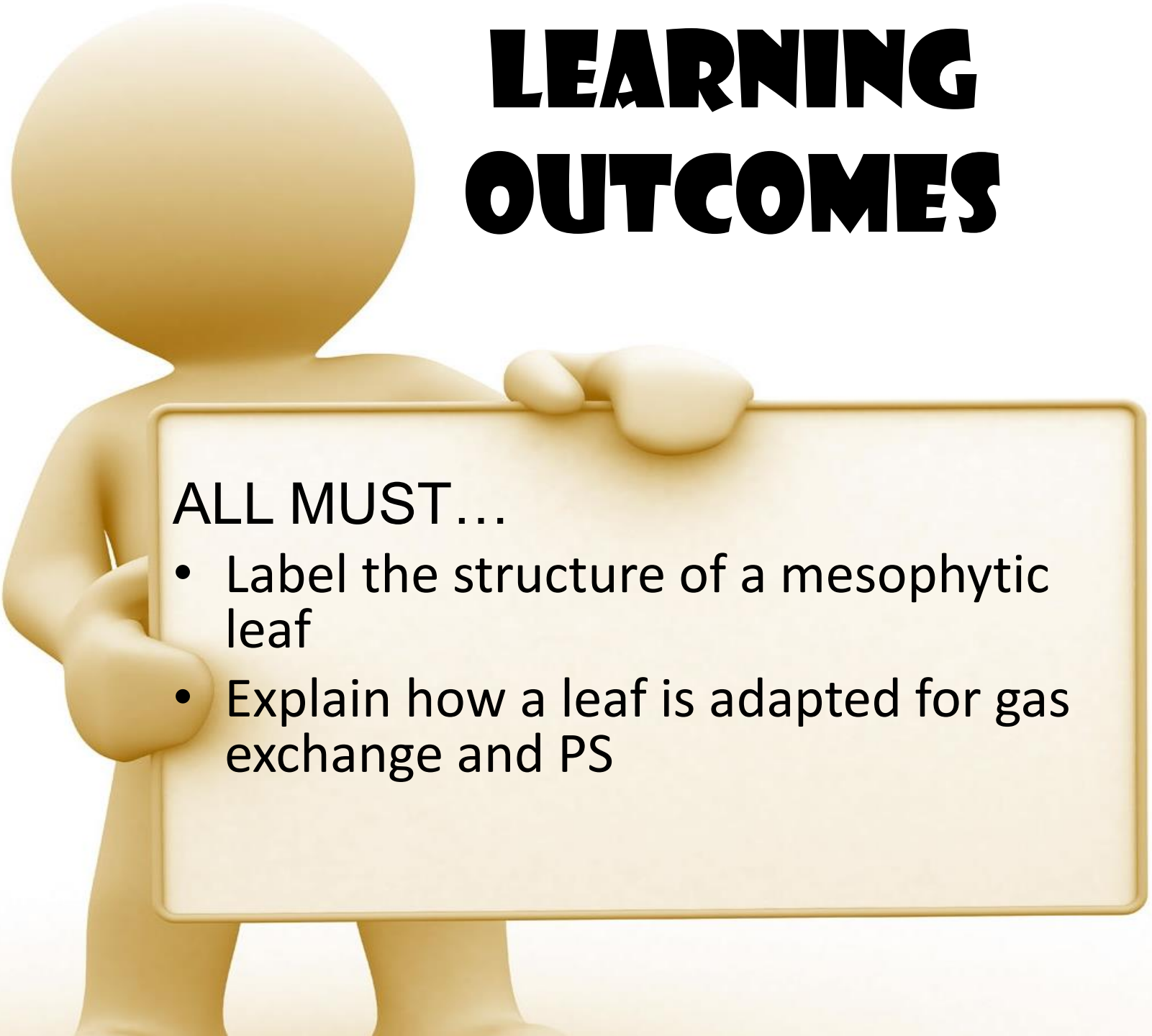

Glenlola Collegiate School
excellence through commitment, contribution and caring
1.2
Photosynthesis

starter activity

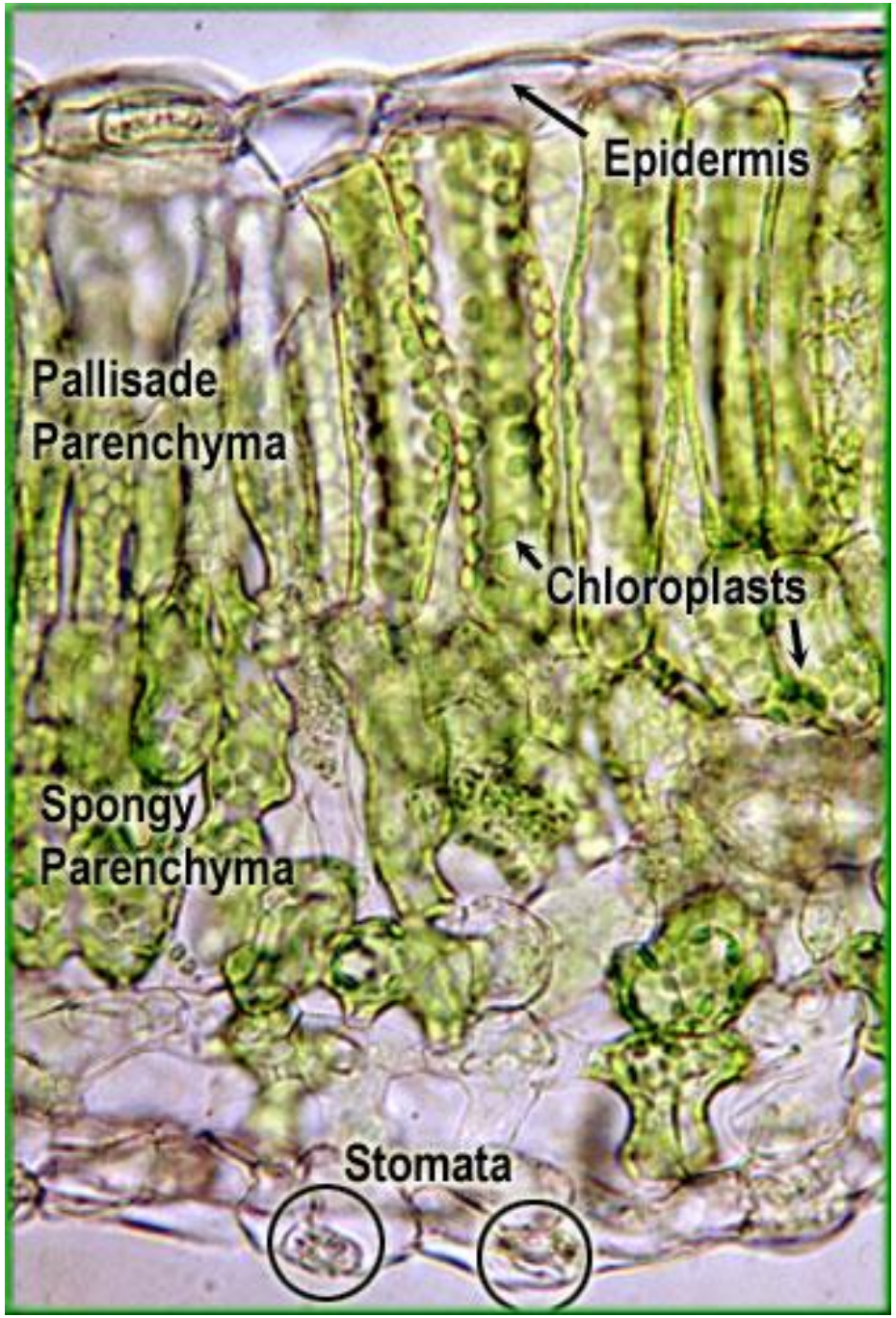
- View celery growing in highlighter fluid
- Describe what you saw
- Explain what you saw
- Share your description and explanation

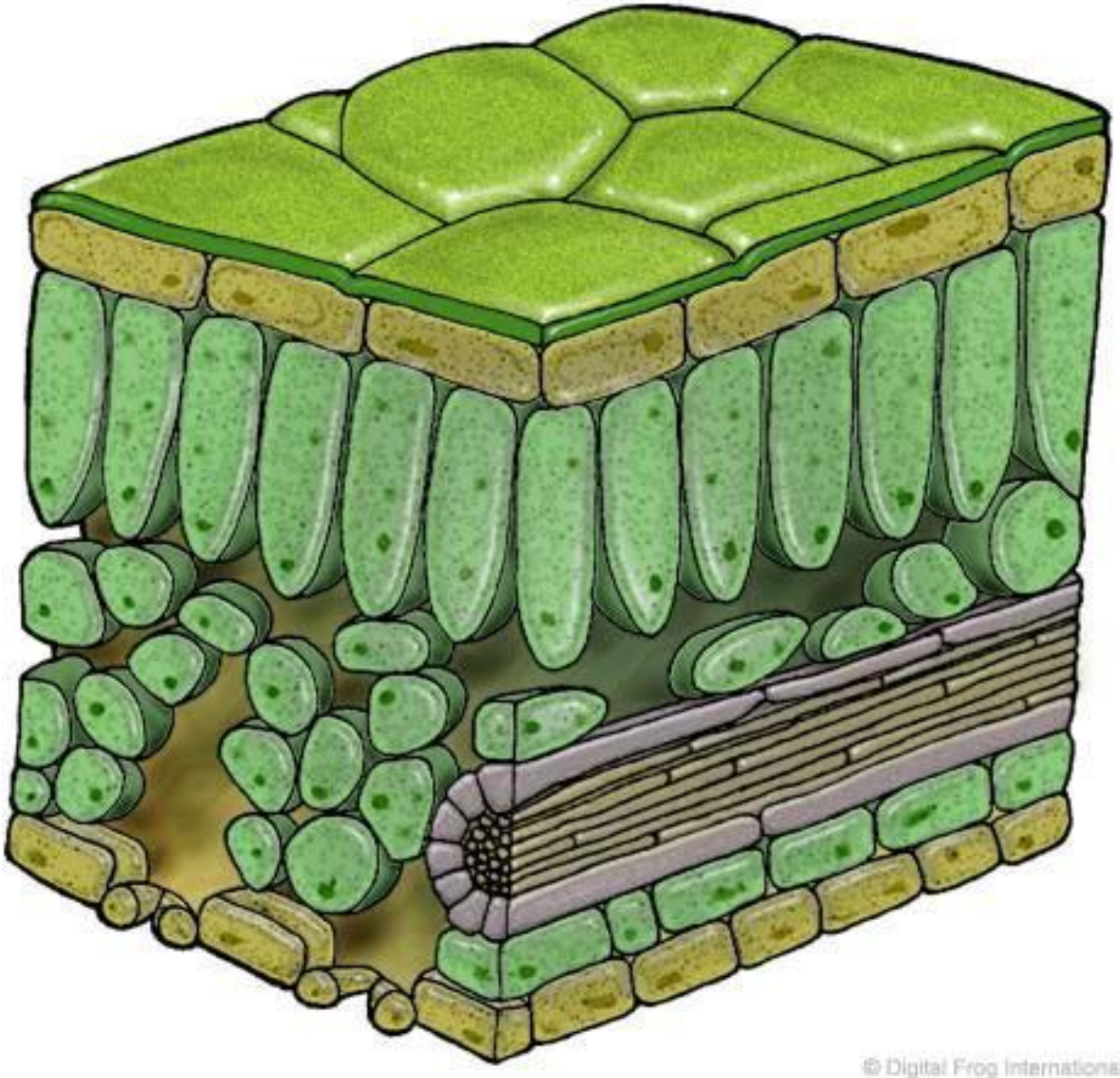
LEARNING OUTCOMES

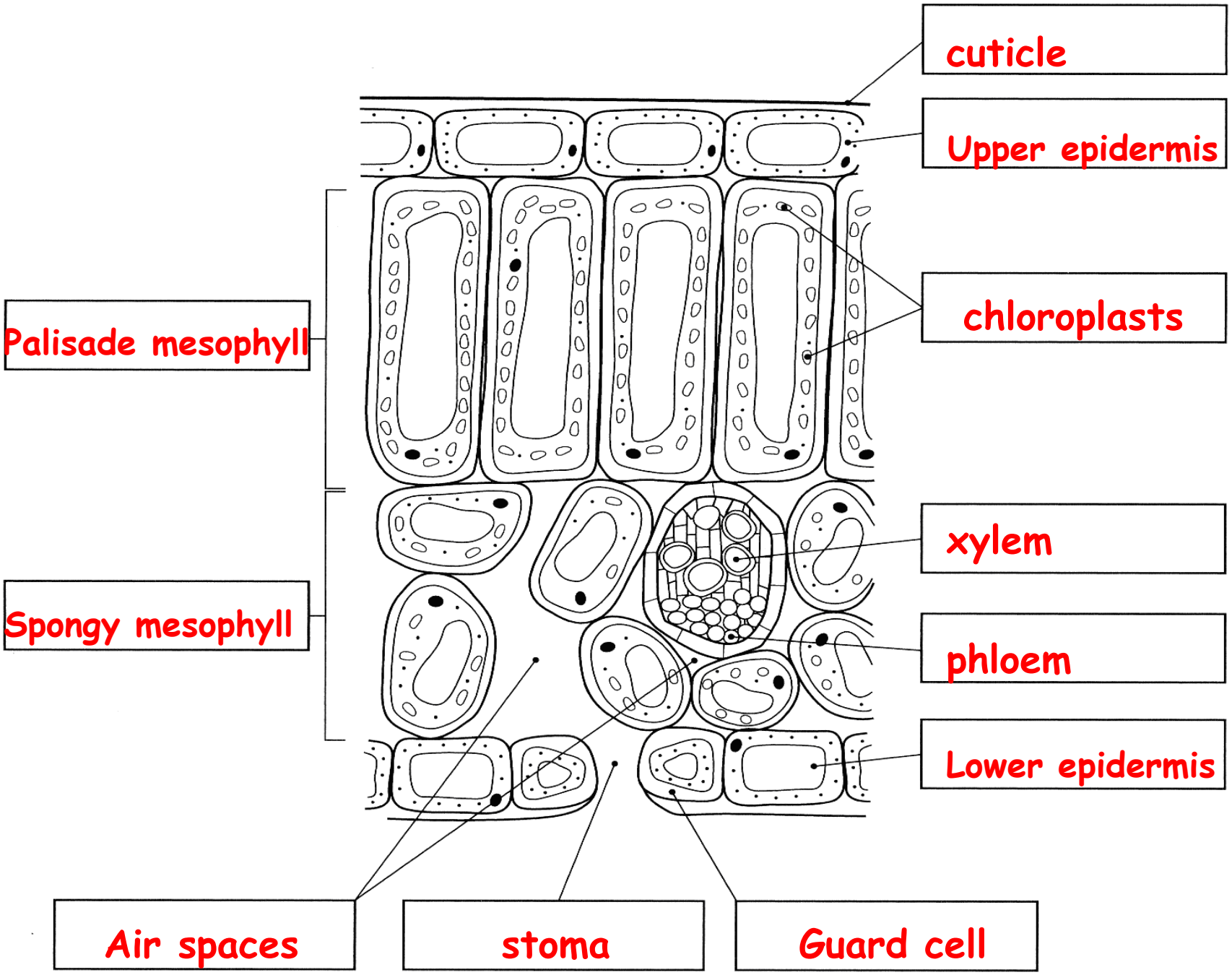


ALL MUST…

- Label the structure of a mesophytic leaf
- Explain how a leaf is adapted for gas exchange and PS


Epidermis
Pallisade
Parenchyma
Chloroplasts
Spongy
Parenchyma
Stomata




cuticle
Upper epidermis
chloroplasts
Palisade mesophyll
xylem
Spongy mesophyll
phloem
Lower epidermis
Air spaces
stoma
Guard cell

