EXAM PAPERS PRACTICE

Photosynthesis Pack

These practice questions can be used by students and teachers and is

Suitable for AQA A Level 7402 Biology Topic Question

Level: AQA A LEVEL 7402

Subject: Biology

Exam Board: AQA A Level 7402

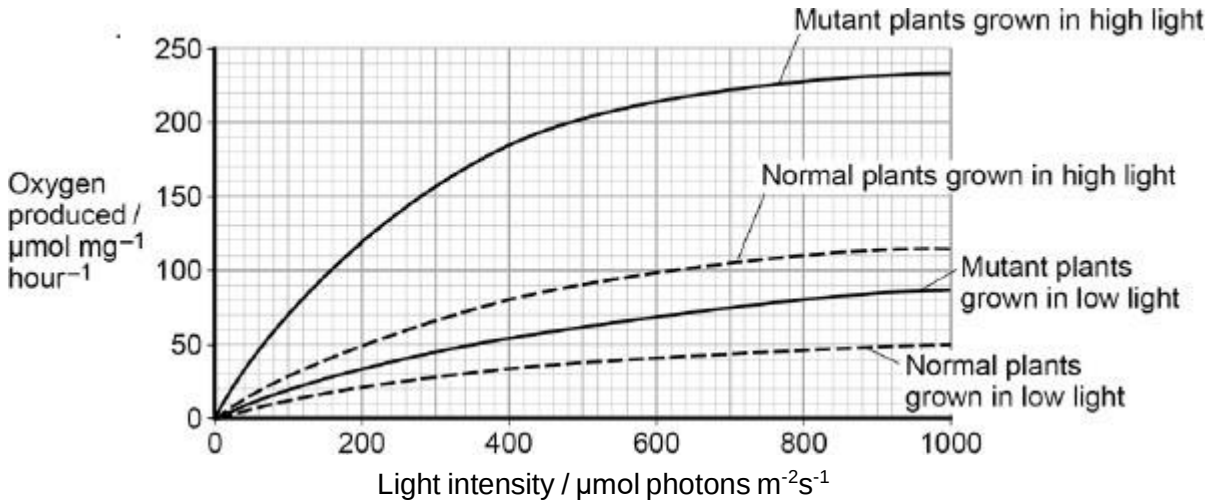
Topic: Photosynthesis Pack

1 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.

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(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 µmol photons m^{-2} s^{-1}.Show your working.

Difference _____ µmol O_2 mg^{-1} $hour^{-1}$

(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.

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(Extra space) _____

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(4)

(Total 8 marks)

2 (a) Where precisely in a cell does the Calvin cycle take place?

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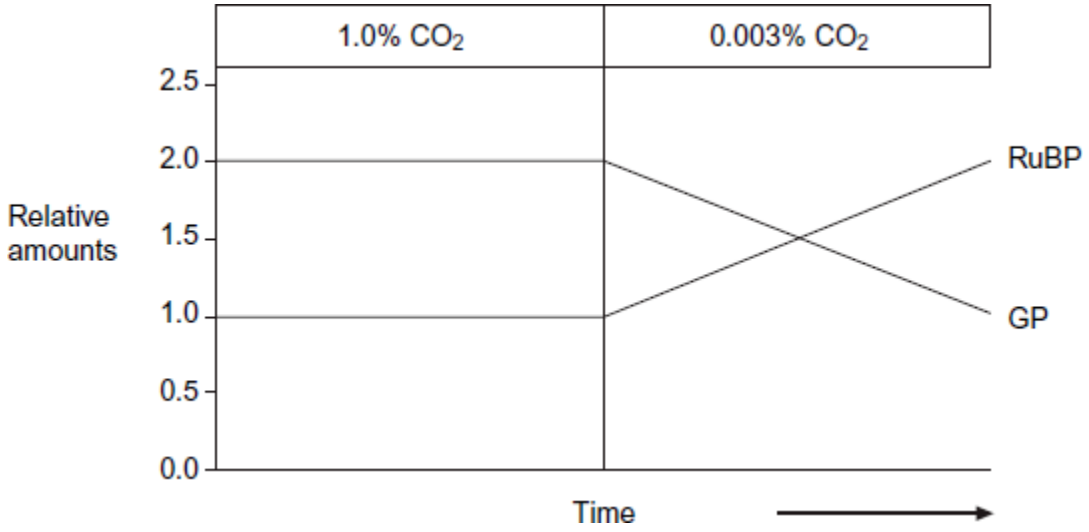
(1)

(b) A scientist investigated the effect of changing the carbon dioxide concentration on the amounts of glycerate-3-phosphate (GP) and ribulose bisphosphate (RuBP) in photosynthesising cells.

The graph shows the results obtained when the carbon dioxide concentration was reduced.



(i) Explain the decrease in the amount of GP after the carbon dioxide concentration was reduced.

_____

_____

(1)

(ii) The scientist carried out a similar experiment but increased the carbon dioxide concentration from 1% to 2%. The relative amounts of GP and RuBP remained the same.

Suggest **two** reasons why.

1. _____

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2. _____

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(2)

(c) Some bacteria use hydrogen sulfide, H_2S, to produce organic compounds.
The hydrogen sulfide has a similar role to that of water in photosynthesis.

A simple equation for this process in bacteria is shown below:

hydrogen sulfide + carbon dioxide ⟶ glucose + sulfur + water

Suggest what the hydrogen sulfide is used for in these bacteria.

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(2)

(Total 6 marks)

3 (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)

4 Scientists studied the rate of carbon dioxide uptake by grape plant leaves. Grape leaves have stomata on the lower surface but no stomata on the upper surface.

The scientists recorded the carbon dioxide uptake by grape leaves with three different treatments:

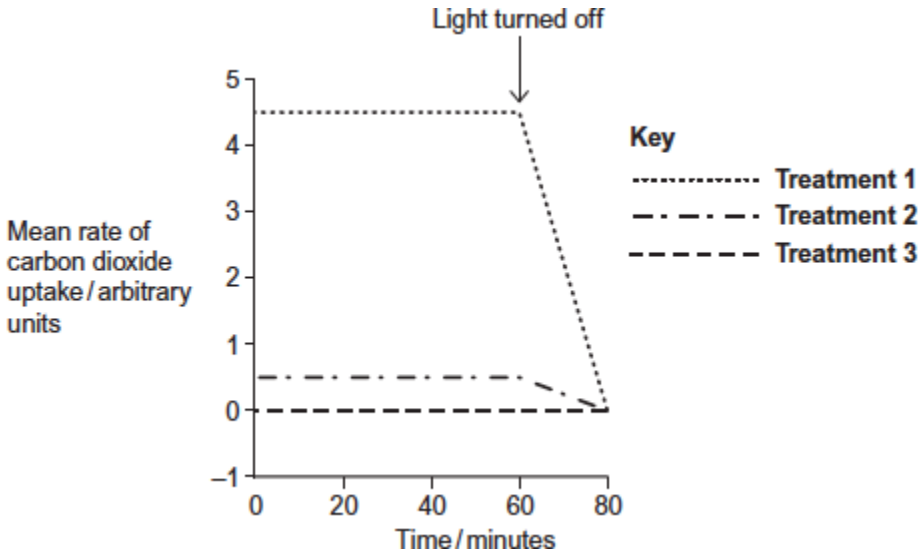
Treatment 1 − No air-sealing grease was applied to either surface of the leaf.

Treatment 2 − The lower surface of the leaf was covered in air-sealing grease that prevents gas exchange.

Treatment 3 − Both the lower surface and the upper surface of the leaf were covered in air–sealing grease that prevents gas exchange.

The scientists measured the rate of carbon dioxide uptake by each leaf for 60 minutes in light and then for 20 minutes in the dark.

The scientists' results are shown in the diagram below.



(a) Suggest the purpose of each of the three leaf treatments.

Treatment 1

Treatment 2

Treatment 3

(3)

(b) (i) Describe the results shown for **Treatment 1**.

(2)

(ii) The stomata close when the light is turned off.

Explain the advantage of this to the plant.

(2)

(c) (i) **Treatment 2** shows that even when the lower surface of the leaf is sealed there is still some uptake of carbon dioxide.

Suggest how this uptake of carbon dioxide continues.

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(1)

(ii) In both **Treatment 1** and **Treatment 2**, the uptake of carbon dioxide falls to zero when the light is turned off.

Explain why.

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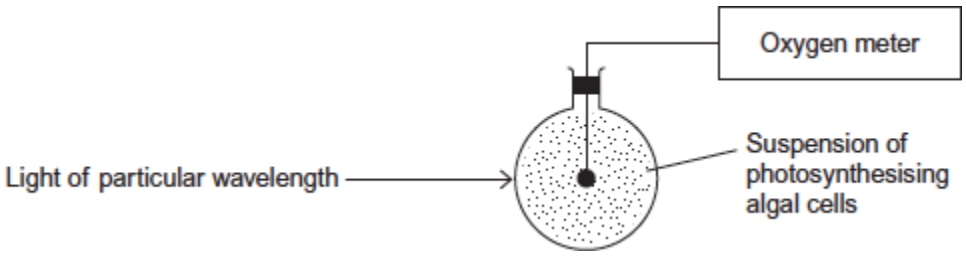
(2)

(Total 10 marks)

5 A student investigated the effect of different wavelengths of light on the rate of photosynthesis. She used the apparatus shown in **Figure 1**.

Figure 1



(a) What measurements should the student have taken to determine the rate of photosynthesis?

_____

_____

(1)

(b) Other than temperature and pH, give **two** factors which should be kept constant during this investigation.

1. _____

2. _____

(2)

(c) The student did **not** use a buffer to maintain the pH of the solution.
Explain what would happen to the pH of the solution during this investigation.

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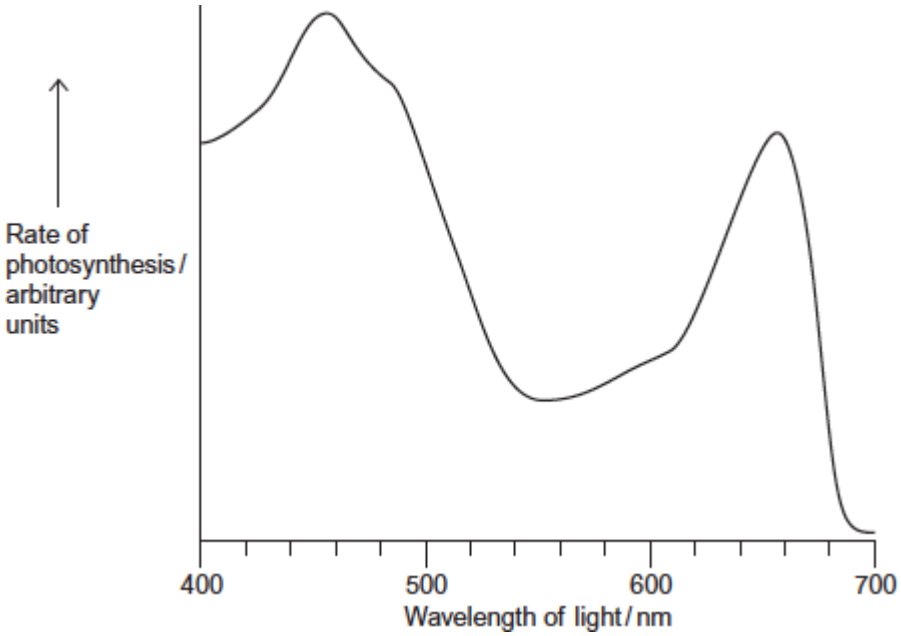
(2)

(d) **Figure 2** shows the student's results.

