Plants and Photosynthesis– Photosynthesis and Plant Products
Lessons 7 and 8

Photosynthesis and Plant Products

Essential Knowledge for Teachers

1. All green plants manufacture their own food, by using energy from the Sun during a process called photosynthesis. They use carbon dioxide (CO_2) from the air, water (H_2 O) from the soil, energy from the Sun in the form of light, minerals from the soil and chlorophyll in their leaves to make organic chemicals, mainly sugar (C6 H12O6), which is their basic food.
2. Oxygen (O_2) is a waste product of the reaction and is released into the atmosphere.
3. Much of the sugar is turned into starch for storage in the leaves.
4. Photosynthesis is summarized in a word equation as:
   Sunlight Chlorophyll Carbon dioxide + water glucose + oxygen Photosynthesis is normally written as a symbol equation:
   Sunlight Chlorophyll $6CO_2 + 6H_2O \; C_6H_{12}O_6 + 6O_2$.
5. Plants use the sugar to manufacture a variety of carbon compounds including oils, proteins, and starches.
6. We use these materials for our food, medicines, dyes, perfumes, fibres etc.
7. Because plants use raw materials to manufacture food, they are called primary producers.
   NB this is one of the key underlying concepts in biology and it is vital that pupils' misconceptions are dealt with immediately.
8. Leaf colour comes from ***pigments***. Pigments are natural substances produced by leaf cells. ***Chlorophyll*** is the most important of three. Without the chlorophyll in leaves, trees wouldn't be able to use sunlight to produce food.
   Trees respond to the decreasing amount of sunlight throughout the year, by producing less and less chlorophyll. Eventually, a tree stops producing chlorophyll. When that happens, the carotenoid pigment, already in the leaves, can finally show through. The leaves then become a bright rainbow of glowing yellows, sparkling oranges and warm browns.

Common Misconceptions

- ✓ Plants get their food from the soil.
- ✓ All plants make their own food.
- ✓ Oxygen is used in photosynthesis.
- ✓ Oxygen is a wanted product from the process.
- ✓ Plants do not respire.
- ✓ Water enters plants through the leaves.
- ✓ The Sun's energy is part of the chemical process.
- ✓ Energy is made during the process.
- ✓ Plants do not respire during the day.

Termly Scientific Skills Development Focus: Evaluation

Questions that should be asked: (For more suggestions see page 16 of the Scheme of Work)

- ✓ Are there any results/observations which don't seem to match others?
- ✓ How would you explain any results/observations that you were not expecting?
- ✓ How would you use science to explain any results/ observations which don't seem to match others?
- ✓ What could you do to make your method better?

Opportunities should be given throughout the lesson for children to use and develop their knowledge of planning investigations and collecting data. They should be encouraged to question the validity of their results.

Plants and Photosynthesis– Photosynthesis and Plant Products
Lessons 7 and 8

Cross curricular links	
Literacy	✓ Write a photosynthesis poem like Mr R. http://sciencepoems.net/sciencepoems/photosynthesis.aspx#.VRZg-vmsVFM ✓ Pupils work in groups of two, three or four (dependent on ICT available). They could complete a newspaper front page on Van Helmont, Priestley and Ingenhousz using the information sheet to help them. ✓ Write an explanation text explaining why leaves change colour throughout the year.
Other subjects	✓ See Van Helmont fact sheet. ✓ Ask pupils to write a little song about photosynthesis including the equation. ✓ Students could create a little 'play' acting out all the various parts of photosynthesis. ✓ Pupils could research and write up their own experiment about photosynthesis identifying how they could study all the factors that affect photosynthesis.

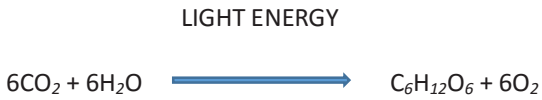
Starter Activity

Either: Review leaf structure by memory map activity.
Or: Think-pair-share:
What do we know about plants? Draw a poster.
(Show the 'Plants' PowerPoint and ask students what they did not remember and re-enforce these aspects).

Activity

Introduction to Photosynthesis

Show the *'Photosynthesis' PowerPoint'*. Use the presentation to explain photosynthesis to pupils. Emphasise the key facts that plants take in Carbon Dioxide from the air and Water from the ground to make Glucose, which it then turns into starch and then uses this to make plant fibre.



Possible Questions/ Suggestions for discussion

Discussion Questions

Collective memory activity on photosynthesis (last slide on PPT)

1. Learners in groups of three or four are given a number within the group: 1, 2, 3 or 4.
2. All the 'ones' are invited up to look at the image hidden on the teacher's desk for 10 seconds and then they return to their group and start to reproduce the image on a blank piece of paper as accurately as possible.
3. After 30 seconds, all the 'twos' come up for 10 seconds, return to the group and help complete and refine the copied picture / diagram.
4. Then the 'threes' and finally the 'fours'.
5. At this point, stop and tell the groups that they are going to have one or two more rounds to reproduce the images. Ask them, "How are you going to best work together to make the image as accurate a copy as possible?" (Perhaps using 'Think, Pair, Share' for this question).

To succeed, learners will need to plan how they will work together (e.g. by splitting the image into quarters and concentrating on one each, or by having one person do the labels etc.). They will also need to develop an awareness of how much information they can retain in their short-term memory. It is valuable to unpick this once the activity is completed.

