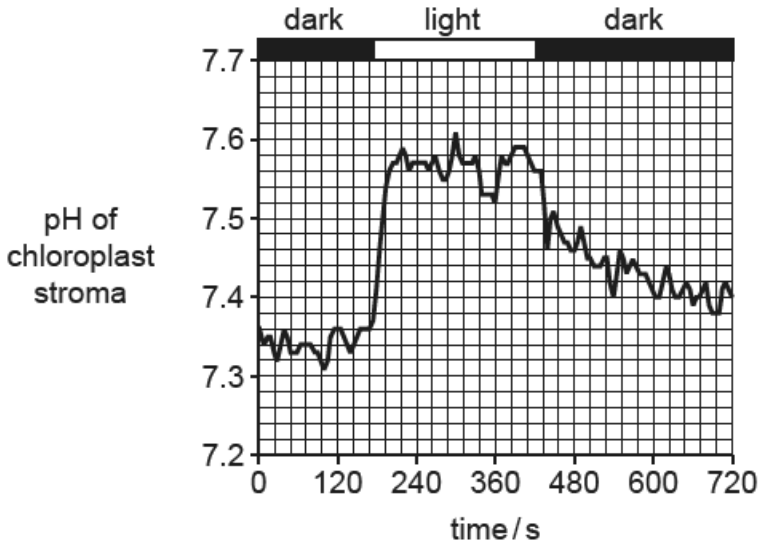


Fig. 3.2

(i) Describe the results shown in Fig. 3.2.

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..... [3]

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(ii) Discuss how the results in Fig. 3.2 support that chemiosmosis occurs during photophosphorylation.

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..... [3]

[Total: 12]

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Photosynthesis – 2023 Biology A2 9700

1. March/2023/Paper_ 9700/42/No.8

(a) Describe the functions of the internal membranes of the chloroplast in photosynthesis.

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..... [7]

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(b) Rubisco activase (RA) is an enzyme that has an effect on the activity of rubisco.

An investigation was carried out on the effect of RA on the activity of rubisco.

- Solutions of rubisco and RuBP were added to two tubes, **A** and **B**.
- RA was added to tube **A**.
- Both tubes were incubated at 25 °C for 6 minutes.
- The activity of rubisco was measured every 30 seconds.

All conditions were kept the same, except for the addition of RA to tube **A**.

The results are shown in Fig. 8.1.

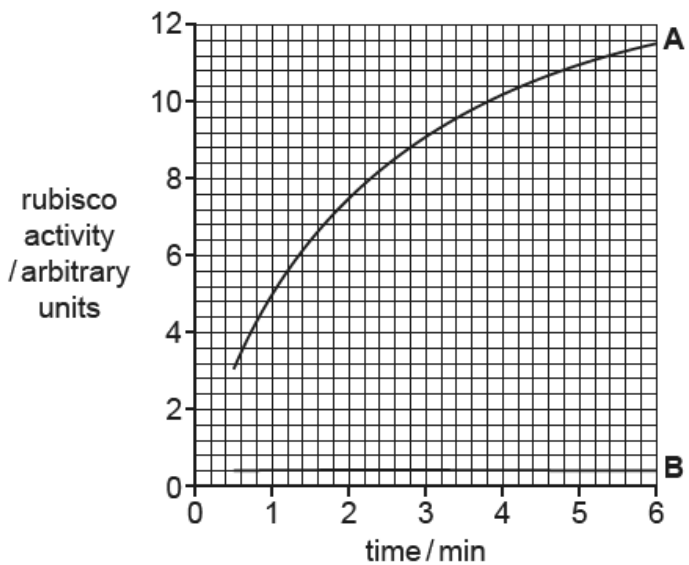


Fig. 8.1

Describe the results shown in Fig. 8.1 **and** suggest an explanation for the effect of RA on the activity of rubisco.

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..... [4]

[Total: 11]

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2. June/2023/Paper_ 9700/41/No.1

Fig. 1.1 shows a transmission electron micrograph of part of a chloroplast.

