Chemistry models link to forests

Continuing the series on IYF in Otherways in 2011 by Jeanie Clark

'Forests are full of chemicals!' - Can you find the symbol for it on the IYF logo? 2011 is also an IY for Chemistry, so let's look for the basic links with forests.

Chemistry in the news

Have you noticed a chemical headlining the news lately? Yes, it's the C word, Carbon! Have your children noticed it? Have they picked up messages about whether this chemical is depicted as good, neutral or bad? Has the media been communicating about this chemical appropriately ie 'Carbon' tax … or should it be a 'Carbon di-oxide' tax? Does this make any difference if it is linked with forests? How can we put the Carbon chemistry into the forests year in a positive way for young folk to absorb the majesty carbon is responsible for in the forests? To me, these things can be explored through the key that the IYF and IYC share - photosynthesis.

Photosynthesis.

Was photosynthesis where you first heard of carbon? You may have learnt about photosynthesis through symbols, a diagram* or as words like 'Carbondioxide and water through the catalyst of chlorophyll converts sunlight (solar energy) to carbohydrate (stored energy) and oxygen'. Whichever way, did you notice where carbon is in this process?

- the resource, the gas **carbon**dioxide CO_2
- the building material, the stored energy **carbo**hydrate CH_2O
- the 'machinery', for the catalyst chlorophyll has **carbon** in it too.

Will/do you treat carbon as a positive life-creating material? All living things are derived from the photosynthesis of plants in which the big player is carbon, and hence the term 'carbon based life'. There are two other important elements in this process, oxygen and hydrogen, but because carbon is able to bond so easily with other things and make over 10 million different compounds, it gets the billing for the organic chemistry, the chemical basis of life.

* There are many diagrams of photosynthesis around. I like best the one on page 32 of *The Visual Dictionary of Plants* (Edited by E. Lindsay and published by Dorling Kindersley in London 1992) which shows the chemical models at each stage.

Now all of this can seem rather complex, with its big words and too small to see parts and processes! Illustrations abound, but you may find it useful to first look at a number of different versions to see what would work best with your children…. or is there an alternative? My choice is to use models to introduce photosynthesis so that children can grasp the processes and to encourage awe at what carbon does.

My first model (step 1) is a numeracy activity that uses blocks that can link. It focuses on the manipulation of the blocks without chemical names. When this procedure with the blocks is familiar and easy to manipulate, more complexity can be added (step 2): the chemical names; the process told as a story and finally introduce the shortcut chemical symbols which are easier to read than the names! All you need is some grasp of the alphabet and numbers to 'read' a simplified equation for photosynthesis such as $CO_2 + H_20 = CH_2O + O_2$ after following this process.

Modelling Photosynthesis

Step one – learn the procedure without the names

You will need:
blocks that link together in three different colours (egs given below) and in groups of the following:

- 1 black ■
- 3 white □ □ □
- 2 red blocks □□

(Counting out the blocks needed is a good numeracy task for younger children too.)

Pieces of materials

- A larger blue or white one
- A smaller green one

Assemble the blocks so there is

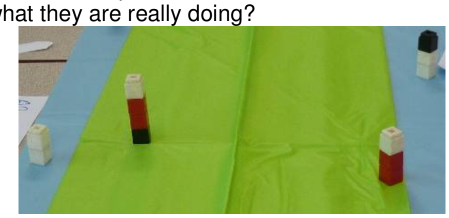
- 1 black is attached to 2 whites□■□ on the blue
- 2 reds attached to 1 white □□□ on the green

Now pick up and move the black/whites□■□ off the blue onto the green material

On the green material

- break the black ■ off from its 2 whites □□
- join the black to the red/whites □■□□
- take the other 2 whites back to the blue. □□

If you have lots of blocks, you can repeat the process a few times, til the pattern is learnt .. and the children may ask what they are really doing?



Modelling Photosynthesis

Step 2 Introduce the chemical concepts

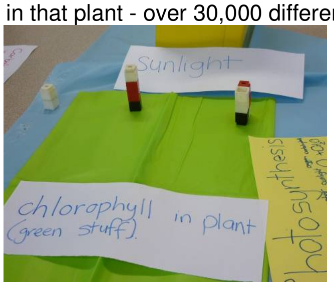
You will need:
all the above from step 1
a mottled surface with say 3 colours eg a bench top

Examine the mottled coloured surface- from a distance is should look like one colour (i.e. linked into substances), but it may be really made of scattered three colour bits (i.e. elements). Air is like this - we can't see its bits.

Identify the different parts of photosynthesis for the model:
3 elements in air: eg carbon C = black blocks, oxygen O = white blocks and hydrogen H = red blocks.
3 substances in the leaf and air: CO_2 (Carbon di-oxide), H_2O (water), O_2 (oxygen gas)
2 more in the leaf: CH_2O (carbohydrate, a starch) and chlorophyll (a hydrocarbon chain/ring, a catalyst).
Air = blue material.
Leaf = green material

Tell a story like this version below (chemical symbols shorten it), while the models are made, broken, moved.

