
# Living processes

## and what plants need to grow



Science & Plants for Schools

FSC
Bringing Environmental Understanding To All

Science and Plants for Schools (SAPS) works with teachers to:

- Develop new resources to support plant science in schools and colleges
- Promote exciting teaching of plant science
- Interest young people in plants

We hope that our approach will help young people to become more aware of the importance of plants in the global economy, and to encourage more of them to follow careers in plant science.

Science and Plants for Schools
Cambridge University Botanic Garden
Cambridge CB2 1JE

Email: saps@hermes.cam.ac.uk
www.saps.org.uk

# Plants for primary pupils 4

# Living processes and what plants need to grow

*The activities in this booklet have been developed by SAPS (Science and Plants for Schools) in collaboration with FSC (Field Studies Council).*

Science and Plants for Schools
Cambridge University Botanic Garden
Cambridge CB2 1JE
Telephone: 01223 748455
www.saps.org.uk

Field Studies Council
Preston Montford, Shrewsbury
Shropshire SY4 1HW
www.field-studies-council.org

# Safety

Teachers using these activities with classes of Primary pupils are advised to refer to the SAPS Safety Notice on the SAPS website, and to undertake their own risk assessment where appropriate.

Further information on safety may be found from the sources listed in the SAPS Safety Notice.

*Please remember...*

- When working with plants, pupils and teachers should ALWAYS wash their hands after handling plants (including seeds), soils, composts, manures, equipment and other related materials.
- Plants (or parts of plants) can be poisonous, cause allergic reactions in some people or may have been treated with chemicals (such as pesticides).
- It is particularly important that pupils understand that they must NEVER eat plants found in the wild or in the school grounds, unless given instructions that they may do so.
- Children with very sensitive skin or allergies should wear gloves when handling plant material.
- Wild flowers should not be picked and it is illegal for anyone (without the permission of the landowner or occupier) to uproot any wild plant.

This resource is part of a series written to support learning with and about plants as part of the Primary Curriculum in England, Wales, Northern Ireland and Scotland. This and the other booklets in the series are also available on the SAPS website (www.saps.org.uk) and can be downloaded freely for educational purposes.



For further details about re-using these materials, please contact :

*Science and Plants for Schools, Cambridge University Botanic Garden, 1 Brookside, Cambridge CB2 1JE.*

*email: saps@hermes.cam.ac.uk*

Some of the materials used in this booklet have been obtained from individuals and organisations. In such cases every effort has been made to ensure that the necessary permissions to reproduce copyright material have been obtained. However, should any omissions be noticed we should be grateful if they could be brought to SAPS' attention.

# Acknowledgments

For the activities listed below, the Writing Group has drawn on ideas that originated in other publications, as shown.

Plants and how they grow

Activity 3 (How strong are plants?) – British Association for Young Scientists (BAYS) award for Young Investigators

Activity 5 (Adding mineral salts – do radishes grow better?) – Hewitson, J. and Price, R. (1994), Plant mineral nutrition in the classroom, *School Science Review*, **76** (274), 45-55

Activity 6 (How does water travel through a plant) – BAYS

Science and Plants for Schools and the Field Studies Council are grateful for permission to include the following copyright material:

**Photographs.** Photographs are by John Bebbington FRPS, with the exceptions of Figures 12, 14 and 22 which are by Erica Larkcom and Figure 26 which is by Maggie Bolt.

**Artwork.** All artwork, including cartoons, is by Anne Bebbington.

Illustrations used in Figure 19 are reproduced by courtesy of The Cavendish School, London.

The design of the container for Petri dishes using take-away boxes (page 9) is by Gill Halton.

The members of the writing group would like to thank Maggie Bolt for her skilful efforts in converting their work into a format suitable for design and printing.

SAPS would also like to thank the following people for reviewing the draft text and offering a variety of comments, many of which were then incorporated into the final published version of the booklet: Nicky Edrich, Susie Kelpie, Judy Vincent and Paul Warwick.

Members of the Writing Group: Anne Bebbington, Colin Bielby, Janette Kean, Ruth Thomas and Erica Clark, editor.

# Contents

# Looking at plant life cycles: a seasonal teaching planner

The timing of studies on plants may depend on the rest of the school curriculum but the following plan suggests the ideal times for studying different aspects of the life of plants. Activities relating to the early stages of the life cycle, involving germination of seeds and growth of young plants, are covered in this booklet. Other activities relating to events in the flower, followed by formation of seeds and fruits and their dispersal, are covered in booklet 2 and 3 of this series (*Reproduction and life cycles*).

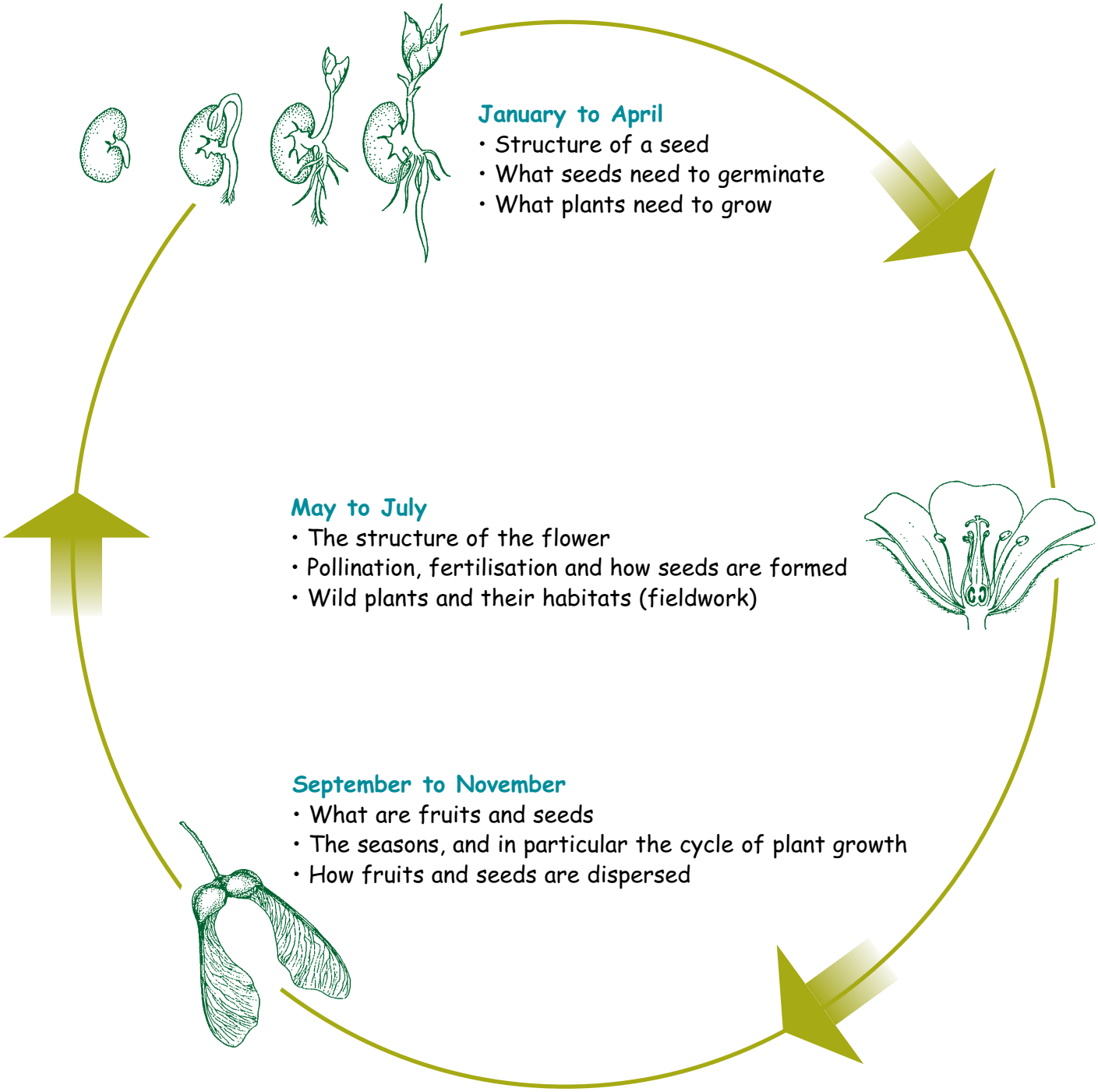



Figure 1. How to plan your plant studies in relation to the seasons – some suggestions.

# Introduction

This resource is part of a series written to support primary pupils learning with and about plants in England, Wales, Northern Ireland and Scotland. The activities have been developed by Science and Plants for Schools in collaboration with FSC (Field Studies Council).

The activities are being developed under a number of themes, each of which is published in a separate booklet and is also presented as website material (see SAPS website).

- **The parts of a plant and their functions**
- **Reproduction and life cycles – Part 1: Parts of a flower and Part 2: Pollination, fertilisation, fruits and seed dispersal**
- **Living processes and what plants need to grow**
- **Grouping and classification**
- **Plants in their natural environment**

Within each set of topics, you will find different types of activities. Some are based in the classroom while others involve growing plants outside (say in tubs in a school yard or in a school garden) or making observations of plants growing in the wider environment. Teachers are encouraged to let children explore links between classroom and outdoor fieldwork activities.

The activities give emphasis to the growing of plants so that children can make first-hand observations, often on their own plant, and become familiar with plants and how they grow. This is supported by a range of activities such as making models of plants, card games that reinforce learning and simple investigations that help children find out more about how plants work. You may not wish to use all the activities in a set, but you will find a good range to choose from, to suit your class and curriculum requirements.

Each topic includes a description of the activity and appropriate information for teachers. There may also be 'pupil worksheets', particularly with the activities intended for older children. An important feature in this series is the inclusion of 'Background information for teachers', written to give advice and guidance to teachers less familiar with botanical jargon or who lack confidence in their teaching on plant topics. In some cases, these notes indicate further sources of information that may be helpful to teachers, including other publications and useful websites.

The illustrations have usually been drawn from living plant material, so they are fresh, botanically accurate and show what a child is realistically likely to see. The activities are also generously supported by photographs – again many taken specially for this series.

# Living processes and what plants need to grow

As the third theme in the series, this booklet includes activities that children can do to find out more about plants. It focuses on ways that children can grow their own plants, from seed and also from other parts of plants. Several of the activities are set out as investigations. The introduction of the Planning Plant provides a means of developing children's approach to investigations in a scientific way. They can investigate, for example, whether plants need water, light, soil and mineral salts. They can design a seed packet (with appropriate instructions for growing a newly discovered plant), find out how strong plants are and how water travels through a plant. Then they can wrap this up in two different games (new plant versions of 'Snakes and ladders' and 'Happy families') that are fun but help reinforce their understanding. A section on having fun growing plants gives opportunities for children to gain a wider experience of plants and, as the activity suggests, have fun!

The booklet is supported by material on the SAPS website that is linked directly to items in this booklet. These include full-sized templates that are provided for certain activities. Usually it would be appropriate to make these items out of lightweight card. To do this, print out the template and photocopy onto appropriately coloured card or paper. Alternatively you may be able to print directly onto the card. You can then make good durable sheets by laminating the pages and then, if needed, cut out the parts for your class. The Pupil Sheets are also available on the SAPS website, usually as both pdf and Word files. You can download the pdf files and use them as they are, or you may prefer to adapt the Word files to your particular version of the game or activity.

Following on from the earlier booklets in this series, this fourth booklet encourages a wider range of approaches. Children are able to develop greater independence, for example, in carrying out investigative work, in devising tables to record results or using IT to draw a graph. In several activities, suggestions are made as to ways that IT can be incorporated. Digital photography can provide a useful tool for recording events and sharing results with others in the class. Remember, however, that drawing encourages careful observation and development of different skills. Both photography and drawing are valuable and can be used as appropriate in several of the activities in this booklet. Teachers should also be aware of opportunities offered in the different activities for development of skills in literacy, numeracy, investigative work and strategies for assessment. (See note below *Reference to literacy, numeracy, assessment and investigative skills)*.

Remember you can use Curriculum Links (on the SAPS website) to find more material to give support within your teaching programme.

## Reference to literacy, numeracy, assessment and investigative skills

For literacy, there are activities on listening, reading, talking, phonics and spelling. The 'Design a seed packet' activity is a good example of one that helps to develop literacy skills.

For numeracy, there are opportunities for work on numbers and number systems, information and data handling, problem solving and using mathematics in a relevant context. Relevant examples include 'How fast do roots grow?' and the effect of adding mineral salts on the growth of radishes

There are also clear opportunities for both formative and summative assessment. Examples include games such as Vines and villains (Snakes and ladders) and Plant quartet (Happy families).

Finally, many of the activities can be developed to help in the teaching of scientific investigation as there are ample opportunities for predicting, planning, observing, recording, analysing and evaluating. Teachers may wish to take opportunities to use the Planning Plant in conjunction with several of the investigations to encourage understanding of how to approach investigations in a scientific way.

## Supporting material on the SAPS website

This material includes templates for some activities (as pdf and / or Word files) and a number of Pupil Sheets. You can download these and adapt Word files as appropriate for use with your class. The material also includes additional background information on rapid-cycling Brassicas together with activities that can be carried out to help illustrate stages of a plant life cycle. These items are linked specifically with this booklet and you can find them on the SAPS website by following the links to "Plants for Primary Pupils".

# Planning investigations

*Teacher Guidance*

## The Planning Plant: an approach to investigations

This booklet includes several investigations and children are encouraged to work through them in a scientific way. The steps taken in simple investigations at this level lay the foundations for more complex investigations they will undertake in their study of science at a higher level.

The Planning Plant (Figure 2) provides a framework or 'scaffold', which can be used to support children as they discuss, plan, analyse and evaluate their investigations. In some activities, only parts of the Planning Plant would be used, but as children progress, they may be able to work through all the stages in the planning framework. It can be used with the whole class as a display but also by the children working individually or in small groups. As given here, the Planning Plant is most suitable for upper primary pupils, but it can be adapted for children of different ages and abilities.

## Using the Planning Plant

Different parts of the plant represent different stages of the planning, recording and evaluation process. The children can be involved at all stages and are prompted or reminded to consider different aspects of the scientific methodology.

As the children start and then progress through different stages of the investigation, they try to complete the relevant sections of the planning plant. Inside the different parts, there are some prompts to help the children work out their responses. For individual and small group work, A4 Pupil Sheets are provided on the SAPS website (see Figure 4 on page 5) and children can write directly on these sheets. If you prefer to work as a whole class, templates are also provided on the SAPS website for a larger poster version. When using the poster version, we suggest that the children's ideas and comments are written on 'Post-it'® notes and then stuck on the poster.

The following notes summarise how to use the different parts of the plant.

### *Planning the investigation*

- Questions go in the **flower pot**
- From the questions, the children make their **prediction** and write it (with their reasoning) on the lowest pair of leaves (the seed leaves)
- On the **stem**, they write what they are going to do
- On the **leaves**, the children decide what they will observe or measure
- The parts of the **flower** are for the variables – what they will change and what they will keep the same
- The equipment they need to use goes into the **watering can**


Figure 2. The Planning Plant – a poster version of 'Planning my investigation'.

When working with a whole class, the flower pot can be made from an envelope so that children 'post' the questions they would like to investigate. The question that is chosen is then placed on the front of the envelope. Extra leaves can be added to the plant if needed. More (or fewer) petals can be used for recording the variables.

## *Results*

The results chart is put on the front of the **seed pod**. It can be adapted, if needed, by adding extra rows.

## *Evaluation*

For the evaluation, use the **open seed pod**. Each numbered seed represents a different stage in the evaluation. An A4 Pupil Sheet is provided for individual and small group work (see SAPS website for template). If using the poster version, we suggest that children write their ideas and comments on numbered 'Post-it'® notes and place these below the pod. There are a few **caterpillars** and these can be used to record any doubts that the children had, say about the accuracy or fairness of their test.

On completing the investigation, further questions the children would like to investigate can be added to the **small plant pot with young plant**.

When working with younger children, you may wish to use just a few seeds. For example, you may wish to focus only on what they have found out, their proof or evidence or perhaps whether they worked well as a group.


Figure 3. The Planning Plant – a poster version of 'Evaluating our investigation'. This example shows some comments on 'Post-it'® notes stuck on around the evaluation pod.

