Photosynthesis

1. Phospholipid bilayers play crucial roles within plant cells.
Which of the following statements linked to the importance of membranes in plant cells is / are true?

Statement 1: ATP synthase embedded in thylakoid membranes maintains chemiosmotic gradients.
Statement 2: Phospholipid bilayers within the chloroplast are impermeable to protons.
Statement 3: Thylakoid membranes contain electron transport chain proteins.

A 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer

[1]

2. Melvin Calvin studied the light-independent reaction (Calvin cycle) in plant cells.

He used radiolabelled $^{14}CO_2$ to measure the production of organic molecules in chloroplasts.

- He placed an aquatic plant in water.
- The plant was given light for 20 minutes.
- The light was then turned off (dark conditions) for a further 30 seconds.

He measured the radioactivity of the solutions produced and used these values to calculate the number of molecules of triose phosphate (TP) and ribulose bisphosphate (RuBP) present.

The results are shown in the table below.

Molecule	**Activity of ^{14}C (x10^{27} Bq)**	
	after 20 minutes light	30 seconds dark conditions
TP	5.5	10.1
RuBP	4.9	0.6

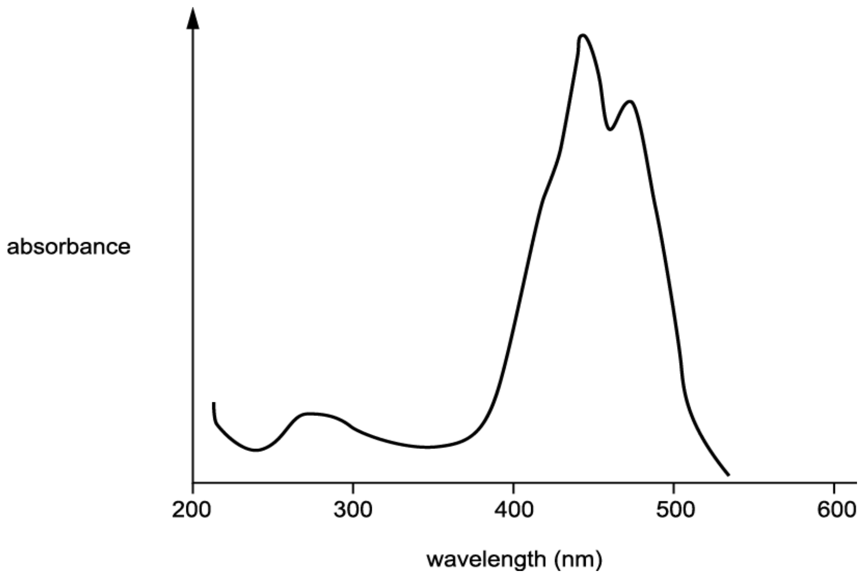
Assuming 8.5×10^{18} Bq are generated by each ^{14}C atom in the molecule, how many **new** TP molecules are produced after 30 seconds in the dark?

A 6.47×10^{8}
B 1.80×10^{8}
C 1.83×10^{27}
D 3.37×10^{27}

Your answer

[1]

3. The following graph shows the absorbance spectrum of an accessory pigment.



Which of the following statements explains why this pigment is orange-red to the human eye?

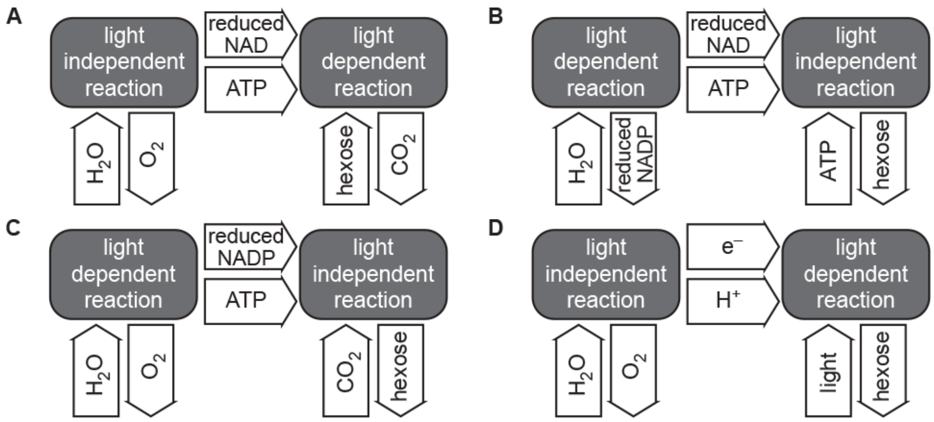
1 The pigment absorbs green and blue light.
2 The pigment has an absorption peak at 500 nm.
3 The pigment passes photons to the primary pigment reaction centre.

