1. Which of the following statements about carotenoids in green plants is correct?

A They increase absorption of green light by chlorophyll.

B They increase absorption of blue and red light by chlorophyll.

C They extend the range of wavelengths of light absorbed and pass hydrogen onto chlorophyll.

D They extend the range of wavelengths of light absorbed and pass energy onto chlorophyll.

2. The following statements describe events occurring during photosynthesis:

1. Carbon dioxide combines with RuBP.
2. ATP synthase generates ATP from ADP and Pi.
3. Hydrogen binds with the coenzyme NADP.
4. 3PG is phosphorylated by ATP.

Which of the statements identify events that occur in carbon fixation (Calvin cycle)?

A 1 and 2 only

B 1 and 4 only

C 2 and 3 only

D 3 and 4 only

3. An action spectrum is a measure of the ability of a plant to

A absorb all wavelengths of light

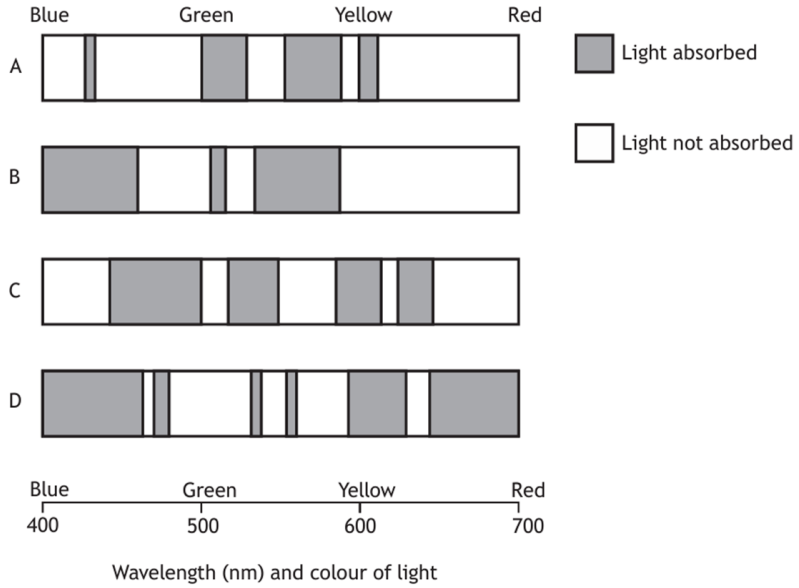
B absorb light of different intensities

C use light to build up food

D use light of different wavelengths for photosynthesis.

4. The following absorption spectra were obtained by testing four different plant extracts.

Which extract contains chlorophyll?



5. Which compound combines with hydrogen during carbon fixation (Calvin cycle)?

A Ribulose biphosphate

B NADP

C Oxygen

D 3-phosphoglycerate

6. The role of NADPH in the carbon fixation stage (Calvin cycle) of photosynthesis is to

A add hydrogen to glyceraldehyde-3-phosphate (G3P)
B phosphorylate glyceraldehyde-3-phosphate (G3P)
C add hydrogen to 3-phosphoglycerate (3PG)
D phosphorylate 3-phosphoglycerate (3PG).

7. The following statements describe stages in the Calvin Cycle (carbon fixation).

1 Carbon dioxide attaches to ribulose bisphosphate (RuBP) producing 3-phosphoglycerate (3PG).
2 3-phosphoglycerate (3PG) forms glyceraldehyde-3-phosphate (G3P).
3 Glyceraldehyde-3-phosphate (G3P) regenerates ribulose bisphosphate (RuBP).

Which row in the table identifies the stage which is catalysed by RuBisCO and the stage which requires hydrogen?

