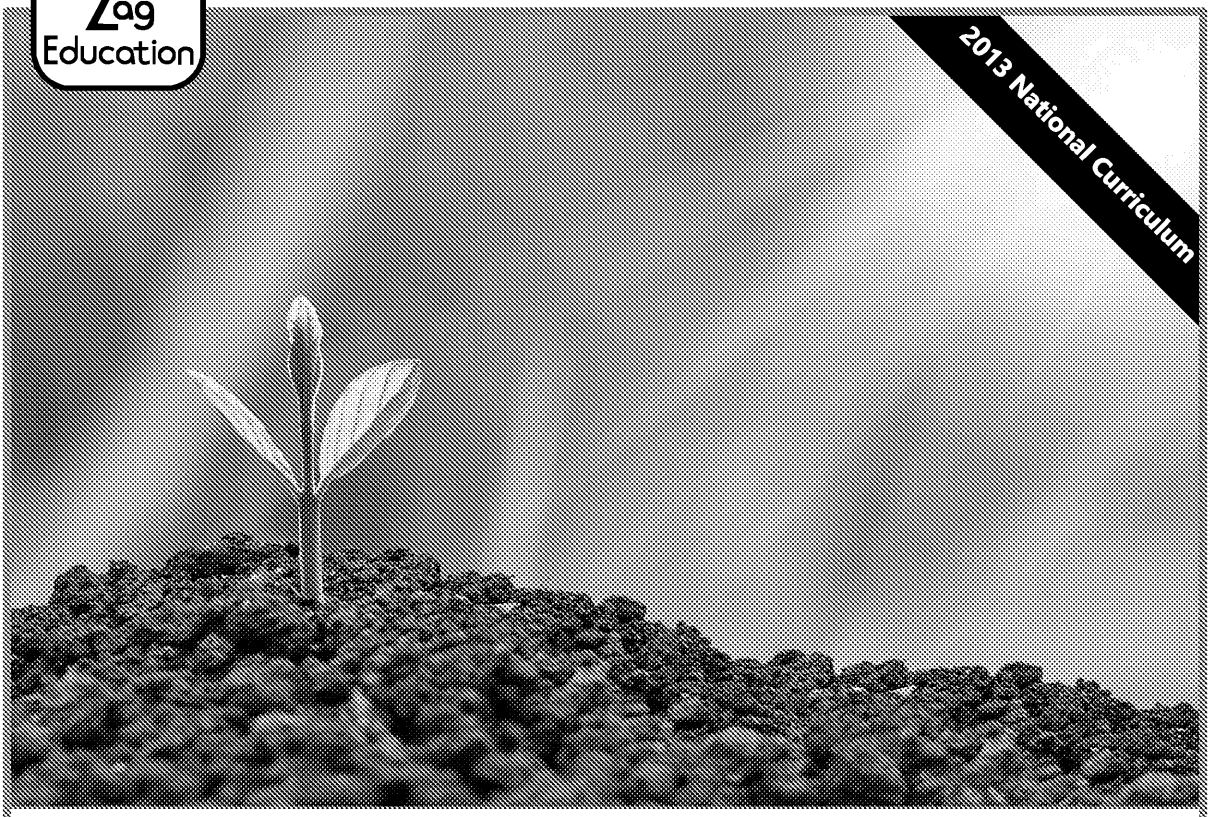
Zig Zag Education

Science

KS3



Photosynthesis

Biology Topic Pack VI for KS3 Science

Download support files from zzed.uk/productsupport

zigzageducation.co.uk

POD 12277

Contents

Teacher's Introduction

Welcome to the Key Stage 3 Photosynthesis Topic Pack, which should be used in Year 9, or possibly Year 8, depending on your school's chosen learning route for Science. The pack has been designed to support learning of this topic by acting as an accompaniment to the teacher's classwork, and should engage students of all abilities. It can be given to students before lessons, or may be used as cover lesson work or homework, and the end-of-topic questions work well as a formative assessment. It is assumed that your learners will have already covered these concepts in Key Stages 1 and 2:

- dissolving and solutions
- energy stores and transfers
- food chains
- respiration, and in particular the substances oxygen, glucose and carbon dioxide

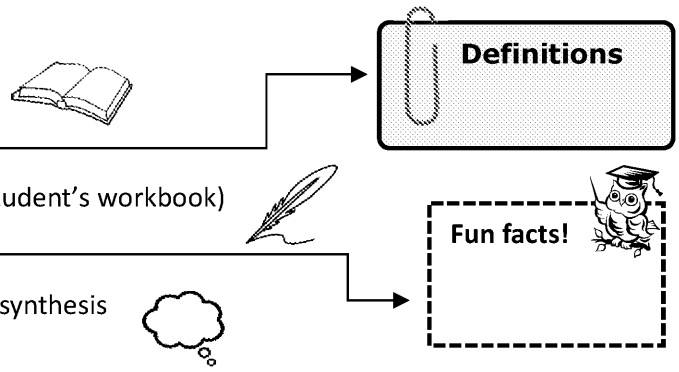
In addition, it would be helpful if learners have a basic understanding of:

- structure of plant cells and the functions of the parts of these cells (covered in KS3 Biology pack I: Cells, tissues and organs)
- diffusion of gases (covered in KS3 Chemistry pack I: States of matter)

The National Curriculum points covered by this topic pack are:

- plants making carbohydrates in their leaves by photosynthesis and gaining mineral nutrients and water from the soil via their roots
- the reactants in, and products of, photosynthesis, and a word summary for photosynthesis
- the dependence of almost all life on Earth on the ability of photosynthetic organisms, such as plants and algae, to use sunlight in photosynthesis to build organic molecules that are an essential energy store and to maintain levels of oxygen and carbon dioxide in the atmosphere
- the adaptations of leaves for photosynthesis

The topic pack includes the following components:



- Explanations and examples of the key concepts
- Key scientific terms and definitions
- Comprehension questions (to be answered in a student's workbook)
- Fun facts
- Working scientifically – focus: investigating photosynthesis and understanding surface area
- Crossword
- End-of-topic questions (to be answered in a student's workbook)*
- Answers

This topic pack covers the material seen in the following two textbooks:

- Activate 2 (Gardom Hulme at al.): Chapters 2.1–2.4 (pp. 22–29)
- Exploring Science 9 (Levesley et al.): Chapters 9Ca–9Cc (pp. 32–37)

August 2023

*A write-on version of the end-of-topic questions is provided on the ZigZag Education Support Files system, which can be accessed via **zzed.uk/productsupport**

What is photosynthesis?

Photosynthesis is how plants produce food. This is why plants are called **producers**.

Photosynthesis comes from two classical Greek words: *photo* and *synthesis*. The word *photo* means light and the word *synthesis* means putting together or combining. Therefore, photosynthesis describes using light to combine some things. So, what is combined?

Plants combine carbon dioxide gas and water to make **glucose** and oxygen. Carbon dioxide and water will never, on their own, combine to make glucose and oxygen. You can blow bubbles of exhaled carbon dioxide through water for as long as you like, but you will never make glucose! Try it…

Photosynthes
where plants u
water to make
sunlight energ
Producers: or
food chains tha
themselves an
Glucose: a sw
make by photo
glucose as an e

Q1: Describe what is meant by photosynthesis.

That's where **chlorophyll** and sunlight come in. Chlorophyll, found inside chloroplasts in plant cells, absorbs light. Chlorophyll uses the energy from light to make the chemical reaction between carbon dioxide and water happen.

We show the importance of chlorophyll and sunlight by adding them to the word equation for photosynthesis. However, they are not **reactants** or **products**, so we put them by the arrow instead.