Structure of a Leaf

Epidermis

Single layer of cells around the leaf:
Upper and lower epidermis

Flat, no chloroplasts
to allow light to pass through

cuticle

Waxy layer covering the upper epidermis

Reduces water loss

Palisade mesophyll

Layer of rectangular shaped cells found below the upper epidermis

Cells arranged side by side, no spaces – traps as much sunlight as possible

Many chloroplasts – lots of photosynthesis

spongy mesophyll

Layer of round cells below palisade cells

Fewer chloroplasts, less photosynthesis

Air spaces

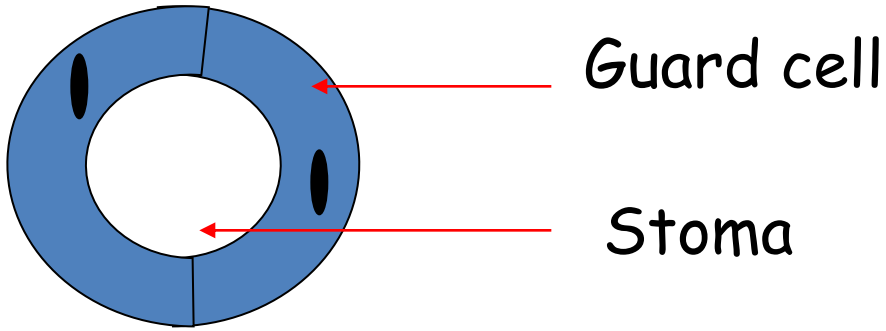
Intercellular spaces

Spaces between the spongy mesophyll cells

Allows diffusion of
oxygen, carbon dioxide and water
between inside the leaf and the air
outside

Stomata and Guard cells

A **stoma** is a small pore
found between the cells of the lower epidermis



Guard cells are the 2 cells that surround each stoma

They allow the stoma to open and close,
controlling movement of gases in and out of the leaf

Midrib and Veins

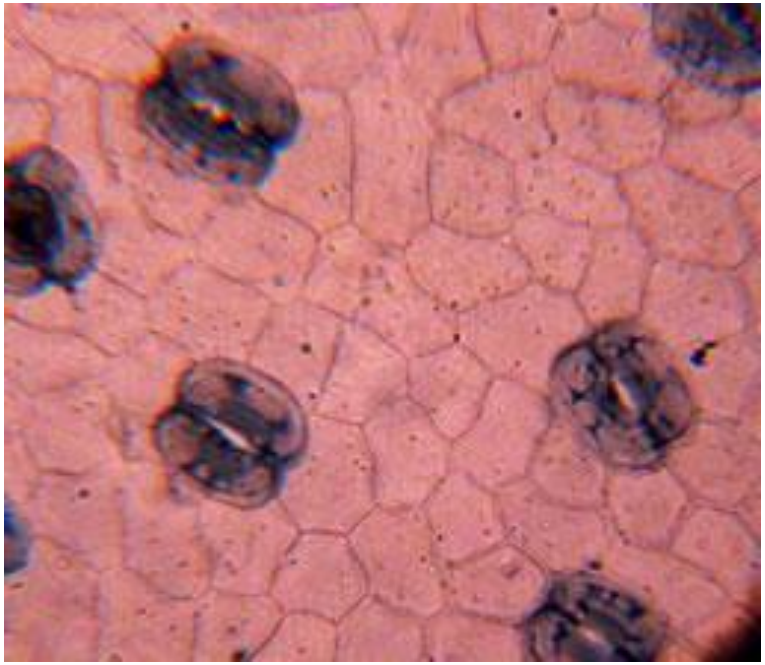
Contain vascular bundles made up of xylem and phloem

XYLEM carries water to the leaf cells from the roots

PHLOEM carries sucrose sugar made in the leaf cells to other parts of the plant

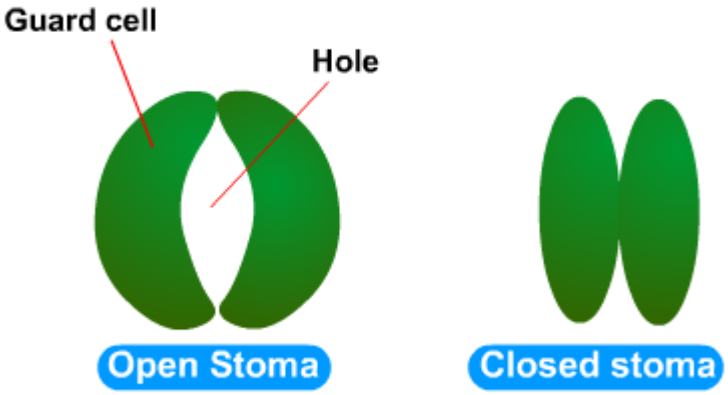
ADAPTATIONS OF A LEAF FOR PHOTOSYNTHESIS

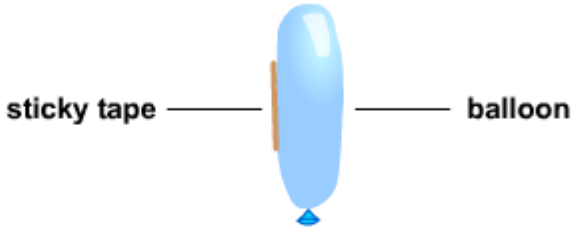
COMPLETE THE TABLE USING PAGE 10 & 11



stomata investigation

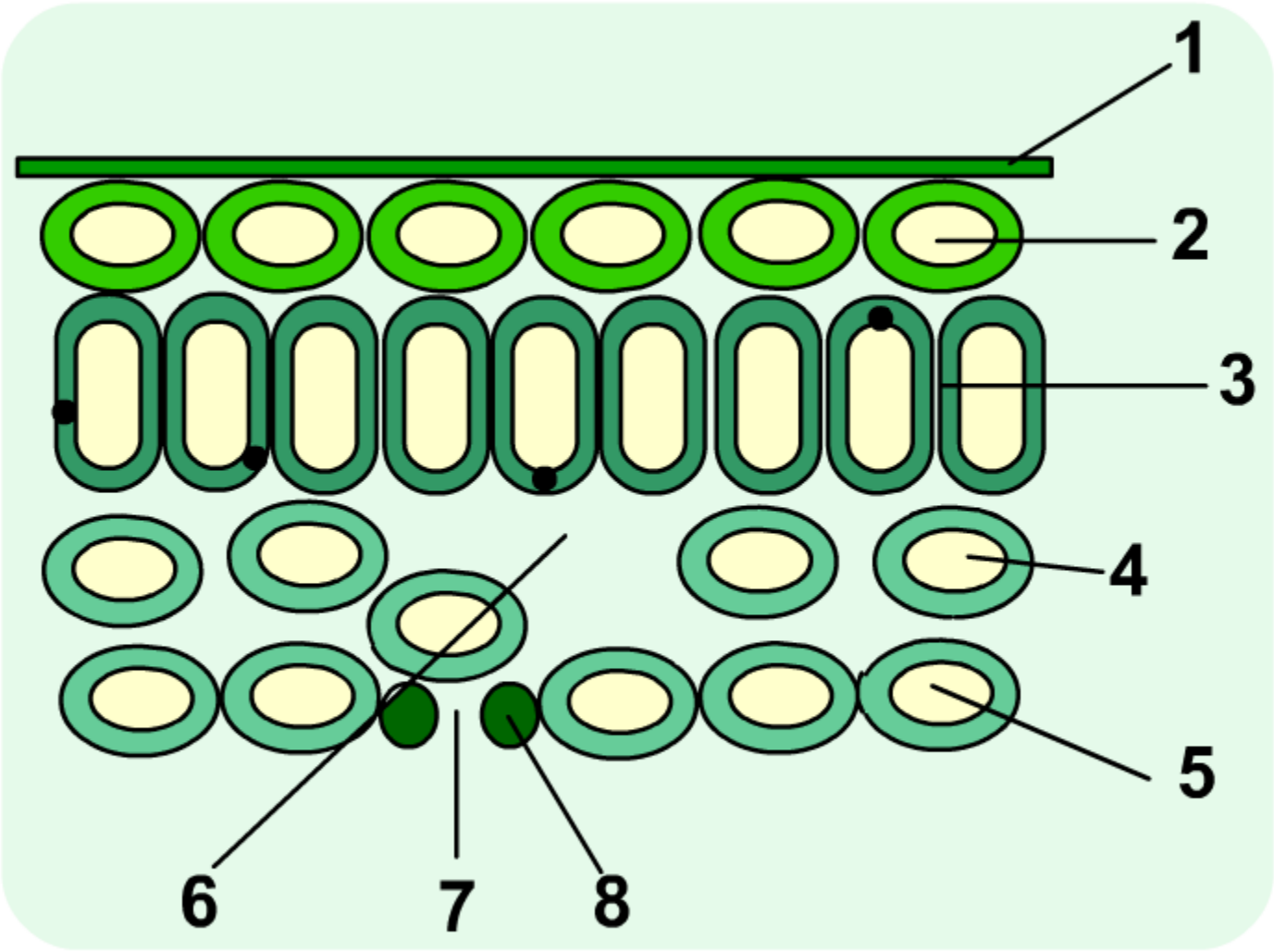
When stomata are open, water evaporates from the leaf.
There are fewer stomata on the surface of a leaf
than underneath because
it is cooler under the leaf (less sunlight), so less water is lost.





Imagine a balloon with sticky tape on one of its sides.

Next


1
2
3
4
5
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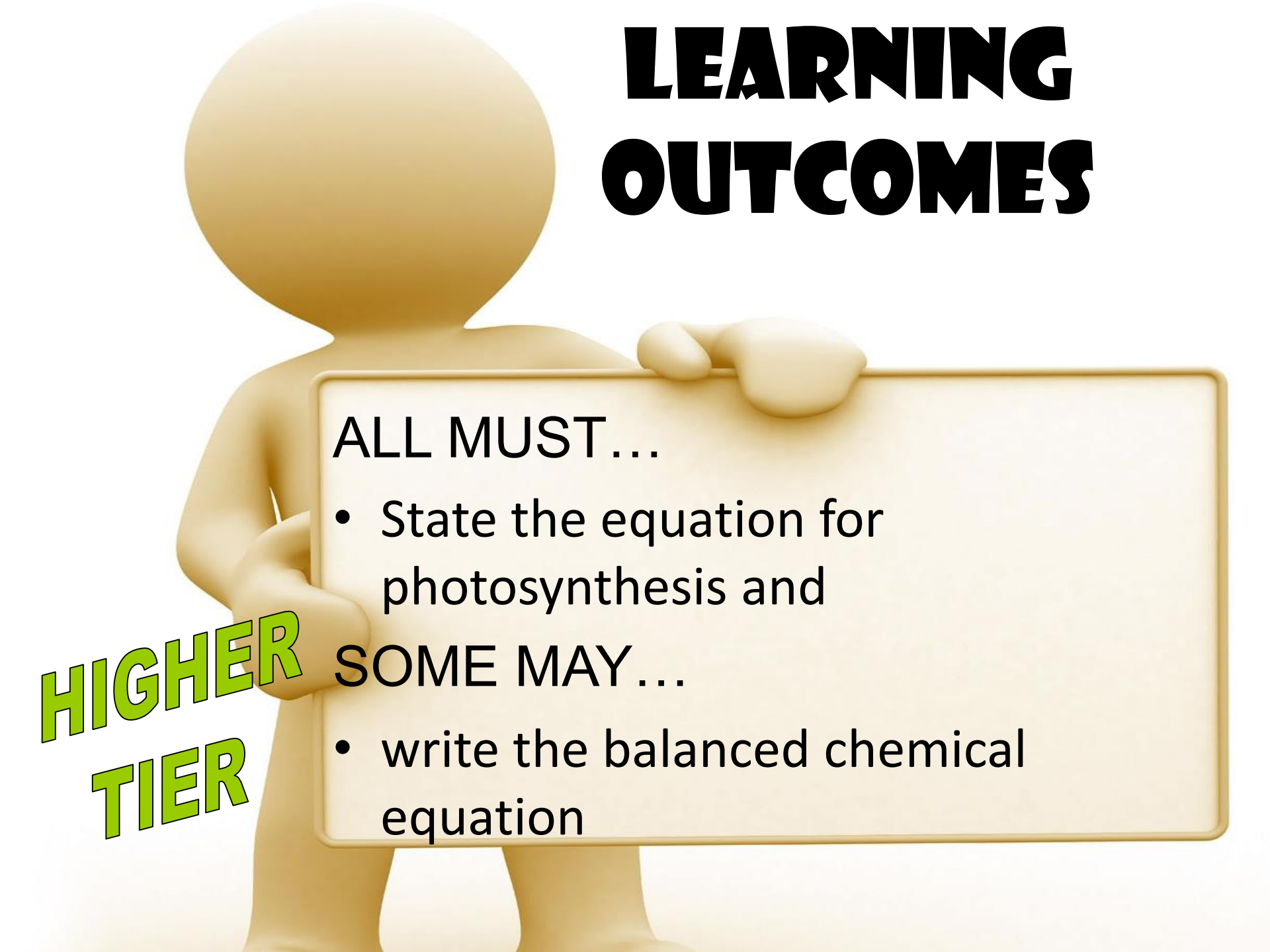
8

QUESTION 5A

LEARNING OUTCOMES



ALL MUST…

- State the equation for photosynthesis and

SOME MAY…

- write the balanced chemical equation

HIGHER TIER

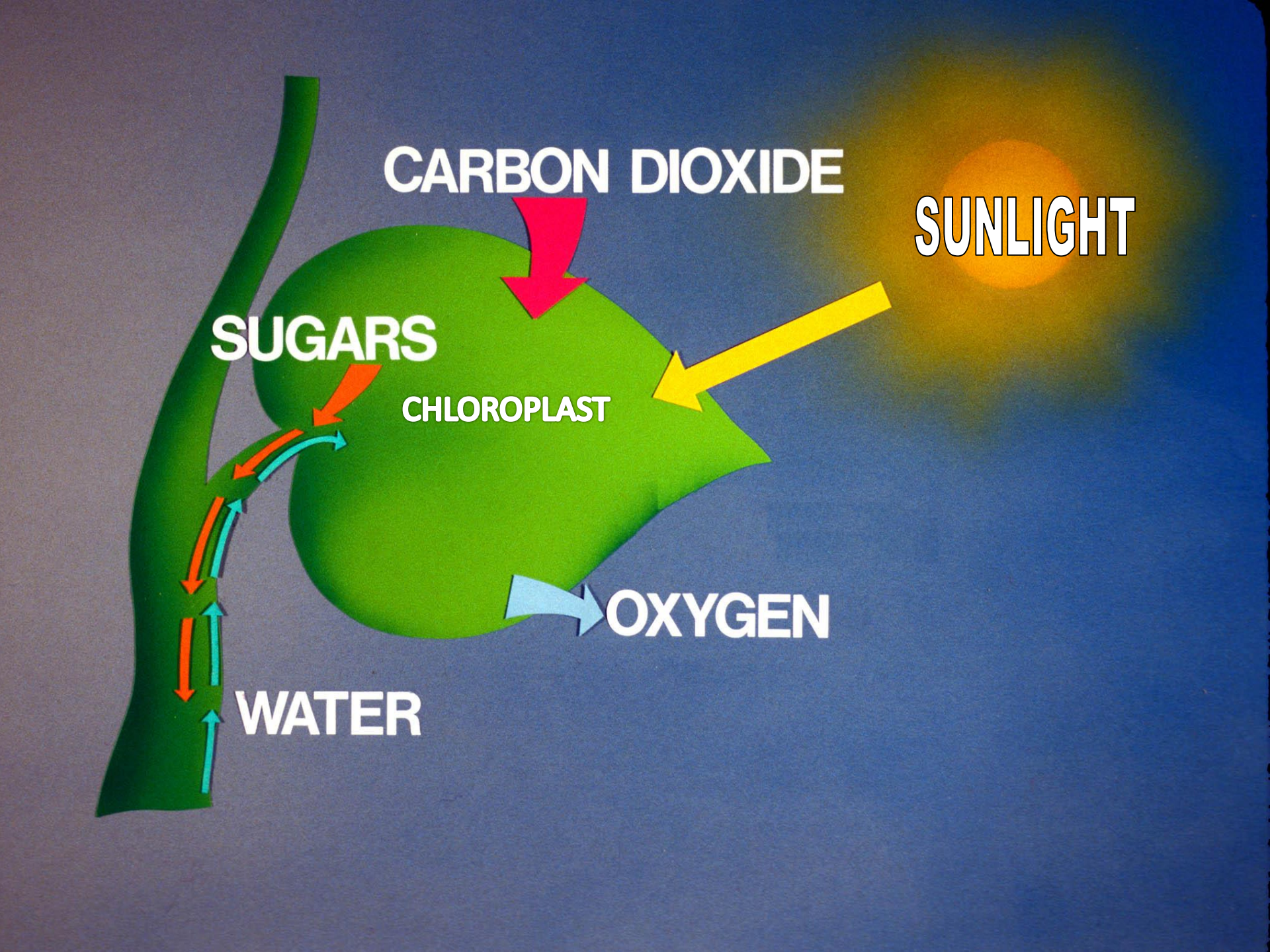
Read pages 19
old GCSE text book

Complete the notes on photosynthesis in your booklet to include:

