Photosynthesis & Photosynthesis Pigments

Question Paper 4

Level	A Level
Subject	Biology
Exam Board	Edexcel
Topic	Energy of Biological Processes
Sub Topic	Photosynthesis and Photosynthesis Pigments
Booklet	Question Paper 4

Time Allowed: **66 minutes**

Score: **/55**

Percentage: **/100**

Grade Boundaries:

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

1 It has been estimated that only 5% of the light energy hitting the surface of a leaf reaches the chloroplasts to be used in the synthesis of organic material. The total energy used in this synthesis is known as the gross primary productivity (GPP).

(a) Suggest **two** reasons why 95% of the light hitting the surface of a leaf is not used by the chloroplasts.

(2)

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(b) The mean GPP for plants on Earth is 24.4×10^6 J m^{-2} $year^{-1}$.

The plants use 3.7×10^6 J m^{-2} $year^{-1}$ of this energy in metabolic processes. The energy in the remaining organic material is known as net primary productivity (NPP).

(i) Explain what is meant by the unit **J m^{-2} $year^{-1}$**.

(1)

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(ii) Calculate the percentage of the mean GPP that remains as NPP within plants on Earth.
Show your working.

(2)

Answer..... %

(iii) Place a cross ☒ in the box next to the metabolic process that best describes the process that accounts for most of the difference between GPP and NPP in plants.

(1)

☒ **A** Chemosynthesis

☒ **B** Respiration

☒ **C** Photosynthesis

☒ **D** Protein synthesis

*(c) With reference to the structures in a chloroplast, explain how the energy from light is made available in ATP molecules for the synthesis of organic materials.

(6)

(Total for Question 1 = 12 marks)

2 The process of photosynthesis has two main stages. The first of these involves the light-dependent reactions.

(a) The statements below describe important parts of the light-dependent reactions of photosynthesis. Place a cross ☒ in the box next to the term that completes each statement correctly.

(i) When light is absorbed by chlorophyll, it excites

(1)

☐ **A** electrons

☐ **B** neutrons

☐ **C** photons

☐ **D** protons

(ii) Oxygen is produced when water molecules are split in the process of

(1)

☐ **A** analysis

☐ **B** autolysis

☐ **C** hydrolysis

☐ **D** photolysis

(iii) The products of the light-dependent reactions that are used in the light-independent reactions are reduced NADP and

(1)

☐ **A** ATP

☐ **B** GALP

☐ **C** DNA

☐ **D** RuBP

(b) Describe the structures in a chloroplast that are involved in the light-dependent reactions of photosynthesis.

(3)

(c) In an investigation, wheat plants were grown using artificial lighting. Three different types of lighting were used. When the wheat plants were mature, the total biomass of the plants and the mass of the grain (seeds) they produced were measured for each type of lighting.

The table below shows the results of this investigation.

Type of lighting	**Total biomass / kg**	**Mass of grain / kg**	**Grain yield as a percentage of total biomass (%)**
Low pressure sodium lamps	171	61.7	36.1
High pressure sodium lamps	159	58.8	37.0
Metal halide lamps	162	62.4	

(i) Calculate the grain yield, as a percentage of total biomass, for the wheat grown under metal halide lamps. Show your working.

(2)

Answer ..... %

(ii) With reference to the data in the table, suggest the conclusions the investigators may have made about the effect of using different types of lighting on grain yield.

(3)

(iii) Suggest **two** advantages of growing crops of wheat in glasshouses with artificial lighting rather than growing them in open fields.

(2)

(Total for Question 2 = 13 marks)

3 An experiment was carried out to investigate the effect of temperature on the activity of the enzyme RUBISCO. This enzyme is involved in the light-independent reaction of photosynthesis.

The RUBISCO was isolated from cotton plants and its activity measured.

The results of this experiment are shown in the table below.

Temperature / °C	Activity of RUBISCO / arbitrary units
25	2.3
30	3.2
35	4.2
40	5.0
45	4.4
50	1.7

(a) Using the information in the table, explain the effects of temperatures above 40 °C on the activity of RUBISCO.

(5)

(b) Name the **two** substrates that would have been used in this experiment.

(1)

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(c) Place a cross ☒ in the box to complete the following sentences.