Figure 2



Suggest and explain why the rate of photosynthesis was low between 525 nm and 575 nm wavelengths of light.

[Extra space]

(2)

(Total 7 marks)

6 (a) On islands in the Caribbean, there are almost 150 species of lizards belonging to the genus *Anolis*. Scientists believe that these species evolved from two species found on mainland USA. Explain how the Caribbean species could have evolved.

(6)

(b) *Anolis sagrei* is a species of lizard that is found on some of the smallest Caribbean islands. Describe how you could use the mark-release-recapture method to estimate the number of *Anolis sagrei* on one of these islands.

(4)

(c) Large areas of tropical forest are still found on some Caribbean islands. The concentration of carbon dioxide in the air of these forests changes over a period of 24 hours and at different heights above ground.

Use your knowledge of photosynthesis and respiration to describe and explain how the concentration of carbon dioxide in the air changes:

- over a period of 24 hours
- at different heights above ground.

(5)

(Total 15 marks)

7 Farmland previously used for growing crops was left for 30 years and developed into woodland. During this period, ecologists recorded an increase in the diversity of birds in the area.

(a) Name the process that resulted in the development of woodland from farmland.

(1)

(b) Explain the increase in the diversity of birds as the woodland developed.

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(Extra space) _____

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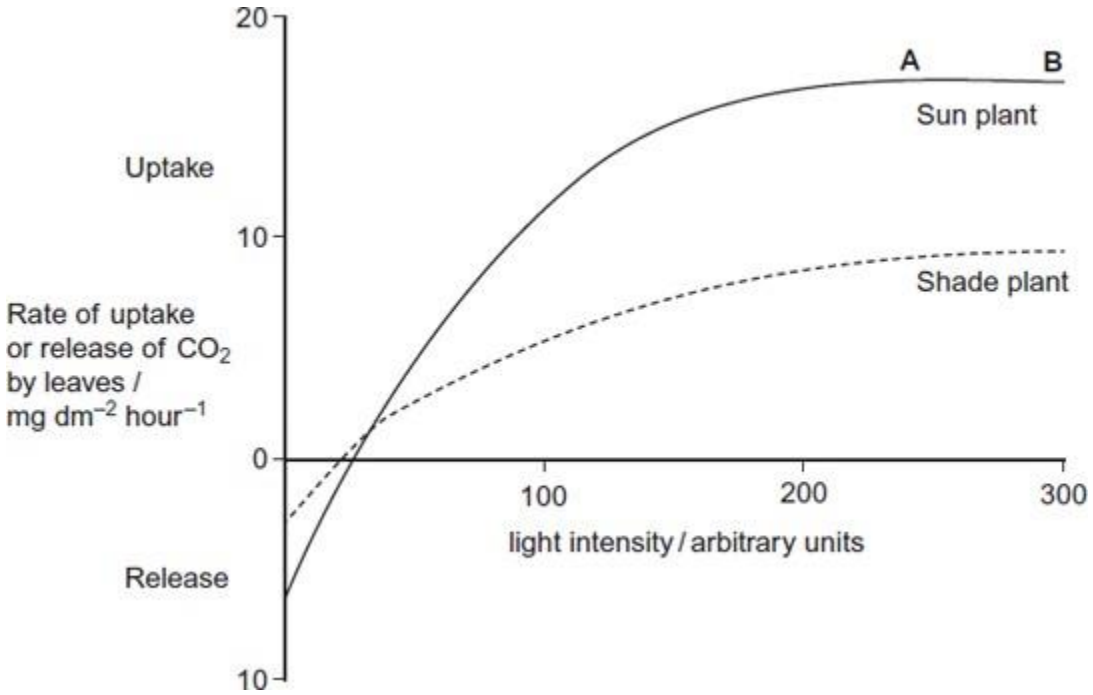
(3)

(c) The ecologists also investigated photosynthesis in two species of plant found in the woodland. One of the species was adapted to growing in bright sunlight (sun plant) and the other was adapted to growing in the shade (shade plant). The ecologists' results are shown in the figure below.



(i) Give **two** factors which could be limiting the rate of photosynthesis in the sun plant between points **A** and **B** on the figure.

1. _____

2. _____

(1)

(ii) Explain why CO_2 uptake is a measure of net productivity.

_____

_____

(Extra space) _____

_____

(1)

(iii) Use the information in the figure to explain how the shade plant is better adapted than the sun plant to growing at low light intensities.

_____

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(Extra space) _____

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(2)

(Total 8 marks)

8 During the light-independent reaction of photosynthesis, carbon dioxide is converted into organic substances. Describe how.

(Extra space)

(Total 6 marks)

9 Scientists measured the rate of respiration in **three** parts of an ecosystem.

They did this by measuring carbon dioxide released into the air by:

- leaves of plants
- stems and roots of plants
- non-photosynthetic soil organisms.

The table below shows the scientists' results for these three parts of the ecosystem.

Part of ecosystem	**Mean rate of carbon dioxide production / $cm^3\ m^{-2}\ s^{-1}$**	**Percentage of total carbon dioxide production measured by the scientists**
Leaves of plants	0.032	25.0
Stems and roots of plants	0.051	
Non-photosynthetic soil organisms	0.045	

(a) Complete the table to show the percentage of total carbon dioxide production by each part of the ecosystem.

Show your working.

(2)

(b) A student who looked at the data in the table concluded that plants carry out more respiration than non-photosynthetic organisms in the ecosystem.

Use the information provided to suggest why these data may **not** support the student's conclusion.

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(2)

(c) What measurements would the scientists have made in order to calculate the rate of carbon dioxide production?

_____

_____

_____

_____

(2)

(d) The scientists calculated the mean rate of carbon dioxide production of the leaves using measurements of carbon dioxide release in the dark.

Explain why they did **not** use measurements taken in the light.

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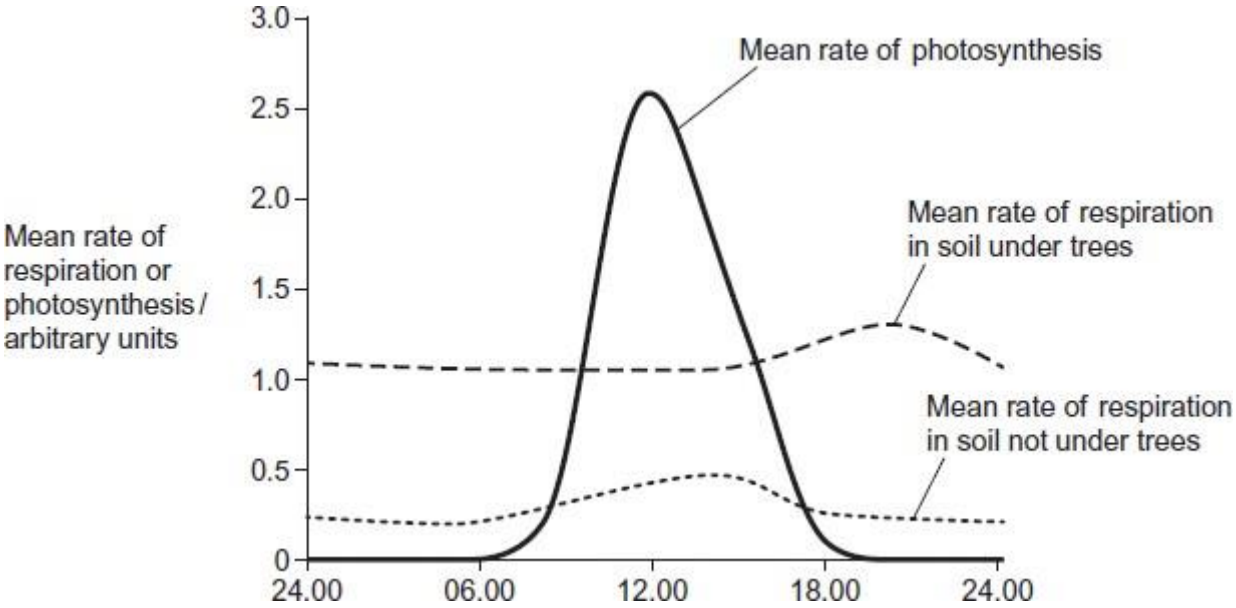
(2)

Another group of scientists measured the mean rate of respiration in soil under trees and soil not under trees in the same wood. They also measured the mean rate of photosynthesis in the trees.

They took measurements at different times of day during the summer.

The figure below shows the scientists' results.



(e) (i) Describe **two** ways in which the mean rate of respiration in soil under trees is different from soil not under trees.

1. _____

_____

2. _____

_____

(2)

(ii) Suggest **one** explanation for the differences in the mean rate of respiration in soil under trees and soil not under trees between 06.00 and 12.00.

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(2)

(f) The scientists suggested that the rise in the mean rate of photosynthesis was the cause of the rise in the mean rate of respiration in soil under trees.

(i) Suggest how the rise in the mean rate of photosynthesis could lead to the rise in the mean rate of respiration in soil under trees.

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_____

_____

(2)

(ii) Suggest why there is a delay between the rise in the mean rate of photosynthesis and the rise in the mean rate of respiration.

_____

_____

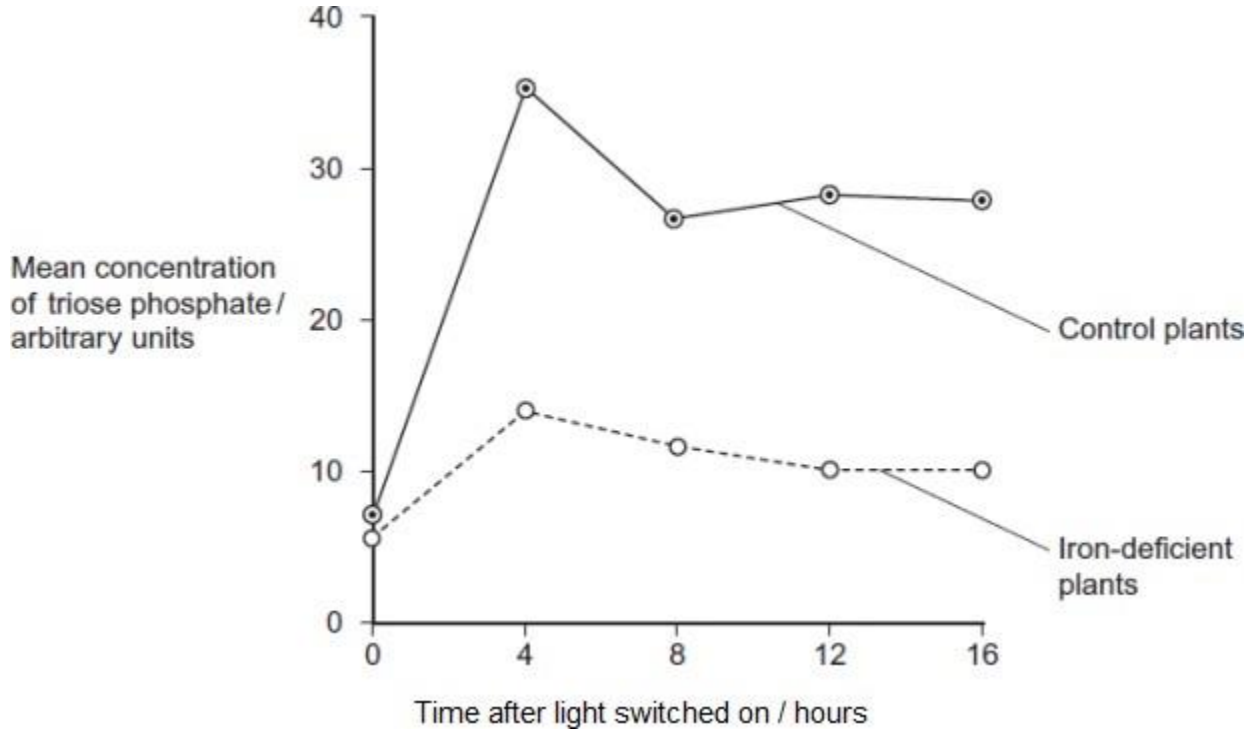
(1)

(Total 15 marks)

10 Scientists investigated the effect of iron deficiency on the production of triose phosphate in sugar beet plants. They grew the plants under the same conditions with their roots in a liquid growth medium containing all the necessary nutrients. Ten days before the experiments, they transferred half the plants to a liquid growth medium containing no iron. The scientists measured the concentration of triose phosphate produced in these plants and in the control plants:

- at the end of 6 hours in the dark
- then for 16 hours in the light.