- Raw materials
- Word equation
- Balanced chemical equation
- Products of photosynthesis

- 10605 Sc Eye

  BBC Bitesize Photosynthesis


CARBON DIOXIDE
SUNLIGHT
SUGARS
CHLOROPLAST
OXYGEN
WATER

How the materials for photosynthesis get to a palisade cell

- **WATER**

  travels from the roots up the xylem to the leaves

- **LIGHT**

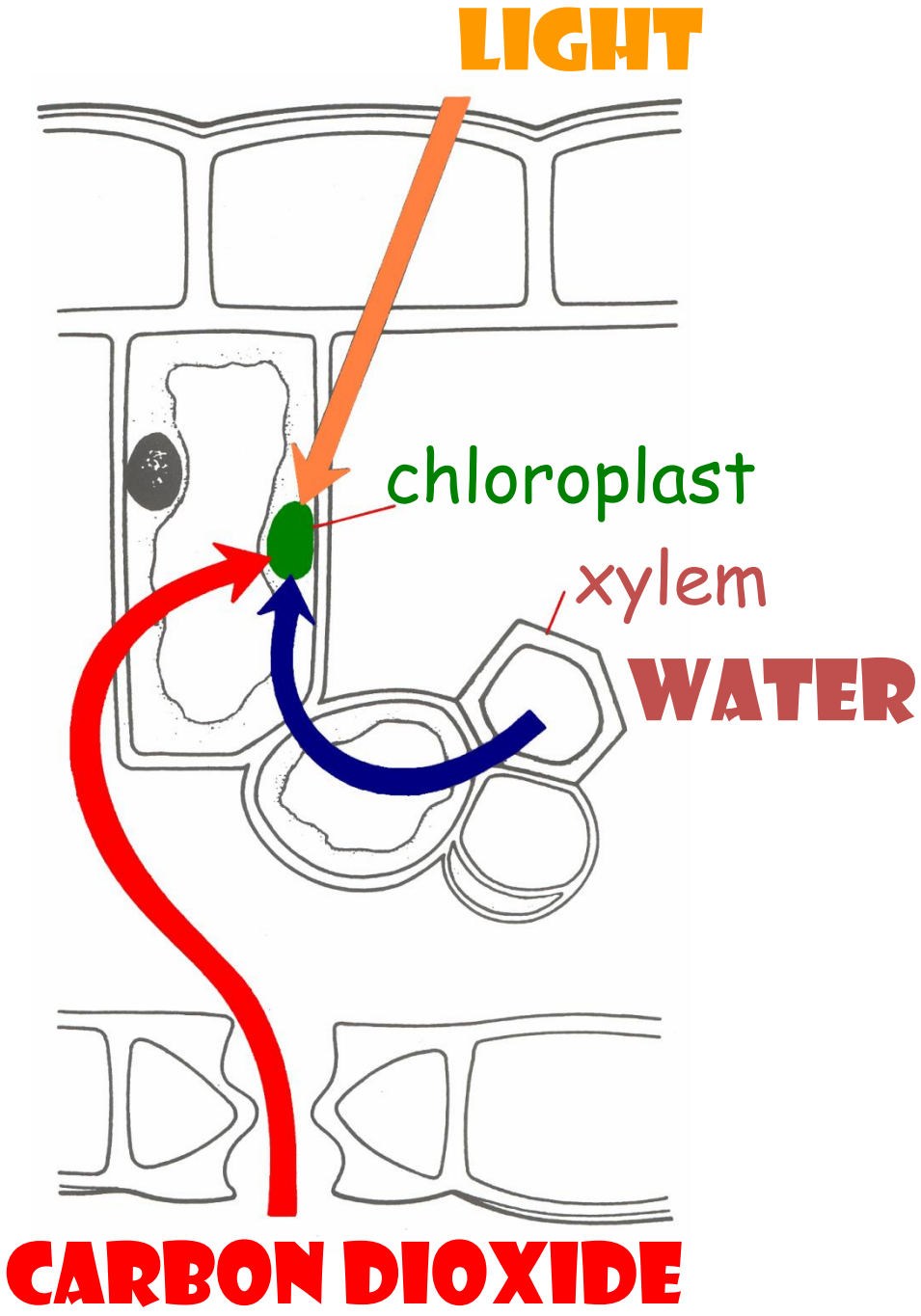
  enters through the clear epidermis

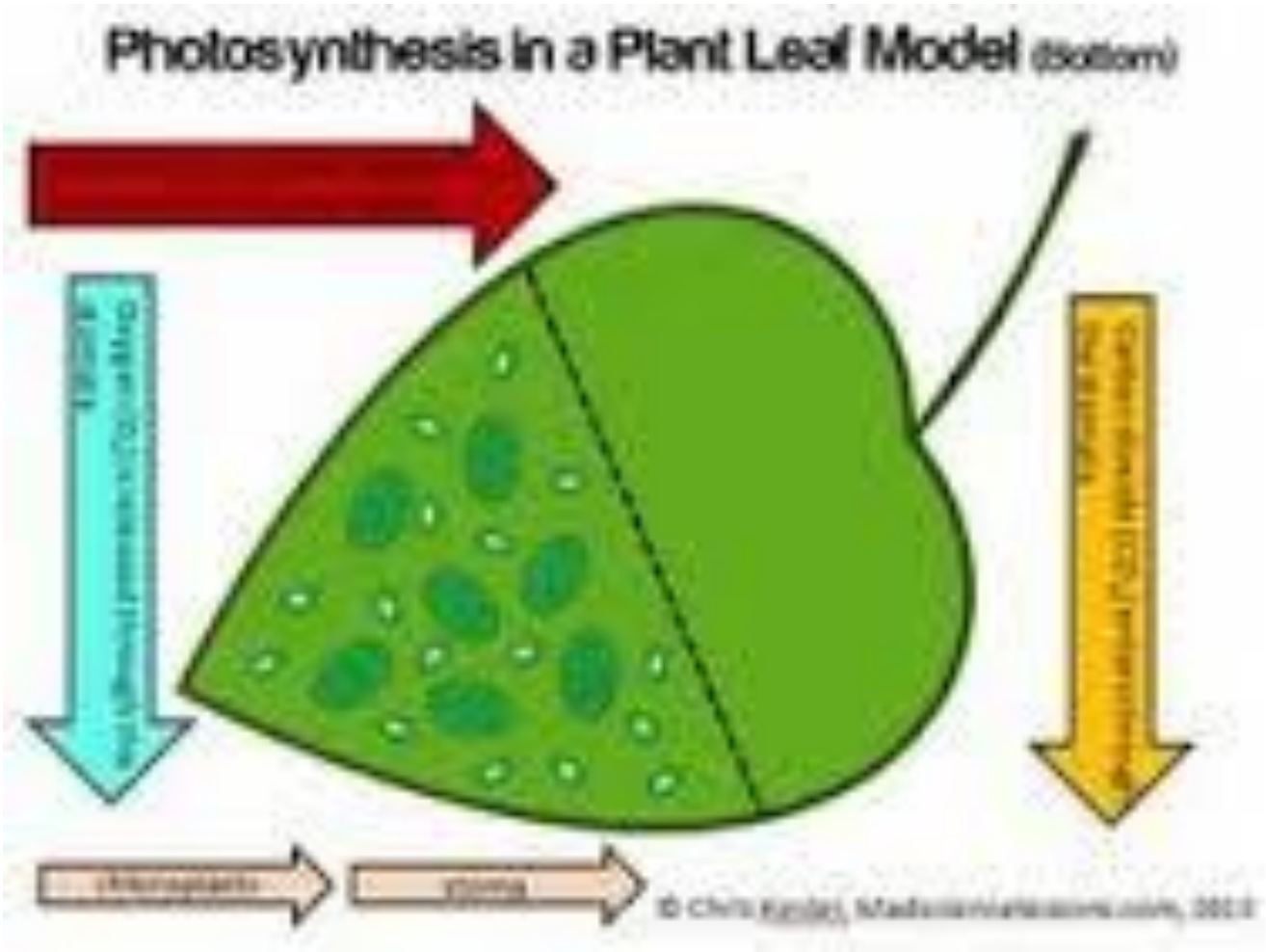
- **CARBON DIOXIDE**

  enters the leaf through the stomata

WORKSHEET

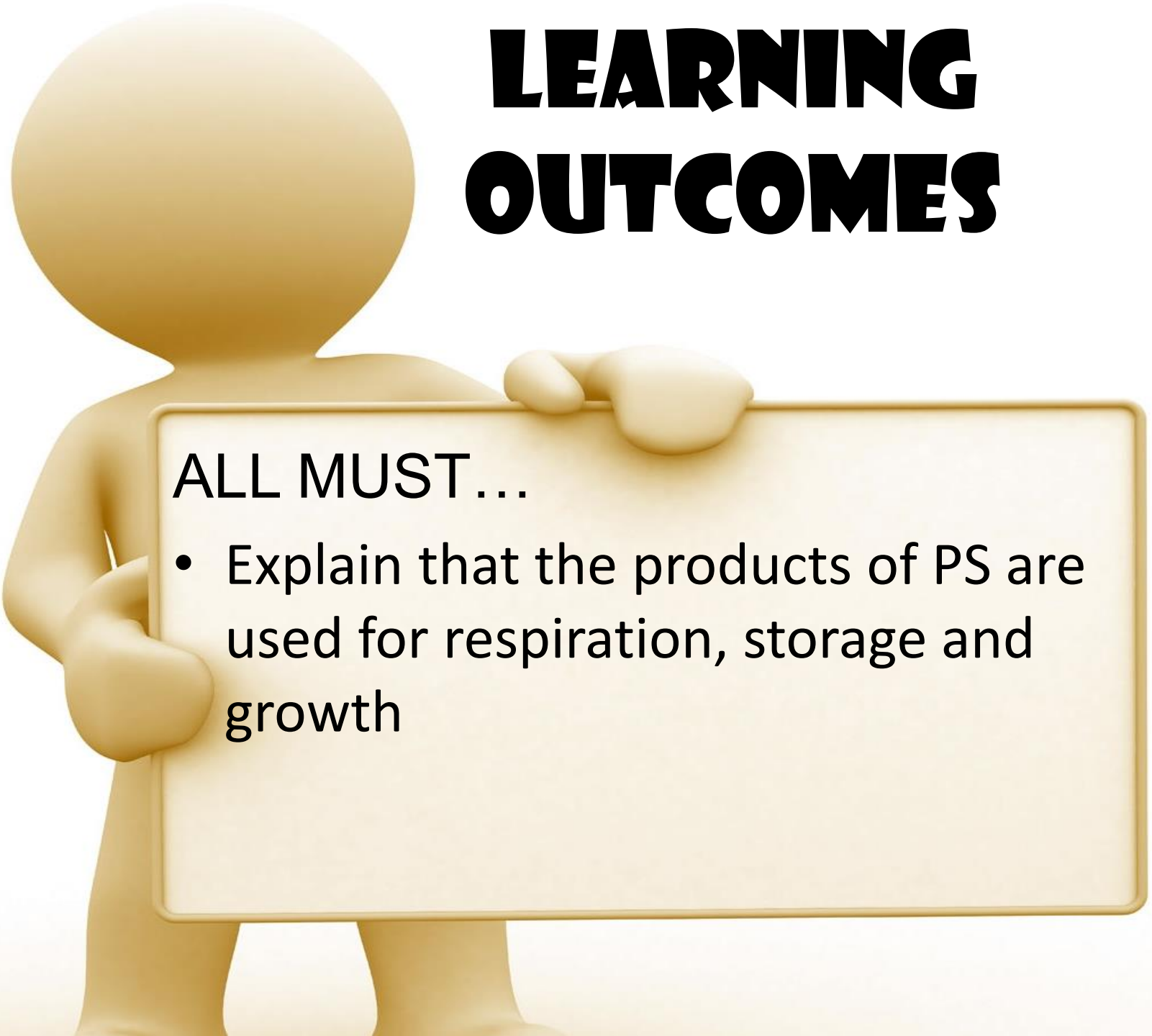
How the materials for photosynthesis get to a palisade cell





Leaf foldable

Learning Outcomes



ALL MUST…

- Explain that the products of PS are used for respiration, storage and growth

USING THE PRODUCTS OF PHOTOSYNTHESIS

Glucose is the main product of photosynthesis.
It is used in respiration to release energy.
Glucose is also converted into other substances.

Read page 22 and then complete the notes on how the following are used by the plant.

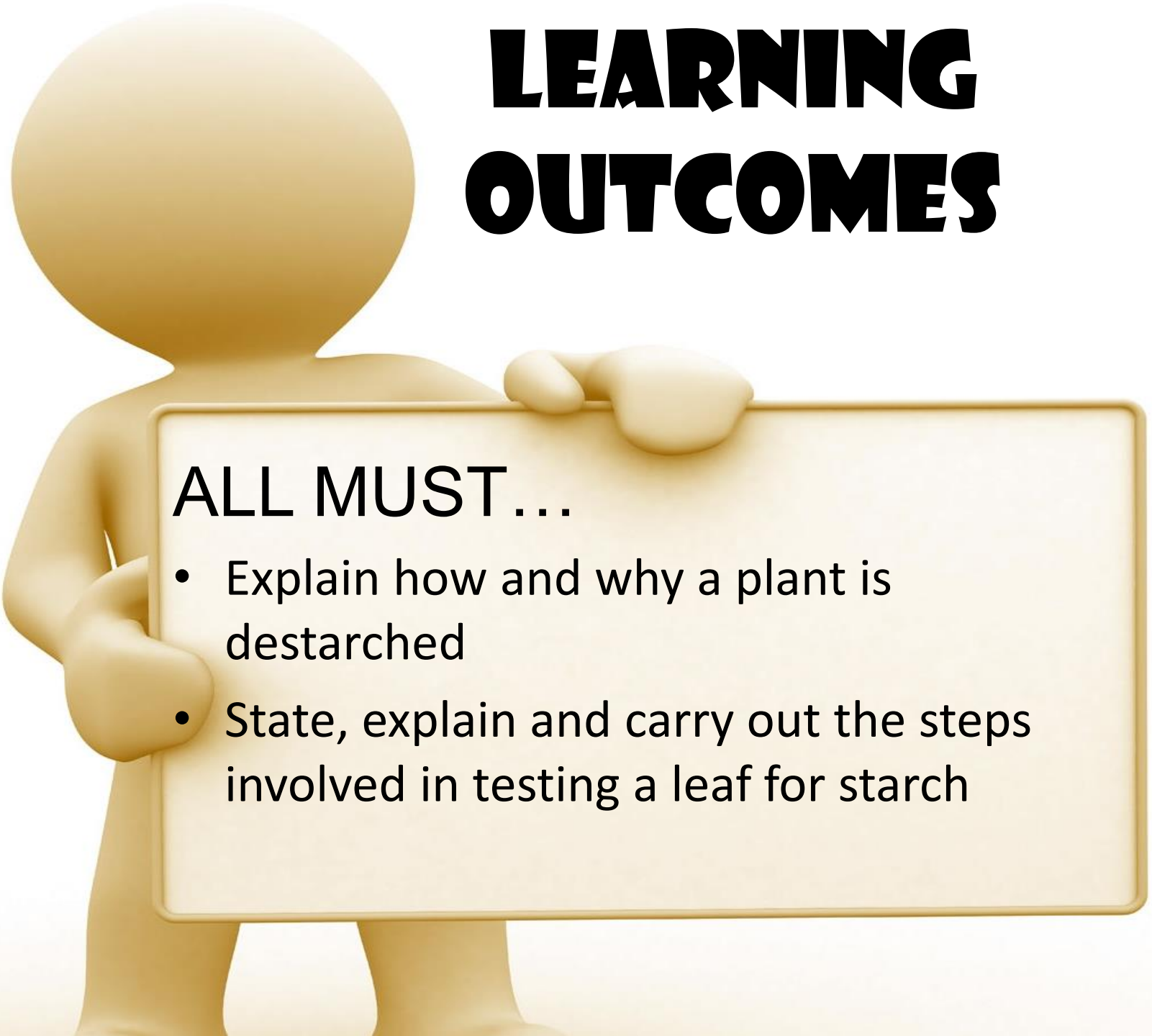
starch

cellulose

amino acids

lipids

LEARNING OUTCOMES



ALL MUST…

- Explain how and why a plant is destarched
- State, explain and carry out the steps involved in testing a leaf for starch