(i) The pH was kept constant to make the experiment

(1)

☒ **A** accurate

☒ **B** precise

☒ **C** reliable

☒ **D** valid

(ii) The optimum temperature of RUBISCO can be determined by

(1)

☒ **A** measuring the activity at 1 °C intervals between 35 °C and 40 °C

☒ **B** measuring the activity at 1 °C intervals between 40 °C and 45 °C

☒ **C** measuring the activity at 1 °C intervals between 35 °C and 45 °C

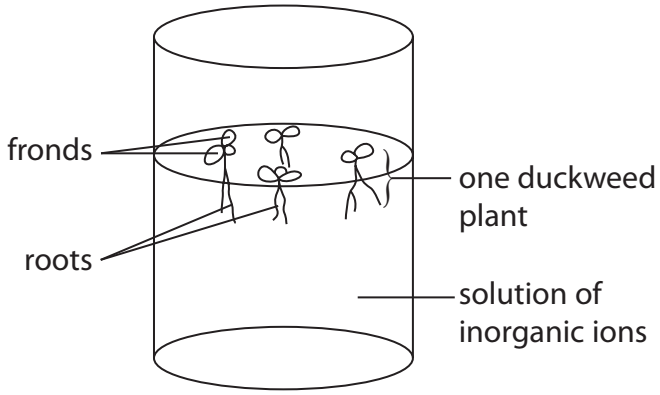
☒ **D** repeating the experiment at 35 °C, 40 °C and 45 °C three more times

(Total for Question 3 = 8 marks)

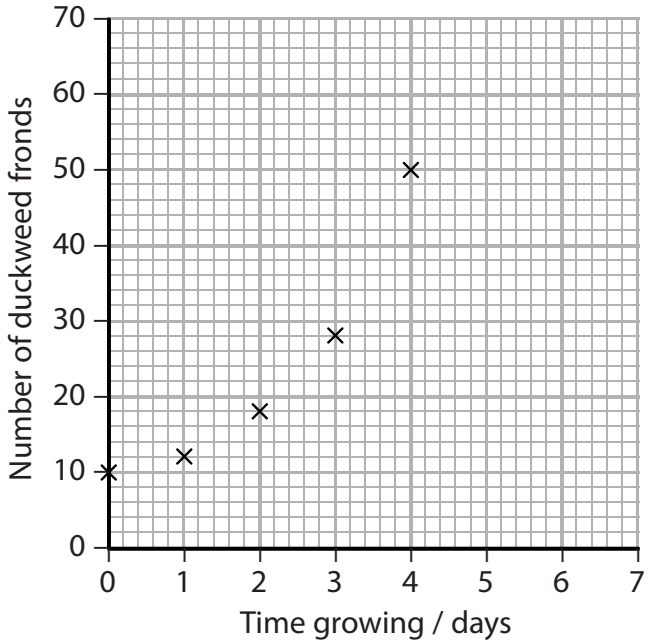
4 Duckweed is a small plant that floats on the surface of water. It could be a source of animal feed as it grows very quickly. Duckweed absorbs dissolved inorganic ions and this decreases water pollution.

Duckweed grows by producing more fronds, which then separate into new plants.

The diagram below shows some duckweed growing in a beaker containing a solution of inorganic ions.



(a) The graph below shows the growth of duckweed over a four-day period.



(i) Explain what the solution should contain for the optimum growth of duckweed.

(3)

(ii) Explain how the information in this graph could be used to estimate the increase in growth after a further six days.

(2)

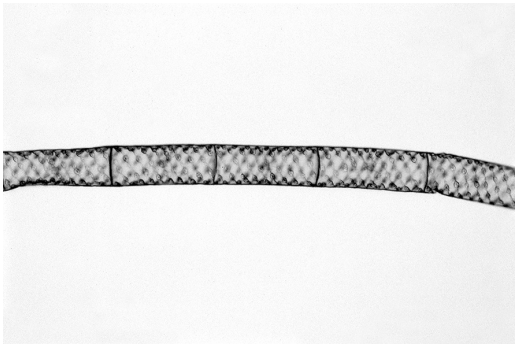
*(b) Describe an experiment that could be carried out to investigate the effect of temperature on the growth of duckweed.

