Plants for primary pupils

Grouping and classification

SAPS

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Bringing Environmental Understanding To All

Science and Plants for Schools (SAPS), an initiative launched in 1990, works with teachers to:

- develop new resources that support the teaching of plant science and molecular biology in schools and colleges
- promote exciting teaching of plant science and molecular biology
- interest young people in plants and in molecular biology

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 and molecular biology.

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4.

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

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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
- 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 booklet is part of a series written to support work that must be undertaken with plants as part of the Primary Curriculum in England, Wales, Northern Ireland and Scotland. The booklet is also available on the SAPS website (www.saps.org.uk) and can be downloaded freely for use by teachers with their classes.

Acknowledgments

For the Copycats activity, the Writing Group has drawn on an idea that came originally from Claire Dalby (a botanical artist).

The cartoon used in Activity 2, page 6 (Living things – what they need and what they can do) was inspired by the Concept Cartoons™ used by Brenda Keogh and Stuart Naylor (Millgate House Publishing; www.conceptcartoons.com).

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Photographs. All photographs are by John Bebbington FRPS, with the exception of some in the PowerPoint presentation.

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

Illustrations used in Figure 5 and Figure 7 are reproduced by courtesy of The Cavendish School, London.

PowerPoint presentation – 'What's in a name?' (on the SAPS website). Photographs are by John Bebbington FRPS, except for those acknowledged separately.

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.

Members of the Writing Group: Anne Bebbington (FSC and SAPS), Colin Bielby (Manchester Metropolitan University), Ruth Thomas (The Cavendish School), Judy Vincent (formerly of Hartest Primary School) and Erica Clark, editor (SAPS).

Progression of ideas within this theme (Grouping and classification)

It is important for teachers to be aware of the underlying progression of ideas being developed through the activities in this booklet. Any of the activities can be selected in isolation and some may be similar to ones already included in a typical teaching strategy. But a closer look should help reveal the links between the activities and opportunities for progressive development of skills.

The section titles reflect the main stages of this progression, summarised below:

- decide whether objects are living or non-living (never been alive) and understand how plants differ from animals
- make careful and accurate observations and use appropriate language in describing the features observed
- sort items and make groups, and begin to give reasons for the separations that are being made. This often leads to understanding why it is important to give names to things (including living things)
- apply the skills developed through the grouping activities to make and use keys

Throughout, the emphasis is on using appropriate material from plants. Other outcomes may be that children realise that it is helpful to give names to objects, particularly if they are interesting or important to us. They may also appreciate why we bother to classify things – how it helps us find them and talk about them to other people. We hope also that they realise there are plenty of ways that plants are interesting and useful to us, so it's worth naming and classifying plants.

An accompanying PowerPoint presentation, entitled 'Why do plants have names and where do the names come from?', gives a colourful and interesting glimpse into some of the stories behind the names plants have today.

Contents

Supporting material on the SAPS website

This material includes full-sized versions of many of the images used in the booklet. In some cases, teachers may wish to project these for the whole class to see or to download them for use in a different form with the activity. Templates are provided for the 'Sort it!' cards. Some Pupil Sheets are provided (as pdf and / or Word files) so that you can adapt them for your class. The material also includes an interactive cartoon to use with the MRS GREN activity, a guide to the dissection of a buttercup to support the buttercup key and additional information about the liquorice plant to add interest to the liquorice allsorts activity. The PowerPoint presentation 'What's in a name?' can be used to encourage children to think about why plants have names and where these names came from. With a few lighthearted examples, this PowerPoint explores the origins of some plant names and looks briefly at the history of scientific naming of plants.

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'.

Introduction

This series of activities aims to cover work that must be undertaken with plants as part of the Primary Curriculum (e.g. in Key Stages 1 and 2 in England, Wales and Northern Ireland, and Scottish Primary P1 to P7 or equivalent). The activities have been developed by SAPS 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.

At the end of each activity, you will find a 'Curriculum Links' box, to help you see where you could use this activity within the appropriate national curriculum framework.

Grouping and classification

This is the fourth theme in the series. The booklet encourages children to explore the nature of living things, understand how we can group objects (both living and not living) leading on to how we classify living things and why we give them names. It enables children to make simple keys based on similarities and differences between objects (including parts of plants) and to use keys to identify certain plants.

Certain activities are available at two levels, so that younger children begin to become aware of the differences (say between living things and 'never been alive' objects) or begin to develop appropriate vocabulary (say for describing leaves or seeds). Older children can then return to these activities but build on earlier knowledge and develop them further and so utilise the information in a more

advanced way. Examples here are the activities that let the children sort a more complex group of objects or build up descriptions of leaves or flowers that can be utilised either to make or to use a key to identify a limited range of things (including leaves and flowers).

Considerable emphasis is given to observation of living material with opportunities for children to develop appropriate vocabulary in making descriptions or to do their own drawings to provide accurate records of their observations. Making a key or using a key are quite difficult concepts, but the activities involving sorting, grouping and describing lead children stepwise to the basic principles for these activities. The challenge of being able to work through the stages of identifying the flower of one of the several buttercups that are commonly found, can be highly rewarding (for both children and the teachers).

Some parts of these topics are often not easy to teach, with the danger that they sink into somewhat dreary lists of 'things that living things do' or unsuccessful attempts at guiding children through sorting and key making. The activities presented provide a fresh approach to some familiar activities and the booklet includes games ('Copycats' and 'Sort it!') that help reinforce learning at different stages and there are opportunities for drawing, all of which are fun. Teachers should also be aware of opportunities offered in the different activities for development of skills, particularly in literacy and numeracy. (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

The activities in this booklet can be used to support the pupils' development in literacy, numeracy and investigative science, as defined in the relevant sections of the National Curriculum for Science and the Literacy and Numeracy Strategy Frameworks in England, and also in the 5-14 guidelines in Scotland.

For literacy, including development of vocabulary and use of speaking and listening skills, two useful activities are 'Observing leaves and learning how to describe them' and 'Sorting seeds into groups'. Both these encourage verbal descriptions of the material as well as accurate observation through drawing. The card game 'Sort it!' and the activities for making keys also require discussion skills when doing the sorting and use of appropriate vocabulary.

For numeracy, the two activities given above ('Observing leaves and learning how to describe them' and 'Sorting seeds into groups') also offer opportunities for children to make careful measurements and then to use these measurements as part of their accurate descriptions.

There are opportunities for formative and summative assessment – a good example is provided by 'Living things – what they need and what they can do' (MRS GREN) and the completion of the Pupil Sheet linked to this activity. The MRS GREN cartoon activity and the card game 'Sort it!' also provide opportunities for assessment. Generally the activities in this booklet provide opportunities for accurate observation and making descriptions rather than formal investigations.

As in earlier booklets in the series, Curriculum links for the 'National Curriculum (Sc2)', 'QCA guidelines – Scheme of work' and the 'Scottish ISE 5-14 framework/attainment targets' are provided at the end of each activity. In addition, several activities are appropriate for the programmes of study in Sc1 (Scientific enquiry), but this has not been highlighted in the booklet. Opportunities are also provided for links with IT, for example requirement for work with branching databases (see activities involving keys).

It should be noted that, at the time of writing (2008), the Scottish curriculum is undergoing change, so teachers should refer to the SAPS website for cross references to the new scheme when these become available.

Living or never alive?

Teacher Guidance

This section encourages children to explore the nature of living organisms. They need to decide whether something is living or has never been alive, and what are the particular characteristics that make something 'living' rather than not living. As they probe further, the children may get some surprises when they realise that plants are living just as much as animals, and that all living things carry out the same processes, but often in rather different ways. In particular, younger children need to recognise that living things move, feed, grow, reproduce and use their senses. Reference to the 'Background information for teachers' may help give teachers a secure grounding and enable them to respond to and take forward some of the ideas that come from the children.

Activity 1: Going on a treasure hunt

The aims are to decide whether objects are living or have never been alive, using features that the children observe. The 'Treasure hunt' approach is probably familiar to many teachers but it is largely through the discussion, in groups and in the class, that children are able to develop and establish their ideas. As they do this, you can begin to elicit children's existing understanding of groups of living things. Then, as they progress through these activities, children begin to become aware of the seven processes carried out by living things and can discuss what living things do.

These activities are likely to be used at two levels – firstly a relatively simple version for younger or less able children and secondly a more complex version that may be used even two years later with older children. The second version gives a useful approach for children ready to understand the differences between plants and animals. Teachers may wish to refer to the Background information for teachers (page 30).

Going on a treasure hunt (1)

This version is suitable for younger or less able children. The initial hunt can be carried out in the school grounds or playground. If this is not possible, the teacher can collect a suitable range of objects before the lesson and the children then carry out the sorting part of the activity. The game can easily be played in an urban school, with some objects being deliberately 'planted'.

Choose objects that are readily available in the chosen area around the school. Here are some suggestions, but make sure that children understand that they should not collect whole plants or whole animals as part of the treasure hunt.

Suggested objects: a piece of paper; a stone; a fallen leaf; a piece of plastic; something made of metal; a twig; a fruit or seed; an artificial flower; something that the child can choose.

The activity

The children can work in groups of three or four. Give each group a bag or tray and a list of the objects they are going to hunt for in the chosen area. The activity can be timed to limit the time spent on the 'hunt'. When time is up, the children bring the objects back to the classroom.

In the classroom

Ask the children to sort the objects into two groups, justifying their choice. Discuss as a class the different ways they have grouped the objects. Let them see that trying to sort things into groups can cause problems.

Whichever criteria they use, the activity is likely to start making them think about alternative ways of classifying objects (e.g. big or small, rough or smooth). Next focus on grouping them into 'living' and 'have never been alive'. Discuss why certain objects have been put into the living group and what they all have in common.

Figure 1a. Here are some things that have once been alive...

Figure 1b. ...and some things that have never been alive.

Going on a treasure hunt (2)

This version is suitable for older or more able children. Follow the instructions as given above, but provide a different list of objects (or the teacher collects them before the lesson). The emphasis now is to begin to sort living things into plants and animals and to use a more extended vocabulary.

Suggested objects: a piece of paper; a rough stone; a fallen leaf; a fallen petal; something from an animal (e.g. a bone, feather, shell, wool, fur); a piece of plastic; something made of metal; a small twig; a fruit or seed; a blade of grass; a pine cone; a smooth round stone; a silk or plastic flower; something that the child can choose.

In the classroom

As in (1), ask the children to sort the objects into groups, but discard the 'never been alive' group of objects. Then let the children focus on the living group and split them into two groups, giving reasons for their choice. Again, discuss as a class the different ways they have grouped the living objects. Within the living group, focus on how they have sorted the objects into 'plant' and 'animal' and the criteria they have used.