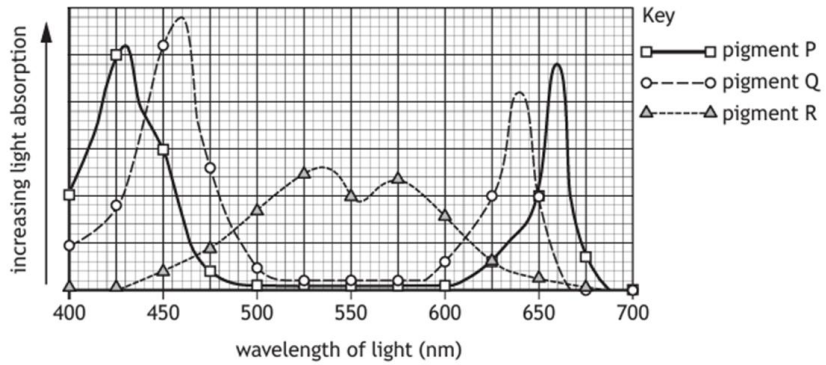
	Catalysed by RuBisCO	*Requires hydrogen*
A	1	2
B	1	3
C	3	1
D	3	2

8. Which of the following results in a transfer of electrons down the electron transport chains during the light dependent reactions of photosynthesis?

A NADP is converted to NADPH
B Water is split by photolysis
C ATP is synthesised
D Pigment molecules absorb energy

9. Water lilies are found on the water surface and algae live below them. Water lilies absorb mostly blue light (400–475 nm) and red light (625–700 nm).

The graph shows the absorption spectra of the three photosynthetic pigments.



To survive below the water lilies, the algae would be expected to have a high concentration of

A pigment P
B pigment Q
C pigment R
D pigments P and Q.

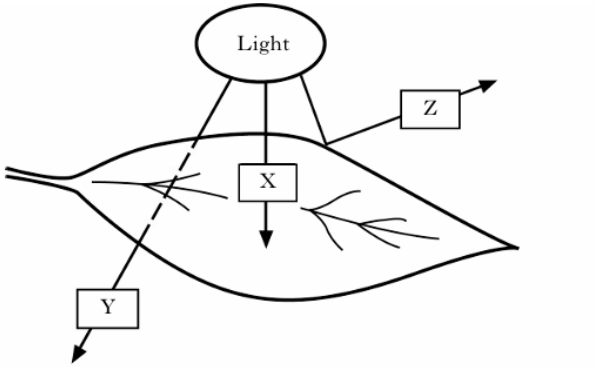
10. The following statements were made about an enzyme involved in photosynthesis:

1. RuBP changes shape to better fit RuBisCO.
2. RuBisCO converts G3P to glucose.
3. RuBisCO catalyses fixation of carbon dioxide.

Which of these statements are correct?

A 2 only
B 3 only
C 1 and 2 only
D 1 and 3 only

1. The diagram below shows light striking a green leaf.



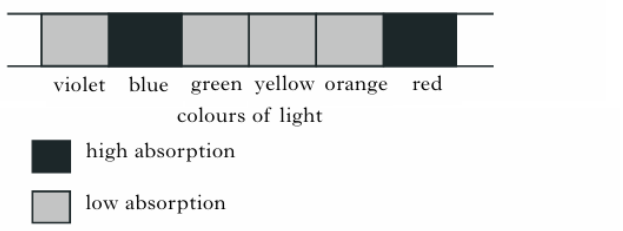
Arrow X shows light being absorbed.

State the terms used to describe what is happening to light at Y and Z.

Y _____

Z _____

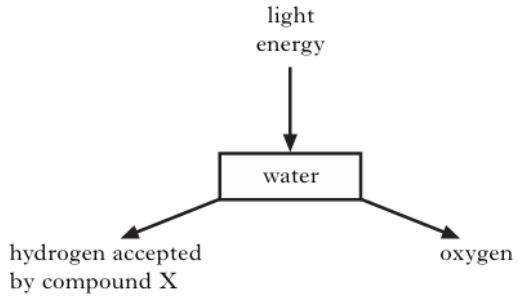
2. The diagram below represents the absorption of different colours of light by a photosynthetic pigment.



(i) Name this photosynthetic pigment.