# Planning investigations

*Pupil Sheet*

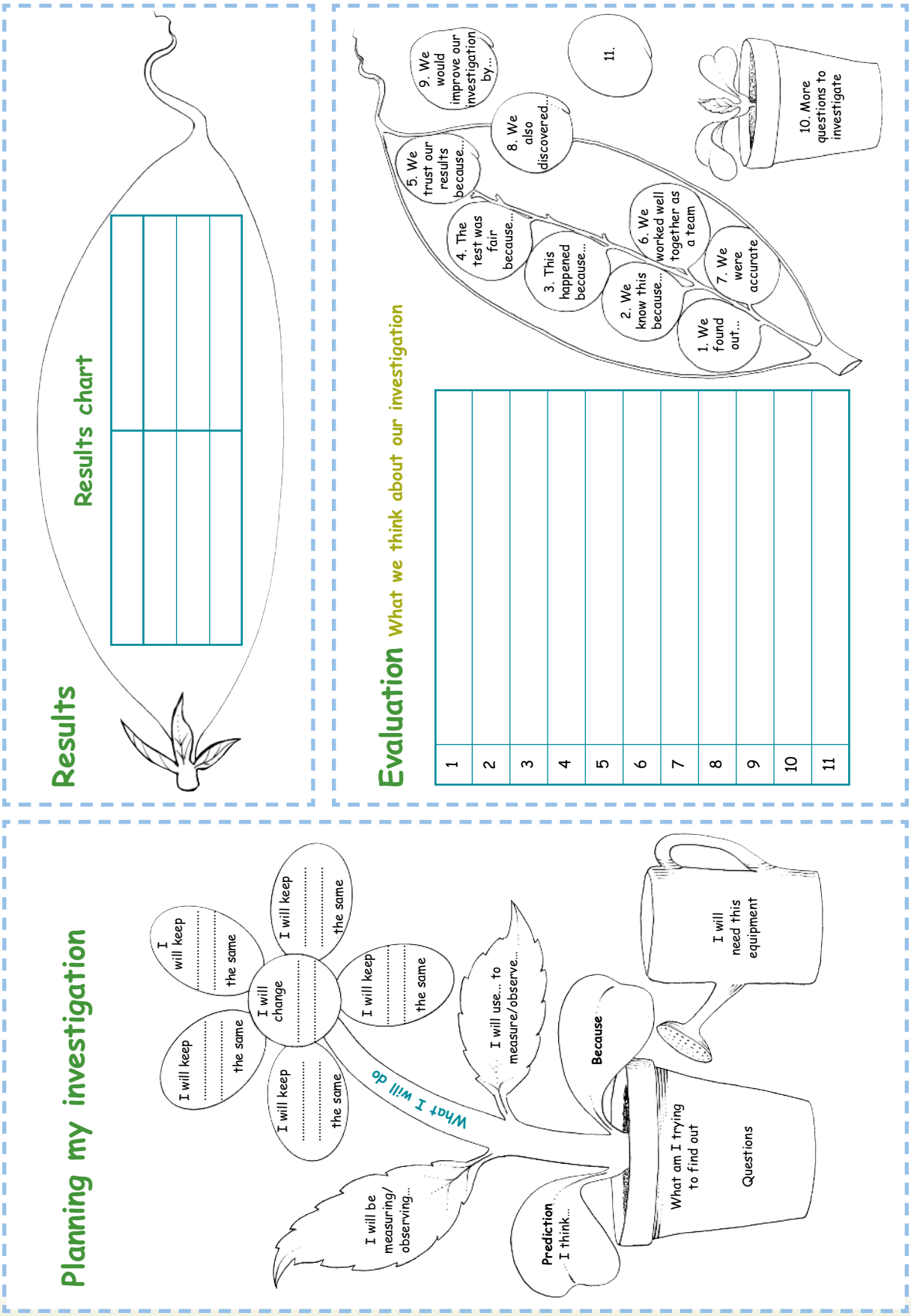



Figure 4. Reduced size versions of Pupil Sheets for use with the Planning Plant. Full-sized templates are provided on the SAPS website.

# Growing plants in the classroom: techniques

*Teacher Guidance*

## Introducing the techniques

Many of the activities in this booklet depend on children growing their own plants, as part of an investigation or sometimes 'for fun'. Both these approaches encourage children to become familiar with plants, to make first-hand observations on the plants and gain an understanding of how they grow. For some it may be a way of developing an early interest in plants that lasts through their lifetime.

The methods described involve the use of **film pots** and **Petri dishes** as the containers for growing plants. We also include reference to **watering systems**, which enable you to leave the plants over an extended time. A section on using a **light bank** aims to show you how to use this in the classroom and the advantages of doing so.

With each method, there is an accompanying Pupil Sheet, showing step by step what the children would do. You may adapt these as appropriate for the investigations you wish to do and for the ability of the children in the class. Word files are provided on the SAPS website for you to download and amend to suit your class. For information on sources of materials and other helpful hints for growing plants in the classroom, see page 42.

## Germinating seeds in small pots

This is a good way of growing seeds when investigating germination and the early stages of growth. Black film pots can be used when there is a need to exclude light, or if using yoghurt /dessert pots, put prepared pots in a light proof container with a hole in the side. (See further information on film pots on page 43.)

Here we suggest using capillary matting in the film pot. (See further information on capillary matting on page 42). Other materials, such as filter paper, cotton wool or sand can be used, providing they hold water and give a surface for the growing plants.

### *Resources*

- ☑ *A clear film pot with a lid or small clear yoghurt pot and cling film for each child*
- ☑ *Small circles of capillary matting to fit the bottom of the film pot*
- ☑ *Seeds*

### *Method*

- Cut a small circle of capillary matting to fit the bottom of the film pot.
- Moisten the circles with water and place in the pot.
- Add three seeds.
- Place the lid or cling film on the pot and put a label on the lid.
- Place the pot in a suitable place to germinate e.g. under a light bank.

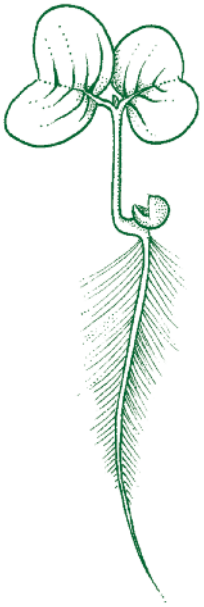
Using this growing technique and a light bank, seeds such as mustard, mung bean and the rapid-cycling Brassica, germinate and form seed leaves in 3 to 5 days.

A Pupil Sheet using this technique is given on page 7. This Pupil Sheet shows the essential steps when working with pots and can be adapted for the particular activity you are doing.

Growing plants in the classroom: techniques

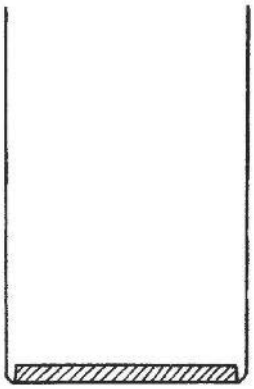
*Pupil Sheet*

# Germinating seeds in a pot

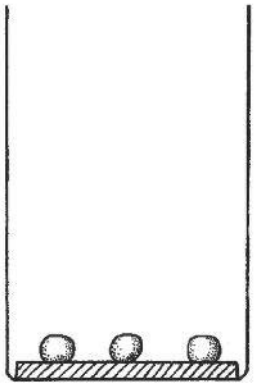


**You need:**

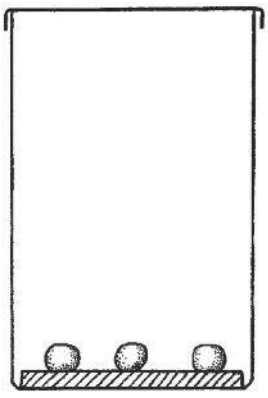
- a clear film pot with a lid or small clear yoghurt pot and cling film
- a piece of damp capillary matting
- a sticky label and pencil



1. Put a piece of damp capillary matting into the pot



2. Add 3 seeds to the pot



3. Put the lid or cling film on your pot. Write your name on a label and stick it on the lid

4. Ask your teacher to put the pot under the light bank

## Growing plants in the classroom: techniques

*Teacher Guidance*

# Germinating seeds in Petri dishes

This method is a modification of the technique using a 1.5 litre plastic mineral water bottle, described in Booklet 1 *Parts of a plant and their functions*. Compared with using a plastic bottle, the take-away plastic container used here keeps the Petri dishes better separated and more stable. The grid makes it easy for children to measure the length of the root and shoot (Figure 5).

This growing technique allows children to see features of germinating seeds very clearly. The seed swells and the seed coat splits, normally within 24 hours. The young root can be seen emerging within 48 hours. Root hairs can be seen clearly. The shoot and green seed leaves appear after 3 to 5 days.

## *Resources*

- *Petri dish (9 cm diameter)*
- *Filter paper (9 cm diameter) or circle of strong absorbent paper (e.g. blotting paper)*
- *A circle of acetate film (9 cm diameter) with a graph paper grid photocopied onto it. The template given (Figure 7) has a mark on it to show the children where to put the seed*
- *Seeds e.g. mustard, tomato, rapid-cycling Brassica*
- *Water*
- *Plastic containers with lids to hold the Petri dishes. Take-away containers are ideal and can be bought very cheaply from hardware stores and discount shops.*

## *Preparation*

To prepare the plastic container, cut four tabs out of the lid. Do this by cutting along the solid line, as shown in Figure 6. Fill the box one quarter full with water.

The children can prepare the Petri dishes. We suggest that the children work in groups of four. Each group will need a Petri dish holder prepared from the plastic containers.

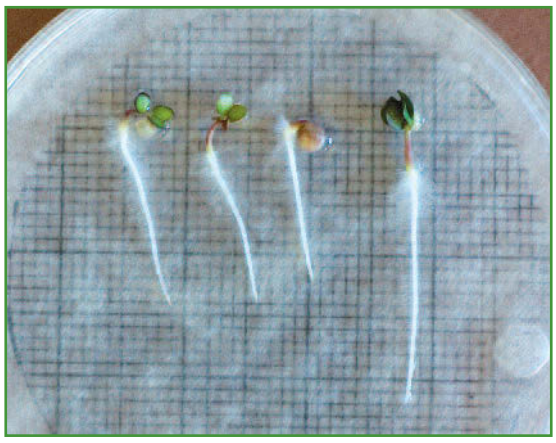


Figure 5. Mustard seedlings in a Petri dish, after three days under a light bank.

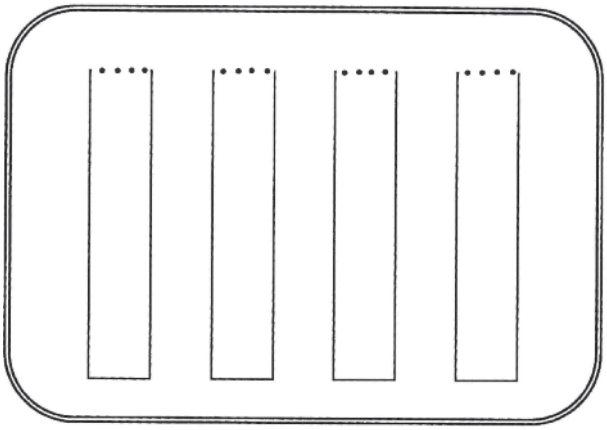


Figure 6. Preparing the lid of the plastic container.

## *The activity*

Ask the children to do the following:

- Place the acetate disc in the Petri dish lid and put the filter paper on top of it.
- Wet the filter paper thoroughly. Pour off any excess water and make sure that there are no air bubbles under the paper disc.
- Put the lid of the Petri dish flat on the table.
- Put four seeds along one of the grid lines about two-thirds of the way up the dish at the positions marked. Leave the dish flat on the table for at least ten minutes. This gives the seed time to produce a secretion which helps the seed stick to the filter paper.

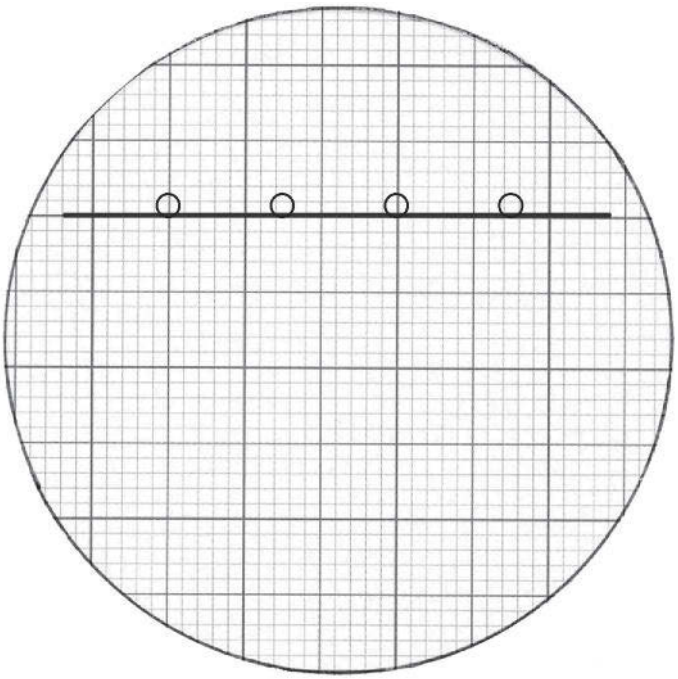


Figure 7. Acetate grid to use in the lid of the Petri dish. The marks show the positions at which the seeds are placed for germination. Note that this grid is exactly the correct size to fit a Petri dish lid.

Pick up the dishes gently and place them on their sides, vertically, in the plastic container. Make sure that the bottom of each Petri dish is covered by about 1 cm of water. Replace any seeds that fall off as they do not germinate successfully in the water. Place the plastic container under a light bank (see page 14) or in another light, warm place. Remember excess heat may kill young seedlings so don't put them close to a radiator or in full summer sunlight.

Figure 8. The plastic container with Petri dishes in place (two views).

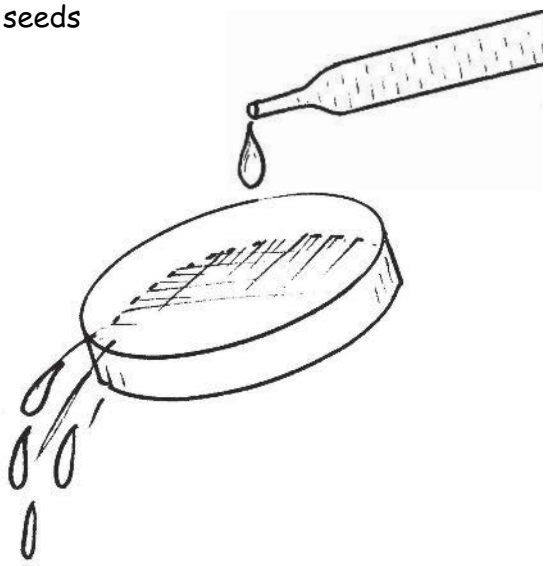
Growing plants in the classroom: techniques

*Pupil Sheet*

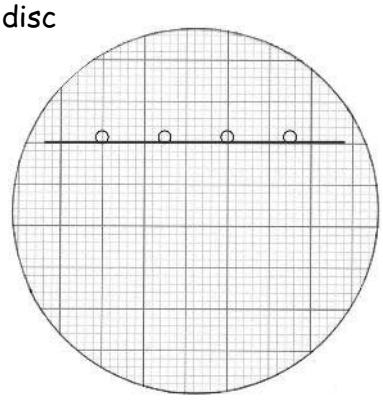
# Germinating seeds in a Petri dish

**You need:**

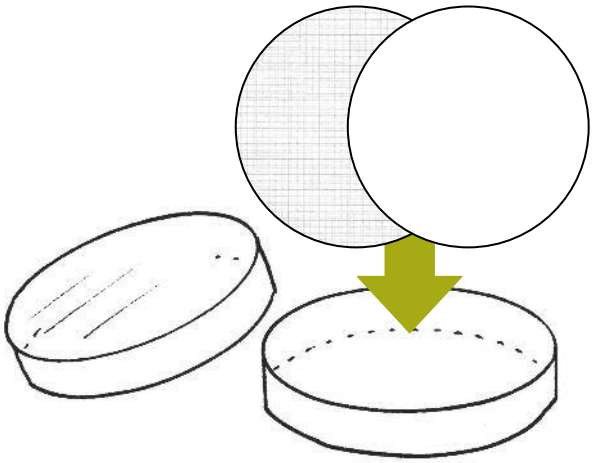
- a Petri dish
- an acetate disc with a grid printed on it
- a piece of filter paper
- water and a dropper
- seeds



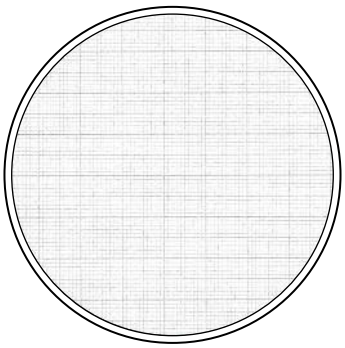
2. Use the dropper with some water and wet the filter paper thoroughly. Pour off any excess water and make sure that there are no air bubbles under the disc



4. Put 4 seeds along one of the grid lines on the marks that are given. Leave the dish flat on the table for at least 10 minutes. This helps the seeds to stick to the filter paper



1. First put the acetate disc in the Petri dish lid. Then place the filter paper on top of it



3. Put the lid of the Petri dish flat on the table

5. Ask your teacher to help you put the dish into the Petri dish box

## Growing plants in the classroom: techniques

*Teacher Guidance*

# Growing plants in pots

Many different plants can be grown using these techniques. The rapid-cycling Brassica, for example, produces flowers and seeds in 15 to 35 days, while radishes can be harvested after 20 to 30 days. Taller plants, like sugar snap peas, may be started in film pots but then transplanted to larger containers such as flower pots. Comparison of different sorts of germination and early growth in plants can be readily investigated by sowing a variety of seeds in different pots at the same time.

The rapid-cycling Brassica needs to grow under a light bank. Most other plants also grow faster and it is easier to control growing conditions with a light bank so the use of a light bank is strongly recommended. See pages 42 to 43 for more information on film pots, capillary matting and soil mix, and page 14 for information on the light bank.