Curriculum links

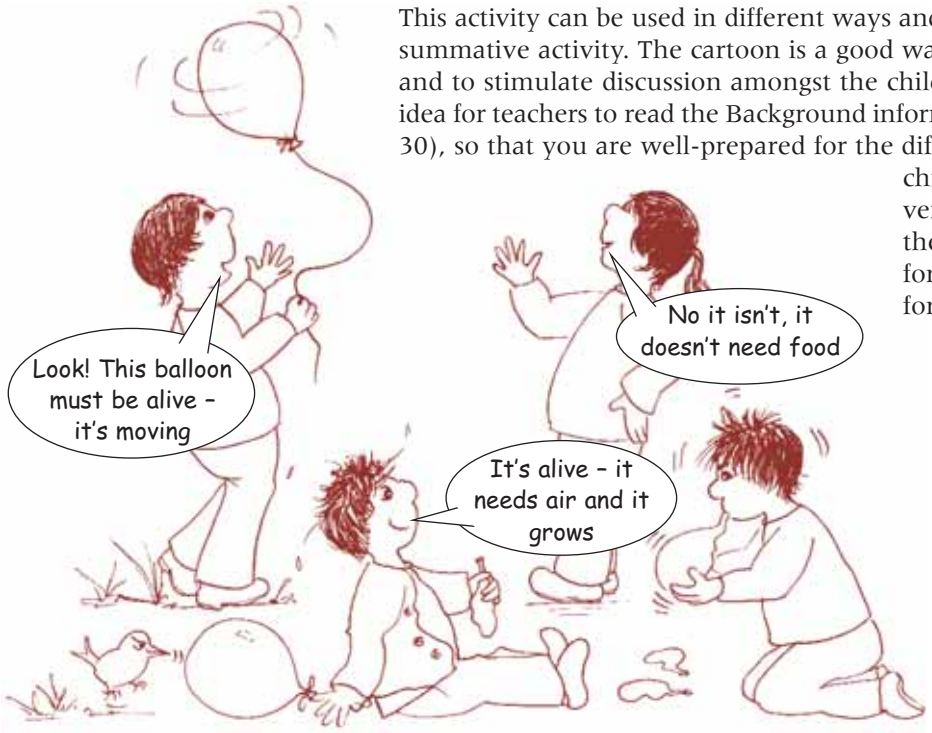
National Curriculum (Sc2)	**KS1: 1a, 4b. KS2: 4c**
QCA guidelines – Scheme of work	**Unit 1B; Unit 2B; Unit 2C**
Scottish ISE 5-14 framework/attainment targets	**LT-A1.2**

Living or never alive?

Teacher Guidance

Activity 2: Living things – what they need and what they can do

This activity follows on naturally from the treasure hunt activities (at either level), in which children begin to become aware of whether things are living or non-living (never been alive). As they try to give reasons for their decisions (in the treasure hunt activity), the children begin to think about what living things do. It is usually easier for children to talk about what animals do (as living things) and harder for them to understand that plants show the same range of characteristics.



This activity can be used in different ways and is useful as a formative or a summative activity. The cartoon is a good way of introducing this activity and to stimulate discussion amongst the children in the class. It is a good idea for teachers to read the Background information for teachers first (page 30), so that you are well-prepared for the different questions that curious children are likely to ask. This version uses 'MRS GREN' as the guide, but you may adapt it for MRS NERG or whatever format you prefer.

The activity

Children may work in groups or individually. In the Pupil Sheet, three of the rows in the table have a greenish background. These rows are suitable for older or more able children, whereas most children should be familiar with the rest of the table (with a white background).

Ask the children to choose an 'example' of a plant, of an animal and of an object that has never been alive. The teacher may provide a selection for the children to choose from. Ask the children to write their chosen examples in the appropriate boxes on the Pupil Sheet. They use their own examples when trying to answer the questions.

Encourage discussion as the children try to write their answers in the boxes and use the cartoon to stimulate discussion. The cartoon is also available as a separate file on the SAPS website, so can be viewed using an interactive whiteboard or displayed in some other way.

Curriculum links

National Curriculum (Sc2)	**KS1: 1a, 4b. KS2: 1a; 1b**
QCA guidelines – Scheme of work	**Unit 2C**
Scottish ISE 5-14 framework/attainment targets	**LT-A1.2**

Living things – what they need and what they can do

1. Choose a plant, then write its name on the dotted line in the box in the table.
   Choose an animal and write its name on the dotted line in the middle box.
   Choose an object that has never been alive and write its name on the dotted line in the last box.

2. Then look at your plant and answer each of the questions. If the plant does the characteristic in the list, write YES in the box.
   If the plant does not do the characteristic, write NO in the box. Then repeat this for the animal and for the object you chose.

First answer the questions for M, G, R and N, in the rows with a white background. Your teacher may also ask you to do the other ones shown with a green background.

Characteristics (Living things need to do all these things)	a plant	an animal	an object that has never been alive .....
M Does it show any movement?			
R Does it need air or oxygen?			
S Does it react to what is happening in its surroundings?			
G Can it grow larger?			
R Can it make more living things like itself?			
E Can it get rid of waste from itself?			
N Does it need food for energy?			

Making observations

Teacher Guidance

As part of a scientific enquiry, children are often asked to observe, then record their observations before drawing any conclusions from the events or situation they have observed. The activities in this section give emphasis to making careful observations (in this case on leaves), then finding ways to describe or record them accurately. As they do this, children begin to develop appropriate vocabulary and realise that this becomes essential in making accurate descriptions that can be passed on to and understood by other people. Children usually enjoy the two drawing activities (the game 'Copycats' and with leaves), yet they bring home to children some important aspects of making observations that are good and representative of the features (or objects) being considered.

Activity 1: Observing leaves and learning how to describe them

In this activity, children are encouraged to look closely at a leaf and its different features. It provides an opportunity to develop appropriate vocabulary in trying to describe the leaves and is a useful introduction to later activities in this booklet aimed at making or using a key for identification. The activity is suitable for older children, and helps them become aware of differences between leaves as well as features that are common to a range of leaves.

As a start, find out what the children already know. Almost certainly they are likely to say that leaves are green and know that they have different shapes. They may also give some other descriptions. The introductory part of the activity then helps children look closely at a selection of leaves and note obvious features. The main part of the activity gives opportunities for the children to use their listening and speaking skills as well as observations that they make and build up descriptions as a class activity. The children should be able to do reasonably accurate drawings of a leaf, perhaps using a hand lens to help with their observations. Some children may need a bit of help to get started.

Resources

For the introductory activity

- ☑ *a class set of leaves without any particularly striking characteristics. All the children have a leaf of the same species. Useful examples include: hazel, fuchsia, privet, apple, pear, lilac (but there are plenty of others you could use).*

For the main activity

- ☑ *a selection of leaves to give a different species of leaf to each child. These should not be too difficult for the children to draw. Useful examples include: oak, maple, dandelion, daisy, beech, lime, apple*
- ☑ *hand lenses – one per pair of children*
- ☑ *rulers*
- ☑ *pencils, coloured pencils (you will need plenty of greens and browns)*

Images of some leaves are provided on page 11, in case you have difficulty in finding suitable leaves. You will also find a wider range of leaves on the SAPS website.

The activity

For the **introductory activity**, give each child a leaf (they must all have a leaf from the same species of plant). Let them think about how to describe it accurately. Encourage them to consider the following: • colour • shape • size • veins • leaf edge • surface • leaf tip • leaf stalk • comparison of upper and lower sides of leaf. Figure 2 gives you a guide to the features they can describe.

You may need 15 to 20 minutes for this stage. Then show the children images of a good range of leaves with very different features – or you may find it helpful to use the images given on page 11. In their discussion of the features of the leaves, let the children develop a list of words to build up into a word bank, using the correct vocabulary and encourage them to use it when describing their leaves. A list of possible words children may use when discussing leaf characters is given in the table on page 10.

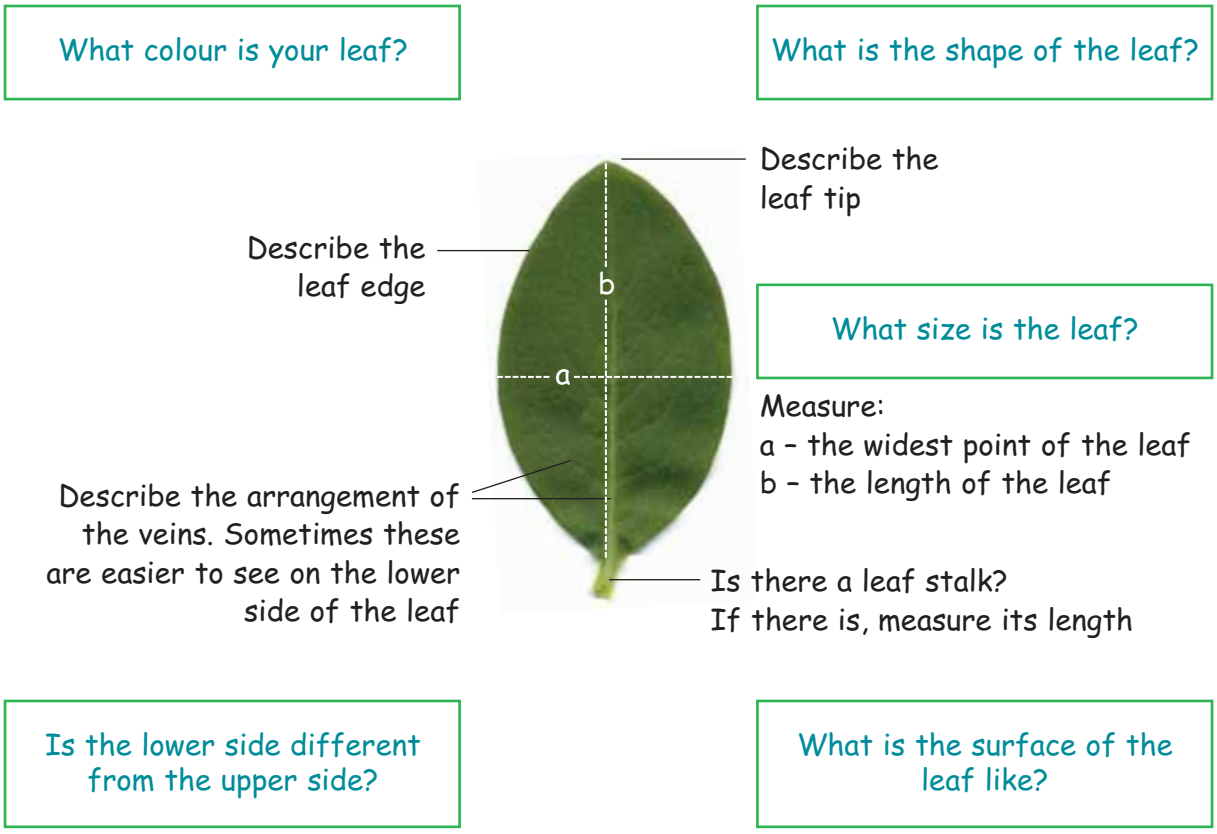


Figure 2. Describing a leaf – the lower side of a Privet leaf showing some of the things to consider when describing it.