_____ **1**

3. The diagram below shows part of the light dependent stage of photosynthesis.



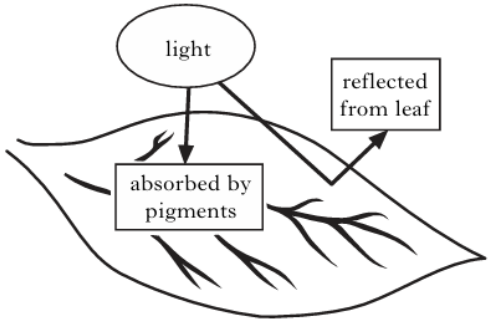
(i) Name this part of the light dependent stage.

_____ **1**

(ii) Name compound X.

_____ **1**

4. The diagram contains information about light striking a leaf.

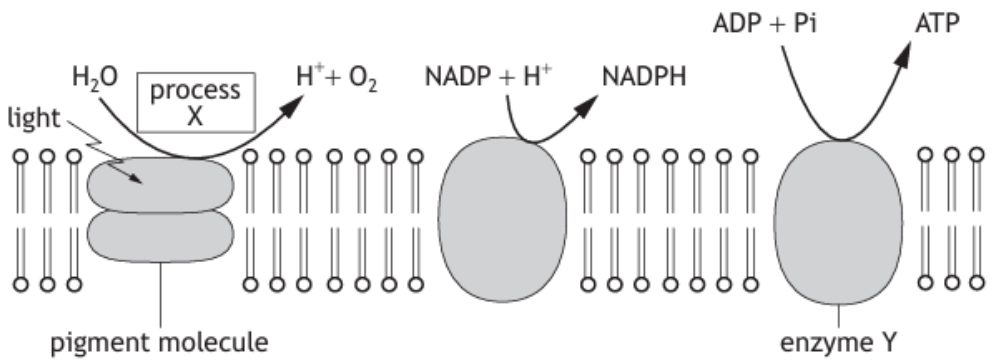


(i) Apart from being absorbed or reflected, what can happen to light which strikes a leaf?

_____ **1**

5. Lettuce can be cultivated commercially in greenhouses.

The diagram represents some stages of the light reaction in photosynthesis in lettuce.



(a) Describe what happens to electrons in pigment molecules when light energy is absorbed. **1**

(b) Name process X and enzyme Y. **2**

Process X _____

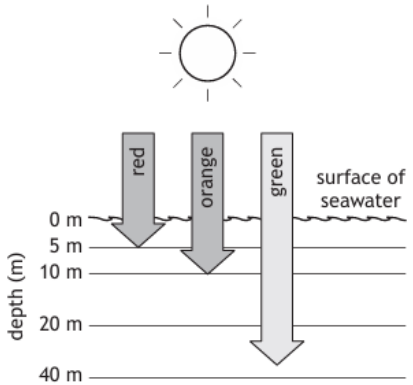
Enzyme Y _____

6. Name a piece of apparatus that could be used to show which colours of light are absorbed by photosynthetic pigments. **1**

7. (a) Name a pigment that absorbs mainly red and blue light. **1**

(b) *H. grandifolius* has higher levels of carotenoids in its cells than *A. mirabilis*.

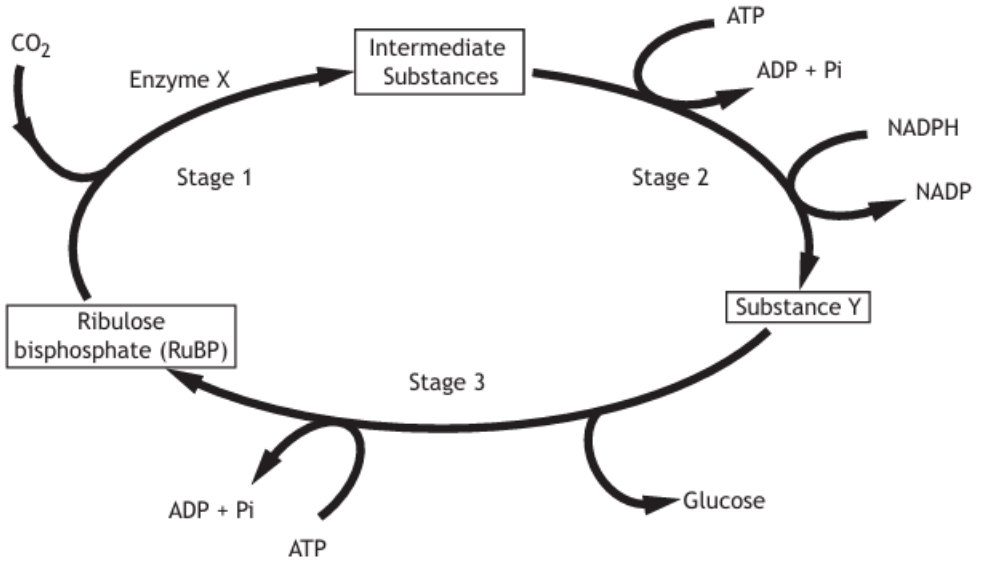
(i) Describe the role of carotenoids. **1**

