Making Light of Photosynthesis

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The Scottish Government
Riaghaltas na h-Alba

SSERC

Advancing science, technology and safety

Aim:

- *to offer hands-on experience of activities to support learning and teaching of photosynthesis at CfE level 3*

Overall aims of CfE:

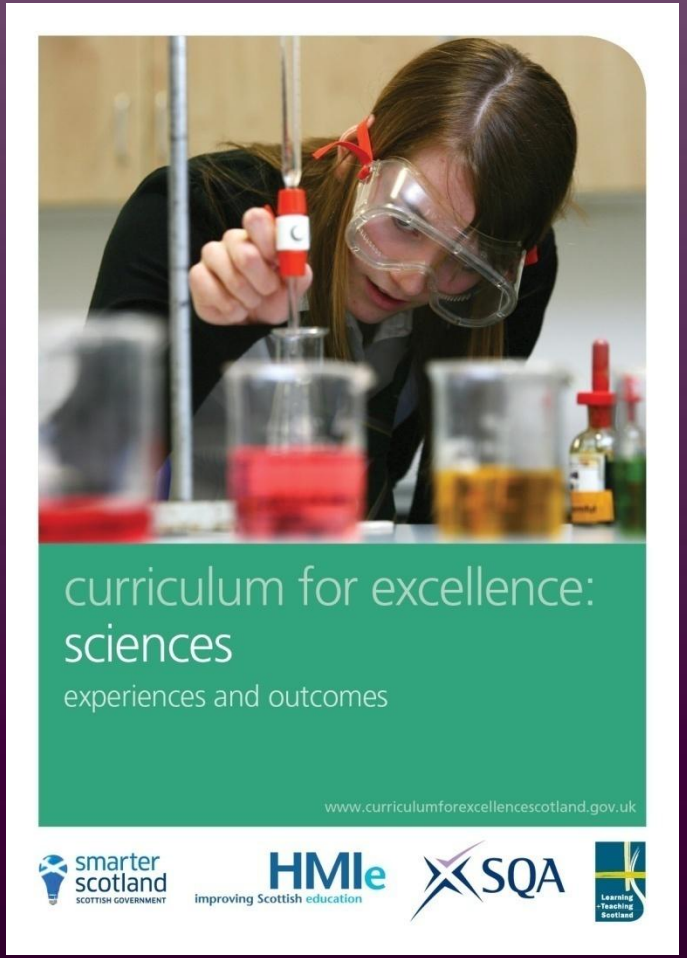
- *Raise standards of achievement*
- *Reduce the achievement gap*
- *Prepare for the future*

…inclusive, learner engagement, improving learning experiences, deeper understanding, HOTS, SLLW, application, flexible, adaptable…

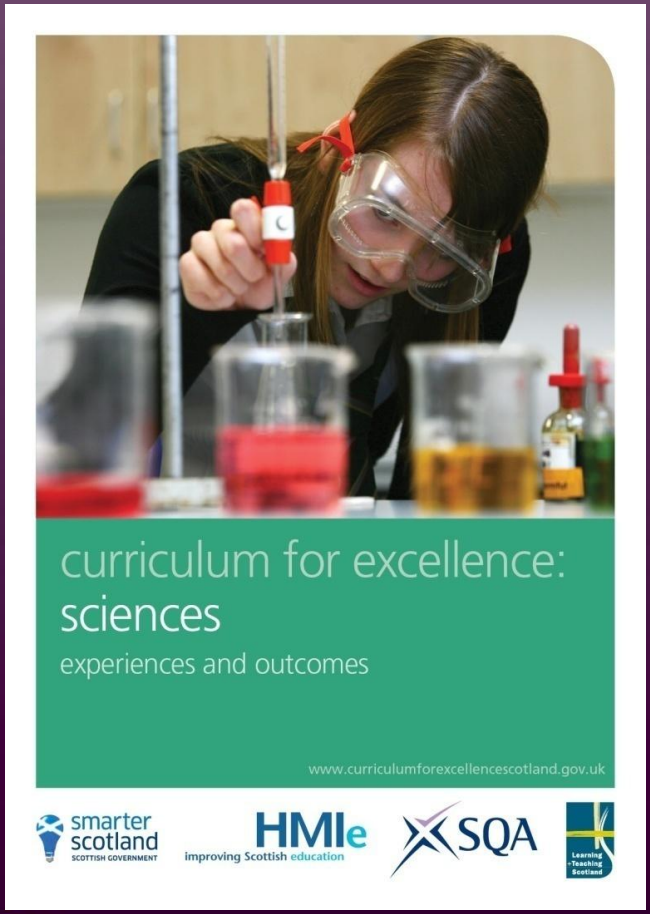
Education Scotland
Foghlam Alba
Transforming lives through learning