A 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer ☐

[1]

4. Which of the images, **A** to **D**, correctly summarises photosynthesis?

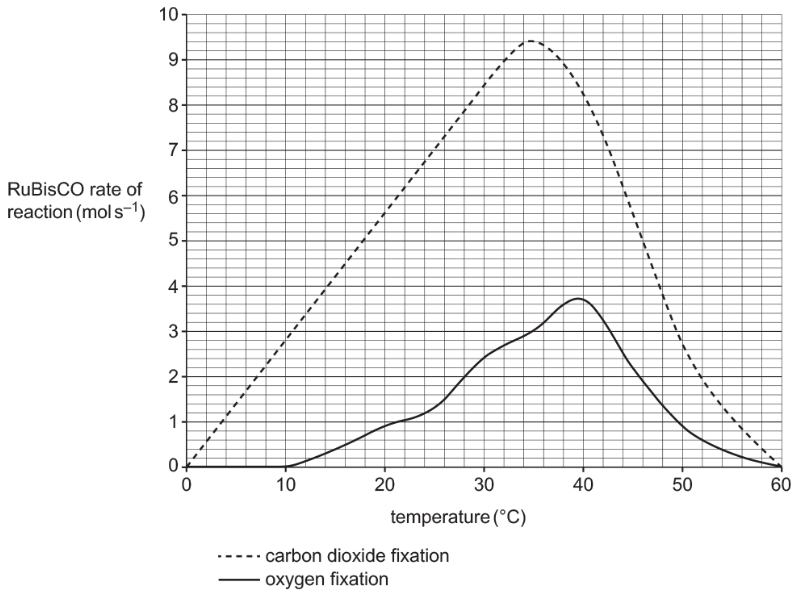


Your answer

[1]

5. RuBisCO is an enzyme that fixes carbon dioxide in photosynthesis. In some conditions, RuBisCO also carries out oxygen fixation.

The graph below shows how the carbon dioxide and oxygen fixing activities of RuBisCO are affected by temperature.



What are the correct percentage changes in RuBisCO carbon dioxide and oxygen fixing activities between 30 °C and 40 °C?

A carbon dioxide fixation – 12.7%, oxygen fixation 23.3%
B carbon dioxide fixation – 14.6%, oxygen fixation 18.9%
C carbon dioxide fixation – 2.4%, oxygen fixation 54.2%
D carbon dioxide fixation – 3.6%, oxygen fixation 35.1%

Your answer

[1]

6. Mistletoe is a plant parasite that lives on the stems of other plants. It survives by removing water and assimilates from the host plant.

The mistletoe binds to the stem of the host plant and grows a specialised root-like tissue called a haustorium that attaches to different tissues in the stem.

One species of mistletoe, *Viscum minimum*, contains no chloroplasts.

Which of the options, **A** to **D**, explains why *V. minimum* does not need chloroplasts?

A the haustorium of *V. minimum* attaches to sieve tube elements
B the haustorium of *V. minimum* attaches to xylem vessels
C the haustorium of *V. minimum* attaches to meristem cells
D the haustorium of *V. minimum* attaches to cambium tissue

Your answer

[1]

7. Which of the following, **A** to **D**, is a similarity in the way ATP is made in respiration and photosynthesis?

A both involve NAD
B both involve substrate level phosphorylation
C both involve photons
D both involve proton gradients

Your answer

[1]

8. Cyanobacteria are photosynthetic prokaryotes.

A scientist exposed cyanobacteria to light of different colours and intensities and made the following observations:

- Most cyanobacteria are blue in colour.
- At low light intensities, glucose production in cyanobacteria is low.
- When light intensity reaches a certain level the rate of glucose production in cyanobacteria stops increasing.

Which of the following statements, **A** to **D**, correctly explains these observations?

A The pigments in cyanobacteria absorb blue light and light intensity is a limiting factor for the rate of photosynthesis.
B The pigments in cyanobacteria absorb red light and light intensity is not a limiting factor for the rate of photosynthesis.
C The pigments in cyanobacteria absorb blue light and light intensity is not a limiting factor for the rate of photosynthesis.
D The pigments in cyanobacteria absorb red light and light intensity is a limiting factor for the rate of photosynthesis.

Your answer

[1]

9(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:

$$\text{volume of cylinder} = \pi r^2 l$$

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]**

ii. 1700 lux is a typical light intensity on a cloudy day in the UK. Calculate the percentage increase in gas production between 1700 and 2000 lux. Show your working.

Answer = ____________________________ % **[2]**

iii. Suggest why soda-lime was **not** placed in the respirometer with the seedlings grown in the light.

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____ **[1]**

(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]**

10. 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.

Fig. 17.1 is a diagram of the chloroplast found in a Chromista cell.

