

Photosynthesis as an energy transfer process

Question Paper 3

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Photosynthesis
Sub Topic	Photosynthesis as an energy transfer process
Booklet	Theory
Paper Type	Question Paper 3

Time Allowed : 74 minutes

Score : / 61

Percentage : /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

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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.

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

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- (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 CO₂ 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

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

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- (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.

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[Total: 15]

(c) In an investigation, mammalian liver cells were homogenised (broken up) and the resulting homogenate centrifuged. Samples of the complete homogenate and samples containing only nuclei, only ribosomes, only mitochondria or only the remaining cytosol were incubated with:

- 1 glucos
- 2 yruvate
- 3 glucose and cyanide
- 4 pyruvate and cyanide

Cyanide inhibits oxidative phosphorylation.

After incubation the presence or absence of carbon dioxide and lactate in each sample was determined.

The results are summarised in Table 7.1.

Table 7.1

	samples of homogenate									
	complete		only nuclei		only ribosomes		only mitochondria		only cytosol	
	carbon dioxide	lactate	carbon dioxide	lactate	carbon dioxide	lactate	carbon dioxide	lactate	carbon dioxide	lactate
1 glucose	✓	✓	✗	✗						✓
2 pyruvate	✓	✓	✗	✗	✗	✗	✓	✗	✗	✓
3 glucose and cyanide	✗	✓	✗	✗						✓
4 pyruvate and cyanide	✗	✓	✗	✗						✓

✗ = absent ✓ = present

(i) With reference to Table 7.1, name the two organelles not involved in respiration.

1.

2. [1]

- (ii) Explain why carbon dioxide is produced when mitochondria are incubated with pyruvate but **not** when they are incubated with glucose.

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- (iii) Explain why, in the presence of cyanide, lactate is produced but carbon dioxide is not.

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[Total: 16]