Curriculum for Excellence: Sciences Experiences and outcomes

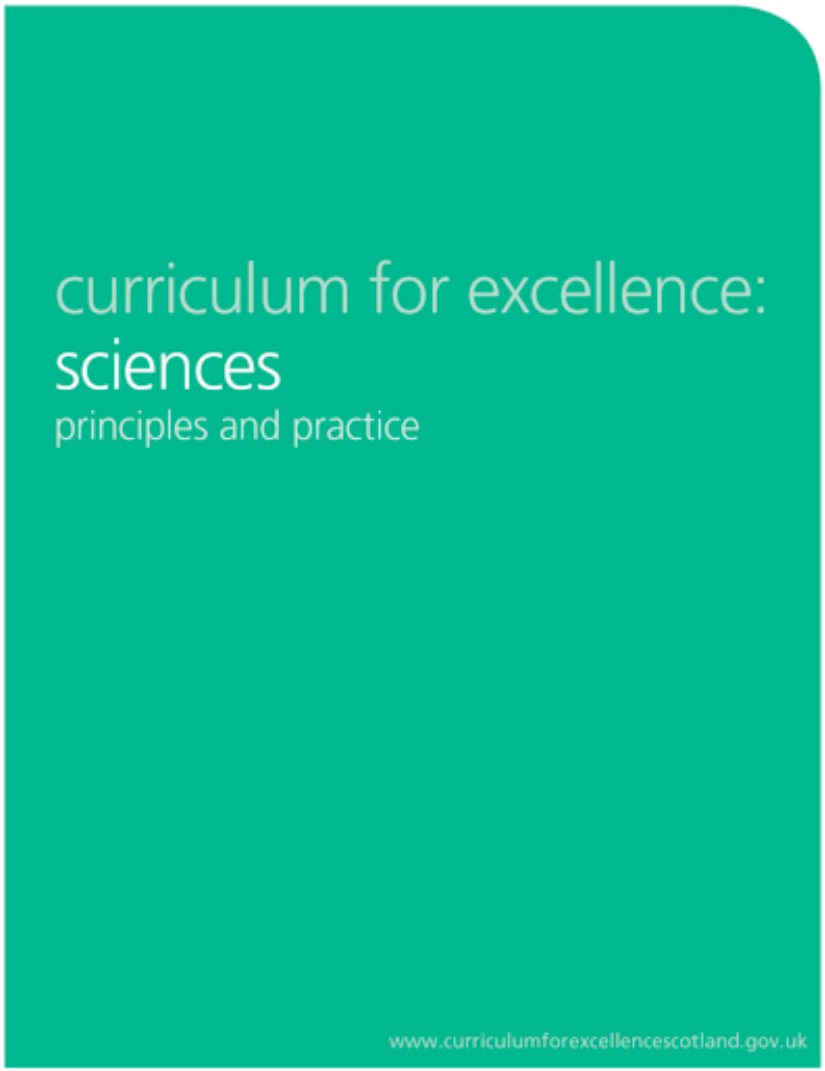
- *I have collaborated on investigations into the process of photosynthesis and I can demonstrate my understanding of why plants are vital to sustaining life on Earth [SCN 3-02A]*



Curriculum for Excellence: Sciences Experiences and outcomes



- *Through exploring the carbon cycle, I can describe the processes involved in maintaining the balance of gases in the air, considering causes and implications of changes in the balance [SCN 4-05b]*

