2. Healthy leaves

2+ hours

Children respond to a letter from a fictional company to investigate plant growth. They construct a giant model leaf using the cells from the smart bricks activity which they then test for strength and survival against mini beast attack. They consider the importance of this to farming industries.

OBJECTIVES

- Ask relevant questions and use different types of scientific enquiries to answer them
- Use straightforward scientific evidence to answer questions or to support their findings

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheet 2a, 2d
- Activity sheet 2b and 2c (per child)
- Selection of leaves (optional)
- Magnifiers (each) or the Intel microscope (optional)
- One pair of large scissors
- One straw, knitting needle, or other spike
- To make one class leaf:
- One set of the smart bricks made in the previous session Roll of double sided sticky tape
- 3 x 2 m of bubble wrap 3 x 2 m of bubble wrap

Safety note

Children should be supervised closely with sharp object.

INTRODUCING THE ACTIVITY

Read the letter from the company (Activity sheet 2a). A company wants to produce a nutrient product that will help crops produce healthy leaves, roots and fruit.

Show the children the pictures of the different stages of growth of a healthy maize plant (corn) (Activity sheet 2b). Children draw pictures to predict the way the plant would have grown if its leaves were removed. Establish that without leaves plants would not grow tall and eventually die because the food in the seed has been used up. Remind children that leaves use sunlight to make their own food for growth. This is useful for revision for national tests.

Remind the children of the different industries that use leaves and require them to be strong and healthy (see card sorting activity from activity 1), and ask the following questions:

- *What does a company growing lettuces, or cabbages require from the leaves of the plants it grows?* Large, strong, healthy, appetising and nutritious leaves that are undamaged by insect bites.
- ***What does a company growing herbs require?*** Strong, healthy, undamaged leaves which are full of flavour.

Establish that plants naturally produce leaves that are strong and healthy for survival and weaker plants do not survive.

Plant companies want to grow large numbers of strong healthy plants to make larger profits.

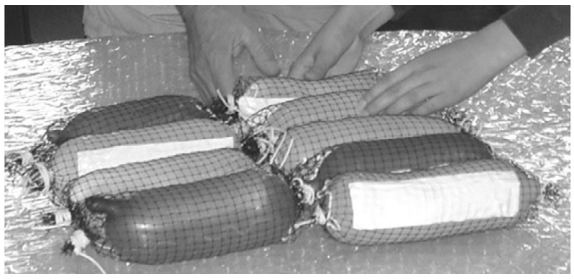
How does a plant produce that kind of leaf? It takes in certain nutrients (minerals) and they help it to strengthen the smart bricks in the leaves and protect them from disease.

Look carefully at a selection of leaves using magnifiers or the Intel microscope. Children note the structure, e.g. central vein, radiating veins, colour, shape, etc. They use observations to draw a labelled diagram of the leaf. They could then look carefully at, and compare, examples of healthy and unhealthy leaves.

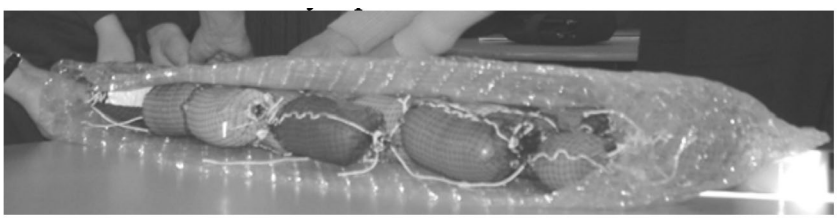
MAIN ACTIVITY

Use one set of their smart bricks from activity 1 to construct a giant leaf, by joining them together with a skin (bubble wrap). You could produce one or two leaves for the whole class depending on their size and the number of smart bricks that you have made.

1. Attach double-sided sticky tape to two opposite sides of the smart brick.
2. Stick the smart bricks down in rows onto the bubble wrap leaving a border at the edges and enough excess bubble wrap on one side to fold over and cover the smart bricks.



