1. Smart bricks

2 hours

Children think about the needs of plants and how the different parts of a plant are made up of 'smart bricks' (cells). They make and test model cells and then consider what parts of the plant are used by different industries.

OBJECTIVES

- Y3 Identify and describe the functions of different parts of flowering plants, roots, stem, trunk, leaves and flowers
- Y3 Explore the requirements of plants for life and growth (air, light, water, nutrients from the soil and room to grow)
- Set up simple practical enquiries, comparative and fair tests

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheet 1a-b (per group: optional)
- Activity sheet 1c (for lower ability children)
- Activity sheet 1d (per child: optional)
- Collection of different plant matter, e.g. a range of flowers, stems and roots
- 1 seed (per class)
- 1 bottle of water (per class)
- Plant pot containing soil (per class)
- Ball of string (per class)
- Long, thin balloons (at least two each)
- Either 2 pieces of 50 x 30 cm (approx.) plastic mesh/netting (per child) or 2 large bird feed nets or orange or onion nets (brought in by children or bought from garden centres)
- Flat thin wooden board (at least 50 x 50 cm)
- Weights (6 x 500 g or 3 x 1 kg)

ADAPTING RESOURCES

Ideally, each group makes two model cells (smart bricks) to use in activities 2 and 3. If this proves difficult, make less smart bricks and adapt the activities. You could either run activity 2 and 3 concurrently or complete as a whole class activity. The resource quantities will need to be revised accordingly. Make sure at least 15 smart bricks are made.

REVISION ACTIVITIES

The introductory activities below are optional and revise plant needs and the functions of plant organs. These are useful as revision activities for national tests. They can be used separately to the lesson if this is more appropriate.

a) Plant needs

Use the concept cartoons (Activity sheet 1a-b) to revise what the children have previously learnt about plant growth, and to provide the opportunity to tackle any misconceptions. This can be done by children circling the pictures/statements that they believe to be correct. If done individually, this can be a useful formative assessment/elicitation activity.

Children can then discuss their ideas in pairs, then two pairs discuss, leading to whole class discussion.

b) Functions of plant organs

Provide a collection of different plants. Children make careful observations by dissecting the plant and describing the texture and how the plants feel inside and out.

Discussion questions can include:

- What do you think they are made of?
- How do you think they grow?
- What does each part do?
- What does a healthy plant look like?
- What does an unhealthy plant look like?

c) 'Plant Consequences'

This is a game to revise the functions of different plant organs. The aim of the game is to produce 'the ultimate plant' that will remain healthy in different conditions.

To play the game, the first member of the group draws the roots and folds the paper, leaving a small section of the drawing showing. The second draws the beginning of the stem. The third draws a stem with a leaf and the fourth draws the top of the stem with a flower. They reveal the whole plant and each member describes the function of their part and reasons why they drew it in such a way.

This can lead into a whole class discussion to establish:

- The root is for anchorage and to draw up water and nutrients.
- The stem is to hold the plant up and to transport water and nutrients to different parts of the plant.
- The leaves are to use sunlight to produce sugars/food and to get rid of waste products.
- The flower is for reproduction.

Activity sheet 1c provides a close activity for the lower ability children to establish the function and different parts of the plant.

INTRODUCING THE ACTIVITY

To introduce the concept of plant cells (or 'smart bricks'), show the class a small seed, a bottle of water and a pot of soil (containing nutrients). Ask the children how they would produce a 1 m high structure using those three materials, sunlight and carbon dioxide from the air. Establish that this is impossible for humans to do, but that plants do it all the time.

Explain that we use bricks to build tall structures and that plants do exactly the same. They build themselves by making smart bricks, or cells.

There are two main parts of the cell; an inner wall or skin (membrane) to hold fluid, and an outer wall to give it shape. Both of these are strong, but flexible.

MAIN ACTIVITY

Ideally, children build two smart bricks each using a long balloon (to represent the inner wall or membrane) and a netting tube tied together at both ends (to represent the restraining outer cell wall).

1. Create a tube with the netting by folding the piece of netting in half and threading the two ends together with string.

2. Seal one end of the tube with string.

3. Push a partially filled balloon into the open end of the net tube and inflate it.
4. Tie a knot to seal the balloon and seal the open end of the netting tube with string. This is your smart brick or cell.