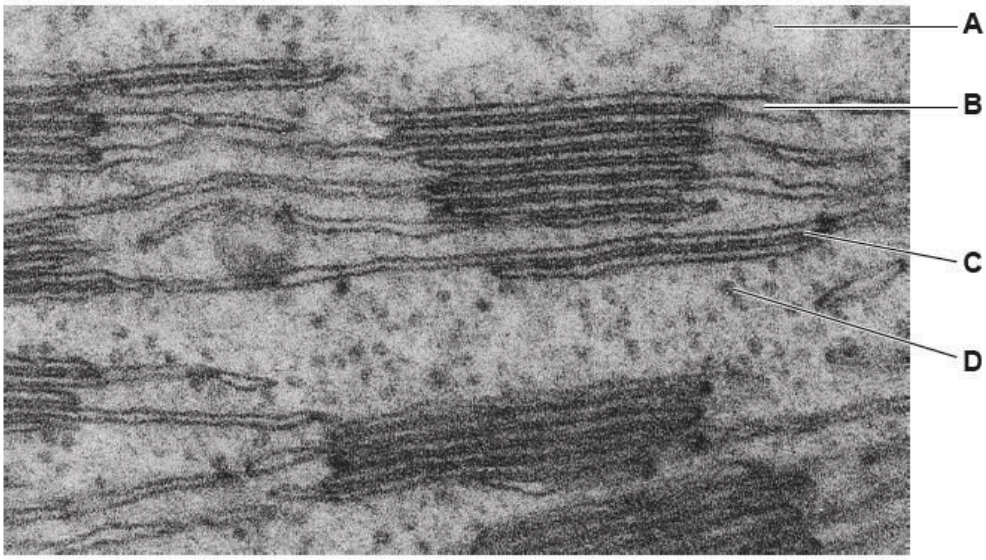


Fig. 1.1

(a) Table 1.1 describes some functions that occur in different parts of a chloroplast.

Complete Table 1.1 by identifying the letter on Fig. 1.1 that is a location matching the description. Each letter may be used once, more than once, or not at all.

Table 1.1

description	letter
accumulates (builds up) a high concentration of protons	
makes triose phosphate	
makes some chloroplast proteins	
pumps protons	

[4]

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(b) Membranes of the type labelled **C** in Fig. 1.1 were made into a liquid extract. Chromatography was then used to separate and identify the coloured components (pigments) in this extract. The resulting chromatogram showed that these membranes contain a yellow pigment, an orange pigment, a green-brown pigment and two different green pigments.

(i) Describe how you would carry out chromatography to separate and identify the coloured pigments in the liquid extract of **C**.

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..... [4]

(ii) Explain why membrane **C** has many different coloured pigments to function efficiently.

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..... [3]

[Total: 11]

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3. June/2023/Paper_ 9700/42/No.8

(a) In plants such as rice, *Oryza sativa*, rubisco has a low rate of activity, which in turn affects the rate of photosynthesis. The cereal crop sorghum, *Sorghum bicolor*, has a high rate of activity of rubisco.

A genetically modified (GM) variety of rice was produced. Parts of the quaternary structure of rubisco in rice were altered to be the same as the rubisco in sorghum.

The rate of activity of rubisco in non-GM rice and GM rice was measured at different concentrations of atmospheric carbon dioxide (CO_2).

The results are shown in Fig. 8.1.

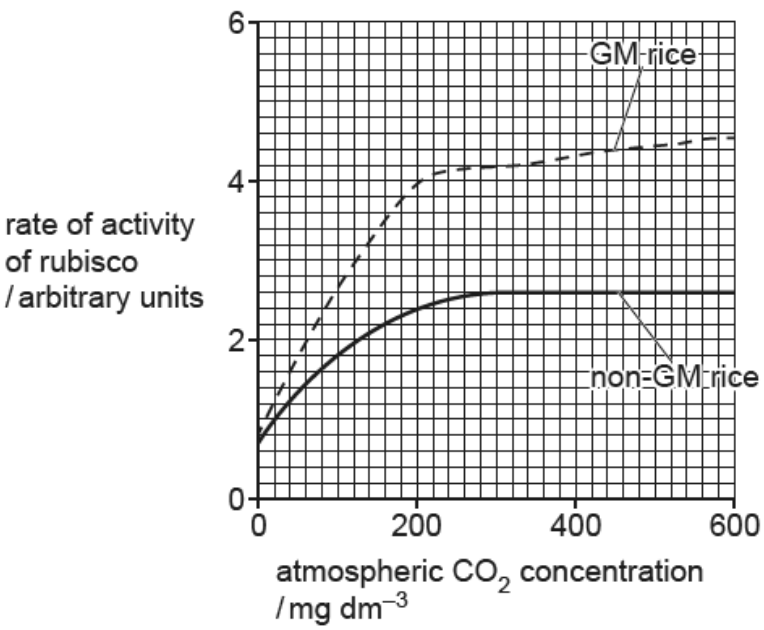


Fig. 8.1

(i) Compare the two curves shown in Fig. 8.1 **and** explain why the curve for non-GM rice levels off.