Their results are shown in the graph.



(a) (i) The experiments were carried out at a high carbon dioxide concentration. Explain why.

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_____

_____

(1)

(ii) Explain why it was important to grow the plants under the same conditions up to ten days before the experiment.

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(1)

(iii) The plants were left in the dark for 6 hours before the experiment. Explain why.

(1)

(b) Iron deficiency reduces electron transport. Use this information and your knowledge of photosynthesis to explain the decrease in production of triose phosphate in the iron-deficient plants.

(Extra space)

(4)

(c) Iron deficiency results in a decrease in the uptake of carbon dioxide. Explain why.

(2)

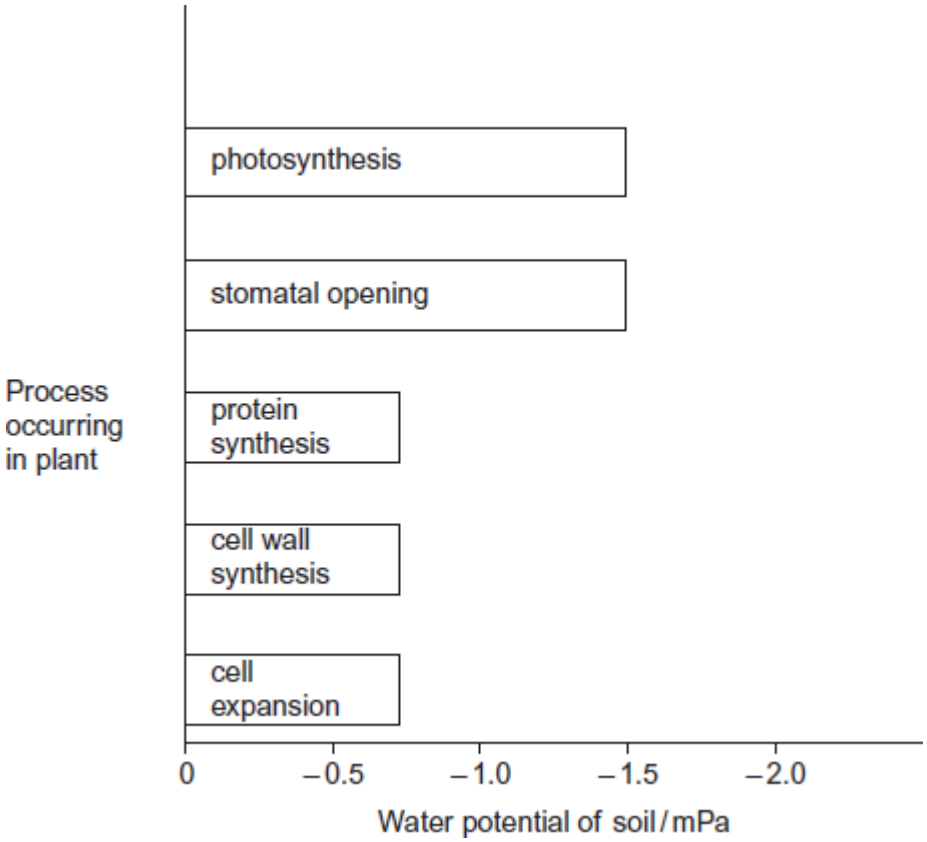
(Total 9 marks)

11 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 up 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.

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_____

_____

(3)

(Total 7 marks)

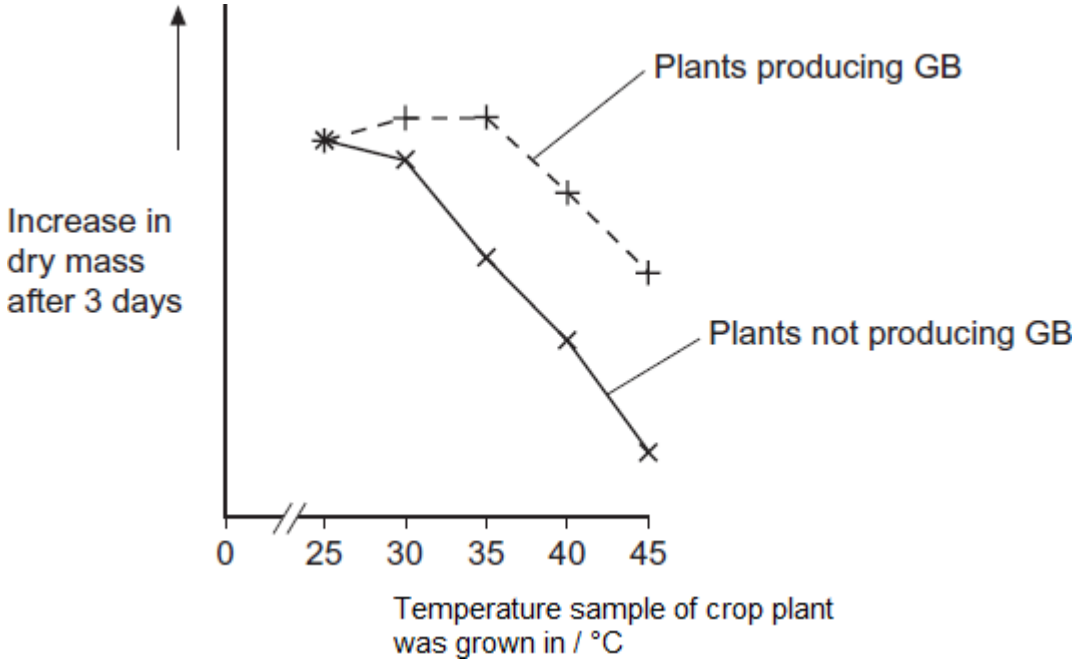
12 Some species of crop plant produce a substance called glycinebetaine (GB).

Scientists transferred the gene for GB into a species of crop plant that does not normally produce GB. These genetically modified plants then produced GB.

The scientists grew large numbers of the same crop plant with and without the gene at different temperatures. After 3 days, they found the increase in dry mass of the plants.

Figure 1 shows their results.

Figure 1



(a) Describe the effect on growth of transferring the gene for GB into this plant.

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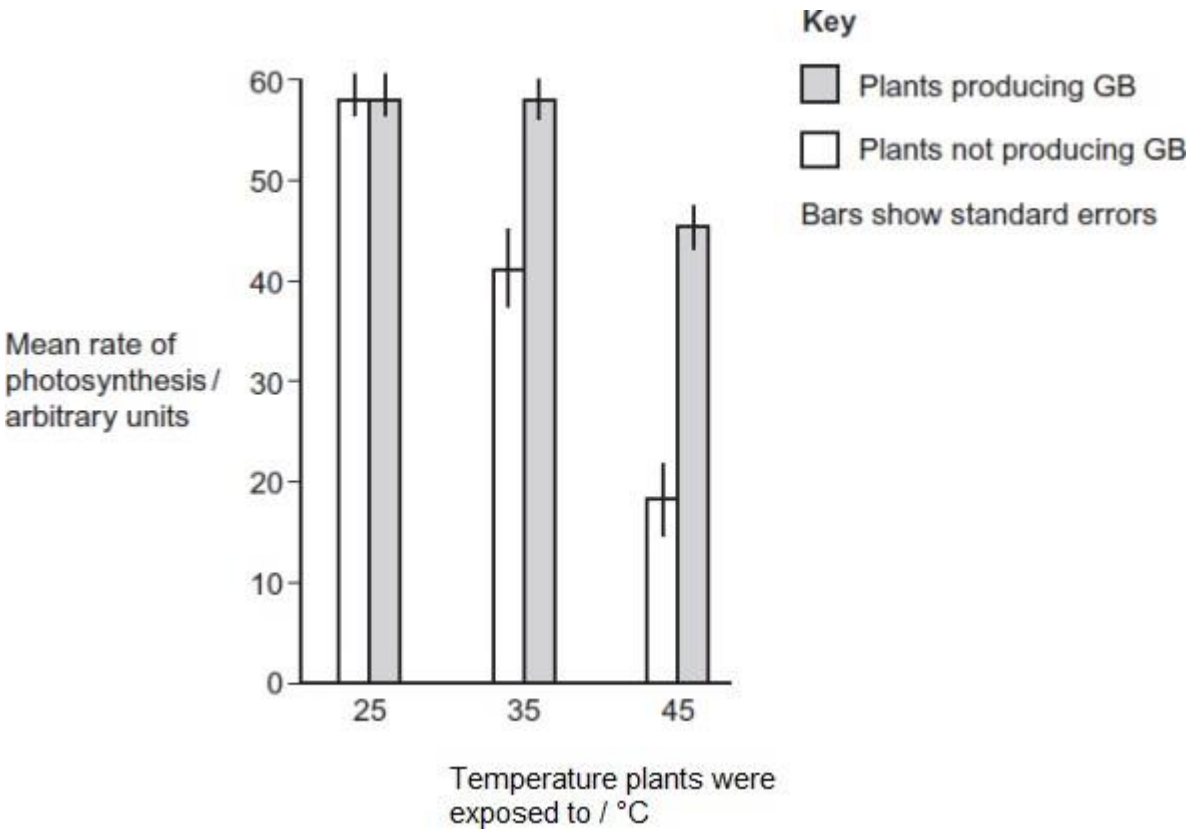
(2)

(b) The scientists measured the rate of photosynthesis in plants that produce GB and plants that do not produce GB at 25°C, 35°C and 45°C.

Figure 2 shows their results.

Figure 2



(i) The scientists concluded that the production of GB protects photosynthesis from damage by high temperatures.

Use these data to support this conclusion.

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_____

(1)

(ii) Use the data from **Figure 2** for plants that do not produce GB to explain the effect of temperature on changes in dry mass of the plants shown in **Figure 1.**

(Extra space)

(4)

Rubisco activase is an enzyme found in chloroplasts. It activates the light-independent reaction of photosynthesis.

