



A-Level Biology

Photosynthesis

Question Paper

Time available: 71 minutes

Marks available: 50 marks

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1.

(a) In photosynthesis, which chemicals are needed for the light-dependent reaction?
Tick (✓) **one** box.

Reduced NADP, ADP, Pi, water and oxygen.

NADP, ATP and water.

Reduced NADP, ATP, water and carbon dioxide.

NADP, ADP, Pi and water.

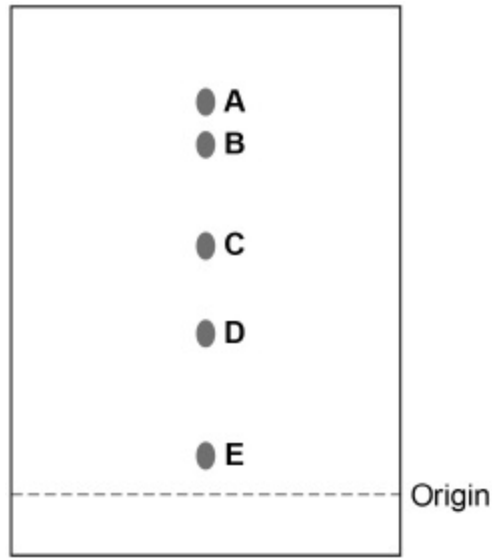
(1)

(b) Describe what happens during photoionisation in the light-dependent reaction.

(2)

A student obtained a solution of pigments from the leaves of a plant. Then the student used paper chromatography to separate the pigments.

The diagram shows the chromatogram produced.



(c) Explain why the student marked the origin using a pencil rather than using ink.

(1)

(d) Describe the method the student used to separate the pigments after the solution of pigments had been applied to the origin.

(2)

- (e) Calculating the R_f values of the pigments can help to identify each pigment. An R_f value compares the distance the pigment has moved from the origin with the distance the solvent front has moved from the origin.

$$R_f = \frac{\text{distance pigment has moved from the origin}}{\text{distance solvent front has moved from the origin}}$$

The distance each pigment has moved is measured from the middle of each spot.

Pigment **A** has an R_f value of 0.95

Use the diagram above to calculate the R_f value of pigment **C**.

R_f value of pigment **C** = _____

(1)

- (f) The pigments in leaves are different colours. Suggest and explain the advantage of having different coloured pigments in leaves.

(1)

(Total 8 marks)

2.

Heat stress is a condition that often occurs in plants exposed to high temperatures for a prolonged period of time. Heat stress is a major factor in limiting the rate of photosynthesis.

(a) Heat stress decreases the light-dependent reaction of photosynthesis.

Explain why this leads to a decrease in the **light-independent reaction**.

(2)

(b) Another effect of heat stress is a decrease in the activity of the enzyme rubisco. A decrease in the activity of an enzyme means that the rate of the reaction it catalyses becomes slower.

A decrease in the activity of the enzyme rubisco would limit the rate of photosynthesis.

Explain why.

(2)

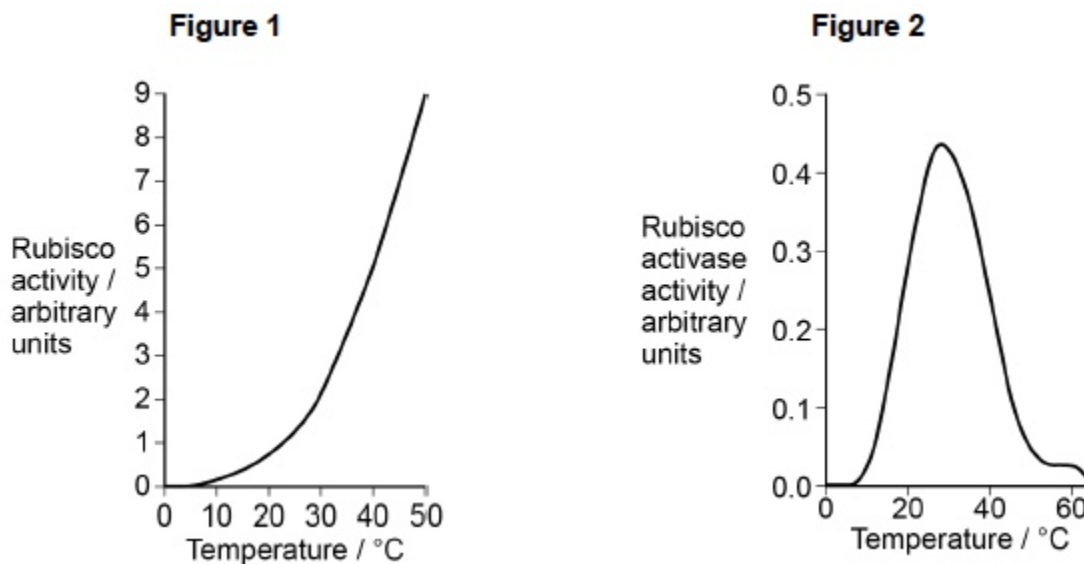
(c) Where precisely is rubisco found in a cell?