8. 

Depth (m)	Seaweed species present
0–5	*A. mirabilis*
15–20	*D. anceps*
20–25	*H. grandifolius* and *D. menziesii*

Using information from the table and the diagram, explain why *H. grandifolius* requires higher levels of carotenoids than *A. mirabilis*. **2**

9. The diagram below shows some stages in the Calvin cycle of photosynthesis.



(a) (i) Name Enzyme X and Substance Y. **2**

Enzyme X _____

Substance Y _____

(ii) Explain the importance of producing glucose and RuBP in Stage 3. **2**

Glucose _____

_____

RuBP _____

Research has been carried out which aims to increase photosynthesis in crop plants by inserting genes for the production of prokaryotic pigments into the cells. These pigments absorb wavelengths of light which are different to those absorbed by the pigments present in the crop plants.

(i) Predict what would happen to the concentrations of ATP and NADPH in the crop plant cells. **2**

ATP _____

NADPH _____

10. Some species of algae live under floating surface plants. These surface plants have high levels of chlorophyll, which absorb mostly red and blue light.

Suggest how the species of algae living under floating surface plants are still able to photosynthesise. **2**

_____

_____

_____

_____

11. State one use that plants make of the light energy absorbed by pigments during photosynthesis. **1**

_____

_____

12. Name an environmental factor, other than light intensity, which could increase the yield of lettuce produced.

Explain how this factor would affect the carbon fixation stage of photosynthesis. **2**

Environmental factor _____

Explanation _____

_____

_____

13. During photosynthesis light energy is absorbed by photosynthetic pigments in the chloroplasts.

(a) (i) State one fate of the light which is **not** absorbed by the photosynthetic pigments. **1**

_____

(ii) Describe the effect of absorbed light energy on the pigment molecules. **1**

_____

_____

(iii) Plants contain several pigments including chlorophyll a, chlorophyll b and carotenoids. Explain the advantage to a plant of having more than one type of photosynthetic pigment. **1**

_____

_____

(b) Following photolysis, hydrogen is transferred to the coenzyme NADP.

State the source of this hydrogen. **1**

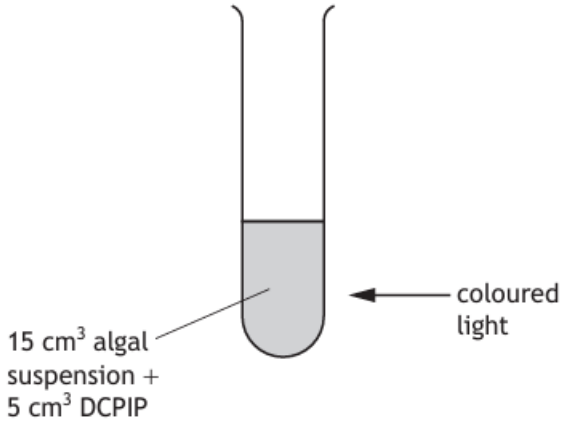
_____

(c) Describe the role of the NADPH in the Calvin cycle (carbon fixation). **1**

_____

_____

14.



The apparatus was placed in a dark room and exposed to green light. The absorbance of the solution was measured every 40 seconds for 200 seconds using a colorimeter. The lower the absorbance, the higher the rate of photolysis.

