About BBSRC and the Schools' Liaison Service

The Biotechnology and Biological Sciences Research Council (BBSRC) promotes and supports high-quality basic, strategic and applied research and related postgraduate training relating to the understanding and exploitation of biological systems.

BBSRC supports over 7,000 scientists, technicians, students and support staff in universities and institutes and is funded principally from the Science Budget of the Office of Science and Technology.

A free service for schools

As part of its schools-based programmes, the BBSRC Schools' Liaison Service runs a Science Club, offering free support and resources, which is open to all schools and colleges in the UK.

To join the Science Club, photocopy, complete and return the slip on this page to the address given below. Membership is free and ensures that your school receives information about the Schools' Liaison Service and free school resources.

About this discovery pack

This pack has been developed by the Biotechnology and Biological Sciences Research Council (BBSRC) with support and technical advice from Suttons Consumer Products Ltd. Suttons produce a range of child friendly 'Seed Squad' seeds which can be used to complete many of the activities suggested in this booklet.

Initially BBSRC worked with a team of primary teachers and Dr Nick Peters of the Institute for Arable Crops Research, Long Ashton Research Station, to develop many of the activities in this booklet. BBSRC thanks the teachers and children of all the schools who helped to trial the activities.

The teacher team:

Jane Nicholls (team coordinator), Brook Field Primary School, Swindon, Wiltshire
Carolyn Adams, Ludwell First School, Shaftesbury, Dorset
Phil Allan, Colerne Primary School, Colerne, Wiltshire
Judy McAteer, Liden Junior School, Swindon, Wiltshire
Penny Wood, Salt Way Primary School, Swindon, Wiltshire

University of Durham

In 1999, Dr Jackie Spence and Dr Phil Gates and colleagues from the School of Biological Sciences, University of Durham developed five further activities for 5 to 7 year olds. These were trialed by 50 primary schools in the BBSRC Science Club. The activities have been included in this booklet.

General themes

All the activities can be used to encourage children to care for and appreciate living things and to think about the world around them.

The activities can also be used to encourage children to think about health and safety issues.

Children should have opportunities to make first hand observation and to use secondary sources of information including books and videos.

Beyond the classroom

All of the activities suggested would be enhanced by experiences beyond the classroom such as a visit to a local garden centre, park, nature area or botanical garden. Many garden centres are keen to welcome organised school parties (if they are given prior notice and can liaise with the teacher) and will offer short guided tours or demonstrations. A number have Sutton Seeds *primary trails*, a series of colourful posters plus quiz and 'did you know' sheets to help children make the most of their visit. Most botanical gardens and nature areas make excellent provision for young visitors and all of these options allow children to interact with a greater range of plants and plant products and to think about growing conditions, habitat, care and conservation.

Links to the Curriculum

This pack has been designed to allow 5 to 12 year old pupils to explore the world of seeds and plant growth. Particular curriculum links are listed below:

England and Wales

- Key Stages 1 and 2: Science: Attainment Target 1 - Experimental and Investigative Science.
- Key Stages 1 and 2: Science: Attainment Target 2 -

  Life Processes and Living Things. In particular:

  3. Green plants as organisms;
  4. Variation and classification, and at Key Stage 2, 5. Living things in their environment - adaptation.

Scotland

Environmental Studies 5-14. P1-P3.
Science: Understanding Living Things and the Processes of Life.

Health and safety

All the seeds suggested in this pack have been especially selected for use by young children and are safe for them to handle. However, all normal precautions should be taken and the teacher should make the children aware of health and safety issues relating to the areas covered. For example, the teacher should explain that the seeds are not sweets and should not be eaten and that children should wash their hands after handling plants or soil. The teacher should also be aware that some of the children may suffer from allergies or asthma and therefore should not smell, or be in prolonged proximity to flowering plants.

The Association for Science Education's *Be Safe!* booklet (second edition ISBN: 0 86357 081 X) is an excellent source of health and safety advice and guidance for primary science and technology teaching.

Be Safe! - plant information

Be Safe! recommends a number of plants for general use and to illustrate growth from seeds. These include: begonia, Busy Lizzy, geranium, runner bean, cress, maize and wheat.

Be Safe! recommends that all parts of the following plants should be considered poisonous; Giant Hogweed, Caster Oil seeds, Holly, Laburnum, Mountain Ash seeds, Potato (except tubers when not green), Privet, Red kidney beans (except when well cooked), Spindle-tree, Rhubarb (except leaf stalks) Tomato (except fruits), Yew, Black Bryony, Black Nightshade, Cuckoo Pint, Deadly Nightshade, Hemlock, Henbane, Ragwort, White Bryony, Woody Nightshade.

Lesson planner

Activity	Suggested age range	Time indicator
1. Discovering seeds	5-7 years	2 weeks set-up; 30 minutes examination
2. Seed sorting	5-7 years	30 minutes activity
3. Sunflower jigsaw	5-7 years	1 hour activity
4. Fun with flowers	5-7 years	2.5 months if grown from seed; 30-45 minutes examination
5. Climbing and crawling	5-7 years	2 months if grown from seed; 30-45 minutes examination
6. Room to grow	5-7 years	4 weeks of plant growth; 30 minutes examination
7. Eating plants	5-7 years	30-45 minutes examination
8. Seed detectives	8-12 years	1 hour
9. Introduction to seed germination	8-12 years	30 minutes preperation; 5 days monitoring
10. Seed dispersal	8-12 years	30 minutes
11. Tank trials - measuring germination	10-12 years	8 days set-up/monitoring
12. The growth cycle of *Sunflower* - looking at variables and planning a fair test	10-12 years	1 hour set-up; 2-3 weeks monitoring

Age 5-7

Time

Preparation and growing time - 10 to 14 days
Discovering seeds activity - 30 minutes

Before the lesson begins
You will need to plant a number of *Sunflower* seeds in individual containers around 10 - 14 days before you undertake this activity.

Several pots should be set up in advance if you want small groups of children to carry out the activity for themselves and continue their work with the extension activity suggested.

Materials
Sunflower seeds.
Sunflower plants grown in individual pots or containers.
Paper towels and/or plastic trays.

activity 1

Discovering seeds

Through this activity children can learn:

- to recognise a seed
- that seeds are living things and that plants can grow from seeds

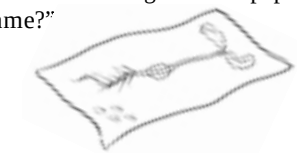
Skills developed:

- observation
- comparison

The activity:

- Allow the children to handle some *sunflower* seeds and ask them to make predictions as to what *they* think the seeds might be. For instance, do they think that seeds are living or not living?

- Introduce a two week old seedling grown in an individual pot.
- Gently remove the seedling from the pot. Place it onto a paper towel or plastic tray and brush away as much of the soil as possible, exposing the seed and the roots.
- Place some dry seeds next to the whole plant and ask the children to comment on what they see by using questions like "are there things on this paper towel/tray that look the same?"



- By identifying the seed in both samples, children can be introduced to the idea that plants can grow from seeds.

Key questions:

Q1. What do you think this is?
Q2. Is there anything on this paper towel/tray that looks the same?

Extension activities:

- Use the remaining pots of *sunflower* seedlings to introduce the children to the idea that plants need light and water to grow. Split the children into smaller groups and give each group the same number of potted seedlings. Explain that their test will be 'fair' because the seedlings have been grown in the same amount and type of soil.
  Group 1 should keep their seedlings in the **dark**.
  Group 2 should keep their seedlings in the **light** (a cool, light classroom window sill is best). Both of these groups should **water** their plants at regular intervals with the *same* amount of water.
  Group 3 should keep their seedlings in the light but should not water the plants.
  After 7 to 10 days the children should examine their plants and draw conclusions.

activity 2

Seed sorting

Age 5-7

Time

Seed sorting activity
- 30 minutes

Materials
Margarine tubs or Petri dishes.

A selection of seeds.

For the extension activity:

Binocular microscope, hand lenses and/or Pupil worksheet 1.

Through these activities children can learn:

- that seeds do not all look the same
- that different species of plant have seed of different shapes and sizes
- to develop ways to describe different species of seed

Skills developed:

- observation
- comparison
- sorting
- classifying
- observational drawing

The activity:

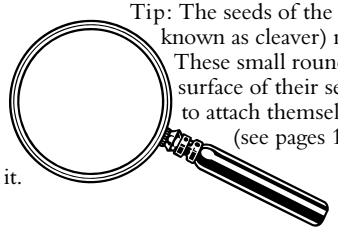
- Introduce a selection of seeds in separate small tubs.
- Let the children examine all the seeds and make general observations and comparisons.
- Split the children into smaller groups and allow them to handle the seeds again. This time ask each group to generate a list of sorting criteria (Q1). Ideas for possible criteria might include: colour, texture, shape and size.
- Ask them to sort and group their seeds according to their own group's criteria.

Key questions:

Q1. What words would you use to describe this seed - smooth, rough, spiky?