Chlorophyll:
plant cells that
enables photos
Reactants: su
together; they
a chemical equ
Products: sub
chemical react
arrow in a che

$$\text{carbon dioxide + water} \xrightarrow[\text{sunlight}]{\text{chlorophyll}} \text{glucose + oxygen}$$

Carbon dioxide and water are called reactants because they react together.

Glucose and oxygen are called products because they are produced in the reaction.

Q2: Write a word equation for photosynthesis.

Q3: Name the pigment in plant cells that allows photosynthesis to happen.

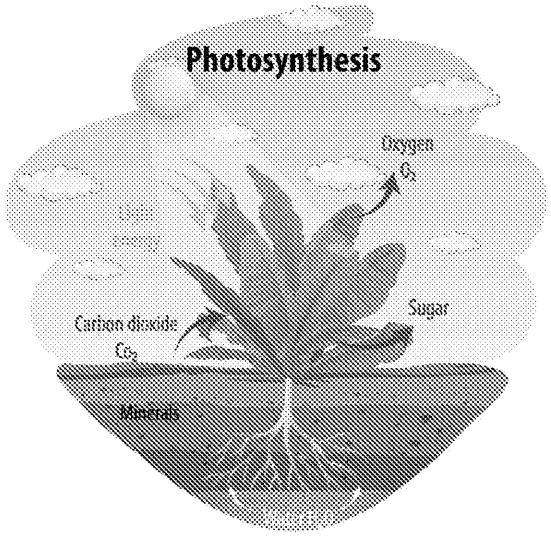
Q4: Describe the job of this pigment in making photosynthesis happen.

Q5: Name

(a) the two reactants in photosynthesis;

(b) the two products of photosynthesis.

Where does photosynthesis happen?

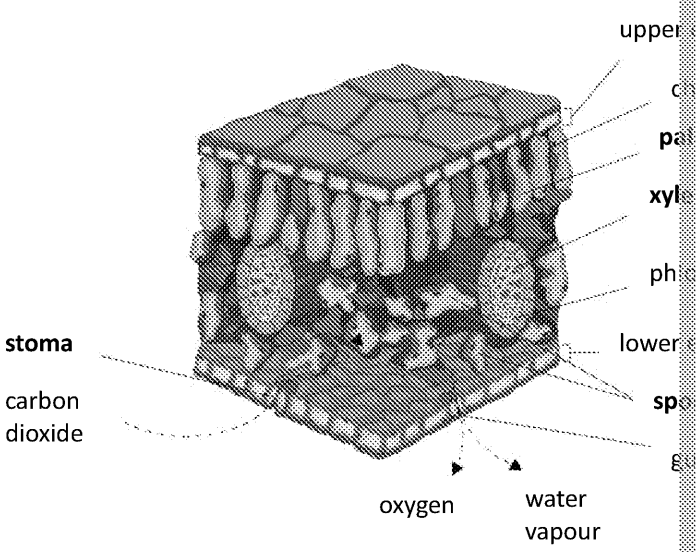


Photosynthesis happens in the
mostly the leaves.

Leaves are specially **adapted** fo
large **surface area** to absorb as
thin to allow gases to **diffuse** in
to penetrate through to all laye

Adapted: made suita
Surface area: the to
is exposed
Diffuse: to move fro
substance to where t

The next diagram shows a cross section of a leaf as it would be seen through a m
terms here, but you don't need to worry about all of these – just the ones in **bold**



The **palisade cells** and **spongy cells** are packed full of chloroplasts, so most of the photosynthesis happens here.

The cells have air spaces between them. These air spaces connect to pores called **stomata** (singular: stoma) that open to the outside.

Palisade cells: colu
top of a leaf that hav
Spongy cells: irregu
middle of a leaf that
them and lots of chlo
Stomata: small pore
that allow gases to d

Fun fact!
We depend completely on photosynthesis for all our food and for oxygen in the atmosphere.