3. Fold over the excess bubble wrap and seal the smart bricks in with sticky tape to create the leaf.



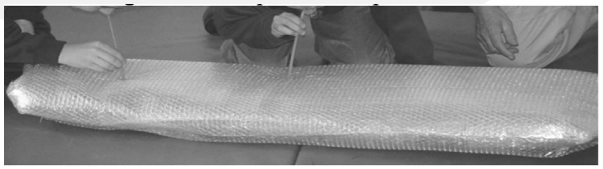
After the leaf or leaves are completed, the children use Activity sheet 2c to consider what would happen to the leaf if it was put under pressure from rain or hail, or attacked by mini-beasts. Children look at the photographs to see that aphids use a proboscis that sticks into the leaf and sucks out the liquid, and a caterpillar bites the leaf with scissor like jaws.

Safety note

Children should be supervised closely with sharp object.

Test the strength of the leaf by asking a volunteer to lie on it. Explain that leaves are a flat cushioned structure, strong enough to withstand weather conditions and the weight of small animals. They are flexible enough to bend and not to snap under the strain.

They then test how the leaf responds to aphid attack by puncturing the leaf. One child could take the role of the aphid and attach a straw to their nose and attack the leaf or use a knitting needle or equivalent to puncture it.



To test protection against the bite of caterpillars, simulate their bite by cutting the leaf with scissors.

PLENARY

Draw a conclusion. In both of these tests, some of the cells become damaged but many remain intact. The structure of the leaf is compartmentalised; so even when one section becomes damaged, the leaf can still produce new food for plant growth by making more cells. Damage in one part of the leaf hardly matters to the overall plant.

Refer back to the letter and the idea of industries making nutrient products to help growth. Ask the children:

- If plants protect themselves so well naturally, why do they need nutrient products?

Establish that some soils lack the nutrients necessary to produce healthy leaves (due to many years of growing crops) and that crop producers use nutrient products to ensure a higher percentage of plants grow healthily.

Examine the labels from the packages of different fertilizers (Activity sheet 2d). Explain that nitrogen is a key nutrient in helping leaves grow strong and healthy (Appendix 1 provides further information for teachers). The children then match the nutrients from this information to those named on the fertilizer labels. Establish which fertilizer would promote the best leaf growth and why.

Appendix 1

Further Information for Teachers about Plant Nutrients, Soils and Nutrient Products

What nutrients do plants need?

Most living organisms have three basic requirements for survival: food, water, and air.

Through photosynthesis ('making things with light'), plants use energy from the sun to change carbon dioxide and water into starches and sugars. These starches and sugars are the plant's food.

Since plants get carbon, hydrogen, and oxygen from the air and water, there is little farmers and gardeners can do to control how much of these nutrients a plant can use. However, whilst all green plants make their food by photosynthesis, they also need to get nutrients from the soil for growth. These dissolve in water and are taken up by the roots of the plant. Amounts of these in the soil can be controlled more easily by farmers and gardeners.

Plants need both non-mineral nutrients, which they get from the air and water, and mineral nutrients, which they get from the ground. The non-mineral nutrients are hydrogen, oxygen and carbon.

The twelve mineral nutrients, which come from the soil, are dissolved in water and absorbed through a plant's roots. There are not always enough of these nutrients in the soil for healthy plant growth. This is why many farmers and gardeners use fertilizers to add the nutrients to the soil.