## *Resource*

- ☑ *Plastic containers with lids for making water boxes (e.g. 2 litre square or rectangular margarine or ice cream tubs will hold 10 film pots. Plastic take-away containers can also be used).*
- ☑ *Water*
- ☑ *Fertiliser pellets*
- ☑ *Soil mix*
- ☑ *Sticky labels*
- ☑ *Seeds*
- ☑ *Capillary matting for water boxes and wicks*
- ☑ *Black film pots or small yoghurt/dessert pots (allow 1 pot for each child)*
- ☑ *Light bank*

## *Preparation for the activity*

1. Make a 2 mm hole in the base of each pot (using, for example, a sharp awl).
2. Cut wicks out of capillary matting. Push a wick into the hole at the base of each pot, carefully pulling it through with blunt forceps.
3. Prepare a water box as follows:
   - Make sure that the plastic container is clean.
   - Cut a slit in one end of the plastic lid.
   - Cut out a piece of capillary matting to fit the lid and with a slightly narrower tail. This should reach three-quarters of the way into the plastic container when pushed through the slit in the lid.
   - Fill the container three-quarters full with water.

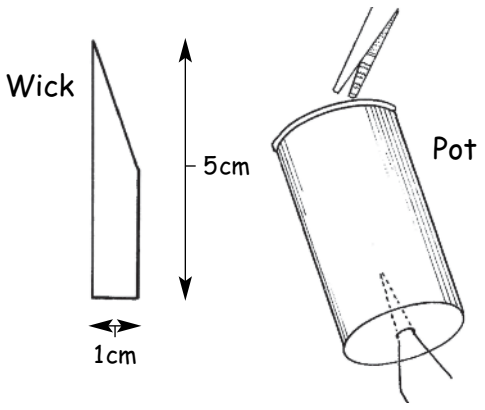



Figure 9. Preparing the wick for a pot.

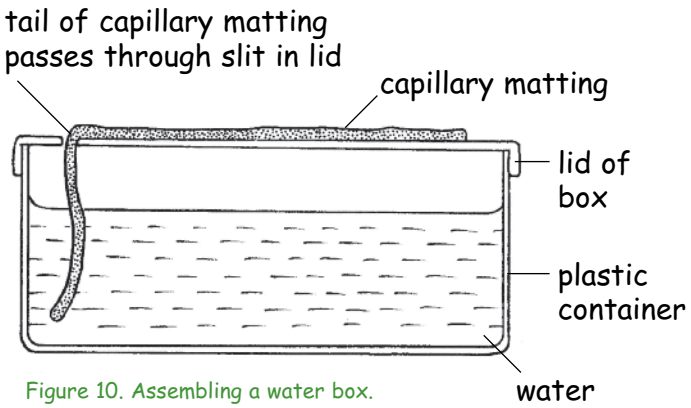



Figure 10. Assembling a water box.

## *Planting*

We suggest that the children work in small groups. Each child has a pot and sows seeds in it as described in the Pupil Sheet on page 13. It is important that the soil mix in the pots is not compressed. It should be pressed down very gently or the bottom of the pot can be tapped while it is being filled.

After planting, the pots from each group are best held together with Scotch™ 'Magic Tape' to make them more stable on the water box. Rubber bands are useful for holding the pots together while the Scotch™ 'Magic Tape' is being secured but are likely to perish under the light bank. An alternative method is to cut out rings from 2 litre plastic lemonade bottles and to use the rings to hold the pots together (see the SAPS website).

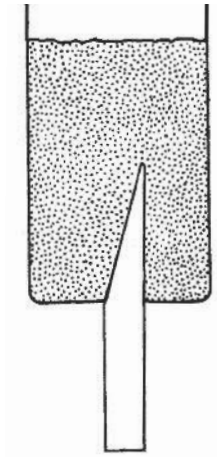
The pots (and later the plants) should be approximately 10 cm away from the light source in the light bank.

A Pupil Sheet using this technique is given on page 13. This Pupil Sheet shows the essential steps when working with pots and can be adapted for the particular activity you are doing.

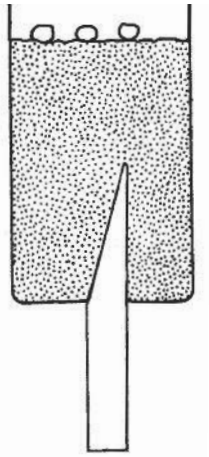
# Growing plants in a pot

**You need:**

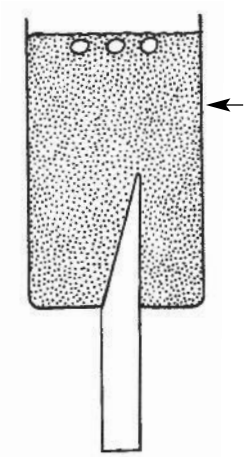
- a small pot with a wick
- some soil mix
- a plastic teaspoon
- seeds
- water and a dropper
- sticky label and pencil



1. Use the plastic spoon and fill your pot with soil mix

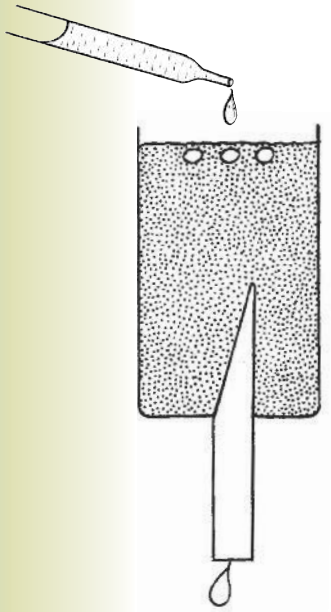


2. Add 3 seeds



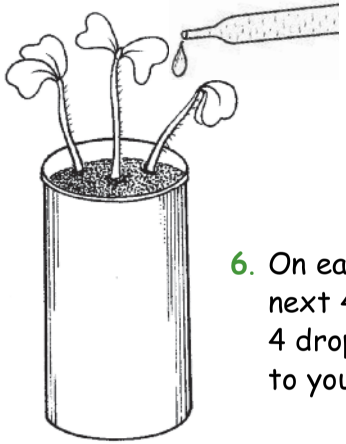
← Stick a label on the pot with your name and the date

3. Just cover the seeds with soil mix and **gently** press the soil down with your finger

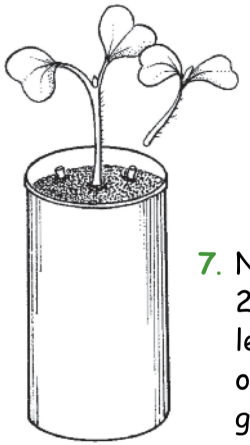


4. Add water with the dropper until water begins to drip off the wick

5. Ask your teacher to put the pot on a water box under the light bank



6. On each of the next 4 days, add 4 drops of water to your pot



7. Now cut off 2 seedlings and leave the strongest one to go on growing

## Growing plants in the classroom: techniques

*Teacher Guidance*

# Using a light bank

Plants need light for growth. They also require a reasonably warm temperature and do not respond well to extremes. Many classrooms do not have window sills. Even if present, window sills are often not an ideal place for carrying out investigations into plant growth because light, temperature and other environmental conditions are difficult to control. A successful alternative is to use a light bank. This provides the necessary light source, gives reasonable temperature control and isolates a small area of the classroom for children to focus on growing their plants. Relatively small portable versions are available. These can be placed on a trolley so they can be stored elsewhere when not in use.

The photograph below (Figure 11) shows how a light bank can be used for several investigations at the same time. At other times, a range of attractive or interesting plants can be growing in the light bank, as a way of encouraging children to become interested in watching plants grow.

The film pots (and later the plants) should be placed approximately 10 cm away from the light source in the light bank. As the plants grow, they can be moved further away. Blocks of polystyrene, wood or other suitable objects can be used to adjust the height of the plants.

For the latest information about suppliers of light banks please see the SAPS website.

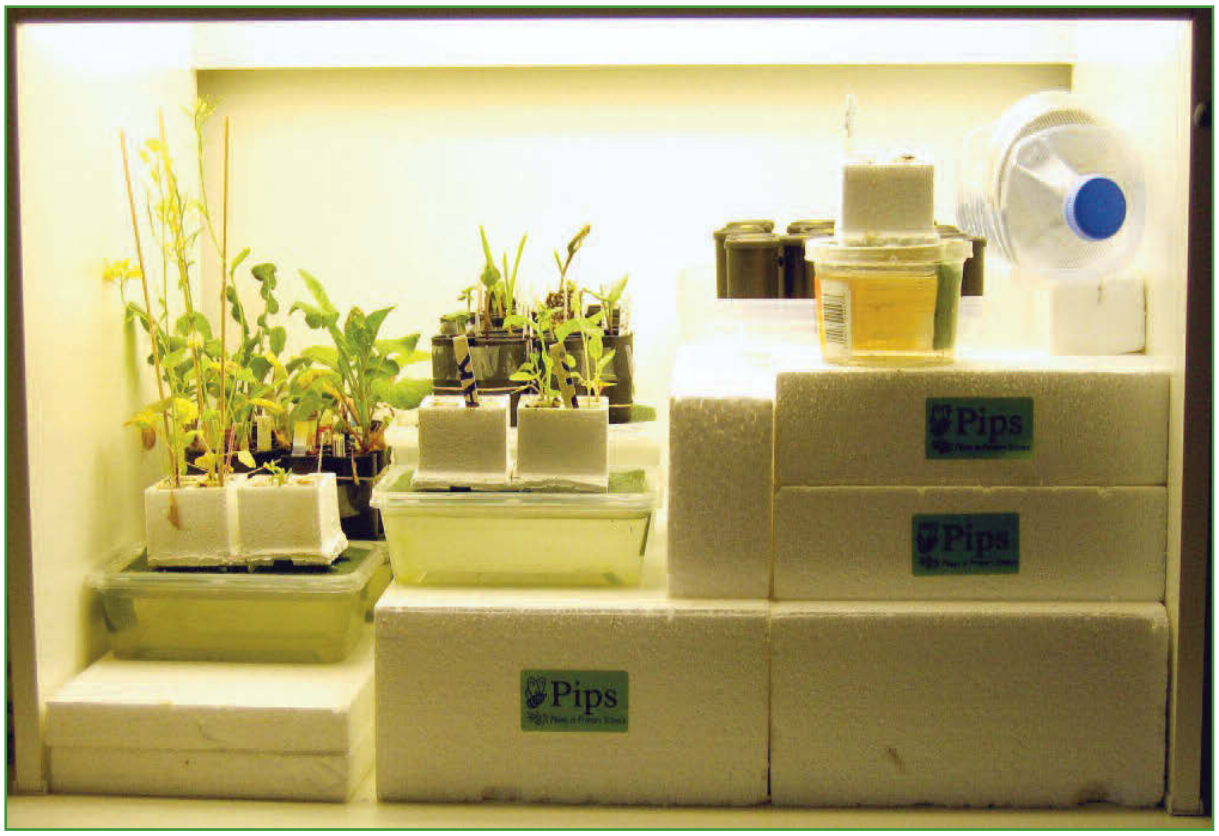



Figure 11. Ways of using a light bank – this shows the light banks being used for several different investigations, with polystyrene blocks for adjustment of the height of the plants.

# The seed and germination

*Teacher Guidance*

## Introducing the seed and germination

This section focuses on the seed and how it begins to develop into a young plant (seedling). The first two activities ('What's in a seed?') let children explore the 'inside' of a seed before it germinates. They then germinate some seeds for themselves and understand that water is needed.

## Activity 1: What's in a seed? – using a 'Giant Brassica' as a model for seed germination

This Giant Brassica demonstration is fun. It make the children curious, encouraging them to ask questions and want to grow their own seeds. The activity provides a good starting point for discussion about what seeds need to germinate and what happens when they germinate. After you have made the model seed, the activity only takes a few minutes. You can refold and dry the seed and use it again many times.

### *Preparation for the activity*

First you have to prepare your 'seed'. Use a cellular sponge at least 1 cm thick. You can, for example, use a supermarket sponge wipe or for a fatter seed use a kitchen mop sponge. Cut out portions that represent the seed leaves (cotyledons), the young shoot (plumule) and young root (radicle).

The diagrams in Figure 13 show you the shapes to be cut out and how to prepare the 'seed'. Full-sized templates are available on the SAPS website.

- Insert the young root and young shoot into the hole in the cotyledon (1).
- Wet the sponge and squeeze out the excess water.
- Fold the sponge in half (2).
- Tuck in the shoot and fold the sponge in half again (3).
- Fold the young root down to the edge (4).
- Bind the folded seed very tightly with thick cord or boot lace (5).
- Leave it to dry for about two days in a warm place.
- When it is completely dry, remove the cord that had been tied around it (6).

### *The activity*

With your class, put the 'seed' in a clear glass bowl, filled with water and watch 'germination' take place! You may need to experiment to find the best way of folding the seed, as this may vary with different sorts of sponge. Ideally, the root should emerge first and the seed float, with the root pointing downwards when the seed is fully open (Figure 12).

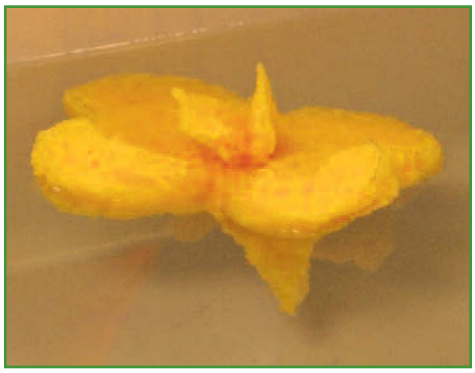


Figure 12. A sponge 'Giant Brassica' as a model seed – opened up and floating in water.

Here are some questions that are useful to prompt discussion:

- What happens to the seed just after it is put in the bowl of water?
- Which part of the young plant emerges first – the young root or the young shoot?
- Which part of the young plant is missing from this model? (*Hint – wait until children have taken the seed apart.*)

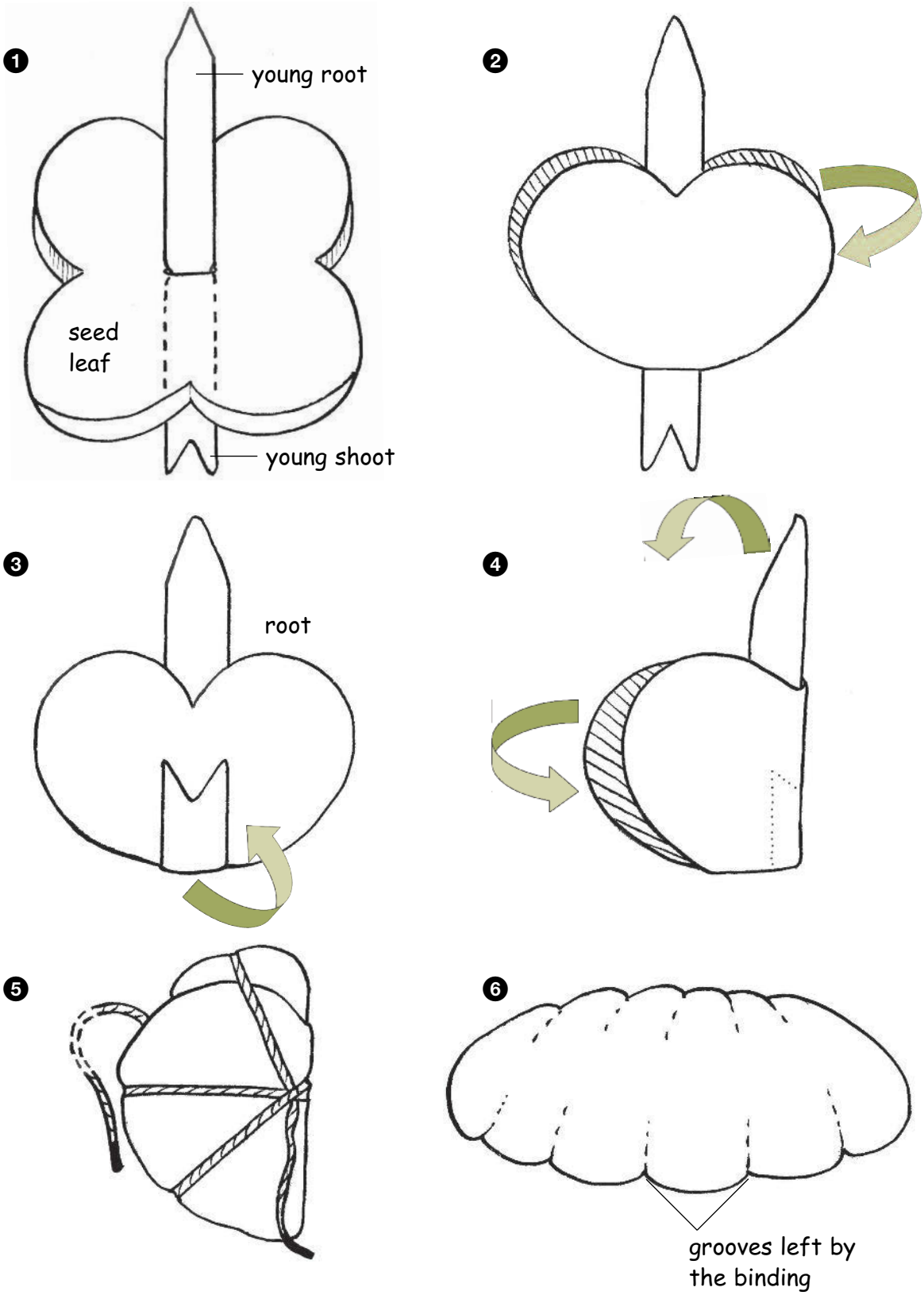
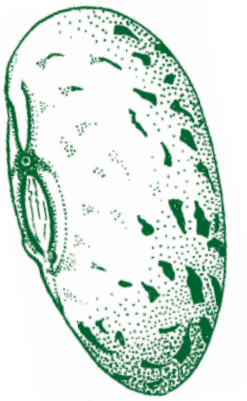



Figure 13. Reduced size version of a giant Brassica as a model for seed germination. Full-sized templates are provided on the SAPS website.