Carbon dioxide moves in through stomata by diffusion to reach the cells, and oxy

The cells in the leaf are supplied with water by the **xylem vessels** that run up through the stem from the roots. Important minerals that are dissolved in water enter the roots and are carried in xylem. For example, magnesium is a mineral that is needed to make chlorophyll and **nitrate** is a mineral that is needed to make proteins. Some of these proteins are needed to make photosynthesis happen.

If soil does not contain enough minerals, then **fertiliser** can be added.

Xylem
carry w
roots to
Nitrate
soil wat
make p
Fertilis
or wast
increas
of soil

Q6: Explain two ways that leaves are adapted to do photosynthesis.

Q7: Name the gas that goes in through stomata when a plant is doing photosyn

Q8: Stomata can be opened and closed. Use information from the leaf section
which cells control this.
(Hint: they are located in the lower epidermis)

Q9: If a plant stops receiving magnesium, suggest how the leaves may change

Plants are not the only organisms that can do photosynthesis. **Algae** and some types of bacteria can also do photosynthesis. They are called **photosynthetic** for that reason. Algae mostly live in water and range from tiny microscopic plankton to huge seaweeds like kelp. The picture below shows an underwater kelp forest. Each kelp can grow up to 50 m tall!

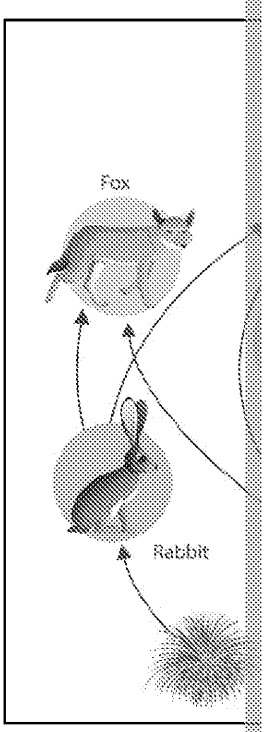
Algae:
whose
cells th
do pho
Photo
ability

Underwater kelp forest

Why is photosynthesis important?

Plants use the glucose that they make in photosynthesis as food. From glucose, they can grow, build fruits, make seeds, form flowers and carry out **respiration**. So, plants could not survive without photosynthesis.

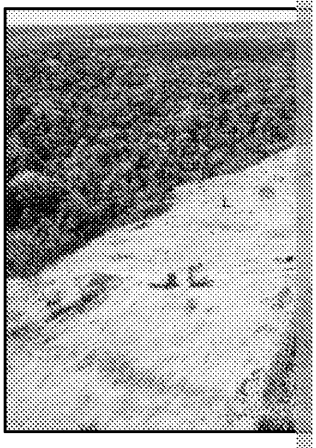
All animals depend on photosynthesis for food.
Even animals that do not eat plants directly feed on other animals that do. For example, rabbits eat grass, which is a plant. Predators of the rabbit, such as foxes, depend on rabbits for food, but rabbits in turn depend on plants.
Plants produce the chemical energy that animals need. The chemical energy is in the form of organic molecules, like proteins and fats. This is why there is always a plant at the start of any food chain or food web.



Fun fact!
No process can *make* energy. Energy can only be transferred from one store to another. For example, photosynthesis transfers light energy to chemical energy.

Plants existed on Earth long before animals. Before plants, there was not enough
The early plants increased the percentage of oxygen in the atmosphere and, at th
percentage of carbon dioxide. This was achieved using photosynthesis and allow

Plants continue to make oxygen for animals and other organisms that depend on it. This happens through photosynthesis. Photosynthesis is also the main way that carbon dioxide is removed from the atmosphere. This helps to reverse the effects of humans putting carbon dioxide into the atmosphere through combustion of fuels.



De

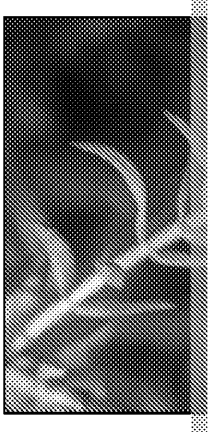
Fun fact!
We lose around 10 million hectares of forests each year – that's a big loss for photosynthesis!