Testing a leaf for starch

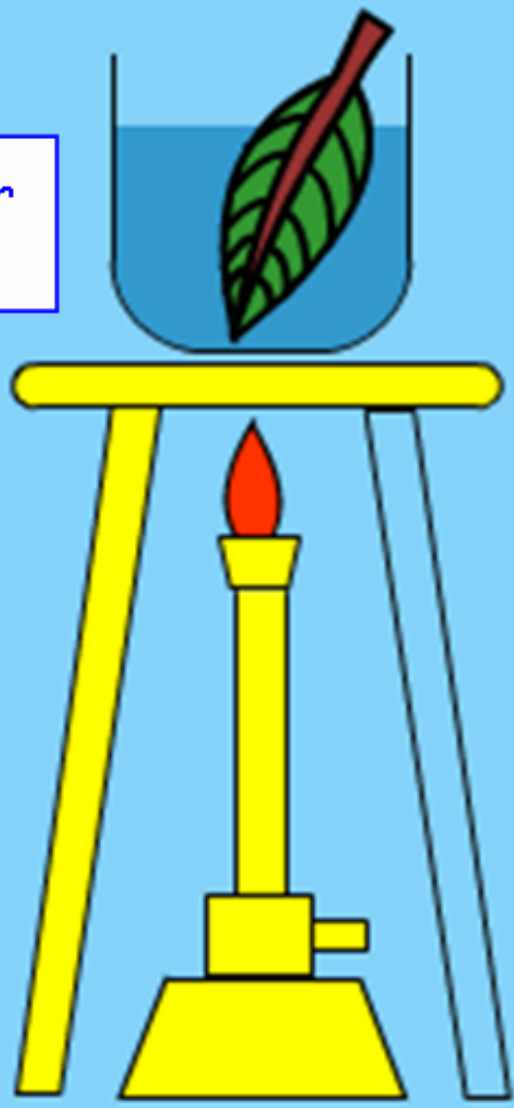
MAKE A KEY

describe

explain

Starch test

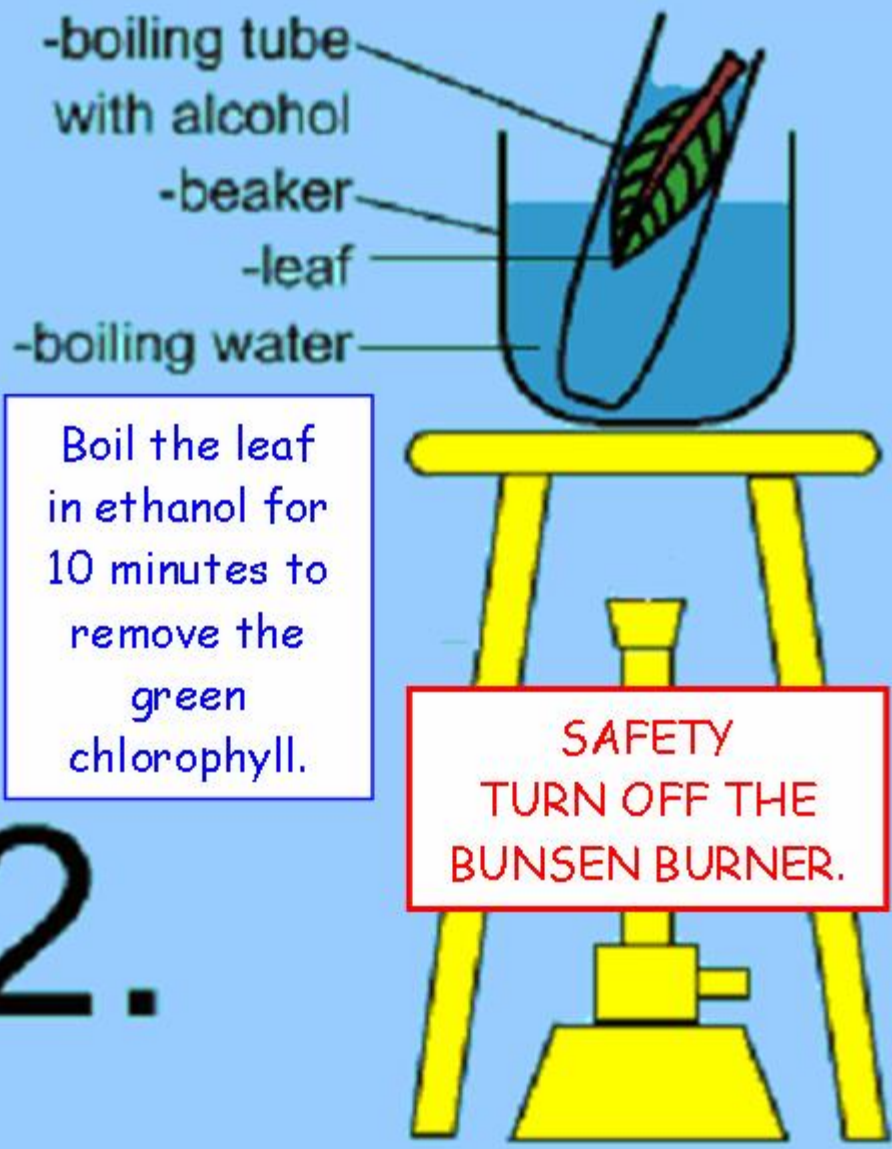
Boil the leaf for 30 seconds



Kills leaf & ensures no further reactions occur

1.

Starch test


-boiling tube with alcohol
-beaker
-leaf
-boiling water
Boil the leaf in ethanol for 10 minutes to remove the green chlorophyll.
2.
SAFETY TURN OFF THE BUNSEN BURNER.
ALCOHOL IS FLAMMABLE

Starch test

Dip the leaf in hot water to remove excess ethanol and soften it.

3.

Starch test

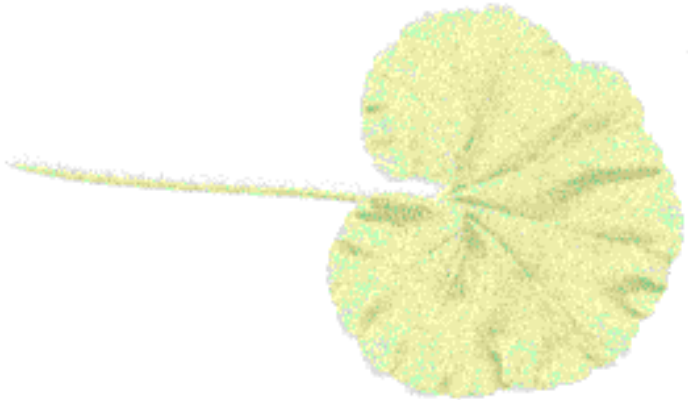
Add iodine solution. If the leaf turns blue/black starch is present.

4.

YELLOW/ORANGE MEANS

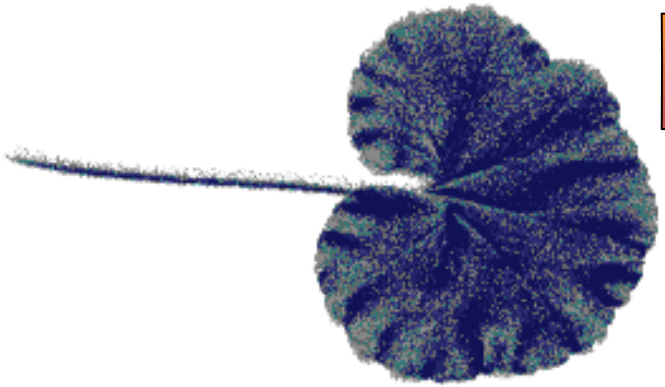
NO STARCH IS PRESENT

Leaf before testing

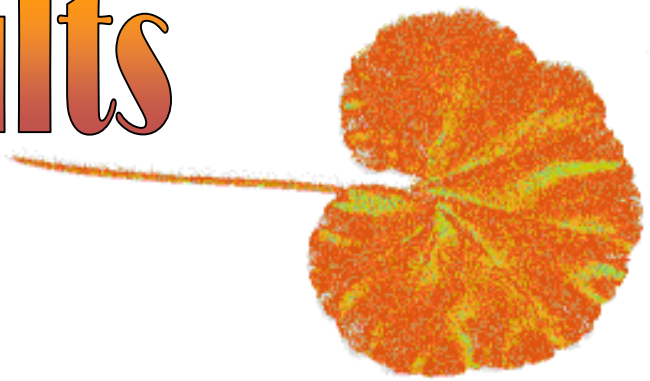


Leaf after boiling in ethanol

results

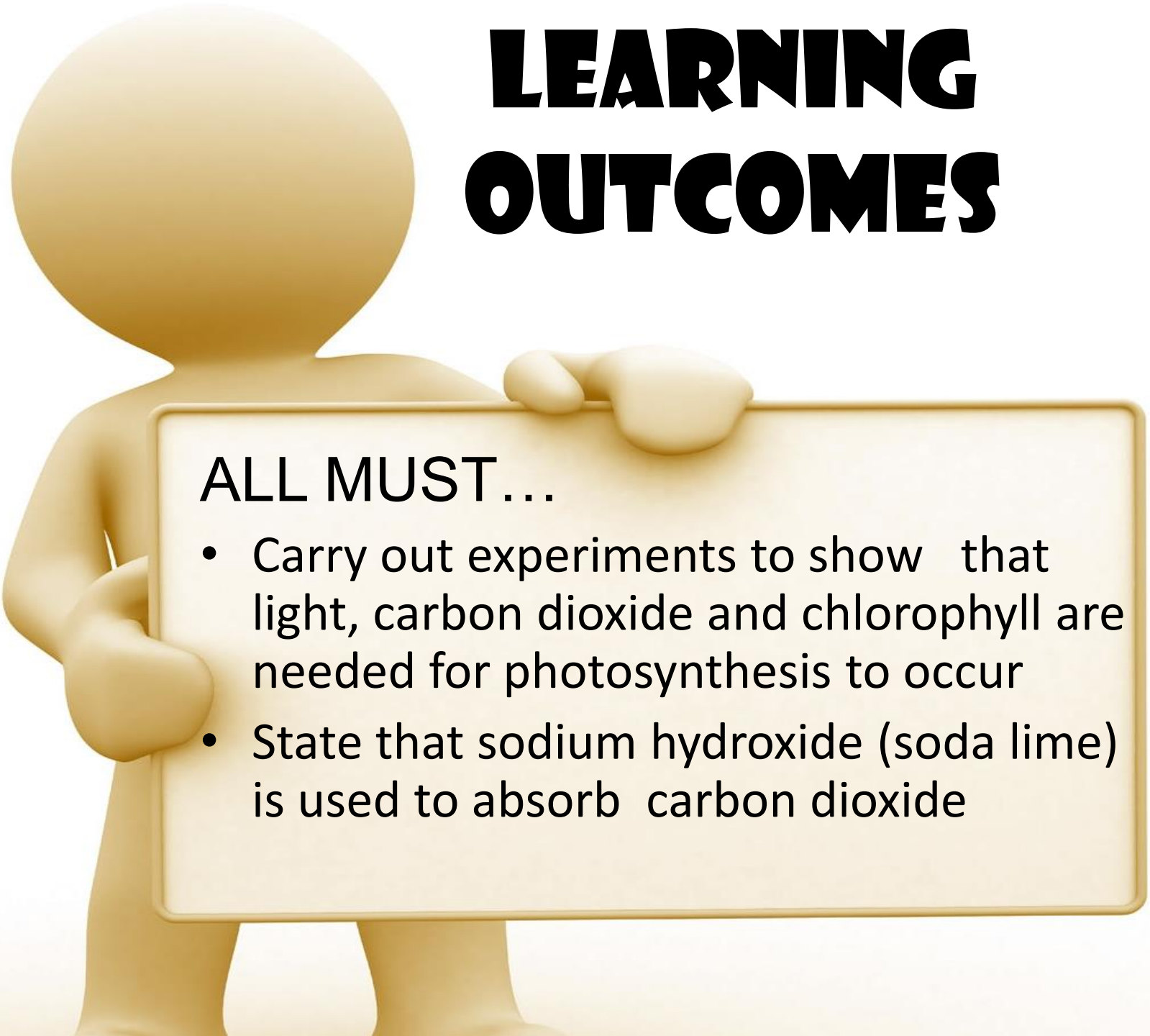


blue/black: contains starch



orange: no starch

LEARNING OUTCOMES

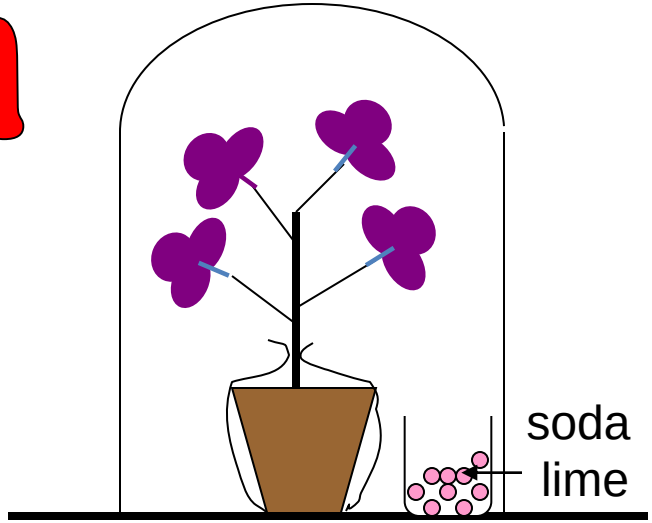


ALL MUST…

- Carry out experiments to show that light, carbon dioxide and chlorophyll are needed for photosynthesis to occur
- State that sodium hydroxide (soda lime) is used to absorb carbon dioxide

experiments to show factors needed for photosynthesis

destarch



soda lime
carbon dioxide

variegated
chlorophyll

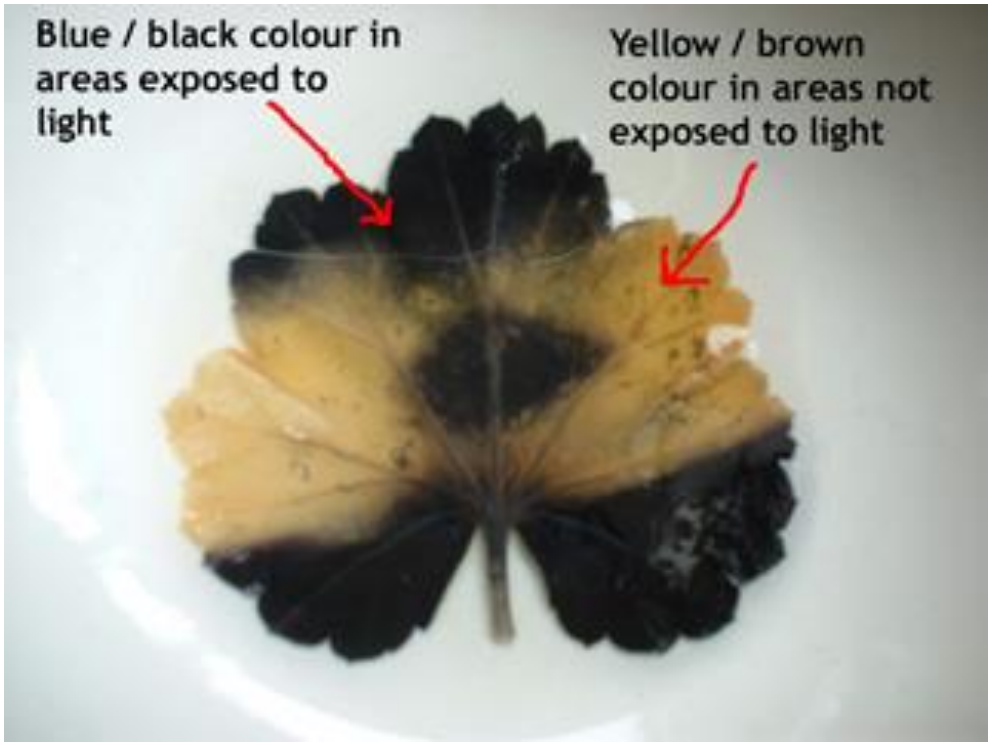
Photosynthesis investigations

De-starching the plant

- Place the plant in a dark place for 48hrs
- This removes all the starch from the leaf
- It shows that any starch found has been produced during the period of the investigation

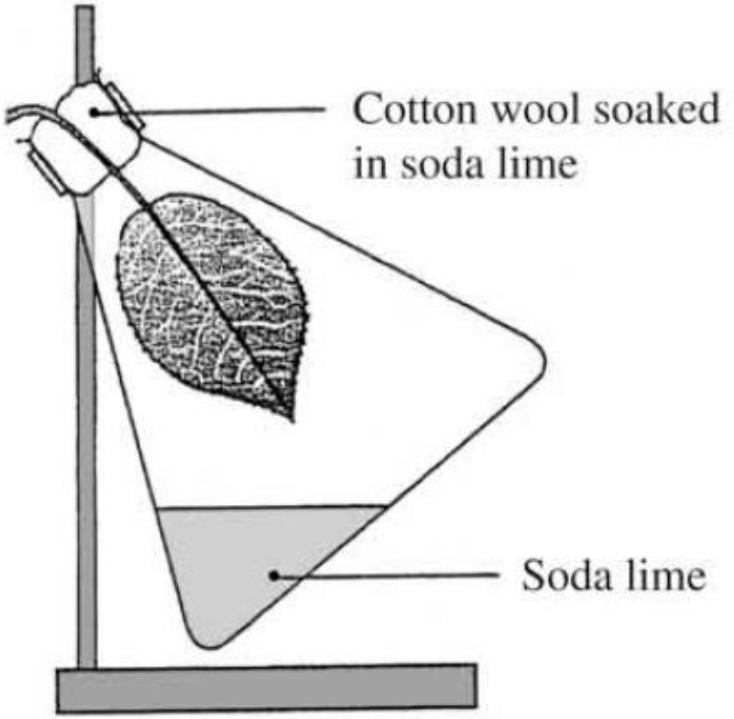
Is light needed for photosynthesis?