## The seed and germination

*Teacher Guidance*

# Activity 2: What's in a seed? – taking a seed apart



This is a more traditional 'dissection' of a seed and gives an opportunity for recording observations, in writing and through drawings. Before starting this activity with children, teachers may wish to read the notes given on page 44, 'The seed and its germination'.

### *Resources and preparation*

For each child, you will need the following:

- ☑ *Two large seeds, such as beans or peas, obtained from your local supermarket.. Soak one seed in water for about twelve hours (but leave longer, say up to two days, if possible).*
- ☑ *Paper towel or similar (to place the seeds on)*
- ☑ *A magnifying glass (can be shared). Alternatively, if available, a digital microscope could be used here, or a webcam so that the image is projected onto a whiteboard.*

**Commercial seeds are sometimes dusted with a fungicide, so we recommend that you obtain peas or beans from a local supermarket.**

### *The activity*

- Give each child one dry and one soaked seed. Discuss the similarities and differences that they observe and ask them why they think one seed is larger than the other.
  – Usually they notice that the larger seed feels damp. You can then explain that it was soaked in water and point out that there is a small hole close to the end of the scar.
- Let the children gently squeeze the seed. They may see bubbles emerging from this hole. Sometimes this can be observed more easily with a magnifying glass.
- Ask children to peel off the outer layer on the soaked seed and do this gently. Discuss what this layer could be and why the seed has it.
  – Explain that this is the seed coat and that it protects the seed.
- Next ask children to open the seed carefully. They should notice that, if using a bean or a pea, it easily splits into two halves, and that the young root and young shoot are lying between the seed leaves.
  – These two halves are the seed leaves or cotyledons. Discuss why they think the seed leaves are large in comparison to the young shoot and root. Explain that the seed leaves give food to the young shoot and root as they start to grow. You can also point out that at first the young root grows more quickly than the shoot. This means that it can anchor the plant and take up water from the soil.

The Pupil Sheet on page 18 gives suggestions for the children to complete, but some teachers may wish to devise their own worksheet. A Word file is provided on the SAPS website for you to download and amend to suit your class.

The seed and germination

*Pupil Sheet*

# Taking a seed apart

| 1. Draw the soaked bean | 2. Split your bean open and draw what you can see |
|---|---|

Make your drawings fill the boxes. Label your drawing using these words to help you.

seed coat | seed leaf | young root | young shoot

How might the water get into the seed? _____

_____

Why does the seed have a coat? _____

_____

Why are the seed leaves so big? _____

_____

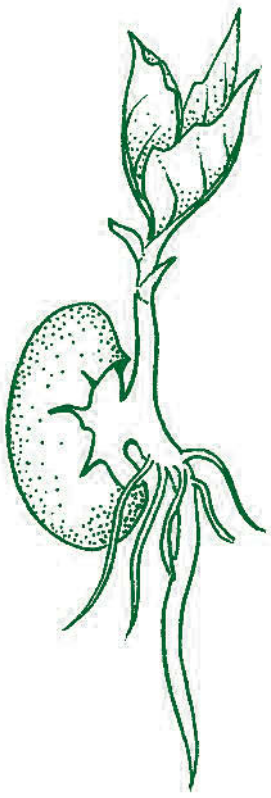
_____

*Teacher Guidance*

# Activity 3: Do seeds need water to germinate?

This is a very simple investigation to find out whether seeds need water to germinate.

For details of the technique, see page 6 (Germinating seeds in film pots). The method given uses capillary matting (cut in circles to the size of the pot), but you can use different things in the pot for the seeds to grow on, provided it is absorbent. Examples include blotting paper and cotton wool. The Pupil Sheet on page 7 can be adapted for use with this investigation. A Word file is provided on the SAPS website for you to download and amend to suit your class.



Mustard seed works well (as they germinate in 3 to 5 days), but others can be used, such as wheat. Times for germination may vary at different temperatures.

## *The activity*

Each child has two clear film pots. They place the damp piece (circle) of capillary matting (or other material, as chosen) in one pot and a dry piece in the other.

After 3 to 5 days, let the children examine the pots. Only the seeds in the pots with damp capillary matting should have germinated.

Remember – you can use the Planning Plant (page 3) to help guide children in your class through the investigation. For this activity, perhaps it would be appropriate to use only part of the planner and to do the planning as a class activity. You could use the planning sheet and work through a **prediction**, the **equipment** needed and how to make this a **fair test**. This is a good activity to make a start on helping the children to adopt a suitable approach to investigations.

# Plants and how they grow

*Teacher Guidance*

## Introduction

Activities 1 to 6 in this series of activities let children investigate different aspects of plant growth and the requirements for successful growth of young plants. Note that there is some progression through the series, with the later activities being more complex or demanding than the earlier ones. The activities incorporate different ways of making observations, presenting results and carrying out evaluations, including suggestions for the use of ICT. Three games (activities 7, 8 and 9) are useful to help reinforce learning or as end-of-topic activities. 'Design a seed packet' gives opportunities for cross-curricular links as well as being a suitable end-of-topic activity. The 'Seeds and chaffinches' activity helps the children to appreciate why, even though large numbers of seeds are produced by a plant, only a few are likely to germinate in the natural environment.

## Activity 1: Do plants need soil to grow?

### *Resources and preparation for the activity*

For the class, you will need the following:

- ☑ *Five clear film or dessert pots*
- ☑ *Labels*
- ☑ *Seeds (such as radish)*
- ☑ *Small plastic teaspoon*
- ☑ *Range of materials that might be suggested by the children, such as: soil, sand, paper, compost, cotton wool*

### *The activity*

Discuss with the children the different types of medium that we use for sowing seeds. Ask if they think seeds would germinate if put in a pot with water only. Let them make a prediction as to which materials the seeds will germinate in and how to make this a fair test.

- Place the same 'amount' of material in each pot. One pot can be left without any material. Discuss with the children what they mean by 'amount' (weight, volume, depth?).
- Wet the material in each pot and then pour off any excess water.
- Add two seeds to each pot and then put the lid or cling film on the pot to keep the material moist.
- Leave for one week then observe the results. (All of the seeds should have germinated, but some seedlings may look better than others.)
- Record their results on the worksheet. This can be increased to an A3 page to give more space for children to write and draw in the boxes. Word files are provided on the SAPS website.

A Pupil Sheet is given on page 21.

Remember – you can use the Planning Plant (page 3) to help guide children in your class through the investigation. For this activity, you may wish to use only part of the planner and to do the planning as a class activity.

Plants and how they grow

*Pupil Sheet*

# Do plants need soil to grow?

**We will need** _____

_____

**What we will do**

We will put a small amount of _____ at the bottom of the pot, add _____ and _____ and put it in the light. We will leave our seeds for a week. It will be fair because we will keep these things the same:

1 _____ 2 _____ 3 _____ 4 _____

and only change _____

| What we put in the pot | What might happen | What did happen |
|---|---|---|
| paper | | |
| compost | | |
| sand | | |
| cotton wool | | |
| nothing | | |

**What we found out** _____

_____

# Activity 2: Do plants need light to grow?

This is an investigation that can be done to find out about the effect of light on young seedlings, grown in film pots. Two comparisons are made and, when looking at the results and interpreting them, children should have the opportunity to consider each situation in turn. For details of the technique, see page 6 (Germinating seeds in film pots).

## *The activity*

In the first comparison, each child has one clear film pot with a clear lid and one black film pot with a black lid. They place the damp pieces (circles) of capillary matting in each pot. They then add the seeds and put the lids on the pots. If using yoghurt /dessert pots put prepared pots all in the same place but one in a light proof container and the other exposed to light. When they have set up their pots, give them a results sheet (page 23) and ask them to draw what they think will happen to the seeds. They can do this in the middle column in the table. This is their prediction.

After 3 to 5 days, let the children examine the pots. Then ask the children to draw what they see when they look in the pots. They do this drawing in the third column in the results table and compare it with their prediction.

When discussing the results you can explain that, without light, at first many young plants can grow rapidly, using up food stored in the seed. In the film pots, they may grow so fast that they are coiled up under the lid. They are likely to be yellow in colour because the green colour (chlorophyll) does not develop in the dark. In the wild, this rapid growth in the dark helps seeds buried in the soil to reach the light quickly and then the green colour develops. Without the green colour, the plants are not able to make their own food (see page 49) and so die when the store of food in the seed has been used up. Young plants with plenty of light grow more slowly and are stronger. In the light they develop the green colour, which means they can go on growing because they can make their own food.

## *Extension*

In the second comparison, each child has two black film pots with black lids. One of the film pots has a hole in the side, near the top. Make the hole with a single hole punch. If using yoghurt /dessert pots put prepared pots in a light proof container with a hole in the side. As before, they place the damp pieces (circles) of capillary matting in each pot. They then add the seeds and put the lids on the pots. When they have set up their pots, on a results sheet, ask them to draw what they think will happen to the seeds. They do this in the middle column in the table. After 3 to 5 days, as in the first activity, the children examine the pots and draw what they see when they look inside. They do this drawing in the third column in the results table and compare it with their prediction.

When looking at the results of this investigation, you can discuss with the children the fact that the young plants in the film pots with a hole in the side are not as tall and spindly as those growing in the dark. They can also see that in the pot with a hole, young plants grow towards the hole, which helps them to get more light. Even when there is only a small amount of light, the young plants are able to develop the green colour and so can make their own food.

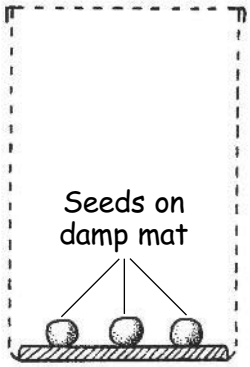
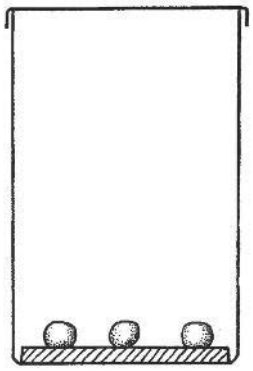
Expected results for both activities are shown in the Teacher Guidance on page 24.

Remember – you can use the Planning Plant (page 3) to help guide children in your class through the investigation. As suggested, you may wish to use part or all stages given in the Planning Plant.

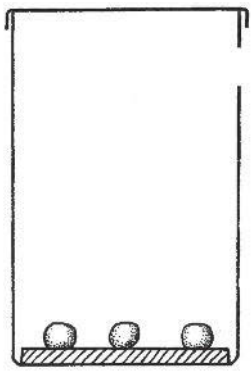
Plants and how they grow

*Pupil Sheet*

# Do plants need light to grow?

| How I set up the pots | What I think will happen to the seeds | What I saw when I looked inside the pot |
|---|---|---|
| Clear pot with clear lid   | | |
| Black pot with black lid  | | |

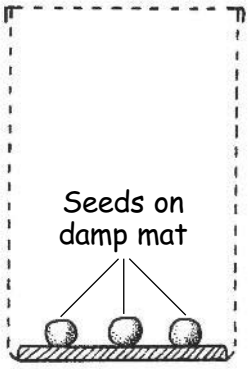
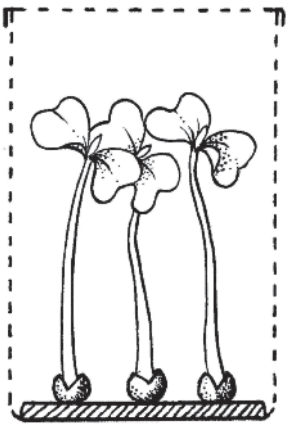
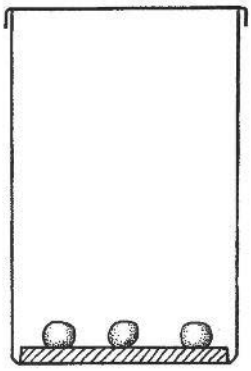
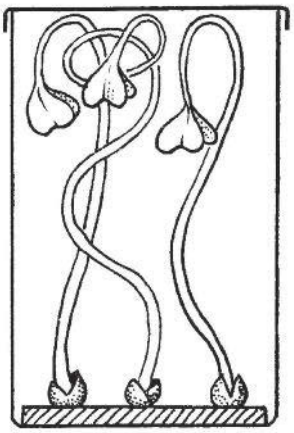
**Extension**

| | | |
|---|---|---|
| Black pot with black lid and hole in side  | | |

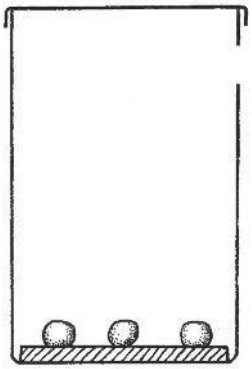
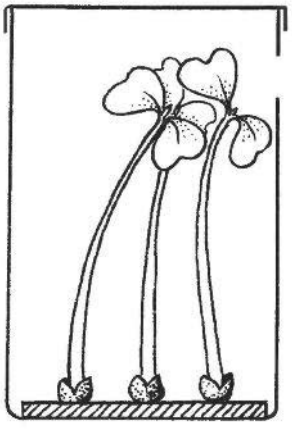
## Plants and how they grow

*Teacher Guidance*

# Do plants need light to grow? Expected results

| How I set up the pots | What I think will happen to the seeds | What I saw when I looked inside the pot |
|---|---|---|
| Clear pot with clear lid   | |  |
| Black pot with black lid  | |  |

**Extension**

| | | |
|---|---|---|
| Black pot with black lid and hole in side  | |  |

# Activity 3: How strong are plants?

This investigation can be set up to let children find out about the strength of the stems of plants. The activity encourages children to make predictions, set up a fair test and record their observations. Start with a discussion about whether any of the children have noticed plants growing through cracks in tarmac and how they manage to do that.

## *Resources and preparation for the activity*

For the class, you will need the following:

- ☑ *3 small pots (e.g. yoghurt pots) with holes in the bottom*
- ☑ *A saucer or lid, which completely covers the pot*
- ☑ *A piece of card, which completely covers the pot*
- ☑ *Plaster of Paris or Polyfilla®*
- ☑ *Compost (see notes on compost page 42)*
- ☑ *12 broad bean seeds, soaked overnight in water*
- ☑ *Sticky labels (to label the pots)*

Figure 14. Plants showing their strength – pushing their way through tarmac at the side of a road.

## *The activity*

- Tell the children that they are going to plant four bean seeds in each of the three pots, just under the surface of the compost.
- Cover one pot with the card, cover the second pot with the saucer and the third pot with a layer (1 cm thick) of plaster of Paris.
- Stand each pot in a tray of water for 10 to 15 minutes each day.

Before setting up the investigation, children can discuss how they will ensure it is a fair test. The children could make predictions as to what will happen in each pot and why. Later they can draw pictures or take photographs to show the results.

Depending on the time of year, you should be able to see the results one week after planting (but in the winter, beans can be rather erratic!). Generally, if all goes well, the bean shoots lift or push through all three materials suggested.

## Plants and how they grow

*Teacher Guidance*

# Activity 4: How fast does a root grow?

In this activity, seeds are grown in Petri dishes so children can make direct observations of the roots as they grow. The activity requires measurements over a number of days. The conversion of the results to growth rate makes links with numeracy skills.

For details of the technique, see page 8 (Germinating seeds in Petri dishes). The Pupil Sheet (page 10) can be used to help the children see how to set up the seeds on the filter paper in the Petri dish. A Word file is provided on the SAPS website for you to download and amend to suit your class.

## *The activity*

You need to arrange the seeds along a line about one-third from the 'top' of the Petri dish (when standing vertically). The diagram given in Figure 7 on page 9 can be used as a template for the acetate grid.

An outline of what the children do is given on the Pupil Sheet (on page 10). Results can be written in the table given on page 27. The Pupil Sheet on page 27 gives guidance as to how they can record and evaluate their results. Alternatively, you may wish to give the children the opportunity to enter data on a simple spreadsheet and use ICT skills to draw graphs. A digital camera may also offer a useful way of providing a visual record of the results.

A number of activities can be developed from this investigation. Here are some ideas:

1. Draw a line graph, using either the number of squares or the actual length in mm. Then extend their line to day 10, to read off their estimated length on that day (Question 2 on the Pupil Sheet).
2. Measure the growth of the shoot as well as that of the root. Then ask the question as to why they think the root grows faster than the shoot (at least at first).
3. 'Can you make a root of a plant move through a maze?' – see the SAPS website.

Plants and how they grow

*Pupil Sheet*

# How fast does a root grow?

How many squares does the root of the seed grow in one day?
The length it grows in a given time is called the growth rate.

- Choose one seed from those growing on the grid in the Petri dish.
- Each day measure the length of its root.
- Use the table below to help you calculate the growth rate of the root.

| Day | Number of squares the root has grown down | Each square is 2 mm. So the length of the root in mm is |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |

**To work out the growth rate**, you need to find two numbers. Follow the steps below.

1. For how many days did your seed grow? _____ days

2. At the end of your investigations, what was the length of the root? _____ mm

Now work out the average length the root grew each day.