Q10: Describe two ways in which animals depend on photosynthesis.

Q11: Name the gas that plants take in from the air during photosynthesis.

Q12: Explain, in terms of photosynthesis, why animals were not able to evolv

Working scientifically – investigating photosynthesis and understanding surface area



You can investigate photosynthesis quite easily using a common pondweed called *Elodea*. *Elodea* (pronounced ell-oh-dee-ah) is sold in shops that supply fish tank and aquarium supplies. The picture shows *Elodea* growing in a fish tank.

When you put *Elodea* in water and shine light on it, you can see small bubbles rising from the plant. You can usually see this at the end of the stem where it was cut, so it helps to cut the stem at an angle.

The diagram below shows how to set this up.

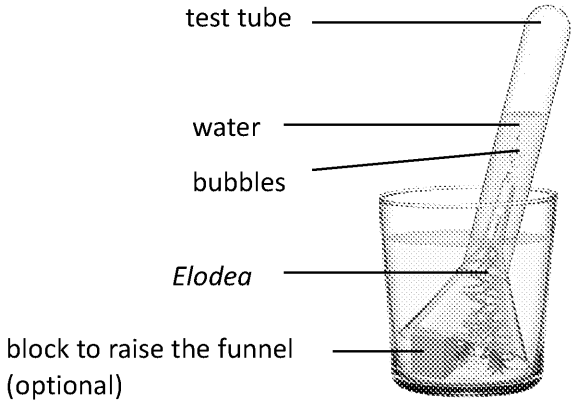


Photo
experi
with E

The speed at which photosynthesis is happening in the plant is called the **rate** of photosynthesis. You can measure the rate of a reaction by measuring how fast a product is formed. So, in this case you can either count the bubbles in a certain time or measure the volume of gas collected in a certain time.

Q13: Explain why there must be a source of light in the *Elodea* experiment.

Q14: What gas is coming out of the *Elodea* in the diagram?

There are three things that could affect the rate of photosynthesis in *Elodea*:

1. temperature
2. light intensity (brightness)
3. carbon dioxide concentration

You can change the carbon dioxide concentration in the water by adding differen sodium hydrogen carbonate (sometimes called sodium bicarbonate) to the wate experiment with 100 cm^3 water and 0, 1, 2, 3, 4 and 5 g of sodium hydrogen carb

Q15: When changing the mass of sodium hydrogen carbonate dissolved in tha variables need to be controlled (kept the same) in order to compare the r

Q16: If the temperature is to be changed, suggest the temperatures that coul

Temperature, light intensity and carbon dioxide concentration are all factors in th
They are not part of the plant itself.

One major factor that affects the rate of photosynthesis in a plant is the surface a

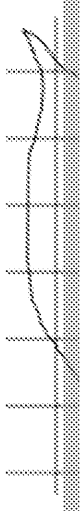
A method for measuring surface area is to place the leaves on graph paper and d
calculate the area of one square on the paper, you can then count the squares co
total area.

For example, if graph paper has squares that are 2 mm × 2 mm, then the area of

2 × 2
= 4 mm^2

Note that the unit in the answer has a squared symbol because it is a length time

You would count complete squares and squares that are more than half inside the leaf shape. You would leave out the squares that are less than half inside the leaf shape.

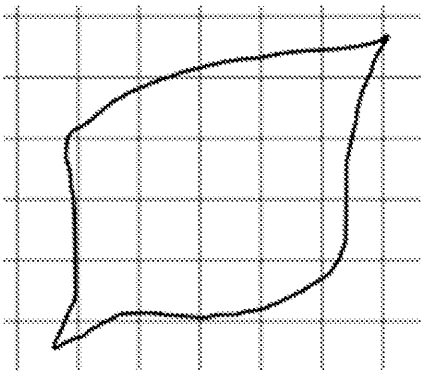


The example shows which squares to count.

