# 13.1 Photosynthesis as an Energy Transfer Process

## Question Paper

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|---|---|
| Course | CIE A Level Biology |
| Section | 13. Photosynthesis |
| Topic | 13.1 Photosynthesis as an Energy Transfer Process |
| Difficulty | Hard |

**Time allowed:** 40

**Score:** /30

**Percentage:** /100

## Question 1a

Corals grow in shallow sea water. Corals consist of colonies of small animals called polyps. These polyps have photosynthetic protoctists called algae within their cells, which is advantageous both to the coral polyps and to the algae.

The algae that live within the cells of coral polyps can also live independently as free-living algae.

The rate of photosynthesis of algae that live within the cells of coral polyps is higher than that of free-living algae.Suggest **and** explain why the rate of photosynthesis in algae that live within the cells of coral polyps is higher than that of free-living algae.

**[3 marks]**

## Question 1b

The algae that live within the cells of coral polyps have five different chloroplast pigments.

Table 1 shows the light wavelengths at which each algal chloroplast pigment shows its two largest peaks of light absorption.

**Table 1**

| **chloroplast pigment** | **peak 1 wavelength / nm** | **peak 2 wavelength / nm** |
|---|---|---|
| chlorophyll *a* | 430 | 662 |
| peridinin | 456 | 485 |
| chlorophyll $c_2$ | 450 | 396 |
| dinoxanthin | 442 | 471 |
| β-carotene | 454 | 480 |

Corals can be kept in glass tanks that are usually lit by lamps radiating mainly violet and blue light, with wavelengths in the range of 400 nm to 490 nm.

With reference to Table 1, suggest why lamps radiating mainly violet and blue light are expected to increase the growth of **coral polyps** more than lamps radiating light of all wavelengths.

**[3 marks]**

## Question 1c

Photosynthesis in the algae living within the cells of coral polyps is the same as photosynthesis in plant cells.

Outline the process of cyclic photophosphorylation.

**[4 marks]**

## Question 2a

Paper chromatography can be used to separate photosynthetic pigments obtained from chloroplasts.

Fig. 1 shows the chromatography strip with distinct pigment bands.

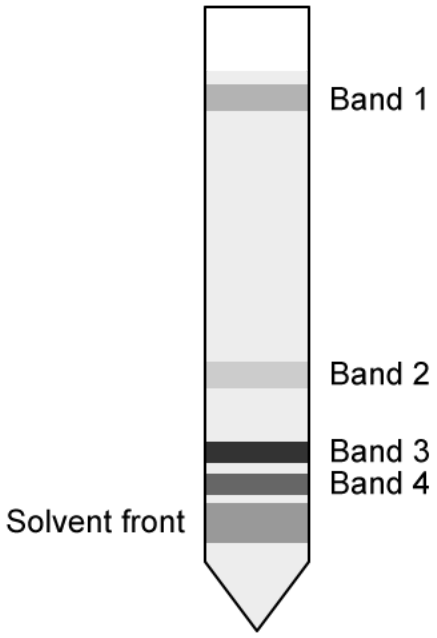


**Fig. 1**

The teacher explains that the four bands represent four pigments: chlorophyll a, chlorophyll b, xanthophylls and carotenes (but not necessarily in that order). The teacher asks a student to suggest which bands most likely represent the two chlorophyll pigments. The student suggests bands 3 and 4.

Explain why this is the correct choice.

**[2 marks]**

## Question 2b

Describe how someone could accurately identify the pigments in the chromatogram shown in part (a).

**[3 marks]**

## Question 2c

The photosynthetic pigments from two aquatic algae, green alga genus *Oedogonium* and red alga genus *Palmaria*, were separated by thin layer chromatography.

Fig. 2 shows the chromatograms.

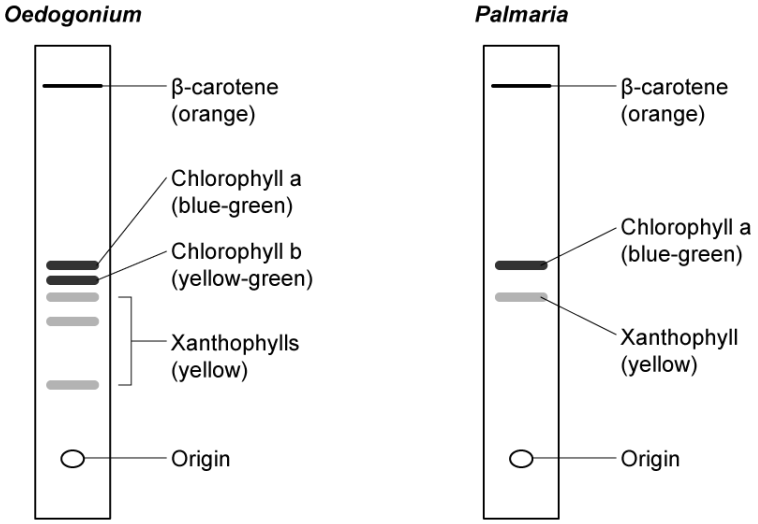


**Fig. 2**

*Palmaria* also contain a red pigment known as phycoerythrin. The pigment appears red because it absorbs blue light and reflects red light. The pigment phycoerythrin is absent from the chromatogram above.

Suggest why this might be.

**[1 mark]**

## Question 2d

Light of shorter wavelengths penetrates water to greater depths than light of longer wavelengths.

Using information here and from part (c), suggest why red algae such as *Palmaria* can live at greater depths than many other aquatic algae.

**[2 marks]**

## Question 3a

In a woodland the concentration of carbon dioxide gas in the air changes during a 24–hour period. It can also vary depending on the height above the ground at which a gas measurement is taken.

Explain the variation in carbon dioxide concentration in a woodland over time and at different heights. Assume that there is no air movement caused by wind throughout the 24–hour period.

**[5 marks]**

## Question 3b

A team of researchers investigated the effect of changing the carbon dioxide concentration on the levels of glycerate-3–phosphate (GP) and ribulose bisphosphate (RuBP) in photosynthesising cells.

Table 1 shows the results obtained when the carbon dioxide concentration was reduced.

**Table 1**

| Photosynthetic intermediate | Level before experiment / arbitrary units | Level after experiment / arbitrary units | |
|---|---|---|---|
| | | 1.0% $CO_2$ | 0.003% $CO_2$ |
| RuBP | 18 | 18 | 37 |
| GP | 36 | 36 | 17 |

Explain the decrease in the level of GP at the lower carbon dioxide concentration.

**[1 mark]**

## Question 3c

The researchers carried out a similar experiment but increased the carbon dioxide concentration from 1% to 2%. The relative levels of GP and RuBP remained the same both before and after the experiment.

Suggest **three** reasons why.

**[3 marks]**

## Question 3d

Some primitive species of bacteria that live on the ocean floor do not have access to light for photosynthesis. Instead, they use the process of chemosynthesis to make food (glucose) using the energy stored in chemicals such as methane, hydrogen sulfide ($H_2S$) and carbon dioxide.

A simplified chemical equation of one of these reactions is shown below:

$$\mathbf{6CO_2 + 12H_2S \rightarrow C_6H_{12}O_6 + 6H_2O + 12S}$$

Use your knowledge of photosynthesis to suggest what the hydrogen sulfide is used for in chemosynthesis in these bacteria.

**[3 marks]**