

Carbon Detectives

How do plants and soil store carbon?

KS2 (Years 3 to 6) and KS3 · About 60 minutes · Part indoors, part outdoors



Facilitator notes

This is the first of four linked sessions. Pupils find out how plants and soil pull carbon out of the air and keep hold of it, then go outside to make their first predictions about where carbon is stored in their own school grounds. The predictions they make today are tested properly in Session 2.

At a glance

Big question	Where does a tree get the stuff it is made of?
Learning outcomes	All pupils: explain that plants take carbon from the air and store it in leaves, wood, roots and soil. Most pupils: describe how carbon moves from air to plant to soil and back again. KS3 and some upper KS2: link this to photosynthesis, respiration and decomposition, and explain why stored carbon can be released.
Curriculum links	KS2 Science: plants (Y3), living things and their habitats (Y4, Y6), working scientifically. KS3 Biology: photosynthesis, cellular respiration, the carbon cycle. KS3 Geography: weather and climate.
Time	About 60 minutes: 35 indoors, 20 outdoors, 5 to wrap up.
You will need	Pupil sheet (one each), the two diagrams in this pack (displayed or printed), Follow the Carbon cards (cut out, one set per group), clipboards and pencils for outside.

National Education Nature Park link

If your school has registered with the Nature Park, have your habitat map to hand. Pupils can use its habitat categories (trees, hedges, grassland and so on) in the outdoor carbon hunt, so today's predictions sit on top of the map you already have. If you have not registered yet, it is free for nurseries, schools and colleges in England at educationnaturepark.org.uk. Session 2 builds on the habitat map, so now is a good time to sign up.

Background for you

Plants build themselves mostly out of air. In photosynthesis, leaves take in carbon dioxide and, using energy from sunlight and water from the roots, turn it into sugar. That sugar is the raw material for everything else: leaves, wood and roots. About half of a tree's dry weight is carbon.

Some of that carbon moves underground. Roots grow and die, leaves fall, and fungi and soil creatures break them down. Part of this carbon is locked into the soil for years or even centuries. Worldwide, soils hold more carbon than all the plants and the atmosphere put together, so the ground under a school field matters as much as the trees on it.

Carbon does not stay stored forever. Plants, animals and fungi release some carbon dioxide as they respire, dead material rots, and digging, burning or sealing over the ground releases more. Stores can grow, hold steady or shrink depending on how land is looked after. That is the idea Session 4 comes back to.

