3. Robust roots

2+ hours

Children explore the function of roots to anchor or draw up water and nutrients. They create a model root system and explore the nutrients that help a root stay healthy and link this to roots in an industrial context.

OBJECTIVES

- Y3 Identify and describe the functions of different parts of flowering plants, roots, stem's 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).

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheet 3
- Activity sheet 2d
- 3 or 4 buckets or large containers (per class)
- To make each root (half the class):
- The remaining smart bricks (Activity 1) A ball of string.

INTRODUCING THE ACTIVITY

Discuss the functions of plant roots with the class by asking the following questions:

- How do plants find water and nutrients? The roots spread through the ground to find water/nutrient sources.
- How do plants get the nutrients from the soil and fertilizers? They draw them up through the roots.
- How do they get the water they need? They draw water that is held in the soil through their roots.
- How do they transport both of these to the parts of the plant that need them? They transport the water and nutrients to other parts of the plant via veins in the stem.

Establish that roots are necessary to (i) anchor the plant to prevent it falling over or being carried away in more extreme weather conditions; (ii) take up water and mineral nutrients.

The children compare tap and spreading root systems by examining photographs (Activity sheet 3) and making careful observations. They relate the photographs to the functions of the root (anchoring and drawing up nutrients) and establish the type of root that is best suited to each function.

Explain that phosphorous and potassium are nutrients that help plants produce healthy roots (Appendix 2). Children look again at fertilizer ingredients (Activity sheet 2d) to find out which fertilizers are best to promote growth in the roots.

Discuss which crop producers or other industries would be interested in the roots of a plant and establish what they would require from the root, e.g. potato, carrot and beetroot farmers, or sugar manufacturers (link to the plenary of activity 1).

MAIN ACTIVITY

Use buckets placed in different parts of the classroom to represent sources of water and nutrients. The only way to reach them is for the smart bricks (cells) to link up in several chains. These represent the growth of root hairs. Using the smart bricks left over from the first session, the children build roots by joining together the cells with string. Half the class build a tap root system and the other half build a spreading root system to reach the sources of water. Explain that although the roots, made by the children, may have one cell thickness, the roots of a plant have millions of cells.

PLENARY

Discuss the two types of root built, and how they might be used by different industries. Discuss what different industries are looking for in the roots of the plants they grow. Use the following questions to aid discussion.

- Which root type is the most successful for reaching scarce sources of water and nutrients? The spreading root, as its roots spread through a larger area, e.g. a tree's roots cover the same area as its branches.
- Which root type would anchor the plant best? The tap root is large and strong and would lodge itself firmly in the ground.
- Which root type would be most useful for industries, e.g the most edible? The tap root produces more edible material, e.g. carrots.

EXTENSION ACTIVITY

Children could observe and draw the roots using either magnifiers or the Intel microscope.

Alternatively, they could research root systems and root hairs on the Internet.

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

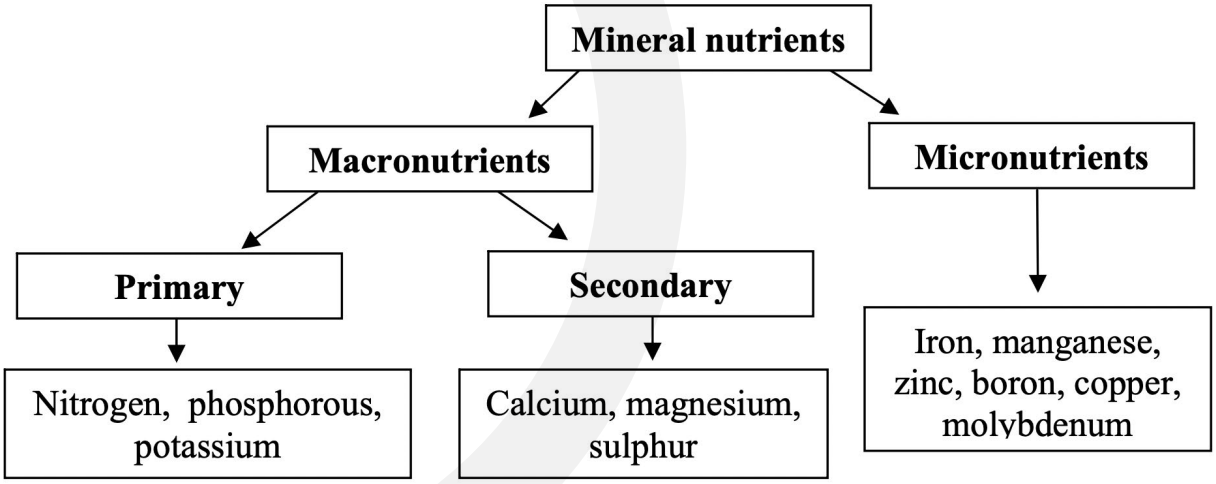
There are twelve essential mineral nutrients which plants must take up from the soil.

