UTTERLY JARVELLOUS

50 PRIMARY SCIENCE ACTIVITIES YOU CAN DO IN A JAR

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Finally, I owe an eternal amount of gratitude to my awe-inspiring, encouraging and ever-supportive parents and brother for always being there for me, nurturing my curiosity and love for learning, and continually joining me on my journey discovering the wonders of science.

Thank you. You're all utterly marvellous!

INTRODUCTION

This book contains a set of 50 (and more, if you explore!) easily accessible, environmentally friendly, incredibly low-cost hands-on activities for children to try out under the supervision of an educator. Its primary audience is teachers of seven- to 11-year-old pupils, but parents and carers, especially homeschoolers, will find this book useful too, as all items can be found within the home and local outdoor areas. All you need to start is a jar!

The aim of each activity is to inspire children to think about science and to play, experiment and link what they observe back to things they've seen or heard of before. For example, do they know why soap helps clean their hands? There are many STEM (science, technology, engineering and mathematics) activities that can be demonstrated with a piece of paper, a pencil or a paperclip, but some of the most engaging and impressive ones need a container of some sort. And with more and more of us reassessing our plastic consumption, the need for environmentally friendly educational activities is vital.

Science isn't just about big explosions and huge chemical reactions. With a few pieces of simple equipment, the science can be just as impressive, if not more so. It's because children get to do it themselves and see the applications and how these activities connect to their daily lives. Children enjoy creating individual experiments on a small scale – for them to take ownership of and observe. Science creates a sense of awe and wonder about the world around us, making us ask questions to figure it all out. As educators we don't know all the answers and we don't need to, but we can work with children to listen to their ideas and encourage them to test them out. The excitement of seeing a reaction happen in their jar, that they've created, will be enough for children to start thinking like a scientist and wanting to investigate further. Every single science experience helps add to a child's science capital, which can help them have a positive outlook about science as they grow older and even encourage them to consider science as a future career.

WHAT TO EXPECT FROM THIS BOOK

The activities in this book are linked to the Key Stage 2 National Curriculum in England, to support the teaching of science to children aged seven to 11. The activities are divided into parts based on the main curriculum area they cover, but most link to more than one curriculum area. Each activity comes with teaching notes that outline the experiment and explain the science behind it, in other words what happens and why. There are photocopiable (or projectable) worksheets for the children complete with instructions to follow the main activity, so they can work a little more independently and record their data, observations and predictions. Questions on the worksheets often prompt children to answer 'What if?' and 'What do you think?', and if there's time children could actually test out their own hypotheses. Each activity provides various alternatives including optional materials. These are only needed if carrying out the further investigative science work given in the 'Explore even more' sections.

The science explanations in the 'What is happening?' sections are full of detail for inquisitive children such as those who attend science clubs. For others, depending on their age, interests and understanding, less of this detail may be appropriate. Feel free to use as much or as little of these descriptions as you need. Children will start to make connections between the science explanations in each activity (and their prior knowledge), helping them understand that with many of the phenomena we see every day, there are several factors at play.

Some activities complement each other because they cover similar topics or use the same materials. This is mentioned in the 'Other activities' sections. By revisiting topics through different activities and using this book alongside other science educational experiences, children's science learning can be reinforced.

THE STORY BEHIND THIS BOOK

I have been working in science education and outreach for 20 years and have always believed that everyone learns best when they're doing something – especially when learning about science.

Working with schools on a regular basis, within classrooms and after-school science clubs, I hear about ever-decreasing school budgets and about the support teachers need to buy equipment and to explain various scientific concepts easily. Teachers mentioned many online resources that have constantly moving webpages (bookmarked webpages may move all the time, but bookmarked activities in this book aren't likely to move, unless you drop the book… not a problem for the e-book version!). Other resources are difficult to download or say 'easy-to-find household materials' but for schools with extremely diverse populations, inclusivity and the offer of adaptations are continually overlooked. For example, we cannot assume that everyone will have access to alcohol itself, let alone wine corks, and some children and teachers may not want to touch beef stock cubes! As resource developers, just because some of us may have these in our homes it doesn't mean everyone will have them. Which is why I feel as someone who works in a diverse range of schools nationally and internationally, understands audiences, and is able to develop and adapt activities, that I can create what I believe is a useful educational activity book.