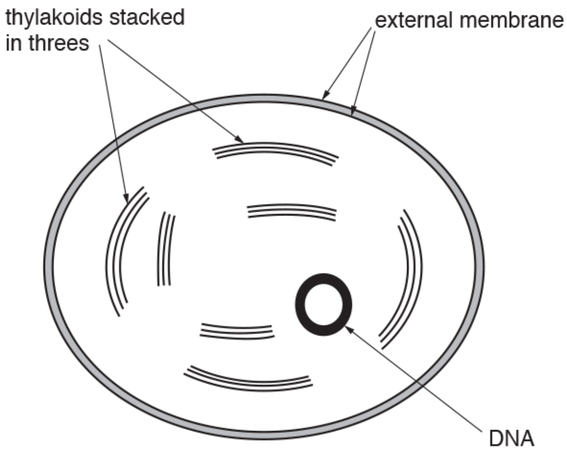

Fig. 17.1

Outline the structural differences between the Chromista chloroplast in Fig. 17.1 and the chloroplasts found in flowering plants.

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____ **[2]**

11. Photosynthesis can occur in organisms other than plants. These organisms have photosynthetic pigments that are adapted to their habitats.

i. The cyanobacterium *Acaryochloris marina* lives in an aquatic habitat with many aquatic plant species.

Acaryochloris marina has a high concentration of chlorophyll D in its cells and a relatively low concentration of chlorophyll A.

The ab sorption spectra of chlorophyll A and chlorophyll D are shown in **Fig. 5.2**.

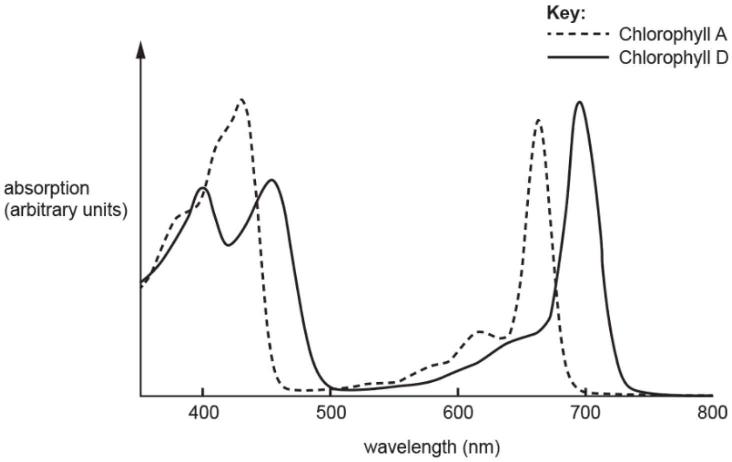

Fig. 5.2

Suggest why having a high concentration of chlorophyll D is an advantage for *Acaryochloris marina*.

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____ **[1]**

ii. Diatoms are unicellular photosynthetic eukaryotes. Diatoms contain high concentrations of the pigment fucoxanthin.

Fig. 5.3 shows a chromatogram with three pigments, **X** to **Z**.

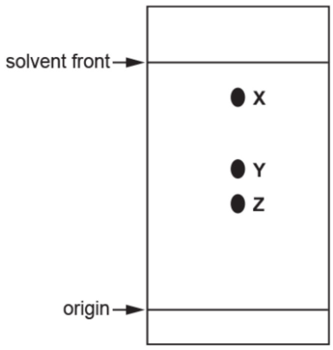

Fig. 5.3

Fucoxanthin has an R*f* value of 0.43.

Identify the letter (**X**, **Y** or **Z**) that represents fucoxanthin.

Fucoxanthin = ... **[1]**

12. *Heliamphora*, shown in Fig. 18.1, is a genus of carnivorous plant. Its leaves are adapted to form water-filled traps for insects. The insects are attracted by nectar, then fall into the traps and drown. The plants digest the insects and absorb the mineral ions produced. This allows *Heliamphora* to survive in soils with low mineral content.

Fig. 18.1

Four pigments, A, B, C and D, were extracted from a *Heliamphora* plant. Thin layer chromatography (TLC) was carried out on the pigments. The results of the TLC are shown in Fig. 18.3.

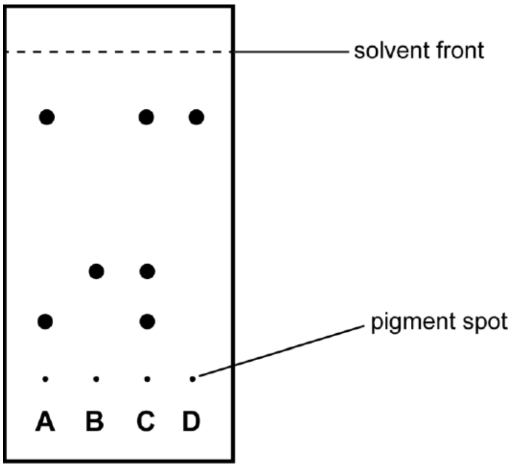

Fig. 18.3

i. Using Fig. 18.3, what can you conclude about the composition of pigments **A** to **D**?

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____ **[3]**

ii. Calculate the Rf value of pigment **B**. Give your answer to **two significant figures**.

Show your working.

Answer = ... **[2]**

13. 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]**

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]**

14. Thin layer chromatography can be used to separate photosynthetic pigments.

i. State a material that can be used as the stationary phase in thin layer chromatography.