Suggest why the absorbance values shown in the table remained high when algal cells were exposed to green light. **2**

_____

_____

_____

15. Oil extracted from the seeds of the crop false flax (*Camelina sativa*) can be used as fuel. An investigation was carried out into the effect of a plant growth regulator paclobutrazol (PBZ) on the photosynthetic pigment content of the leaves and the oil yield from the seeds of false flax. The results are shown in the table.

Treatment	*Average photosynthetic pigment content* (mg/g of leaf)		*Average oil yield* (g/plant)
	Chlorophyll a and b	*Carotenoids*	
Untreated	3·28	3·02	1·7
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Absorption spectra for pigments from the treated and untreated plants were produced and are shown in the graph.

(ii) **Use evidence from the table** to explain the difference in the absorption spectra. **1**

(iii) State one use that plants make of the light energy absorbed by pigments during photosynthesis. **1**

(b) Suggest why seeds from the plants treated with PBZ yield more oil. **2**

1. Which of the following statements about carotenoids in green plants is correct?

A They increase absorption of green light by chlorophyll.

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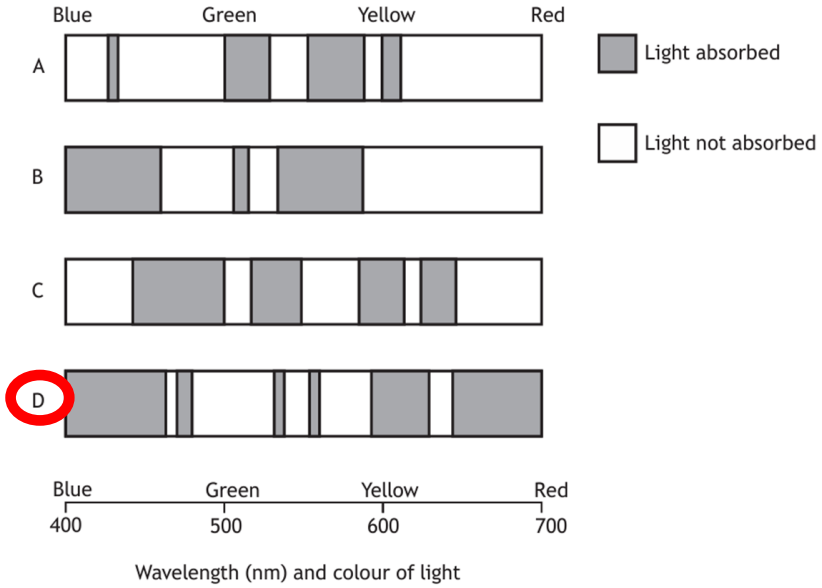

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8. Which of the following results in a transfer of electrons down the electron transport chains during the light dependent reactions of photosynthesis?

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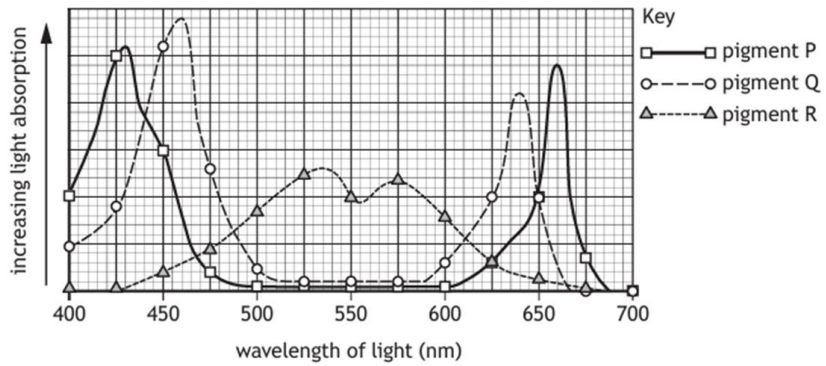

To survive below the water lilies, the algae would be expected to have a high concentration of

A pigment P
B pigment Q
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10. The following statements were made about an enzyme involved in photosynthesis:

1. RuBP changes shape to better fit RuBisCO.
2. RuBisCO converts G3P to glucose.
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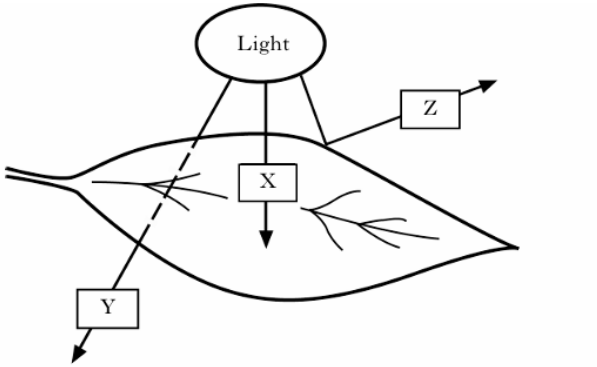
1. The diagram below shows light striking a green leaf.



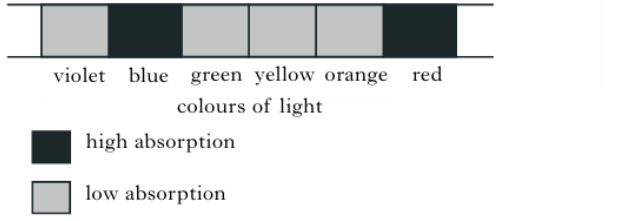
Arrow X shows light being absorbed.

State the terms used to describe what is happening to light at Y and Z.

Y transmit

Z reflect

2. The diagram below represents the absorption of different colours of light by a photosynthetic pigment.

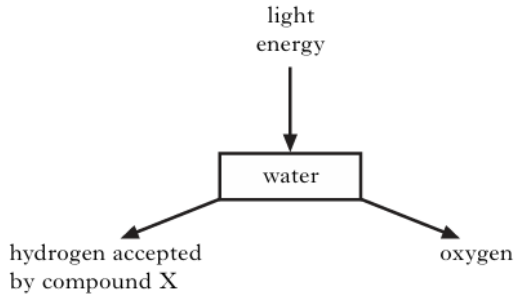


(i) Name this photosynthetic pigment.

chlorphyll

1

3. The diagram below shows part of the light dependent stage of photosynthesis.



(i) Name this part of the light dependent stage.

photolysis

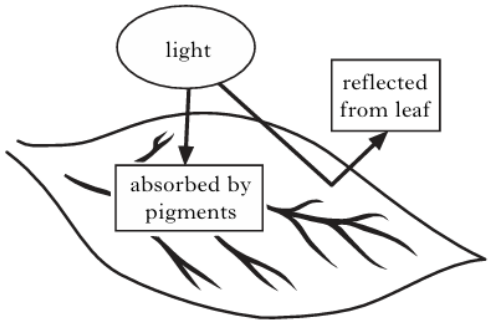
1

(ii) Name compound X.

NADP

1

4. The diagram contains information about light striking a leaf.



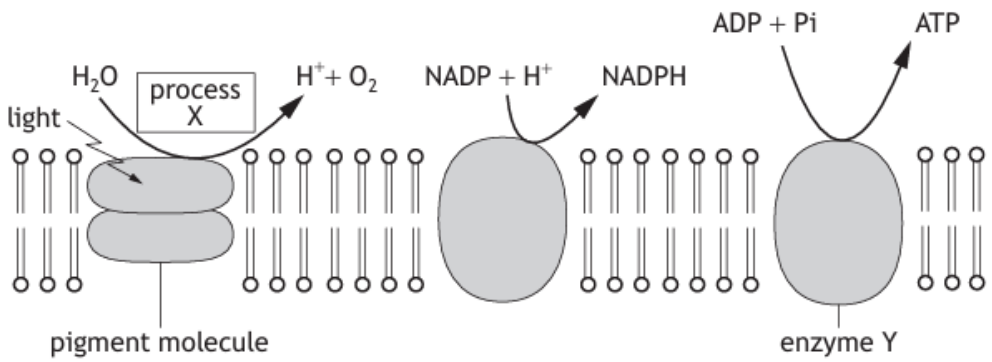
(i) Apart from being absorbed or reflected, what can happen to light which strikes a leaf?

transmit

1

5. Lettuce can be cultivated commercially in greenhouses.

The diagram represents some stages of the light reaction in photosynthesis in lettuce.