My root grew _____

Your answer is the growth rate over 6 days.

**Look carefully at your results** and then answer these questions.

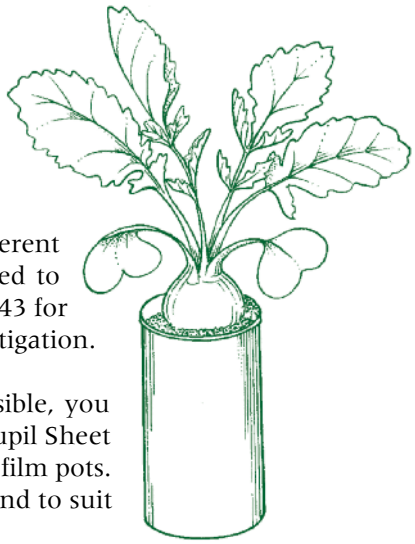
1. Did your root grow the same length each day? _____

2. If the growth rate stays the same, how long would the root be on day 10? _____

## Plants and how they grow

*Teacher Guidance*

# Activity 5: Adding mineral salts – do radishes grow better?



As a start, discuss with the children why gardeners and farmers add 'fertiliser' to their plants and crops. The children may think that the plants are being 'fed'. This is an opportunity to introduce the need for mineral salts. (See note on 'Food' in plants in booklet 1, *Parts of a plant and their functions*, page 20.)

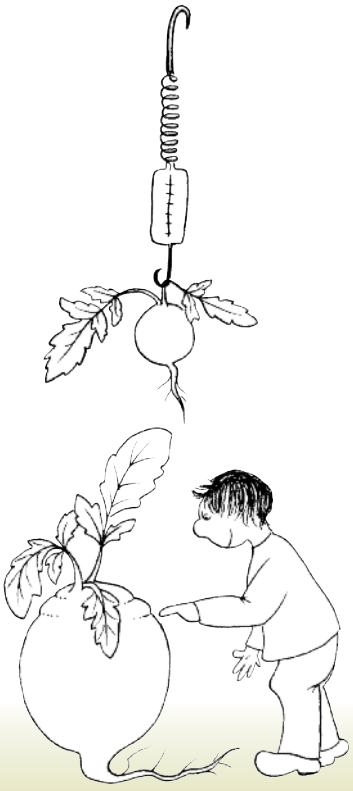
In this investigation, radishes are grown in film pots containing different numbers of fertiliser pellets. The growth (or 'crop') is compared. You need to explain to the children that fertiliser pellets contain mineral salts. See page 43 for further information on radishes and why they are good to use in this investigation.

For details of the technique, see page 11 (Growing plants in pots). If possible, you should use a light bank for growing the radishes in this investigation. The Pupil Sheet (page 13) can be used to help the children see how to grow the radishes in film pots. A Word file is provided on the SAPS website for you to download and amend to suit your class.

## *The activity*

Following on from the title, ask the question 'Does adding mineral salts to radishes make them grow better?' Discuss what 'better' might mean. Does it mean a bigger radish – in terms of weight, diameter or circumference? Ask the children to make a prediction and work with them to plan the investigation.

Each child has a film pot and it is suggested that children work in groups of five. They need to use black film pots and fill them with an inert material so that there is no source of mineral salts in the growing medium. For this activity, the best results are obtained with a soil mix with very low mineral salt content (e.g. moss peat). Mineral salts can be provided by using fertiliser pellets. So in a group of five children, each child adds a different number of fertiliser pellets – say 0, 5, 10, 15 and 25 pellets.



## *Results*

Children can make observations on any differences in growth at 2 or 3 day intervals and record their observations. They can harvest their radishes after three to four weeks. Explore with the children the differences they can see in the radishes and how these differences could be measured. They may find that plants with more leaf growth may not have the biggest radishes.

Various features can then be 'measured' depending on the ability of the class. For example, you can trim the leaves and separate them from the radishes and other parts of the root. Different parts of the plants obtained in the different fertiliser pellet treatments can be weighed. A good way of showing the 'yield' of radish is to use a 'radogram' in which the radish roots obtained for each mineral salt treatment are lined up side by side, like drawing a bar chart (see Figure 15).


Figure 15. A 'radogram' – a slice was cut across the widest part of each of the five radishes grown in pots, with the number of fertiliser pellets shown. These slices have been built up into a bar chart, known as a 'radogram'.

## *What we have discovered*

There is likely to be some variation in the results between the different groups. This provides an opportunity to discuss with the children the importance of doing replicates. The biggest radishes usually grow in the pots with 10 to 15 fertiliser pellets. With higher concentrations of mineral salts (25 fertiliser pellets), growth is inhibited. You may wish to discuss with the children whether the 'biggest' radish is necessarily the 'best' one. How important is taste and appearance?

## *Evaluation*

Discuss with the children whether they think the test was fair. How might they improve it? Were all the fertiliser pellets the same size (or does that not matter)? What else could they investigate in relation to mineral salts and growth of the radishes?

Remember – you can use the Planning Plant (page 3) to help guide children in your class through the investigation.

## Plants and how they grow

*Teacher Guidance*

# Activity 6: How does water travel through a plant?

These two activities can be used with more able children at upper primary, to show that water is taken up by the roots and then travels through the plant to the leaves.

## Activity 6a: Following the pathway of water through celery

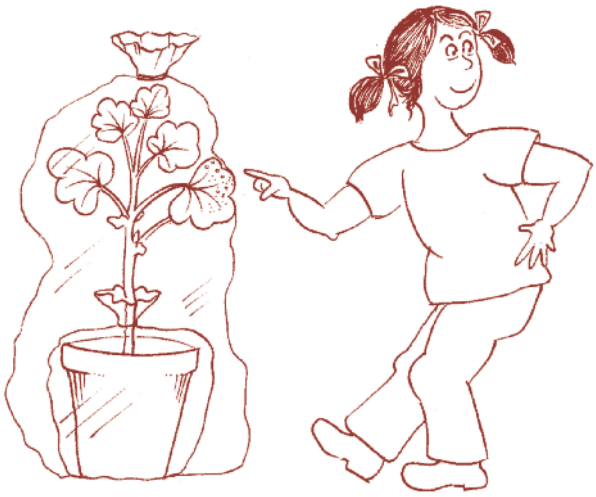
### *Resources*

- ☑ *Celery (with leaves, if possible)*
- ☑ *A knife*
- ☑ *Coloured ink, e.g. red or blue (mixed 50 : 50 with water)*
- ☑ *Suitable container to hold the celery*

### *The activity*

- Place some whole pieces of celery in the container so that one end stands in the coloured ink mixture, with any leaves at the top. Discuss with the children what they think might happen.
- After a few hours, let the children take a celery piece out of the ink mixture and cut it into three equal parts. They should write down their observations. [They are likely to see several dots (red or blue, depending on the colour of ink used).]
- Then they can take another of the pieces of celery, slice it in half lengthwise and again write down their observations. [Now they are likely to see coloured lines (red or blue). These are the 'tubes' that the water travels through.]
- The children can try and pull the coloured lines that they see from the celery. Discuss with the children what these coloured lines are and why they are the same colour as the water the celery has been standing in.

## Activity 6b: Loss of water from a plant



### *Resources*

- ☑ *A potted plant, such as a geranium (*Pelargonium*), preferably with a strong central stem*
- ☑ *2 clear polythene bags, one larger than the other (and large enough to fit over the plant)*
- ☑ *2 elastic bands*

### *The activity*

- Water the potted plant.
- Place the pot of the potted plant in the smaller polythene bag and tie the bag around the lower part of the stem with one of the elastic bands.
- Now put the whole plant in the second larger polythene bag and secure the top of the bag with an elastic band.

Discuss with the children what might happen. After a few hours, the children are likely to see droplets of water on the inside of the polythene bag. Discuss with them how the water has got here.

*Teacher Guidance*

# Activity 7: Seeds and chaffinches game

This is a game for helping children to learn what plants need to live and grow. It is best played with upper primary children and can be a useful end-of-topic activity.

## *The activity*

- Mark off a rectangle of grass (the 'field') with tape measures or rope (approximately 20 x 10 m).
- Take four buckets and label them: sun, air, water and mineral salts. Put different coloured tokens (about 20) in each.
- Choose three children to be chaffinches and the rest of the children are seeds.
- Place these buckets along one of the long sides of the rectangle. Line up the children along the opposite side.


The seeds have to get across the field without being caught by the chaffinches. They have to collect a token from each bucket in order to live and grow but on each journey can collect only one token. So they have to make four journeys across the field to have any hope of surviving! Any seed touched by a chaffinch is deemed to have been eaten and is out!

For safety reasons, both the seeds and chaffinches are only allowed to jump with both feet together. (No running allowed!)

What usually happens is that only one or two children manage to collect the required tokens in the time allowed for the game. Stop the game when a large proportion of the children have been caught.

The point is made that many plants produce large numbers of seeds but very few survive. The game can be repeated, but modified in a number of ways. Here are some ideas.

- Put only a few tokens in the water bucket. The children soon complain that there are not enough water tokens to go around. You can explain how lack of water often affects the survival of plants.
- Using the sun, water and air buckets only, revise how plants make food (photosynthesis).

## Plants and how they grow

*Teacher Guidance*

# Activity 8: Vines and villains – a game

This board game is a variation of snakes and ladders. It can be used to reinforce the children's understanding about what seeds need to germinate and what plants need to grow well.

## *Preparation for the game*

For the class, you will need the following:

- ☑ *The game board*
- ☑ *A counter for each child*
- ☑ *Growth cards (with questions)*
- ☑ *A die*

The **game board** (Figure 16) is available on the SAPS website for you to download. A black and white version is provided for the children to colour in themselves or you may prefer to use the coloured version. The templates can also be enlarged to A3 size if you wish. The templates can be printed onto card and laminated to make them more durable.

Prepare twelve **growth cards**, each with a question written on one side. The cards can be any shape or size and made out of suitable card. Suggestions for questions (and their answers) are given here (page 33). Alternatively, the children could devise their own questions for the game as part of an end-of-topic activity. You may also wish to prepare a set of cards with the answers to the questions, so that the children can check their own answers while playing the game.

## *Playing the game*

This is a game for two to four players. The aim is to reach 'Home and grown' first, but during the game, players may **climb up the vines** and **slide down the slug trails**.

- The growth cards are placed face downwards beside the board. Do the same with the answer cards, if you would like the children to check their own answers.
- To **start** the game, the child who throws the highest number with the die goes first.
- If a child's counter lands on a **growth square**, they take the top card and try to answer the question. If they answer the question correctly, they advance four spaces, but if their answer is wrong, they go back four spaces.
- To end at square 36, the exact number must be thrown. The first child to reach this square is the winner. As an alternative, children may prefer to count forwards (as far as square 36) then backwards for the required number of squares to use up the numbers on the die. They then continue in this manner until they finally land on square 36 and become the winner.

# Vines and Villains

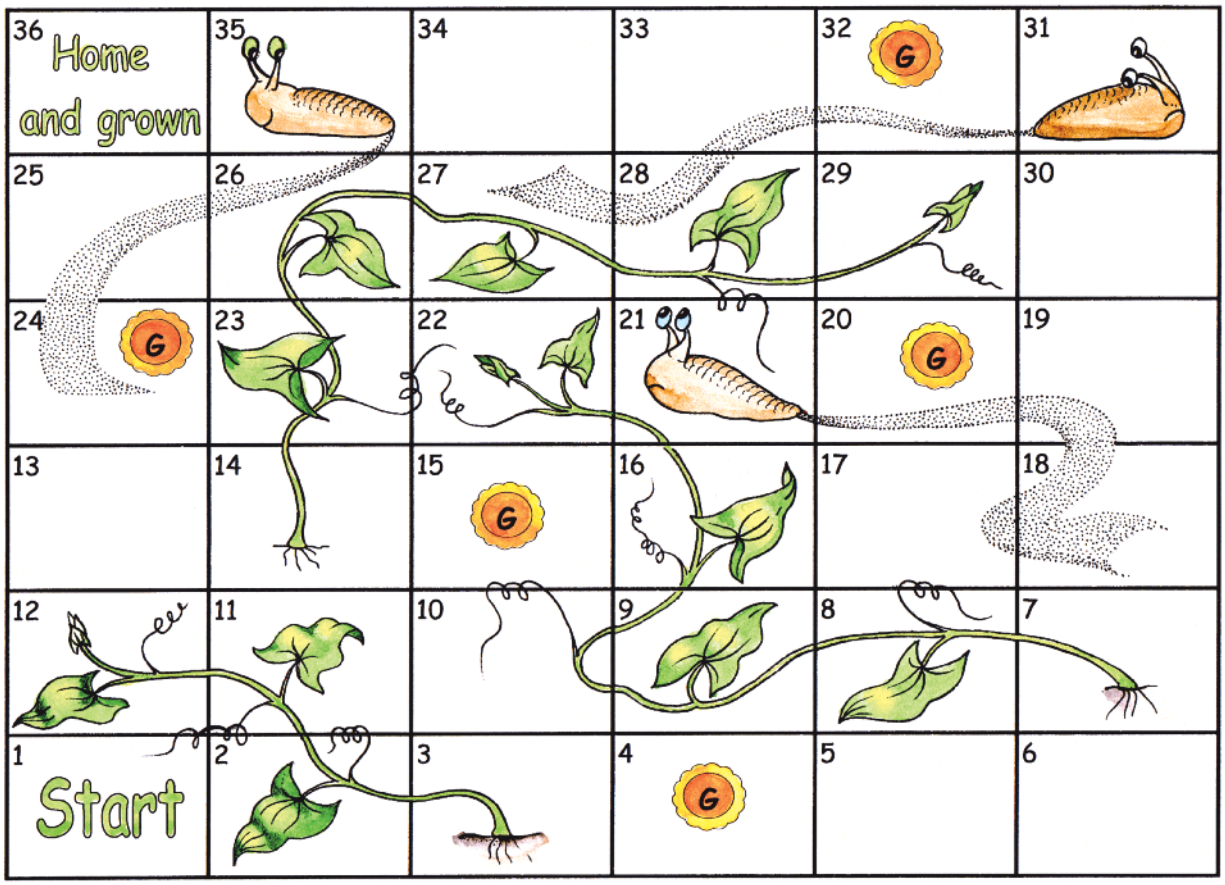



Figure 16. Reduced size colour version of the board for playing Vines and villains.

## *Questions*

***1.*** To start germinating, a seed needs oxygen and a suitable temperature. What else does it need?*(Water)*

***2.*** What is dissolved in water, taken up by the roots and needed for plants to grow well? (*Mineral salts*)

***3.*** What three things does a plant need to make its food? (*Water, carbon dioxide and light*)

***4.*** What sort of energy does the plant use to make its food? (*Light*)

***5.*** Which gas is used in photosynthesis? (*Carbon dioxide*)

***6.*** Which gas is produced in photosynthesis? (*Oxygen*)

***7.*** How do gases get into and out of the plant? (*Through holes on the leaves*)

***8.*** What is the process called that plants use to make their food? (*Photosynthesis*)

***9.*** Which is the main part of the plant where the process for making food takes place? (*The leaf*)

***10.*** How does water get into the plant? (*Through the roots*)

***11.*** Why do plants need mineral salts? (*For healthy growth*)

***12.*** Which life process is to do with plants making food? (*Nutrition*)

## Plants and how they grow

*Teacher Guidance*

# Activity 9: Plant quartet (Happy families)

This is a version of the card game 'Happy families'. There are 48 cards in the pack, made up of 12 sets of four cards (a quartet). Each set represents the plant of a wild flower with one card in each set for each of the things that it needs to grow well: water, air, light and mineral salts. Reduced size versions of the cards are illustrated in Figure 18 on page 35. During the game, the children try to collect as many sets (of each wild flower) as they can.

The game can be used to help children reinforce their understanding of the requirements for successful growth of plants. It also provides a way of helping children to become familiar with some common wild flowers and their names.

## *Preparation for the game*

First you need to make a pack of cards. Full-sized templates of the 12 wild flower cards are given on the SAPS website. Download these and print four copies of each of the two pages. You can print onto normal paper, then paste this onto card (e.g. using spray mount), or print straight onto a suitable weight of card. In the spaces for each of the pages, write the word for each of the four growth requirements. (See the example in Figure 17 below.) You may then wish to laminate the sheet to make the card sets more durable. Finally, cut out the individual cards to make the pack of 48.

## *Playing the game*

This game is best played with three to six players, but can be played with two. The idea is for the players to complete as many sets of wild flower cards as they can.

- Deal five cards to each child (seven cards if only two are playing). Place the remaining cards face down in a pile on the table.
- The child to the left of the dealer starts. This child asks one of the other players for a specific card by saying, for example, 'Please may I have mineral salts for foxglove'. The child must have at least one card of the set they are asking for.
- If the player asked has that card, they must give it up. The child receiving the card then has another turn.
- If the player asked does not have the card, they reply 'Go gardening'. The first child must then draw the top card from the pile. If this card happens to be the one they were asking for (unlikely, but possible), the child shows it and then has another turn. If it is not what they asked for, the turn then passes to the player who said 'Go gardening'.
- As soon as a child has a complete set of four cards, they must show this and place it on the table in front of them.