For the **main activity**, divide the class into groups of three. Send one child from the group into a part of the room where the others can't see what they are doing. This child looks carefully at a leaf (say an oak leaf), then returns to the other two in the group and describes the leaf. The two who have not seen the leaf must listen and ask questions and then try to draw the leaf from the spoken description. They can refer to the word bank as they do this. The child who saw the original leaf can return as often as necessary, but it is important to have a time limit. Allow no more than about 10 minutes, then show them the leaf to see how well they managed.

Repeat with the other two children in the group, and each describes a different leaf. Encourage the children to use a hand lens for detailed observation and to use correct language in their descriptions.

The activity involves speaking, listening and measuring skills as well as giving an opportunity for the children to become familiar with appropriate vocabulary for describing leaves and you may wish to spend some time on it.

Possible words to use in the word bank

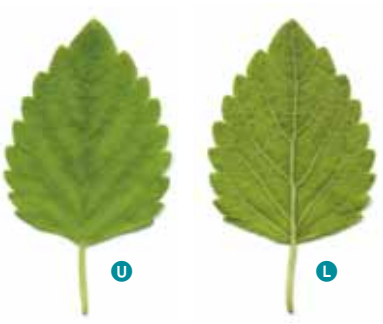
As the children talk about their leaves, they use different words to try and describe the leaf characters. Their ideas and vocabulary develop as they do this. Some of the children's words are probably not standard botanical terms (e.g. 'fluffy', 'furry'), but are the children's words and represent their attempt to make descriptions that mean something to them. The list below includes ideas that the children may suggest and that could be incorporated into a word bank for your class. It is not intended to be used as a list to be learnt and children may not need to use all of the words listed here.

Colour	green, brown, yellow, red
Leaf edge	smooth, toothed, wavy, prickly
Leaf surface	smooth, rough, wrinkly dull, glossy hairy, furry, not hairy
Leaf tip	pointed, rounded
Leaf stalk	present, absent
Veins	 one main vein with branches  several veins starting from the bottom of the leaf and coming together again at the tip  several main veins spreading out from the bottom of the leaf

Curriculum links

National Curriculum (Sc2)	**KS1: 3b. KS2: 4c**
QCA guidelines – Scheme of work	**Unit 1B; Unit 4B**
Scottish ISE 5-14 framework/attainment targets	**LT-A3.1; B2.4; C2.4**

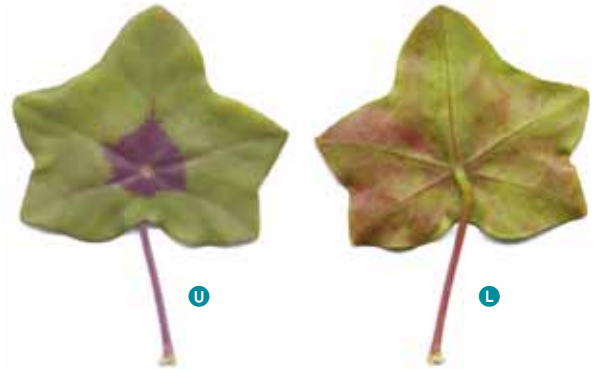
Describing leaves



Lemon balm

White clover

Bugle

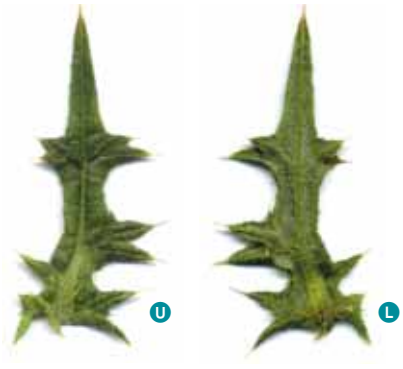


Pelargonium

Stargazer lily

Sorrel

Periwinkle



Spear thistle

Lamb's tongue

Figure 3. Images of leaves showing different features. The leaves were scanned (U upper side and L lower side) and are shown here at approximately two thirds life-size.

Teacher Guidance

Activity 2: Copycats – a game

This activity provides an enjoyable way of reinforcing the importance of accurate observation and recording. It encourages the children to understand why, when doing science work, they should draw what they see and not add anything or leave something out. The activity also helps to make the point that even though drawing living plants or animals is difficult, if you copy other people's work, you copy any mistakes they have made. If an illustration is copied several times, mistakes add up!

The game is based on 'Chinese whispers', but in 'Copycats' an original drawing is copied by one child, then the different children, each in turn, copy the previous child's drawing without seeing the original. It is more fun if you don't explain the point of the activity beforehand. Make sure they only look at the drawing done by the child just before, but don't let them see the earlier drawings (until the end of the activity).

The game can be played with as few as ten children, but the more children that copy the drawings made the more the copies are likely to change from the original. It is often a good idea to use this activity while the children are occupied on another task, such as drawing a living plant.

Resources and preparation for the activity

- ☑ *the picture to be copied, printed onto a piece of card*
- ☑ *similar-sized blank cards, enough for each child in the class. Number these on the back, starting at number 1*
- ☑ *some sharp pencils*

The activity

Explain to the children that you are going to give them a drawing, and you want them to copy it as accurately as they can within a time limit (we suggest two minutes).

- In a quiet corner of the room, give the first child the original drawing and the card numbered 1 (and give the child a sharp pencil). After two minutes, ask the child to stop and return to what they were doing with the rest of the class.
- Call another child into the corner. Give them the blank card number 2 and the drawing on card number 1 to copy.
- Continue in this way until all the children in turn have copied the preceding child's drawing.
- Display the drawings in sequence, placing a copy of the original drawing at the beginning and end of the series.

The children can then see what has happened to the drawing as it has been copied, and you can discuss with them and emphasise the value of making careful observations on living material and recording these observations accurately.

Curriculum links

National Curriculum (Sc2)	**KS1: 3b. KS2: 4c**
QCA guidelines – Scheme of work	**Unit 1B; Unit 4B**
Scottish ISE 5-14 framework/attainment targets	**LT-A3.1; B2.4; C2.4**

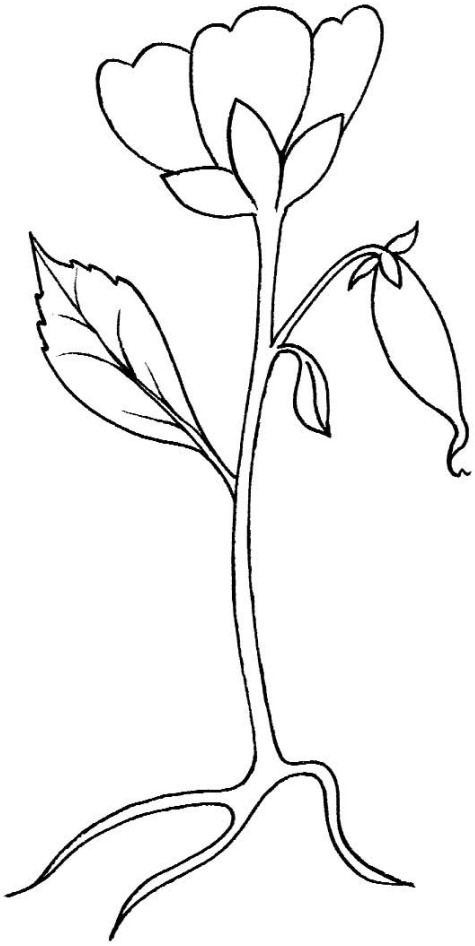


Figure 4.
Copycats - original picture of a flower for the first child to draw. The rest of the children copy, in turn, the drawing done by the previous child.

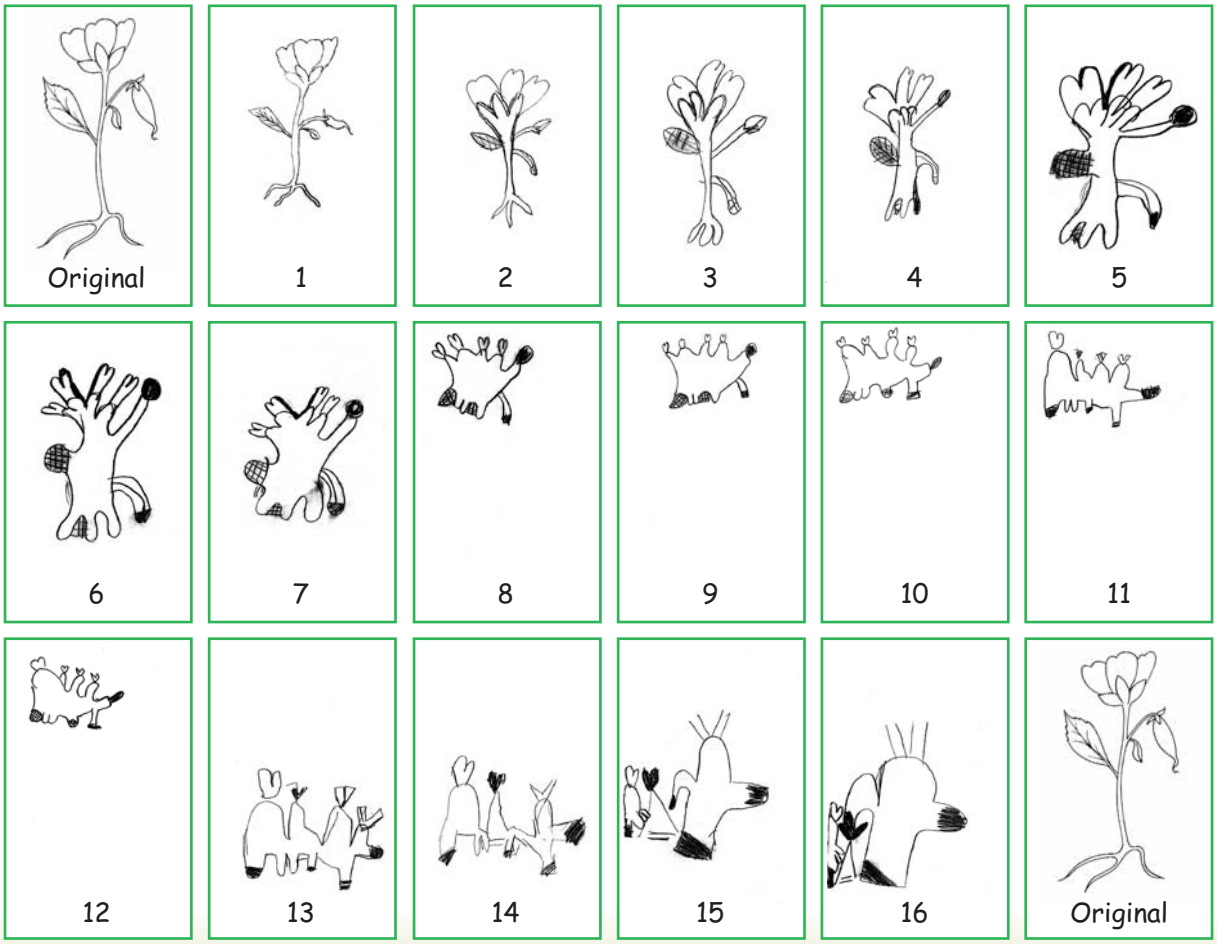


Figure 5. A series of 'Copycat' drawings done by children (in Year 4 at The Cavendish School, in 2007). This helps to show how mistakes add up and how features in the original picture are scarcely recognisable in the final drawing.