(1)

Scientists investigated the effect of temperature on the activity of two enzymes isolated from the leaf cells of cotton plants.

- Rubisco
- Rubisco activase – an enzyme that activates rubisco

Figure 1 and Figure 2 show their results.



- (d) The scientists concluded that heat stress reduces the activity of rubisco in plant leaves by affecting rubisco activase.

Use all the information to evaluate their conclusion.

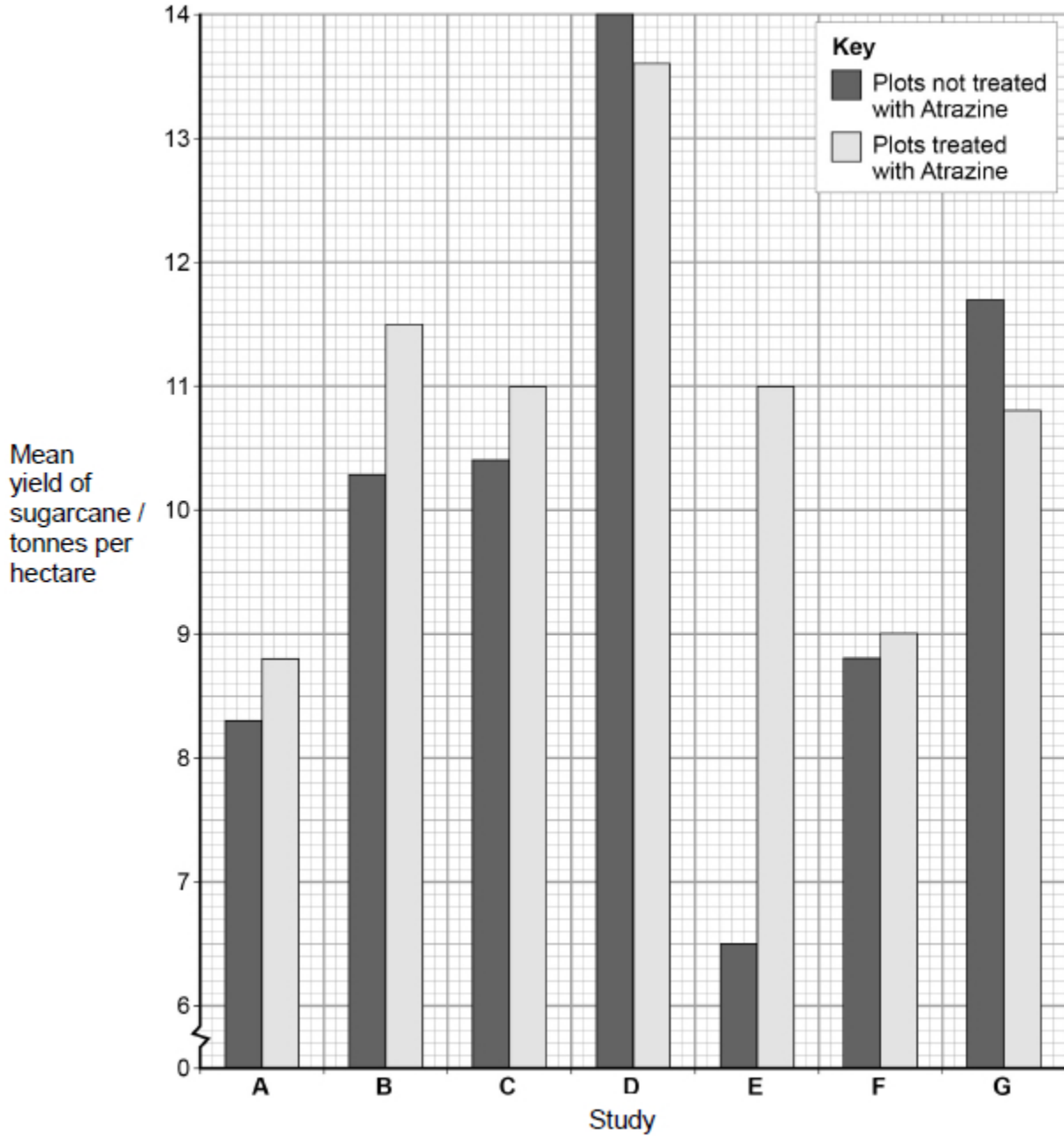
(4)
(Total 9 marks)

