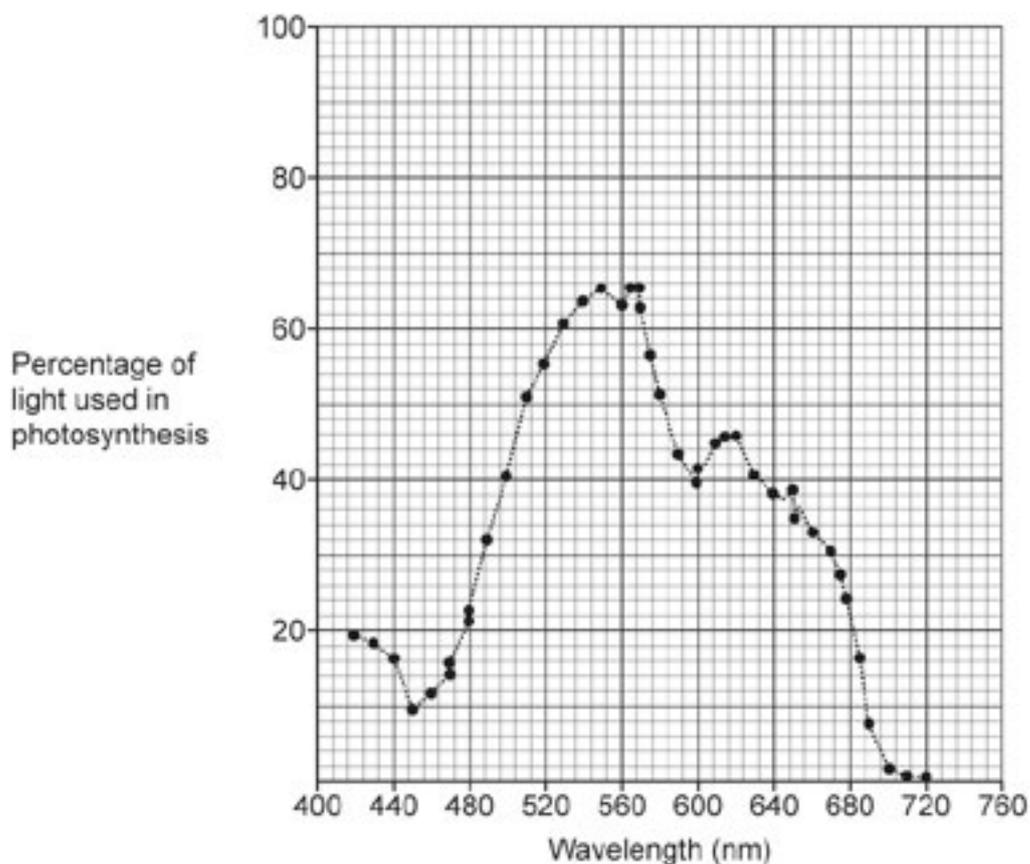


**1(a).** Algae, such as seaweed, can occur in a range of colours. Algae carry out photosynthesis in the same way as plants, using chlorophyll a as the primary photosynthetic pigment.

The graph shows the percentage of light at each wavelength that is used in photosynthesis by the red alga *Porphyra naiadum*.



- i. Chlorophyll a has an absorption peak at 680 nm.

Use the graph to estimate the percentage of light absorbed by chlorophyll a that is used in photosynthesis by *Porphyra naiadum*.

Percentage absorbed = .....[1]

- ii. Explain why the percentage of light used in photosynthesis is higher than your answer to part (i) at wavelengths other than 680 nm.

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- iii. *Porphyra naiadum* grows in deep water.

Use the data in the graph to suggest how it is able to survive in conditions where other types of algae or plant cannot.