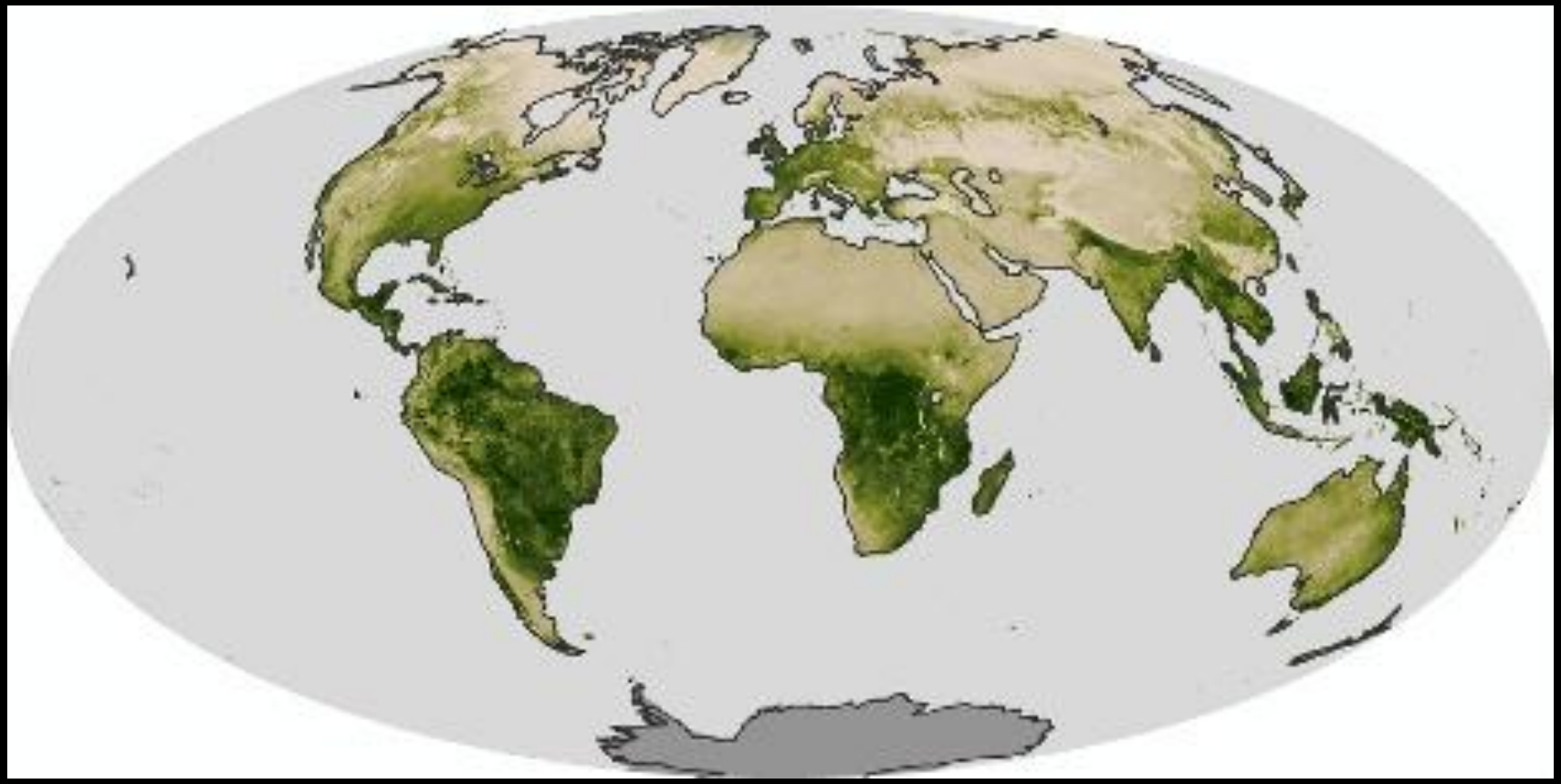

curriculum for excellence:
sciences
principles and practice
www.curriculumforexcellencescotland.gov.uk
smarter scotland
SCOTTISH GOVERNMENT
HMIe
improving Scottish education
SQA
Learning and Teaching Scotland

Today's workshop supports:

- *Active learning*
- *Scientific practical investigation and inquiry*
  - *Carry out experiments*
  - *Observe, collect, measure & record evidence*
  - *Present , analyse and interpret data to draw conclusions*
  - *Review and evaluate results to identify limitations and improvements*
  - *Present and report on findings*

Today's workshop supports:

- *Analytical thinking skills*
  - *Linking and applying learning*
  - *Thinking creatively and critically*
  - *Reasoning to provide explanations supported by evidence*
  - *Making predictions, generalisations & deductions*
  - *Drawing conclusions*



Capturing CO_2

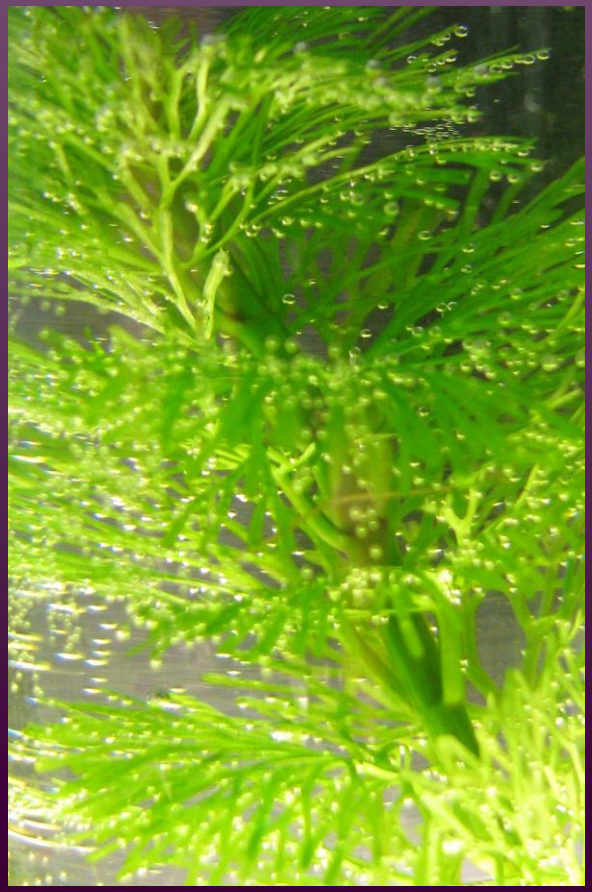
The numbers are HUGE!

- *Atmospheric CO_2 is 0.035% (and rising!)*
- *Total CO_2 in atmosphere 700 x 10^9 t*
- *Photosynthesis fixes ~100 x 10^9 t yr^{-1}*
- *~15% of total atmospheric CO_2 moves into photosynthetic organisms each year!*

Today's practical work:

- *Photosynthesis, in particular gas-exchange*
  - *Cabomba*
  - *hydrogencarbonate indicator*
  - *sodium hydrogencarbonate*
- *Investigations*