Extension activity:

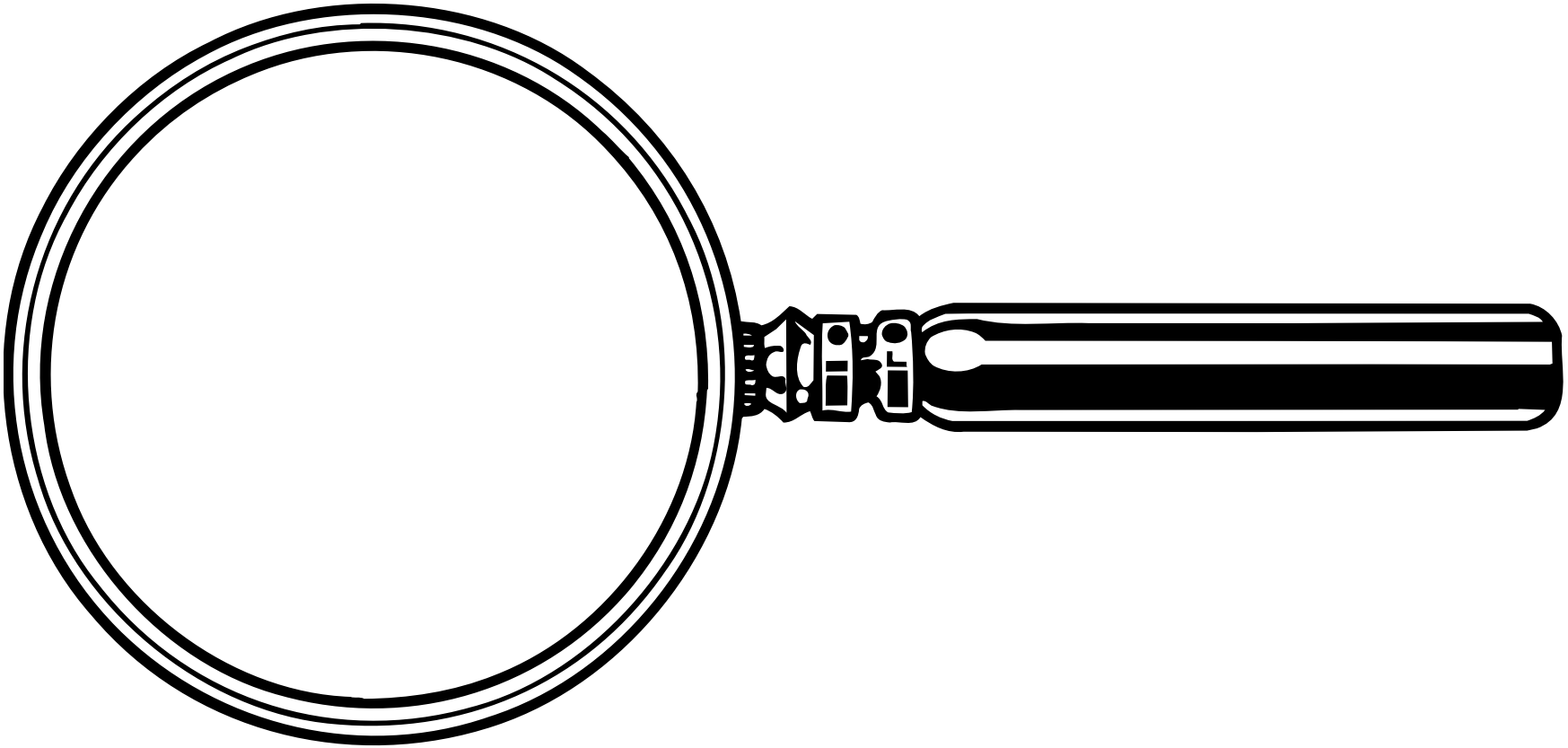
- Select one type of seed with an interesting seed coat. Ask the children to use a binocular microscope or hand magnifier to examine one of these seeds carefully and make an observational drawing.
- Alternatively, use Pupil worksheet 1 as a template to produce card magnifying glass cut outs which the children can use to help them 'frame' and focus in on a seed while they are drawing it.



Tip: The seeds of the weed *Galium* (commonly known as cleaver) make good subjects for study. These small round seeds have hooks on the surface of their seed coats which allow them to attach themselves to material and fur (see pages 19 and 20).

Activity 2: Pupil worksheet 1

Template for a card magnifying glass



activity 3

Sunflower jigsaw

Age 5-7

Time

Activity - 1 hour
Extension - 20 minutes

Materials
Teacher worksheet 1.
Pupil worksheet 2.
Teacher worksheet 2.
Coloured pencils and/or crayons.
Scissors.
Appropriate child-safe glue.
Plain A4 or A3 paper.

Through this activity children can learn:

- to recognise and name the main parts of a flowering plant - root, stem, leaf and flower

Skills developed:

- fine motor skills
- accurate labelling

The activity:

- Through group discussion introduce the idea that plants can grow from seeds (you may wish to use Activity 1: *Discovering seeds* to illustrate this).
- This could be followed by a teacher-led discussion on the main parts of a plant. Teacher worksheet 1 can be used to reinforce your explanation.
- Using Pupil worksheet 2, ask each child to colour, cut out, re-order, stick back together and label the mixed up diagram of a *Sunflower*. Very young children may find it easier to cut and paste the jigsaw if it has been enlarged to A3 size. Alternatively, they could colour in a copy of Teacher worksheet 2.
- Compare Teacher worksheet 2 (a labelled *Sunflower* poster) to the children's *Sunflower* jigsaws, asking them to re-label their drawings if necessary.

Extension activities:

- If a long term activity is appropriate, children should be asked to plant and grow their Sunflower seeds. Teachers' note: Over planting by a factor of three, followed by pricking out if necessary, is advised.
- If the children are split into small groups they can compete to grow the tallest sunflower.

Activity 3: Teacher worksheet 1

Plants belong to the kingdom plantae. The plant kingdom can be divided into the following sub-groups or phyla: algae; bryophyta (mosses and liverworts); pteridophyta (ferns and horsetails) and spermatophyta (seed-bearing plants). Spermatophyta can be further divided into two classes; gymnosperms (seed-bearing plants that do not have real flowers - the seeds grow inside cones) and angiosperms (flowering plants). This pack focuses on the seeds of angiosperms.

The main parts of a flowering plant

Flower

Just as there are male and female animals, there are male and female parts to a plant. These parts each have their own special job and are located in the centre of the flower.

The male part of the flower is called the stamen – it is made up of an anther and a filament and looks a bit like a lollipop. The anther contains pollen. Pollen is the male sex cell. It must be moved to the female part of another flower of the same species.

The female part of the flower is called the carpel. It is made up of a stigma, a style and an ovary. When the 'male' pollen lands on the 'female' stigma pollination occurs. The pollen starts to grow towards the ovary where there are one or more ovules – these are the female sex cells. When the pollen reaches an ovule, fertilisation occurs. After fertilisation, the ovule develops into a seed.

Seeds

All flowering plants produce seeds. Seeds contain a food store protected by a hard outer coat. When seeds are dispersed (or moved away) from their parent plant they can start to germinate and grow, but only if water, air and the correct temperature are present.

Petals

The petals of a flower are usually brightly coloured and often scented. Bright colours and scent help to attract insects.

Many petals have visible lines and grooves on their surface which help guide insects to the base of the petal. There they find the plant's nectary. This produces a sugary substance called nectar. As insects search for the nectary they brush past the anthers which, if ripe, burst and dust them with pollen which they carry to the next flower they visit.

Leaves

Plants make food in their leaves. To make food, plants need sunlight, water and the gas carbon dioxide which they get from the air (leaves take in carbon dioxide from the air around them through tiny holes called stomata). The leaves contain a pigment called chlorophyll which makes the leaves look green. In the presence of light, chlorophyll converts water and carbon dioxide into carbohydrates (food) and oxygen.

Stem

The stem supports the flower and the leaves, holding them up to the sunlight. Water travels from the roots through the stem to all the other parts of the plant.

Roots

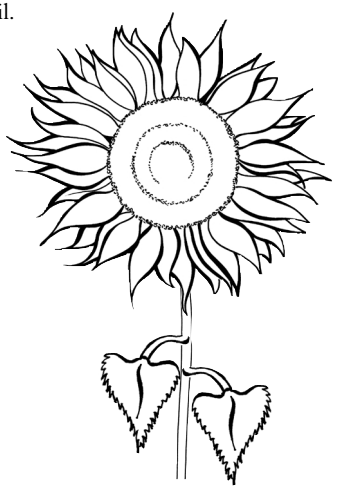
Roots take up water and nutrients from the soil. They also spread out in the soil and anchor the plant in one place. Large plants like oak trees would topple over without their large spreading roots.

Further information

Almost all plants are green because they contain chlorophyll which they use for photosynthesis. Through photosynthesis, plants make their food. Some plants store reserves of foods in specially adapted stems or roots.

These specially adapted food-storing organs usually form a dormant overwintering stage in life of the plants. They allow the plants to be biennials (plants that take two years to complete their life cycle) or perennials (plants that live for many years).

