A Level Biology B

H422/02 Scientific literacy in biology

Question Set 17

1. (a)

In the 1950s, Melvin Calvin studied the series of reactions that we now know as the Calvin Cycle.

Calvin's 'lollipop' experiment was so called because it used a lollipop-shaped glass flask containing single-celled photosynthetic algae growing in culture.

A diagram of the apparatus Calvin used is shown in Fig. 4.1.

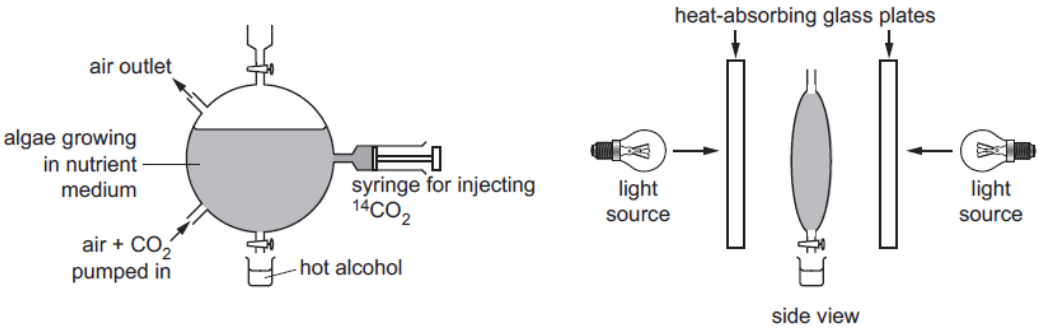

Fig. 4.1

The algae were illuminated for 30 minutes before the start of the experiment. Air and carbon dioxide were pumped into the suspension throughout.

At time zero, a small amount of radioactively-labelled carbon dioxide ($^{14}CO_2$) was injected from the syringe.

At intervals after addition of the $^{14}CO_2$, samples of the suspension were run off into hot alcohol before being analysed.

Suggest the reasons for the following steps in the experiment.

1. Illuminating the algae for 30 minutes before the start of the experiment.

2. Placing heat-absorbing glass between the light sources and the flask.

3. Running each sample into hot alcohol before analysis.

[3]

(b) **(i)** Calvin measured the relative radioactivity in various compounds at 2 seconds, 10 seconds and 30 seconds after addition of the $^{14}CO_2$.

The results of the analysis are shown in Table 4. Presence of radioactivity is represented in the table as '+' and no radioactivity as '–'.

Organic compound	Relative radioactivity present at time after addition of $^{14}CO_2$		
	2 s	10 s	30 s
Amino acids	–	–	+
Glycerate-3-phosphate (GP)	+	+	+
Sucrose	–	–	+
Sugar phosphates	–	–	+
Triose phosphate (TP)	–	+	+

Table 4

Name the enzyme responsible for the initial incorporation of radioactive CO_2 into organic compounds.

[1]

(ii) Use the results in Table 4 to explain the order in which the organic compounds are produced during photosynthesis.

[3]

(c) Calvin isolated the compounds formed at the earliest time points and found they contained three carbon atoms.

This led him to conclude that the first reaction in the cycle was between CO_2 and a 2-carbon compound.

Explain why Calvin's conclusion was **incorrect**.

[2]

(d) **(i)** Fig. 4.2 shows the relationship between the net rate of photosynthesis and light intensity in a plant growing at atmospheric CO_2 concentration (0.04%).

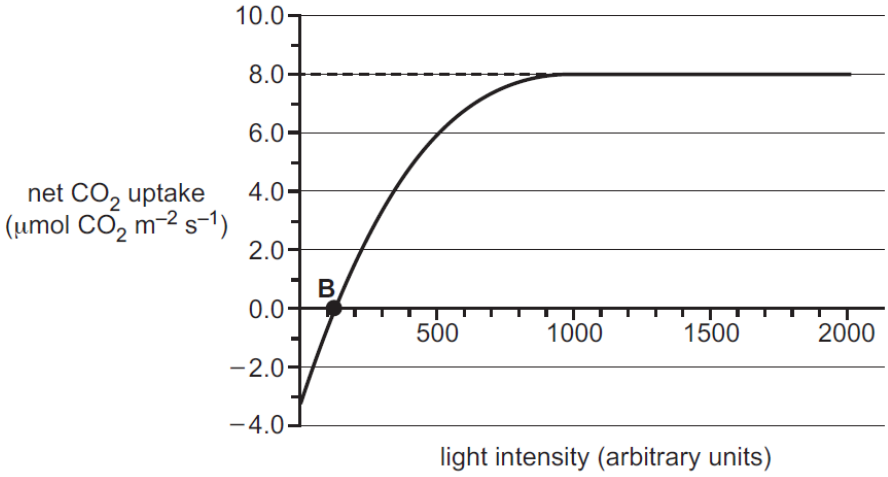

Fig. 4.2

The plant had a leaf area of 0.97 m^2.

Calculate (in μmol) the maximum amount of CO_2 that the plant can take up in 1 minute. **[2]**

(ii) Explain the significance of the point labelled **B** on Fig. 4.2. **[1]**

(e) Winter wheat seeds are usually sown in the autumn and flower the following summer. Seeds sown in the spring will usually not flower.

The Russian geneticist Lysenko discovered that winter wheat seeds can be treated with cold and moisture.

Explain why winter wheat seeds treated in this way and sown in spring are able to flower. **[2]**

(f) Chrysanthemums normally flower only in autumn.

Commercial growers obtain flowers earlier in the year by growing the chrysanthemums in greenhouses where they can use screens or curtains to provide at least 12 hours of darkness.

Explain how this method stimulates early flowering and why it will not work if the plants are exposed to a brief period of light during the 12 hours of darkness. **[3]**

Total Marks for Question Set 17: 17