Of course, a leaf has two surfaces: top and bottom. We usually only work out the surface area of the top because this is the area exposed to sunlight.

Q17: Paper is printed with squares that are 1 mm across. What is the area of

Q18: A student has graph paper with squares that are 1 cm × 1 cm.
The student places a leaf on that paper and draws around the leaf as sh



Use this information to work out the surface area of this leaf.

You can change the surface area in *Elodea.* Take several pieces of *Elodea* that are
different numbers of leaves from each. Then set up the experiment as shown on

Q19: When changing the surface area of *Elodea*, the lengths of the plants are
List as many other variables as you can that need to be kept the same in
(Hint: two variables is a good answer, three is very good and four is exce

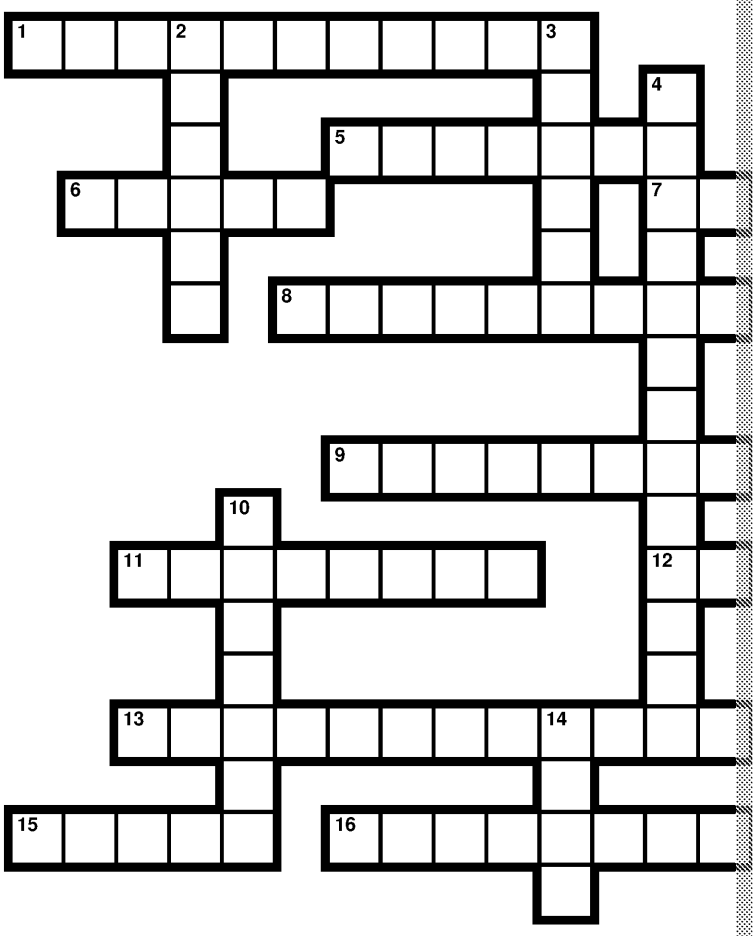
Q20: Make a prediction of how surface area of leaves would affect the rate of
Give reasons for your prediction.

If you have time, or have the resources, then you could try this experiment. Ligh
to change. You can do this by moving a bright lamp to different distances from th
careful when working with electricity and water together!

Let your teacher check your plan before you set up the experiment.

If you do not have the time or the resources, there are plenty of online simulatio
Search online for 'pondweed photosynthesis simulation'. Have fun!