Activity 3: Observing leaves and learning about their shapes – What can you turn your leaf into?

In this activity, children are encouraged to look closely at a leaf and think carefully about its shape. The activity is particularly useful for young children as a way of helping them to make observations. It can also be used with older children to give them a chance to have some fun.

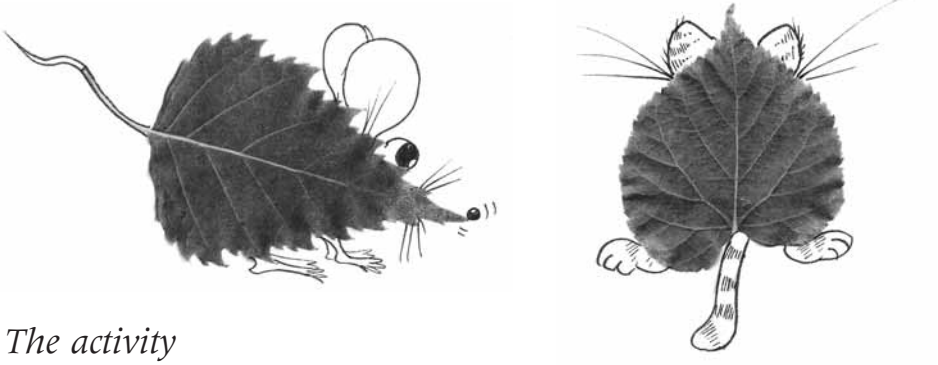


Figure 6.
What can you turn your leaf into? ... a mouse? ... a cat? Some ideas of animals created from leaves - but these are for inspiration (not to be copied!).

The activity

Let the children choose a leaf. You can bring some into the classroom or they may find some leaves in the school grounds or wherever is convenient. It doesn't matter whether the leaves are all the same or different. Get the children to do a wax rubbing of the leaf or the teacher can do a photocopy or scan of each child's leaf.

Show the children a leaf that you have collected. Discuss its shape with them and how you might turn it into an animal. Then ask them to do a drawing that turns their leaf shape into an animal or whatever they may choose to do! As they do the drawing encourage the children to talk about the different features of the leaf so that they become more familiar with appropriate vocabulary.

Some 'leaf animals', drawn by Year 4 children, are given in Figure 7 and there are more examples on the SAPS website. Let the children use their observations to develop their own ideas, but encourage them to draw from their leaf rather than copy a picture that someone else has done. Get them to do more than one if you can. These leaf rubbings can make delightful greeting cards.

Help the children to learn the names of some of the leaves and if possible, take them out of the classroom and see if they can recognise 'their leaves' on the plants.

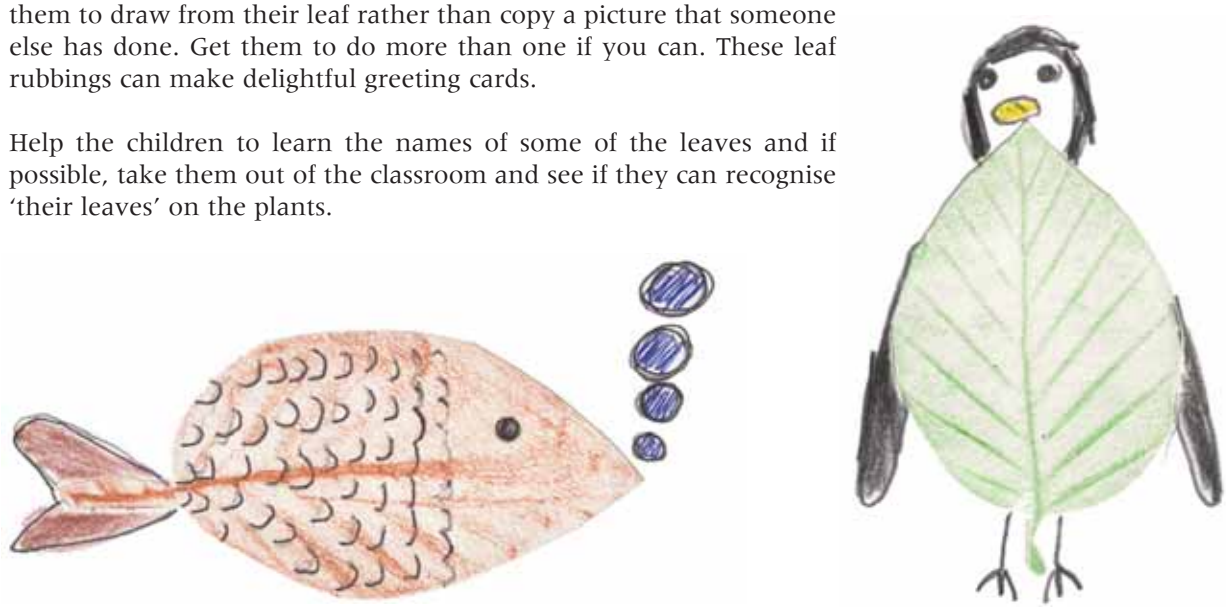


Figure 7. Some 'leaf animals' created by children (in Year 4 at The Cavendish School, in 2007).

Sorting, grouping and naming

Teacher Guidance

This section takes observation activities a stage further, so that children begin to recognise similarities and differences between objects and this leads them on to sorting the objects into groups. The groups that they make are based on their observations but they need to give reasons to justify their grouping. So from this, discussions can develop as to why we so often try to group things and why this becomes easier if we give names to objects (including living things). Grouping can then lead to classification. Just as there are different ways of grouping things, the children also begin to understand that there may be different ways of making a classification of living things. The choice of classification system often depends on the use to which it may be put. The first activity, which can be run at different levels, uses seeds for the objects to be sorted, and all sorts of interesting discussions can develop as the activity progresses.

Activity 1: Sorting seeds into groups

This activity is suitable for younger pupils, and helps them move towards making and using keys. It should also encourage them to make close observations and develop appropriate vocabulary. As they do the activity, they can be encouraged to consider the value and purpose of sorting and classifying. The activity is likely to spread over two sessions.

Resources and preparation for the activity

Children should work in pairs and each pair has a selection of seeds in a small pot or other container with a lid. You can obtain a suitable range of seeds from supermarkets and health food shops. As these are for eating, this avoids risks that might be associated with seeds from other sources. The list below gives some ideas for you to choose from.

- ☑ *Suggested seeds to choose from: avocado; various beans (e.g. black beans; Borlotti beans; butter beans; haricot beans; kidney beans; mung beans; soya beans); chick peas; dried peas; lentils; mango; poppy seed; sunflower; sweet corn (maize); wheat*

Other resources

- ☑ *small pot (such as a yoghurt pot) per pair of pupils (to put the seeds in)*
- ☑ *trays or large sheets of paper (to prevent the seeds falling off tables)*
- ☑ *hand lenses*
- ☑ *rulers*
- ☑ *access to photographs of seeds and plants (an opportunity to use IT skills to search the website for suitable images)*

In the pot for each pair of children, put at least 10 different kinds of seeds. Include a range of different sizes. They need at least 1 or 2 of each seed, but several for the very small seeds.

The activity

Start by giving one seed to each pair of children. A sunflower seed is good for this part of the activity. Let them look at the seed and talk about it, using appropriate vocabulary. Ask them to describe it in as much detail as possible. Use every opportunity to be accurate. If, for example, they say it is 'small', let them measure it. They may ask whether it is dead or alive, so they can try to work out if it fits any of the Mrs GREN categories.

Then produce the pot of seeds and ask the children to 'sort' them. Five minutes is enough for this, and it doesn't matter if you stop them before they have finished. Ask them to talk about the groups they

made and say what they did and why. List the features that they used to separate the seeds. Insist on accurate vocabulary. Depending on your selection of seeds, the children are likely to include words such as smooth, rough; small, big (with measurements); patterns and shapes; colours; hard, soft. You can build up a vocabulary list on the board as they do this.

This part of the discussion can go in different ways, depending on their grouping. Various questions may pop up ... What sort of plants do they grow into? ... Do the biggest plants have the biggest seeds? ... Are they alive?

Further discussion can lead on to who needs to identify and sort seeds, and why. Here are some ideas that may be brought into the discussion.

- birds – goldfinches prefer *Niger* seeds, blue tits love peanuts and chickens like black sunflower seeds
- cooks – haricot beans make baked beans, but red kidney beans are poisonous at one stage of cooking!
- gardeners – if they want a lettuce, they don't plant runner bean seeds!
- farmers – they grow a lot of our food and the supermarkets ask them to grow particular fruits and vegetables

For the final part of the activity, get the children to choose two seeds. Give them hand lenses and ask them to draw the two seeds to highlight the differences between them. They need to use appropriate vocabulary for the labels and they can refer to the bank of words put up on the board.

Useful images of seeds can be found on various websites. Try **www.theseedsite**, googleimages or other search engines.

You may decide to obtain seeds from other sources, such as: garden centres or similar outlets (for sowing); pet food shops (e.g. 'bird seed'); or collected from an area outside, say around the school. Seeds you might obtain from these sources include: acorn (oak); ash; beech; conker (horse chestnut); dandelion; gourd; pumpkin; sycamore... and a coconut! These sources increase the range of seeds the children can sort, but you should be aware of possible risks and that some seeds may be poisonous.

Note that seeds for sowing may be dusted with fungicide or other chemicals and that mixtures of 'bird seed' may contain peanuts. In all cases, whilst handling seeds, you should make sure that the children do not put their fingers in their mouth and that they wash their hands at the end of the activity. Generally, seeds being sold for food are the safest to use. Teachers are advised to obtain further information from appropriate organisations, such as ASE, CLEAPSS or SSERC.

Further activities

1. At some point, it is a good idea to show them some familiar seeds. This can be done on an interactive whiteboard or other suitable method in the classroom.
2. Repeat the exercise and see if there are other ways that they can sort the seeds. They may then begin to see that each seed ends up in a group of its own.
3. Look in a supermarket at the huge variety of fruits and vegetables. See if they can find any seeds in a vegetable or fruit and bring them to school.
4. Try to answer the question: Is the size of a seed related to the size of the plant it grows into? Think about a broad bean seed and an acorn. They are about the same size as seeds, but what size plant do they each grow into?