- Partially cover a leaf with black paper or tinfoil.
- Leave in light for 48hrs
- Test for starch



Is CO_2 needed for photosynthesis?

- Place a leaf in a conical flask containing soda lime (sodium hydroxide) (as below).
- The soda lime removes CO_2
- Repeat with a second leaf but replace soda lime with water
- This is the control
- Leave in light for 48hrs
- Test for starch



Is chlorophyll needed for photosynthesis?

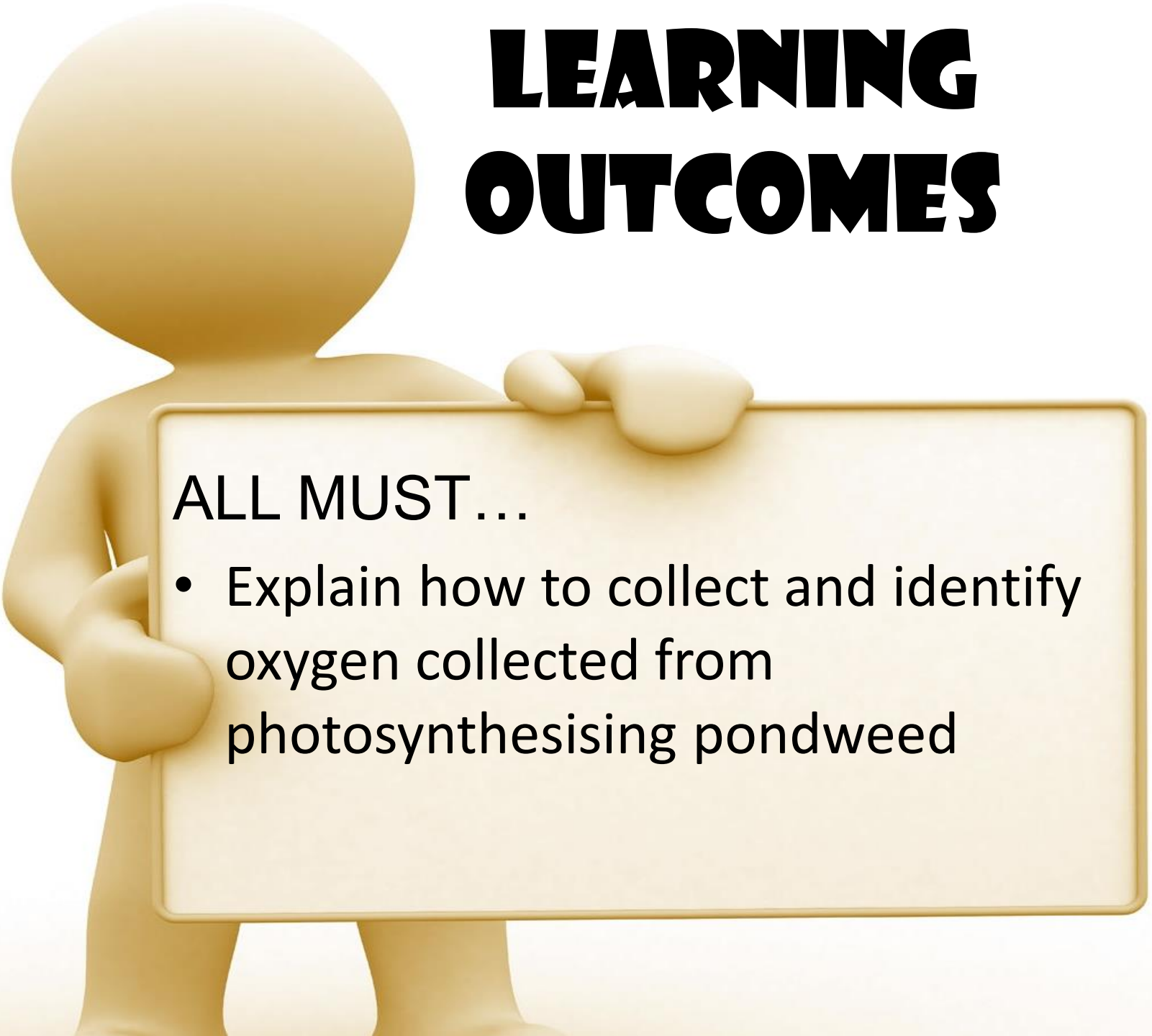
- Use a variegated leaf (some parts have chlorophyll and others don't)
- Leave in light for 48hrs
- Test for starch

QUESTION 1 & 2
HOMEWORK BOOKLET

- 1613 testing for Oxygen

  BBC - Learning Zone Class Clips - Testing for oxygen produced by underwater plants - Science Video

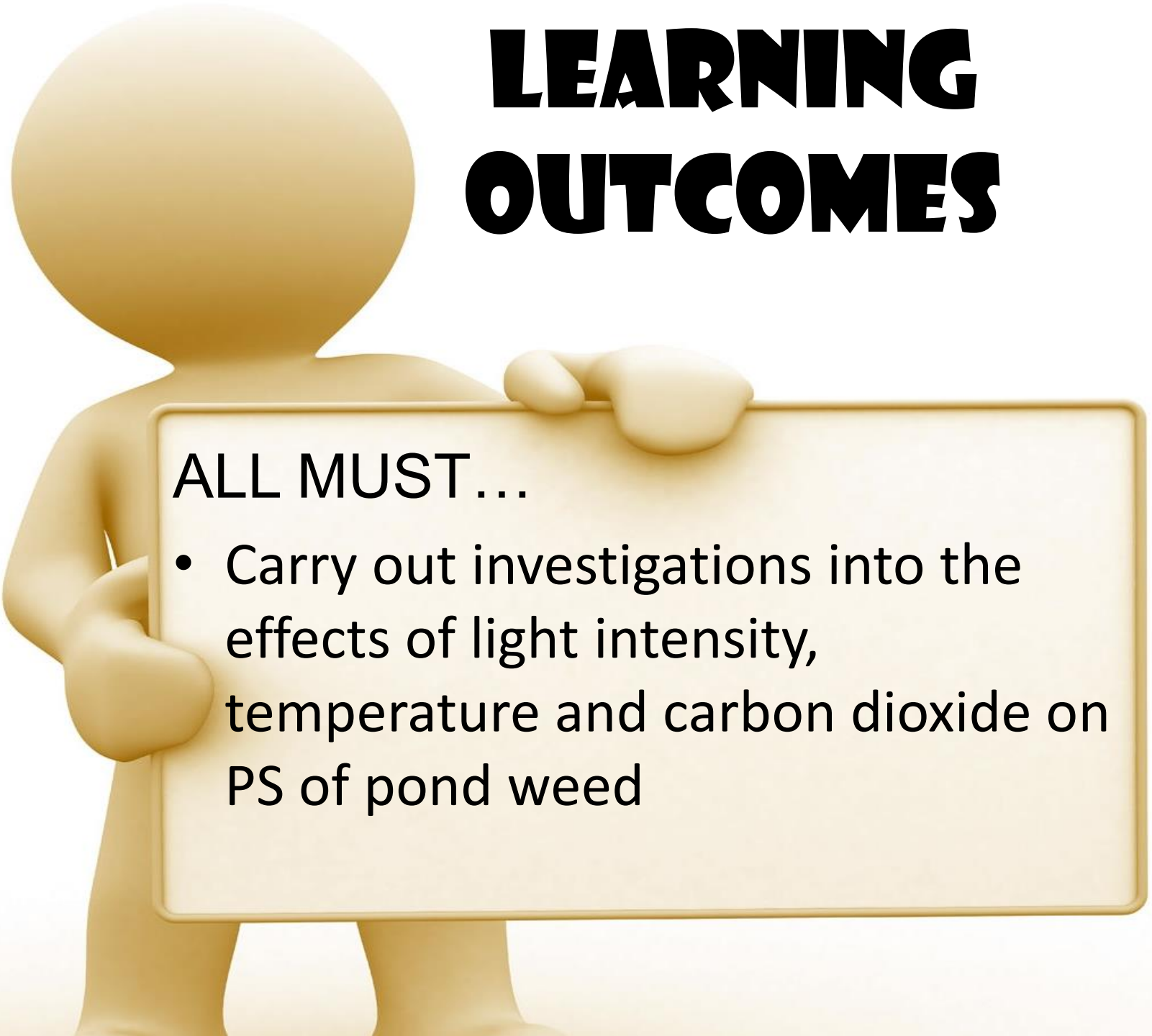
LEARNING OUTCOMES



ALL MUST…

- Explain how to collect and identify oxygen collected from photosynthesising pondweed

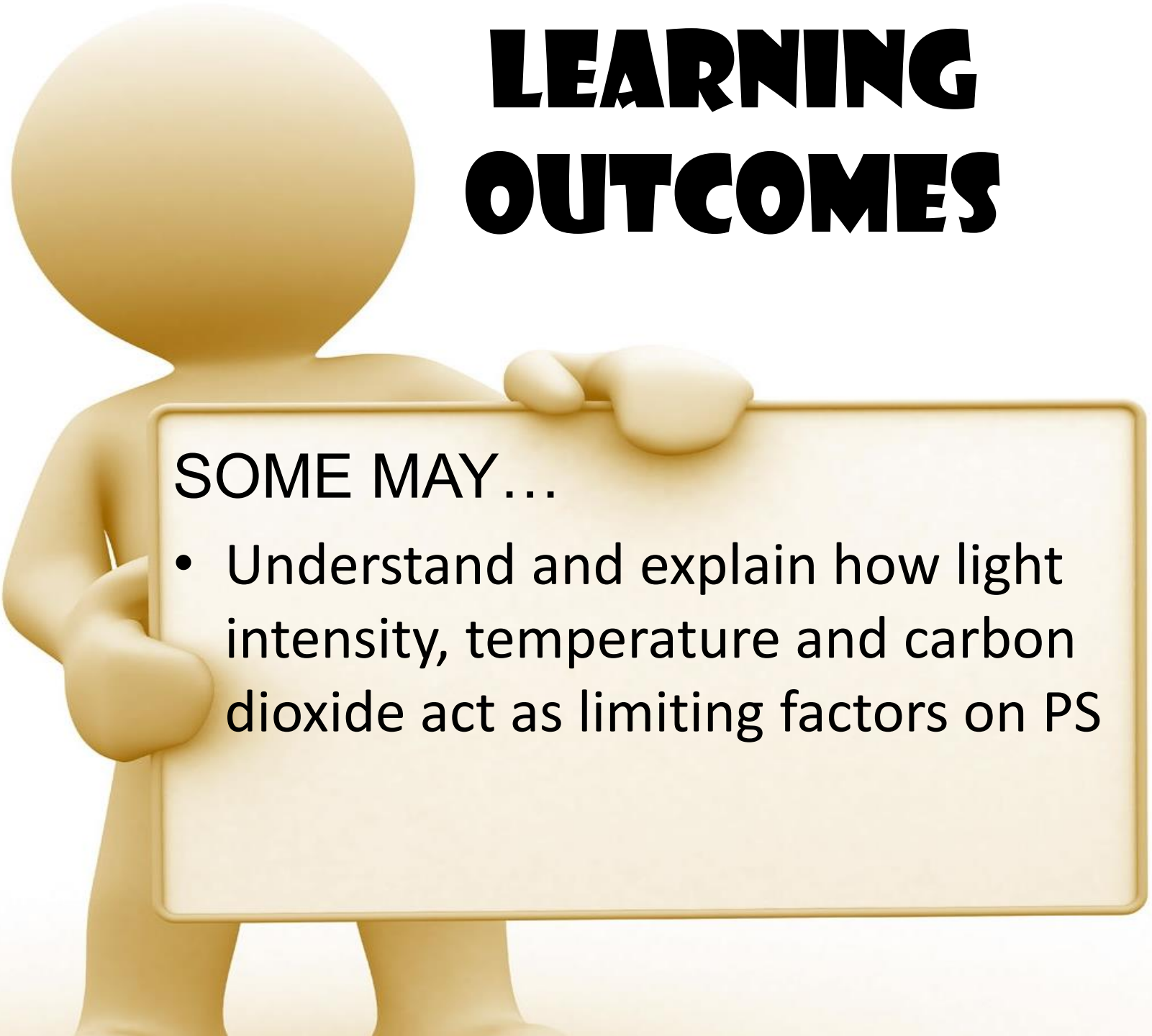
LEARNING OUTCOMES



ALL MUST…

- Carry out investigations into the effects of light intensity, temperature and carbon dioxide on PS of pond weed