____ **[1]**

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

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____ **[2]**

15(a). A student investigated photosynthetic pigments in spinach leaves using thin layer chromatography (TLC).

Fig. 17.1 shows the student's plate at the end of the investigation.

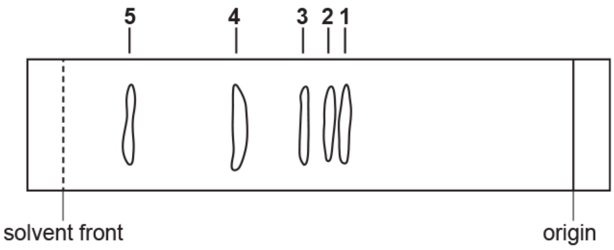

Fig. 17.1

The table shows colours and R_f values for several photosynthetic pigments.

Pigment	Colour	R_f
Carotene	Yellow-orange	0.90
Chlorophyll a	Blue-green	0.53
Chlorophyll b	Green	0.49
Pheophytin	Grey	0.65
Xanthophylls	Yellow	0.32–0.44

i. Calculate the R_f value for spot **3** and use this to identify the pigment that spot **3** represents.

Rf = ...

pigment = ...
[3]

ii. Predict the colour of spot **4**.

____ **[1]**

iii. The solvent used for the separation was non-polar.

Identify the spot corresponding to the **least** polar pigment. Give a reason for your choice.

spot ____

reason ____

____
[2]

(b). The student used the following method for the investigation:

Step 1: Extraction of pigments

- Take 0.5 g of fresh spinach and add 1 g of sand.
- Grind the mixture until it becomes a fine, light green powder.
- Transfer the powder to a test tube and add 2 cm^3 of propanone.
- Stir for about 1 minute then allow to stand for another minute.
- Transfer the dark green upper layer with a pipette to a clean test tube and seal with film when not in use.

Step 2: TLC analysis

- Hold the TLC plate carefully by the edges and avoid damaging the surface of the plate.
- Draw a pencil line across the width of the TLC plate 1 cm from the bottom edge.
- Spot the extract on the pencil line using a pipette, one drop at a time, allowing the spot to dry before adding the next drop.
- Place chromatography solvent in a jar so that it is no more than 0.5 cm deep.
- Lower the TLC plate into the jar and lean the top against the side of the jar. Make sure the plate does not touch the sides of the jar anywhere else.
- Place a cap on the jar and allow the solvent to soak up the plate.
- When the solvent has reached a few mm from the top of the plate, remove the plate from the jar and mark the position of the solvent front with a pencil.

i. Explain why the method included the following precautions:

Hold the TLC plate carefully by the edges and avoid damaging the surface of the plate.

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Make sure the plate does not touch the sides of the jar anywhere else.

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____ **[2]**

ii. Suggest an advantage of working as quickly as possible in Step 1.

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____ **[1]**

16. 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]**

ii. DCPIP is reduced in the Hill reaction.

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

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____ **[2]**

iii. Using the results shown in the table, explain what can be concluded from each tube, or pair of tubes, about the light-dependent stage of photosynthesis.

Tube A ....

....

....

Tube B ....

....

....

Tubes C & D ....

....

....

Tube E ....

....

....

[4]

iv. The student knew that it was important to use sucrose solution when homogenising the leaves.

Explain why it was important that the pellet was suspended in buffer solution **and** why it did not contain sucrose.

....

....

....

....

.... **[2]**

v. Suggest and explain **two** improvements that would increase the validity of the method.

Improvement 1 ____

____

Explanation ____

____

____

Improvement 2 ____

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Explanation ____

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[4]

17. 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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____ **[2]**

18. Plants grow successfully in temperatures that are suited to their metabolism. Some plants are adapted for growth in cool climates while others can grow well in warm climates.

Plants also vary in their photosynthetic metabolism. Many plants produce a 3-carbon compound as the first product of carbon fixation and so are referred to as C3 plants. Another group of plants produces a 4-carbon compound as the first product and so are referred to as C4 plants. C3 plants include barley, lentil, rice, soya, sunflower and wheat. C4 plants include maize, millet, sorghum and sugar cane.

Fig. 18.2 shows the assimilation of carbon dioxide by four different crops at different temperatures.

