# **Photosynthesis** Question Paper 1

Level	A Level
Subject	Biology
Exam Board	OCR
Module	Communication, homeostasis and energy
Торіс	Photosynthesis
Booklet	Question Paper 1

Time allow	ed:	81 minute	81 minutes				
Score:		/60					
Percentage	:	/100	/100				
Grade Bour	idaries:						
A*	А	В	С	D	E		
>69%	56%	50%	42%	34%	26%		

### **Question 1**



Which of the images, A to D, correctly summarises photosynthesis?

# CHEMISTRY ONLINE — TUITION —

Temperature and light intensity are two factors that affect the rate of photosynthesis.

A student investigated how temperature and light intensity affected the rate of photosynthesis in the aquatic plant *Elodea canadensis*. The rate of photosynthesis was measured by counting the number of bubbles produced by the plant per minute.

Light intensity	Temperature (°C)	Number of bubbles produced / minute
8	25.0	10
32	25.0	31
127	25.0	102
510	25.0	108
8	40.5	25
32	40.5	28
127	40.5	118
510	40.5	133
8	70.0	2
32	32 70.0	
127	70.0	12
510	70.0	16

The student's results are shown in Table 3.

### Table 3

(a) (i) Identify the anomalous result in Table 3 and explain how this result could be confirmed as an anomaly.

[2]

(ii)\* Describe how the student could improve their experimental method **and** the presentation of their data.



(b) Photosynthesis occurs in two stages: the light-dependent stage and the light-independent stage. The light-independent stage is affected by temperature more than the light-dependent stage.

Explain why temperature has a greater effect on the rate of the light-independent stage.

[2]

(c) :	Scientists are able to clone desirable plants that show a high rate of photosynthesis. The following passage describes how plants are cloned.	
	Complete the passage using the most appropriate words or phrases.	[4]
	Cells are removed from the meristem tissue in axial buds or	
	tips. The tissue sample that is removed is called the Ethanol ca	an
	be used to the plant tissue. Hormones are used to stimulate mitosi	is,
	which produces a mass of cells called a	

[Total: 14]

### **Question 3**

(a) Plants photosynthesise and respire. Fig. 18.1 shows the rate of production of carbohydrate in photosynthesis and the rate of use of carbohydrate by respiration.



(iii) What is happening at the points indicated by the letter L?

[1]

(b) Plants grow successfully in temperatures that are suited to their metabolism. Some plants are adapted for growth in cool climates while others can grow well in warm climates.

Plants also vary in their photosynthetic metabolism. Many plants produce a 3-carbon compound as the first product of carbon fixation and so are referred to as C3 plants. Another group of plants produces a 4-carbon compound as the first product and so are referred to as C4 plants. C3 plants include barley, lentil, rice, soya, sunflower and wheat. C4 plants include maize, millet, sorghum and sugar cane.

Fig. 18.2 shows the assimilation of carbon dioxide by four different crops at different temperatures.



Fig. 18.2

(i) With reference to Fig. 18.2, what is the general relationship between increasing temperature and the assimilation of carbon dioxide?

[2]

- (ii) Calculate the values for the mean assimilation of carbon dioxide by C3 plants and C4 plants at 20 °C. Include units in your answer.
  [2]
  - C4
- (iii) Suggest a conclusion that could be drawn from the mean values you calculated in part (ii).
- (iv) With reference to Fig. 18.2, suggest which curve corresponds to each of the following crops:

[2]

[1]

Sugar cane, which grows in warm climates.

C3

Barley, which grows in cool climates.

## <u>CHEMISTRY ONLINE</u> — TUITION —

- (c) Temperature is very important in determining a plant's ability to photosynthesise effectively. Temperature stress is becoming of great concern to plant physiologists because of climate change.
  - High temperature (HT) stress is defined as the rise in temperature that is sufficient to cause irreversible damage to plant growth and development.

Some of the stress effects of temperature have been recorded in various plants and are outlined in Table 18.1.

Temperature	Effect		
	Heat-induced deactivation of RuBisCO		
Moderate HT stress	No change in chlorophyll fluorescence in PSII		
	Reduction in stomatal aperture		
Severe HT stress	Decrease in chlorophyll content as a result of photodeterioration Changes in the ultrastructure of the chloroplast		

Table 18.1

(i) Assess the impact of moderate HT stress on the process of photosynthesis.

[3]

(ii) Suggest two ways in which the ultrastructure of the chloroplast can be altered by high temperatures.

For each suggestion, explain the effect that it will have on photosynthesis.