Crossword



Across

1 Green pigment in leaves (11)

5 Small pores in the underside of leaves that let gases in and out (7)

6 The meaning of 'photo' in photosynthesis (5)

7 Where plants take in water and minerals (5)

8 How gases move in and out of a leaf (9)

9 Mineral needed to make chlorophyll (9)

11 Tall, thin cells near the top of a leaf that are packed with chloroplasts (8)

12 Hollow tubes that carry water and minerals in plants (5)

13 Organisms that can do photosynthesis are described as... (14)

15 Besides plants, these organisms can also do photosynthesis (5)

16 This can be added to soil to increase the mineral content (10)

End-of-topic Questions

1. Write down the meaning of the word photosynthesis.

2. In photosynthesis, name
   (a) one reactant
   (b) one product

3. Name **two** things that are needed for photosynthesis to happen, but are **no**

4. (a) Explain why plants are called producers.
   (b) **Challenge!** Try to think of one food that we eat that is **not** a plant or pl
   plant at the start of its food chain. (Must be a food and not a food addi
   ingredient such as water.) Write down your chosen food.

5. Copy and complete these sentences using words from the list. You may not

   oxygen **chlorophyll** **water** **carbon dioxide**

   The store of chemical energy produced during photosynthesis is called _____
   Photosynthesis is the main way that _____ *gas gets out of the atm*
   The reactant in photosynthesis that is taken in through roots is _____

6. Name the group of organisms that have cells like those in animals and that c

7. The diagram to the right shows part of a section through a leaf.
   Write down
   (a) the type of specialised cells in layer B
   (b) the letter of the layer where most stomata are found
   (c) the letter that shows a spongy cell
   (d) (i) the name of the vessels labelled D
   (ii) the substances carried in the vessels labelled D

8. A farmer adds fertiliser to soil. The fertiliser contains magnesium and nitrate. Explain why these two substances are included in the fertiliser.

9. A student investigates the rate of photosynthesis using the pondweed *Elodea*.
   The student varies the distance of a lamp from the *Elodea* and counts the number of bubbles produced in 1 minute at each distance.
   (a) For this experiment, write down:
   (i) the independent variable [**hint:** this is the variable that you decide
   (ii) the dependent variable [**hint:** this is the variable that depends on
   (iii) **three** control variables [**hint:** these are variables that are kept the
   (b) The table shows the student's results.

distance between the lamp and *Elodea* / cm	number of bubbles in		
	experiment 1	experiment 2	exp
10	38	36	
20	16	19	
30	7	8	
40	5	4	
50	4	4	

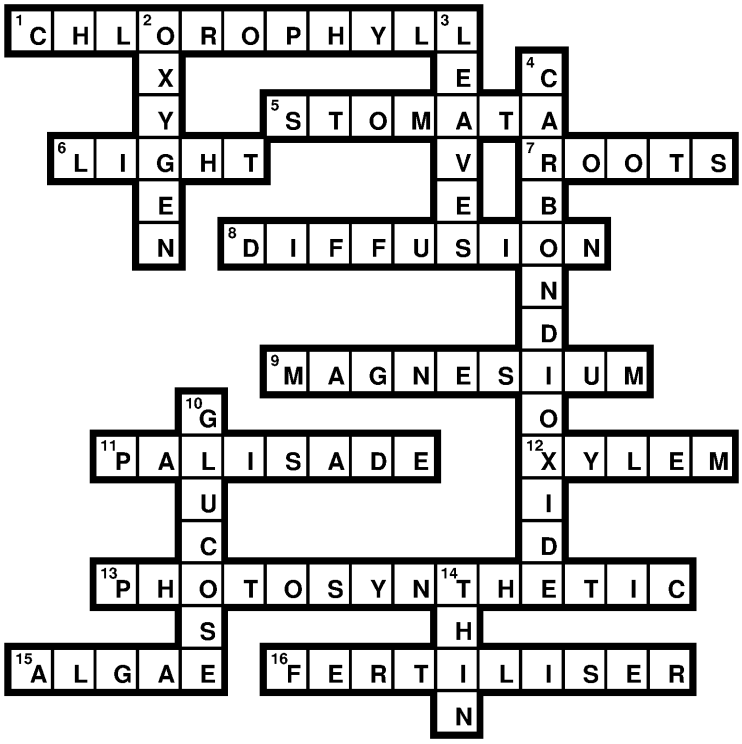
   (i) Calculate the mean for the 20 cm distance. Round your answer to
   (ii) The student thinks one of the results is anomalous. Which one? [
   the pattern]
   (iii) Describe what the student should do about this anomalous result.