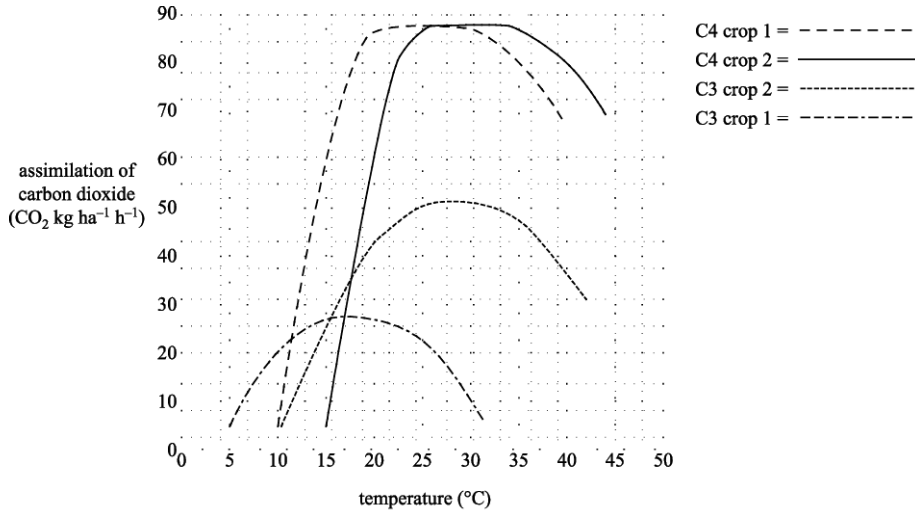

Fig. 18.2

i. With reference to **Fig. 18.2**, what is the general relationship between increasing temperature and the assimilation of carbon dioxide?

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____ **[2]**

ii. Calculate the values for the mean assimilation of carbon dioxide by C3 plants and C4 plants at 20 °C. Include units in your answer.

C3

____

C4

____ **[2]**

iii. Suggest a conclusion that could be drawn from the mean values you calculated in part **(ii)**.

____

____ **[1]**

iv. With reference to **Fig. 18.2**, suggest which curve corresponds to each of the following crops:

Sugar cane, which grows in warm climates.

____

Barley, which grows in cool climates.

____ **[2]**

19. During the light-independent stage of photosynthesis, triose phosphate (TP) is synthesised in the chloroplasts of plant cells.

i. State **two** possible uses of this molecule within the plant.

1 ____

____

2 ____

____

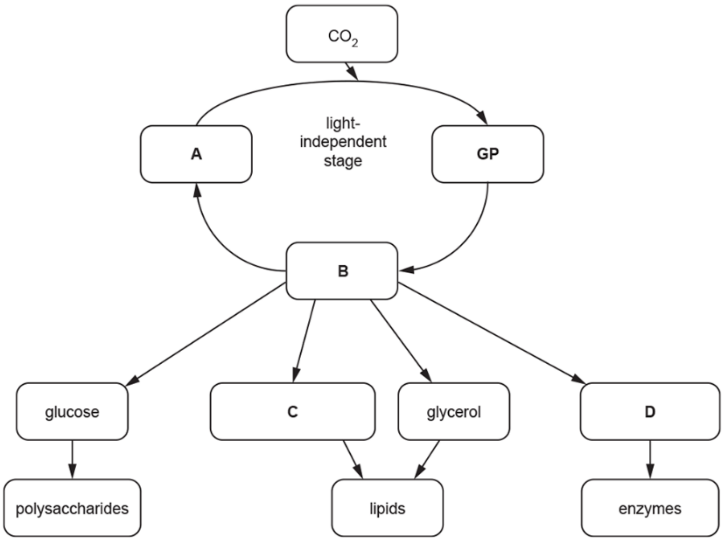
[2]

ii. From which molecule is TP synthesised during the light-independent stage?

____ **[1]**

20(a). 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.



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

A ____

B ____

C ____

D ____

[4]

(b). The light-independent stage of photosynthesis used to be referred to as the 'dark reaction'.

i. Explain why this is both an accurate **and** an inaccurate way to describe the light-independent stage.

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____ **[2]**

ii. Name the enzyme responsible for fixing CO_2 in the light-independent stage.

____ **[1]**

21(a). Plants photosynthesise and respire. **Fig. 18.1** shows the rate of production of carbohydrate in photosynthesis and the rate of use of carbohydrate by respiration.

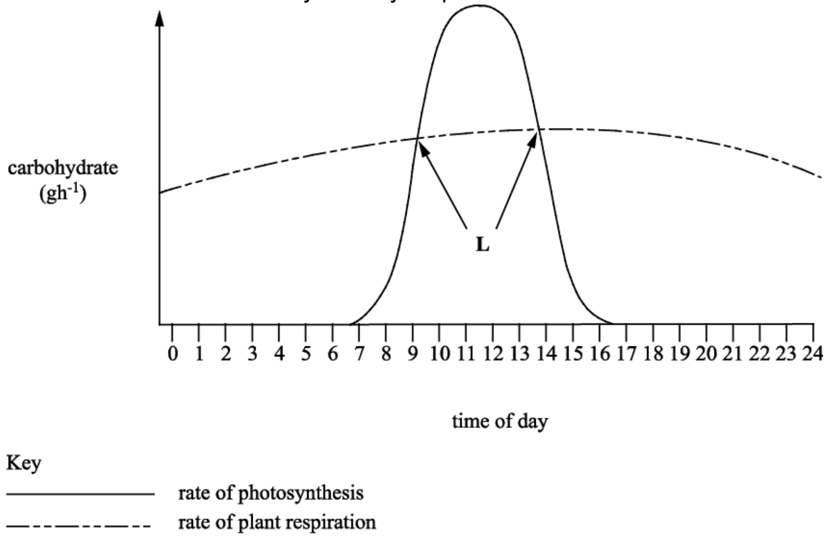

Fig. 18.1

i. Explain the shape of the curve for the rate of photosynthesis in **Fig. 18.1**.