Cabomba

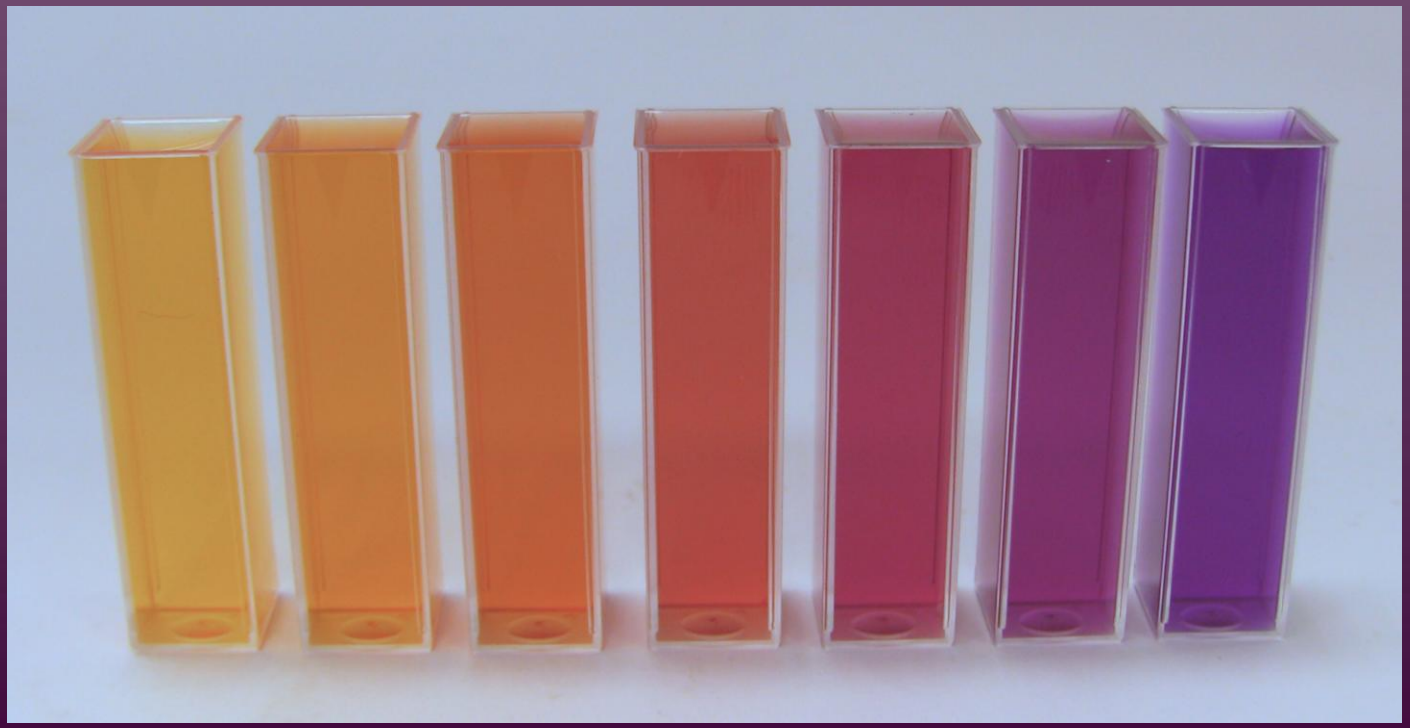


- *Water plant*
- *Non-native so care in disposal!*
- *Aquaria*
- *Wonderful alternative to Elodea*

Hydrogencarbonate indicator

- *Used to measure [CO_2]*
- *Orange/red in air*
- *Increasingly yellow as [CO_2] increases*
- *Orange → red → magenta → deep purple as [CO_2] decreases*

Hydrogencarbonate indicator



pH 6.8 ⟶ *9.2*

(in 0.4 increments)

Cabomba 1:

- *Compare the effect of Cabomba on hydrogencarbonate indicator in light and dark conditions*

- *From knowledge of hydrogencarbonate indicator, make deductions about gas exchange in Cabomba under different conditions*

Before starting:

- *Wash two empty Bijou bottles with a small quantity of hydrogencarbonate indicator, then discard the indicator (wash in sink)*

- *If there is any colour change, rinse again*

- *Continue until there is no colour change*

1. *Cut 10 fronds of roughly equal size from a stem of Cabomba*

Add 5 fronds to each of two empty Bijou bottles

2. *Fill each bottle with hydrogencarbonate indicator*

3,4. Cover one Bijou with black paper. Irradiate both bottles.

(30-40 min)

Match the characteristics to the organism

Animals	Plants

use sugars

contain chlorophyll

use light energy

respire

use carbon dioxide

photosynthesise

release carbon dioxide

release carbon dioxide

respire

use carbon dioxide

use light energy

make sugars

contain chlorophyll

Match the characteristics to the organism

Animals	Plants
Respire • Use oxygen • Use sugars • Release carbon dioxide Consumer	Respire • Use oxygen • Use sugars • Release carbon dioxide Photosynthesise • Use carbon dioxide • Use light energy • Contain chlorophyll • Make sugars • Release oxygen Producer