Answers

Comprehension questions

1. the chemical reaction where plants make glucose (and oxygen) from carbon dioxide
   chlorophyll and energy from light
2. $$\text{carbon dioxide + water} \xrightarrow[\text{sunlight}]{\text{chlorophyll}} \text{glucose + oxygen}$$
   chemical formulae can be used but only credited if correct
3. chlorophyll
4. absorbing light to provide energy for carbon dioxide and water to react
5. (a) carbon dioxide and water
   (b) glucose and oxygen
6. *two from:*
   - are thin – *either* to allow gases to diffuse in and out easily *or* to allow light to r
   - have stomata – to allow gases to diffuse in and out
   - *either* are green *or* have chloroplasts – to absorb light
   - large surface area – to absorb as much light as possible
7. carbon dioxide
8. guard cell(s)
9. lose their green colour *or* turn yellow *or* turn paler green
10. for food because plants are producers
    for oxygen OR for respiration because photosynthesis produces oxygen
11. carbon dioxide (not CO_2 because question asks for name)
12. animals would have had no food / animals depend on plants for food
    there would not have been any/enough oxygen in the air for them
13. because light is needed for photosynthesis to happen
14. oxygen
15. - same mass *or* length *or* same piece of *Elodea*
    - same temperature
    - same light intensity *or* same light source
    - bubbles counted *or* volume of gas measured for the same time
16. - no less than 0 °C and no more than 100 °C
    - temperatures given in equal intervals
    - minimum of five temperatures given
17. 1×1
    $= 1\ mm^2$
    answer must include unit
18 each square = $1\ cm^2$
    number of squares = 17
    surface area = $17\ cm^2$
    if this is doubled to give top and bottom, or total, surface area then this must be sta
19. - temperature
    - carbon dioxide concentration
    - light intensity or brightness of light
    - method of determining the rate (e.g. counting bubbles or measuring gas volur
20. the greater the surface area, the greater the rate of photosynthesis (or reverse argu
    leaves are where (most) photosynthesis happens
    more leaves means more photosynthesis
    reference to some photosynthesis happening in the stem because it is green

Crossword



End-of-topic questions

1. making glucose / making carbohydrate / making food
   from carbon dioxide and water / from simple inorganic molecules
   using energy from sunlight
   using chlorophyll
   accept a correct word equation with light and chlorophyll on the arrow
2. (a) *either* carbon dioxide *or* water
   (b) *either* glucose *or* oxygen
3. light
   chlorophyll
4. (a) plants carry out photosynthesis
   producing food for animals
   (b) mushrooms or any fungal product, e.g. mycoprotein
5. The store of chemical energy produced during photosynthesis is called **glucose**.
   Photosynthesis is the main way that **carbon dioxide** gas gets out of the atmosphere.
   The reactant in photosynthesis that is taken in through roots is **water**.
6. algae
7. (a) palisade
   (b) E
   (c) C
   (d) (i) xylem
   (ii) water and minerals
8. they are minerals needed by plants
   magnesium to make chlorophyll
   nitrate to make proteins *or* to make amino acids
9. (a) (i) distance from the lamp *or* light intensity *or* brightness of the light
   (ii) rate of photosynthesis *or* number of bubbles in 1 minute
   (iii) • temperature
   • mass or length or surface area of *Elodea*
   • carbon dioxide concentration *or* mass / concentration of sodium hyd
   (b) (i) $\frac{(16+19+18)}{3} = 17.\dot{6}$ or 17.67
   = 18 to the nearest whole number
   (ii) 9 *or* the 40 cm distance, experiment 3
   (iii) repeat that experiment *or* omit that result from the mean