(a) Describe what happens to electrons in pigment molecules when light energy is absorbed. **1**

Electrons excited

(b) Name process X and enzyme Y. **2**

Process X photolysis

Enzyme Y ATP synthase

6. Name a piece of apparatus that could be used to show which colours of light are absorbed by photosynthetic pigments. **1**

Colorimeter/spectrophotometer

7. (a) Name a pigment that absorbs mainly red and blue light. **1**

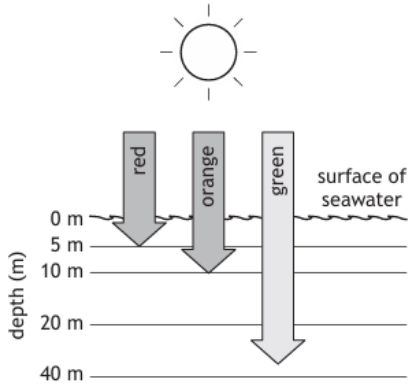
chlorophyll

(b) *H. grandifolius* has higher levels of carotenoids in its cells than *A. mirabilis*.

(i) Describe the role of carotenoids. **1**

Increase wavelengths of light absorbed and pass energy to chlorophyll for photosynthesis

8.



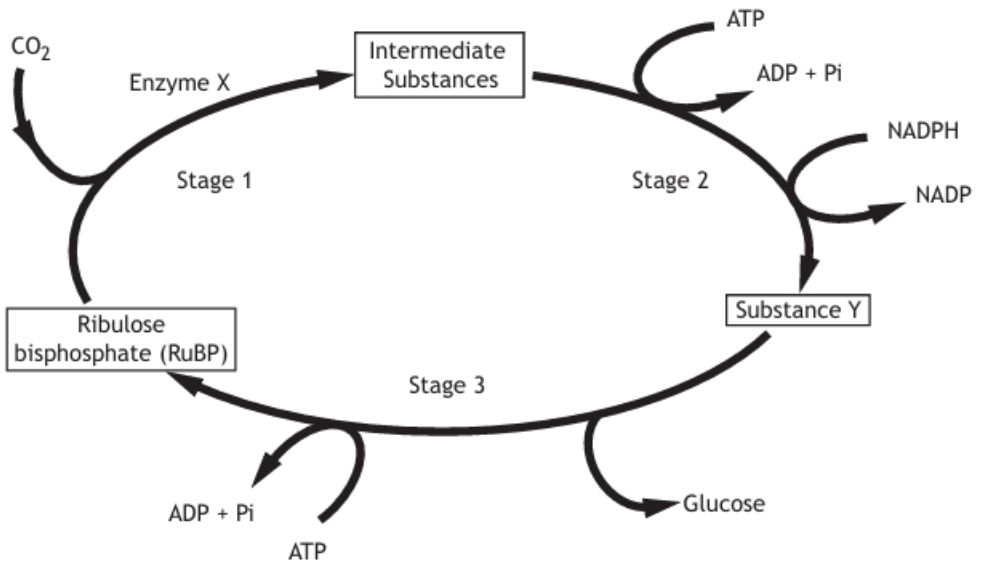
Depth (m)	Seaweed species present
0–5	*A. mirabilis*
15–20	*D. anceps*
20–25	*H. grandifolius* and *D. menziesii*

Using information from the table and the diagram, explain why *H. grandifolius* requires higher levels of carotenoids than *A. mirabilis*. **2**

H. grandifolius is found at a greater depth/20 – 25 m (1)

Carotenoids allow absorption of green light.(1)

9. The diagram below shows some stages in the Calvin cycle of photosynthesis.



(a) (i) Name Enzyme X and Substance Y. **2**

Enzyme X rubisco

Substance Y G3P

(ii) Explain the importance of producing glucose and RuBP in Stage 3. **2**

Glucose To make starch/cellulose/for respiration

RuBP To make 3PG OR for cycle to continue

Research has been carried out which aims to increase photosynthesis in crop plants by inserting genes for the production of prokaryotic pigments into the cells. These pigments absorb wavelengths of light which are different to those absorbed by the pigments present in the crop plants.