Note. Strictly speaking some of the 'seeds' listed above are fruits containing a single seed, but for this activity, treat all as seeds.

Curriculum links

National Curriculum (Sc2)	**KS1: 4b. KS2: 3d**
QCA guidelines – Scheme of work	**Unit 2B; Unit 2C**
Scottish ISE 5-14 framework/attainment targets	**LT-B2.4**

Teacher Guidance

Activity 2: Sort it! – a game with cards

This activity is based on the card game 'Happy families'. There are 24 cards in the pack, made up of six sets of four cards. The game takes further some of the ideas established in Activity 1 (Sorting seeds into groups) – see page 15. The game is most suitable for older children.

While playing the game, children have opportunities to:

- practise sorting objects into groups
- learn that there is usually more than one way of sorting objects into a group
- appreciate that it helps to have names for objects when trying to sort them

Preparation for the game

You will need one pack of cards for each group in the class. The master sheet (Figure 8) shows the complete set of cards (reduced size). You can use this page as a template to prepare your pack of cards. Enlarge the page by photocopying from A4 to A3 and this will give you suitable sized cards to use for your pack. Full-sized templates of each set of cards and a master sheet are given on the SAPS website. Download these and print sets of the 24 cards. You can print onto normal paper, then paste this onto card (e.g. use spray mount), or print straight onto a suitable weight of card. Don't show the master sheet to the children until they have attempted to sort their own pack of cards into groups.

Playing the game

This game is best played with three to four players, but can be played with two. There are several stages as they progress through the game.

1. Give each group a pack of 24 cards. Ask them to spread the cards out (face upwards) and then sort them into groups in whatever way they like. Give them several minutes to discuss this. Then the children report back to the rest of the class saying how they have sorted their cards and their justification for doing so.
   - They should find lots of different ways of sorting the cards into groups. As they do this, make the point that most objects, including living things, can be sorted in different ways. Then tell them that the person who devised the game of 'Sort it!' actually divided the cards into six sets of four cards.
2. Ask the children if they can sort the cards into six sets of four cards. Again, let them discuss how they decided to group their cards.
3. The 'master sheet' (Figure 8) shows how the six sets of cards can be grouped into families, using certain characters. If the children haven't grouped their cards in this way, you can then show them the master sheet. Discuss with the children the characters that were used to put the cards into the 'families' shown on the master sheet.
4. Next explain how to play 'Sort it!' with the cards and give each group a chance to play the game. (The game is based on 'Happy families' – see 'Plant quartet' on page 34 of *Living processes and what plants need to grow* for an outline of how to play).
5. After a few minutes of playing the game, ask if they are having any problems or discuss how they could make the game easier to play. Guide the discussion towards the value of using names for the families.
6. Let them give names to the families and then play the game again. Finally, the children can complete the activity by colouring the cards.

Curriculum links

National Curriculum (Sc2)	**KS1: 4b. KS2: 3d**
QCA guidelines – Scheme of work	**Unit 2B; Unit 2C**
Scottish ISE 5-14 framework/attainment targets	**LT-B2.4**

Sorting, grouping and naming

Teacher Guidance

Sort it! Master sheet for the six families of cards

Family 1

Family 2

Family 3

Family 4

Family 5

Family 6

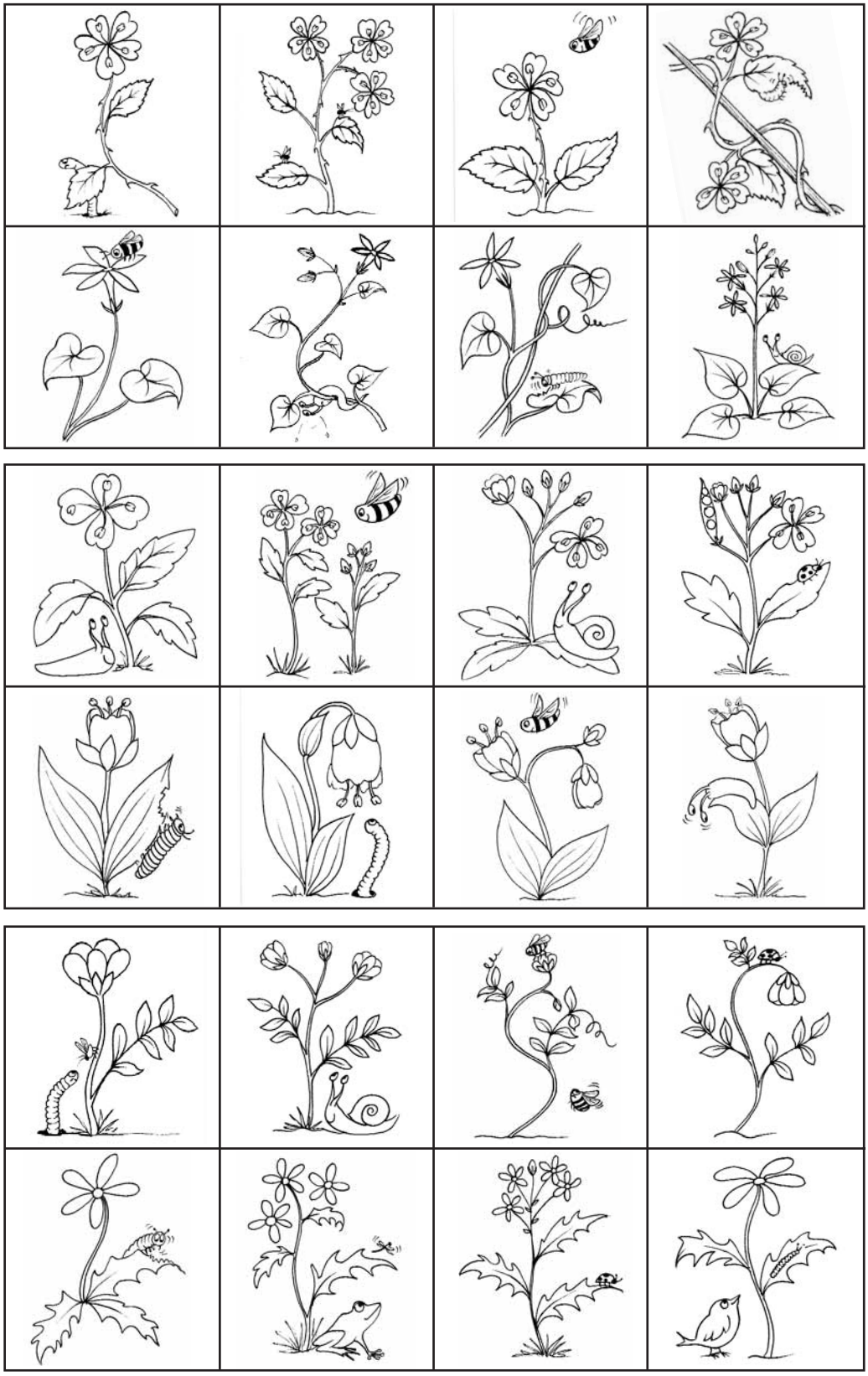


Figure 8. Sort it! - master sheet. This master sheet shows the complete set of cards (reduced size), grouped into 'families', based on certain features shown by the different plants on the cards. This page can be used as a template to make a pack of cards (see instructions on page 17). Full-sized templates are available on the SAPS website.

Making and using keys

Teacher Guidance

Activities in earlier sections should have laid foundations that lead children to these more complex activities, in which they apply their observation and sorting skills to the practical activities of making and using a key. Using liquorice allsorts as a simple starter, children have a bit of fun and also establish the principles of making a key. They are then taken through a series of steps using leaves, first to make accurate observations that they build up into a 'fact file'. From this they can take the next steps and convert the 'fact file' into a key. At least one species of buttercup is likely to be found near most schools, so, for the final activity, children can 'follow the trail' and identify a buttercup. This is an activity that draws together a range of skills, particularly careful observation, developed in the earlier range of activities. This is beautifully illustrated with photographs, intended to be used for confirmation *after* the identification has been attempted. This activity also enables some revision of flower parts, providing a link with booklet 2.2 (*Reproduction and life cycles Part 2: Pollination, fertilisation, fruits and seed dispersal*).

Activity 1: Introducing keys – with liquorice allsorts

Several versions of 'liquorice allsorts' keys are already in circulation, and it is difficult to know where the idea originated. We include yet another version in this booklet, because liquorice allsorts are bright and appealing to children and also have enough different characters to enable children to sort and group them in different ways and then devise a simple key to 'identify' the particular one they have got. To make the exercise even more interesting, you may wish to give the children some information about the liquorice plant (see SAPS website).

Liquorice allsorts have differences and similarities that are easy to see and observe and only a simple vocabulary is needed to describe them. The characters include shape, colour and arrangement of the layers. (Similar exercises can be devised with 'Dolly mixtures'.) As a starter, this is a good way to establish the principles of making and using a key, before going ahead with more complex material using plants. (See also further information on making and using keys in Background information for teachers, page 33.)

You need a packet of liquorice allsorts from which you can make selections of different kind of sweets. It is best for the children to use the real thing in the activity, but you can use pictures if you have difficulty in obtaining liquorice allsorts. A set of photographs of the 'standard' kinds of liquorice allsorts in a typical pack is given on the SAPS website. You can download these and cut out the pictures for the children in your class.

The activity

The children work in small groups. Choose four liquorice allsorts and give each group of children a set of these four sweets. Ask the children to look at the characteristics (features) of their four sweets, then begin to collect their descriptions on the 'board' (in whatever form is suitable).

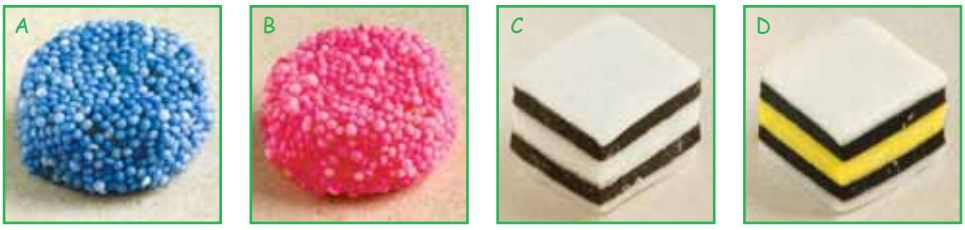


Figure 9. Examples of liquorice allsorts sweets, selected to make a simple key.