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____ **[2]**

ii. Explain the shape of the curve for the rate of plant respiration in **Fig. 18.1**.

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____ **[2]**

iii. What is happening at the points indicated by the letter **L**?

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____ **[1]**

(b). Temperature is very important in determining a plant's ability to photosynthesise effectively. Temperature stress is becoming of great concern to plant physiologists because of climate change.

- High temperature (HT) stress is defined as the rise in temperature that is sufficient to cause irreversible damage to plant growth and development.

Some of the stress effects of temperature have been recorded in various plants and are outlined in **Table 18.1**.

Temperature	Effect
Moderate HT stress	Heat-induced deactivation of RuBisCO No change in chlorophyll fluorescence in PSII Reduction in stomatal aperture
Severe HT stress	Decrease in chlorophyll content as a result of photodeterioration Changes in the ultrastructure of the chloroplast

Table 18.1

i. Assess the impact of moderate HT stress on the process of photosynthesis.

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____ **[3]**

ii. Suggest **two** ways in which the ultrastructure of the chloroplast can be altered by high temperatures.

For each suggestion, explain the effect that it will have on photosynthesis.

Suggestion ____

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Explanation ____

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Suggestion ____

____

Explanation ____

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[4]

22. Palisade mesophyll cells are an example of a specialised plant cell. These cells are the main site of photosynthesis in plants.

A team of scientists investigated the effect of shining light on the upper and lower surfaces of a leaf on the rate of photosynthesis.

The results are shown in Fig. 3.2.

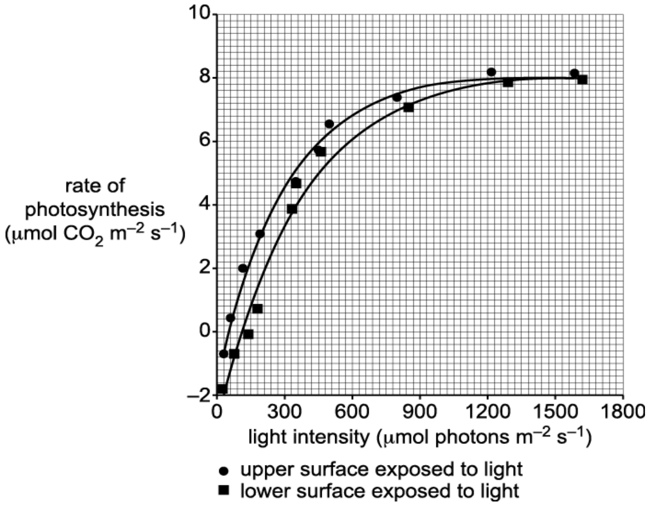

Fig. 3.2

What conclusions can you draw from the data in Fig. 3.2 about the effects of light **and** the internal structure of a leaf? Explain your answer.

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____ **[4]**

23. Light intensity, carbon dioxide concentration and temperature are all limiting factors in photosynthesis.

Explain what is meant by a **limiting factor**.

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____ **[2]**

24. Temperature and light intensity are two factors that affect the rate of photosynthesis.

A student investigated how temperature and light intensity affected the rate of photosynthesis in the aquatic plant *Elodea canadensis*. The rate of photosynthesis was measured by counting the number of bubbles produced by the plant per minute.

The student's results are shown in Table 3.

Light intensity	Temperature (°C)	Number of bubbles produced / minute
8	25.0	10
32	25.0	31
127	25.0	102
510	25.0	108
8	40.5	25
32	40.5	28
127	40.5	118
510	40.5	133
8	70.0	2
32	70.0	4
127	70.0	12
510	70.0	16

Table 3

i. Identify the anomalous result in Table 3 and explain how this result could be confirmed as an anomaly.

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____ **[2]**

ii. * Describe how the student could improve their experimental method **and** the presentation of their data.

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____ **[6]**

25(a). A scientist investigated the rate of photosynthesis in lesser pondweed, *Potamogeton pusillus*.