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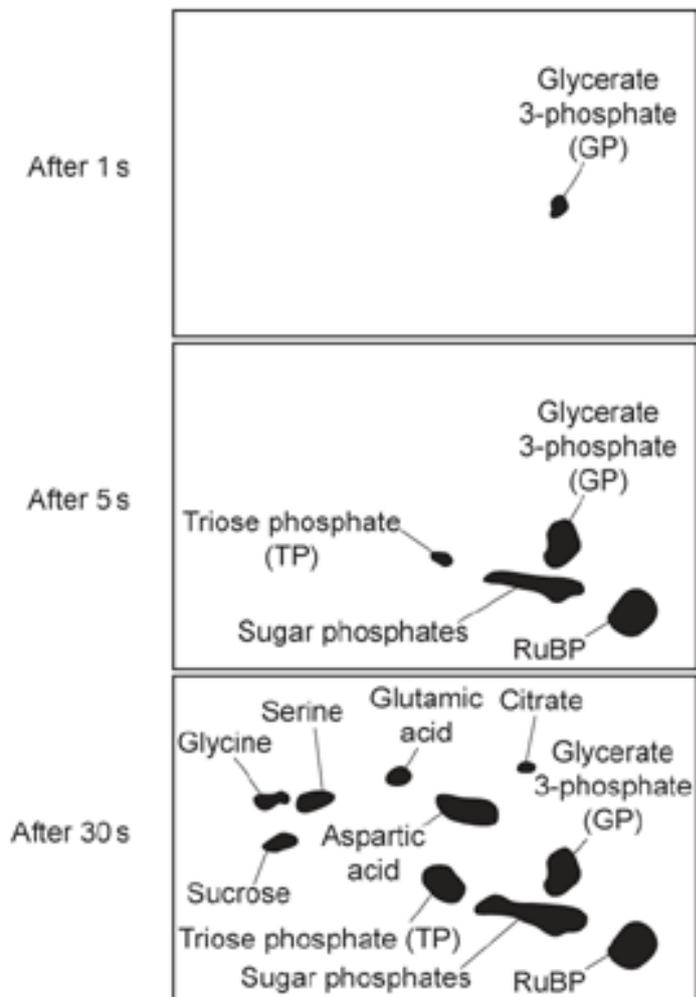
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[2]

- (b). Melvin Calvin and co-workers worked out the reactions of the light independent stage of photosynthesis.

They illuminated a suspension of green algae in the presence of radioactive carbon dioxide. They removed samples of the suspension at different times after addition of the radioactive carbon dioxide and used paper chromatography to identify the compounds in what is now known as the Calvin cycle.

This figure shows their results.



- i. Calvin concluded that GP was the first product of carbon fixation, and that GP was converted into TP.

Use the data in the figure above to explain how Calvin reached this conclusion.

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----- [2]

- ii. State what you can conclude from the figure about what happens to TP.

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----- [1]

2. Which of the statements about the effect of light intensity on the concentrations of GP, RuBP and TP is/are correct?

- 1 At low light intensity, less GP is converted into TP because there is less product of the light dependent stage available.
- 2 At high light intensity, RuBP concentration is high because it is regenerated from TP.
- 3 At high light intensity, RuBP accumulates because it cannot be converted to GP.

- A** 1, 2 and 3 are correct  
**B** Only 1 and 2 are correct  
**C** Only 2 and 3 are correct  
**D** Only 1 is correct

Your answer

[1]