Next ask the children to sort the sweets into two groups. Then the children need to find a question that gives a reason for the separation into groups. An example could be "**Is it round?**"

If they use the four sweets shown on the previous page, the answer is YES for A and B, but NO for C and D. They can group the YES sweets together, separate from the NO sweets. They then find a question that can separate A and B, and another question that can separate C and D. Possible questions for A and B – "**Is it blue?**", or for C and D – "**Is it only black and white?**"

Help the children build up a chart to summarise their questions. You can do this by using an interactive whiteboard or by writing the questions on 'Post-it' notes and sticking them on a board. Already they have created a very simple key. Here is how this could be laid out.

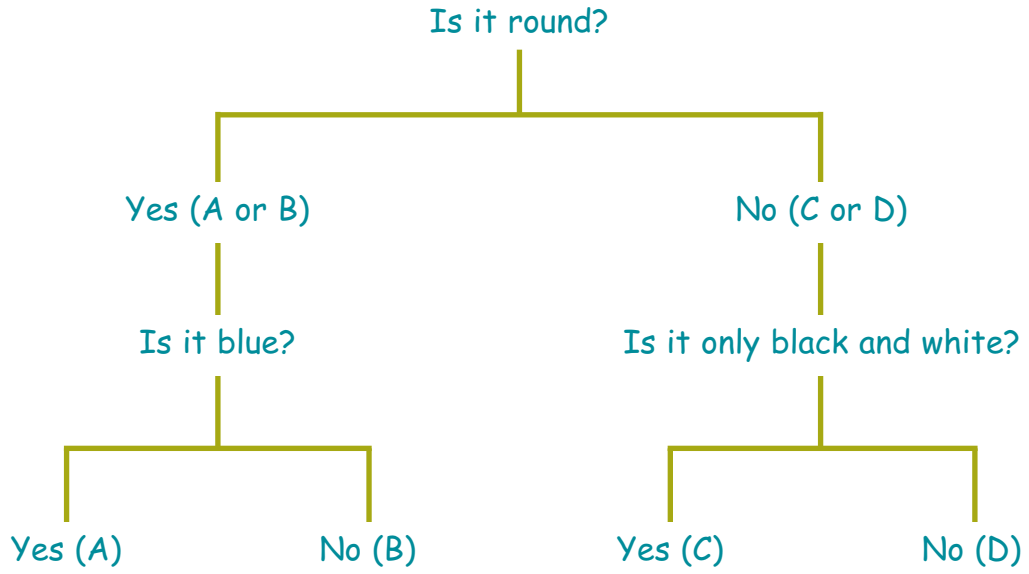


Figure 10. An example of a simple key to four liquorice allsort sweets, developed from a sorting exercise.

Let the children check the pathway through (to 'identify' a sweet). They pick one of the sweets, then start with the first question at the top.

You can extend the activity by using more sweets. Put the children into small groups and give six different sweets to each group. Soon they would see that this key works only for the four sweets used. If they want to add more sweets, they have to think of more questions. See if they can make their own key. They will probably find it helpful if they name each sweet, say with a letter or the name of a person. You can find an example of a key made with six liquorice allsorts on page 34.

From this introductory exercise, the children should then be ready to move on to a more advanced exercise, such as Activity 2 (Making a key – using leaves – see page 21) or Activity 3 (Using a key – following the trail with buttercups – see page 25). An activity giving further ways of using liquorice allsorts in the development of keys is available on the SAPS website.

Curriculum links

National Curriculum (Sc2)	**KS2: 4a**
QCA guidelines – Scheme of work	**Unit 4B**
Scottish ISE 5-14 framework/attainment targets	**LT-C1.3; E1.2**

Activity 2: Making a key – using leaves (mainly from tree and hedgerow plants)

This activity builds on other activities that have focussed on children making observations on leaves and describing them. The activity leads children to the stage of being able to construct their own key, using the observations they have made. The finished key can then be used to 'identify' a particular leaf by working systematically through the series of questions, and following the pathway that leads on from each answer. Before starting this activity, teachers may find it helpful to read the notes on 'Constructing keys' in the Background information for teachers (page 33).

Resources and preparation for the activity

You need some leaves – a minimum of five species and up to a maximum of about eight. Figure 11 gives examples of suitable leaves. If you choose two leaves from each group, you have a good selection to make a key.

If possible, collect fresh leaves for the children to use for their observations. In an urban area, most of the leaves can be obtained from trees or hedges in parks or gardens, or in the school grounds. The set of scanned leaves in Figure 3 (page 11) is also available on the SAPS website for you to download if you are unable to find fresh leaves. Note that some features of the leaf, such as texture or hairiness, are not easy to describe from scanned leaves.

The activity

The children work in groups. Give each group some leaves from one of the species you have chosen. Each group has a different leaf species. First, ask each group to look carefully at the leaves they have been given and collect information about them. They record this information in the 'Leaf fact file' on the Pupil Sheet (page 22). On the same page, the children can draw a picture of their leaf, being careful that they have accurately represented all features, especially those that they have recorded in their fact file.

Next, working as a whole class, collect information about all the leaves and put this into a 'leaf character table' (page 23). Write the names of the species used in the boxes across the top of the table.

Now the children can begin to construct a key. Work with the children to help them sort the leaves into two groups, using the information in the character table. Using 'post-it' notes, write down the character they have used to make the separation and stick these notes onto a board. Alternatively, you may prefer to work with an interactive whiteboard. Then take each of the two groups in turn and divide it into successively smaller groups. At each stage, record the character used to make the separation on post-it notes. An example of a key created in this way with liquorice allsorts is shown in Figure 16 (page 34) and an example of a key with leaves is given on the SAPS website.

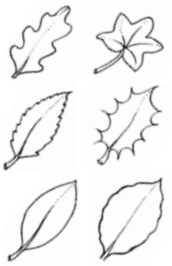
Let the children check whether the key works. They choose a leaf, then try to key it out by beginning at the START and see whether the children can identify the leaf correctly. Remember, the key does not work for leaves outside the list you used to construct it.

Curriculum links

National Curriculum (Sc2)	**KS2: 4a**
QCA guidelines – Scheme of work	**Unit 4B**
Scottish ISE 5-14 framework/attainment targets	**LT-C1.3**

Leaf fact file

Look at your leaf and write the answer **yes** or **no** beside each question



1. Is the leaf lobed? _____
2. Do the leaf edges have teeth or prickles? _____
3. Are the leaf edges smooth or slightly wavy? _____
4. Does the leaf have one main vein (running from the stalk to the leaf tip)? _____
5. Does the leaf have more than one main vein (running from the leaf stalk to the leaf edges)? _____
6. Do the side veins mostly come off the main veins in pairs? _____
7. Do the side veins all come off the main vein one at a time? _____
8. Is the leaf stalk longer than 1 cm? (You will need a ruler to answer this question) _____
9. Does the leaf stalk have small bumps on it? (These are glands) _____
10. Is the leaf stalk red? _____
11. Is there anything else interesting about your leaf? _____

Draw a picture of your leaf here

Leaf character table

Write the names of the leaves you are using in the class in the boxes under 'Leaf name'.
Tick in the boxes below if your leaf has these characters.
You can then use information from the leaf fact files from all the groups in the class to complete the table.

Character	Leaf name					
Leaf is lobed						
Leaf edge has teeth or prickles						
Leaf edge is smooth or slightly wavy						
Leaf has one main vein (running from stalk to leaf tip)						
Leaf has more than one main vein (running from the stalk to the leaf edges)						
Side veins mostly come off the main veins in pairs						
Side veins all come off the main vein one at a time						
Leaf stalk is longer than 1 cm						
Leaf stalk has small bumps on it (these are glands)						
Leaf stalk is red						

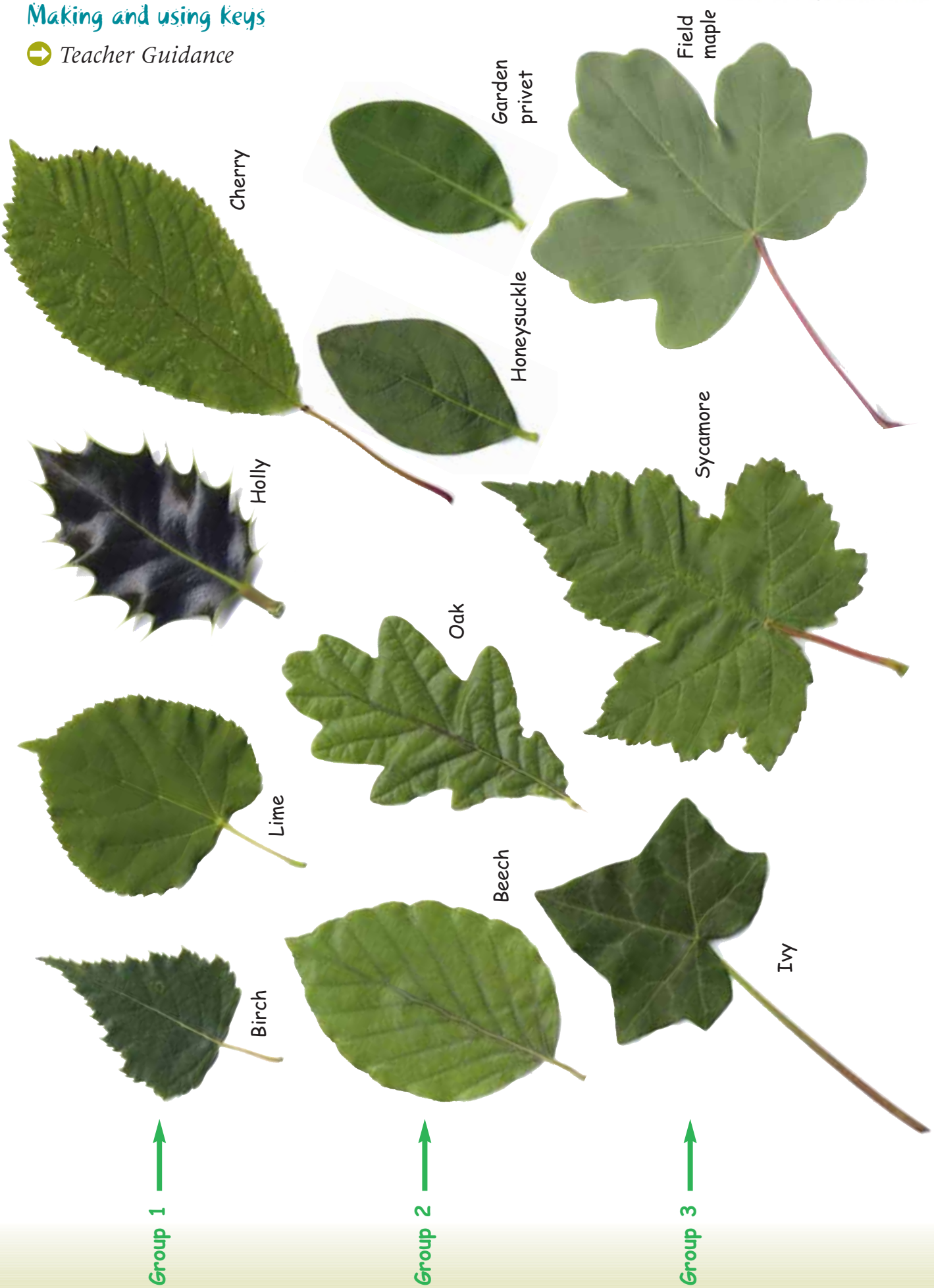


Figure 11. Suggested leaves to use for making a leaf key. Choose two leaves from each group to have a good selection. (These leaves are slightly smaller than life size.)