I have always reused items in my outreach activities but had become increasingly aware of the amount of waste created (whether plastic or food) during events. Using household items should be about repurposing current waste, not going out to buy specific items in order to create more waste. For example, we shouldn't buy a roll of clingfilm purely to use the thick cardboard roll inside it and then throw away all the clingfilm, should we? But unfortunately, it happens. (Those rolls are stronger than kitchen roll tubes and very useful, but what about aluminium foil rolls instead? This way we can use the foil in activities too and reuse or recycle all of it afterwards.)

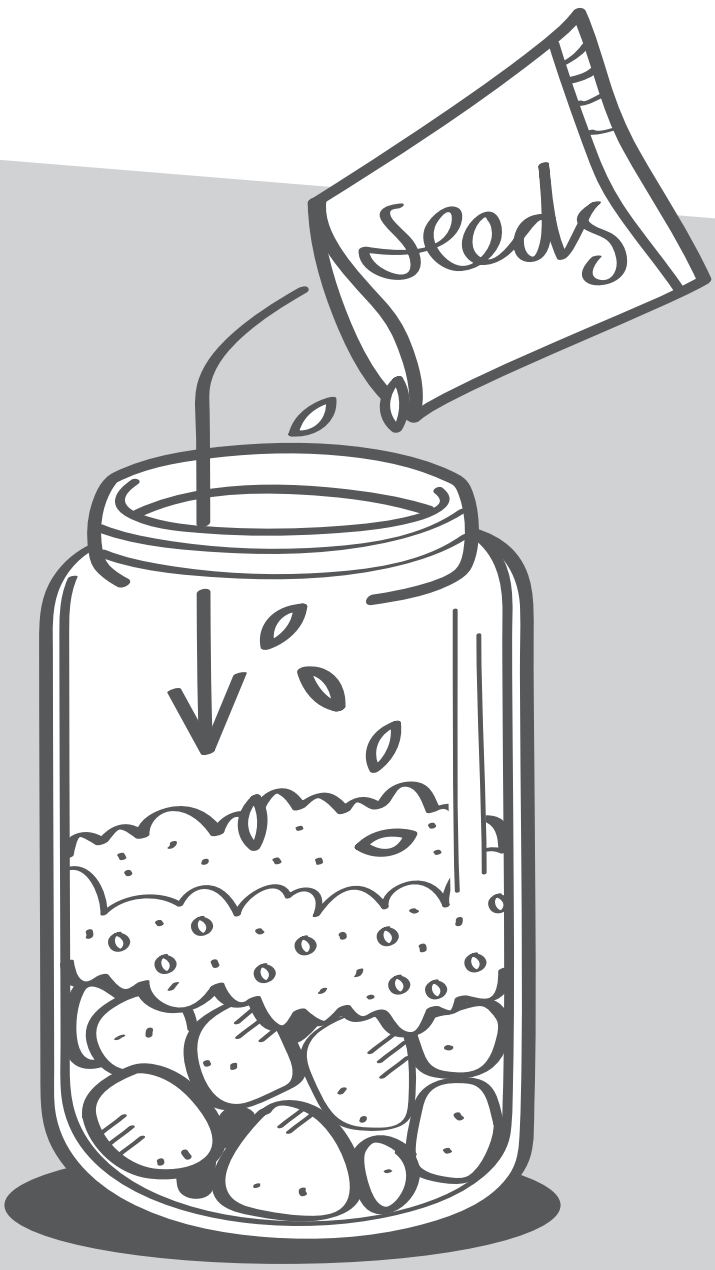
The environmental angle is often encouraged in science activities as 'here's a great way to use your waste'. For years I collected old food containers for children to do their experiments in, which I could rinse and reuse for the next session. And wherever needed (for example, when containers split open), I recycled. I was thrilled when children started asking to take their experiments and creations home. But when some said, 'My mum/dad thought it was rubbish and threw it in the bin', it made me wonder about the environmental repercussions of others disposing what I had given them. While I had the waste I was able to reuse and recycle it, but I had no idea what happened to these items once they'd left me. I felt guilty and a huge sense of responsibility to adapt my activities to ensure that whatever I was supplying, and whatever children were taking home, was either recyclable, edible, biodegradable or compostable. This is how the idea for this book came about.

Everyone has a jar available. We eat jams, pickles, chutneys, olives, relishes… so many foods come in jars! And there's much more to empty jars than trapping spiders (although catching spiders to study and then releasing them outdoors is not a bad use for a jar at all!). As children and budding scientists, jars are the first piece of scientific equipment we see: they look exactly like the beakers and test tubes in labs! Perfect labware hidden in the kitchen. They may be heavier to carry around for outreach, but I feel it's worth it. Jar lids come in all shapes and sizes too, and when upturned they provide useful dishes for leaving smaller reactions happening on the side. Everyone is more likely to reuse glass jars when they see them, rather than throw them away. Volunteers at outreach events always ask where to rinse and keep jars. Plastic containers on the other hand always look destined for the bin even if they are reusable.