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..... [3]

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(ii) Suggest which part of the rubisco molecule was altered to produce the GM variety of rice.

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..... [1]

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(b) Fig. 8.2 shows an outline of the Calvin cycle.

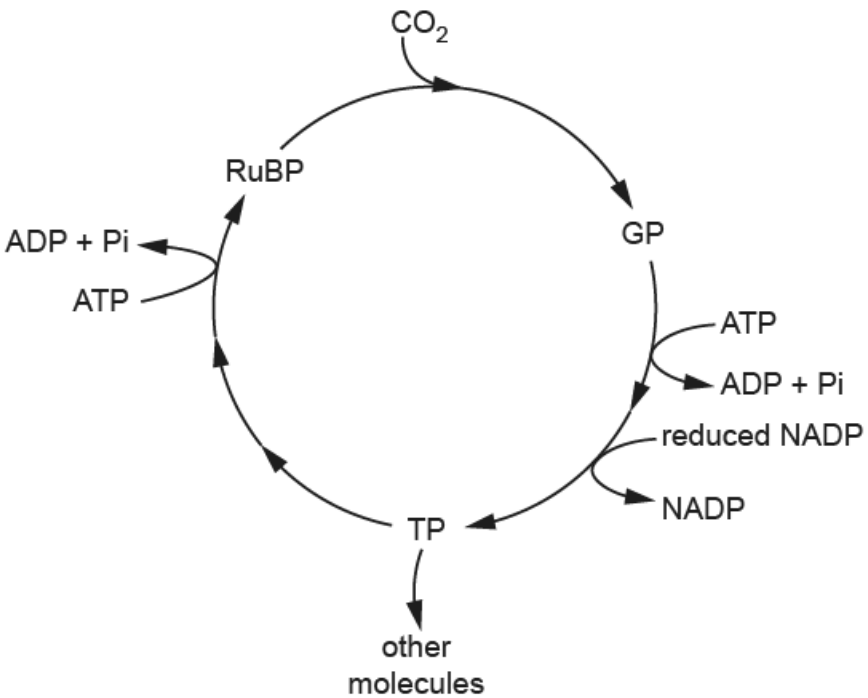


Fig. 8.2

(i) Name the process that involves the enzyme rubisco.

..... [1]

(ii) State the type of reaction that occurs when GP is converted to TP.

..... [1]

(iii) RuBP is regenerated from molecules of TP.

State how many molecules of RuBP are produced from 10 molecules of TP.

..... [1]

(iv) TP molecules that are **not** involved in the regeneration of RuBP can be used in the synthesis of other molecules.

State **two** molecules that can be produced from these TP molecules.

.....

..... [2]

[Total: 9]

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4. June/2023/Paper_ 9700/43/No.8

(a) Fig. 8.1 is a diagram of a chloroplast.

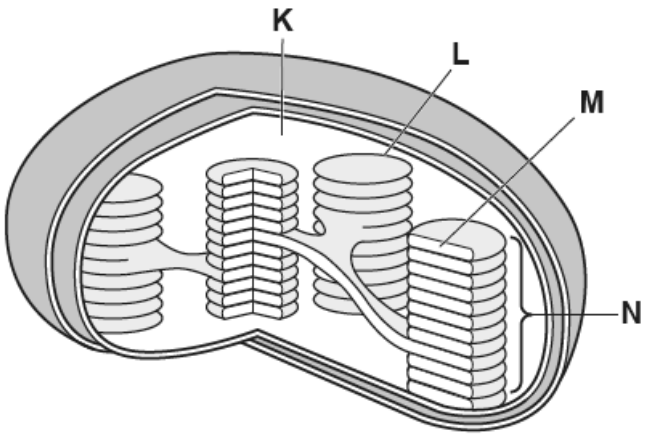


Fig. 8.1

Using the letters **K**–**N**, complete Table 8.1.