3. Which of the statements about factors affecting the rate of photosynthesis is/are correct?

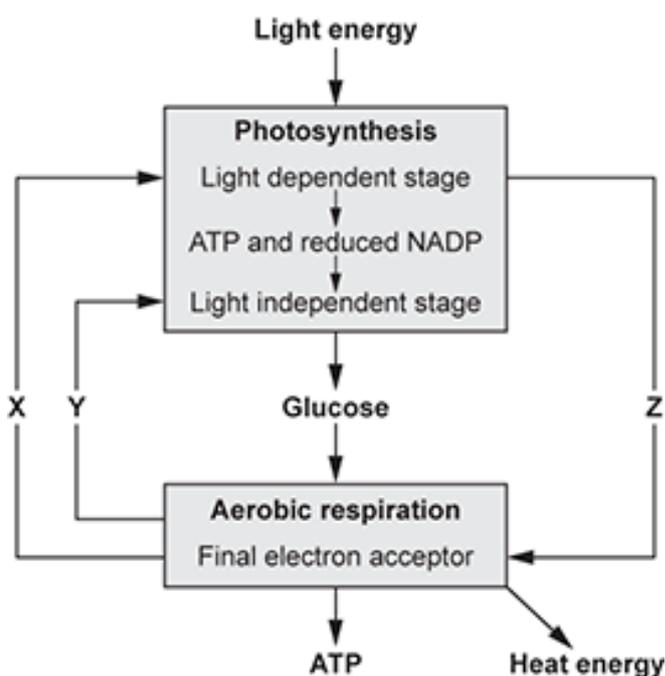
- 1 Lack of water is not usually a limiting factor, although it does cause closure of stomata which reduces carbon dioxide levels.
- 2 Carbon dioxide concentrations can be low inside greenhouses; therefore, growers will often enrich the atmosphere with carbon dioxide.
- 3 Between zero and 25 °C the rate of photosynthesis doubles for every 10 °C rise in temperature.

- A** 1, 2 and 3 are correct  
**B** Only 1 and 2 are correct  
**C** Only 2 and 3 are correct  
**D** Only 1 is correct

Your answer

[1]

4. The figure shows the relationship between photosynthesis and aerobic respiration.



i. Identify the molecules labelled X, Y and Z in the figure

X \_\_\_\_\_

Y \_\_\_\_\_

Z \_\_\_\_\_

[2]

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

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----- [3]

5. Chemiosmosis is a mechanism that is thought to occur in both respiration and photosynthesis.

- i. Evidence for chemiosmosis during photosynthesis can be demonstrated by:
- isolating chloroplasts from plant cells
  - placing the chloroplasts in an acidic solution, in the dark
  - shining light onto the chloroplasts in the solution
  - measuring the final pH of the solution.

Explain what is likely to happen to the pH of the solution when light is shone on the chloroplasts.

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----- [2]

- ii. André Jagendorf provided evidence for chemiosmosis in an experiment carried out in the 1960s.

In his experiment, Jagendorf:

- broke open chloroplasts to expose thylakoids, in the dark
- placed the thylakoids into a solution buffered at pH 4 (solution 1)
- after a short time period, transferred some of these thylakoids to a new solution buffered at pH 4 that contained ADP and  $P_i$  (solution 2)
- transferred other thylakoids from solution 1 to a new solution buffered at pH 8 that contained ADP and  $P_i$  (solution 3).

