Photosynthesis – A2 9700 Biology June 2022

1. June/2022/Paper_41/No.2

(a) In eukaryotes, the cells of plants and photosynthetic protoctists contain chloroplasts.

Describe the relationship between the function of a chloroplast and its structure.

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(b) Outline the main features of cyclic photophosphorylation.

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(c) Red algae are aquatic protoctists that are multicellular. The cells of red algae have chloroplasts containing photosynthetic pigments. Many red algae live in deep water.

Two of the accessory pigments of red algae chloroplasts are:

- phycoerythrin (appears red), often present in large concentrations
- phycocyanin (appears blue).

The first few metres of water nearest the surface absorb the red wavelengths of light. If the water also contains particles of organic material it absorbs blue wavelengths.

Fig. 2.1 shows absorption spectra of some pigments in red algae chloroplasts.

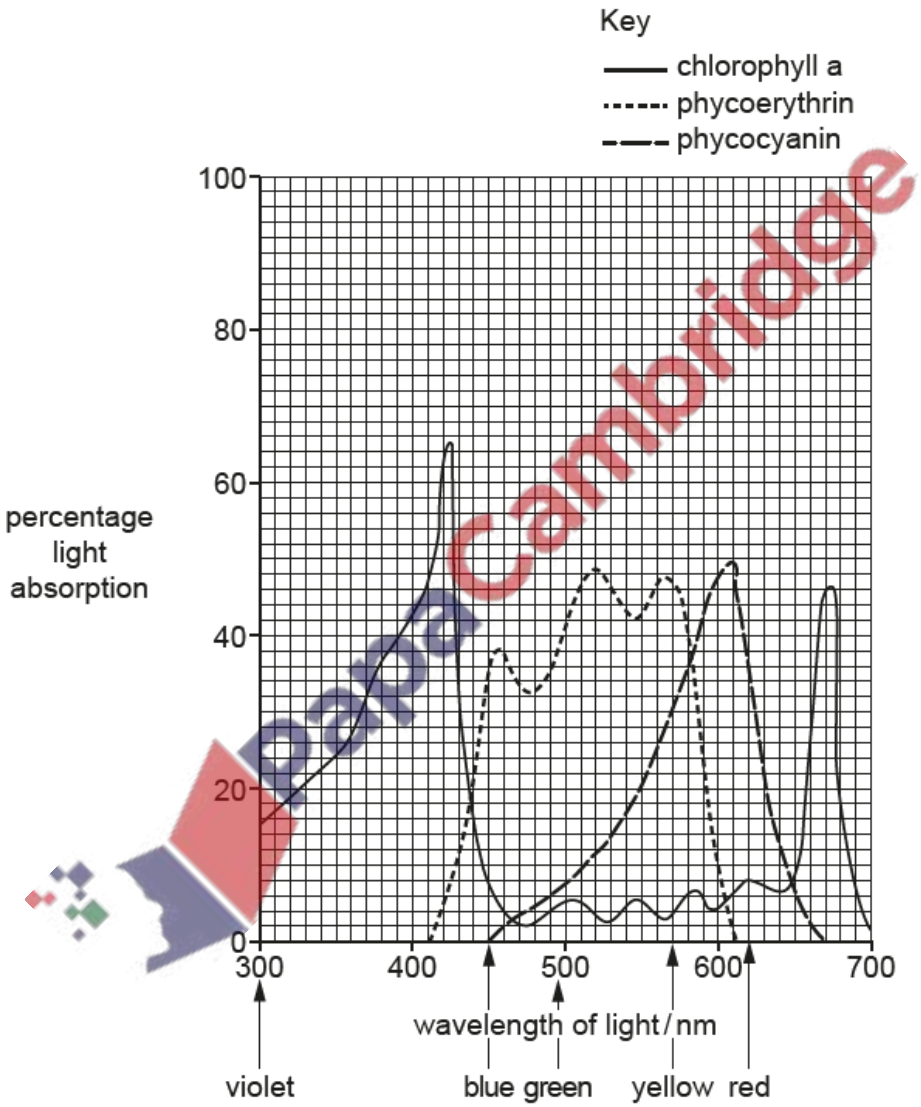

Fig. 2.1

Describe the differences in the absorption spectra of the three photosynthetic pigments shown in Fig. 2.1 **and** explain how these differences help red algae to survive in deep water.

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[Total: 14]

2. June/2022/Paper_41/No.9

(a) Stomata are involved in both transpiration and photosynthesis in plants.

Fig. 9.1 is a diagram of an open stoma, its guard cells and surrounding epidermal cells.