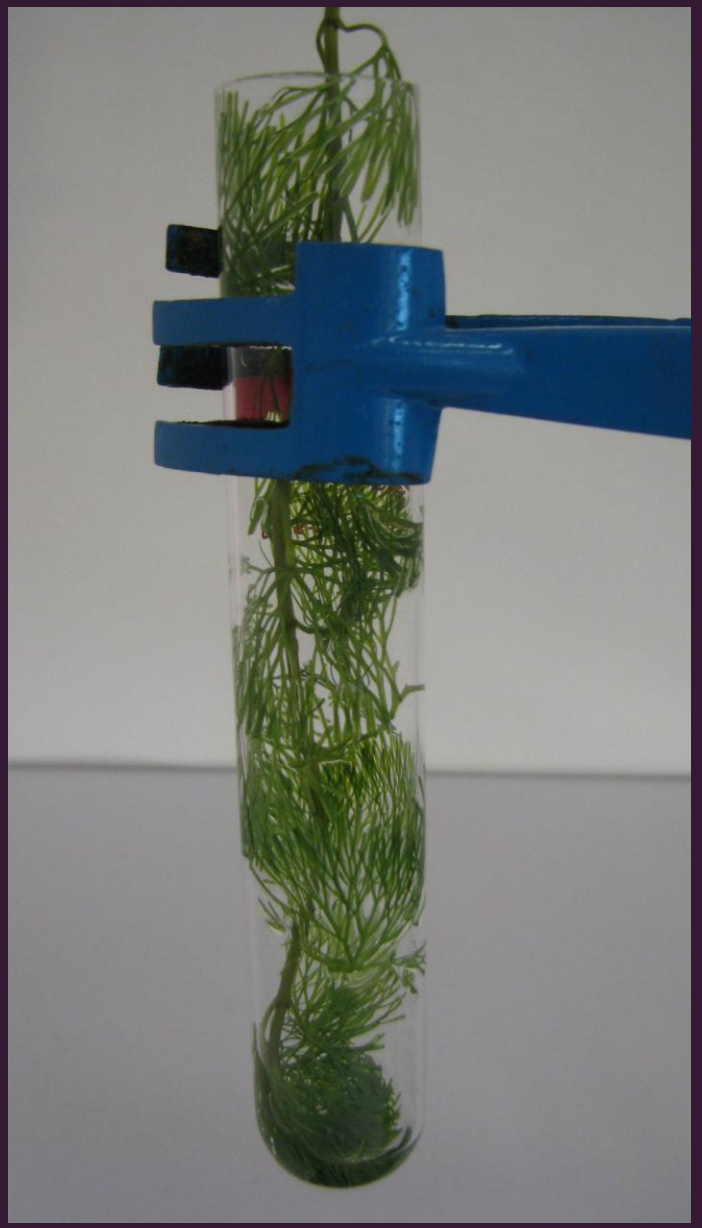
Cabomba 2

- *To investigate gas evolution under different lighting conditions*

- *To contribute to the development of an understanding of why plants are vital to sustaining life on Earth*

1. *A piece of Cabomba equal to the length of a boiling tube.*

Place Cabomba in the boiling tube, stem end upwards

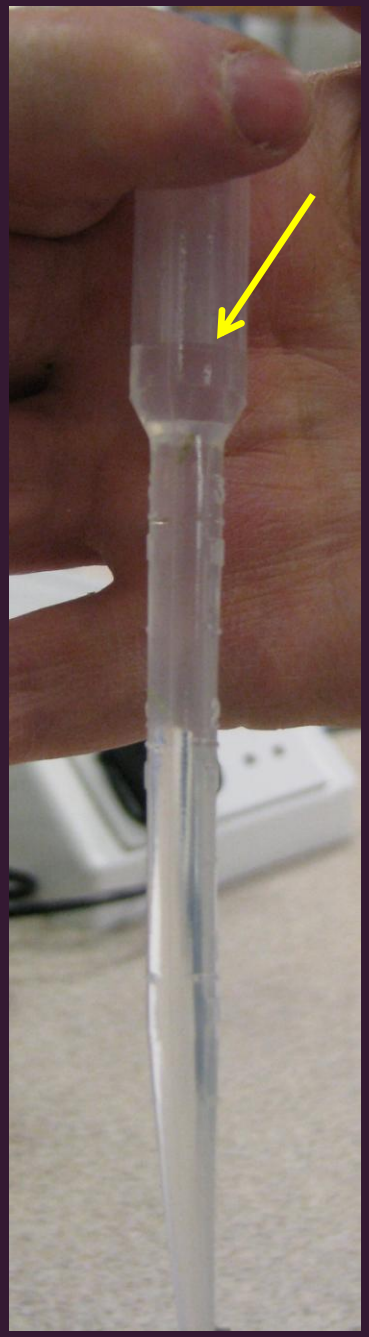


Fill boiling tube with 1% sodium hydrogencarbonate

2. *Cut the Cabomba stem under the liquid*

3-5. *'Play' with lamp*

6. *Squeeze the bulb of a 3 cm^3 plastic pipette very tightly and extract fluid until pipette fills*