The method used is outlined below:

- Add 200 cm^3 of distilled water to a 300 cm^3 glass beaker.
- Dissolve 5 g of $NaHCO_3$ in the water to provide an excess of CO_2.
- Place the beaker in a water bath at 10 °C and leave for 10 min to equilibrate.
- Insert an oxygen sensor into the water in the beaker and measure the baseline O_2 concentration.
- Place 100 g of *P. pusillus* into the beaker.
- Remove all other light sources from the room and place an LED light source 20 cm above the top of the beaker.
- Use a light intensity meter to ensure the light intensity above the beaker is 5000 lux.
- Measure the concentration of oxygen dissolved in the water using a data logger every 10 min for 200 min.
- Carry out four more repeats at 10 °C.
- Repeat all the above steps in water baths at 15 °C, 20 °C, 25 °C and 30 °C.

i. Identify the following variables from the scientist's method:

independent variable ____

dependent variable ____

one control variable ____

[3]

ii. Identify **one** variable that was **not** controlled in the scientist's method.

____ **[1]**

(b). 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.

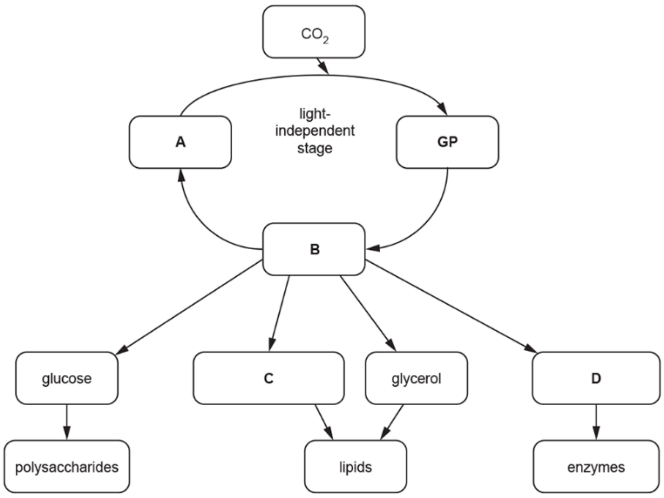

Fig. 22.1

Fig. 22.2 is a graph of the scientist's results.

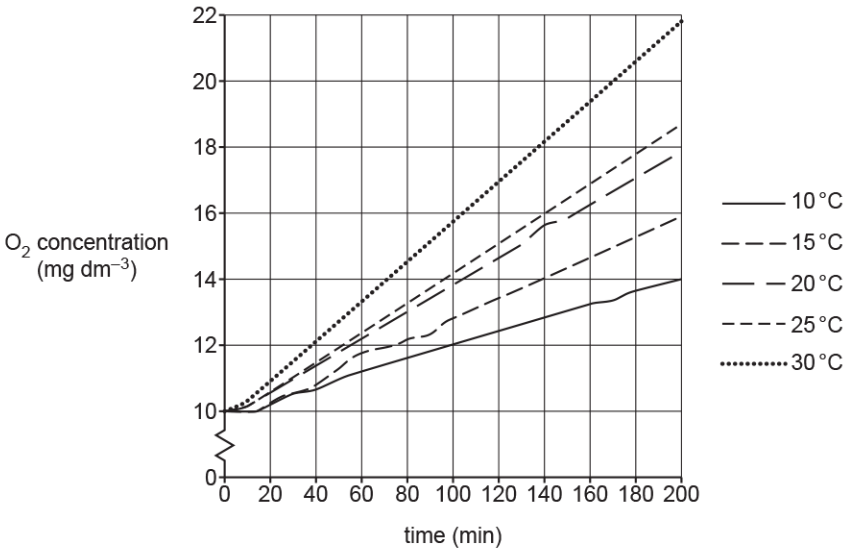

Fig. 22.2

Describe **and** explain what these results show about photosynthesis in *P. pusillus*.

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____ **[3]**

26. 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.

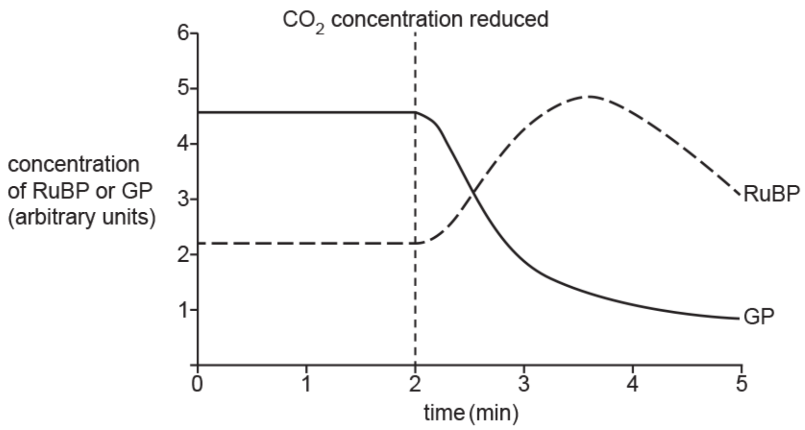

Fig. 17.2

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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____ **[3]**

27. Students investigated the effect of light on the growth of garden cress seedlings.

- A total of 120 seedlings were divided into 2 groups of 60.
- Group A was grown in darkness for 2 days.
- Group B was grown for 1 day in darkness and then for 1 day in white light using the set-up shown in Fig. 3.1.