3.

Herbicides can be used to reduce the growth of weeds.

Scientists completed seven studies to determine how the use of the herbicide Atrazine affected the yield of sugarcane. In each study, some plots were treated with Atrazine and some plots were not treated with Atrazine.

The graph below shows the scientists' results. (1 hectare = 10 000 m²)



(a) Calculate the percentage decrease in yield caused by the use of Atrazine in study G.

Answer = _____ %

(1)

(b) A teacher studying these data with her students told her class that no definite conclusions could be drawn when comparing the mean values in the graph.

Suggest why the teacher said this.

(2)

(c) Atrazine binds to proteins in the electron transfer chain in chloroplasts of weeds, reducing the transfer of electrons down the chain.

Explain how this reduces the rate of photosynthesis in weeds.

(4)

(d) When treated with Atrazine, weeds have been shown to give off small amounts of heat.

Suggest an explanation for this observation.

(1)

(Total 8 marks)

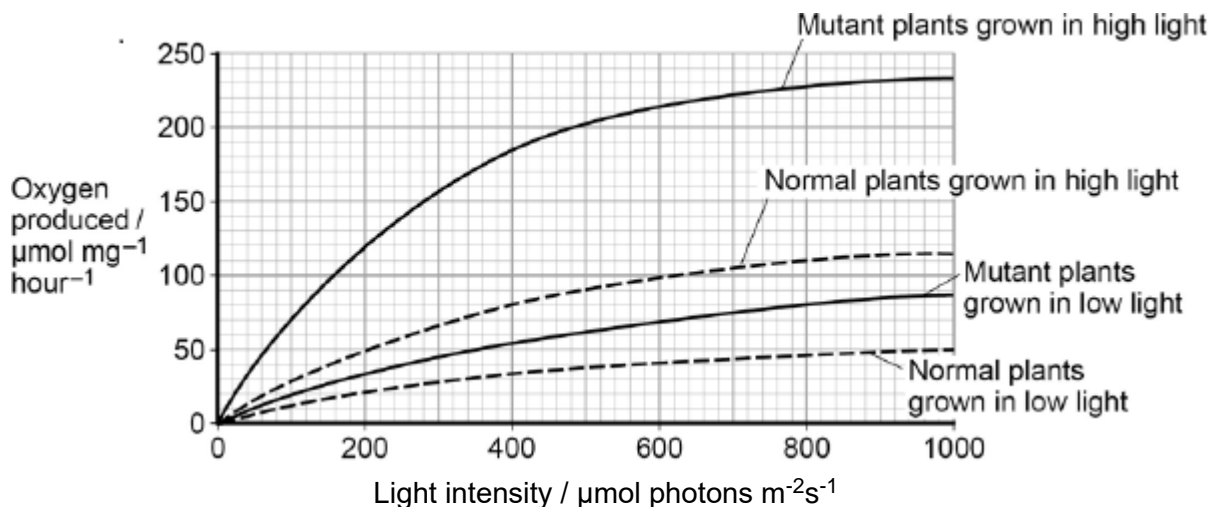
4.

Chloroplasts contain chlorophyll a and chlorophyll b. Scientists found tobacco plants with a mutation that caused them to make more chlorophyll b than normal tobacco plants. They investigated the effect of this mutation on the rate of photosynthesis.

The scientists carried out the following investigation.

- They grew normal and mutant tobacco plants. They grew some of each in low light intensity and grew others in high light intensity.
- They isolated samples of chloroplasts from mature plants of both types.
- Finally, they measured oxygen production by the chloroplasts they had isolated from the plants.