7. *Seal pipette by placing Blu-tack™ over tip*

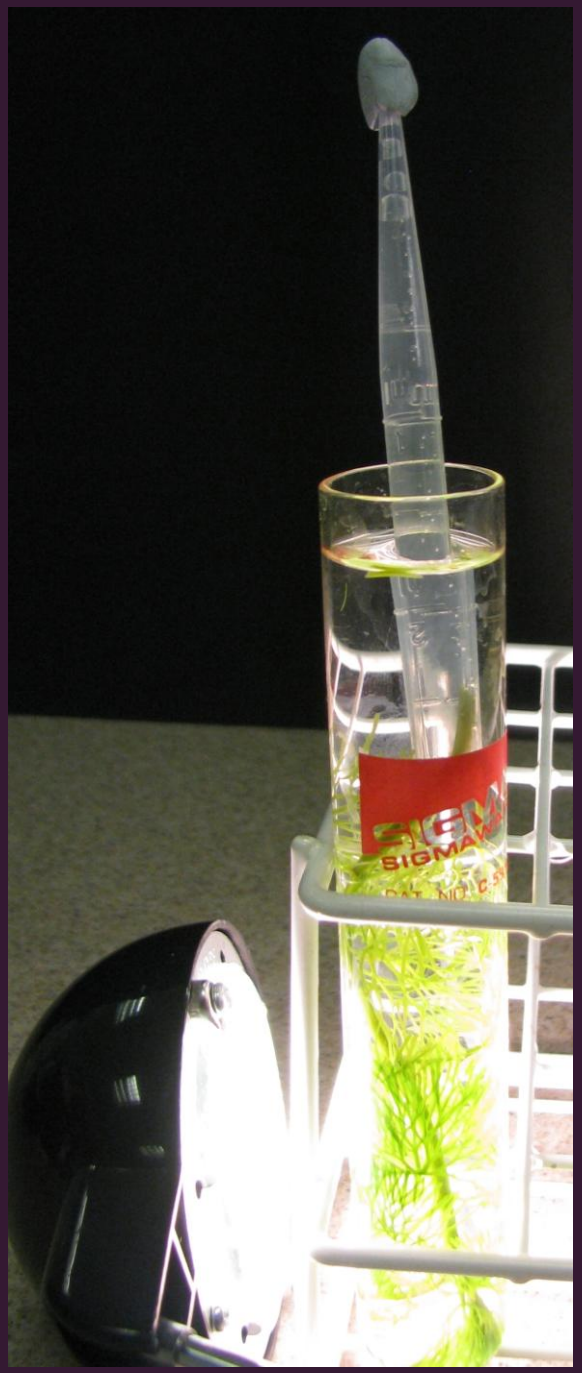
8,9. *Cut pipette at 3 cm^3 mark, then top up any fluid lost from the weighing boat*

Full pipette essential!

10, 11.

Quickly invert the full pipette and place over the Cabomba tip

12. Irradiate for 30 – 40 min



Cabomba 2

- *How could we identify what gas is being given off by the Cabomba?*

Cabomba 1

5. *What colour changes do you notice in the hydrogencarbonate indicator?*

- *Can you suggest a reason for the colour change in the*
  - *light*
  - *dark?*

Cabomba 1

- Can you suggest a reason for the colour change in the:

light

dark

Cabomba 1

6. *To help, pour the hydrogencarbonate indicator from the Bijou that has been in the light into a Universal bottle. Use a straw to gently blow through it.*

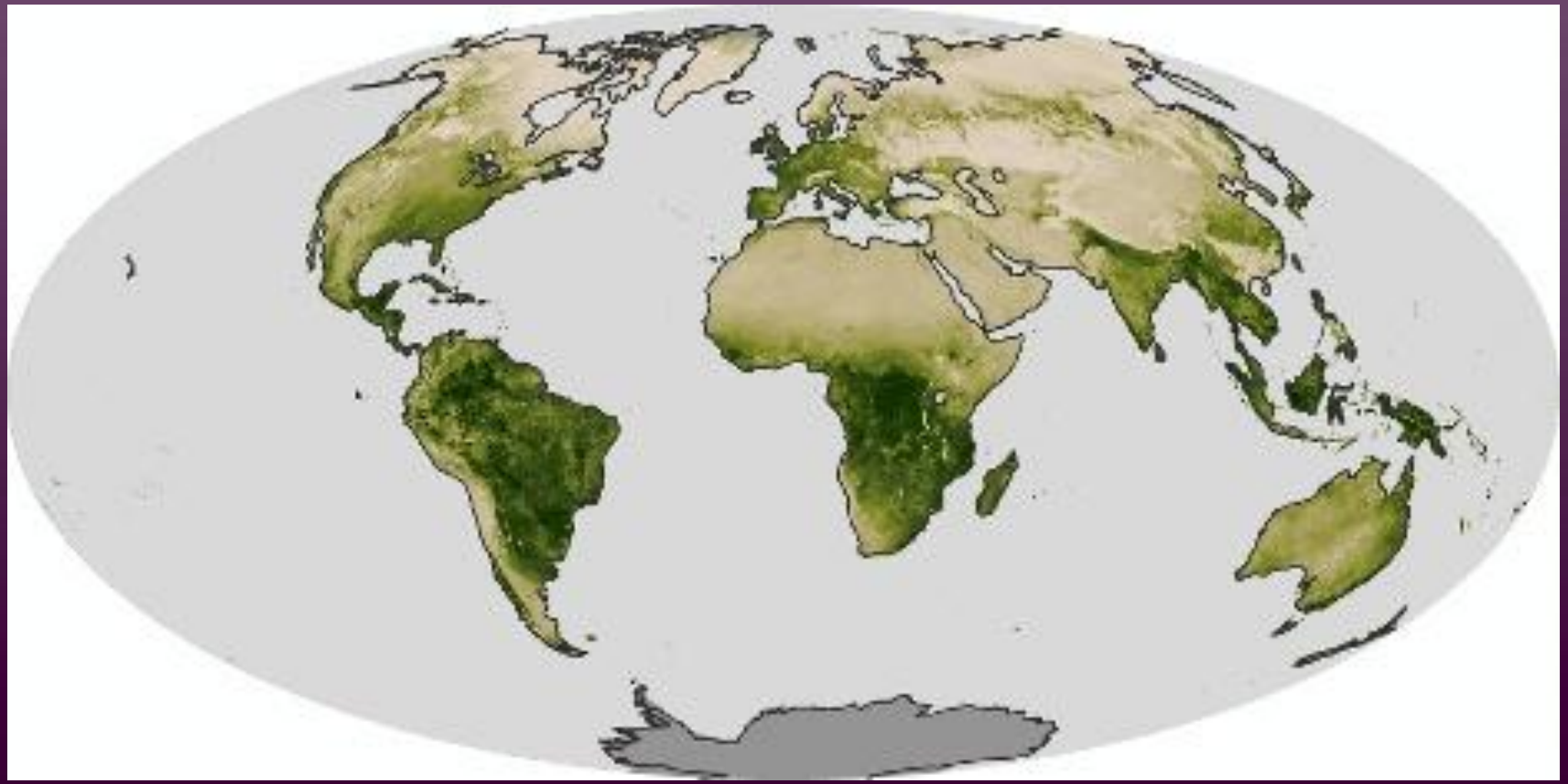
Work in groups:

Use the results from your practical work and the information in your T-chart to arrange the cards to show how plants and animals use carbon

What do you notice?

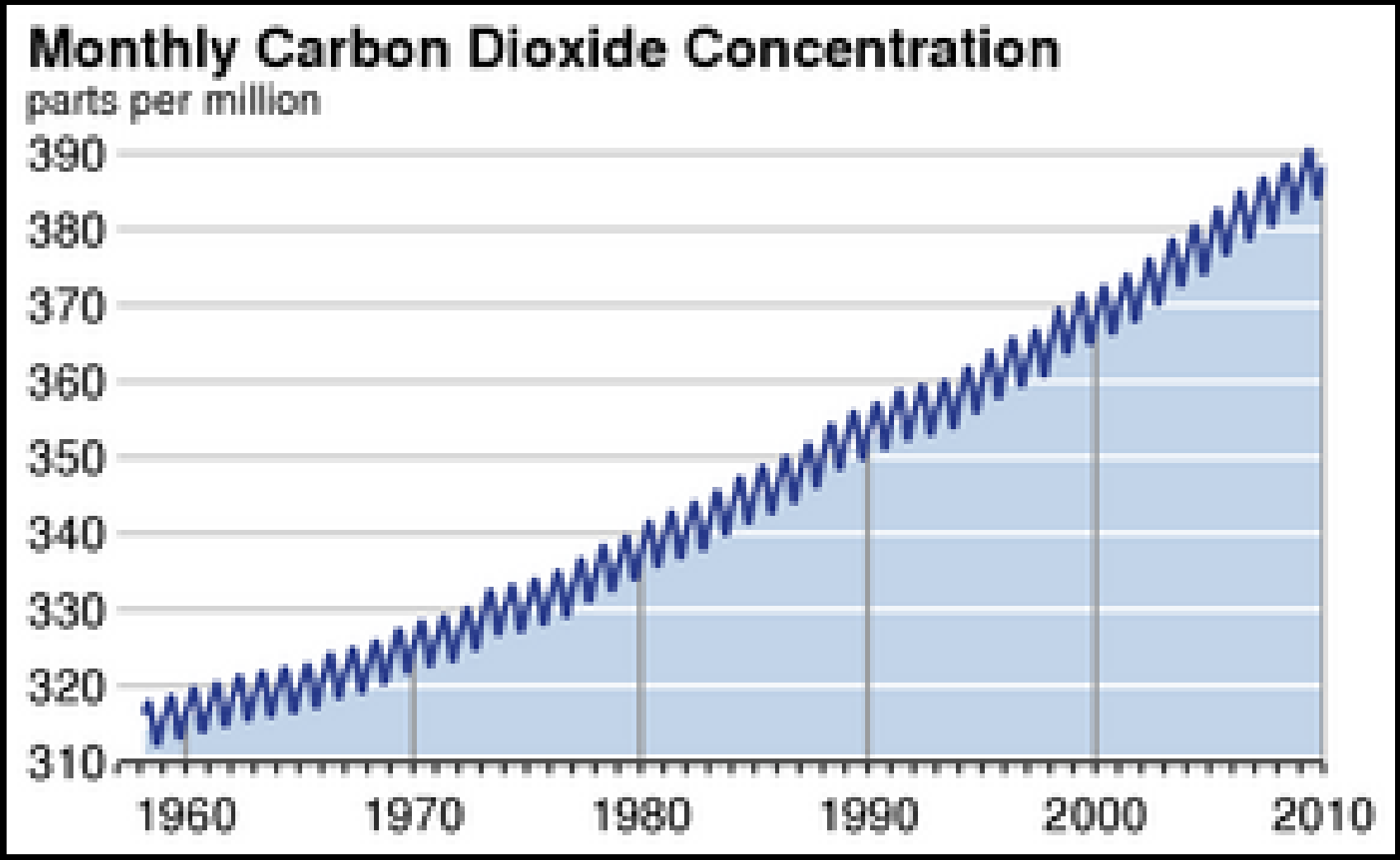
You might have come up with something like this……