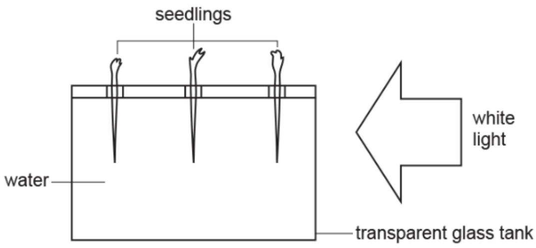

Fig. 3.1

The results of the students' experiment are shown in Tables 3.1 and 3.2.

Group	Mean length (mm)		Mean mass (μg)	
	stem	root	stem	root
A	13	18	102	60
B	25	23	160	120

Table 3.1

	Number of seedlings	
Direction of growth in Group B	stem	root
Away from light	2	29
Neither away from nor towards light	3	20
Towards light	55	11

Table 3.2

i. * Describe and explain the results shown in Tables 3.1 and 3.2.

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____

[6]

ii. The students wanted to test whether there was a significant difference between the stem lengths of the seedlings in Group A and the seedlings in Group B.

State the name of the most appropriate statistical test for the students to use.

[1]

iii. Justify your choice of statistical test given in part **(ii)**.

[1]

iv. Table 3.2 records the direction of growth as:

- away from light
- neither away from nor towards light
- towards light.

The students used the chi-squared test to determine whether the direction of root growth was significantly different from their expectations.

Their null hypothesis was:

There is no difference between the expected direction of root growth and the observed direction of root growth.

The calculated chi-squared value was 8.10.

The students compared their chi-squared value of 8.10 to the values in Table 3.3.

Degrees of freedom	Probability (p)		
	0.10	**0.05**	**0.01**
1	2.71	3.84	6.64
2	4.60	5.99	9.21
3	6.25	7.82	11.34
4	7.78	9.49	13.28
5	9.24	11.07	15.09

Table 3.3

What can the students conclude about their results based on a chi-squared value of 8.10?

____

____

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____

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____

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____ **[3]**

28(a). 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*.

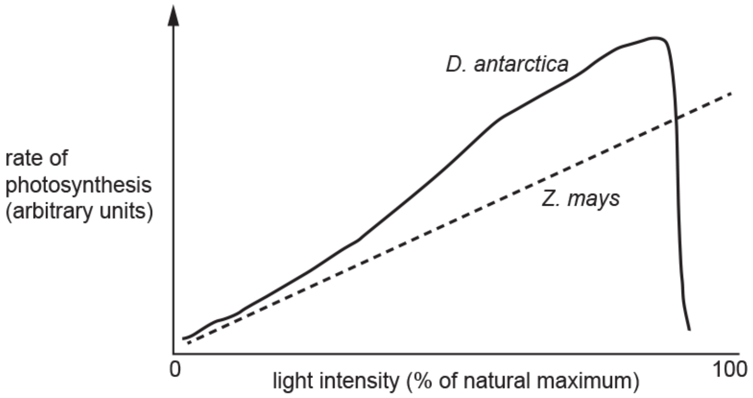

Fig. 5.1

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

____ **[2]**

(b). Water availability can affect the rate of photosynthesis in some plants.

Some students investigated the effect of soil water content on the rate of photosynthesis in two plant species: maize, *Z. mays*, and a xerophyte called *Calotropis procera*.

The students took measurements at six different sites for each species. They measured the water content of the soil and calculated the rate of photosynthesis at each site.

The students' data are shown in **Table 5.2**.

Calotropis procera		***Z. mays***	
Water content of soil (% by volume)	Mean rate of photosynthesis (μmol CO_2 m^{-2} s^{-1})	Water content of soil (% by volume)	Mean rate of photosynthesis (μmol CO_2 m^{-2} s^{-1})
12.1	4.2	32.3	21.6
10.0	4.0	29.0	20.2
7.2	6.0	24.5	19.2
4.0	4.1	18.1	16.5
2.5	3.3	15.4	16.8
1.8	2.0	11.6	8.0

Table 5.2

Table 5.3 shows a statistical table for r_s values.

***p* (%)**	**10**	**5**	**1**
n			
5	0.800	0.900	1.000
6	0.657	0.829	0.943
7	0.571	0.714	0.893
8	0.524	0.643	0.833

Table 5.3

i. The students investigated the relationship between the water content of soils and mean rate of photosynthesis for the two plants.

Using the values in **Table 5.2**, calculate the Spearman's Rank Correlation Coefficient for water content and rate of photosynthesis in *Z. mays*.

Use the formula:

$$r_s = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

r_s = ... **[3]**

ii. Use **Table 5.3** to decide what the students can conclude from the r_s value you calculated in part **(i)**.

---**[1]**

iii. The students calculated the r_s value for water content and rate of photosynthesis in *Calotropis procera* as 0.714.

Use **Table 5.3** to decide what the students can conclude from the r_s value of 0.714.

---**[1]**