Plants and Photosynthesis– Photosynthesis and Plant Products
Lessons 7 and 8

Teacher Demonstration

Demonstration: Where is starch formed in the leaf?

1. Ask pupils to pick a small leaf off the top of any plant or provide 15 variegated geranium leaves to class.
2. Arrange a plastic 250ml beaker on a desk and boil a full kettle of water.
3. Once the kettle has boiled, place the leaves in the kettle for a few mins.
4. Remove the leaves and place them into the bottom of the boiling tube.
5. Pour around 10mls of methylated spirit into the boiling tube to cover the leaves and place into beaker.
6. Reboil the kettle and place 150ml boiling water into the beaker.
7. The methylated spirit will boil (it boils around 700^{C}) and the solution will turn green as it removes the chlorophyll from the leaves.
8. After 10 mins carefully remove the leaves, unfurl and lie flat on a white tile.
9. Add a few drops of iodine solution to the leaves and wherever starch is present the leaf will turn black.
http://www.biotopics.co.uk/plants/psfac2.html
10. Allow children to examine the leaves when cooled.

Extra Demonstration: To show that oxygen is released during photosynthesis

Set up the elodea or Cabomba demonstration explaining why the equipment is set up in this way and that any bubbles of gas released will float to the top of the upside down test tube.
As it does this the water in the tube is forced out. You do not have to set up the control, but if you do it will show that light is needed for the process.

http://www.saps.org.uk/secondary/teaching-resources/190-using-cabomba-to-demonstrate-oxygen-evolution-in-the-process-of-photosynthesis-

This will help pupils understand that oxygen is released by the plant and not part of the process or used by the plant. Through careful higher order questioning, stress that without plants we would have no oxygen to breathe and life on Earth would cease. This is why we must make our forests sustainable.

Children's Investigation

Investigation: What plant products contain starch?

Pairs of children will need: spotting tile, variety of food, iodine solution

1. Using the spotting tiles, simply ask pupils to place a little of the food substances you have into each of the dimples.(bread, potato, cheese, rice, orange etc)
2. Add 1 or 2 drops of iodine solution from the dropping bottles to the food samples.
3. If starch is present the food will turn black.
4. Pupils can then create a little table for the results and show which foods contain lots of starch.

Possible Questions/ Suggestions for discussion

- Did every leaf make the water turn the same shade of green? Can you suggest why?
What would happen if we used yellow leaves or red leaves?
- Comparison of energy contained in foods. Did all foods turn the same colour? Why?
- What patterns did pairs spot?
- Group foods which turned another colour, and those which were less affected. What reasons can children give?

In this activity it is important that pupils understand that fats contain more energy than sugar. Our bodies use up sugar first for energy and any fat not used is stored. You could stress that food content data is on all food packages and the need for a balanced diet that contains the right amount of different nutrients for each person.

Plants and Photosynthesis– Photosynthesis and Plant Products
Lessons 7 and 8

Learning Outcomes	
All children should	✓ Understand that appearance of leaves can be used to classify them e.g. shape (round, pointed etc.), number together, how grouped. ✓ Learn about insect eating plants using the Venus Fly Trap investigation to find its trigger time. ✓ Learn the term Photosynthesis and its very basic meaning. ✓ Develop the skills of pattern seeking and drawing scientific graphs. ✓ Investigate what materials are given off by leaves. ✓ Learn how to recognise patterns and draw scientific graphs.
Some children could	✓ Identify that data does not always produce valid patterns. They could go on to try to give reasons for this. ✓ Draw and interpret line graphs. ✓ Suggest ways in which to improve experimental design. ✓ Make species identification cards for interesting plants they have researched. Eg Titum arum, the smelliest plant at Kew.
A few children could	✓ Research and present a project on the history of the development of our understanding of photosynthesis. (This could be a homework activity.) Information sheet Computers PowerPoint of newspaper formats ***NB*** *If computers not available, print out blank A3 versions of the formats for pupils to complete.*

Plenary/Review including Skills Progression focus: Evaluation

Evaluation involves critically considering the reliability of the data and discussing how it can be improved. Pupils explain whether their evidence is robust enough to support a firm conclusion. They also suggest ideas to enable their investigation to provide additional relevant evidence.

- ✓ Through whole class discussion elicit from the pupils what they observed.
- ✓ What do children think they needed to do to ensure that they would get the same results if they or someone else was to repeat this experiment?
- ✓ The class should write on their experiment sheets an agreed definition for the term 'valid data'.
- ✓ How could this experiment be improved to make the data more precise, accurate and valid?
- ✓ In what ways might data from this type of experiment be useful in the real world?

Useful websites

https://www.woodlandtrust.org.uk/learn/british-trees/native-trees/
http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/plants/plants1.shtml
http://www.bbc.co.uk/bitesize/ks2/science/living_things/plants/read/1/
http://www.saps.org.uk/primary
http://www.sciencekids.co.nz/plants.html
http://www.nuffieldfoundation.org/practical-biology/recording-variation-ivy-leaves
https://www.youtube.com/watch?v=igkjcuw_n_U
https://www.youtube.com/watch?v=jkMjYJCdmF0
http://www.visuallanguagelab.com/cast/images/Photosynthesis_Expository.jpg
https://www.youtube.com/watch?v=C1_uez5WX1o
https://www.youtube.com/watch?v=pE82qtKSSH4
https://www.youtube.com/watch?v=_xeYNnzwpSE