(5)

(Total for Question 4 = 10 marks)

5 Filamentous algae are simple photosynthetic organisms that consist of long strands of very similar eukaryotic cells. Each of the cells in the strand is enclosed within a cellulose cell wall. The strand increases in length as the cells divide and elongate.

The photographs below show some cells in strands of a filamentous alga, as seen using a light microscope.



Magnification ×200

Magnification ×200

(a) (i) Put a cross ☒ in the box next to the term that describes the process involved in the cell divisions in a filamentous alga.

(1)

☒ **A** exocytosis

☒ **B** meiosis

☒ **C** mitosis

☒ **D** osmosis

(ii) Put a cross ☒ in the box next to the structure that would **not** be found in a cell from the strand of a filamentous alga.

(1)

☒ **A** lysosome

☒ **B** mitochondrion

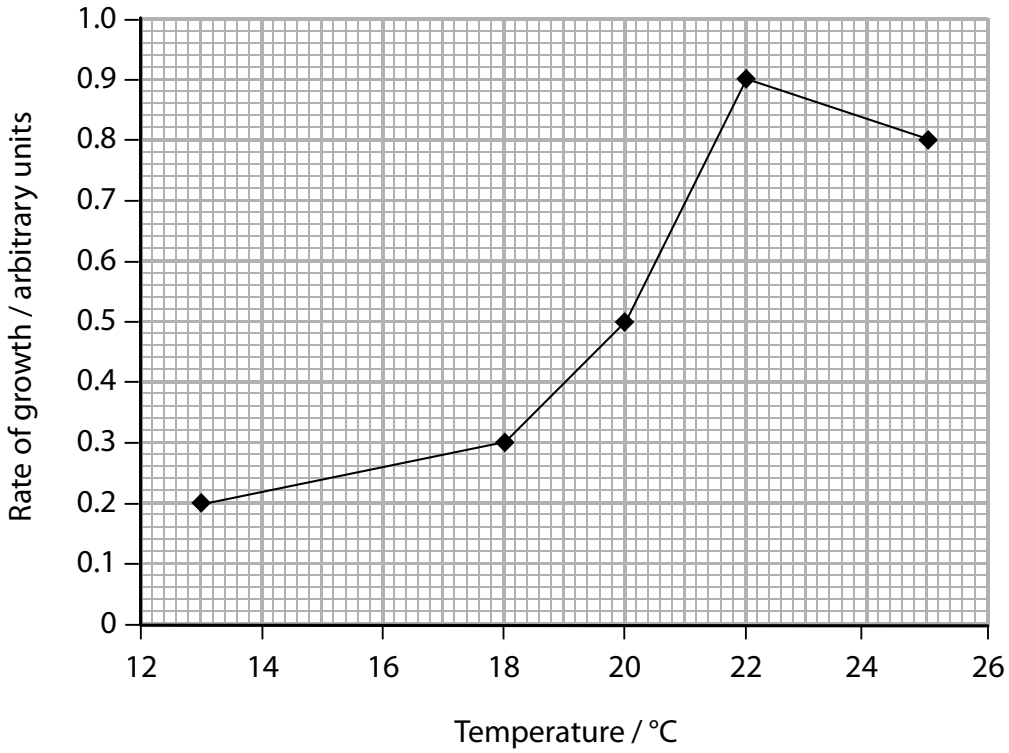
☒ **C** plasmid

☒ **D** ribosome

(b) An investigation was carried out into the effect of temperature on the rate of growth of a filamentous alga. Several short strands of the alga were placed into culture solutions which were kept at five different temperatures and at a high light intensity.

The number of cells in the strands, in each culture solution, was counted at the beginning of the time period and again after 18 days.
The rate of growth was then calculated.

The results of this investigation are shown in the graph below.



(i) Name the **independent** variable in this investigation.

(1)

(ii) Using the information in the graph, describe and suggest explanations for the effect of temperature on the rate of growth of the filamentous alga.

(4)

(iii) Suggest why it was important that this investigation was carried out at a high light intensity.

(3)

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(iv) Suggest **two** abiotic factors, other than light intensity, that would need to be controlled in this investigation.

(2)

1 .....

2 .....

(Total for Question 5 = 12 marks)