(i) Predict what would happen to the concentrations of ATP and NADPH in the crop plant cells. **2**

ATP increase

NADPH increase

10. Some species of algae live under floating surface plants. These surface plants have high levels of chlorophyll, which absorb mostly red and blue light.

Suggest how the species of algae living under floating surface plants are still able to photosynthesise. **2**

Green light transmitted to algae

Have cartenoids

11. State one use that plants make of the light energy absorbed by pigments during photosynthesis. **1**

They have carotenoids (1)

They absorb/use light transmitted/by surface plants. (1)

12. Name an environmental factor, other than light intensity, which could increase the yield of lettuce produced.

Explain how this factor would affect the carbon fixation stage of photosynthesis. **2**

Environmental factor Carbon dioxide

Explanation Combines with RuBp

Temperature/pH

Optimum enzyme activity

Water

More Hydrogen for 3PG to G3P

13. During photosynthesis light energy is absorbed by photosynthetic pigments in the chloroplasts.

(a) (i) State one fate of the light which is **not** absorbed by the photosynthetic pigments. 1

Transmit/reflect

(ii) Describe the effect of absorbed light energy on the pigment molecules. 1

Excites electrons

(iii) Plants contain several pigments including chlorophyll a, chlorophyll b and carotenoids. Explain the advantage to a plant of having more than one type of photosynthetic pigment. 1

Increase wavelengths of light absorbed and pass energy to chlorophyll for photosynthesis

(b) Following photolysis, hydrogen is transferred to the coenzyme NADP.

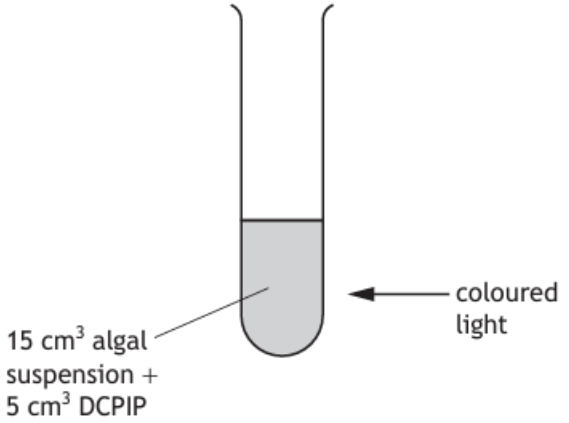
State the source of this hydrogen. 1

water

(c) Describe the role of the NADPH in the Calvin cycle (carbon fixation). 1

Provide hydrogen for 3PG to go to G3P

14.



The apparatus was placed in a dark room and exposed to green light. The absorbance of the solution was measured every 40 seconds for 200 seconds using a colorimeter. The lower the absorbance, the higher the rate of photolysis.

Suggest why the absorbance values shown in the table remained high when algal cells were exposed to green light. 2

green light is transmitted/reflected from algae OR not absorbed

No photolysis so numbers stay high

15. Oil extracted from the seeds of the crop false flax (*Camelina sativa*) can be used as fuel. An investigation was carried out into the effect of a plant growth regulator paclobutrazol (PBZ) on the photosynthetic pigment content of the leaves and the oil yield from the seeds of false flax. The results are shown in the table.

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Absorption spectra for pigments from the treated and untreated plants were produced and are shown in the graph.

(ii) **Use evidence from the table** to explain the difference in the absorption spectra. **1**

Treated plants have a higher carotenoid content

(iii) State one use that plants make of the light energy absorbed by pigments during photosynthesis. **1**

Used for photolysis/to make H_2. OR Generate ATP/excite electrons

(b) Suggest why seeds from the plants treated with PBZ yield more oil. **2**

1. More photosynthesis 2. more glucose for growth