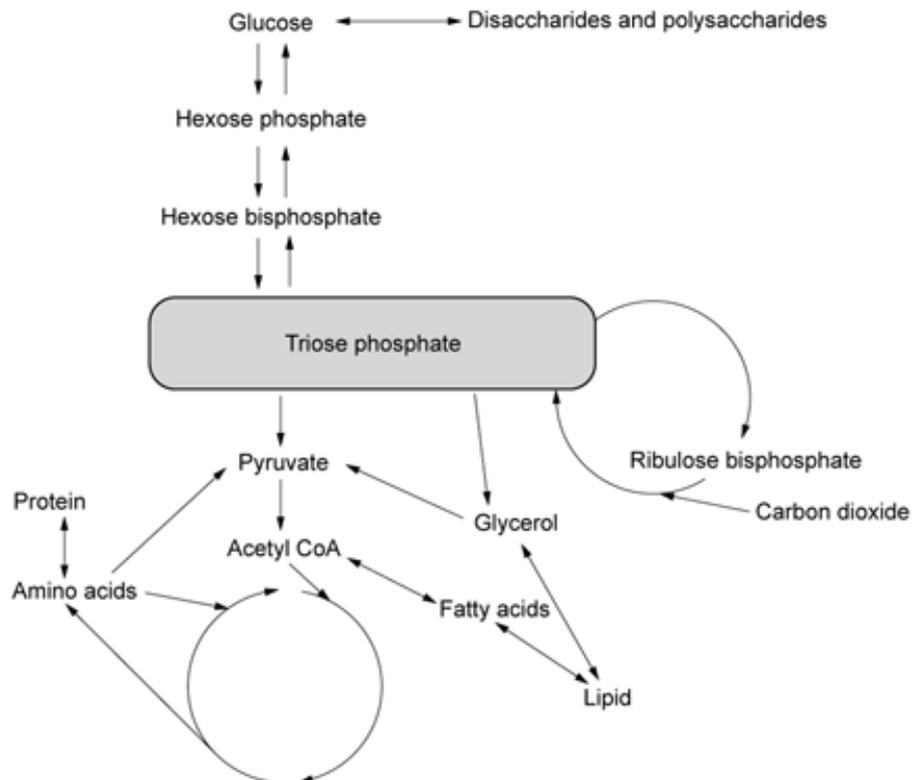


iii. Often a single company holds the patent for a GM crop plant.

Suggest a potential ethical issue that may exist if one company holds the patent for a GM crop plant.

[1]

7. The diagram shows some of the reactions that take place in a leaf cell in a flowering plant.



Which of the following statements about triose phosphate is/are correct?

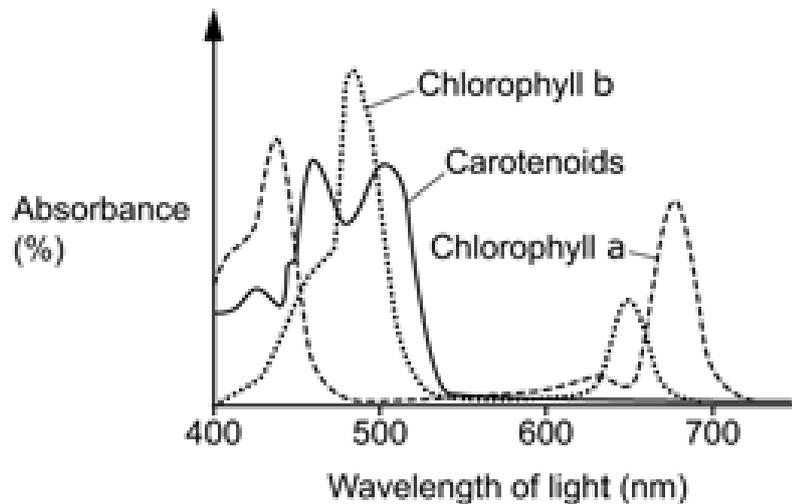
- 1 Six turns of the Calvin cycle produces 6 molecules of triose phosphate.
- 2 Triose phosphate from the Calvin cycle can be recycled to ribulose bisphosphate.
- 3 Triose phosphate from the Calvin cycle can be used to make cellulose, lipids and proteins.

- A** 1, 2 and 3 are correct
- B** Only 1 and 2 are correct
- C** Only 2 and 3 are correct
- D** Only 1 is correct

Your answer

[1]

8. The diagram shows the absorption spectra of different photosynthetic pigments.



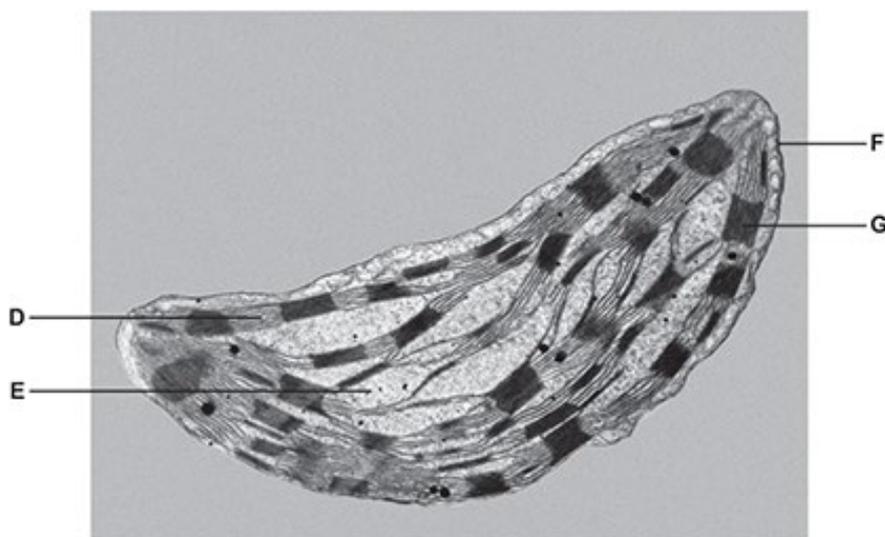
Which of the statements about the absorption spectra shown in the diagram is **not** correct?