The game continues until one of the children has no cards left or the original pile runs out. The winner is the player with most sets (quartets) of wild flowers.

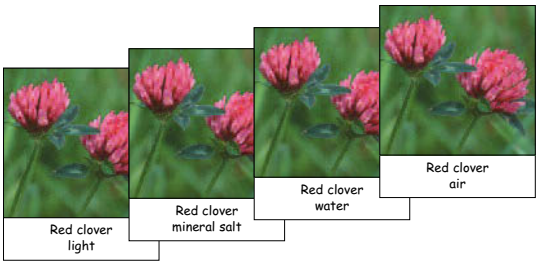



Figure 17. A 'quartet' of red clover cards.


Figure 18. Reduced size versions of cards for Plant quartet. Full-size versions are provided on the SAPS website.

## Plants and how they grow

*Teacher Guidance*

# Activity 10: Design a seed packet

This activity involves designing a seed packet for seeds that have come from a newly discovered plant. It stimulates discussion on what the seeds need to grow and how to care for the young growing plant. It gives the children an opportunity to write instructional texts and requires some creative thinking in the design of the packet. This provides useful opportunities for developing literacy and presentation skills as well as being a good end-of-topic activity.

You will need some A4 envelopes to be the basis of their seed packets.

### *The activity*

Tell the children that they are going on an expedition to look for new plants. They will only be able to bring back seeds and not the whole plant. Ask the children to design a seed packet with instructions to help other people grow the seeds.

Here are some suggestions you can ask the children to include in this activity.

- Make a drawing of the plant they discover, as seen growing in the wild, and give its name.
- List the equipment that they will need for growing the seeds.
- Write instructions for sowing the seeds, including what sort of soil or compost should be used and where they should be grown.
- Say how much soil or compost would be used and how deep the seeds should be planted.
- Suggest a suitable temperature for the seeds to germinate, then for the young plants to grow.
- Give instructions about watering the seeds and growing the plants.
- Discuss important features for the design of the seed packet, to make other people want to buy the seeds and then grow them.

To make the seed packet, the children can attach the drawing of the flower to the front of a large A4 envelope. They can write their instructions for planting and care, then attach this to the back of the envelope, so that it becomes the seed packet.

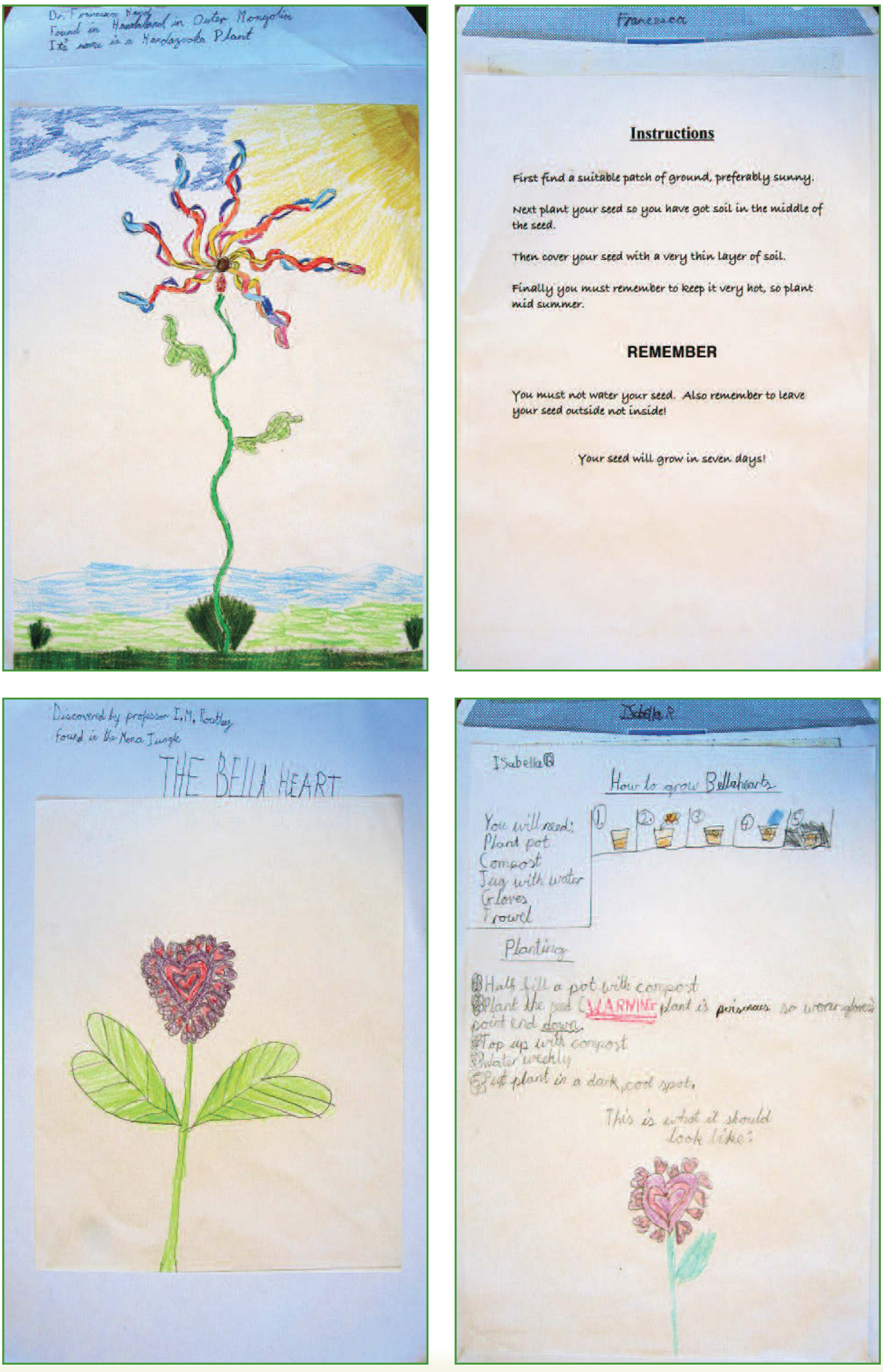


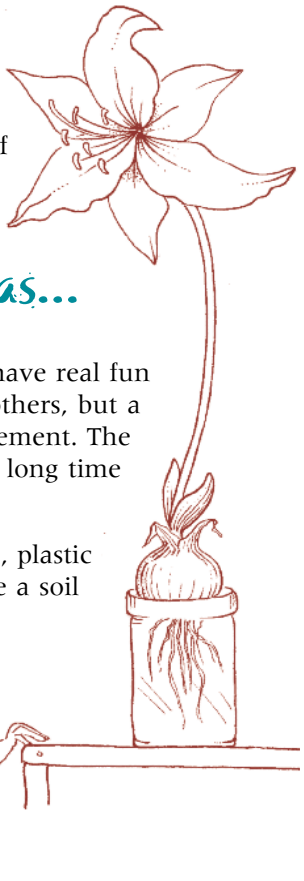

Figure 19. Two seed packets created by children (in Year 4 at the The Cavendish School in 2005).

# Having fun growing plants

*Teacher Guidance*

## Introduction

The activities here are intended to be fun for the children, growing real plants and encouraging as much participation from them as possible. With regard to the curriculum, the first activity is about seeds (resulting from sexual reproduction), whereas the second activity finds ways of growing more plants from other 'bits' of plants (asexual reproduction). There are lots of opportunities here for questions from the children, to try different things and just having fun!



## Activity 1: Conkers, acorns, pips and other ideas...

This activity gives children a chance to bring their own ideas and materials and have real fun trying to grow some plants. Some 'seeds' are likely to be more successful than others, but a little exploring and watching what happens can bring its own surprises and excitement. The children may need to be patient as some things they bring in could take quite a long time before they germinate – perhaps a term or more.

For most seeds you need some simple containers (such as yoghurt pots, film pots, plastic plant pots – depending on size), and a way of keeping them warm. They can use a soil mix or just capillary matting or paper towels as a medium to start the germination process. Children should know that they need to add water and keep them moist. It may be worth trying some under a light bank.



You may wish to buy seeds of interesting plants from a garden centre, e.g. sensitive plants (*Mimosa pudica*). You can also ask the children to suggest some ideas and let them bring in the seeds, e.g. lemon and orange pips, avocado pips, acorns and conkers.

Some seeds won't grow immediately because they need a period of dormancy (such as acorns and conkers). Collect these in the autumn and put them in containers of sand (preferably tins) to keep out mice and leave them in an unsheltered place outside. Make holes in the lid and bottom to allow aeration and drainage. In about March, bring them into the warm and plant them. At the same time collect twigs (e.g. horse-chestnut) and allow these to sprout indoors (see Exploring a horse-chestnut bud, on the SAPS website').

### *Further activities*

1. A day in the life of a star fruit plant (and other activities) by Karen van Oostrum – see the SAPS website.
2. Create a 'bottle garden' and grow some plants in the classroom. You can use ideas shown in 'A propagator for small plants or seedlings' on the SAPS website'.

Figure 20.
The sensitive plant (*Mimosa pudica*) – fun to grow from seed.

## Having fun growing plants

*Teacher Guidance*

# Activity 2: More ideas for growing plants

In many plants, a new plant can be grown from other parts of the plant as well as from seeds (see Background information for teachers: Comparing sexual and asexual [vegetative] reproduction).

## Activity 2a: Growing geraniums (pelargoniums) from cuttings

Geraniums (pelargoniums) are easy plants to keep and grow in the classroom. They flower from early summer to late autumn. Geraniums are easy to grow from cuttings taken from a mature plant. Three or four large mature plants can provide cuttings for 20 to 25 children, which they then plant and grow. It is usually recommended that cuttings are taken in late summer but they can be taken early in the spring term. This avoids the problem of looking after the plants through the winter. Cuttings taken in early spring should be in flower by July and are still likely to be in flower at the beginning of the autumn term.

The most important factors when growing plants from cuttings are:

- to prevent cuttings dying from lack of water due to water loss through the leaves (transpiration)
- to ensure the developing roots are in a well aerated growing medium. This allows them to have plenty of oxygen and also prevents them getting too wet and then rotting

### *Resources*

For each child you need the following:

- ☑ *A small plastic pot (7 cm diameter). If using margarine pots or yoghurt cartons make some holes in the bottom so they can drain freely*
- ☑ *A large plastic spoon or small trowel*
- ☑ *Half of a 1.5 litre lemonade bottle (cut in half across the middle) or a polythene bag large enough to enclose the pot*

You also need:

- ☑ *A 50 : 50 mixture of a peat-free compost and horticultural sand*
- ☑ *Plant labels*
- ☑ *Healthy mature geranium plants from which to take the cuttings*
- ☑ *A sharp knife (for use by the teacher)*

### *Preparing the pots*

Let each child fill their pot with the soil mix, pressing it down gently. (Remember the soil needs to have plenty of air in it.) Place the pots in dishes of water until the surface becomes moist and then leave the pots to drain while the cuttings are being taken.

### *Taking the cuttings*

This is best done by the teacher, ideally whilst the children are watching.

- Select a healthy shoot preferably without flowers (especially if using a scented geranium)
- Remove about 5 cm of shoot cutting with a sharp knife just below a leaf joint
- Remove all except the uppermost pair of fully-developed leaves (this helps to reduce water loss through the leaves)
- As you are working, keep the cuttings moist by storing them in a wet polythene bag

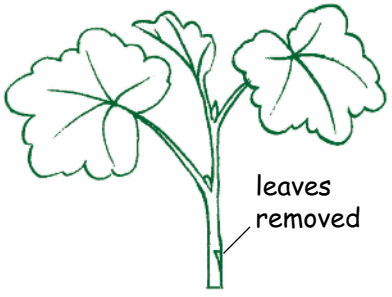



Figure 21. Taking cuttings of a geranium.

### *Planting the cuttings*

- Let each child push their cutting gently into the soil to just below the lowest leaf and firm it in by gently pressing on the soil around it.
- Cover the cuttings with a transparent cover. Half lemonade bottles are ideal. Polythene bags can be used but should be arranged so that they are not touching the cutting.
- Place the cuttings in a warm light place, preferably not in full sun. They do well under a light bank (see page 14).

After one week, water the pots by standing them in dishes of water. Repeat after about 10 days by which time the cuttings should have rooted and new leaves should have started to develop.

### *Looking after the cuttings*

Keep the plants in a place where there is plenty of light. If kept indoors, trays filled with wet gravel keep them sufficiently moist. If you wish to keep the plants out of doors, either in pots or planted into beds or hanging baskets, they need to be hardened off. As long as there is no frost, put them outside during the daytime and bring them indoors at night (or at the end of the school day). After one to two weeks, they can be left outside permanently, providing there is no risk of night-time frosts.

Plants can be kept over winter somewhere with a dry atmosphere and where the temperature does not fall below 10 °C. Water sparingly about once a week.

## Activity 2b: Growing potatoes in a bucket

### *Resources*

- ☑ *Suitable containers, such as buckets or large pots (not less than 25 cm diameter). Make sure the containers have holes in the bottom to allow for drainage.*
- ☑ *'Seed' potatoes – usually available in garden centres in January and should be purchased then. Choose one of the 'first early' varieties, such as Arran Pilot.* ***(Note that these 'seed' potatoes are actually stem tubers, not seeds – see page 48.)*** *The stem tubers have buds in small depressions next to leaf scars (eyes). These are usually concentrated at one end, often known as the 'rose' end.*
- ☑ *Compost – use a multipurpose compost, peat-free if possible (see page 42)*
- ☑ *Trowels*
- ☑ *Egg trays*

**Sprouting the potatoes.** In January or early February place the seed potatoes on an egg tray with the rose end uppermost. Leave them under a table at room temperature to sprout. They are ready for planting when the sprouts are about 2 cm long. This takes about 4 to 5 weeks.

**Planting the potatoes.** Place some crocks or gravel in the container to help drainage and nearly fill it with moist compost. Put one potato in the container with the sprouts uppermost. Cover the potato with 2 to 3 cm of compost.

Keep the container indoors or put it in a sheltered place outside, where it is free from frost. Water it regularly (the compost needs to be just damp). As the potato grows you may need to add a bit more soil to keep the underground parts covered. Potatoes should have formed 12 to 14 weeks after planting. Carefully lift the plant and have a look. Pick off the largest potatoes and then replace the plant in the soil so that the potato plant can continue growing.

### *Further activities*

***1***. Try growing some different varieties of potato. Here are some names for you to try and find: Duke of York, Charlotte, Anya, Belle de Fontenay, King Edward, Pink Fir Apple.

***2***. Make a list of the different ways in which potatoes can be cooked.

## *Further activities: growing plants by vegetative reproduction*

Here are some more ideas that can be fun for children to do.

1. **A hanging basket –** Plant up a hanging basket with cuttings the children have grown. Fuchsias are easy to grow from cuttings and look good mixed with zonal and trailing geraniums. Wandering Jew (*Tradescantia fluminensis*) has attractive foliage and also grows well from cuttings. If you have a local Botanic Garden with an Education Unit they may be prepared to help your class grow a wider range of cuttings and also set up the hanging baskets.
2. **Plants from the supermarket –** Grow carrot, beetroot and other root vegetable tops. Pineapple tops also sprout well.
3. **Mint (or ginger) from its underground stem –** Plant a small piece of underground mint stem with buds (a rhizome) in a pot and watch it produce new shoots in a few weeks. You can do the same thing with ginger from a supermarket.
4. **Growing plantlets –** Take small plants from the ends of above ground shoots (stolons). Good plants to try are the spider plant (*Chlorophytum comosum*) and ground ivy, especially the variegated form (*Glechoma hederacea variegata*). Ground ivy produces long trailing shoots and is a good plant for hanging baskets. The Mexican hat plant (*Kalanchoe daigremoniana*) produces lots of little plantlets along the edges of its leaves and these can be picked off and grown.
5. **Growing pussy willow –** Find a male sallow tree (the male catkins are the 'pussies'). Cut willow shoots in the spring before they come into leaf (make sure you have permission before you do this). Plant the sticks outside in a good garden soil in a moist shady place. They quickly develop roots and begin to grow. Some primary schools develop this activity further and make a living willow fence or grow a willow dome (see Figure 22).
6. **Growing bulbs and corms in lemonade bottles or film pots –** Fill the bottle (or film pot) with water and balance the bulb or corm on the top. Suitable plants to try are amaryllis, crocuses, cyclamen, daffodils, garlic, hyacinth and tulips. Some bulbs may need special treatment (e.g. a period of very cold temperature) before they grow. It is, therefore, advisable to buy pre-treated bulbs for growing indoors. See also notes on vegetative reproduction on page 47 in Background information for teachers.
7. **Activities in the school garden –** For teachers who wish to extend their activities outside the classroom, use the Field Studies Council publication *Gardening for Primary Schools*. This guide gives practical advice on how to set up a horticultural garden in the school grounds, and also shows how to make links between gardening activities outside and investigations on growing plants in the classroom.

Figure 22. A willow arch, grown from cuttings – fun to create in school grounds.

# Background information for teachers

*These notes are provided to give teachers the background they may need when teaching these topics on plants. The vocabulary and words used are botanically correct. It is always advisable to keep closely to the standard terminology so that pupils have a firm foundation to build on and don't have to 'undo' their learning and vocabulary at a later stage. However, it is not intended that you pass these notes on to pupils in the form presented here.*

## Materials and some helpful hints for growing plants

This section gives information about materials referred to in this booklet for use in the classroom when growing plants and provides additional support for the basic methods described on pages 6 to 14. Most of the items are available from Garden Centres and you may have your own ideas that work well.