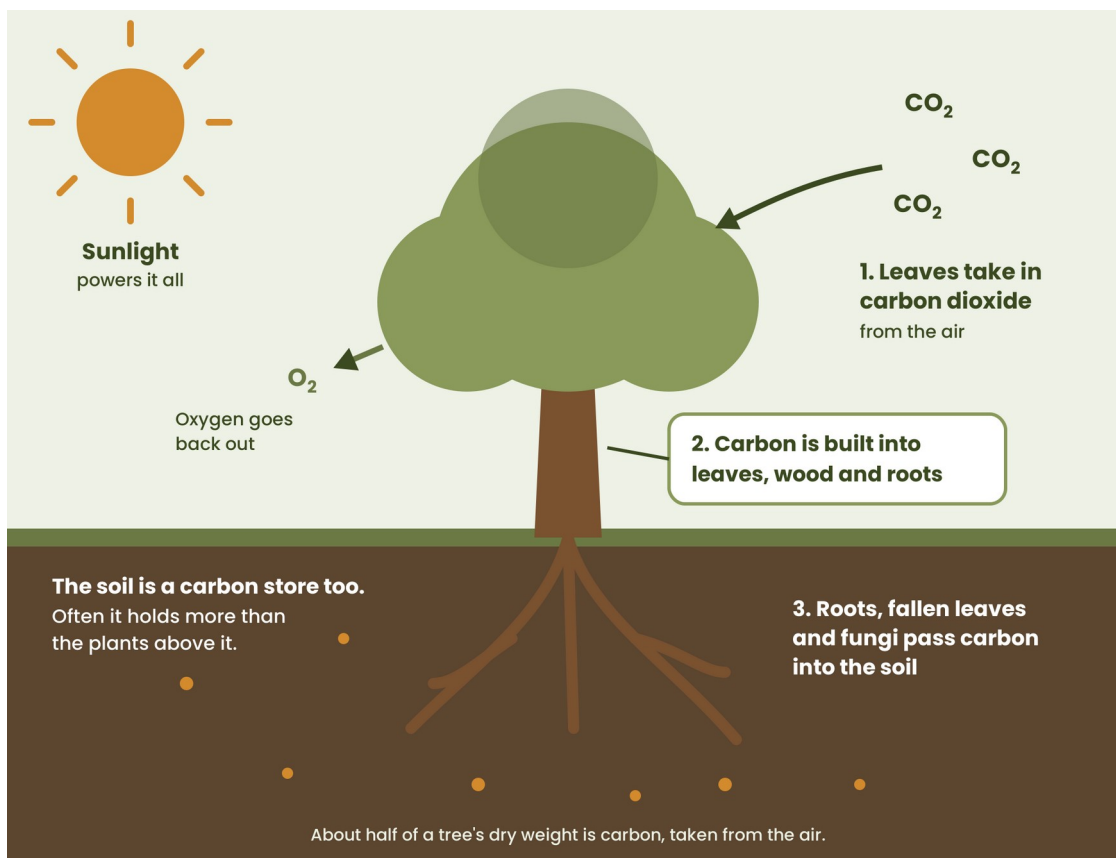


Diagram 1: How a tree stores carbon. Display this during Part 3.

Session plan

Part 1. The tree question (10 minutes)

Hold up a picture of a big tree, or point to one through the window.

Say: A big oak can weigh as much as several cars. But a tree starts life as a tiny acorn. So where did all that stuff come from?

Pupils vote by moving to a corner of the room, or by ticking a box on their sheet: the soil, water, sunlight, or the air. Ask two or three pupils in each group to explain their choice. Do not give the answer yet.

Expect most votes for soil. That is a very common idea, held by plenty of adults too, so treat it as a good guess rather than a wrong answer.

Part 2. The 400-year-old experiment (10 minutes)

Tell the story of Jan Baptist van Helmont, a scientist working in the 1600s who wanted to settle this question.

Say: Van Helmont weighed out a pot of dried soil and planted a small willow tree in it. For five years he gave it nothing but rainwater. Then he weighed everything again. The willow had grown from about 2 kilograms to about 77 kilograms. How much soil do you think had disappeared?

Take guesses, then reveal: the soil had lost only about 57 grams, roughly the weight of an egg. Van Helmont decided the tree must be made of water. He was partly right, but he missed something he could not see.

Say: *The biggest ingredient came out of the air. Trees are built mainly from carbon dioxide.*

Return to the vote. Who wants to change corners now?

Part 3. Follow the carbon (15 minutes)

In small groups, pupils put the Follow the Carbon cards in order to show the journey of carbon from the air, through a plant, into the soil and back again. Then display Diagram 1 so they can check their order.

The correct order is A, B, C, D, E, F, and then back to A. Point out that it is a loop, not a line. Ask: where on this loop could carbon stay put for a long time? (In wood and in the soil.)

Pupils then complete the Follow the Carbon boxes on their sheet in their own words.

Part 4. Carbon detectives outside (20 minutes)

Take pupils into the grounds with their sheets and clipboards. Their job is to find five different places where they think carbon might be stored, and to give each one a carbon score from 0 (none) to 5 (lots). They must give a reason for every score. They should also find one place where they think almost no carbon is stored.

Prompt them to think below ground as well as above. A patch of mown grass looks empty, but what about the soil underneath? What about the playground?

Safety: agree boundaries before going out, and remind pupils not to pick fungi or touch anything they cannot name. Usual school outdoor learning rules apply.

Part 5. Wrap up (5 minutes)

Back inside, display Diagram 2. Pupils compare it with their own scores. Where did they agree? What surprised them? Many are surprised that tarmac scores zero and that grass scores more than they expected because of the soil.

Finish with the detective's conclusion on the pupil sheet.