The scientists discovered that, as temperature increased from 25°C to 45°C, rubisco activase began attaching to thylakoid membranes in chloroplasts and this stopped it working.

(c) Rubisco activase stops working when it attaches to a thylakoid.

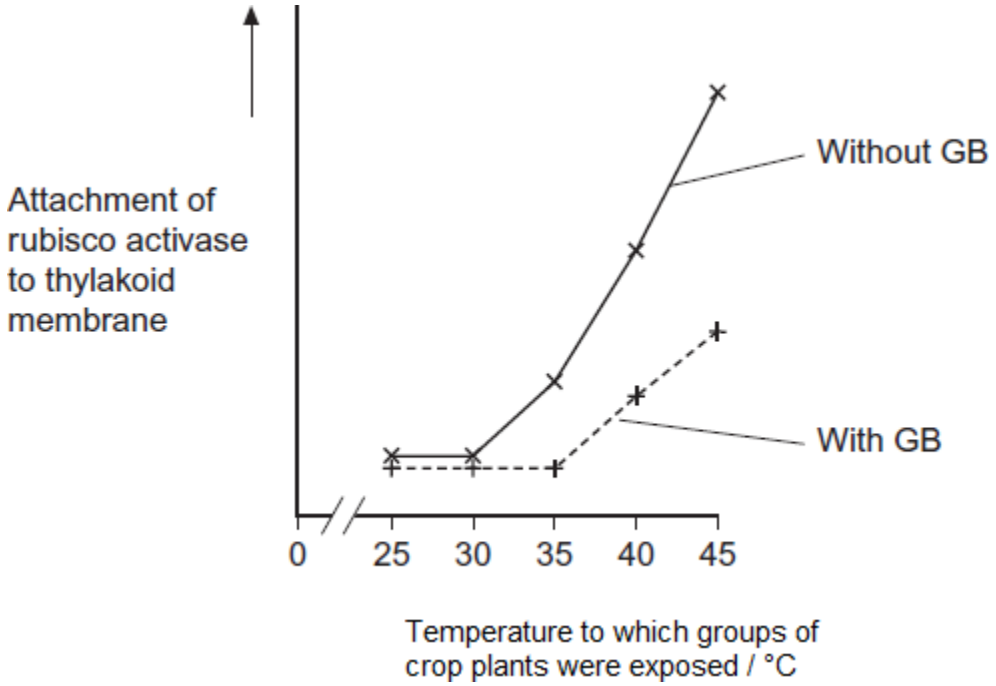
Use your knowledge of protein structure to explain why.

(2)

(d) The scientists investigated the effect of GB on attachment of rubisco activase to thylakoid membranes at different temperatures.

Figure 3 shows their results.

Figure 3



Use information from **Figure 2** and **Figure 3** to suggest how GB protects the crop plant from high temperatures.

(Extra space)

(4)

(e) The scientists' hypothesis at the start of the investigation was that crop plants genetically engineered to produce GB would become more resistant to high environmental temperatures.
The scientists developed this hypothesis on the basis of previous research on crops that are grown in hot climates.

Suggest how the scientists arrived at their hypothesis.

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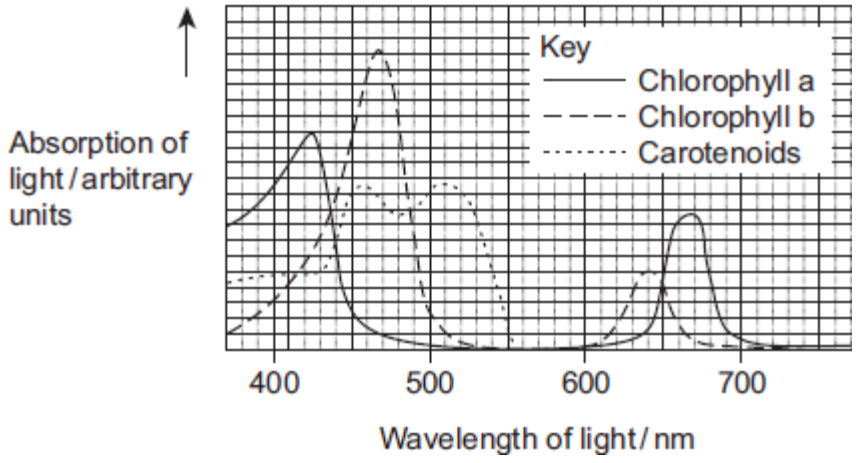
(2)

(Total 15 marks)

13 Plants have pigments that absorb light energy for photosynthesis. These pigments include two types of chlorophyll and a group of pigments known as carotenoids. Different species of plant contain different amounts of these pigments. The pigments that each plant species has are adaptations to where and how they live; their ecological niche.

Figure 1 shows the absorption of light of different wavelengths by chlorophyll a, chlorophyll b and carotenoids.

Figure 1

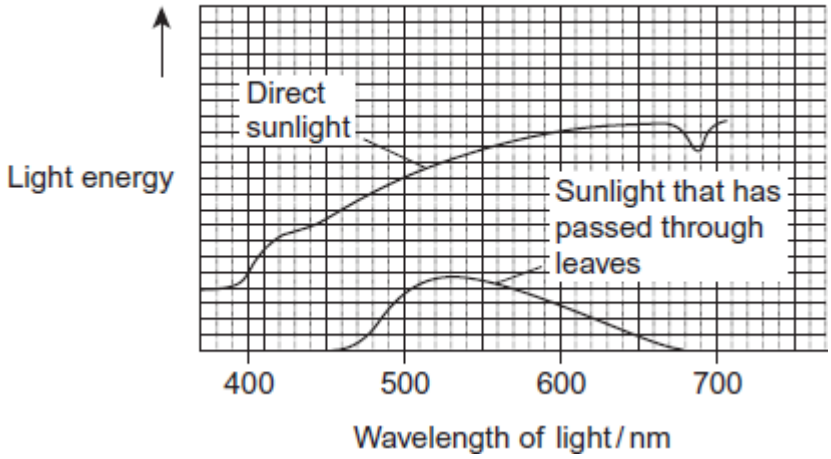


A scientist investigated the energy in light of different wavelengths reaching the ground in a forest. She measured the energy in

- direct sunlight
- sunlight that had passed through the leaves of trees.

Figure 2 shows her results.

Figure 2



(a) Use **Figure 1** to describe the absorption of light of different wavelengths by chlorophyll a.

(2)

(b) Few species of plant can live below large trees in a forest.
Use the information in **Figure 1** and **Figure 2** to suggest why.

(Extra space)

(3)

(c) In leaves at the top of trees in a forest, carbon dioxide is often the limiting factor for photosynthesis.
Use your knowledge of photosynthesis to suggest and explain **one** reason why.

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(2)

(Total 7 marks)

14 Beech trees have two types of leaves called sun leaves and shade leaves. Sun leaves grow on branches exposed to direct sunlight, shade leaves grow on branches exposed to light that has passed through leaves. An ecologist collected sun leaves and shade leaves from beech trees and determined the mean mass of each photosynthetic pigment in both types of leaf. His results are shown the table below.

Photosynthetic pigment	**Mean mass of each pigment per m^2 of leaf area / µg (± standard deviation)**	
	Sun leaves	**Shade leaves**
Chlorophyll a	299.3 (± 2.1)	288.9 (± 0.1)
Chlorophyll b	290.7 (± 2.1)	111.1 (± 0.1)
Chlorophyll c	0.10 (± 0.01)	0.07 (± 0.01)

(a) Describe how you would present the data in the table as a graph.

_____

_____

_____

_____

_____

(2)

(b) The ecologist collected shade leaves at random from a branch.
Suggest a method he could have used to collect shade leaves at random from a branch.

_____

_____

_____

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(2)

(c) The ecologist concluded that there is a significant difference between the amounts of chlorophyll b in sun leaves and shade leaves of beech trees.

Do you agree with this conclusion?

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(2)

(d) Each type of chlorophyll is produced by a specific enzyme-controlled pathway.
Use this information to suggest how the same beech tree can produce more chlorophyll b in some leaf cells than others.

_____

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_____

_____

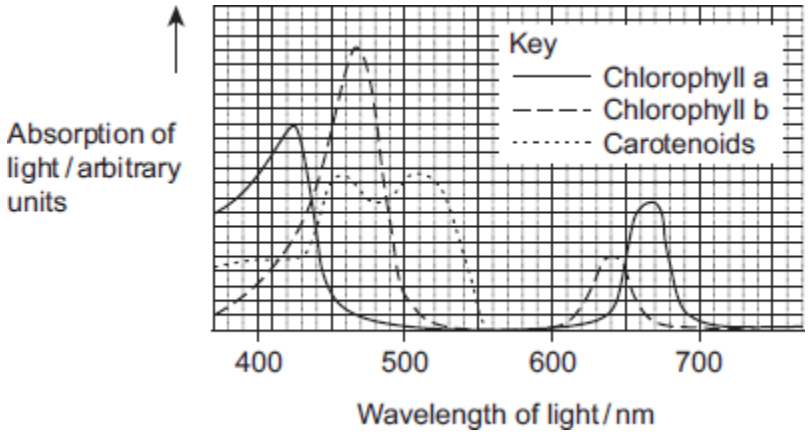
(2)

(Total 8 marks)

15 Plants have pigments that absorb light energy for photosynthesis. These pigments include two types of chlorophyll and a group of pigments known as carotenoids. Different species of plant contain different amounts of these pigments. The pigments that each plant species has are adaptations to where and how they live; their ecological niche.

Figure 1 shows the absorption of light of different wavelengths by chlorophyll a, chlorophyll b and carotenoids.

Figure 1

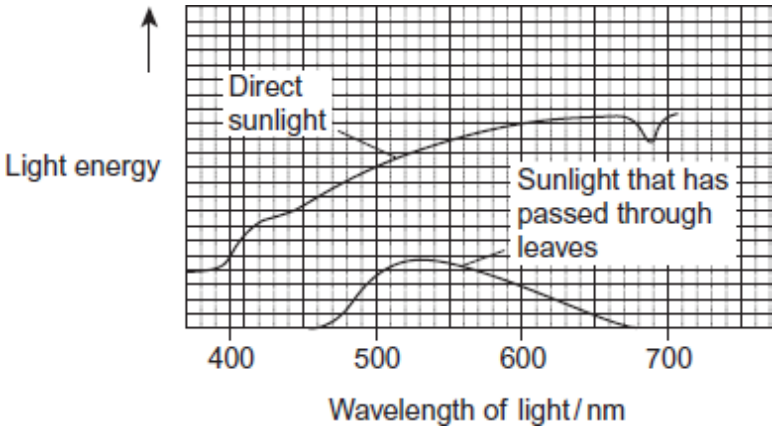


A scientist investigated the energy in light of different wavelengths reaching the ground in a forest. She measured the energy in

- direct sunlight
- sunlight that had passed through the leaves of trees.

Figure 2 shows her results.

Figure 2



Beech trees have two types of leaves called sun leaves and shade leaves. Sun leaves grow on branches exposed to direct sunlight, shade leaves grow on branches exposed to light that has passed through leaves. An ecologist collected sun leaves and shade leaves from beech trees and determined the mean mass of each photosynthetic pigment in both types of leaf. His results are shown in **Figure 3**.