### *Soil mix and a note about 'compost'*

For growing plants in film pots (or small dessert pots), use any good quality multipurpose potting compost. Mix the compost 50 : 50 with fine grade vermiculite to help retain moisture (but this is not essential). Wherever possible, use a peat-free compost as this encourages awareness of environmental concerns. However, when investigating the effect of adding different amounts of fertiliser, it is necessary to use a compost that is low in mineral salts, so here moss peat works well. Vermiculite on its own does not supply plants with enough physical support. For growing insectivorous plants, many thrive only on moss peat, but buy the minimum that you need.

There may be some confusion about the use of the term 'compost'. The process of composting is used in many gardens as a way of decomposing waste plant material (including some household waste, such as vegetable peelings) and converting it into a soil-like material, known as compost (see, for example, *OSMOSIS* **18)**. The decomposition occurs as a result of microbial activity (mainly bacteria and fungi). The resulting compost is a valuable material for use in the garden, supplying nutrients (in the form of mineral salts) and contributing to improved soil structure and texture. Gardeners also use prepared 'composts' for growing seeds and plants, particularly during their young stages. These prepared 'potting composts' are made up of various mixtures of loam or peat, with sand or grit and added nutrients. They are sieved to provide a fine and uniform texture and sterilised to remove weed seeds. For this booklet, we have adopted the neutral term 'soil mix' to avoid confusion with different types of composts and other growing materials.

### *Fertiliser pellets*

Fertiliser pellets (e.g. Osmocote®) consist of a water-soluble granule containing a mixture of nitrogen, phosphorus and potassium (often abbreviated NPK) in the right balance to supply the necessary mineral salts and promote healthy growth in plants. Each pellet is coated with a thin layer of resin, which controls the release of nutrients.

### *Capillary matting*

Several kinds of capillary matting are available, with different textures and weights. Lightweight types are preferable for use in the classroom. Capillary matting may seem relatively expensive, but it can be re-used several times). Wash the matting carefully and soak it in a very dilute sterilising solution, prepared from sterilising tablets used for babies' feeding bottles. Rinse thoroughly before using it again.

## *Film pots and yoghurt pots*

When these booklets were originally written many of the activities involved using film pots as they could be re-used many times, each child could have their own pot, they required only small amounts of soil mix or other materials and took up little room in the classroom. Very small yoghurt/dessert pots (e.g. Petits Filous) are a suitable alternative. Putting a piece of cling film secured with an elastic band over the pot acts as a lid and prevents the seeds drying out. If there is a need to exclude light, place them in a light proof container.

## *Some notes on seeds and suitable plants to grow for investigations in the classroom*

For very young children, it is best to use large seeds, which are easy for them to handle. Suitable examples are peas, beans, sunflower and sweet corn. Other seeds that are good for growing in the classroom and using in investigations include mustard, cress, mung bean and wheat. Make sure that any seeds you use are within the sowing date.

Seeds may be dusted with fungicide and it is good practice to teach the children that they should never put seeds in their mouth and must always wash their hands after handling seeds.

### The sugar snap pea

The life cycle of a sugar snap pea and how to grow it are described in the first booklet of this series (*Parts of a plant and their functions*, see page 8). For younger children, it is an ideal plant to grow because the seeds are large enough for children to handle and the life cycle is relatively short. Seeds sown in March produce flowers in June and edible peas would be produced by the end of the summer term (July). It can be grown out of doors or in the classroom.

Figure 23. A sugar snap pea

### Using radishes in investigations

The radish (*Raphanus sativus*) is a useful plant for carrying out simple investigations (for example, see page 28). The seed is inexpensive and widely available. Seeds in a single packet show relatively little genetic variation, compared with some other plants. This means that when comparisons are made, differences are likely to be due to the experimental conditions rather than variation between the seeds. They can be grown successfully in film pots. Radish plants are small and compact and, if grown under a light bank, can give a 'crop' within three to four weeks. This crop can then be measured in a variety of ways.

### Rapid-cycling Brassicas

Rapid-cycling Brassicas are small plants and take up relatively little space. They produce flowers within two to three weeks and ripe seeds within 5 weeks. Rapid-cycling Brassicas are also known as 'fast plants'. These 'fast plants' have become a very useful teaching resource for a number of other reasons. The plants can be used to illustrate all stages of the life cycle and, because of the short timescale, the children's interest can be maintained. The plants need to be cross-pollinated and children can be involved in doing this.

Note that rapid-cycling Brassicas need to be grown under a light bank (see page 14). Seed is available from Blades Biological Ltd (**www.blades-bio.co.uk**) or from Philip Harris (**www.philipharris.co.uk**).

## Background information for teachers

# The seed and its germination

This section provides material that may give confidence to teachers and help you to offer suitable responses when faced with a range of questions from curious and observant children. The drawings should help you to interpret the sort of things you are likely to see as different seeds germinate.

The structure of seeds and their development vary from plant to plant and children may notice differences between the plants they are growing. Some of the basic differences found in commonly grown classroom plants are described here.

## *The structure of the seed*

To examine seed structure, look at a large seed. You can, for example, use a fresh bean or one from a seed packet soaked in water for at least 24 hours. If you can leave it for 48 hours the developing embryo shows a little more clearly. Take the seed apart carefully and it should be possible to see the structures shown in the diagrams and described below.

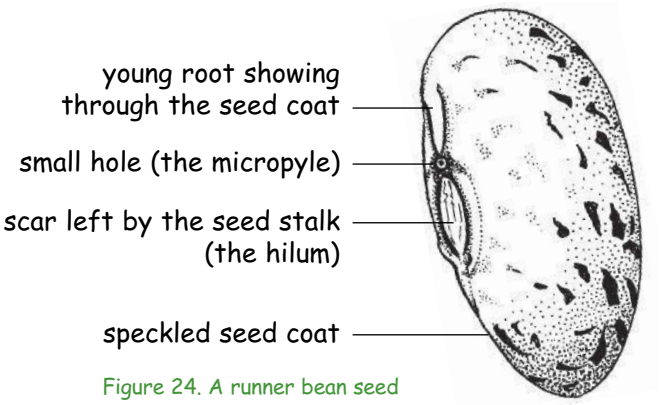



Figure 24. A runner bean seed

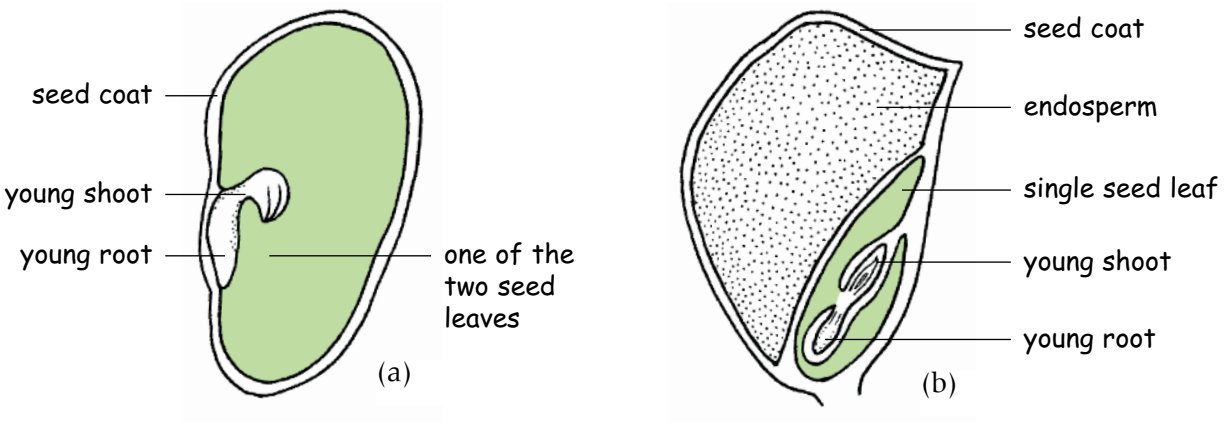



Figure 25. (a) A section through a bean seed - a dicot, with two seed leaves and no endosperm.
(b) A section through a sweet corn seed - a monocot, with one seed leaf and a well developed endosperm.

### The seed coat (the testa)

The seed is surrounded by a protective coat. This may be formed by the true seed coat only (e.g. the garden pea). However, in some single-seeded fruits, what looks like a single coat is in fact formed by the fusion of the seed coat with the fruit wall (e.g. the sunflower).

### The micropyle

This is where the pollen tube entered the ovule. In the seed it remains as a small hole. In some seeds it is an important route for water entering the seed.

### The seed leaves (cotyledons)

Flowering plants are classified into two main groups according to the number of seed leaves (cotyledons) inside the seed. The dicotyledons (dicots) have two seed leaves, e.g. bean, pea and radish. The monocotyledons (monocots), have one seed leaf, e.g. sweet corn.

### The embryo

In dicots, the embryo lies between the seed leaves, whereas in monocots, it lies to one side of the single seed leaf. The embryo is made up of a young root (the radicle), which forms the root system, and a young shoot (the plumule), which forms the rest of the plant. The young root develops first.

### Food storage tissue

Most seeds have a supply of stored food, which they use as they develop and germinate, but this storage tissue may develop in different ways. In some seeds (e.g. sweet corn, wheat and rice) there is a special storage tissue known as the endosperm. This lasts until the seed is mature and ready to germinate. Some of these endospermic seeds provide important sources of food for humans and other animals.

In other seeds (e.g. bean, radish, mustard) the endosperm is used up as the seed develops and has disappeared by the time the seed is mature. In these, the main food store for the germinating seed is found in the cotyledons. Seeds with large well-developed cotyledons (like peas and beans) are also valuable foods for humans and other animals.

A third group of plants produces seeds with virtually no food stores. These seeds are minute, produced in vast numbers and widely dispersed, usually by wind. The trade-off for this successful wide dispersal mechanism is that most seeds do not survive.

## *Germination*

Before germination occurs, there is usually a waiting period (dormancy). This is very important as it means the seeds do not germinate until conditions are suitable. It may also result in staggered germination so that if the first group of germinating seeds fails, because of poor environmental conditions, other seeds of the same generation are still available. Plants have a number of interesting ways of making sure that the right period of dormancy takes place, for example:

1. Germination cannot take place until germination inhibitors within the seed are gradually washed away or evaporate.
2. The seed coat is very tough and requires a certain amount of physical, biological and chemical weathering before water and oxygen can reach the seed.
3. Germination is triggered only by a particular temperature or light regime, e.g. by very low temperatures (even freezing) or very high temperatures, such as may occur during a forest fire.

Figure 26. Strelitzia – a plant that depends on fire to trigger its germination.

*Strelitzia* grows naturally in the Fynbos, a dense bushy vegetation found in South Africa. In this area many seeds do not germinate until after a bush fire. Normally there would not be enough light and not enough nutrients for young plants to grow and survive. However, after fire there is no shade and there are plenty of nutrients in the soil, at just the right time for seeds to germinate, especially if the rainy season is starting. So how does the seed know that it's the right time to start germinating? Scientists have discovered that getting soaked in smoky water as the first rains dissolve the ash in the soil, helps to break seed dormancy allowing young plants to start growing under ideal conditions. Gardeners can now buy discs of paper soaked in bushfire smoke, which they can use to trigger germination of seeds from plants like the *Strelitzia*.

### The germination process

The seed begins to take up water. Oxygen enables energy to be released from the stored food and living processes in the cells speed up. The young root develops first and grows downwards. This anchors the seed and allows it to obtain water and mineral salts from the soil. Then either seed leaves (cotyledons) or the true leaves appear above ground. These become green and begin to carry out photosynthesis (making food). At first the young plant was dependent on the food reserves within the seed, but by this stage (when it can make its own food) it becomes an independent plant. As the shoot begins to develop and emerge from the seed, two different types of seedling growth may be seen.

### 1. The seed leaves emerge above ground and quickly become green

This type is found, for example, in the radish, mustard, sunflower, French bean and kidney bean. These first seed leaves are usually very different in shape and form from the first true leaves, which develop later. In mustard and cress, most of us never see the true leaves as we eat the plant before the true leaves are formed! (But let them grow on a bit to see the true leaves that develop.)

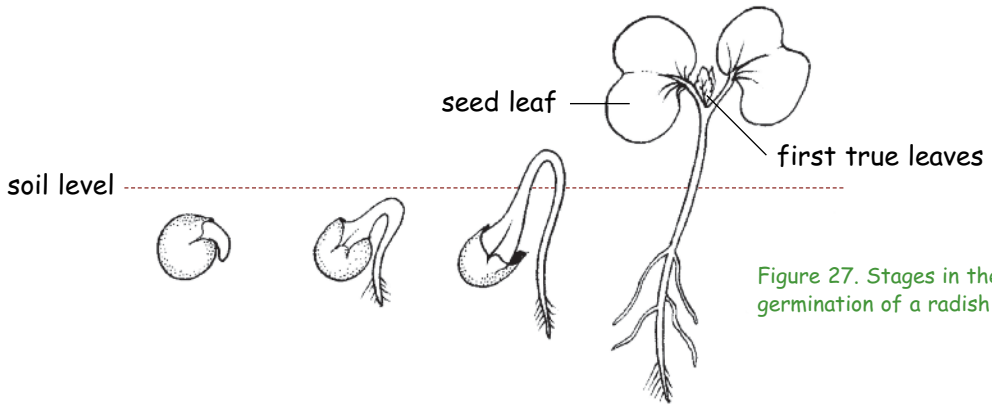



Figure 27. Stages in the germination of a radish seed.

### 2. The seed leaves (cotyledons) remain below ground and act as a food store

This type is found, for example, in the garden pea, broad bean and runner bean. The seed leaves remain below ground, shrivelling up as the developing shoot uses the food. The first true leaves develop and appear above ground.

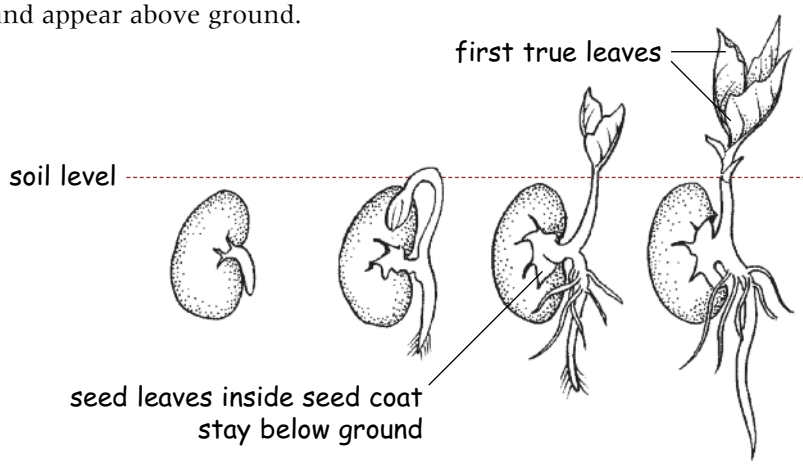



Figure 28. Stages in the germination of a runner bean seed.

## *A hazardous journey!*

To protect the seed leaves or young shoot as they push through the soil, many plants produce greater growth on one side of the stem so that a loop forms. It is the point of the loop that pushes through the soil, not the delicate growing point (Figure 29). Peas, beans and radishes all show this loop as they germinate. In other plants, (e.g. sweet corn and grasses), the first leaf grows straight up through the soil protected by a sheath, known as the coleoptile (Figure 30).

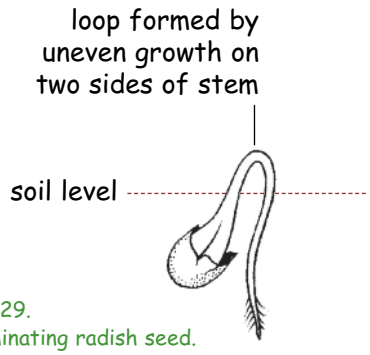



Figure 29.
*A germinating radish seed.*

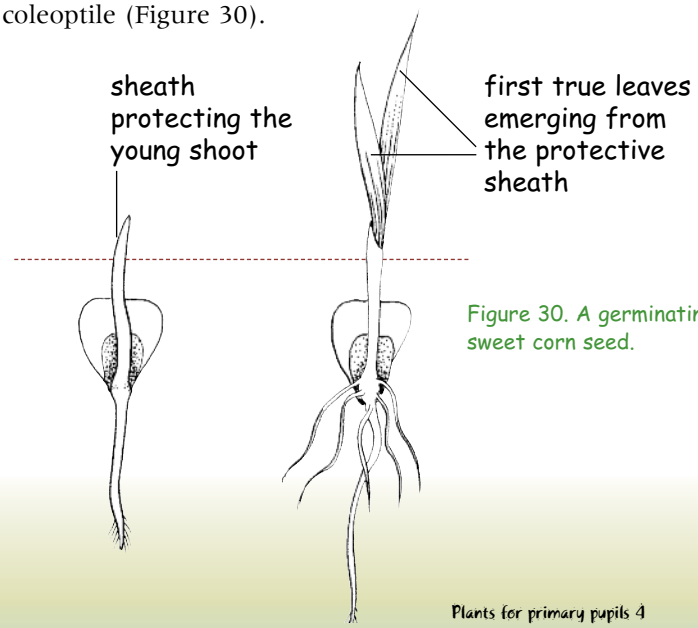



Figure 30. A germinating sweet corn seed.