The figure below shows the scientists' results.



(a) Explain why the scientists measured the rate of production of oxygen in this investigation.

(2)

In each trial, the scientists collected oxygen for 15 minutes.

- (b) Calculate the difference in the oxygen produced by the chloroplasts from mutant plants grown in low and high light intensities at a light intensity of $500 \mu\text{mol photons m}^{-2} \text{s}^{-1}$.

Show your working.

Difference _____ $\mu\text{mol O}_2 \text{ mg}^{-1} \text{ hour}^{-1}$

(2)

- (c) The scientists suggested that mutant plants producing more chlorophyll b would grow faster than normal plants in all light intensities.

Explain how these data support this suggestion.

(4)

(Total 8 marks)

5.

(a) Crops use light energy to produce photosynthetic products.
Describe how crop plants use light energy during the light-dependent reaction.

(5)

(b) After harvesting, the remains of crop plants are often ploughed into the soil.
Explain how microorganisms in the soil produce a source of nitrates from these remains.

(5)

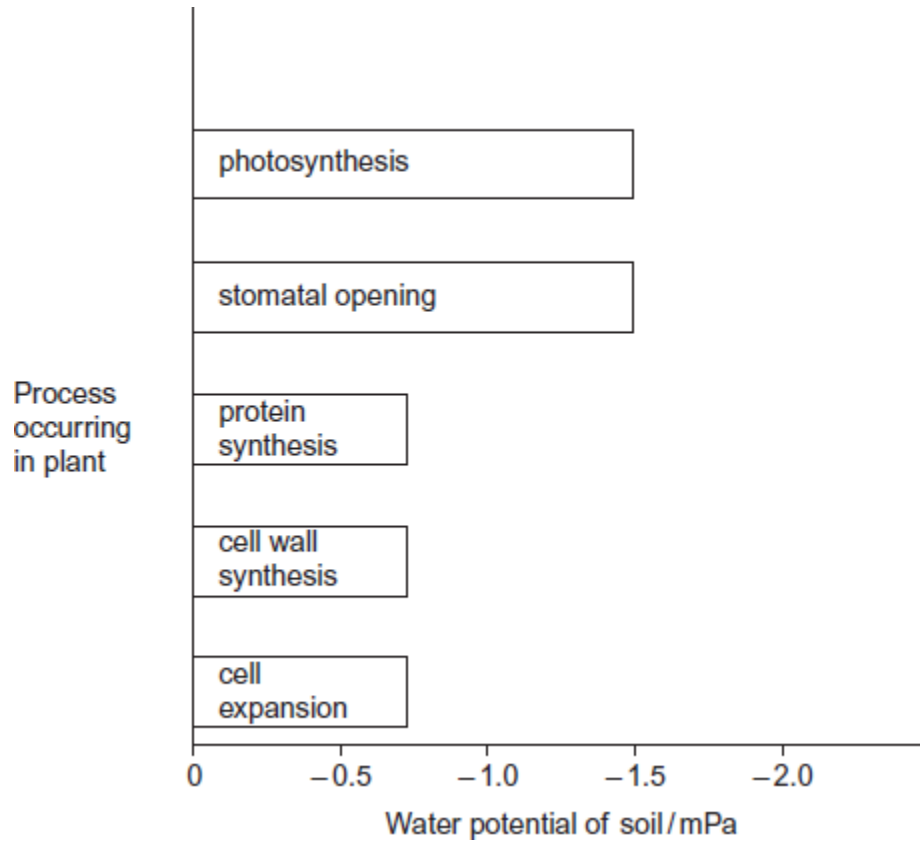
(Total 10 marks)

6.

Scientists investigated the effect of the water potential of soil water on plant growth. They investigated the effect of this water potential on several plant processes.

The figure below shows their results in the form they were presented. The bars show whether or not each process was occurring.

The plants stopped growing when the water potential of the soil water was below -0.7 mPa. All of the changes in the plants were related to the ability of the roots to take water from the soil.



(a) Describe the results in the figure.

(2)

(b) Explain the relationship between stomatal opening and photosynthesis.

(2)

- (c) Although photosynthesis is still occurring, plants stop growing when the soil water potential falls below -0.7 mPa.

Use information from the figure above to suggest two reasons why.

(3)

(Total 7 marks)