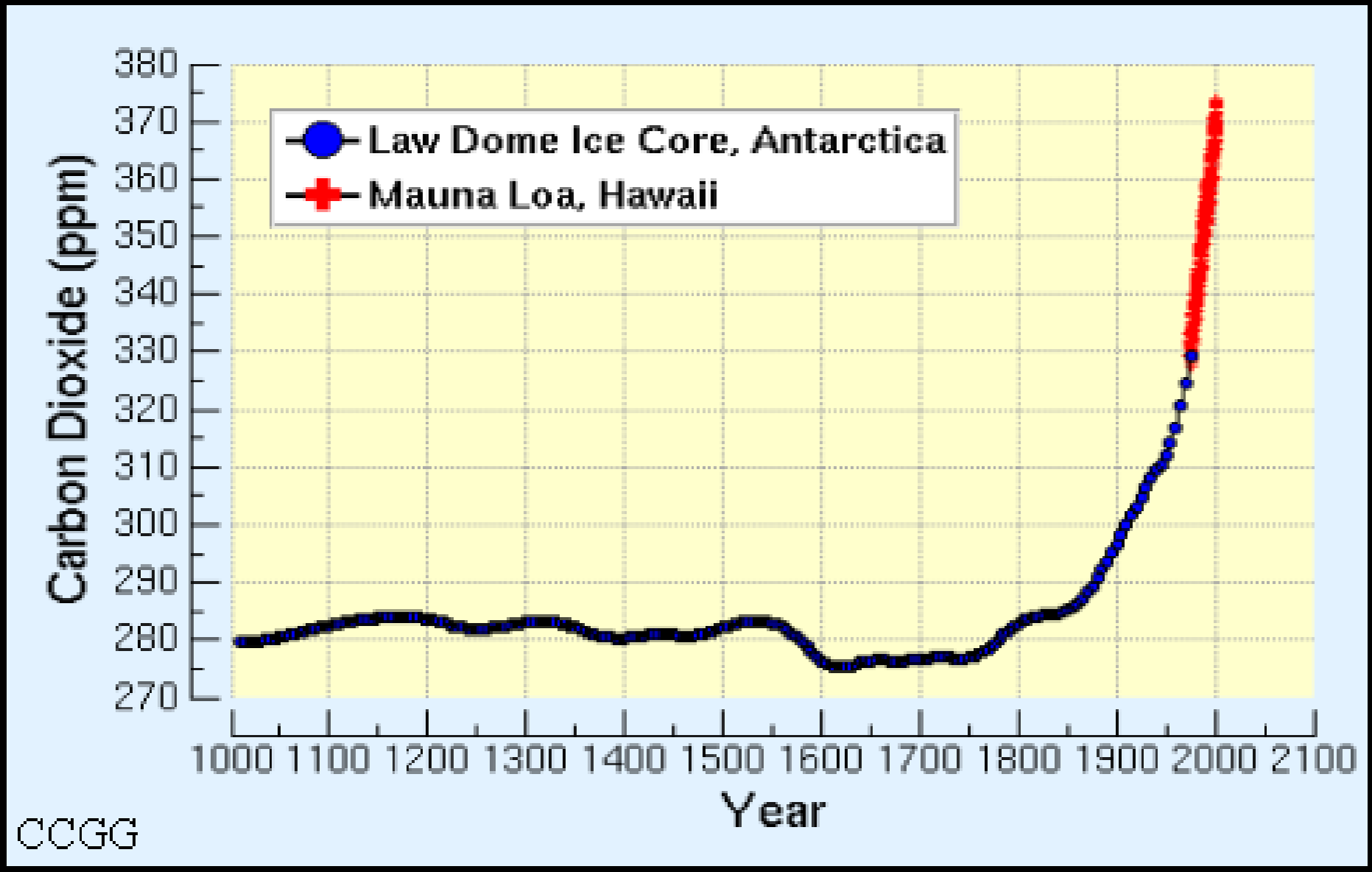
Cross-curricular opportunities



http://earthobservatory.nasa.gov/GlobalMaps/

Atmospheric CO_2 measured at Mauna Loa - Keeling Curve (taken from Scripps Institution of Oceanography)




Law Dome Ice Core, Antarctica
Mauna Loa, Hawaii
Carbon Dioxide (ppm)
380
370
360
350
340
330
320
310
300
290
280
270
1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100
Year
CCGG

(Taken from Scripps Institution of Oceanography)