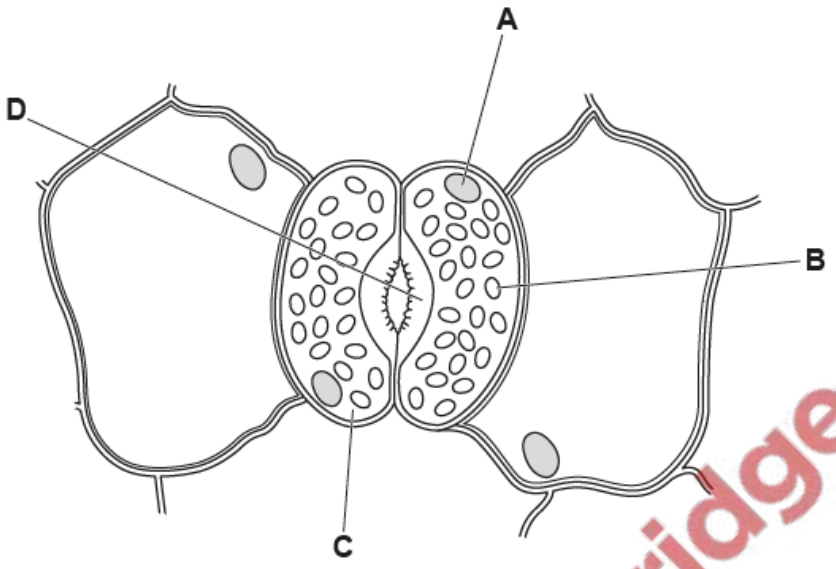

Fig. 9.1

Complete Table 9.1 by choosing the correct letter from Fig. 9.1 to match the feature stated in Table 9.1.

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

Table 9.1

letter	feature
.....	location of Calvin cycle
.....	made mainly of cellulose

[2]

(b) The opening and closing of stomata are due to changes in environmental conditions. Hydrogen ions (H^+) and potassium ions (K^+) are involved in the opening of stomata.

Describe how hydrogen ions and potassium ions are involved in the opening of a stoma.

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[Total: 6]

3. June/2022/Paper_42/No.2

(a) Photosynthesis is affected by many environmental factors.

(i) Explain why light intensity can be a limiting factor in photosynthesis.

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(ii) The concentration of carbon dioxide (CO_2) can also be a limiting factor. It has an effect on the Calvin cycle in the light-independent stage of photosynthesis.

Ribulose bisphosphate (RuBP), triose phosphate (TP) and glycerate 3-phosphate (GP) are three important molecules in the Calvin cycle.

Fig. 2.1 shows how the concentration of GP changes when the concentration of CO_2 is reduced from 0.04% (atmospheric) to 0.008%.

Complete Fig. 2.1 by sketching the lines for RuBP and TP when the concentration of CO_2 is reduced from 0.04% to 0.008%.