Each letter may be used once, more than once, or not at all.

Table 8.1

	letter
high concentration of protons	.....
location of photosynthetic pigments	.....
site of light-independent stage	.....
site of light-dependent stage	.....

[4]

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(b) Chlorophyll *a* is the main photosynthetic pigment in plants.

Describe the role of other photosynthetic pigments found in plant chloroplasts.

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.....[4]

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(c) The absorption of different wavelengths of light by chloroplast pigments can be represented by an absorption spectrum.

Fig. 8.2 is an absorption spectrum of an extract of chloroplast pigments and an absorption spectrum of whole chloroplasts.

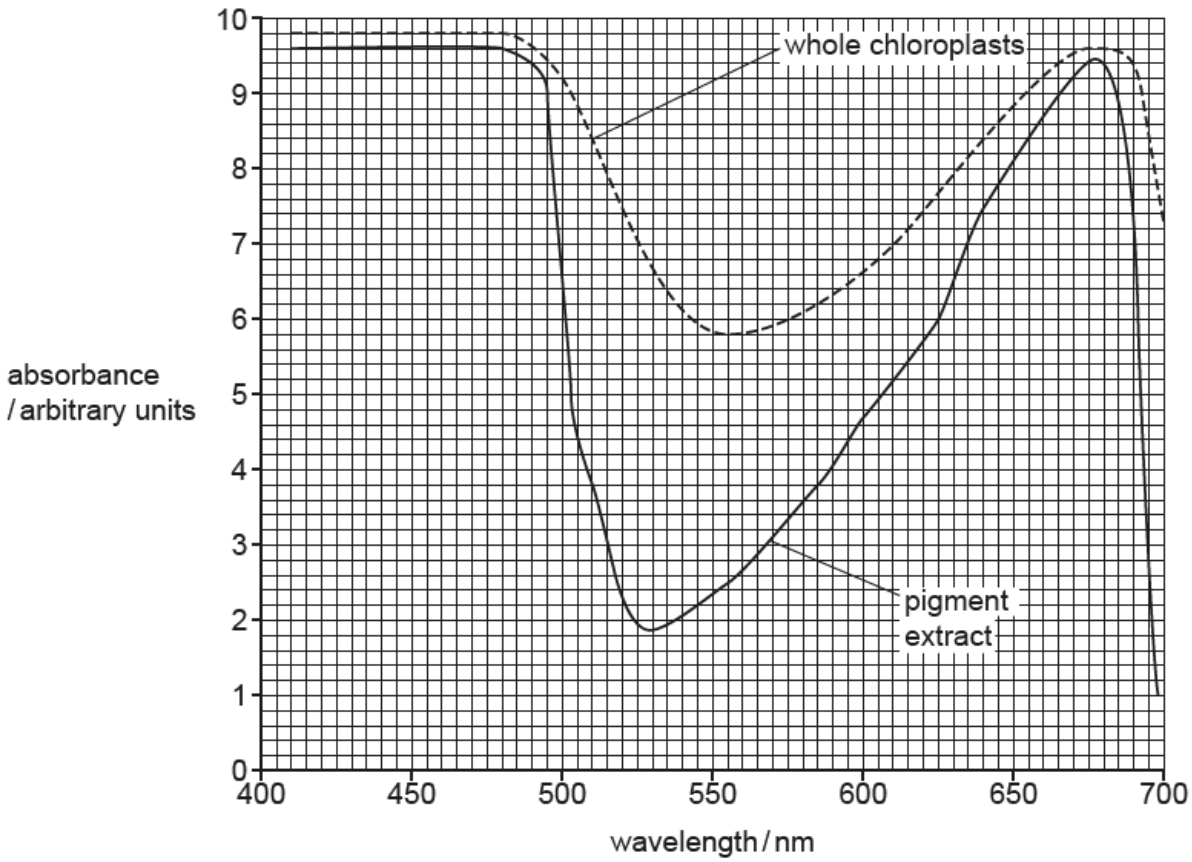


Fig. 8.2

With reference to Fig. 8.2, describe the differences between the two spectra **and** suggest explanations for the differences.