- A Absorption of light energy by accessory pigments such as chlorophyll b and carotenoids increases the efficiency of light harvesting.
- B Chlorophyll a absorbs red light but not blue light and chlorophyll b absorbs blue light but not red light.
- C Chlorophyll b and carotenoids are described as accessory pigments because they are not involved directly in the light dependent reaction of photosynthesis.
- D The absorption spectra explain why plants appear green because they absorb red and blue wavelengths of light.

Your answer

[1]

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



Complete the table using the letters from the TEM which identifies the structure or function.

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

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

[4]

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

Carbon fixation occurs in the Calvin cycle when  $\text{CO}_2$  combines with the five-carbon molecule ..... . This forms an unstable six-carbon molecule that immediately breaks down into two molecules of ..... These are reduced to triose phosphate using ..... and ..... that are formed in the light-dependent stage of photosynthesis. Triose phosphate is used to form hexose phosphates which can be converted to ..... for transport elsewhere in the plant.

[5]

10. Which of the statements about the relationship between photosynthesis and aerobic respiration in plants is/are correct?

- 1 During the day, photosynthesis produces all the ATP that cells in the leaves require.
- 2 Carbon dioxide produced in respiration can be used as a carbon source in photosynthesis.
- 3 Oxygen produced in photosynthesis can be used in aerobic respiration.

- A 1, 2 and 3 are correct  
B Only 1 and 2 are correct  
C Only 2 and 3 are correct  
D Only 1 is correct

Your answer

[1]

11. Which option is **not** a component of a chloroplast?

- A Cristae  
B DNA  
C Ribosome  
D Thylakoid

Your answer

[1]

12. A class compared the number of chloroplasts in the leaves taken from plants of the same species growing in two areas. One area had a high light intensity, the other had a low light intensity.

One student examined a cross section of a leaf under a light microscope.

They counted the number of chloroplasts in each cell in the field of view. Their results are shown in the table.

| Cell number            | 1  | 2  | 3  | 4  | 5  | 6  | 7  |
|------------------------|----|----|----|----|----|----|----|
| Number of chloroplasts | 13 | 14 | 13 | 21 | 14 | 13 | 17 |

Which option gives the correct values for mean, median and mode?

- A Mean = 13, median = 14, mode = 15  
B Mean = 14, median = 15, mode = 13  
C Mean = 15, median = 14, mode = 13  
D Mean = 15, median = 13, mode = 14

Your answer

[1]

**13.** A class compared the number of chloroplasts in the leaves taken from plants of the same species growing in two areas. One area had a high light intensity, the other had a low light intensity.

Which option is the correct procedure for statistical analysis of the data collected by the class?

- A** Calculate the mean number of chloroplasts per cell in the high and low light intensity areas and use a paired t-test.
- B** Calculate the mean number of chloroplasts per cell in the high and low light intensity areas and use an unpaired t-test.
- C** Calculate the median number of chloroplasts per cell in the high and low light intensity areas and calculate Spearman's rank correlation coefficient.
- D** Calculate the median number of chloroplasts per cell in the high and low light intensity areas and use a chi-squared test.

Your answer

**[1]**

**END OF QUESTION PAPER**