LEARNING OUTCOMES



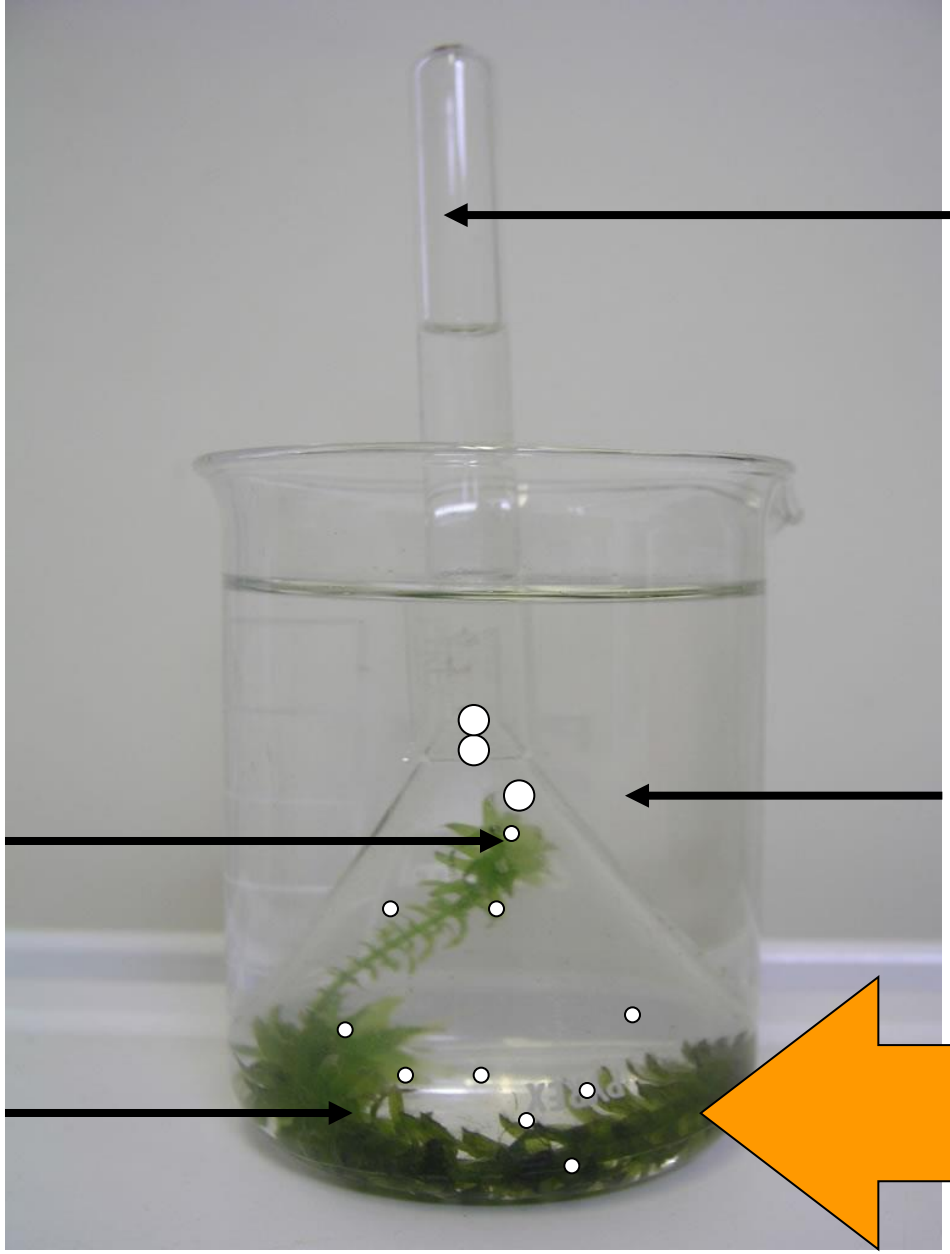
SOME MAY…

- Understand and explain how light intensity, temperature and carbon dioxide act as limiting factors on PS

Measuring the rate of photosynthesis

The rate of photosynthesis can be measured using the apparatus below in two ways:

- The number of bubbles produced in a given time
- The volume of oxygen produced in a given time



VOLUME OF OXYGEN

SODIUM HYDROGEN CARBONATE SOLUTION

OXYGEN BUBBLES

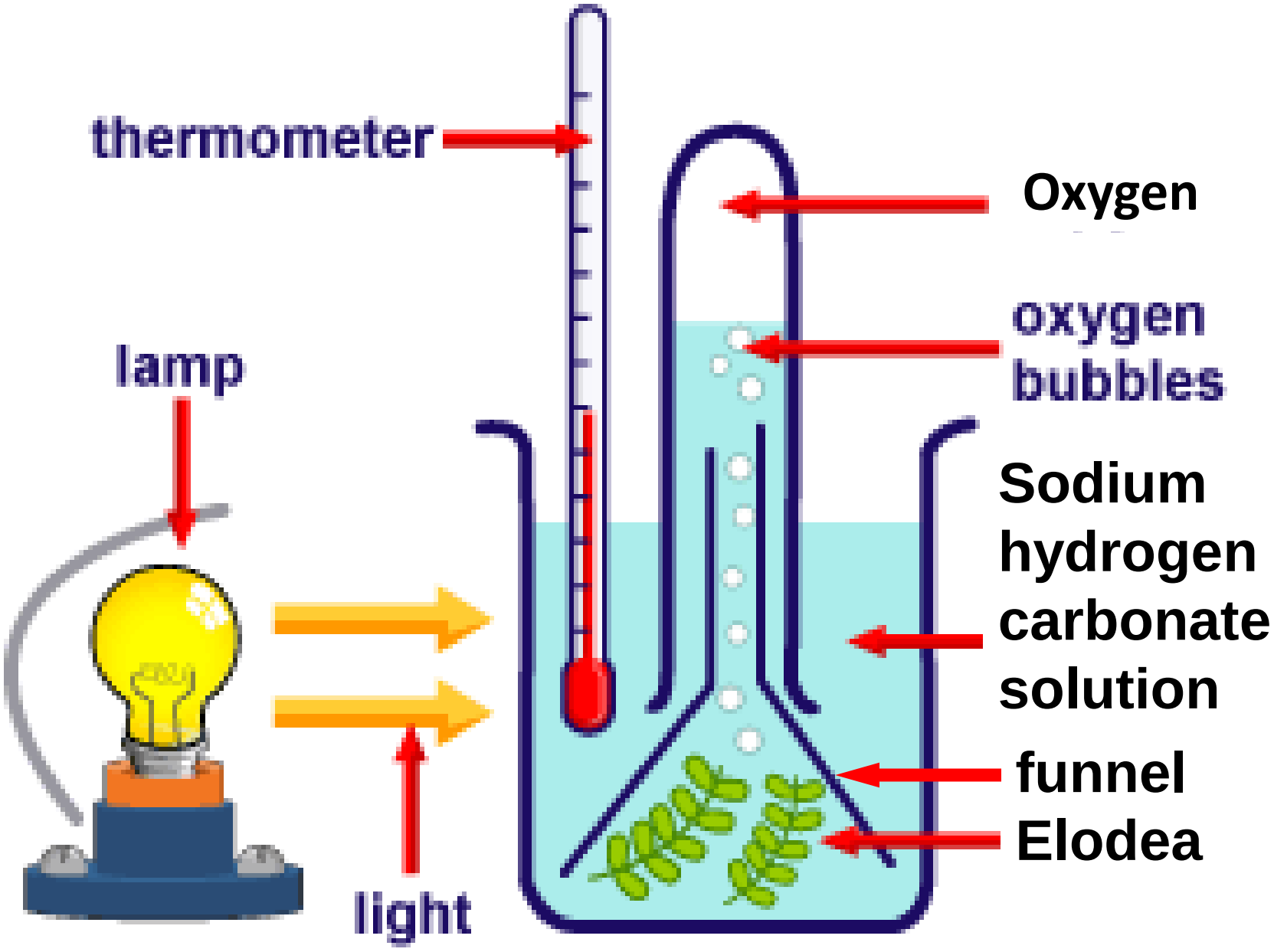
ELODEA

LIGHT

MEASURING THE RATE OF PHOTOSYNTHESIS

starter activity

- View algae balls placed at different distances from a lamp.
- Jot down any differences you see.
- Share with your pair & the class.


thermometer
Oxygen
oxygen bubbles
lamp
Sodium hydrogen carbonate solution
funnel
Elodea
light

- This apparatus can be used to compare rates of photosynthesis in different conditions
- eg by moving the position of the lamp you can measure the effect of light intensity on photosynthesis
- The sodium hydrogen carbonate solution provides an excess of CO_2
- A thermometer is used to monitor the temperature

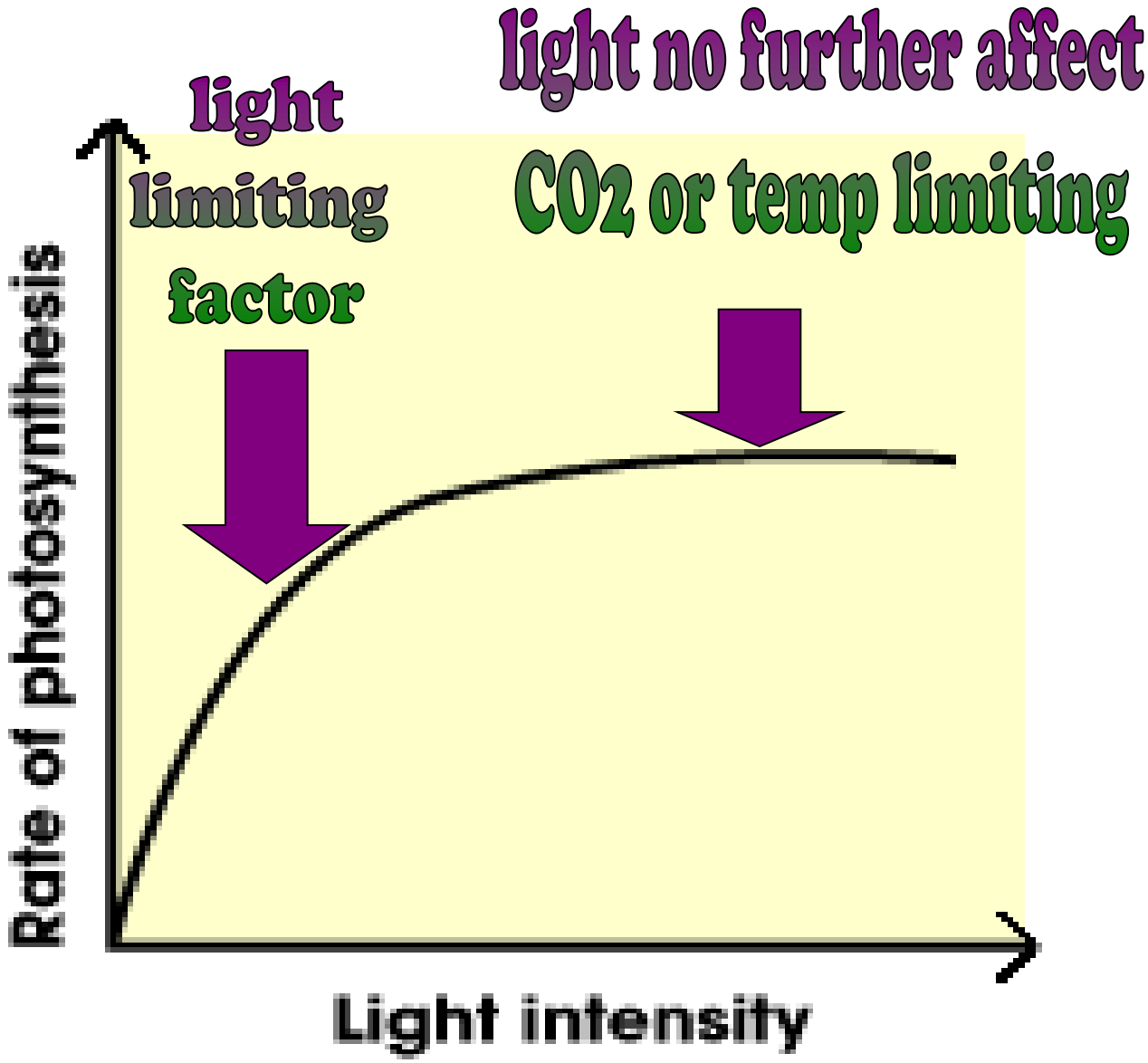
Factors affecting the rate of photosynthesis

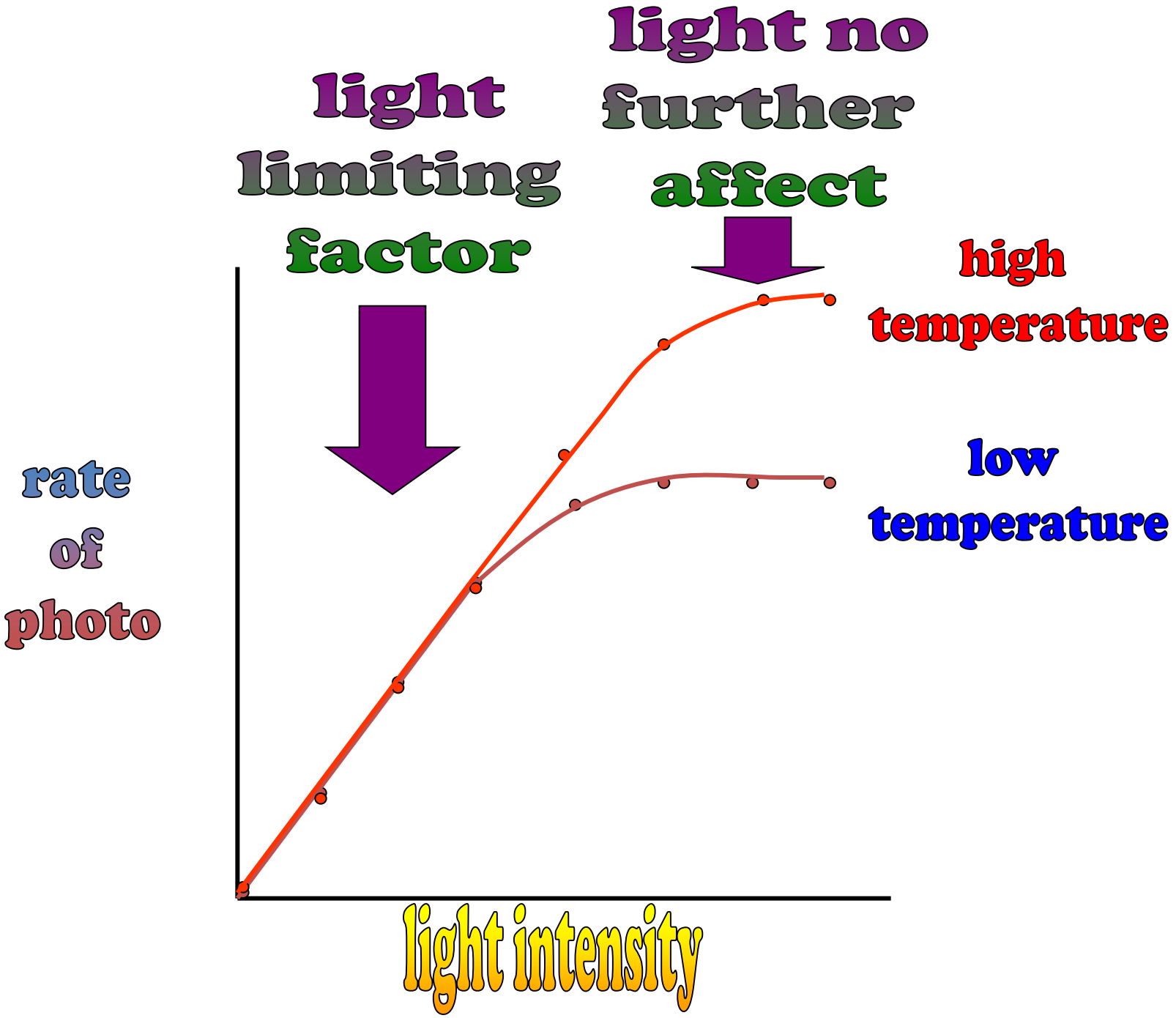
- The levels of CO_2, light and temperature all affect the rate at which photosynthesis happens
- If photosynthesis happens at it's maximum rate these factors must be at their optimum
- If one or more factors is in short supply then it limits the rate of photosynthesis
- It is said to be a LIMITING FACTOR

Light Intensity

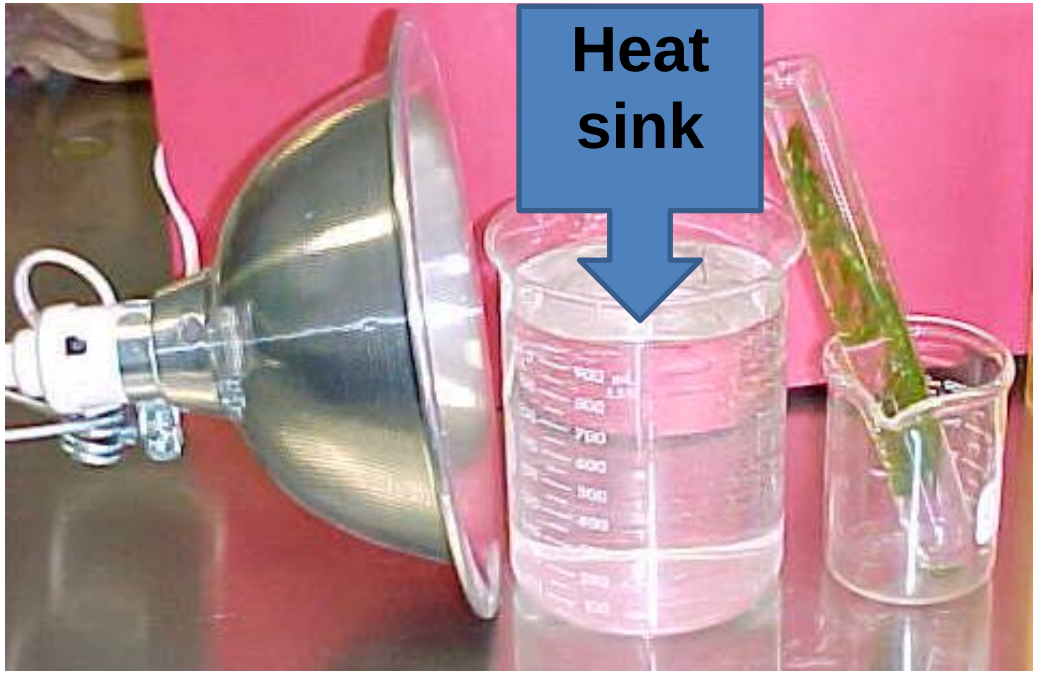
- As a lamp moves closer to the beaker the light intensity increases and the rate of photosynthesis increases to a point.
- After this light has no further affect; either CO_2 or temperature becomes a limiting factor and the line levels out.