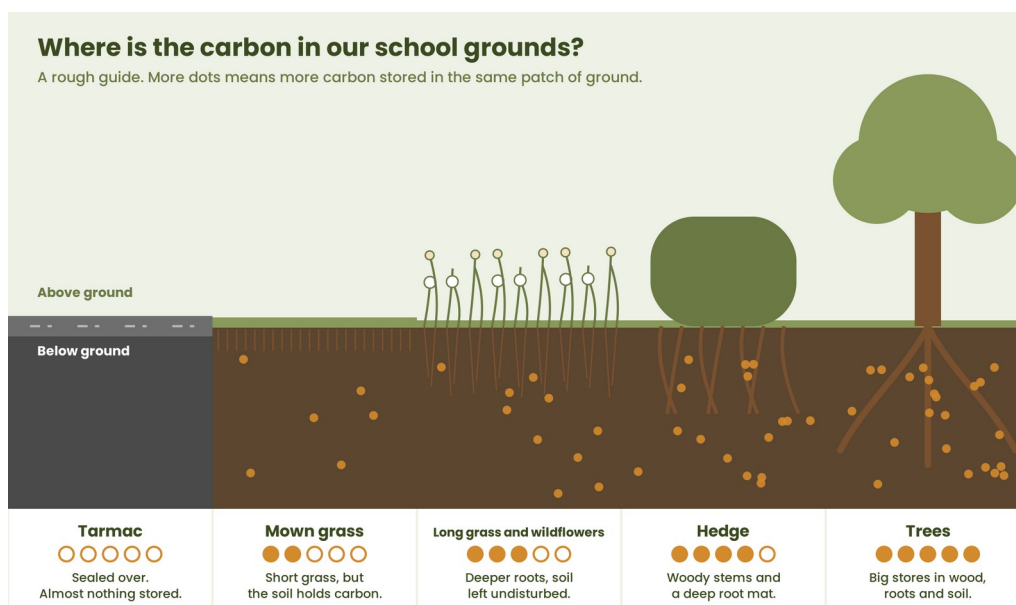


Diagram 2: Where is the carbon in our school grounds? Display this in Part 5. The scores are a rough guide for comparison, not measurements.

Common misconceptions

- **Plants get their food from the soil.** Soil supplies water and small amounts of minerals. The bulk of a plant comes from carbon dioxide in the air.
- **Plants breathe in carbon dioxide and only give out oxygen.** Plants also respire all the time and release some carbon dioxide. Over a growing season, a healthy plant takes in more than it gives out.
- **Once carbon is stored, it is stored forever.** Stored carbon can be released by rotting, burning, digging or building over the ground.
- **Trees are the only thing that counts.** Soils, hedges and long grass all store carbon. Different habitats do different jobs, which Session 3 explores.

Adapting the session

- **Lower KS2:** use the cards as a picture sequence and keep to three ideas: air in, plant grows, carbon goes into the soil. Score the outdoor places as none, some or lots.
- **Upper KS2:** use the full card sort and 0 to 5 scores, and ask pupils to explain the difference between above-ground and below-ground carbon.
- **KS3:** add the photosynthesis word equation and the KS3 challenge on the pupil sheet. Discuss which processes return carbon to the air: respiration, decomposition and combustion.

Coming next: Session 2, The Grounds Audit

Pupils test today's predictions properly. They measure tree trunks to estimate stored carbon, map surfaces and habitats, and add a carbon layer to the school's Nature Park habitat map. Keep today's pupil sheets so pupils can compare their predictions with what they find.

Follow the Carbon cards

Cut along the dashed lines. One set per group. Answer: A, B, C, D, E, F, then back to A.

A

Carbon dioxide gas floats in the air all around us.

B

Leaves take in carbon dioxide. Sunlight gives them the energy to use it.

C

Inside the leaf, the carbon is turned into sugar.

D

The plant uses the sugar to build new leaves, wood and roots.

E

Leaves fall and old roots die. Fungi and minibeasts break them down.

F

Some carbon gets locked into the soil. Some goes back into the air.

Carbon Detectives: Pupil sheet

Name: _____ Class: _____

1. My first guess

A big tree weighs as much as several cars. Most of that stuff came from... (tick one)

☐ the soil ☐ water ☐ sunlight ☐ the air

I think this because

2. Follow the carbon

Fill in each box to show where the carbon goes. The first one is done for you.

1. In the air → <i>Carbon dioxide floats in the air.</i>	2. Into the leaf →	3. Into the plant →
4. Into the soil	5. Back to the air	6. So the carbon goes round in a...

3. Carbon hunt

Find five places in your school grounds where carbon might be stored. Give each a carbon score from 0 (none) to 5 (lots). Remember to think about what is under the ground too.

Place	What is there?	Score (0 to 5)	Why did you give this score?

One place with almost no carbon stored: _____

4. Detective's conclusion

The place in our grounds that I think stores the most carbon is _____ because

One thing that surprised me today was

KS3 challenge

Complete the word equation for photosynthesis:

_____ + water → glucose + _____
(*using energy from light*)

Name two ways that carbon stored in a tree or in soil can get back into the air.