Figure 3

Photosynthetic pigment	Mean mass of each pigment per m^2 of leaf area / µg (± standard deviation)	
	Sun leaves	Shade leaves
Chlorophyll a	299.3 (± 2.1)	288.9 (± 0.1)
Chlorophyll b	90.7 (± 2.1)	111.1 (± 0.1)
Carotenoids	0.10 (± 0.01)	0.07 (± 0.01)

(a) It is an advantage to beech trees to produce more chlorophyll b in the shade leaves.

Suggest and explain why.

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_____

_____

_____

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(2)

(b) There are two hypotheses about the advantage to plants of producing carotenoids.

Hypothesis 1

Carotenoids help shade leaves to absorb more light of wavelengths 480 nm to 520nm for photosynthesis.

Hypothesis 2

Carotenoids prevent damage to chlorophyll from very bright light.

(i) Which hypothesis do the data provided on the resource sheet support?

Explain your answer.

Hypothesis _____

Explanation _____

_____

_____

_____

(2)

(ii) Suggest **one** other piece of experimental evidence you would need in order to be more confident about drawing your conclusion in (b)(i).

_____

_____

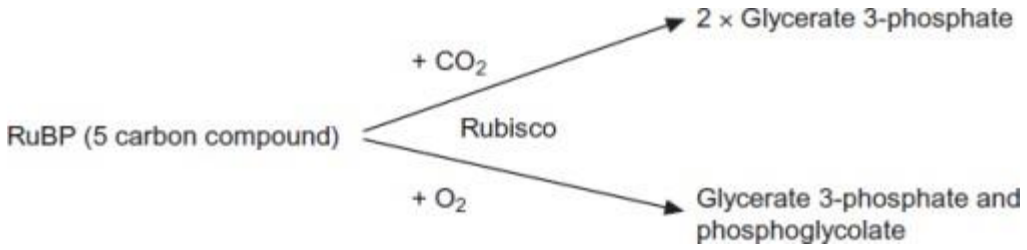
_____

(1)

(Total 5 marks)

16 During photosynthesis, carbon dioxide reacts with ribulose bisphosphate (RuBP) to form two molecules of glycerate 3-phosphate (GP). This reaction is catalysed by the enzyme Rubisco. Rubisco can also catalyse a reaction between RuBP and oxygen to form one molecule of GP and one molecule of phosphoglycolate. Both the reactions catalysed by Rubisco are shown in **Figure 1**.

Figure 1



(a) (i) Where exactly in a cell is the enzyme Rubisco found?

_____

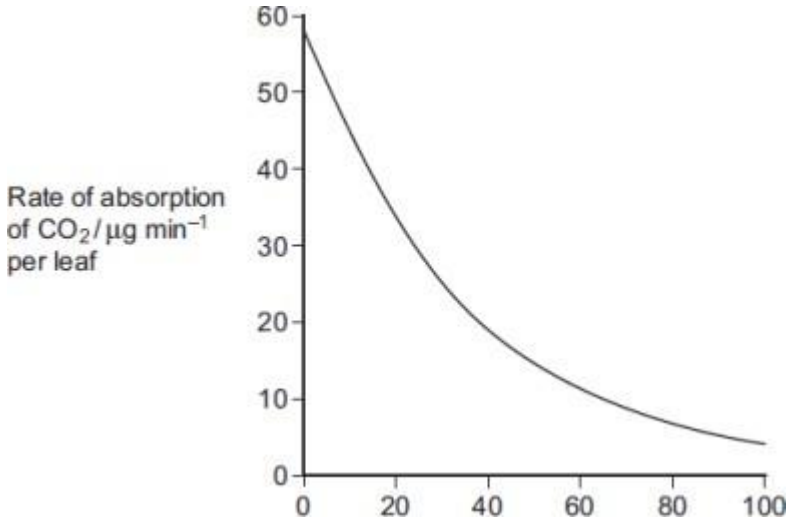
(1)

(ii) Use the information provided to give the number of carbon atoms in **one** molecule of phosphoglycolate.

(1)

(b) Scientists investigated the effect of different concentrations of oxygen on the rate of absorption of carbon dioxide by leaves of soya bean plants. Their results are shown in **Figure 2**.

Figure 2



Use **Figure 1** to explain the results obtained in **Figure 2**.

(2)

(c) Use the information provided and your knowledge of the light-independent reaction to explain why the yield from soya bean plants is decreased at higher concentrations of oxygen. Phosphoglycolate is not used in the light-independent reaction.

(Extra space)

(3)

(Total 7 marks)

17 (a) Energy enters most ecosystems through the light-dependent reaction of photosynthesis. Describe what happens during the light-dependent reaction.

(5)

(b) Changes in ecosystems can lead to speciation. A high concentration of copper in soil is toxic to most plants. In some areas where the soil is polluted with copper, populations of grasses are found to be growing. These populations of grass belong to a species also found growing on unpolluted soils.

It has been suggested that a new species of grass may evolve on soil that has been polluted with copper. Explain how this new species might evolve.

(5)

(Total 10 marks)

18 A scientist investigated the uptake of radioactively labelled carbon dioxide in chloroplasts. She used three tubes, each containing different components of chloroplasts. She measured the uptake of carbon dioxide in each of these tubes.
Her results are shown in the table.

Tube	Contents of tube	Uptake of radioactively labelled CO_2 / counts per minute
A	Stroma and grana	96 000
B	Stroma, ATP and reduced NADP	97 000
C	Stroma	4 000

(a) Name the substance which combines with carbon dioxide in a chloroplast.

_____

(1)

(b) Explain why the results in tube **B** are similar to those in tube **A**.

_____

_____

_____

(1)

(c) Use the information in the table to predict the uptake of radioactively labelled carbon dioxide if tube **A** was placed in the dark. Explain your answer.

_____

_____

_____

_____

_____

(2)

(d) Use your knowledge of the light-independent reaction to explain why the uptake of carbon dioxide in tube **C** was less than the uptake in tube **B**.

_____

_____

_____

_____

_____

(2)

(e) DCMU is used as a weed killer. It inhibits electron transfer during photosynthesis. The addition of DCMU to tube **A** decreased the uptake of carbon dioxide. Explain why.

_____

_____

_____

_____

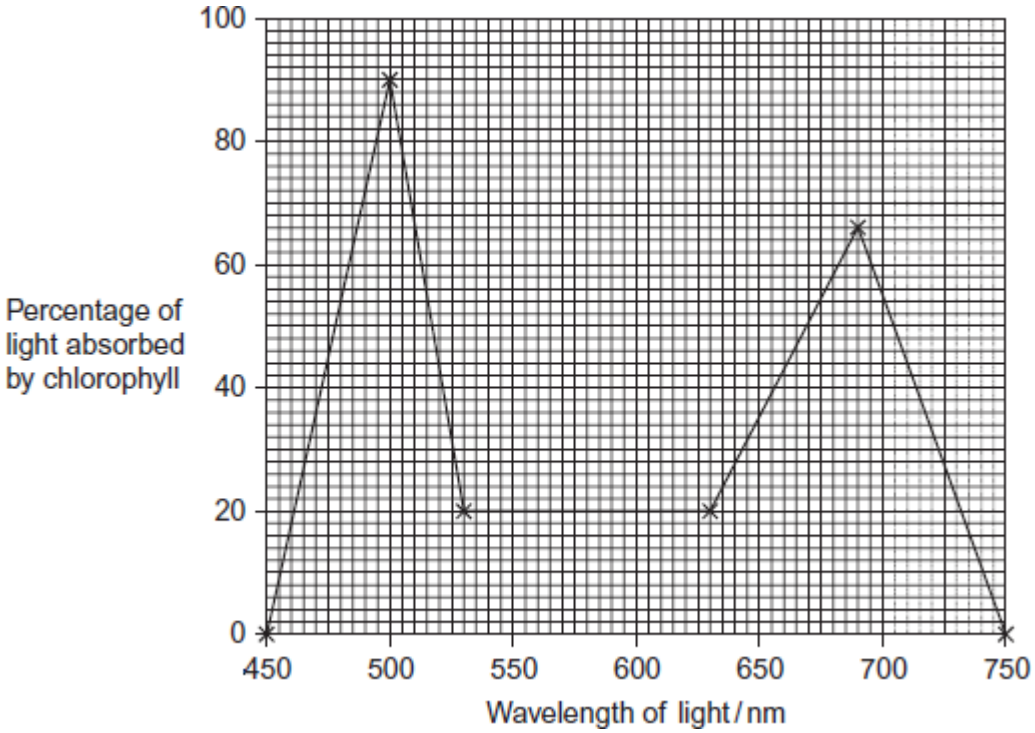
_____

(2)

(Total 8 marks)

19 **Figure 1** shows the effect of wavelength on the percentage of light absorbed by the chlorophyll from these seaweeds.

Figure 1



Some scientists investigated the growth of these seaweeds in artificial conditions.
They investigated the effect of different lamps on the rate of photosynthesis of the seaweeds.

- Lamp **P** produced light containing all wavelengths of visible light. (450 to 750 nm)
- Lamp **Q** only produced light of wavelength 460 nm.

The scientists measured photosynthesis by recording the rate of oxygen production. Their results are shown in **Figure 2**.

Figure 2

	Mean rate of photosynthesis / arbitrary units (± standard deviation)	
Species	Lamp **P** Light of all wavelengths of visible light	Lamp **Q** Light of wavelength 460nm
Ulva pertusa	1300.9 (± 125.4)	776.6 (± 105.6)
Mastocarpus yendoi	318.9 (± 69.5)	299.6 (± 83.2)

(a) Between 500 and 700 nm, what range of wavelengths of light is absorbed least by chlorophyll?

(1)

(b) The scientists measured the oxygen produced by the light-dependent reaction of photosynthesis. Name **two** other substances produced by the light-dependent reaction.

1. _____

2. _____

(2)

(c) (i) The scientists measured the rate of photosynthesis of the seaweeds in this investigation in terms of oxygen produced.
Suggest the units they should use.

_____

(2)

(ii) This investigation was carried out in bright light. Explain why reducing the light intensity would affect the amount of oxygen released by the seaweeds.

_____

_____

_____

_____

_____

_____

(Extra space)_____

_____

_____

(3)

(d) In this investigation, the scientists kept the temperature at 15 °C. A student suggested that repeating the investigation at 20 °C would not affect the amount of oxygen released by the seaweed. Evaluate this suggestion.

(Extra space)

(3)

(e) (i) Did the type of lamp used affect the rate of photosynthesis in *M. yendoi*? Explain the evidence for your answer.