1) Tap roots are robust primary roots which often penetrate some depth below ground level. They are sometimes specialised for storage, e.g. carrots.
2) Tubers are the swollen part of a stem or root which are often modified to store food. Stem tuber examples include potatoes; foot tuber examples include dahlias.
3) Corms are short swollen underground stems, e.g. crocus.
4) Bulbs are fleshy, underground, highly modified shoots made up of colourless swollen scale leaves or leaf bases.
   The centre of the bulb contains the immature foliage leaves, the future flower and rudimentary roots.
   The outermost leaves do not contain food but are scaly and protect the bulb, e.g. daffodil.

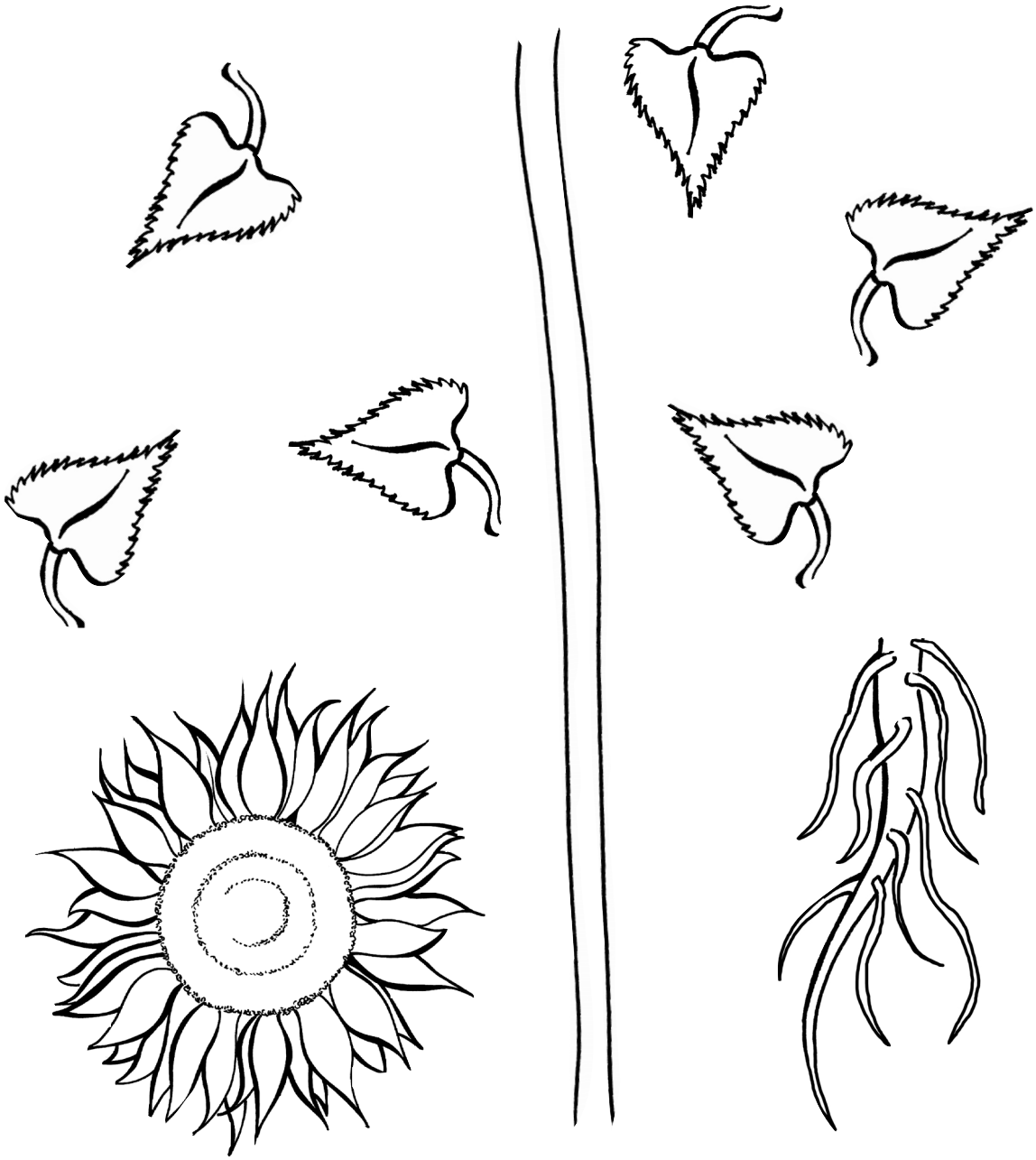


The Sunflower jigsaw

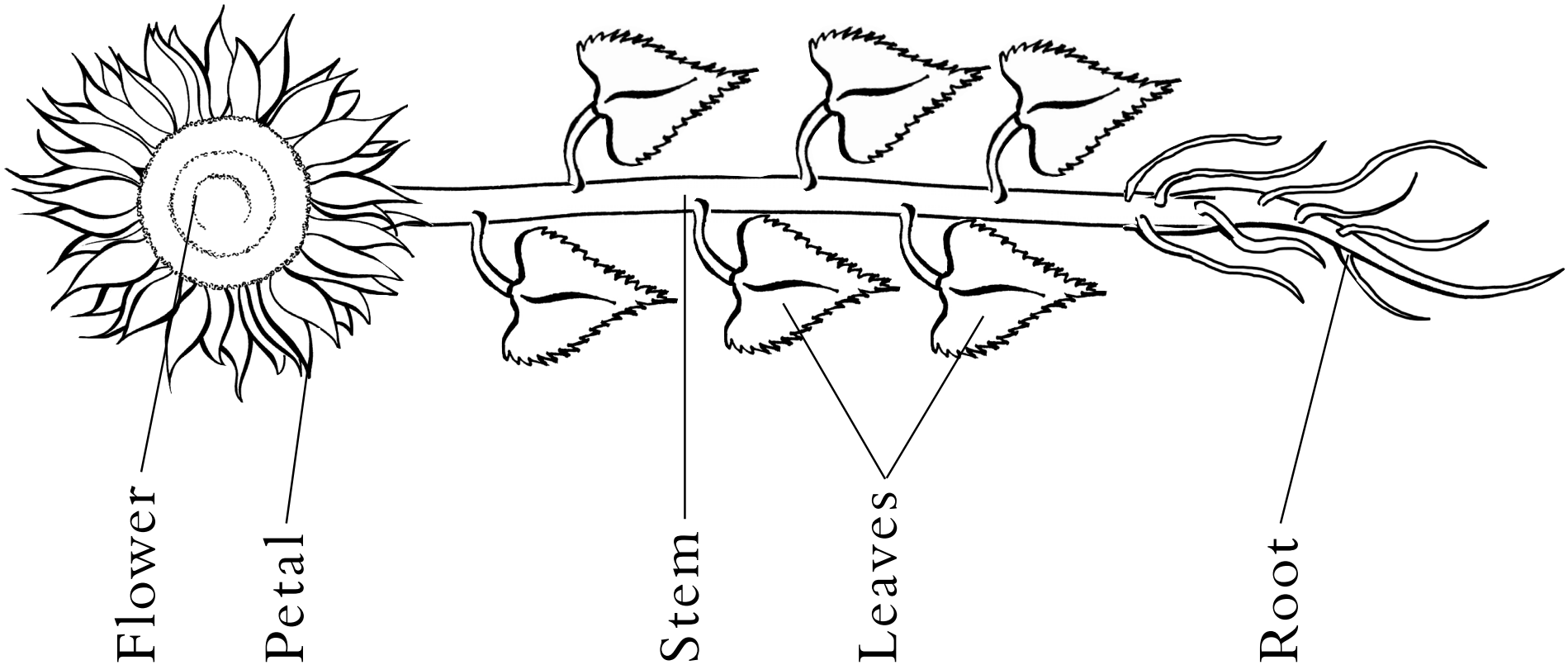
Re-arrange this picture to make a Sunflower.
Colour in your picture and label it

Flower Petal Root

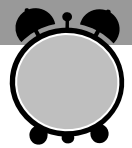
Leaves Stem



Activity 3: Teacher worksheet 2



Age 5-7



Time

Preparation and growing time -
2 to 2.5 months
Activity - 30 to 45 minutes

Before the lesson begins
You should encourage the children to sow their seed mixture in trays or pots. Plants can be started off indoors but seedlings should be transplanted to an outdoor site to reach maturity. An ideal time to plant seeds indoors is late March, moving to an outside location in April.

Materials
Trays or pots of mixed flowers.
Coloured pens and paper.
Extension: Narrow bore plastic pipette.

activity 4

Fun with flowers

Through this activity children can learn:

- that flowers come in different shapes and sizes
- that some flowers are coloured and scented to attract insect pollinators
- that insects can see and smell

Skills developed:

- observation • comparison
- recording data • observational drawing

The activity:

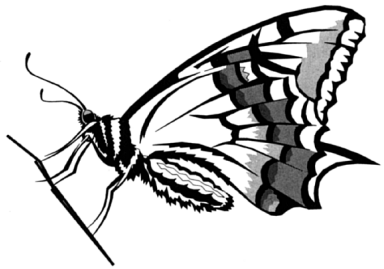
- Introduce the children to a single flower and allow them to examine it and make general observations.
- Split the children into smaller groups and introduce the trays or pots of flowers. Ask each group to examine the flowers and list the different colours they can see in the petals.
- Ask each group to smell the flowers. Are they scented?
- Ask the children to draw and colour their favourite flower.