## Background information for teachers

# Comparing sexual and asexual (vegetative) reproduction

Many flowering plants reproduce by both sexual and asexual (vegetative) reproduction. Descriptions of the life cycle of a flowering plant and the role of the flower in sexual reproduction are given in booklet 2 '*Reproduction and life cycles part 1: Parts of a flower*', and booklet 3 '*Reproduction and life cycles part 2: Pollination, fertilisation, fruits and seed dispersal*'. Some notes on asexual or vegetative reproduction are given on the SAPS website.

In this booklet emphasis has been on growing plants from seeds but with brief reference to growing plants from 'other parts of plants' (e.g. cuttings and tubers) – see page 39. If we consider these two methods of reproduction from the view point of the plant, in terms of the success and survival of the species, each has advantages and disadvantages.

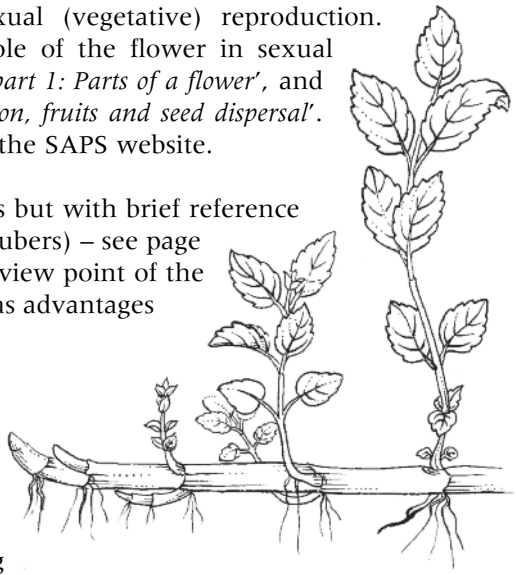


Figure 31. Mint (*Mentha spiccata*) – showing asexual reproduction by rhizomes

A big advantage of sexual reproduction is that it results in offspring that are slightly different from each other and from their parents. In other words, they show variation. If environmental conditions change, it is likely that at least one or two of the individuals in the population of plants would be able to survive. Variation allows a species to adapt to an ever changing environment.

However, the production of seeds through the process of sexual reproduction is a complicated and risky business. Even when ripe seeds are successfully produced in the natural environment, a very high percentage fails to grow into mature plants. Some reasons why sexual reproduction may fail are given in the table below. You can discuss these with your class and refer to activities in this booklet to understand why seeds may not germinate and grow.

Many plants use the alternative method of asexual (vegetative) reproduction. Some even rely on it and do not reproduce sexually. Asexual reproduction occurs when a 'bit' of the plant becomes detached and then grows into a new plant. Offspring from plants that have reproduced asexually are all more or less the same as each other and as the parent. In other words, they do not show variation. This can have both disadvantages and advantages.

**Sexual reproduction might fail because:**

- Parts of the flower become damaged by insects or other animals
- The right pollinating insect is not around (at the right time)
- The pollen tube might not reach the ovule
- Developing fruits might be damaged by cold winds or frosts
- Developing fruits might be eaten by animals

**Seeds may not germinate and grow because:**

- The seeds do not land in a suitable place to grow
- Seeds or young plants are eaten by birds or other animals
- Germination cannot take place because there is not enough water or temperatures are too low
- Seedlings do not have enough light
- Seedlings are killed by frost or by temperatures that are too high

If the environment changes in a way that is unsuitable for the species, all the offspring may die and

the species has lost its ability to adapt to environmental changes. However, in the short term, vegetative reproduction may be an advantage as it often allows the plant to spread rapidly in an area.

Many of our most successful weeds have the ability to reproduce vegetatively (e.g. stinging nettles, ground elder, couch grass). Gardeners who may wish to reproduce exactly a favourite flower or fruit often use vegetative reproduction in preference to growing their plants from seed. Vegetative reproduction is used widely in the horticultural industry to produce large quantities of plants with the desired characteristics.

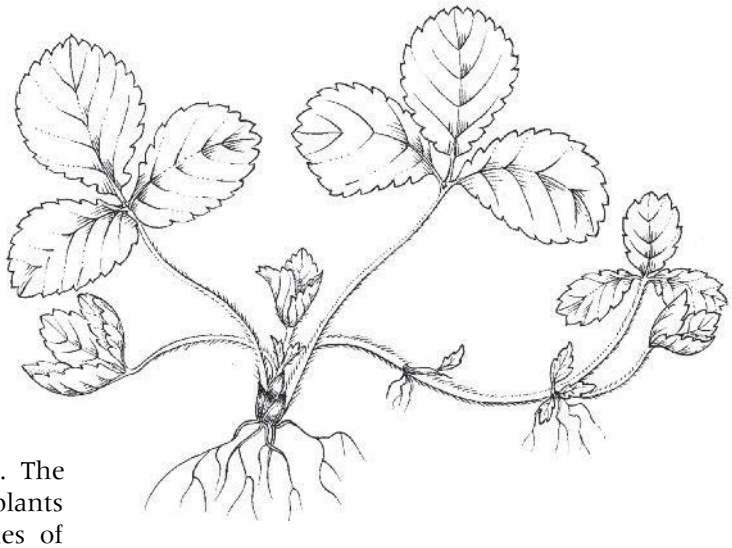


Figure 32. Wild strawberry (*Fragaria vesca*) – showing asexual reproduction by runners

Plants can reproduce vegetatively in different ways. The table below gives some natural ways in which plants reproduce vegetatively, together with some examples of plants that you can show to the children. Often parts of a plant for which the main function is to act as a storage organ and thus allow the plant to survive harsh winter conditions, also have the ability to produce new plants if they become separated from the parent plant. An example is the rhizomes of bearded iris and more are given in the table. Gardeners often deliberately detach bits of plants and encourage them to form new plants.

| Reproductive organ | Part of the plant and how it develops | Examples |
|---|---|---|
| Tubers | • swollen tips of underground stems<br>• shoots develop from clusters of buds developing above leaf scars (eyes) | Potato, dahlia |
| Rhizomes | • horizontal underground stem<br>• new shoots develop from buds in the axils of the scale leaves | Bearded iris, ginger |
| Stolons (offsets and runners) | • stems that develop from buds above ground<br>• they run along the ground and develop new shoots | Strawberry, *Sempervivum* spp |
| Corms | • swollen base of a stem, surrounded by scale leaves<br>• buds in the axils of these form new corms | Crocus |
| Bulbs | • short fleshy stem surrounded by scale leaves<br>• new bulbs develop in the axils of leaves | Hyacinth, onion |
| Bulbils | • tiny bulbs that develop above ground in the axils of leaves or within a flower head | Leaf axils – tiger lily, madonna lily<br>Flower heads – tree onion |
| Leaf plantlets | • tiny plants that develop from special groups of cells on the leaves | Mexican hat plant (*Kalanchoe daigremontiana*) |
| Shoots | • fragments of leafy shoots that can develop into new plants when they become detached from the parent plant | Slender speedwell (*Veronica filiformis*) |

See page 41 for ideas that you can use to encourage children to explore ways of growing plants using vegetative reproduction with some of these examples.

## Background information for teachers

# Respiration and photosynthesis made easy

Strictly, neither of these words appears on the curriculum for children at this level. However, indirect reference is likely to be made to both processes, so we give these background notes in a way that could be used with children. These are not easy concepts at this level, but it is very important that a suitable approach is adopted and so avoid misconceptions that occur all too frequently at later stages in the study of science (and biology in particular). Teachers may also wish to refer to the General note on 'Food in plants' in the first booklet (*Parts of a plant and their functions*, page 20).

First, it is important to establish that both processes are unique to living organisms. Both processes are concerned with energy; both processes are involved with the exchange of two gases (oxygen and carbon dioxide) and both processes are part of the carbon cycle.

We look at each process in turn, but remember it's all to do with **energy**, **oxygen** and **carbon dioxide**. Children should also understand that in science, we link 'food' primarily with it being a source of energy.

### Respiration = the way that energy is released from food

**Respiration** occurs in ALL living organisms ALL the time. When an organism stops respiring, it is no longer alive. Respiration uses food molecules (usually glucose) and releases energy from them. Respiration usually requires oxygen to do this and gives off carbon dioxide. Remember that plants as well as animals carry out respiration and don't confuse 'respiration' with 'breathing' (see extra notes below).

### Photosynthesis = the way plants use energy to make food

**Photosynthesis** occurs ONLY in green plants (and some simple organisms that contain pigments similar to chlorophyll) and ONLY when there is light. The green pigment (chlorophyll) traps the energy in the (sun)light and then uses this energy to build up certain carbohydrates (including glucose). The process of photosynthesis uses carbon dioxide from the air and water inside the plant to make this glucose. The process gives off oxygen and this passes out of the plant into the air. The glucose is the 'food' that has been made and it can then be converted into other substances in the plant (including proteins, fats and other carbohydrates).

Look at the words: **photo** + **synthesis** (light + building up); **carbo** + **hydrate** (carbon dioxide + water).

---

## *Some extra notes*

### Respiration

1. The energy released is used in different ways by the living organism – for living processes, moving around, keeping warm, growing, making new substances.
2. People often get confused with 'breathing' and 'respiration' and use the words as if they mean the same thing. Make sure the children understand that in humans, 'breathing' is the way we fill our lungs with air (and so get oxygen into the body) then empty the lungs (and so get rid of the carbon dioxide that has been produced). Plants also need a supply of oxygen and to get rid of carbon dioxide, but the gases pass in and out of the leaf (or other parts of the plant) without any special breathing movements.

### Photosynthesis

1. Chlorophyll is the green pigment in plants. Other pigments can trap light energy, and this energy can also contribute to photosynthesis. Some leaves look red because another pigment obscures the green chlorophyll, but the chlorophyll is still there and can trap the light energy for photosynthesis.
2. There is plenty of water already inside the cells of a plant, so the plant does not take in extra water just for photosynthesis.

**Gases in and out of a plant** – Let's look more closely at what happens to the gasses involved in photosynthesis in a (green) leaf of a plant. Remember, respiration is going on all the time, so the leaf is using oxygen and giving off carbon dioxide. If it is a bright sunny day, photosynthesis is occurring at the same time. This means the net effect is that the leaf uses carbon dioxide and gives off oxygen. So it probably uses up the carbon dioxide (already inside the leaf) given off from respiration and then takes in more from the air outside the leaf. Similarly, some of the oxygen (from photosynthesis) is used by the plant for respiration and any extra oxygen passes out of the leaf into the air.

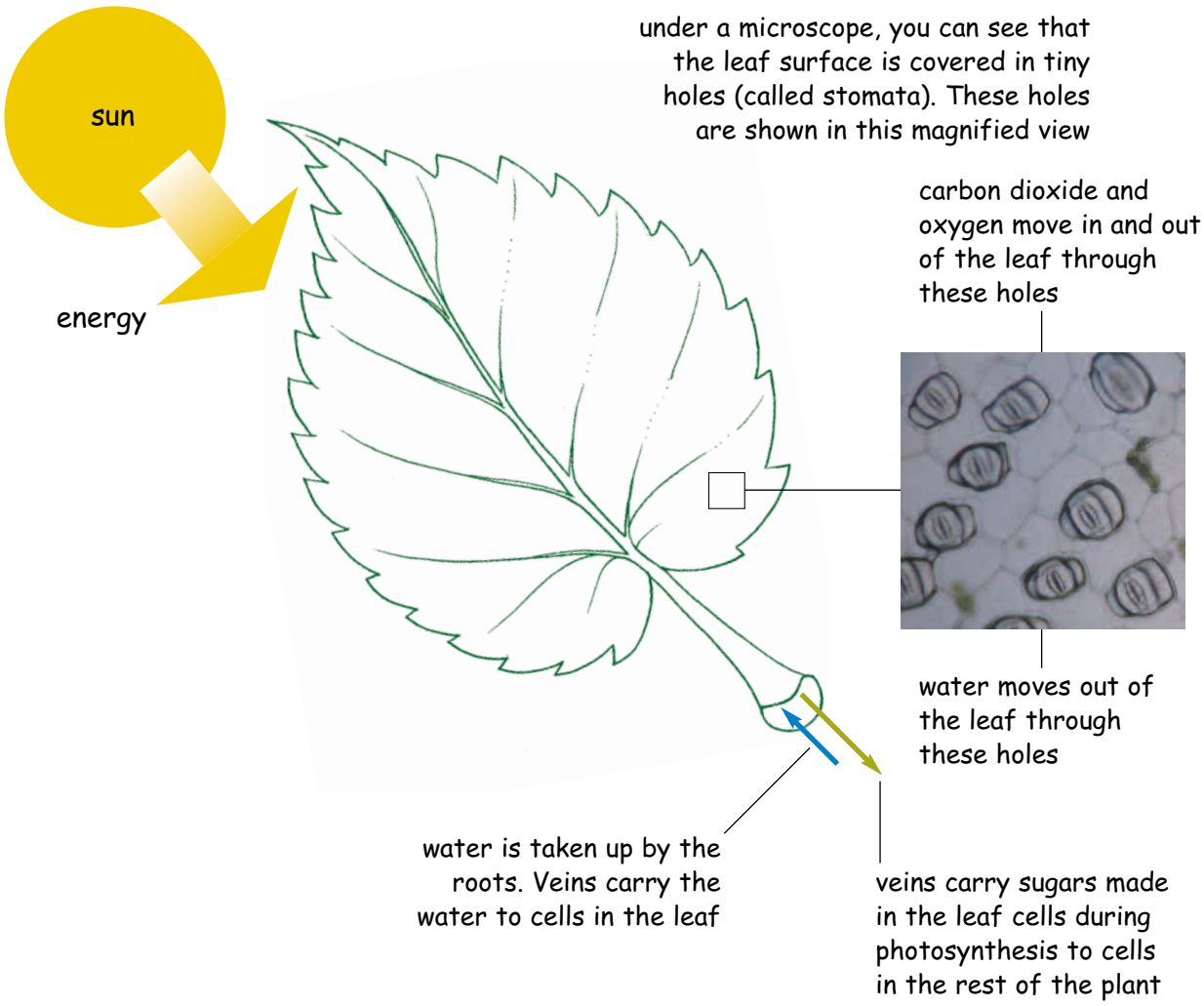
**Energy capture and release** – The process of photosynthesis captures energy in light and converts it into a form that can then be built into food substances. The substances in the plant formed by this process (such as glucose and other carbohydrates) now contain this energy, which is then released in the process of respiration.

## *Respiration and photosynthesis in a leaf*

A summary of these two processes is shown in the box.

| | | |
|---|---|---|
| Respiration | food (glucose) + oxygen | → energy + carbon dioxide + water |
| Photosynthesis | water + carbon dioxide + energy | → food (glucose) + oxygen |

The diagram shows you materials needed for respiration and photosynthesis pass into and out of a leaf.

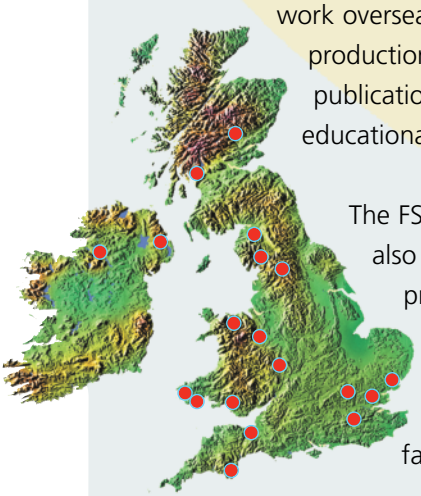


FSC

BRINGING ENVIRONMENTAL UNDERSTANDING TO ALL

The FSC (Field Studies Council) is an independent educational charity formed in 1943 to help people discover, explore, understand and be inspired by the natural environment… '*bringing environmental understanding to all*'.

Over the last 60 years the FSC has touched the hearts and minds of individuals of all ages through fieldwork and courses at our network of Field Centres throughout the UK, work overseas and the production of publications and educational resources.



The FSC also offers a programme of leisure learning for adults and families.

For general enquiries and details of FSC courses please contact:


**FSC Head Office**
Preston Montford, Montford Bridge, Shrewsbury, Shropshire SY4 1HW, UK

T 01743 852 100

E headoffice@field-studies-council.org

W www.field-studies-council.org

**FSC Publications**
Unit C1, Stafford Park 15, Telford TF3 3BB, UK

T 0845 345 4072

E publications@field-studies-council.org

W www.field-studies-council.org

# Living processes
## and what plants need to grow

*Living processes and what plants need to grow* is the third theme in a series of booklets developed to support primary pupils learning with and about plants in England, Wales, Northern Ireland and Scotland. In this booklet, children are encouraged to grow their own plants and carry out investigations within a scientific framework to find out what seeds need to germinate and what plants need to grow. There are activities in the booklet that provide opportunities for development of skills in numeracy, IT and literacy, and it includes some that are fun but at the same time reinforce pupil learning and help them to be ready to move on to the next stage.

Science and Plants for Schools
Cambridge University Botanic Garden
Cambridge CB2 1JE
Email: saps@hermes.cam.ac.uk
www.saps.org.uk

Field Studies Council
Preston Montford, Shrewsbury
Shropshire SY4 1HW
www.field-studies-council.org