Mineral Nutrients

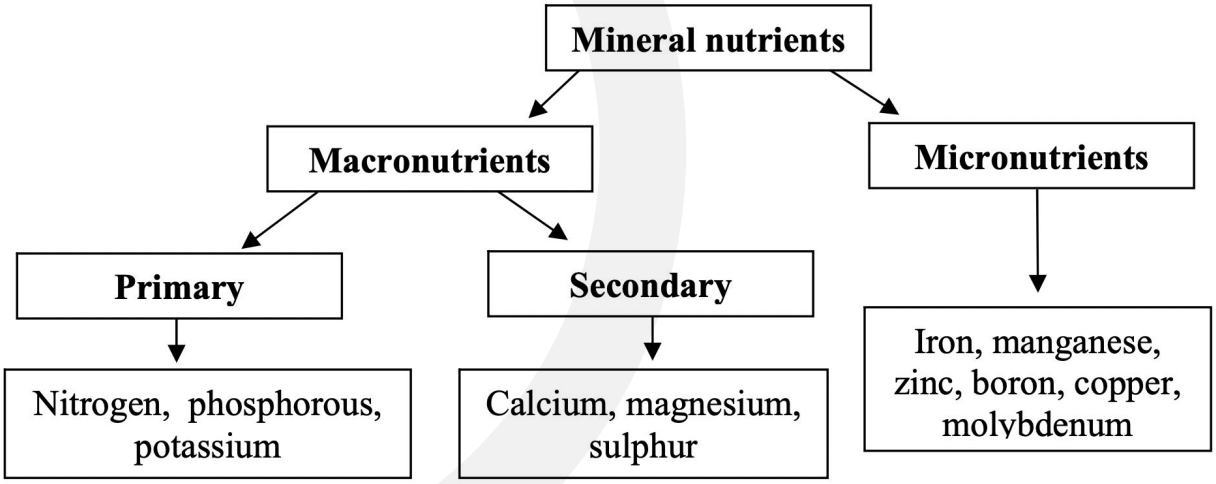
There are twelve essential mineral nutrients which plants must take up from the soil.

Nutrient	Symbol
Nitrogen	N
Phosphorus	P
Potassium	K
Calcium	Ca
Magnesium	Mg
Sulphur	S
Iron	Fe
Manganese	Mn
Zinc	Zn
Boron	B
Copper	Cu
Molybdenum	Mo

They are divided into two groups: macronutrients and micronutrients. Although they are all equally important to the plants health, the plant needs much more of a macronutrient than a micronutrient. A shortage of any one will result in poor crop growth.

Macronutrients can be broken into two more groups: primary and secondary nutrients. Nitrogen, phosphorous, and potassium are primary nutrients. Because plants need so much of these, this can lead to a deficiency in some soils. Calcium, magnesium, and sulphur are secondary nutrients. There are usually enough of these nutrients in the soil so fertilisation is not always needed. Also, large amounts of calcium are added when lime is applied to soils. Sulphur is usually found in sufficient amounts from the slow decomposition of soil organic matter.

Micronutrients are essential for plant growth but are needed in only very small amounts. They are boron, copper, iron, manganese, molybdenum and zinc.



How do the nutrients help the plant?

Nutrient	Part of the plant it affects	How it helps the plant
Nitrogen	Leaves	This helps above-ground leafy growth and gives a dark green colour to leaves.
Phosphorous	Roots, flowers and seeds	This encourages plant cell division. Without phosphorous, flowers and seeds could not form. It helps root growth and protects plants from disease.
Potassium	Roots and leaves	This increases the plant's resistance to disease and encourages root growth. It is needed for the making of chlorophyll.

Recycling organic matter is an excellent way of providing macronutrients and micronutrients to growing plants.

How important is the soil type?

Most plants absorb water and nutrients from the soil as part of the growing process. The nature of the soil is important in determining how much of a nutrient the plant can retrieve. Most soils contain a combination of sand, silt, clay, and organic matter. The soil texture and acidity determine the extent to which nutrients are available to plants.

Soil texture is important for water and nutrient retention. Clays and organic soils hold nutrients and water much better than sandy soils. As water drains from sandy soils, it causes leaching (ridding the soil of nutrients), as it carries nutrients along with it. An ideal soil contains equivalent portions of sand, silt, clay, and organic matter.

The acidity or alkalinity of the soil is also important in determining the availability of nutrients. Acidic soils tend to have less macronutrients and alkaline soils tend to have less micronutrients. Lime can be added to the soil to make it less acidic and also supplies calcium for plants to use. In neutral soils nutrients are more readily available to plants. Microbes convert nitrogen and sulphur to forms that plants can use. This process is necessary for the plant to receive its essential nutrients. Lime also enhances the physical properties of the soil that promote water and air movement.