Key questions:

Q1. How many different colours can you see in the flowers in your tray?
Q2. Why do you think the flowers are beautifully coloured and have a nice smell?
(Answer: to attract insect pollinators).

Extension activities:

- Ask the children to count the number of petals on different flowers.
- In Summer the trays can be placed outdoors and insect visitors can be observed. Alternatively, you might like to ask the children to sow some of their seeds directly into the soil in a protected area of the school grounds and compare growth here to growth in trays in the classroom. Sowing outdoors also provides an opportunity to create space ready for a minibeast pitfall trap. This allows children to examine minibeasts and think about habitat and whether the animals they catch are helpful or harmful to plants.
- *Nasturtium* flowers have a large nectospur at the back of the flower and the nectar can be extracted using a narrow pipette. Show this to the children and explain this is a sugary gift from the flower to the insect.



Age 5-7

Time

Preparation and growing time - 2 months
Climbing and crawling activity -
30 to 45 minutes

Before the lesson begins
You should encourage the children to sow their seeds in trays or pots, keeping the *Nasturtium* and *bean* seeds in separate containers. Seedlings should be transplanted to a cool, light outside area to grow to maturity.

Remind the children that the experiment should be 'fair' i.e. that both sets of seeds should have the same growth medium (soil) and receive the same amount of water, warmth and light.

Materials
Trays of *bean* and *Nasturtium* seedlings.
Ruler.
Pupil worksheet 3.

Extension activities
Pea seeds.

activity 5

Climbing and crawling

Through this activity children can learn:

- that plants grow in different ways
- that plants can move by growing

Skills developed:

- observation
- measuring
- recording
- comparison
- prediction

The activity:

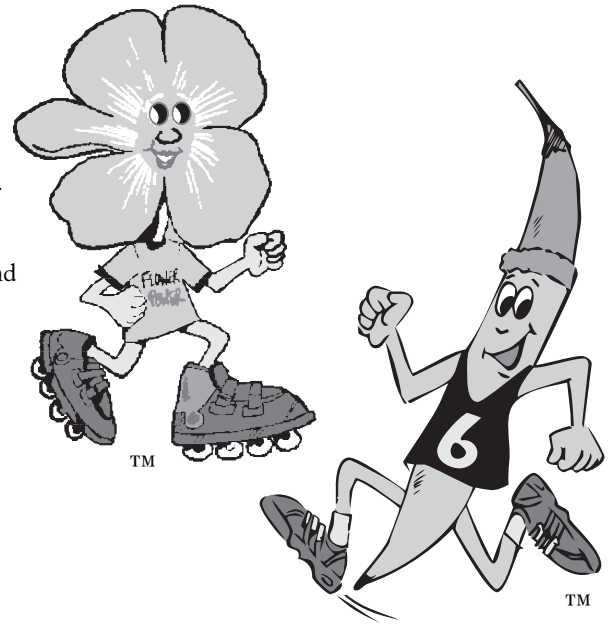
- Introduce the children to some *bean* and *Nasturtium* seedlings.
- Ask the children to select one healthy *bean* seedling and one healthy *Nasturtium* seedling and measure how tall the plant is and how far along the soil it has grown. Measurements should be made at regular intervals, ideally over a number of weeks. Record the results in Pupil Workheet 3. (Note: the *beans* should grow tall and the *Nasturtiums* should grow along the ground).
- Explain to the children that the *beans* grow tall and 'climb' by curling around stakes and other supports. *Nasturtiums* stay short but grow by 'crawling' along the ground.

Key questions:

Q1. Do plants move?

Extension activities:

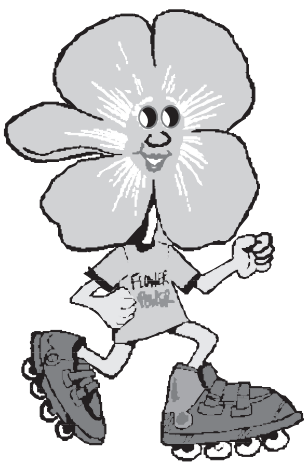
- Grow some *peas* and show the children that *peas* have tendrils to help them hang on as they grow.
- Measure a young (baby) *Nasturtium* seedling and continue these measurements at regular intervals. Ask the children to decide when the plant is fully grown (adult). Each plant should reach a maximum size. Generally for the *Nasturtium* variety this is about 7 cm from the ground.



My name _____

My plant is called a _____

Week	Height:	Width:
Week	Height:	Width:
Week	Height:	Width:
Week	Height:	Width:
Week	Height:	Width:
Week	Height:	Width:



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activity 6

Room to grow

Age 5-7

Time

Preparation and growing time - 4 weeks
Room to grow activity - 30 minutes

Before the lesson begins
You should encourage the children to sow their seeds in trays or pots.

Remind the children that the experiment should be 'fair' i.e. that both sets of seed should have the same growth medium (compost/soil) and receive the same amount of water, warmth and light.

Materials
Trays of *radishes* sown close together.
Trays of *radishes* sown far apart.

Extension activities
Dandelions that have gone to seed or another seasonal plant which seeds.

Through this activity children can learn:

- that plants need room to grow
- that plants compete for food and resources
- that plants spread their seed away from the parent plant so that the offspring are not competing for resources.

Skills developed:

- observation
- comparison
- prediction

The activity:

- Ask the children to crouch down and get as close to each other as they can. Get the children to pretend to be growing plants by standing up and spreading their arms and legs. The children's arms and legs should become entangled and some children may not be able to move.
- Introduce the children to trays of *radish* plants which have been sown very close together and to trays of plants which have been sown quite far apart. Ask the children to examine each tray of plants and record the differences. The plants sown close together should be much smaller.
- Carefully remove a few plants from each tray and ask the children to examine the roots and record differences. The roots of the plants sown close together should be entangled and some radishes may be fused (odd shaped' fused vegetables such as carrots may be available at local shops or supermarkets). The plants which have been sown quite far apart should have grown well and produced good sized, normal shaped *radishes*.

Key questions:

Q1. Why are the radish plants sown close together weaker and smaller than those sown far apart?

Extension activities:

- Compare plants on the outside of the group which have been sown close together to plants on the inside of that group.
- Introduce the children to *dandelions*. Show them how the seeds are spread by the wind and explain that this helps the new plants to grow away from their parent plants so that they do not compete for space or resources. You might like to refer to Teacher worksheet 4.
- Consider a topic on farming. Ask the children the think about how the farmer must plant seeds carefully in order to grow the best crop.

Age 5-7

Time

Preparation and growing time -
2 to 3 months if growing from seed
Eating plants activity - 30 to 45 minutes

Materials
Trays of vegetables. Where possible the vegetable plant should be in its pot or container.

Pot grown vegetables may be *supplemented* by a selection of vegetables from your local shop or supermarket or by vegetables brought in by the children.

Extension activity:
You might like to encourage the children to sow their seeds in trays or pots.

Suggestions.
Radishes, lettuce, carrots, beans or peas.

Approximate growth times.
Radish: growth time - 5 to 6 weeks.
Bean: from seed to planting out -
1 month. From planting out to pod formation - 2 months.

activity 7

Eating plants

Through this activity children can learn:

- that we eat different parts of the plant
- that roots and leaves come in different shapes and sizes

Skills developed:

- observation
- classification

The activity:

- Show the children the typical structure of a plant: stem, leaf, root, flower. You might like to use Activity 3 - Teacher worksheets 1 and 2.
- Split the children into smaller groups and allocate each group a tray of vegetable plants. Ask each group to describe the leaves, and fruits (if they have them) on their plants.
- Help each group to carefully dig up one of the plants and lay it out. Ask each group to describe the roots of their plant.

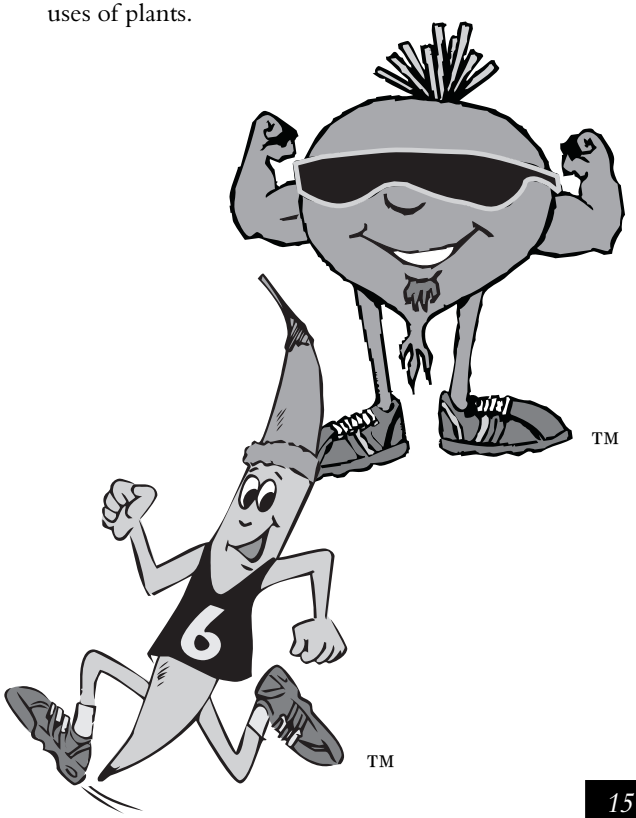
Key questions:

Q1. Which part of each plant do we eat?