(2)

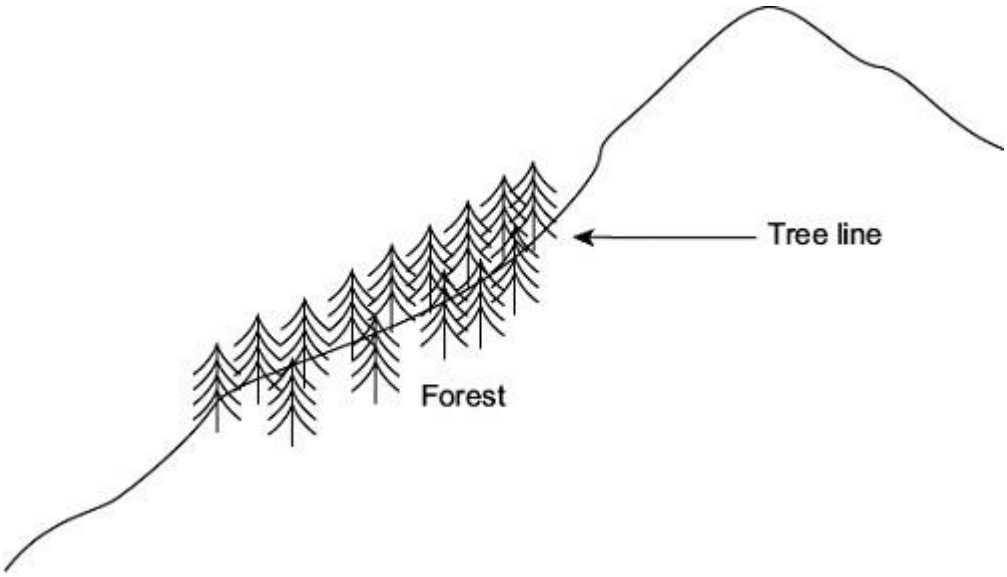
(ii) The different lamps resulted in different rates of photosynthesis by *U. pertusa*. Explain why there was a higher rate of photosynthesis when the seaweed was illuminated with lamp **P**.

(Extra space)

(3)

(Total 16 marks)

20 Mountains are harsh environments. The higher up the mountain, the lower the temperature becomes. The diagram shows a forest growing on the side of a mountain.
The upper boundary of the forest is called the tree line. Trees do not grow above the tree line.



(a) (i) The position of the tree line is determined by abiotic factors.
What is meant by an abiotic factor?

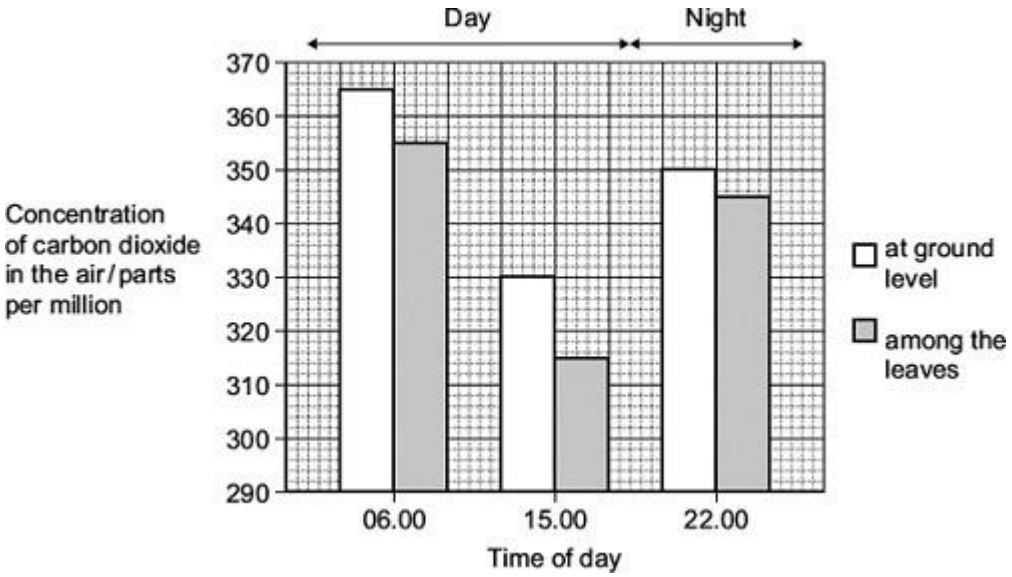
(1)

(ii) Other than temperature, suggest **one** abiotic factor that is likely to affect the position of the tree line on the mountain.

_____

(1)

(b) Scientists measured the concentration of carbon dioxide in the air in one part of the forest. They took measurements at different times of day and at two different heights above the ground. Their results are shown in the bar chart.



Use your knowledge of photosynthesis and respiration to explain the data in the bar chart.

_____

_____

_____

_____

_____

_____

_____

_____

*(Extra space)*_____

_____

_____

_____

(4)

(c) The population of trees in the forest evolved adaptations to the mountain environment. Use your knowledge of selection to explain how.

(Extra space)

(3)

(Total 9 marks)

21 (a) ATP is useful in many biological processes. Explain why.

(Extra space)

(4)

(b) Describe how ATP is made in mitochondria.

(Extra space)

(6)

(c) Plants produce ATP in their chloroplasts during photosynthesis. They also produce ATP during respiration. Explain why it is important for plants to produce ATP during respiration in addition to during photosynthesis.

(Extra space)

(5)

(Total 15 marks)

22 (a) The table contains statements about three biological processes.

Complete the table with a tick if the statement in the first column is true, for each process.

	Photosynthesis	**Anaerobic respiration**	**Aerobic respiration**
ATP produced			
Occurs in organelles			
Electron transport chain involved			

(3)

(b) Write a simple equation to show how ATP is synthesised from ADP.

_____

(1)

(c) Give **two** ways in which the properties of ATP make it a suitable source of energy in biological processes.

1. _____

_____

2. _____

_____

(2)

(d) Humans synthesise more than their body mass of ATP each day. Explain why it is necessary for them to synthesise such a large amount of ATP.

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

23 Much of Indonesia is covered with forest. Large areas of forest have been cleared and planted with oil-palm trees to be used in the production of fuel.

(a) In these forests, nitrogen in dead leaves is made available to growing plants by the action of bacteria. Describe the role of bacteria in making the nitrogen in dead leaves available to growing plants.

(Extra space)

(5)

(b) During photosynthesis, oil-palm trees convert carbon dioxide into organic substances. Describe how.

(Extra space)

(6)

(Total 11 marks)

Mark schemes

1

(a) 1. Oxygen produced in light-dependent reaction;
2. The faster (oxygen) is produced, the faster the light-dependent reaction.

(b) 35–36 µmol Oxygen per mg chlorophyll.

Correct difference at 500 µmol photons m^{-2} s^{-1} or incorrect difference but division by 4 shown = 1 mark.

(c) At all light intensities, chloroplasts from mutant plants:
1. Have faster production of ATP and reduced NADP;
2. (So) have faster / more light-independent reaction;
3. (So) produce more sugars that can be used in respiration;
4. (So) have more energy for growth;
5. Have faster / more synthesis of new organic materials.

Accept converse points if clear answer relates to non-mutant plants

2

(a) Stroma (of chloroplasts);

Reject: stoma.

Reject: stroma of chlorophyll or any reference to chlorophyll.

Accept: stroma of chloroplasts.

1

(b) (i) (Less) RuBP combines with carbon dioxide;

Accept: binds/joins.

1

(ii) 1. Temperature is a limiting factor/below optimum;
2. Light is a limiting factor/below optimum;

Accept: limited by reduced NADP or ATP.

3. Limited by RuBP (available/produced);

Accept: RuBP will always give 2 GP (at high CO_2).

4. Limited by enzyme;

Accept: limited by Rubisco.

2 max

(c) 1. (Provides) hydrogen / protons/H^+ **and** electrons/e^-;

Ignore: if water is used as source of hydrogen.

2. For reduction;

Reject: reduction of NAD.

Reject: reduction by H^+ or protons on their own.

3. Source of electrons for chlorophyll/electron transfer chain;

Accept: electrons for photophosphorylation.

Ignore: photosystems.

2 max

[6]

2

2

4 max

[8]

3

(a) 1. Excites electrons / electrons removed (from chlorophyll);

Accept: higher energy level as 'excites'.

2. Electrons move along carriers/electron transfer chain releasing energy;

Accept: movement of H^+/protons across membrane releases energy.

Reject: 'produces energy' for either mark but not for both.

3. Energy used to join ADP and Pi to form ATP;

Reject: 'produces energy' for either mark but not for both.

Accept: energy used for phosphorylation of ADP to ATP

Do not accept P as Pi but accept phosphate.

4. Photolysis of water produces protons, electrons and oxygen;
5. NADP reduced by electrons / electrons and protons / hydrogen;

Accept: NADP to NADPH (or equivalent) by addition of electrons/hydrogen.

Do not accept NADP reduced by protons on its own.

5

(b) 1. Protein/amino acids/DNA into ammonium compounds / ammonia;

Accept: any named nitrogen containing compound e.g. urea.

2. By saprobionts;

Accept: saprophytes.

3. Ammonium/ammonia into nitrite;
4. Nitrite into nitrate;
5. By nitrifying bacteria/microorganisms;

Reject: nitrifying bacteria in root nodules.

1, 3 and 4. Accept: marks for conversion even if incorrect type of bacteria named as being involved.

2 and 5. Reject: marks for type of bacteria if linked to incorrect process e.g. nitrite converted to nitrate by saprobionts.

3 and 4. Accept: for one mark ammonia/ammonium into nitrate if neither mark point 3 or 4 awarded.

Note: there are no marks for the role of nitrogen-fixing bacteria as the question refers to producing a source of nitrates from the remains of crops.

5

[10]

4

(a) 1. (No grease)
means stomata are open
OR
allows normal CO_2 uptake;

Allow 'gas exchange' for CO_2 uptake.

'As a control' is insufficient on its own.

2. (Grease on lower surface)
seals stomata
OR
stops CO_2 uptake through
stomata
OR
to find CO_2 uptake through
stomata
OR
shows CO_2 uptake through cuticle / upper surface;

3. (Grease on both surfaces) shows sealing is effective
OR
stops all CO_2 uptake.

3

(b) (i) 1. (Mean rate of) carbon dioxide uptake was constant *and* fell after the light turned off;

Ignore absence of arbitrary units in both marking points.

Both ideas needed for mark.

Accept 'stayed at 4.5' as equivalent to 'was constant'.

2. Uptake fell from 4.5 to 0 / uptake started to fall at 60 minutes and reached lowest at 80 minutes / uptake fell over period of 20 minutes;

One correct use of figures required.

Accept fell to nothing / no uptake for 0.

2

2

(ii) 1. (Because) water is lost through stomata;
2. (Closure) prevents / reduces water loss;
3. Maintain water content of cells.

This marking point rewards an understanding of reducing water loss e.g. reduce wilting, maintain turgor, and is not related to photosynthesis.

2 max

(c) (i) (Carbon dioxide uptake) through the upper surface of the leaf / through cuticle.

1

(ii) 1. No use of carbon dioxide in photosynthesis (in the dark);
2. No diffusion gradient (maintained) for carbon dioxide into leaf / there is now a diffusion gradient for carbon dioxide out of leaf (due to respiration).

[10]

5

(a) Oxygen production / concentration and time.

Accept: oxygen volume / concentration

Reject: oxygen uptake

Neutral: reference to carbon dioxide uptake

1

(b) 1. Intensity of light;

Accept: distance from light

2. Amount / number / mass / species of algae / photosynthesising cells;
3. Carbon dioxide (concentration / partial pressure);
4. Time.

2 max

(c) 1. (pH) increases;

Neutral: becomes more alkaline / less acidic

2. As (more) carbon dioxide removed (for photosynthesis).

2

(d) 1. Less absorption / (more) reflection (of these wavelengths of light);

Reject: no absorption or cannot absorb unless in context of green light.

Note: no green light absorbed or green light reflected = 2 marks.