Activity 3: Using a key – following the trail with buttercups

This activity gives children an opportunity to use a key to identify (and name) certain buttercups. It is suitable for upper primary children, particularly as an extension activity.

The simple key provided includes seven members of the buttercup group (Genus *Ranunculus*). All have yellow flowers and are common and widespread. They include species known correctly as buttercups as well as some that closely resemble buttercups and are often mistaken for them. The buttercups included in the key flower from early spring to late summer. You only need one or two examples, so, wherever your school is, you should be able to find some buttercups in flower nearby. Usually the end of the summer term is the best time for this activity.

This activity provides a useful way of revising what the children know about the parts of a flower. Before using the key, let the children look closely at a buttercup flower and take it apart (see booklet 2.1 – *Reproduction and life cycles Part 1: Parts of a flower*, page 5). A drawing of a dissected buttercup flower is given on the SAPS website, together with notes that help to interpret its structure. Using the key then helps the children to reinforce what they have learnt and begin to understand how the flower parts, as well as characters of the leaf and stem, can be important when trying to identify the species.

The activity

Take the children out into the field where you know some buttercups are growing. Alternatively, do this as a classroom activity and bring some buttercup flowers into the room. It is very difficult to do this successfully from pictures of flowers, simply because the children cannot examine the flowers closely enough to see the necessary detail.

The children can work in groups. Ask the children, in their groups, to answer the questions on the Pupil Sheet 'Buttercup fact file' (page 26). As they do this, they can make a drawing of the buttercup flower and leaf, showing the important features that they have observed. This completes their observations on the buttercup.

The children can then start to work through the pathway of the key, starting from 'START HERE' at the top. At each level, they decide which alternative is correct, then follow the pathway to the next pair of statements in the trail. They have already answered several of the 'questions' when building up their Buttercup fact file.

Pictures and some notes relating to the different kinds of buttercup are provided on pages 28 to 29. These can be used for confirmation **after** the children have worked through the key.

Curriculum links

National Curriculum (Sc2)	**KS2: 4a**
QCA guidelines – Scheme of work	**Unit 4B; Unit 6A**
Scottish ISE 5-14 framework/attainment targets	**LT-C1.3**

Making and using keys

Pupil Sheet

Buttercup fact file

1. How many sepals are there? _____ How many petals are there? _____

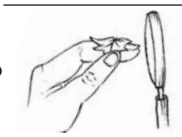
2. Are the leaf blades divided up into smaller leaflets or deeply lobed?

leaflet _____

3. Are the sepals turned back?

_____

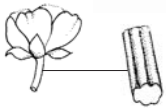
4. Are the leaves covered in tiny hairs?



wrap the leaf around your finger and use a magnifying glass to see the hairs

_____

5. Do the flower stalks have clear grooves running along their length?



_____

6. What sort of place was the plant growing in (e.g. a grassy field, a woodland, the edge of a pond)? _____

7. Is there anything else interesting that you have noticed about your plant? _____

_____

_____

Draw a picture of the flower here	Draw a picture of the leaf here

Now use the key to find out the name of your 'buttercup'.

A key to common buttercups

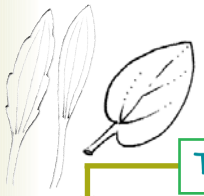
Which buttercup have you found? Follow the trail to find out

Start here

Most flowers have 5 sepals and 5 petals or fewer than 5 petals

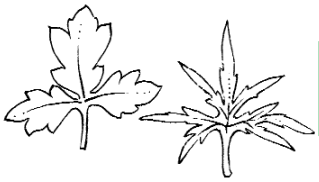
Most flowers have 3 sepals and 7 to 12 petals

Lesser celandine

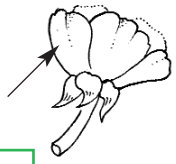


The leaves are not lobed

Lesser spearwort

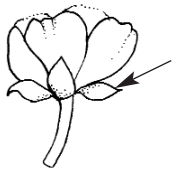


The leaves are deeply lobed or divided into smaller leaves (leaflets)



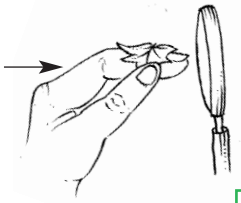
The open flower has its sepals turned back

Bulbous buttercup



The open flower has upright sepals

The leaves have lots of tiny hairs



Wrap the leaf around your finger and use a magnifying glass

The leaves are not hairy or have only a few hairs

The stalks with flowers have clear grooves. The leaflets have stalks

Creeping buttercup

The stalks with flowers do not have grooves. The leaflets have no stalks

Meadow buttercup

The flowers are less than 1 cm across. A plant of wet places

Celery-leaved buttercup

The flowers are more than 1 cm across. A woodland plant

Goldilocks buttercup

The flowers on this plant often have petals missing

If your flower has missing and deformed petals it may be the Goldilocks buttercup. This sometimes has a few hairs on its leaves

Goldilocks buttercup

Usually found in woodland. Flowers in April and May.

Goldilocks flower showing missing and deformed petals.

Leaf at bottom of plant.

Leaf from flowering stem – notice it has no hairs.

Lesser celandine

Common in woodland, grassland and on stream sides. Flowers in April and May.

Most flowers of the lesser celandine have 3 sepals and 7 to 12 petals.

Heart-shaped lesser celandine leaves.

Celery-leaved buttercup

Common on damp mud at the edges of ponds. Flowers from May to September.

Leaf from celery-leaved buttercup showing no hairs.

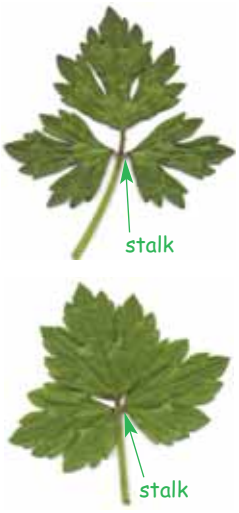
Bulbous buttercup

Found in dry, grassy areas. Flowers in May and June.

Bulbous buttercup showing its turned back sepals. Like the creeping buttercup (see below) the leaflets have stalks.

Creeping buttercup

Found in damp, grassy places and woodland. Also a common garden weed. Flowers from May to August.



Flower showing upright sepals and a grooved stalk. The leaflets have stalks.

Lesser spearwort

Common in wet places e.g. edges of ponds. Flowers from June to August.

Meadow buttercup

Common in grassy places. Flowers in June and July.

Flower showing upright sepals and a smooth stalk. The leaflets have no stalks.

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.

At primary level, it is often not easy for children to appreciate that plants (even trees!) are living things, that they reproduce, require food, show sensitivity and do all the things that the more familiar animals do. However, the activities in the booklet should help children develop understanding at a suitable level and these notes aim to give teachers enough support to be able to respond to questions from curious children that are appropriate for their understanding, yet still biologically correct. The outline classification, with emphasis on plant groups, goes beyond what primary children would be expected to know, but it is important for teachers to be aware of the correct framework, so that it can be passed on to children if the discussions go further in the class. The guidance given on construction of keys should help teachers gain confidence as they do this with children in their class.

The PowerPoint 'What's in a name?' (available on the SAPS website), makes children think about why plants have names and where these names came from. With a few light-hearted examples, the PowerPoint explores the origins of some plant names and looks briefly at the history of scientific naming of plants. It also highlights ways in which plants are important to people. Use the PowerPoint as a way of introducing topics related to grouping, classification and naming of living organisms. Or you can also use it as an end of topic activity to stimulate discussion on what they have done in the different activities described in the booklet.

Characteristics of living things

In their own way, children are aware of most of these characteristics, but may find it difficult to understand them fully and express their ideas in suitable scientific terms. In particular, they often do not find it easy to apply the descriptions to plants. These notes attempt to give a basic understanding that teachers can use with children and which can be built on as children's knowledge progresses and they become more familiar with the biological processes that occur in living things. Unfortunately, a number of words are used loosely in everyday language and so there are conflicts with correct biological use. As far as possible, teachers should try to establish the correct use of words to avoid misuse at a later stage.

The mnemonic **M R S G R E N** is a useful way of remembering the seven processes that are characteristic of living things and the name helps to give children a way of remembering them. Some teachers may prefer the mnemonic 'MRS NERG' or have other ways of reminding the children about the characteristics in the 'list'.

For convenience, these notes are presented in the sequence **M R S G R E N**. For each characteristic, we make sure that suitable emphasis is given to how plants carry out the process. For most children, you are likely to deal with movement, nutrition, growth and reproduction, but with more able children you may wish to consider all of them. In discussions with children, remember that non-living organisms may show some of these characteristics, but never all of them.

Movement

All living things move in some way. Most animals are mobile and move their whole body from place to place (e.g. by swimming, walking or flying). In plants, movements are less obvious and usually involve parts of a plant rather than the whole plant. Examples are seen in the way leaves turn towards light and roots grow downwards into the soil. Tendrils on a sugar snap pea plant rotate (or move around) until they touch something they then cling to.

Figure 12. Movement of parts of plants – these images of a sugar snap pea shows (1) the young tendril, (2) the young tendril growing in a wide circle thus increasing its chance of making contact and finally (3) making contact with a stick and coiling round it.

Respiration

In the cells of living things, respiration is the process by which energy is released from food. Oxygen is usually required to do this and carbon dioxide and water are produced. Remember, all living things carry out respiration all the time. If a living thing stops respiring it is no longer alive. Respiration should not be confused with breathing. Children should understand that, in humans (and many other animals), breathing is the way in which we get air into and out of our lungs, and so get oxygen into the body and remove carbon dioxide. (See booklet 3 *Living processes and what plants need to grow*, page 49.)

Sensitivity

Living things can react to what is happening around them. For example, humans can feel the difference between hot and cold, a person jumps in response to a loud noise and a plant shoot grows towards light (see Figure 14). In plants, response (sensitivity) is often linked to growth and movement.

Figure 13. Touch a sensitive plant and watch its leaves collapse – a sensitive plant (*Mimosa pudica*) before being touched (1) and after being touched (2).