Extension activities:

- Using a larger selection of harvested vegetables collected from shops or supplied by the children, ask which part of the plant each harvested vegetable comes from (e.g. a *lettuce* is the leafy body of the *lettuce* plant; a *carrot* is the specialised tap root of a *carrot* plant; a *pea* is the seed of the *pea* plant).

- Introduce the idea of a food chain.
- Introduce the idea of poisonous plants and relate this to health and safety issues. Further details of poisonous plants and plants suitable for use in the primary classroom are given in the introduction to this pack.
- Discuss some of the things which plants can be used for including non-food uses of plants. Get the children to source examples and create a floor book or picture montage. Teacher worksheet 3 offers some examples of uses of plants.



Activity 7: Teacher worksheet 3

Most children will appreciate that many types of plants can be used as food both for themselves and other animals but it may be interesting to ask them to think about other uses of plants. Here are just some examples to help the discussion.

Stems

Woody stems can be used as fuel.

Paper is made from tiny pieces of wood mixed with water to make pulp. The pulp is squeezed dry between huge rollers to make paper.

Some stems have fibres (thin threads) which can be made into clothes. An example is the flax from the flax plant which can be woven into linen.

Leaves

Some leaves contain natural colourings which we call dyes. A blue coloured dye called indigo is made from the woad plant. Ancient Britons pained their faces with indigo to scare their enemies.

Leaves and stems can be used for animal bedding, for example straw is used in horse stables.

Some leaves and stems like those of the Raffia palm tree can be woven into mats and baskets.

Some leaves contain natural medicines. The peppermint plant contains a natural form of menthol.

Petals

Some petals like those of the elderflower can be pressed and help make up drinks like elderflower cordial and elderflower wine.

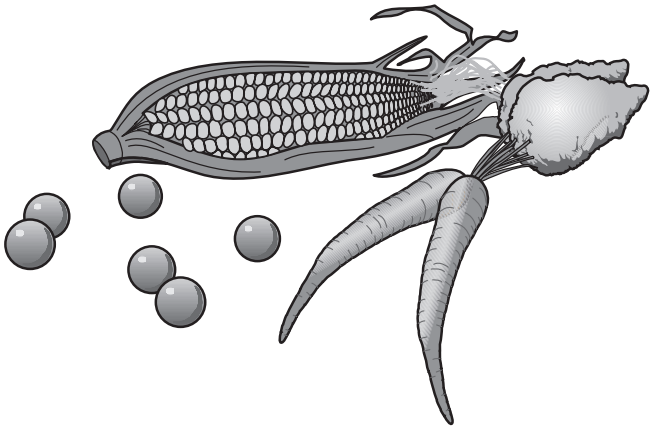
The petals of the henna plant contain a red dye called henna which is sometimes used in shampoo to colour hair.

Flower petals can be dried and used for pot pouri. Some, like the rose and Lilley of the Valley, are used to make perfume.

Roots

The root of the sugar beet plant is used to make sugar.

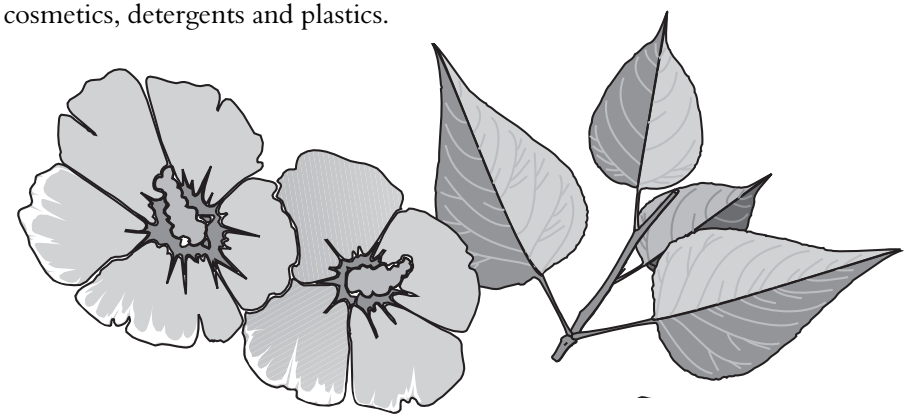
Many roots like turnips and carrots are a source of food.



Seeds

Many seeds are used as food. Examples include peas, sweetcorn and rice. We grind coffee beans to make coffee and wheat seeds to make flour and products like cornflakes.

Seeds contain *starch* which is used in glues and pastes like wallpaper paste; and *oils* which are used in many things including cooking oils, margarines, cosmetics, detergents and plastics.



activity 8

Seed detectives

Age 8-9

Time
Activity - 1 hour

Materials

Pupil worksheet 4 showing an electron microscope.

Pupil worksheets 5-10 showing: electron micrographs of *Cleaver* seeds, *Sunflower* seeds, *Dandelion* seeds .

Samples of *Cleaver, Sunflower, Dandelion* seeds.

Binocular microscope and/or hand-held magnifiers.

Teacher worksheet 4 (optional).

Through these activities children can learn:

- that seed coats can be observed more accurately and in more detail when they are magnified
- that seed coats have adaptions which help in the seed's dispersal (hooks, 'parachutes' etc)

Skills developed:

- observation
- prediction
- sketch drawing

How to begin:

- Using the photograph supplied, introduce an electron microscope. Explain that this is a very powerful microscope and that it makes tiny things look much bigger. Explain that scientists can use this powerful microscope to take photographs called electron micrographs. Stress to the children that the photographs they will see are *greatly enlarged.*
- Show the children the electron micrographs and ask for comments (Q1). Don't reveal the fact that they show the surface of seeds immediately - let the children guess and make predictions as to what they think the photographs show (Q2). They may like to make their own drawing of one of the photographs and write their predictions under the picture.
- When a range of different ideas have been put forward by the class, show the children the seeds and let them examine these seeds under magnification and compare them to the appropriate electron micrographs. A binocular microscope is ideal for this exercise, however, the hooks and grooves of many seeds coats can be seen quite well using a hand-held magnifier. Ask the children why they think the seeds have these special coats (Q3).
- You may wish to ask the children to make observational drawings of the coats of their seed samples with the help of the hand-held magnifiers or the binocular microscope.

Key questions:

Q1. Look at the photographs. What can you see? The children should be encouraged to describe bumps, lumps, lines, grooves, hooks, etc.

Q2. What are these photographs of? Write suggestions on the board or into the floor book as the children observe the photographs.

Q3. Why do you think these seeds have hooks/spikes/grooves? You may wish to use Teacher worksheet 4 from Activity 10.

activity 9

Introduction to seed germination

Age 8-12

Time

Preparation - 30 minutes
Germination - 1 week
Activity - 30 minutes

Materials
Seeds.
Filter paper circles.
Low level clear dish or Petri dishes.
A plastic measuring syringe or 4 ml teaspoon.
Clear polythene bags plus tape or wire to secure.

Through these activities children can learn:

- that certain conditions are necessary for germination (including warmth and moisture)

Skills developed:

- prediction
- hypothesis
- investigation
- recording
- formulation of conclusions

How to begin:

- Show the children the seeds which they are going to grow.
- Tell them that when seeds begin to grow this is known as germination. Ask two questions:"Why aren't the seeds growing now?" and "How could we help these seeds to begin to grow or germinate?" (Q1 & 2).
- Take the children's ideas and then impose the constraint of having to be able to see the seeds germinate - remind the children that if the seeds are planted in soil, they will not be able to see root and initial shoot growth.
- If the children's ideas are appropriate use them. Alternatively, you might like to use the activity directions which follow.

Key questions:

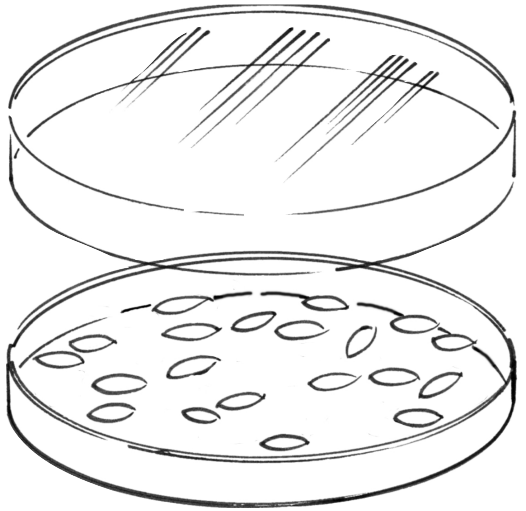
Q1. Why aren't these seeds growing now?

Q2. How could we help these seeds to begin to grow or germinate?

Q3. What will happen to the seed when it starts to grow or germinate?