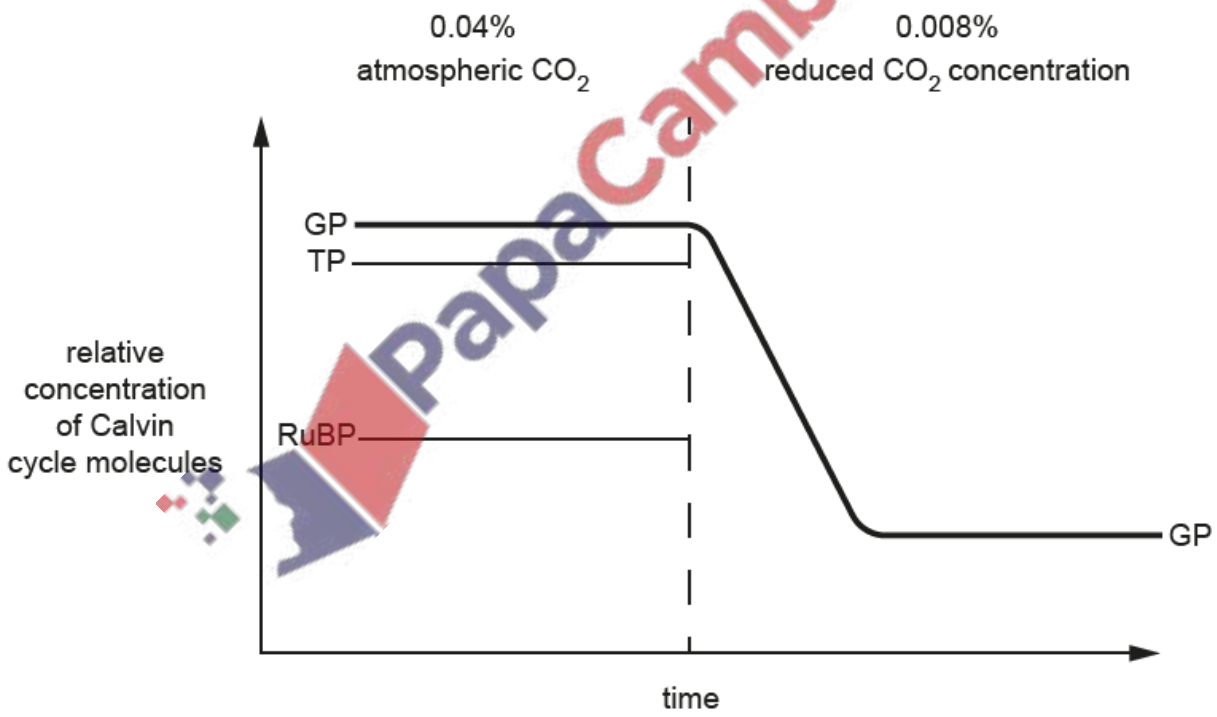

Fig. 2.1 [2]

(iii) In very dry conditions, CO_2 concentration can become the main limiting factor of photosynthesis in plants.

Explain how very dry conditions cause CO_2 concentration to become the main limiting factor of photosynthesis in plants.

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(b) A factor that can limit the rate of photosynthesis is the rate of regeneration of RuBP.

Sedoheptulose-1,7-bisphosphatase (SBPase) is an enzyme in the Calvin cycle that controls the rate of regeneration of RuBP. SBPase is coded for by the gene *SBPase*.

In an experiment, wheat plants were genetically modified to make more SBPase by introducing the *SBPase* gene from another grass species, *Brachypodium distachyon*. The resulting GM wheat plants were named Sox4.

- Wild type plants (not GM) and Sox4 plants were grown in a greenhouse.
- Light intensity, CO_2 concentration and temperature were kept constant.
- Mature plants were removed and dried to measure the biomass.

Fig. 2.2 shows the mean plant biomass for the wild type plants and GM Sox4 plants.

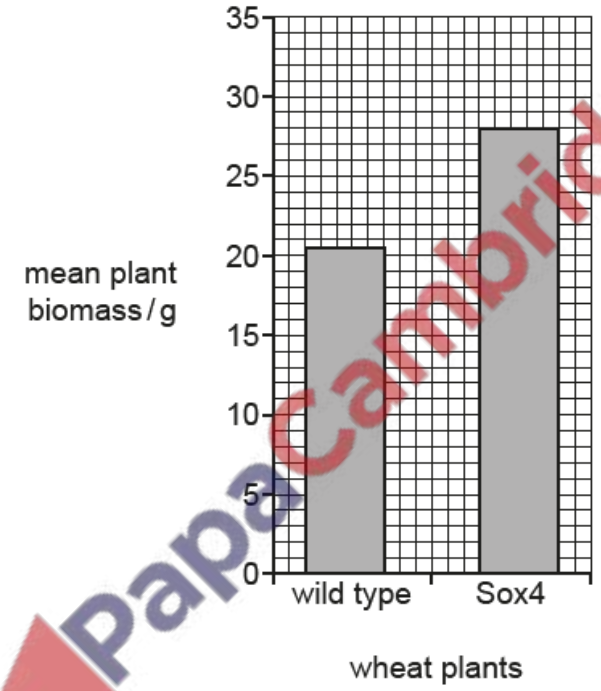

Fig. 2.2

(i) Calculate the percentage change in mean plant biomass when Sox4 plants are grown compared to wild type plants.

Show your working.

percentage change = ... % [2]

(ii) Suggest **and** explain why Sox4 plants have a different mean plant biomass than wild type plants.

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(iii) Some soils may be deficient in nitrates.

Suggest how nitrate deficiency could limit the quantity of SBPase made by Sox4 plants.

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[Total: 15]

4. June/2022/Paper_43/No.2

Photosynthesis is an energy transfer process that results in the production of carbohydrate. It has two stages: the light-dependent stage and the light-independent stage.

Cyclic photophosphorylation and non-cyclic photophosphorylation are essential pathways in photosynthesis that occur in the light-dependent stage.

(a) (i) Describe the similarities and differences between cyclic photophosphorylation and non-cyclic photophosphorylation.

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(ii) Explain why herbicides that prevent cyclic photophosphorylation and non-cyclic photophosphorylation stop carbohydrate being produced in the chloroplast.

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(b) The rate of regeneration of RuBP in the Calvin cycle is known to limit the rate of photosynthesis.

Sedoheptulose-1,7-bisphosphatase (SBPase) is an enzyme in the Calvin cycle that controls the rate of regeneration of RuBP. SBPase is coded for by the gene *SBPase*.

In an experiment, wheat plants were genetically modified to make more SBPase by introducing the *SBPase* gene from another grass species, *Brachypodium distachyon*. The resulting GM wheat plants were named Sox4.