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.....[4]

[Total: 12]

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1. Nov/2023/Paper_9700/41/No.1

Chloroplasts carry out photosynthesis.

Fig. 1.1 shows some structural features of a chloroplast and some processes that occur within it.

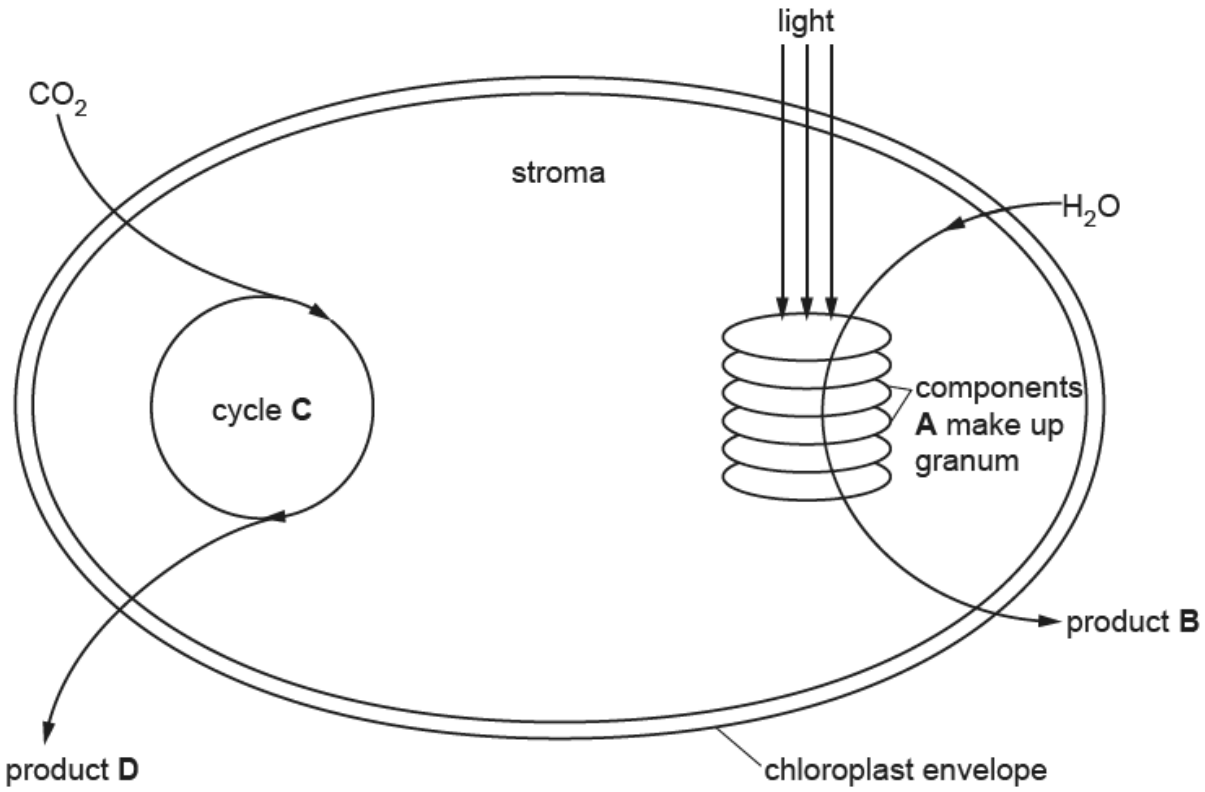


Fig. 1.1

(a) (i) Identify the structures labelled **A** in Fig. 1.1.

A ..... [1]

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(ii) Explain how the structure **and** appearance of the granum, and the components labelled **A**, relate to their function.

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..... [4]

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(b) (i) Identify the metabolic pathway labelled cycle **C** in Fig. 1.1.

C ..... [1]

(ii) Explain why pathway **C** is described as a cycle.

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..... [2]

(c) (i) Identify the products of photosynthesis labelled **B** and **D** in Fig. 1.1.

B .....

D ..... [2]

(ii) Suggest **and** explain the importance of glucose and the product labelled **B** in Fig. 1.1 to ecosystems.

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..... [3]

[Total: 13]

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