Q4. How long do you think this will take?

Q5. Which seed sample do you think will show the best growth and why?



Age 8-12

activity 9 continued

Activity directions:

In this activity you will be considering two variables - temperature and water. To do this you will set up four Petri dishes in all.

- Line four Petri dishes *each* with four filter paper circles. Scatter twenty seeds into each dish.
- Take two of the lined Petri dishes containing seeds and add 8 ml of water to each of them using a plastic measuring syringe or two x 4 ml teaspoons of water. The remaining two dishes should not be given water. Put each dish into its own small, clear polythene bag and tie up the mouth of each bag.
- Check the 'wet' dishes each day to make sure the filter paper is moist. This is best done by tilting the Petri dish and seeing if a small 'tear-drop' of water appears at the lower edge of the dish. If it does, there is enough water in the dish. If a droplet does not appear, add an extra 1 to 2 ml of water (this amount of water will probably be needed after the first day, but it is important to check the dishes for water every day). Take care not to flood the dishes - overwatering will result in poor germination.
- Place two dishes - one 'with water', one 'without water' - in the same cold environment (e.g. outside the building in Winter or Spring, or in a fridge but not in the freezer!); and the remaining two dishes in a medium to warm environment (a classroom table or shelf).
- Through discussion, ask the children to predict which seed sample will show the most growth within a week. (Q3-5).
- Record growth and formulate conclusions.

Expected results:

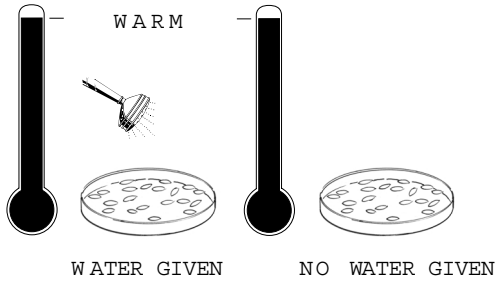
The seeds which have been given 8 ml of water and placed in the warm environment should germinate in around a week. It is best therefore to observe these dishes every day. If the seeds which have been given water and placed in the cold environment germinate, growth will be slower. The seeds which have not been given any water will not germinate.

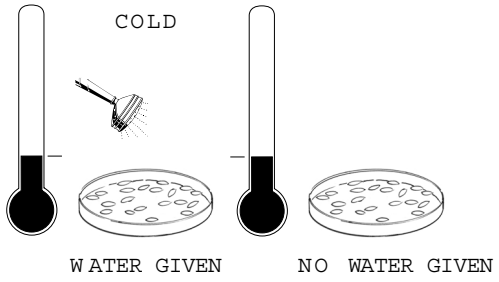
Teachers' note:

Germination in some plant species is helped along if they are left exposed to the light, while some prefer to germinate in darkness (any light/dark preference is normally indicated on the seed packet).

Extension activities:

- Compare the speed of germination of *different* seed species using the directions given above.
- Using *different* seed species, test for light or dark germination preferences e.g. freshly collected *dandelion* seed prefers to germinate in the light.





activity 10

Seed dispersal

Age 8-12

Time
Activity - 30 minutes

Materials
Seed suggestions: *Dandelion, Cleaver, Sunflower*.
Whole *Apples* and/or *Blackberries* (optional).
Electron micrographs of the seed selection.
Teacher worksheet 4.
Pupil worksheet 11.

Through these activities children can learn:

- that there are variations in seed shapes
- that these variations are important because they help the seed to reach a suitable habitat and to colonise new areas, free of competition from their own species.

Skills developed:

- observation
- classification
- discussion
- interpretation

How to begin:

- Explain that dispersal ensures that a seed moves away from its 'parent' plant so that it has room to grow. Try, during discussion, to introduce a country-to-country scale, as well as a local scale.
- Ask the children to predict different ways in which they think a seed might move away from its 'parent' plant to another place (Q1).
- Look at the seeds and the corresponding electron micrographs. Use a binocular microscope if available, or hand-held magnifiers. Ensure the examining area is well lit.
- Talk about the samples and the photographs. Encourage the children to identify possible methods of dispersal (Q2).
- Initiate a classification exercise. You may wish to use Teacher worksheet 4 and Pupil worksheet 11.

Key questions:

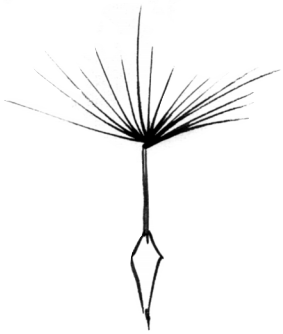
Q1. Can you think of ways in which a seed can move around?

Q2. What kinds of dispersal method do you think these seeds use?

Extension activities:

Extension activities may be achieved through any of the questions below:

- Which fabric is best for collecting hooked seeds? Devise a fair test.
- Is it true that all large plants grow from large seeds? Devise a fair test to prove or disprove your ideas.
- Do all fruits contain the same number of seeds? Examine a range of fruits to try and find out the answer. You may wish to encourage the children to use biological reference books.



Dandelion Seed

Sycamore Seed

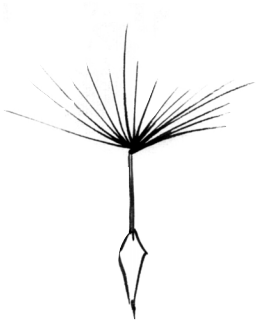
This worksheet can be used to support both the *Seed dispersal* and *Seed detective* activities

Seed Movement

The four main ways that seeds and fruits move away from their parent plant are:

1. Wind

Small seeds often have a large surface area but little weight. Some may have parachutes like *Cotton* or wings like *Pine*. Fruits with parachutes include *Dandelion*, winged fruits include *Sycamore*.



Dandelion

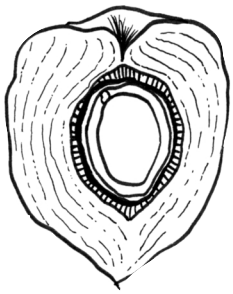
Sycamore

2. Water

Seeds and fruits have a spongy outer casing as in a *Water Lily* or a fibrous, buoyant casing as in a *Coconut**, which allows the seed or fruit to float.

* Generally the *Coconuts* you can buy in a supermarket or greengrocers have had their fibrous casing removed.

Water Lily



Coconut

3. Animals

Animals may disperse seeds and fruits by:
i) eating the seed/fruit and passing the seed in faeces or through scattering, e.g. *Blackberries*, eaten by birds; *Acorns,* scattered by squirrels.
ii) attachment of seed or fruit onto the animal by hooks, e.g. *Cleavers* on human clothing or on animal fur.

Blackberry

Cleaver

4. Propulsion or explosion (also called 'mechanical')

Here the construction of the plant means that it propels its seeds away from itself; it does not rely on any of the above agents. There are two main mechanisms:
i) tensions created by the unequal drying of the wall of the fruit (the pericarp), e.g. the *Violet* and the *Pea*;
ii) turgidity of the pericarp, e.g. the *Geranium*.

Pea

Geranium

Activity 10: Pupil worksheet 11

Name _____

Seed name			
Seed coat feature observed			
How does this feature help dispersal?			
Type of dispersal (choose from wind, water, animal or propulsion/explosion)			

activity 11

Tank trials - measuring germination

Age 10-12

Time

8 days (see below)

Seed fixation - 30 minutes;
glue drying - 3 days;
water immersion and soaking - 6 hours;
stand in black bag - 4 days;
observation - 30 minutes or longer if required

Materials

Growth tank, growth tank lid and growth tank sheet.
Teacher worksheet 5.
All purpose adhesive glue.
Blotting paper.
Black bags.
PVC/Freezer tape.
Pencil and ruler.
OHP pens (optional).
Paper clips.

Through these activities children can learn:

- that plants need certain conditions to germinate
- that different varieties of plant have different germination rates

Skills developed:

- prediction
- hypothesis
- observation

How to begin:

Plant scientists use growth tanks as a method of examining the early stages of growth (see Fig 1). Following the instructions provided, set up some tank trials. Remember to allow three days for the seeds to adhere firmly to the paper and a further six hours or more for the seeds to soak in water. Note: to allow the children to make measurements easily after the seeds have germinated, you may wish to rule the front of the 'tanks' (plastic bottles) using water soluble OHP pens or rule pencil lines onto the blotting paper.

Key questions

Q1. What do you think will happen to the seeds?

Possible recording options

- Teacher-led floor book - recording predictions.
- Allow the children to sketch the seeds and indicate on their drawing from which area of the seed they think new growth will appear and what they think this new growth might look like.

Extension activities:

- 'Tanks' may be used to study the effects of gravity. Invert the seed sheet (the plastic with blotting paper and seeds attached to it) when the shoots on the seedlings are around 2 or 3 cm long. The roots of the seedlings will curve towards the source of the gravity, the shoots will curve away from it.
- For multiple experiments - using different varieties of seed, or to examine the effect of temperature or light on growth, several 'tanks' may be used.
- 'Tanks' may be used to study non-seed reproduction. e.g. from rhizomes★.