Light intensity




light no further affect
light limiting factor
high temperature
low temperature
rate of photo
light intensity

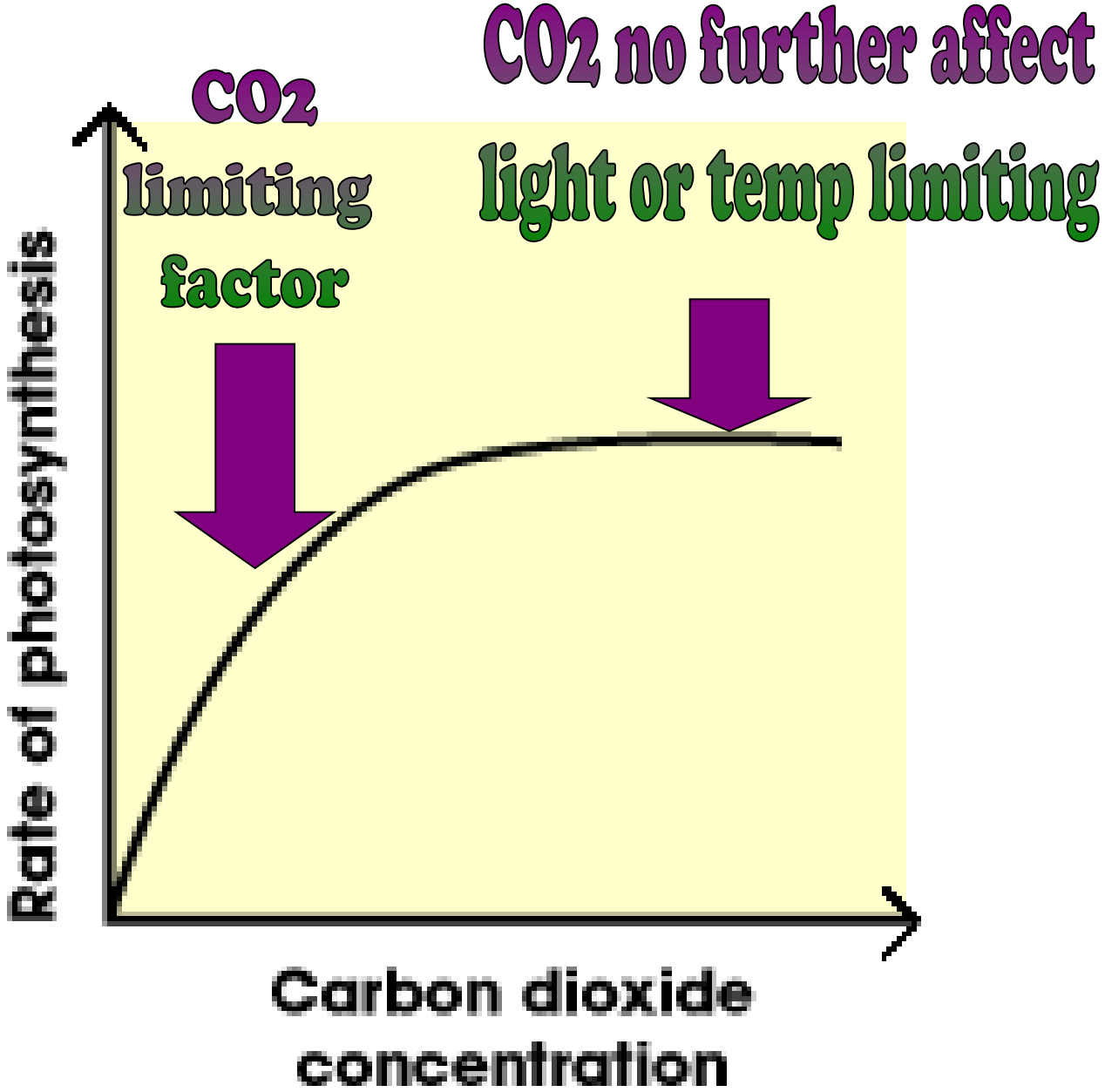
- A **heat sink** is used to prevent the heat from the lamp affecting the results
- This is a beaker of water that is placed between the lamp and the plant
- The water heats up, but does not affect the amount of light reaching the plant.



CO_2 concentration

- As CO_2 concentration increases rate of photosynthesis increases to a point
- Then either light or temperature becomes a limiting factor.

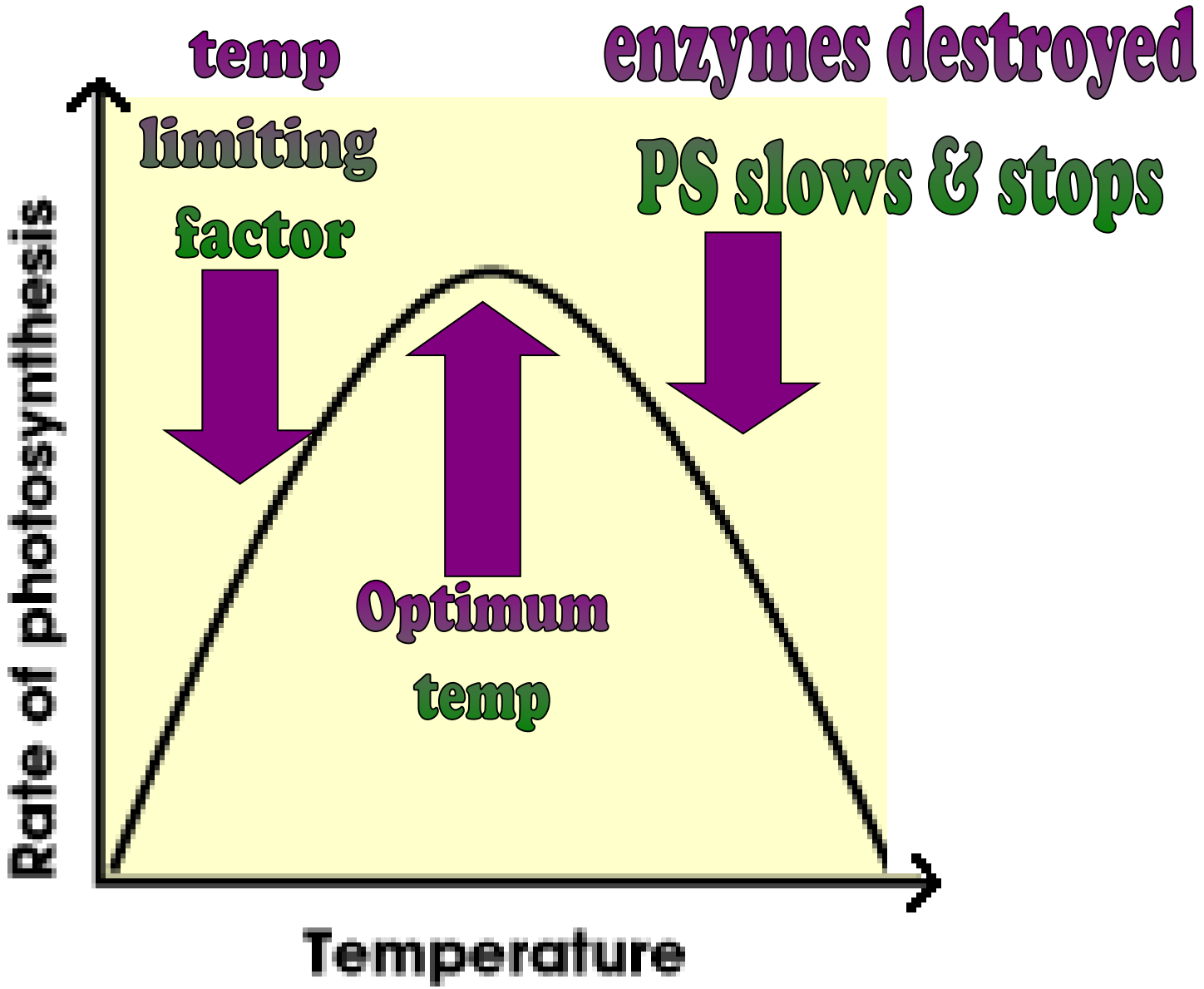
CO2 concentration



Temperature

- As temperature increases the rate of photosynthesis increases to a point as there is more kinetic energy.
- At very high temperatures photosynthesis stops as enzymes are destroyed.

Temperature concentration



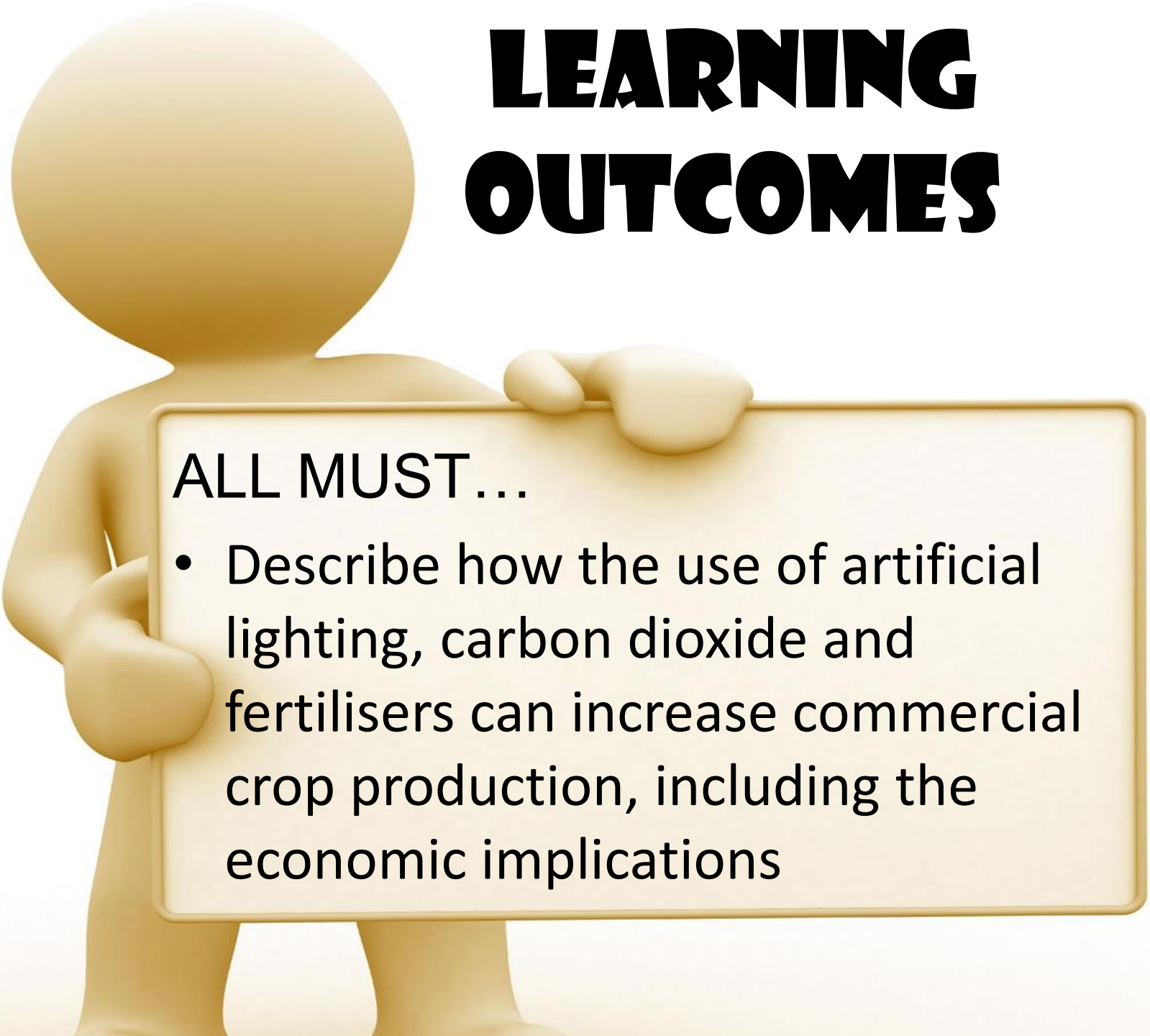
- 6021 Raw materials & products
  BBC - Learning Zone Class Clips - Plants and photosynthesis - Science Video

https://www.youtube.com/watch?v=yg8vqsBOFMw

https://www.youtube.com/watch?v=eIEJ0FfB-VI

QUESTION 3 & 5B HOMEWORK BOOKLET

LEARNING OUTCOMES

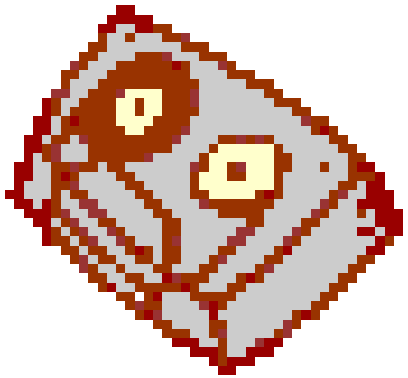


ALL MUST…

- Describe how the use of artificial lighting, carbon dioxide and fertilisers can increase commercial crop production, including the economic implications

video

in the greenhouse



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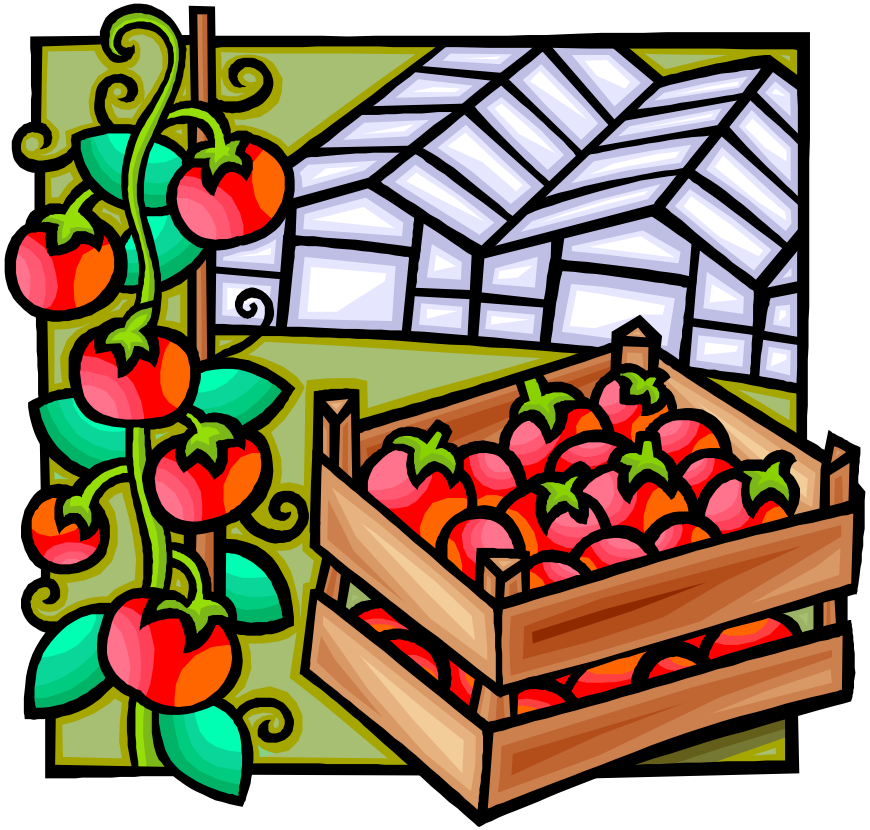
Crop Production



In crop production it may be possible and profitable to control the environmental conditions to increase productivity.