2. (Light required) for light dependent (reaction) / photolysis

Accept: for excitation / removal of electrons (from chlorophyll)

3. (Represents) green light / colour of chlorophyll.

2 max

[7]

6 (a) 1. Geographic(al) isolation;

2. Separate gene pools / no interbreeding / gene flow (between populations);

Accept: reproductive isolation

This mark should only be awarded in context of during the process of speciation. Do not credit if context is after speciation has occurred.

3. Variation due to mutation;
4. Different selection pressures / different abiotic / biotic conditions / environments / habitats;

Neutral: different conditions / climates if not qualified

Accept: named abiotic / biotic conditions

5. Different(ial) reproductive success / selected organisms (survive and) reproduce;

Accept: pass on alleles / genes to next generation as equivalent to reproduce

6. Leads to change / increase in allele frequency.

Accept: increase in proportion / percentage as equivalent to frequency

6

(b) 1. Capture / collect sample, mark and release;
2. Method of marking does not harm lizard / make it more visible to predators;
3. Leave sufficient time for lizards to (randomly) distribute (on island) before collecting a second sample;
4. (Population =) number in first sample × number in second sample divided by number of marked lizards in second sample / number recaptured.

4

(c) 1. High concentration of / increase in carbon dioxide linked with respiration at night / in darkness;
2. No photosynthesis in dark / night / photosynthesis only in light / day;

Neutral: less photosynthesis

3. In light net uptake of carbon dioxide / use more carbon dioxide than produced / (rate of) photosynthesis greater than rate of respiration;
4. Decrease in carbon dioxide concentration with height;

More carbon dioxide absorbed higher up

Accept: less carbon dioxide higher up / more carbon dioxide lower down

5. (At ground level)
less photosynthesis / less photosynthesising tissue / more respiration / more micro-organisms / micro-organisms produce carbon dioxide.

Neutral: less leaves unqualified or reference to animals

5

[15]

7 (a) Succession;

Ignore any word in front of succession e.g. secondary / ecological succession.

Neutral 'forestation'.

1

(b) 1. Greater variety / diversity of plants / insects / more plant / insect species;

Neutral: more plants.

2. More food sources / more varieties of food;

Neutral: more food / more / greater food source (singular).

3. Greater variety / more habitats / niches;

Accept: more nesting sites.

Q *Neutral: more homes / shelters.*

3

(c) (i) Temperature and carbon dioxide;

Neutral: water, chlorophyll.

1

(ii) Shows (gross) photosynthesis / productivity minus respiration / more carbon dioxide used in photosynthesis than produced in respiration;

Correct answers are often shown as: net productivity = (gross) photosynthesis – (minus) respiration.

1

(iii) 1. (Shade plant) has lower (rate of) respiration / respiratory losses / less CO_2 released at 0 light intensity / in dark;

Accept use of figures.

Accept: lower compensation point.

2. Greater (net) productivity / less sugars / glucose used / more sugars / glucose available;

Neutral: any references to rate of photosynthesis.

2

[8]

8

1. Carbon dioxide combines with ribulose bisphosphate / RuBP;

2. Produces two glycerate (3-)phosphate / GP;

   Accept: any answer which indicates that 2 x as much GP produced from one RuBP.

3. GP reduced to triose phosphate / TP;

   Must have idea of reduction. This may be conveyed by stating m.p. 4.

4. Using reduced NADP;

   ***Reject**: Any reference to reduced NAD for m.p.4 but allow reference to reduction for m.p. 3.*

5. Using <u>energy</u> from ATP;

   Must be in context of GP to TP.

6. Triose phosphate converted to glucose / hexose / RuBP / ribulose bisphosphate / named organic substance;

[6]

9

(a)

Part of ecosystem	**Mean rate of carbon dioxide production / $cm^3\ m^{-2}\ s^{-1}$**	**Percentage of total carbon dioxide production measured by the scientists**
Leaves of plants	0.032	25.0
Stems and roots of plants	0.051	**<u>39.8</u>**
Non-photosynthetic soil organisms	0.045	**<u>35.2</u>**

2 correct = 2 marks;;

Adding rates to get 0.128 = 1;

If rounded to 40 and 35 in table;

- *but working shows decimal points, then award 2 marks*
- *but no working shown, then 1 max*

2 max

(b) 1. Data only include (heterotrophic) soil organisms;

2. Doesn't include animals (above ground) / other (non-soil) organisms;

3. Doesn't take into account anaerobic respiration;

Award points in any combination

Accept for 1 mark idea that CO_2 for leaves doesn't take into account photosynthesis – not told in dark until part (d)

2 max

(c) **All three** of following = 2 marks;;

Two of them = 1 mark;

Volume of carbon dioxide given off

(From known) area / per m^2 / m^{-2}

In a known / set time

Ignore 'amount' / concentration of CO_2

Accept per second / per unit time

2

(d) 1. (In the light) photosynthesis / in the dark no photosynthesis;

2. (In light,) carbon dioxide (from respiration) being used / taken up (by photosynthesis);

2

(e) (i) (Rate of respiration)

Assume "it" means soil under trees

1. In soil under trees (always) higher;

Accept converse for soil not under trees

Accept 'in the shade' means under the trees

2. In soil under trees does not rise between 06.00 and 12.00 / in the middle of the day / peaks at 20:00-21.00 / in the evening;

3. In soil **not** under trees, peaks at about 14:00-15:00 / in middle of day;

2. and 3. No mm grid, so accept 'between 18.00 and 24.00' or 'between 12.00 and 18.00'

2 max

(ii) (Between 06.00 and 12.00, (No Mark))

Respiration higher in soil under tree, (No mark)

Do not mix and match mark points

No list rule

1. Tree roots carry out (a lot of) respiration;

2. More / there are roots under tree;

Accept converse for soil not under trees

OR

3. More food under trees;

4. So more active / greater mass of / more organisms (carrying out respiration);

Accept converse for soil not under trees

OR

Soil not under trees respiration increases (No mark)

5. Soil in sunlight gets warmer;

6. Enzymes (of respiration) work faster;

Accept converse for soil under trees

2 max

(f) (i) 1. Photosynthesis produces sugars;

2. Sugars moved to roots;

Do not penalise named sugars other than sucrose

3. (Sugars) are used / required for respiration;

2 max

(ii) Takes time to move sugars to roots;

Look for movement idea in (i) – can carry forward to (ii)

1

[15]

10

(a) (i) So it / CO_2 is not a limiting factor (on growth / photosynthesis);

Accept: CO_2 is a limiting factor

1

(ii) So any difference is due to iron (deficiency);

Accept: iron is the variable

1

(iii) Amount of triose phosphate / TP will be similar / same / low (at start);

Accept: to allow triose phosphate to stabilise / become constant

Reject: so all triose phosphate is used up

Reject: so no triose phosphate

1

(b) 1. (Less) ATP produced;

Accept: alternatives for reduced NADP ie NADP with hydrogen / s attached

2. (Less) reduced NADP produced;

3. ATP / reduced NADP produced during light-dependent reaction;

4. (Less) GP to triose phosphate / TP;

4

(c) 1. Less triose phosphate converted to RuBP;

Accept: less triose phosphate so less RuBP

2. CO_2 combines with RuBP;

2

[9]

11 (a) 1. Protein synthesis **and** cell wall synthesis **and** cell expansion stop at −0.7 / at a *higher* water potential than other two;

If all 3 are correctly identified in marking point 1, accept 'the others / the other two' in marking point 2, and vice versa

2. Photosynthesis **and** stomatal opening stop at -1.5 / at a *lower* water potential than other three;

Correct processes must be named in at least one of marking point 1 or marking point 2

Where reference to water potential differences are made, they must be comparative, eg 'higher'

2

(b) 1. Stomata allow uptake of carbon dioxide;

2. Carbon dioxide used in / required for photosynthesis;

2

(c) 1. Growth involves cell division / cell expansion / increase in mass;

Marking point 1 is for the principle

2. Protein synthesis stops **so** no enzymes / no membrane proteins / no named protein (for growth / division);

Marking points 2, 3 and 4 require appreciation of 'why' before credit can be awarded

'named' protein must relate to proteins involved in growth or cell division

3. Cell wall synthesis stops **so** no new cells can be made;

Full credit is possible without a statement of the principle (marking point 1)

4. No cell expansion / increase in mass **because** (cells) stop taking up water;

3 max

[7]

12

(a) 1. No effect at 25°C

The question only refers to plants with GB

1. Reject same mass

2. Keeps growing at 30°C and 35°C / up to 35°C (more than without GB);

3. Above 35°C, falls but grows more than plant without GB;

3. Accept at all temperatures above 25°C more growth than without GB

2 max

(b) (i) Significantly different / SEs do not overlap ;

Accept converse without GB

1

(ii) (As temperature increases,)

1. Enzyme activity reduced / (some) enzymes denatured;

2. Less photosynthesis, so fewer sugars formed;

3. Less respiration / less energy / ATP for growth;

4. Less energy for named function associated with growth

4. Eg mitosis, uptake of mineral ions

4

(c) 1. (Rubisco activase attaches to thylakoid and) this changes shape / tertiary structure (of enzyme) / blocks active site / changes active site;

Note - question states enzyme stops working when it attaches to thylakoid, not before

1. Accept rubisco in this context

2. (This) prevents substrate / RuBP entering active site / binding;

2. Accept prevents ES complex forming

2. Accept no longer complementary to substrate / RuBP

2

(d) 1. GB prevents / reduces binding of rubiscoactivase to (thylakoid membrane);

1. Accept enzyme instead of rubiscoactivase. Accept rubisco

2. (Prevents it) up to 35°C;

3. (So) rubiscoactivase / enzyme remains active;

4. (So) photosynthesis / light-independent stage still happens;

4. Accept descriptions of light-independent stage

5. Above 35°C, some binding still occurs but less than without GB, so less reduction in growth;

4 max

(e) 1. Looked for information / journals, on crop plants that grow at high temperatures;

1. "other research" is minimum accepted

1. Accept previous experiments research with temperature resistant crops

Ignore simple references to looking at previous studies / other plants - need to relate to this context

2. (Crop plants cited in this research) contain / make GB;

3. So assumed making plants produce GB makes them resistant to high temperatures;

2 max

[15]

13 (a) 1. Peaks at 420-430 and 660-670;

2. No absorption of light between approximately 500 and 600;

3. Highest peak at 420-430;

2 max

(b) 1. Less (light) energy passes through leaves / reaches ground;

2. Smaller range of wavelengths passes through leaves;
Accept reference to only green (and yellow) light pass through

3. Little light for chlorophyll to absorb;
Accept carotenoids can absorb this light

4. So insufficient photosynthesis (for growth);
Sufficient photosynthesis for plants with carotenoids

5. Photosynthesis unlikely to exceed respiration;

3 max

(c) 1. Light not limiting / lots of light (as no shading);

2. Light-dependent reaction not limiting / fast;

OR

3. Temperature not limiting / Warm (as no shading);

4. Fast reactions of enzymes in light-independent reaction;

OR

5. High use of CO_2;

6. Light-independent reaction is limiting;
Mark as a pair

4. Pick out of bag with som

14

(a) 1. Bar chart;

2. Error bars to represent standard deviation (of mean);

3. Photosynthetic pigment on *x* axis and mass of pigment on *y* axis;
Accept suitable sketch

(b) 1. Number leaves on the branch;