The gas CO_2 came from the air into the leaf.
The liquid H_2O came from the soil up the roots through the stems to the leaf.
Sunlight (energy) and chlorophyll (green stuff) broke CO_2 and H_2O apart in a process called photosynthesis as these molecules met in the leaf.
The O_2 was left on its own and moved out of the leaf.
The C joined the H_2O to form CH_2O – a new substance- that could change and make all the different structures and scents in that plant - over 30,000 different things!.



Using diagrams of photosynthesis may be more useful and better understood now than at the start. But I'd still leave them and instead go off to examine a plant (real, drawn or photographed) to marvel at the many different shapes, sizes, colours and smells that have been created from this material and energy giving process, i.e. marvel at life, carbon-based life!

Carbon structures in plants

Where does the carbon go to make the parts of the plant? Botany and science books don't tend to show where the carbon is, but they are great on all the different structures. So my next model shows where the carbon and water go through the plant. It is great fun to make, but the key concepts are that:

- water mainly comes from the soil and goes up the plant from the roots to join the carbon in the leaf,
- carbon as gas comes in from the air to the leaf, is changed to a solid that grows into different forms throughout the plant making all its different parts.

Carbon complexity

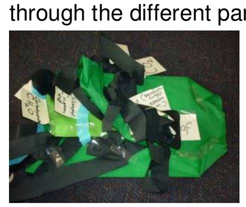
Carbohydrates can join together to make repeated chains. Each is a more complex structure and material:
Carbohydrate - CH_2O = simple starch building block, from photosynthesis, used in all plant cells for energy

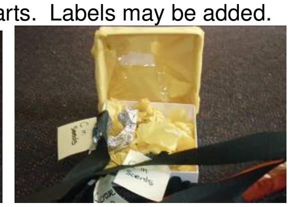
Modelling Carbon and Water in a tree

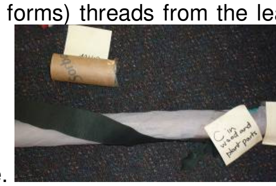
Make the model of the tree first from cardboard rolls and packaging wrapped in coloured crepe paper (below):
Roots = thinnest rolls (paper towel) wrapped in brown
Trunk = fattest, biggest roll (post) wrapped in dark grey
Branches = toilet rolls joined wrapped in light brown
Fruits/flowers= chocolate box with lid wrapped in yellow and opening to white crepe flowers inside with a
Seed = (real) charcoal wrapped in foil under a flower
Leaf = padded A4 envelope wrapped in dark green, with a slit into a parcel of light green (chlorophyll) inside it

For the modelling of the movements of water and carbon in its forms, you will need long thin strips of crepe paper, about 5 of each. They start at each end of the tree and thread its way to reach all of the structures as you/children discuss the processes and parts of the tree.
Water = **blue** crepe paper, starts at the roots and goes inside the rolls to thread up to the leaf package, i.e. water moves from the roots up the trunk, branches and into the leaves, fruit and flowers bringing nutrients too.
Carbon = **black** crepe paper, starts in the air (as CO_2) and is slid into the leaf to reach the chlorophyll. It is then changed to into CH_2O and in this form, carbon moves through all the plant **making** all the key structures above.

This finished model should have threads woven all through the different parts. Labels may be added.







Black streamers (carbon forms) threads from the leaf to 'grow' all parts of the tree.

Glucose - $C_6H_{12}O_6$ = the simple sugar = six linked carbohydrates, i.e.(6 X CH_2O)
Sucrose - $C_{12}H_{22}O_{11}$ = simple 2- sugar molecule = two linked glucose molecules less the excess water which the plant can use, i.e. [(2 X CH_2O) - (H_2O)]
Starch eg cellulose (best place to store C) - $(C_6H_{10}O_5)_n$ = complex sugars where n = 1000's of glucose less water repeats, i.e. {nX[(6 X CH_2O) - (H_2O)]}
Lipids - fatty acids, waxes, vitamins, hormones, scents eg the glycerol [$CH_2(OH)CH(OH)CH_2OH$]
Chlorophyll (b type in plants) - $C_{55}H_{70}O_6N_4Mg$ = a ring with magnesium in the centre, surrounded by Nitrogen and then Carbon and Oxygen all attached to a long unsaturated hydrocarbon chain, which gives it the green colour (There is a great model of this in Challoner, Jack. *The Visual Dictionary of Chemistry* RD Press, Surrey Hills. 2010 page 38).
Nucleaic Acids - DNA & RNA codes for passing on life

Did you notice C (H and O) in these formulae? Coming from the start in photosynthesis, they are the chemicals largely responsible for the creation of the plants and trees of the forests. From this vegetation, creature life has foods, and forests their biodiversity. Linking the IYChem with the IYForests can help develop an appreciation of the miracle of carbon based life, and the good side of carbon. Have fun modelling!