Are all fertilizers the same?

There are many types of fertilizer and nutrient products available. The type of fertilizer ideal for a crop depends on the type of crop, the soil texture, the acidity or alkalinity of the soil and the nutrients already available in the soil. Farmers will regularly send samples of soils and organic matter to laboratories to analyse their nutritional content, and will use certain nutrient products depending on the diagnosis.

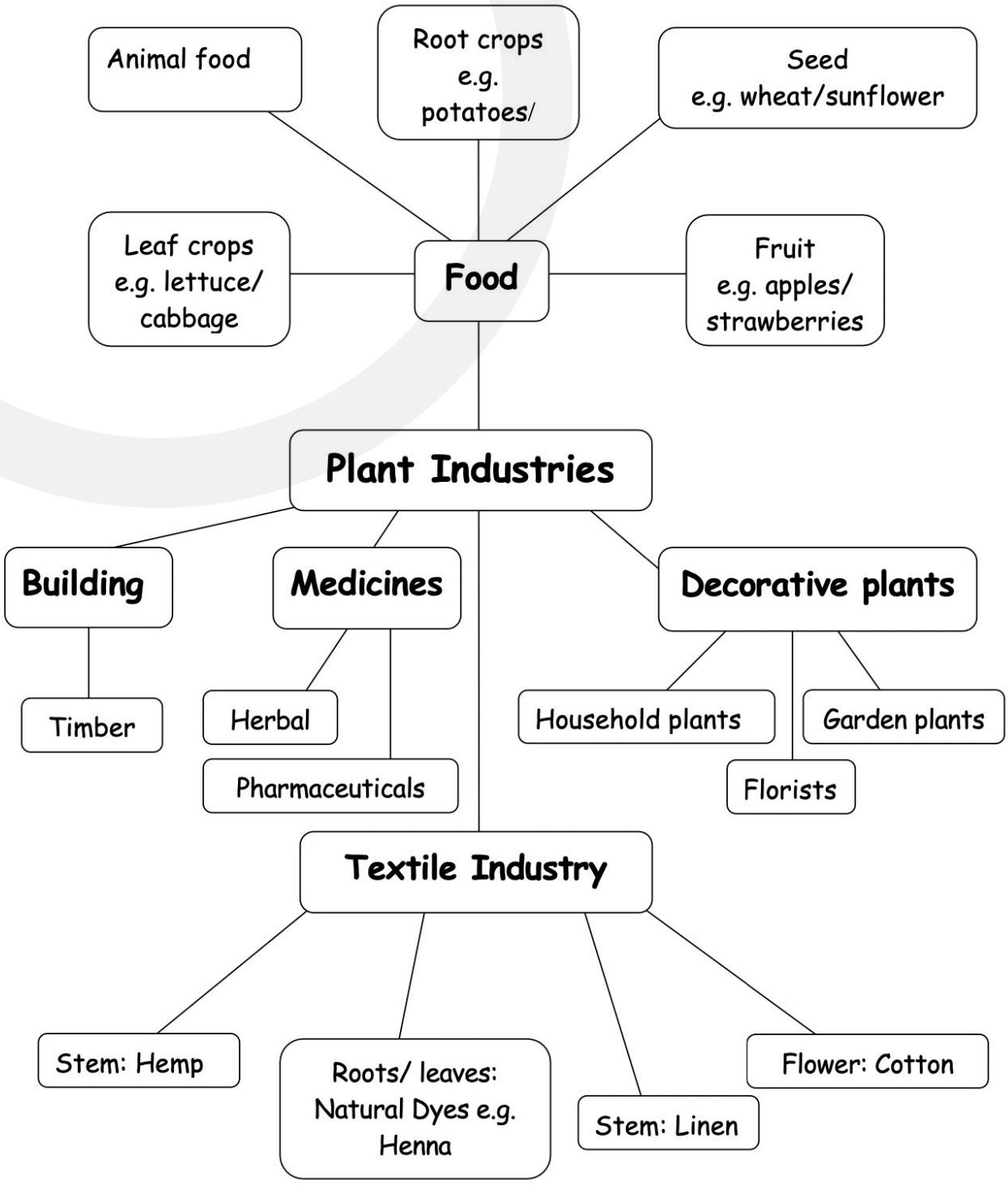
There are three main ways of distributing fertilizer. They are:

- broadcasting (a uniform distribution over the whole cropped field)
- placement (applying the fertilizer in bands or areas near the plants or plant rows)
- foliar sprays (the fertilizers are sprayed, covering the plants, and are absorbed into the leaves).

Plant growth without soil

Glass house production of vegetables is often without soil. Instead, plants can be grown in water or soil-less media (which are inert, water retentive, give support and have good aeration and moisture balances), e.g. sand, peat or vermiculite. Nutrient solutions are added to provide the essential nutrients for healthy plant growth. This process is called hydroponics. (Aeroponics is similar, but plant roots are suspended in a dark chamber and sprayed with the nutrient solution.)

Appendix 2: Plant Industry Mind map



COMMON MISCONCEPTIONS FROM CHILDREN REGARDING PLANT NUTRITION[1]

Misconception	Fact
Plants get their food from the soil and roots are organs for feeding.	Plants make their food. They make it from simple substances from the environment. The first step is by photosynthesis.
Plants have multiple sources of food: e.g. by photosynthesis as well as the environment.	Raw materials come from the environment but they make all of their food.
Water, minerals, carbon dioxide and sunlight are all food for plants.	Plants take in gases and liquids that are chemically changed into solids.
Water is for plant drinking and carbon dioxide is for plant breathing and these substances remain unchanged.	An analogy for plant nutrition is a factory. The plant takes in raw materials to make the food product.
Photosynthesis is a way for plants to make food for the benefit of animals and people, rather than for the plant itself.	Plants need food to grow. They grow to make new plants usually by producing seeds.
Plants need heat and light from the sun for photosynthesis.	It is the light that drives photosynthesis but plants cannot survive below a critical temperature.
Plants need light to grow.	Plants need light in order to produce food for it to grow.

1 Sourced from: Leeds National Curriculum Science Support Project

Smart Bricks for Smart Plants: Healthy Leaves
Experimental and investigative science: Assessment of performance

	Level 1	Level 2	Level 3	Level 4	Level 5
Planning Asking questions	To begin to carry out ready planned tests.	With guidance, make suggestions about how they could collect evidence or data to answer questions. *"We need to grow plants to see if that happens."*	Put forward their own ideas about how to find the answers to questions. Recognise and explain a fair test. Describe what they think might happen. (Predict)	To begin to offer an appropriate approach to answering a question. Plan a fair test by describing which factors to keep the same and which to change. *"We need to make sure they all have the same water ."*	To identify an appropriate approach to answer scientific questions. Recognise key factors to consider when carrying out a fair test. Make predictions using scientific evidence.
Obtaining Evidence Systematic Observations	To begin to make measurements. To begin to fill in a table to collect data	To begin to make measurements. To begin to fill in a table to collect data.	Make measurements using equipment provided with relevance to the task. Fill in a table to collect data.	Make accurate measurements with direct relevance to the task. Record data using tables.	Take repeated measurements to ensure reliability. Make a decision of what to measure. Create their own table to record data. *Think about the differences between height and leaf size.*
Considering Evidence Explain observations and measurements	With support, say what has happened.	Say what has happened and whether it was what they expected.	Begin to offer explanations for what they have found out. Explain what they see and begin to identify patterns in recorded measurements. *"They have all grown but this one started first and grew best"*	Relate their conclusion to scientific knowledge and understanding. *"The ones in loam grew best because it has more things in it."* Suggest improvements in their work, giving reasons.	Draw conclusions that are consistent with the evidence. Relate evidence to scientific knowledge and understanding. Make practical suggestions as to how their working methods could be improved. *"We need to do this with more plants and see what happens over a longer time."*