2. Use random number table / calculator / pick numbers from bag to determine which leaf to pick;
Accept use of random number generator

OR

3. Collect large number of leaves;

2

[7]

2 max

2

(c) No (no mark)

1. No stats test carried out;

2. Standard error / 95% confidence interval calculation identified;

If awarded, student scores 2 marks – for points 1 and 2

Yes (no mark)

3. No overlap shown by the standard deviations;

4. Ranges around mean stated;

88.6-92.8 and 111.0-111.2 (1 × SD) or 86.5-94.9 and 110.9-111.3 (2 × SD)

2 max

(d) In shade leaves:

1. Greater amount of enzyme / enzyme activity (for production of chlorophyll b);

2. Greater gene expression / transcription of the gene / more mRNA produced / gene switched on;

3. Greater translation;

4. Enzyme / substrate is light sensitive – faster rate of reaction with lower light;

2 max

[8]

15 (a) 1. (Some of the) light that passes through is absorbed by chlorophyll b;

2. This is light of around 500 and / or around 640;

Accept any value or range between 460 and 540 and / or 600 and 670

2

(b) (i) Supports hypothesis 2 (no mark)

1. Greater carotenoid found in sun leaves than shade leaves of beech tree;

2. Sun leaves exposed to much brighter light than shade leaves;

OR

It supports hypothesis 2 because it does not support hypothesis 1 (no mark)

3. Although carotenoids absorb wavelengths of light that pass through leaves;

4. There are not more carotenoids in shade leaves;

2

(ii) 1. Mass of pigments / carotenoids in sun and shade leaves of other trees;

2. Position of carotenoids in leaf cells;

3. Effect of bright light on (isolated) chlorophyll;

4. Whether without carotenoids chlorophyll is damaged (supporting hypothesis 2) / photosynthesis is reduced (supporting hypothesis 1);

1 max

[5]

16 (a) (i) Stroma (of chloroplasts);

Reject: stoma

1

(ii) 2;

1

(b) 1. As oxygen (concentration) increases less Rubisco / RuBP reacts / binds with carbon dioxide;

1. Accept - as oxygen (concentration) increases more Rubisco / RuBP reacts / binds with oxygen

1. Accept – less GP / more phosphoglycolate formed as oxygen (concentration) increases

2. Competitive inhibition / competition between oxygen and carbon dioxide for rubisco / enzyme / active site (therefore) less RuBP formed / regenerated (to join with carbon dioxide);

2. Accept oxygen and carbon dioxide are complementary to active site

2

(c) 1. Less glycerate 3-phosphate / GP produced;

1. Accept one GP formed rather than two GP

2. (Less) triose phosphate to form sugars / protein / organic (product) / any named photosynthetic product;

3. Less RuBP formed / regenerated;

3. Accept RuBP takes longer to form

3

[7]

17 (a) 1. Chlorophyll absorbs light energy;

Accept light energy 'hits' chlorophyll

Accept photon for light energy

2. Excites electrons / electrons removed (from chlorophyll);

Accept higher energy level as 'excites'

3. Electrons move along carriers / electron transport chain releasing energy;

Accept movement of H^+ / protons across membrane releases energy

4. Energy used to join ADP and Pi to form ATP;

Negate 'produces energy' for either mark but not for both

Accept energy used for phosphorylation of ADP to ATP

Do not accept P as Pi

5. Photolysis of water produces protons, electrons and oxygen;

3. and 4.

6. NADP reduced by electrons / electrons and protons / hydrogen;

Accept NADP to NADPH (or equivalent) by addition of electrons / hydrogen

Do not accept NADP reduced by protons on their own

5 max

(b) 1. Variation / variety;

2. Mutation;

Do not accept answers which suggest the mutation is caused by copper

3. Some plants have allele to survive / grow / live in high concentration of copper / polluted soils;

Reference to immunity disqualifies this mark

Do not disqualify mark for references to allele providing resistance to copper

4. (Differential) reproductive success / adapted organisms reproduce;

5. Increase in frequency of allele;

6. No interbreeding (with other populations) / separate gene pool / gene pool differs (from other populations);

Accept reproductive isolation

(a) max **[10]**

18

1. Ribulose bisphosphate / RuBP;

Accept Ribulose biphosphate or Ribulose diphosphate

Accept phonetic spellings

Accept any variation in upper or lower case for RuBP

1

2. ATP and reduced NADP are produced in grana / thylakoids / present in A / both tubes;

Must be reduced NADP but accept any alternative which show hydrogen attached to NADP

Must be reduced NADP not reduced NAD

1

(c) 1. 4 000;

Accept 'same as in (tube) C', but not 'same' on its own

2. Light-dependent reaction does not occur / ATP and reduced NADP are not produced;

Accept converse for mark point 2

2

(d) 1. (Less) GP converted to TP;

GP = glycerate 3-phosphate

TP = triose phosphate but abbreviations are sufficient

2. (Less) TP converted to RuBP;

Accept GALP as TP

2

(e) 1. No / less ATP / ATP produced (during electron transport);

Must be reduced NADP but accept any alternative which shows hydrogen attached to NADP

2. No / less reduced NADP / reduced NADP produced (during electron transport)

2

[8]

19

(a) 530 to 630;

1

(b) 1. Reduced NADP;

Accept NADPH or rNADP

2. ATP;

Reduced NAD is incorrect

2

(c) (i) 1. Unit of volume and unit of time;
Accept any reasonable unit of volume
E.g. cm^3 or ml
Accept any reasonable unit of time
E.g. s, min or h

2. Unit of area / mass;
Accept any reasonable unit of area or mass
E.g. cm^2 or g
Symbols should be correct. Do not accept m for minutes.

2

(ii) 1. (Light intensity) limiting factor;

2. Fewer electrons (released) from chlorophyll;

3. Less photolysis therefore (less) oxygen from water;

3

(d) Will not affect (no mark):

1. Photolysis / splitting of water does not use enzymes;

Will affect (no mark):

2. May increase respiration;

3. Respiration uses oxygen;

3

(e) (i) 1. Overlap in standard deviations;

2. Unlikely that any difference is significant;

2

(ii) 1. **P** / visible light has more wavelengths;

2. **Q** has only light of wavelength 460 nm;

3. Wavelengths over 460 nm can also be used for photosynthesis / wavelengths over 460 nm can also be absorbed;

3

[16]

20 (a) (i) Non-living / physical / chemical factor / non biological;
Do not accept named factor unless general answer given.

1

(ii) Accept an abiotic factor that may limit photosynthesis / growth;

Reject altitude / height

Water

Named soil factor

Not "soil" / "weather"

Light

Carbon dioxide

Accept Oxygen

Incline / aspect

Wind / wind speed

1

(b) 1. Correct explanation for differences between day and night e.g. photosynthesises only during the daytime / no photosynthesis / only respiration at night;

2. Net carbon dioxide uptake during the day / in light

OR

No carbon dioxide taken up at night / in dark / carbon dioxide released at night / in dark;

3. At ground level more respiration / in leaves more photosynthesis;

4. Carbon dioxide produced at ground level / carbon dioxide taken up in leaves;

Principles

Comparing day and night / light and dark

1. Explanation in terms of photosynthesis / respiration

2. Effect on carbon dioxide production / uptake

Comparing leaves with ground level

3. Explanation in terms of photosynthesis / respiration

4. Effect on carbon dioxide production / uptake

2 and 4 must relate to why the change occurs

4

(c) 1. Variation in original colonisers / mutations took place;

2. Some better (adapted for) survival (in mountains);

2. Allow "advantage so able to survive"

3. Greater reproductive success;

4. Allele frequencies change;

4. Reject gene / genotype

3 max

[9]

21

(a) 1. Releases energy in small / manageable amounts;

1. Accept less than glucose

2. (Broken down) in a one step / single bond broken immediate energy compound / makes energy available rapidly;

2. Accept easily broken down

3. Phosphorylates / adds phosphate makes (phosphorylated substances) more reactive / lowers activation energy;

3. Do not accept phosphorus or P on its own

4. Reformed / made again;

4. Must relate to regeneration

(b) 1. Substrate level phosphorylation / ATP produced in Krebs cycle;

Accept alternatives for reduced NAD

2. Krebs cycle / link reaction produces reduced coenzyme / reduced NAD / reduced FAD;

2. Accept description of either Krebs cycle or link reaction

3. Electrons released from reduced / coenzymes / NAD / FAD;

4. (Electrons) pass along carriers / through electron transport chain / through series of redox reactions;

5. Energy released;

5. Allow this mark in context of electron transport or chemiosmosis

6. ADP / ADP + Pi;

6. Accept H^+ or hydrogen ions and cristae

7. Protons move into intermembrane space;

7. Allow description of movement through membrane

8. ATP synthase;

8. Accept ATPase. Reject stalked particles

(c) 1. In the dark no ATP production in photosynthesis;

1. In context of in photosynthetic tissue / leaves

2. Some tissues unable to photosynthesise / produce ATP;

3. ATP cannot be moved from cell to cell / stored;

4. Plant uses more ATP than produced in photosynthesis;

5. ATP for active transport / synthesis (of n

amed substance);

4

(b) max

5

[15]

22 (a)

	Photosynthesis	Anaerobic respiration	Aerobic respiration
ATP produced	✓	✓	✓
Occurs in organelles	✓		✓
Electron transport chain involved	✓		✓

1 mark per column

Mark ticks only. Ignore anything else if different symbols such as crosses are used as well.

If crosses are used instead of ticks allow cross as equivalent to a tick.

Reject tick with a line through

3

(b) $ADP + P_i \longrightarrow ATP$;

Both sides correct, but allow other recognised symbols or words for phosphate ion. Reject P unless in a circle.

Accept = as equivalent to arrow

Accept reversible arrow

Ignore any reference to kJ / water

1

(c) 1. Energy released in small / suitable amounts;

2. Soluble;

3. Involves a single / simple reaction;

1. In context of release, not storage. Ignore producing energy / manageable amounts.

2. Reject "broken down easily / readily". Reject "quickly / easily resynthesised".

2 max

(d) 1. ATP cannot be stored / is an immediate source of energy;

2. ATP only releases a small amount of energy at a time;

2

[8]

23

(a) 1. Saprobionts / saprophytes;

2. Digest / break down proteins / DNA / nitrogen-containing substances;

3. Extracellular digestion / release of enzymes;

4. Ammonia / ammonium produced;

5. Ammonia converted to nitrite to nitrate / ammonia to nitrate;

6. Nitrifying (bacteria) / nitrification;

7. Oxidation;

Ignore all references to other parts of the nitrogen cycle

1. Accept saprotrophs. Allow this mark if saprobionts linked to fungi.

2. Ignore"nitrogen in plants"

Ignore enzymes excreted

6. Accept Nitrosomonas / Nitrobacter

5 max

(b) 1. Carbon dioxide combines with ribulose bisphosphate / RuBP;

2. Produces two molecules of glycerate (3-)phosphate / GP;

3. Reduced to triose phosphate / TP;

4. Using reduced NADP;

5. Using energy from ATP;

6. Triose phosphate converted to other organic substances / named organic substances / ribulose bisphosphate;

7. In light independent reaction / Calvin cycle;

3. Accept add hydrogen for reduced

4. Accept alternatives such as NADPH for reduced NADP / GALP for TP / ribulose biphosphate

6 max

[11]