[4]



[Total: 19]

Explanation

Our knowledge of the process of photosynthesis in green plants has been informed by work carried out by scientists who used a variety of techniques.

One of these techniques involved the use of purple sulfur bacteria, belonging to the Kingdom Prokaryotae. These bacteria can photosynthesise and so were used as a model for the process taking place in green plants.

- (a) With respect to photosynthesis, how would the cellular structure of purple sulfur bacteria differ from that of plant cells? [1]
- (b) The photosynthesis carried out by purple sulfur bacteria was investigated.
  - These bacteria use hydrogen sulfide (H<sub>2</sub>S) to supply the electrons needed to synthesise reduced NADP and ATP.
  - These bacteria carry out the light-dependent reaction using only photosystem I.

Photosynthesis in these bacteria may be summarised in the following equation:

$$2H_2S + CO_2 \rightarrow (CH_2O)_n + H_2O + 2S$$

(i) Photosynthesis in green plants produces oxygen gas. State which of the reactants in photosynthesis by green plants is the origin of the oxygen produced **and** provide supporting evidence from the information above.

reactant

evidence

[1]

(ii) Evaluate whether the purple sulfur bacterium was an appropriate model organism to use to investigate photosynthesis in green plants. [2]

(c) An investigation was carried out in which single-celled photosynthetic eukaryotes were supplied with CO<sub>2</sub> containing radioactive carbon atoms for a 24 hour period.

The organisms were exposed to light for the first 12 hours, after which they were kept in the dark.

The concentrations of three compounds, glycerate 3-phosphate (GP), ribulose bisphosphate (RuBP) and glucose, which had incorporated the radioactive carbon atoms, were measured at intervals during the investigation.



The results are shown in Fig. 5.1.

Fig. 5.1

- (i) Explain why the concentration of radioactive GP increased initially. [1]
- (ii) Explain why the concentration of RuBP decreased in the last 12 hours of the investigation. [2]
- (iii) Explain why the concentration of GP increased and then remained constant in the last 12 hours of the investigation. [2]
- (iv) Explain why the concentration of glucose decreased in the last 12 hours of the investigation. [1]

[Total: 10]



(a) Explain what is meant by the terms *autotroph* and *heterotroph*.

autotroph

heterotroph

(b) Fig. 3.1 is a transmission electron micrograph showing part of a chloroplast, including some of the internal membranes.



[2]

[2]

(ii) The chloroplast contains fat droplets, as shown in Fig. 3.1. These act as a reserve of raw material for the chloroplast.

Suggest what this raw material might be used for in the chloroplast. [1]

(c) Fig. 3.2 represents the light harvesting system found on the surface of the internal membranes of the chloroplast.



Fig. 3.2

Use the information in Fig. 3.2 to describe how light is harvested in the chloroplast membranes.

In your answer, you should use appropriate technical terms, spelled correctly.



Ø

[5]

(d) Many herbicides act by inhibiting photosynthesis in weeds. A series of research studies were carried out to evaluate the effectiveness of a triazine herbicide on the yield of a crop of corn, *Zea mays*. Some of the data obtained is shown in Table 3.1.

Study	Plots not treated with herbicide		Plots treated with herbicide		Yield difference with herbicide	
	Number of plots	Mean yield (kg ha <sup>−1</sup> )	Number of plots	Mean yield (kg ha <sup>-1</sup> )	(kgha <sup>−1</sup> )	(%)
Α	90	8321.4	51	8756.9	+435.5	+5.2
В	21	10344.8	3	11457.0	+1112.2	+10.8
С	30	10411.8	14	10954.5	+542.7	+5.2
D	20	13982.9	7	13607.7	-375.2	-2.7
Е	2	6532.5	8	11041.6	+4509.1	+69.0
F	66	8750.2	63	8971.3	+221.1	+2.5
G	17	11671.4	7	10807.1		

#### Table 3.1

(i) Calculate the yield difference caused by the application of herbicide in study **G**.

Show your working.

- (ii) Suggest why the researchers concluded that the data obtained from Study **E** was not useful in evaluating the effectiveness of the herbicide.
  - [1]

[2]

(iii) Triazine herbicide acts on the weeds by binding to a specific protein associated with photosystem II, blocking the movement of electrons between electron carriers.

Explain the effect that the herbicide binding to this protein will have on photosynthesis.

[2]

(iv) Plants treated with triazine herbicide can, when illuminated under experimental conditions, be seen to fluoresce (emit light) and give off small quantities of heat.

Suggest how this experimental finding could be explained.

[1]