  Dig up a rhizome of either *Couch Grass* or *Mint*. Attach a section of the rhizome root to the blotting paper by stitching a cotton loop through the paper and over the rhizome, and repeat the tank trial instructions as before.

★ *A rhizome is a horizontal, underground stem. Through branching out and/or being broken up, the rhizome acts as an agent of vegetative reproduction.*

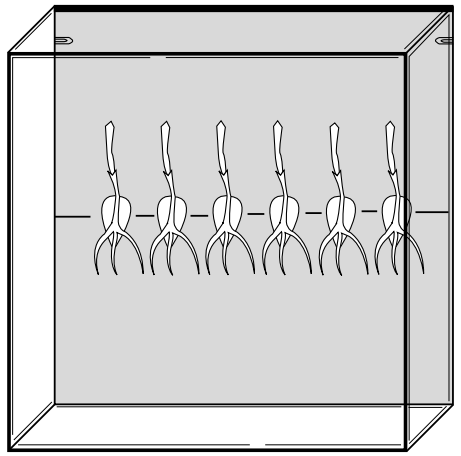


Fig.1: A typical growth tank.

Activity 11: Teacher worksheet 5

Activity 11: Tank trials - measuring germination. Children should watch their teacher complete steps 1-7.

1. Take a piece of blotting paper cut to the size of the growth tank (pre-cut pieces are provided). Place it on a clean surface. Draw a pencil line half way down the paper and mark this line at six regular intervals with small vertical pencil lines as shown in diagram 1. (Do not use a ballpoint or water-based pen.)

2. Using an all purpose adhesive glue (in our trials we used UHU glue), place a small drop of glue on the first of the vertical pencil lines. Select a *Sunflower* seed and place it directly onto the glue, making sure that the grooved side of the seed is pressed onto the paper and that the most pointed end of the seed (the embryo end) is facing the bottom of the paper. Use the same method to fix two more seeds onto the blotting paper. A pair of forceps can help to position the seeds, but be careful not to squeeze the seed too much. Use diagram 2 as a guide.

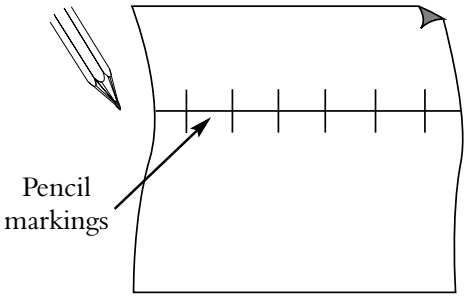
3. Now select another variety of seed. Employing the same technique you used with the *Sunflower* seeds, gently press the seed (with its embryo end facing downwards) onto a drop of glue. Repeat this exercise with two more seeds.

You should now have six seeds fixed onto the blotting paper at regular intervals along a pencil line, each with its embryo end facing downwards as shown in diagram 3a. (To help you remember which are the embryo ends, pencil in a small arrow somewhere on the blotting paper.)

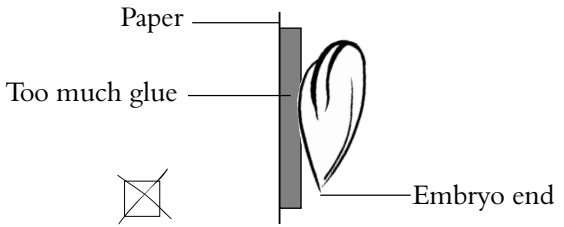
Allow the glue to dry for a few hours so that the seeds are firmly attached to the paper. Then, using another sheet of blotting paper, cut out a long thin strip of the paper (around 1 cm in depth) and put this over the line of seeds – fixing it in place using small drops of glue in between each of the seeds (see diagram 3b). Allow the glue fixing down the strip to dry and then loosely cover the seeds and the whole sheet with a clean sheet of paper to keep everything clean and dry.

Leave the seeds to dry fully onto the paper in a well-ventilated, dry area for around three days.

1.

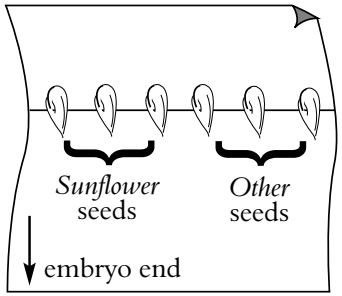


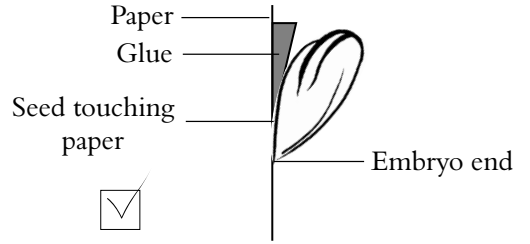
2. Q: How much glue is too much glue?



Too much glue prevents the seed from making contact with the filter paper and therefore with the source of moisture needed for germination.

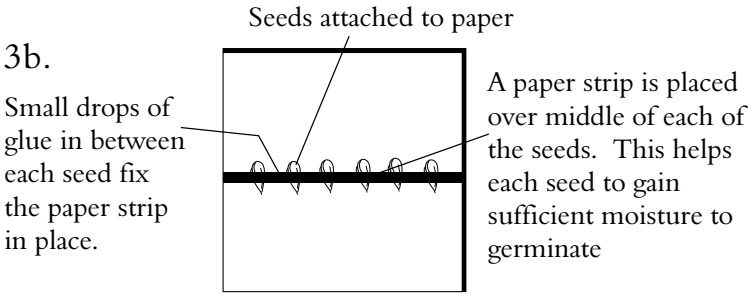
3a.





This is correct: The glue is not preventing the seed from touching the filter paper.

3b.



Teacher worksheet 5 - continued

4. Find two clear plastic bottles, one should be a couple of centimetres larger than the other. Rinse, clean and dry the bottles. Cut the top and neck off both bottles.

5. When the glue has thoroughly dried, place the blotting paper and seeds on top of an identical sized sheet of blotting paper and clip the two layers (seed layer on top) onto the outer edge of the small plastic bottle using large paper clips. Slide the small bottle into the larger bottle to form your 'tank', making sure that the embryo ends of the seeds are facing downwards towards the bottom of the 'tank' (see diagram 4).

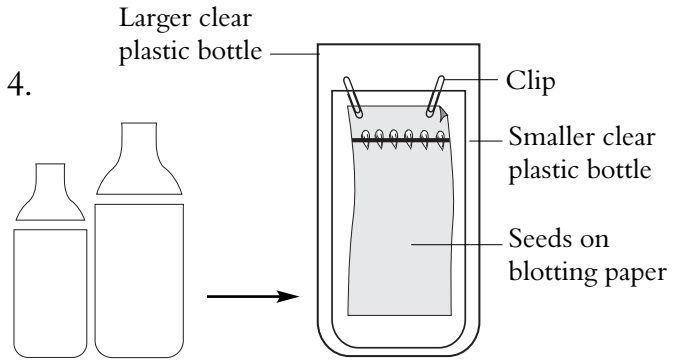
6. Place the 'tank' in a sink or washing-up bowl and slowly fill with water as shown in diagram 5). Leave for around six hours so that the seeds are thoroughly soaked.

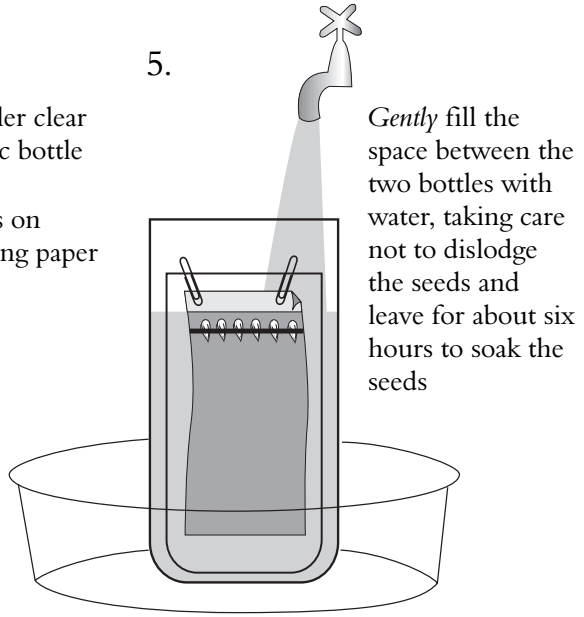
After six hours, lift the smaller bottle out of the larger bottle and place upright on a clean surface, being careful not to dislodge the seeds. Drain the water from the larger bottle and rinse it. Add a small amount of water to the large bottle (enough to rise to around 1 cm - 2 cm) and then gently replace the small bottle and it's *seed sheet*, making sure the embryo ends of the seeds are pointing downwards (see diagram 6).

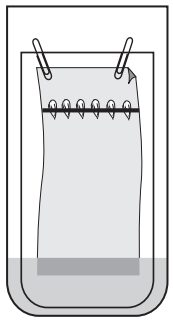
7. Wipe the open ends of the 'tank' with a tissue and then cover them with perforated cling film or foil. Keeping the 'tank' upright, place it inside two black polythene bags – making sure no light can get in by sealing each bag with PVC tape (see diagram 7). Maintaining its upright position, place the 'tank' in a safe area and leave for four days.