Sensors are used to monitor and control the conditions inside a greenhouse.

They detect changes in the conditions that are needed for photosynthesis.

By turning on and off specific apparatus it is possible to ensure there are no limiting factors so that photosynthesis and growth are at an optimum.

This also reduces running costs.

Increase CO_2

- Burn fossil fuels e.g. paraffin
- Pipe in from canisters

Gas Exchange & humidity

Open/close windows

GREENHOUSE

- MORE photosynthesis
- MORE growth
- BIGGER yield

LIGHT

Artificial lights used to increase light intensity, daylength AND season length

HEAT

- Use electric heaters
- Burn fossil fuels

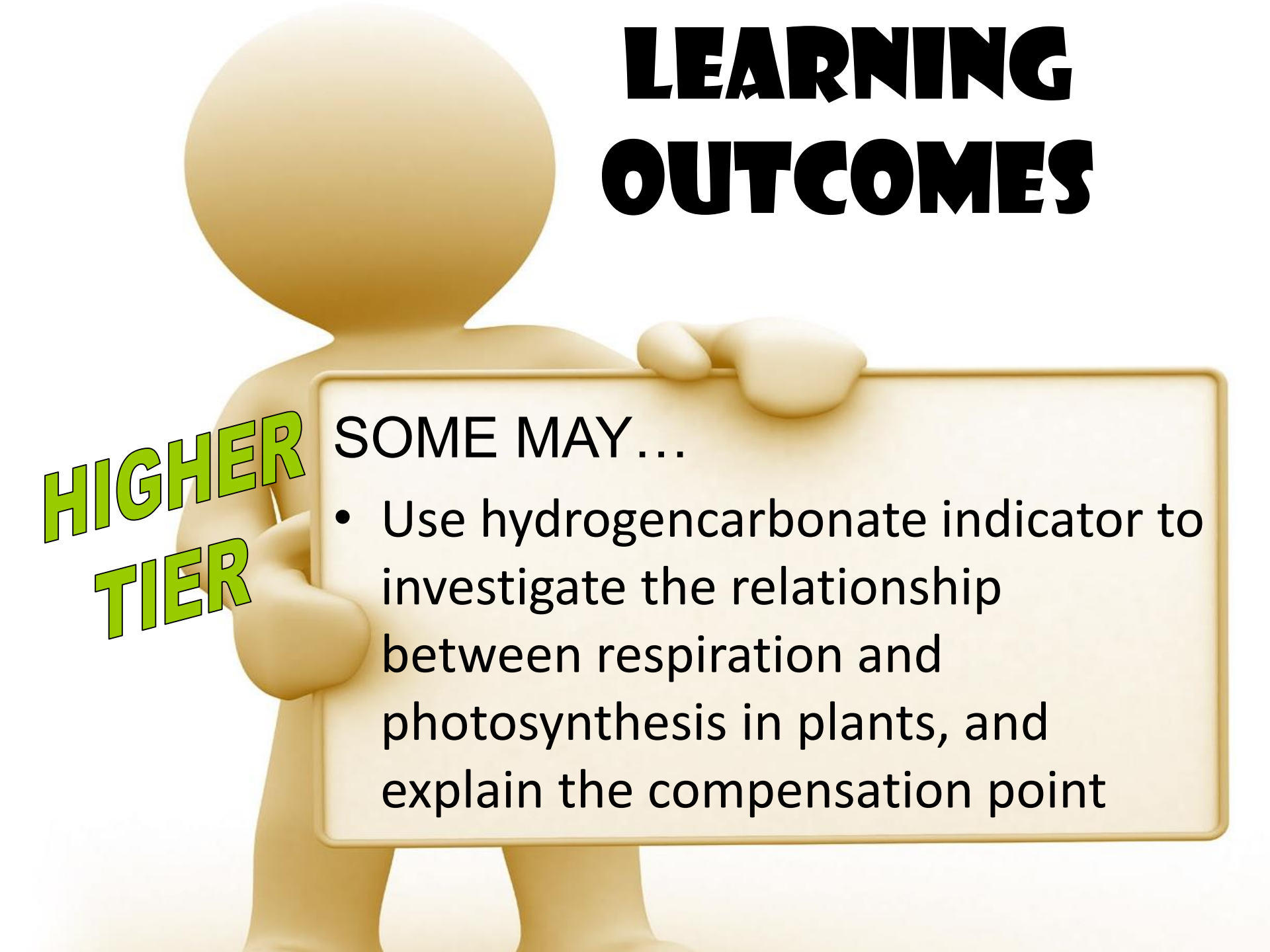
FERTILISERS

- Organic e.g. manure
- Inorganic e.g. NPK

- The grower must consider the cost of increasing carbon dioxide concentration and temperature in the greenhouse.
- The cost of the raw materials must be balanced by the increase in productivity to maximise profit.

QUESTION 4
HOMEWORK BOOKLET

LEARNING OUTCOMES



HIGHER TIER

SOME MAY…

- Use hydrogencarbonate indicator to investigate the relationship between respiration and photosynthesis in plants, and explain the compensation point

BALANCING GASES

All living organisms respire **during the day AND night**

- Remember:-

Glucose + O_2 ⟶ CO_2 + Water + Energy

This is the equation for respiration

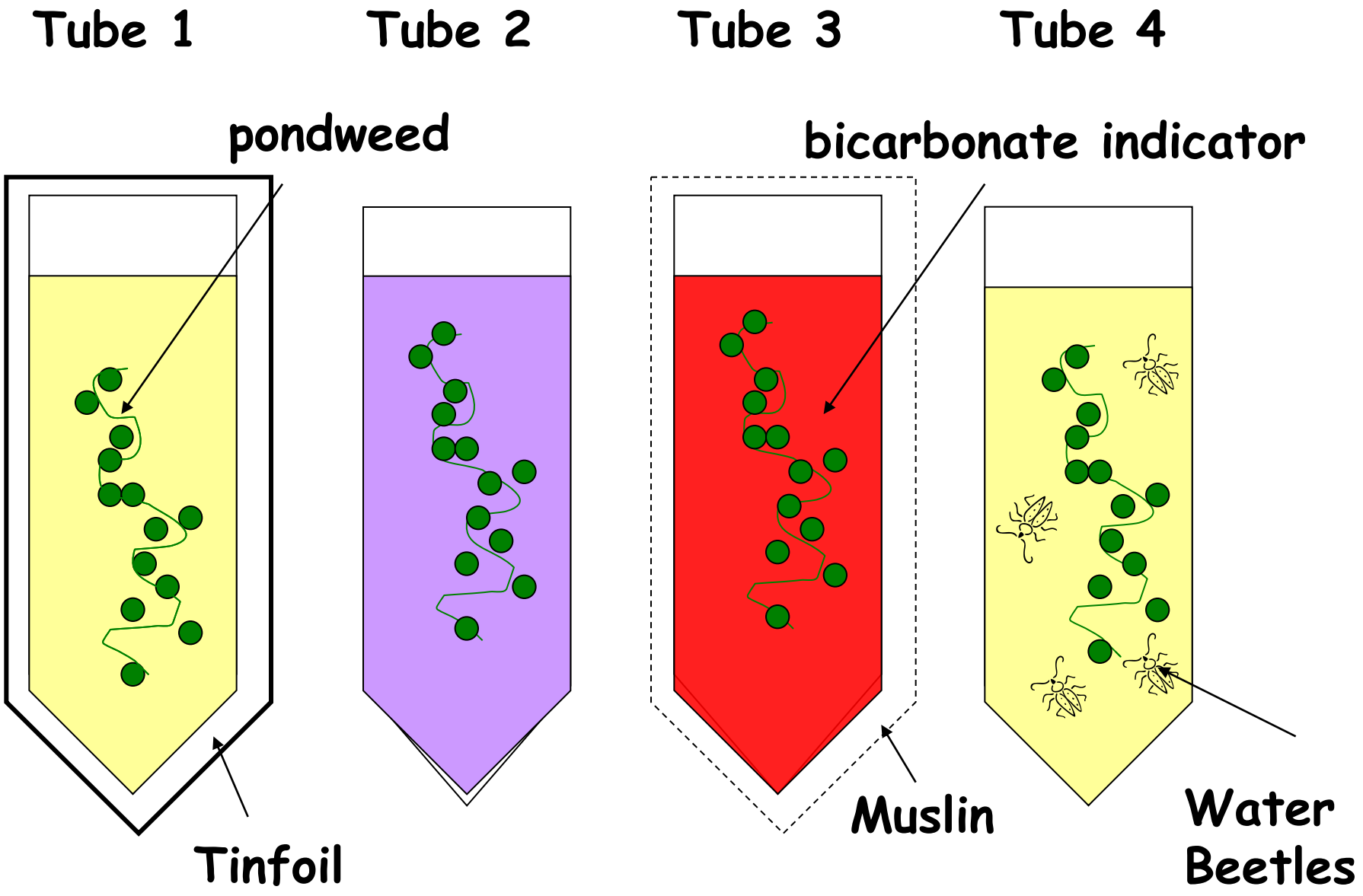
(It is the reverse equation for Photosynthesis!!)

- In plants the glucose and oxygen produced in **photosynthesis** can be used for **respiration**.

- The carbon dioxide and water produced in **respiration** can be used **photosynthesis**.

- Sometimes the two processes **balance each other out**.

- Photosynthesis and respiration happen **during the day**
- Only respiration happens **at night**
- **Hydrogen carbonate indicator** can be used to show this relationship



Red – normal CO_2 Yellow – high CO_2 Purple – low CO_2

TUBE 1

The tinfoil stops **light** getting to the plant. This is like **night** when there is **no photosynthesis**

but **respiration** still continues so **CO_2 is released** from the plant, turning the hydrogen carbonate indicator **YELLOW**.

TUBE 2

There is a **lot of light** available to the plant.

During the day the rate of **photosynthesis** *is* **greater than** the rate of **respiration** so **more carbon dioxide is taken up** by the plant than is released in respiration. The **low CO_2 level** makes the hydrogen carbonate indicator **PURPLE**.

TUBE 3

The muslin **reduces the light**, this mimics dawn and dusk when the **rate of photosynthesis is equal to the rate of respiration**.

All the CO_2 released in respiration is used in photosynthesis (we say there is no net output of gas).

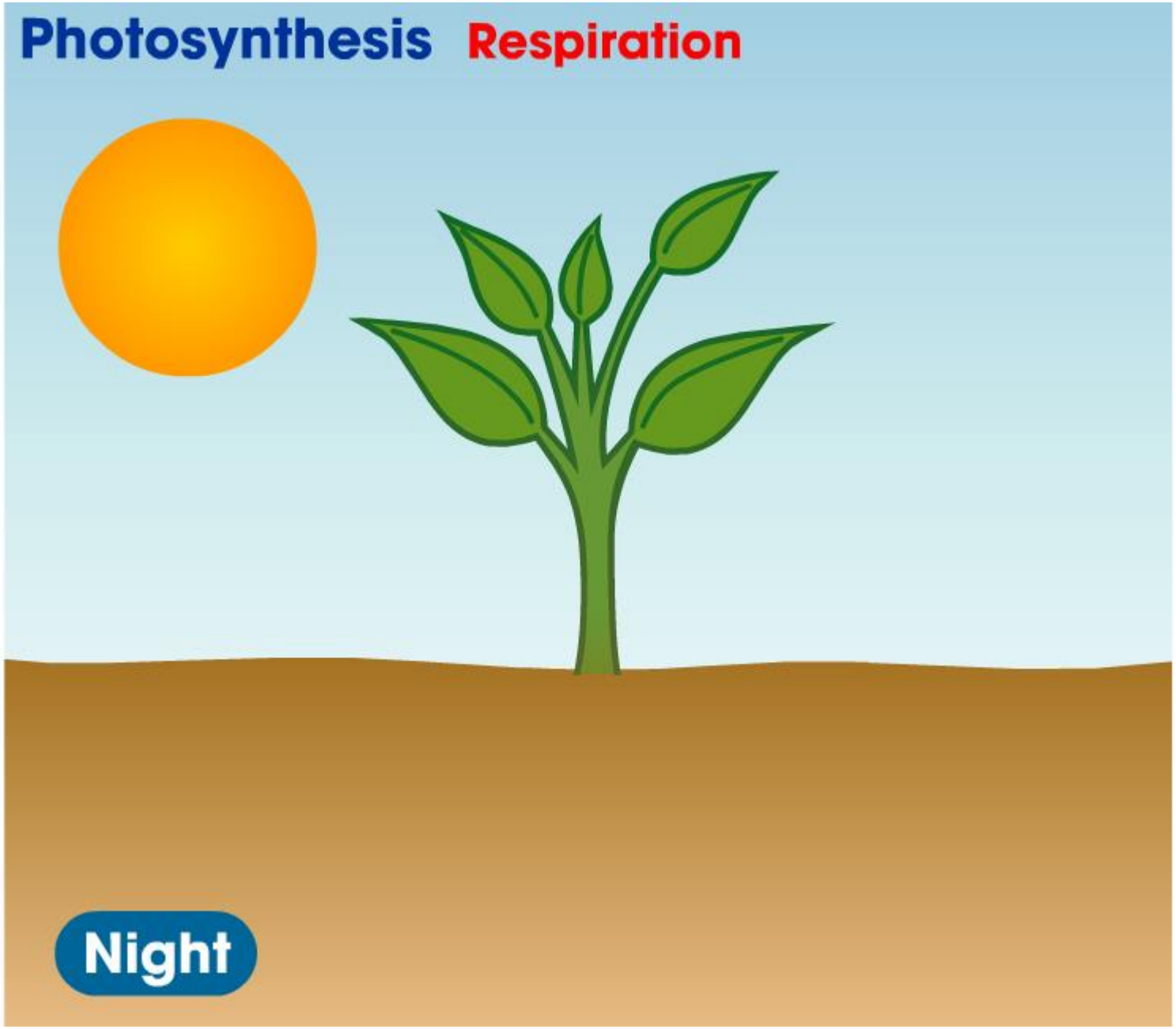
The bicarbonate indicator does not change colour, it remains **RED**.

THIS IS CALLED THE

COMPENSATION POINT

TUBE 4

The water beetles are **respiring** as well as the pond weed and therefore **more CO_2 is produced than can be taken up in photosynthesis**, causing the hydrogen carbonate indicator to turn **YELLOW**.



resp

photo

QUESTION 6
HOMEWORK BOOKLET

Clip 6126 1.14

BBC - Learning Zone Class Clips - Plant photosynthesis - Science Video

Clip 6021 3.12

- BBC - Learning Zone Class Clips - Plants and photosynthesis - Science Video

Clip 10656 1.51

BBC - Learning Zone Class Clips - Plants and photosynthesis - Science Video

Clip 10655 3.13

BBC - Learning Zone Class Clips - Adaptations of the leaf for photosynthesis - Science Video

Clip 10608 1.57

BBC - Learning Zone Class Clips - Photosynthesis and respiration in plants - Science Video

Clip 10605 2.34

- BBC - Learning Zone Class Clips - Photosynthesis in plant leaves - Science Video

Clip 1613 0.39

BBC - Learning Zone Class Clips - Testing for oxygen produced by underwater plants - Science Video

DVD:
photosynthesis
Scientific Eye
Bio collection 2
20 mins

DVD:
photosynthesis
Short Circuit
Bio collection 2
20 mins

DVD:
photosynthesis
Science Bank
Bio collection 2
15 mins

DVD:
photosynthesis
Biovideo
Bio collection 5
30 mins
(old but some good bits)

DVD:
plants for food
Scientific Eye
Bio collection 5
20 mins

DVD:
plant nutrition
GCSE Bitesize Revision
3 mins

DVD:
photosynthesis
curriculum bites 11-14
7 mins

DVD:

photosynthesis

curriculum bites 14-16