If smart bricks or cells hold plants up, they need to be strong. The children now investigate the cell strength, either in groups or as a whole class. They do this by placing a board on top of the smart brick, and adding 3 or 4 kg weights gradually to it. They record the results in a table. The more adventurous could attempt to stand on it with support! With strong netting the cell should hold up to about 75 kg (12 stone).

Safety note

The children will need support when standing on the 'smart brick'.

PLENARY

Explain that plants are made of millions of these smart bricks.

Discuss the following questions:

- Why does it need to be so strong? To hold the plant up and for protection.
- What might the smart brick contain instead of air? Fluid: mainly water.
- What happens to plants when they go without water? Why? They wilt because the smart bricks are empty and not as strong and rigid.

Establish that the full balloon provides strength and that cells are similar but contain fluid (mainly water) instead of air. If cells are full, the plant stands upright; if the cells are empty the plant becomes weaker and wilts. Thus the plant needs water to stay strong, robust and healthy. Remind children of the moistness of dissected plants (optional activity b).

Using the children's ideas, produce a mind map of the types of companies that might grow, use or sell plants (see Appendix 2 for an example).

- *What do these industries need from the plants?*
- *Do they all require the same thing from the plants they need?* No, e.g. flower cultivators want bright, healthy, long-lasting flowers. Cabbage growers need strong, healthy, but tender leaves. Potato growers need large, strong, healthy roots etc.

Children cut the cards out and set out the title cards: *root, stem, leaf, flower/fruit.* They then match the types of industry to the parts of the plants used. There are blank cards for children to fill in any other relevant industries. This activity could be given as a homework activity if preferred.

This table shows possible answers.

Root	Stem	Leaf	Flower/fruit
Sugar Beet Potato farmer Domestic plant cultivator Herbal medicine company Natural dye industry	Asparagus grower Hemp making industry Domestic plant cultivator Herbal medicine company	Lettuce grower Herb grower Domestic plant cultivator Herbal medicine company Natural dye industry	Strawberry growers Tomato grower Market gardener Flower cultivator Grain farmer Olive tree grower Domestic plant cultivator Herbal medicine company Natural dye industry Cotton industry

EXTENSION ACTIVITY

Take a slide of a plant stem or leaf, or peel off the membrane from an onion and look at it under the Intel microscope to look at the smart bricks or cells and make observational drawings.

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

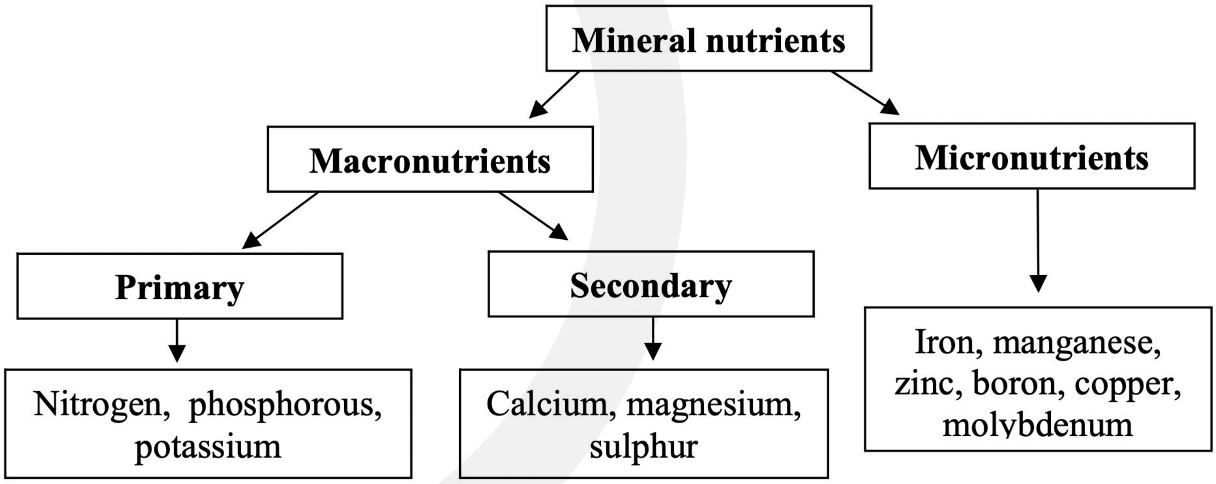
There are twelve essential mineral nutrients which plants must take up from the soil.