- Wild type plants (not GM) and Sox4 plants were grown.
- A leaf from the wild type plant was placed in a sealed glass vessel.
- The carbon dioxide (CO_2) concentration in the vessel was increased so that the intercellular air spaces also had an increase in CO_2 concentration.
- The other environmental conditions were kept constant.
- The rate of fixation of CO_2 was measured for the leaf.
- The experiment was repeated with a leaf from a Sox4 plant.

Fig. 2.1 shows the rate of fixation of CO_2 by the leaves of wild type plants and Sox4 plants when the intercellular air space CO_2 concentration was increased.

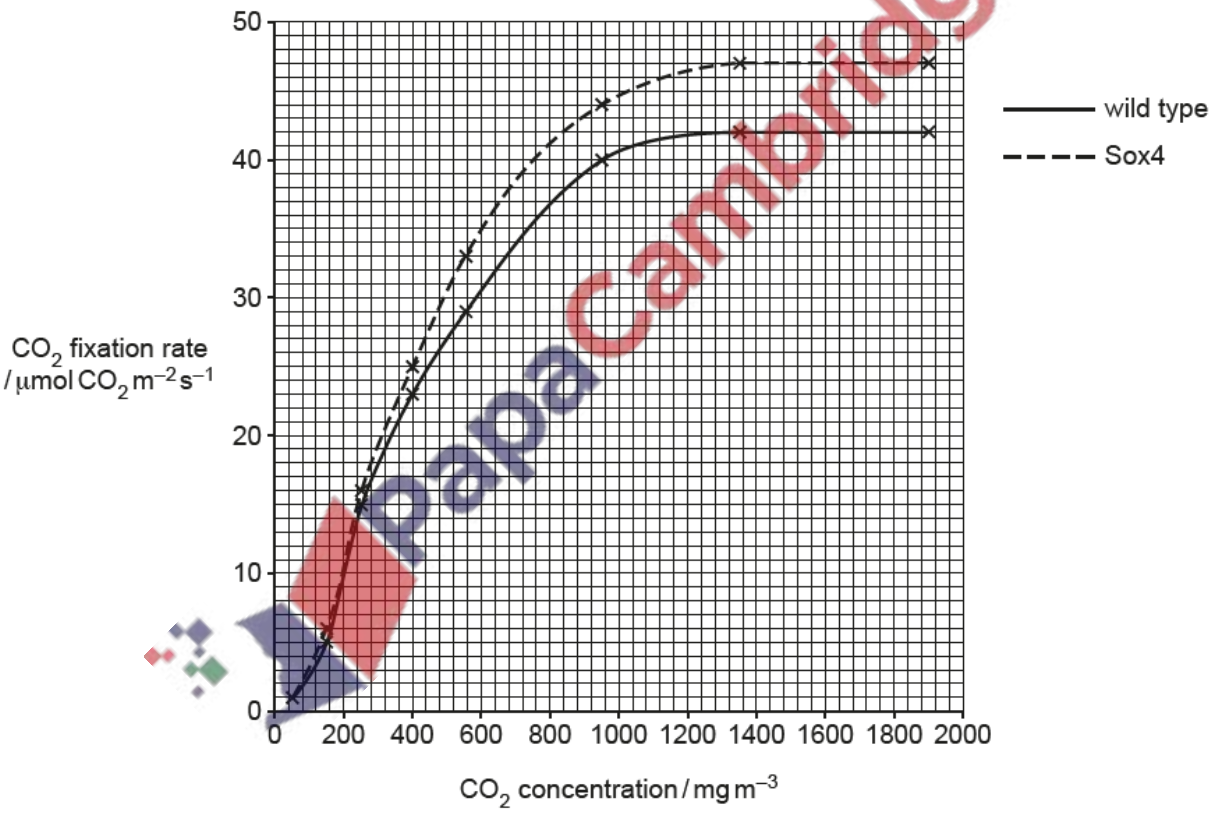

Fig. 2.1

(i) With reference to Fig. 2.1, describe **and** explain the results shown by the **wild type** plants.

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(ii) With reference to Fig. 2.1, describe **and** suggest explanations for the differences in the rate of fixation of CO_2 between wild type plants and Sox4 plants.

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[Total: 13]

5. June/2022/Paper_43/No.3

(a) ATP is synthesised from ADP and P_i in a phosphorylation reaction.

State the **two** different ways in which this phosphorylation reaction occurs in aerobic respiration.

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(b) Coenzymes are important in all four stages of aerobic respiration.

Describe **and** explain the role of the coenzymes NAD and FAD in aerobic respiration.

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(c) The enzyme pyruvate dehydrogenase catalyses the link reaction. Pyruvate dehydrogenase is inhibited when the ratio of acetyl coenzyme A to coenzyme A increases.

Suggest the importance of this inhibition to the functioning of the cell.

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[Total: 10]