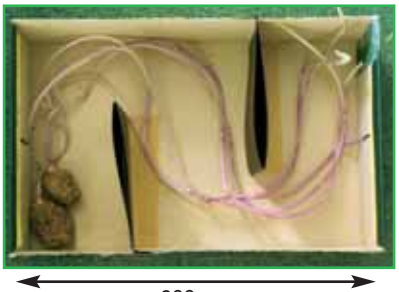


Figure 14. Response and sensitivity – the potato was left in the shoe box, with a lid on, for 12 weeks. The potato shoots grew round the two barriers in the box, towards the hole that was letting in some light. This illustrates response to light.

Growth

Over a period of time, living things make new materials and become larger and more complex. Damaged parts of both animals and plants can also be repaired by new growth. Living things use some of the energy released from their food for growing and food materials are incorporated into the new parts or increased size.

Figure 15. Compare the sizes of this beech seedling (about 4 cm high) and the mature beech tree (up to 40 m in height). A lot of new material has contributed to the growth of this tree.

Reproduction

All living things can reproduce, making more living things like themselves. (See *Reproduction and life cycles – parts 1 and 2* for sexual reproduction in plants, and booklet 3 *Living processes and what plants need to grow*, for some information on asexual reproduction in plants.)

Excretion

All living things get rid of the waste materials produced from living processes. Both animals and plants give off carbon dioxide as a waste material from respiration. In humans, another example of an excreted material is contained in the liquid known as urine, and plants give off waste oxygen from photosynthesis. Children are likely to ask about faeces and whether this is part of excretion. You can explain that this is material that has been through the body but not actually taken part in the living processes inside cells. Biologists do not use the term 'excretion' for material contained in faeces.

Nutrition

Living things need energy for the various living processes they carry out. They get this energy from their food (see Respiration, above). Plants make their food from carbon dioxide and water, using energy from sunlight, in the process known as photosynthesis. Animals get their food by eating plants or other animals. (See also booklet 1 *Parts of a plant and their functions*, page 20, and booklet 3 *Living processes and what plants need to grow*, page 49.)

Background information for teachers

Constructing Keys

The principles that provide the basis for construction of keys have all been covered, stage by stage, in the various activities in this booklet. Children who have progressed through a reasonable selection of these activities should have developed skills that enable them both to use and to construct a key. You (and the children) may be surprised that it does fall into place, usually quite successfully.

The liquorice allsorts activity (see page 19) is a good, simple sorting activity. The characters used (mostly shape, colour and arrangement of the different layers) are obvious, bright and appealing. Children are likely to get on with the sorting and devising questions to support their groups and have built up a simple key before they realise what they have done. It is, therefore, good as an activity to introduce constructing keys.

To construct (and use) keys with plant material, involves much more information. Children need to make more critical observations of features in the plant material. They also learn that living things often show a lot of variability and this needs to be considered when handling the information. For example, individual plants of the same species may have flowers of different colours and even single plants may have leaves with different shapes and sizes. The best characters to use for sorting and classifying are those that don't vary.

Children then need to organise the information into a form they can utilise when building up a key. Creating a 'fact file' can prove very useful as an intermediate step. Following on from this, the 'character table' is a way of collecting together information from different groups of children who will have been making their own fact files for different material. With the help of the teacher, this information can then easily be sorted into a simple key (see Figure 16). More able children can be encouraged to move on from a YES / NO approach in answer to questions to devising matched alternative descriptions for their choices when moving through the key.

We suggest the following sequence of steps for constructing a simple dichotomous key. (This is a key with two branches at each stage.)

Step 1. Describing and making a fact file

The children make careful observations and accurately describe the specimens (items / objects / species) they have been given or chosen. They should be encouraged to use suitable vocabulary and give measurements where appropriate. It is often helpful to guide children by giving them a series of questions. These questions help them collect suitable information and to create a 'fact file' for the specimens they are looking at (see Pupil Sheet on page 22 for an example).

Step 2. Creating a character table

The information collected in the fact files created by the children is collated and summarised in a 'character table' (see Pupil Sheet on page 23 for an example).

Step 3. Separating the specimens into groups

The children use the character table, and look for differences and similarities between the specimens. Using their sorting skills, they then separate the specimens into two groups. Then, taking each of these two groups in turn, the children progressively sort the specimens into smaller groups and finally to individuals.

When separating items (specimens) into groups, there is no need for these groups to be equal in size. This is often advocated by teachers as the only correct way of making a key. Equal-sized groups do lead to a shorter key and, conversely, keying off one specimen at a time gives a longer key. Some sort of compromise needs to be reached. If a specimen has a very distinctive character (say prickles) which is not shared by any of the other specimens, it is often useful to separate this specimen right at the beginning of the key. This would lead to a 'very small' group, but the rest may be more evenly balanced. We should not lose sight of the fact that, in the real world, the best (and most user-friendly) keys often have uneven-sized groups. The compromise is likely to be a mixture of these two approaches (see Figure 17 on page 34).

For practical advice on how to create a key from the character table, see 'Making a key – using leaves'. Note that when using plant material, the 'specimens' are often (but not always) separate species. Remember – there are usually several different ways that you can construct a key, but at each stage, you focus on the special characters of a particular species, and this would enable a person to name the species you are referring to.

When the key is complete, it can be tidied up and perhaps formatted to fit an A3 or A4 page. The key can be written manually or it may be possible for children to use their IT skills. You may also be able to photocopy or scan the children's drawings, reduce them in size and use them to illustrate the key.

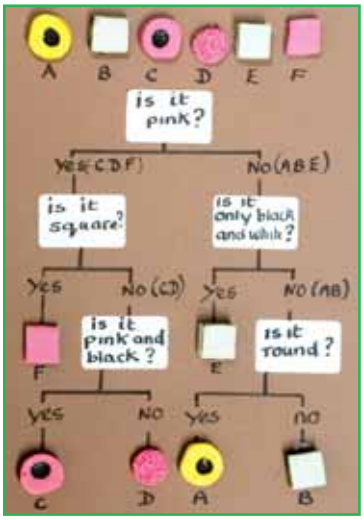


Figure 16. An example of a simple key to six liquorice allsorts.

An alternative activity for constructing a key using fruit dispersal mechanisms is available on the SAPS website. This shows an example of a key devised in this way by pupils from Ursuline Preparatory School, Wimbledon (in October 2001).

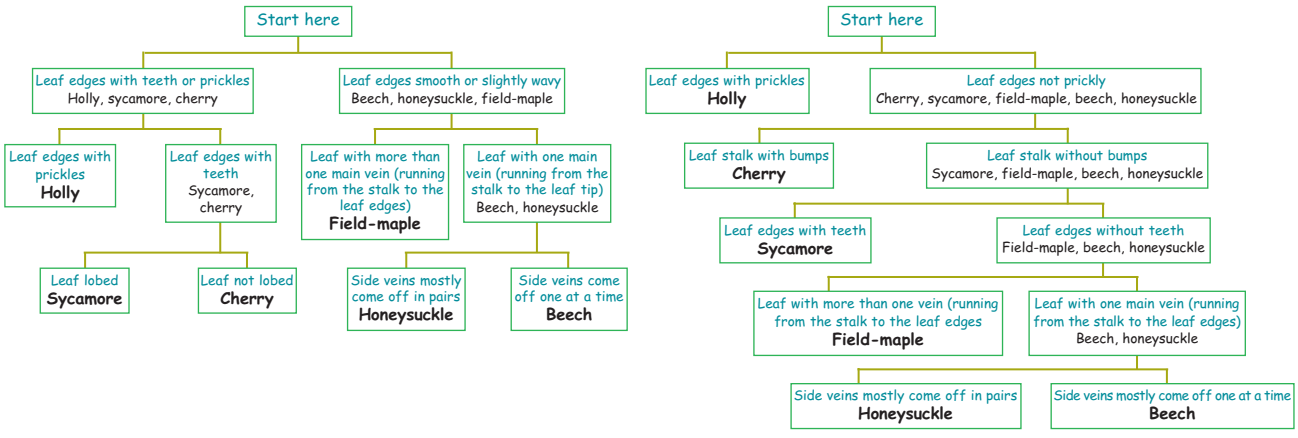


Figure 17. Leaves chosen: holly, cherry, honeysuckle, sycamore, field-maple, beech. The shorter key on the left uses equal-sized groups. The key on the right keys off one specimen at a time and results in a longer key, but sometimes this is appropriate for part of the key.

Background information for teachers

Classification of living things

Children need to understand why living things are classified. They should also understand that a classification system is devised by people and can change, but at primary level they are not expected to know details of how living things are classified. These notes are provided for teachers to help you understand the broad classification of living things and to answer questions from children when they ask about the classification of different things (e.g. 'What is a mushroom?').

Why do we classify things?

When there are large numbers of things (like living things), our senses become overwhelmed by information. Sorting helps us to make sense of the information. We put things into categories and can see patterns, reflecting similarities and differences between them. It is at this stage we realise how important it is for the 'things' we are sorting to have names. It gets rather cumbersome to say the 'long pointed orange things with leaves on top' – it's much easier just to talk about 'carrots'.

Why does the classification of living things change?

Because of the huge number and variety of living things, it is difficult to fit them all neatly into groups. (One estimate of those so far discovered suggests the number is in the region of 1.75 million.) New living things are constantly being discovered and these may not fit into the existing groups. In addition, new ideas about how living things should be grouped are put forward by scientists and this leads to changes in the classification used.

The Five Kingdom classification

Currently, the most widely accepted classification of living things is the 'Five Kingdom' classification. The major groups, known as **kingdoms** are: Prokaryotae, Protoctista, Fungi, Plantae, Animalia. Here we give an outline of the main features of members of the plant kingdom, illustrated by examples of the five main groups of plants. A similar outline of all five kingdoms (prokaryotes, protoctista, fungi, plants and animals) is given on the SAPS website. Also on the SAPS website is a PowerPoint presentation 'What's in a name?' and it may be useful to view this alongside discussions of classification.

Plantae

- Multicellular organisms
- Non-motile (do not move from place to place)
- Contain chlorophyll (so make food through photosynthesis – but there are a few parasitic forms)
- Cell walls contain cellulose

There are four main groups of plants:

Mosses and liverworts

A thalloid liverwort (*Marchantia* sp.)

Wall screw moss (*Tortula* sp.)

Ferns, horsetails, etc.

Male fern (*Dryopteris filix-mas*)

Horsetail (*Equisetum telmateia*)

Conifers

Male and female 'flowers' of Scots pine (*Pinus sylvestris*)

Norway spruce (*Picea abies*) with cones

Flowering plants

Wild strawberry (*Fragaria vesca*)
Flowers and fruit

Field maple (*Acer campestre*)
Flowers and leaves

Field maple (*Acer campestre*)
Fruits and leaves

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Grouping and classification

Grouping and classification is the fourth theme in a series of booklets being developed to cover the work that must be undertaken with plants as part of the Primary curriculum. In this booklet, children explore the nature of living things, find ways to group living and non-living things, and understand how we classify living things and why we give them names. Children learn to make simple keys and use them to identify certain plants. 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.

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