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.

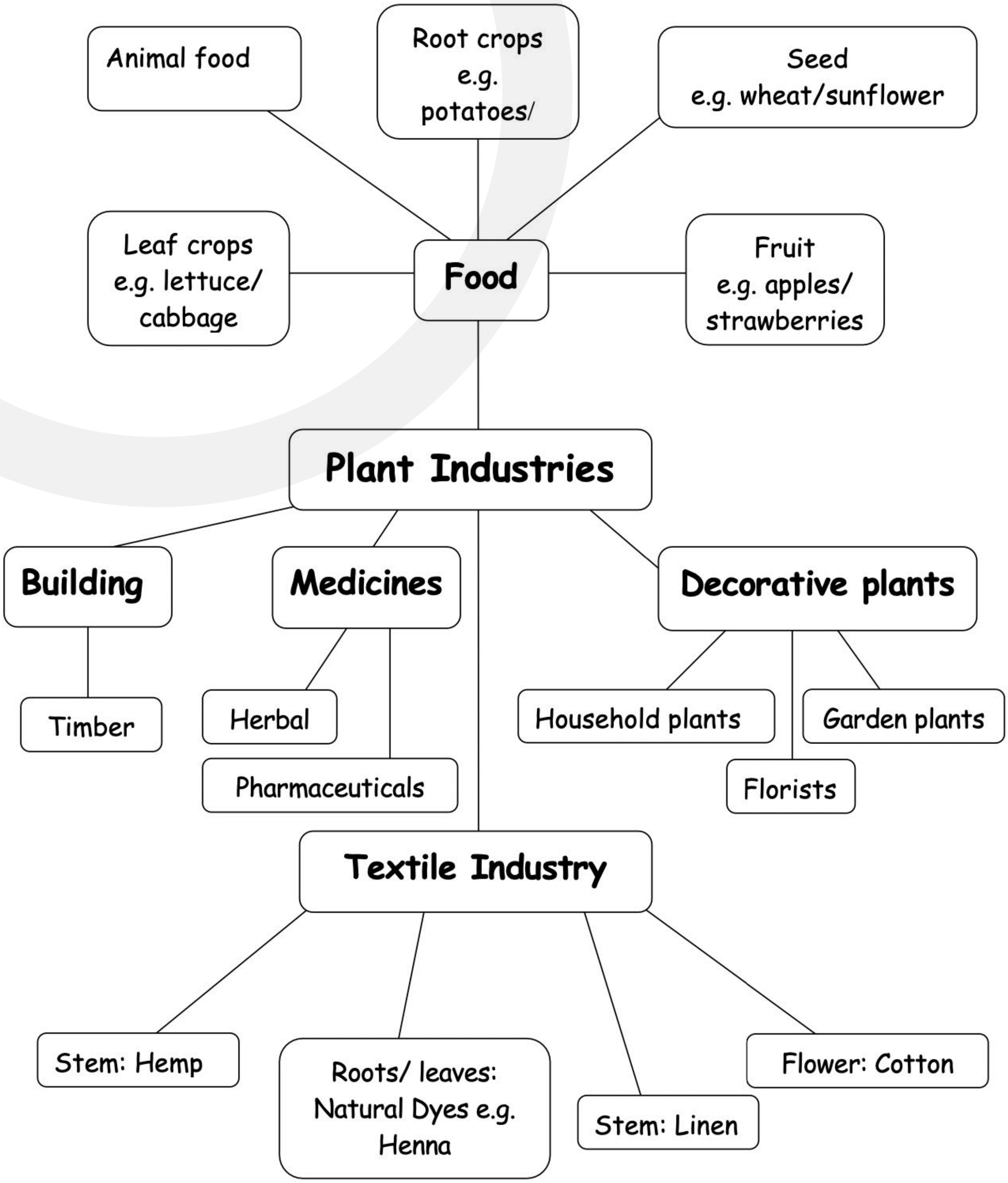
There are three main ways of distributing fertilizer. They are:

- 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



Appendix 3

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

Appendix 4

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."*