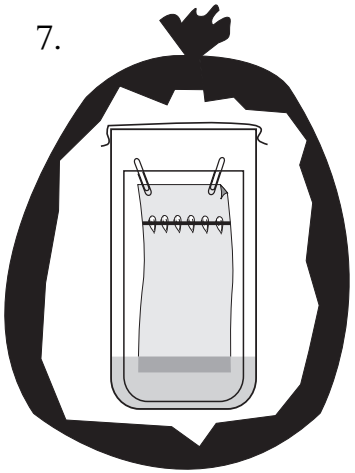
8. After four days, remove the bags and examine the seeds. To help you examine the seeds, you may lift the small bottle and it's *seed sheet* out of the larger bottle and very gently remove the thin strip of blotting paper covering the seeds taking care not to damage the new growth.

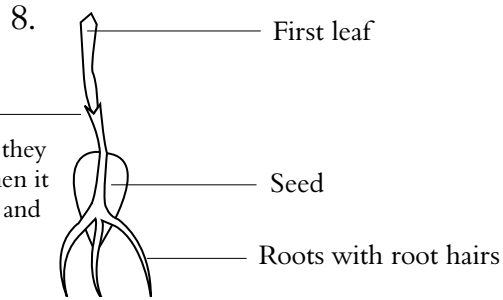
9. Once the seedlings have been exposed to light the coleoptile sheath will stop growing and shortly afterwards the first leaves will emerge from the sheath (see diagram 8).











Coleoptile Sheath

In the field, the sheath protects the shoot and leaves as they move upward through the soil. It will stop growing when it is exposed to light (i.e when it reaches the soil surface) and the shoot and first leaves will emerge.

activity 12

The growth cycle of *Sunflower* - looking at variables and planning a fair test

Age 10-12

Time

Discussion and set up - 1 hour
Plant growth - 2 weeks to seedling stage, 4 months to mature plant producing seed
Plant care - 10 minutes each day
Observation time - flexible

Materials

Each group will need:
Plant pots or trays.
Growth media and a pot to act as a scoop/measure.
Three *Sunflower* seeds per pot or tray compartment.
Sticky labels and pen/pencil to mark individual pots.

Pupil worksheet (enlarge to A3 size would be best).

Some groups will need:

Two black bags or cardboard boxes.
Plastic syringes.*
Room thermometer.*
Soil thermometer.*
Light meter. * (*if available)

Note: For more rapid germination and growth, seeds of the herb *Coriander* are recommended.

Through these activities pupils can learn:

- about the factors affecting germination and growth
- about the growth cycle
- to identify and label the main parts of a plant

Skills developed:

- plant care
- close observation
- accurate measurement and recording
- prediction, questioning, researching

How to begin:

Work in small groups or as a whole class. Use discussion to establish the conditions necessary for healthy growth. The main variables involved are: light, water, temperature, and the growing medium (containing nutrients). (Q1 & 2).

Key questions:

Q1. What do you think a seed needs in order to grow into a healthy plant and why?

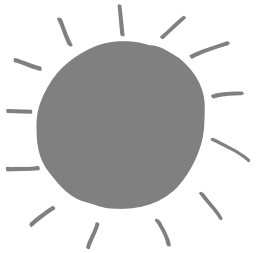
Q2. What parts of the plant do you think will grow first?

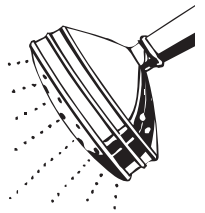
When favourable conditions have been explored through discussion, the growth activity can be introduced. A whole class might study the effect of changing just one of the variables, e.g. water, or small groups might be assigned one variable each (the first group light, the second heat, the third water, and so on) and report back to the whole class at the end of the activity.

As a parallel activity, children might also study the stages of plant growth - examining the parts of a plant and their functions. For this you may wish to use Teacher worksheet 1 from Activity 3 - the *Sunflower jigsaw*.

Possible recording options

- Floor books; pictorial diaries; pictograms, bar charts or IT. You may wish to use Pupil worksheet 12.





activity 12

Continued

Age 10-12

Teachers' note

As with all seed growth activities, it is best to over plant by a factor of three to ensure adequate germination.

Ensure good drainage by making holes in the bottom of the pots if necessary and by placing the seed pots/trays in drainage trays.

1. Investigating growth media

In this case the variable being studied is the growth medium. Children should be encouraged to decide which growth media to test (possible choices include sand, pebbles and stones, garden soil and potting compost).

They should be reminded of the fair test - that each pot or tray of seeds should:

- have the same amount of growth media (children might use a pot as a 'scoop' to measure out equal amounts of the media)
- have the same number of seeds
- receive the same amounts of heat and light
- be given the same amount of water (enough to keep the soil moist)

Expected results: Seeds in the potting compost should show the strongest growth. This is a nutrient rich environment with a friable structure ideal for root and shoot development.

Seeds in the garden soil should also germinate, although growth may be slower than the seedlings in the potting compost because the soil may not have the same concentration of nutrients and its structure may not be as friable.

The seedlings grown in sand and in small stones/pebbles may germinate as each seed has a built-in food reserve to draw on, but subsequent growth will be weak because of the lack of nutrients and the unsuitable physical structure of the stone/pebble environment.

2. Investigating water

A plastic syringe is ideal for this activity. Children might deprive the first pot or tray of water, give the second enough water to keep the soil moist and the third an excessive amount of water.

Expected results:

Pot 1 - no growth.

Pot 2 - germination and maximum growth rate.

Pot 3 - little or no germination due to over watering.

Alternatively, a set amount of water can be given to each pot of seeds but the *frequency* of watering changed for each pot.

3. Investigating light

Leave the first pot/tray of seeds in darkness by placing a black plastic bag or cardboard box over it and removing it only to water and make observations.

Give the second pot/tray bursts of light by removing its black plastic bag or box for two hours a day.

Leave the third in good light conditions e.g. close to a window (but not on a window ledge - it may get too warm behind the glass).

If facilities allow, expose a fourth pot to continuous artificial light.

Care should be taken that temperature levels are the same for each pot. If available, a light meter may be used to gain accurate measurements.

Expected results:

Pot 1 - initial germination may occur but there is little or no subsequent growth - seedlings may look yellow and limp.

Pot 2 - germination will occur but again seedling growth will be slow and plants will look weak.

Pot 3 - most of the seeds will germinate and seedling growth should be strong and healthy.

Pot 4 - germination will occur and growth will be rapid. Shoots may be elongated compared with those grown in daylight.

4. Investigating heat

Place the pots or trays in a cool outdoor location, a warm classroom location and a hot location near to a radiator, heater or behind glass. Care should be taken to ensure light levels are the same for each pot. The use of a room thermometer (and a soil thermometer, if available,) will allow accurate measurements to be taken. Mercury-in-glass thermometers should be handled by adults only. Children may use liquid crystal strips, dial type or digital thermometers.

Expected results: the seeds placed in the temperate environment of the classroom should show the best germination and growth rates, followed by those in the hot location. However this situation may reverse depending on the amount of water given to each pot (i.e. if the pot in the hot location is kept well watered a 'greenhouse effect' may lead to superior germination and growth).

Activity 12: Pupil worksheet 12

Name _____

Investigating the growth cycle of _____ (plant name)

Our prediction:	Week 1	Week 2
What is going to happen and why:	Week 3	Week 4
The equipment we will need and how we will keep the test 'fair':	Week 5	Week 6
The outcome of our investigation:		

Age 8-12

30 minutes

activity

Wandering Wild-oats

Wild-oat demonstration:

Place several *Wild-oat* seeds in a dish, bowl or plastic tray lined with kitchen or blotting paper. Spray with water until the paper is moist. Ask children to observe and comment on what they see. The seed motion is a response to the change in moisture levels. The response is explained in the teachers' note below.

Key questions:

Q1. Why are these seeds doing this?

Q2. Why do you think it is an advantage for seeds to be able to move?

Q3. What do you think will happen when the seeds dry out again?

Teachers' note

- The common *Wild-oat* is a serious weed, particularly of cereal crops. It is widely distributed throughout the world. One of the reasons for the successful distribution of this weed has been its specially modified seed husk. The husk is coated with fine hairs which all point in one direction. The hairs enable the seed to become trapped in clothing, animal fur and farm machinery.
- The husk also has a specifically modified structure called an awn. This looks like a very thick stiff hair, which has a bend in it. The awn is attached to the back of the husk. When the awn dries, cells in the lower part of it respond by becoming smaller, forcing it to coil into a helix. The upper part of the awn does not coil.
- When the seed becomes wet, the lower part of the awn un-coils and twists the upper part of the awn against the surface on which it is resting. This results in seed rotation, causing the seed to move across the surface. The seeds' awns are very sensitive to moisture and this movement will continue as often as the wetting and drying cycle continues.
- In the field this movement is important because it can propel the seed across the soil surface and into cracks in the soil or under stones. Here the seed is protected against predators including birds and mice.

Wild-oats placed in a circle which has been drawn onto some blotting paper or kitchen paper will start to move out of the circle when they are misted with water.