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.

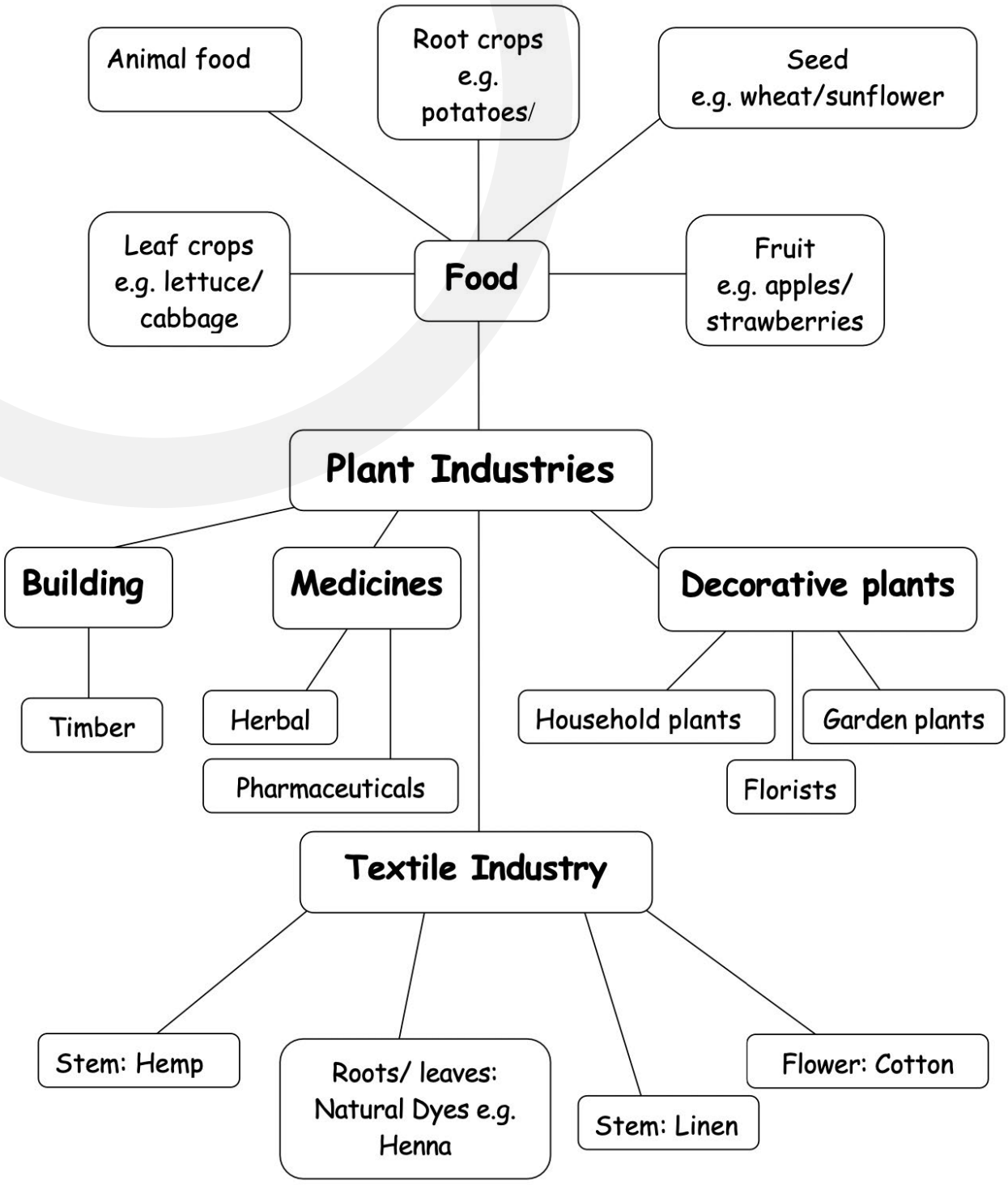
There are three main ways of distributing fertilizer. They are:

- 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."*