As my expertise is in informal science learning, I promote a love for learning that goes beyond curriculum science, so many of the activities in this book take the science a little bit further than the Key Stage 2 curriculum. While there is no need to go into the complexities of the science these activities should serve as a way to introduce concepts within the curriculum and as a gentle, playful introduction to the science children will learn at secondary level and beyond. Let the children's imaginations decide how far they take the experiments and their learning…

Dr Sai Pathmanathan

PART 1
PLANTS



1 LET IT GROW

TIME TAKEN
20–30 minutes to set up, 2–3 weeks for growing and observation

Some children may have already grown a broad bean or kidney bean, but this activity gives children an opportunity to grow seeds and gain a better understanding of how plants grow, and to think about what goes into growing food.

CURRICULUM LINKS

- Year 3 Programme of Study: Plants
- Years 4, 5 and 6 Programmes of Study: Living things and their habitats
- Year 4 Programme of Study: States of matter
- Year 6 Programme of Study: Evolution and inheritance

OTHER ACTIVITIES

This works well with the 'Totally natural' and 'Basil dazzle' activities, as these activities also involve nature, wildlife, seeds and growing.

MATERIALS

REQUIRED:

- Jar and lid (larger ones work best, such as pickle jars)
- Extra jar lid
- Seeds (e.g. basil, coriander, cress, alfalfa, tomato)
- Kitchen roll
- Soil or compost
- Sand or gravel
- Teaspoon
- Water
- Beans (e.g. broad beans, mung beans, kidney beans)

OPTIONAL:

- Pencil
- Thermometers
- Rulers
- Extra jars and lids
- Potato

RUNNING THE ACTIVITY

These activities are best done in the spring, especially if the school has an outdoor area for planting (as then you could move some plants, such as tomatoes, outdoors later). Herbs can be grown indoors all year round.

PART 1

Ask children to place some stones or a layer of gravel at the bottom of a jar, gently add some soil or compost mixed with sand (to ensure good drainage) until half of the jar is full, and to then pour in some water (until the soil looks damp). Give them a choice of seeds to sow (eight to ten seeds each should be enough). Using a teaspoon handle or pencil, they can make some shallow holes in the soil mix and add seeds into these. Ask them to add a little more compost on top, and sprinkle some water using the teaspoon. These mini greenhouse (terrarium) jars can be left on the side, in a sunny area but not in direct sunlight, with the lids on.

Choose a time every two to three days for children to check on their jars and to observe what's happening inside. Does it look like there is enough water inside? When do they see their first seedlings? How could they compare a temperature or light difference on their jars? You could split the class into groups and ask them to investigate a different variable required for seed germination and seedling growth.

Explain that in an experiment there is always a variable (a factor or condition) that is changed. This is known as an independent variable, such as if you were going to change the amount of water poured onto a plant. The other variables (such as the amount of light or soil) are controlled variables, and stay the same.

PART 2

Using another jar lid, children can fold a couple of sheets of kitchen roll and add some water. Then they sprinkle some cress seeds in the shape of their initial. The kitchen roll needs to be kept moist (children can use teaspoons to water their seeds gently, so that the seeds don't move around) and within a few days to a week, they should see some growth. Once the seedlings are long enough, children can cut them off and taste them (see earlier section on safety guidelines).

PART 3

Children could try growing 'zig-zag' plants. Ask them to place a few sheets of kitchen roll to line the inside of the jar and press a broad bean, kidney bean or any other type of bean, between the glass jar wall and the kitchen roll. Ask them to moisten the kitchen roll, put

the lid on the jar, and leave it in a sunny place, but out of direct sunlight. Then as they see the roots and the shoots appear, they can twirl the jar away from the Sun, or turn it upside down. They continue doing this every time they see the roots and shoots growing in a certain direction. The kitchen roll needs to be kept moist.

EXPLORE EVEN MORE

Children could run a variety of investigations. For example, using similar jars with equal amounts of soil and water, can they compare a terrarium containing plants to one without? What does the inside of the jar look like, and does this depend on the temperature of the room? How could they measure the temperature inside the terrarium without always opening the jars?

Or, what is the best medium to germinate and grow seeds on? Tissue, card, soil, sand? How will children measure success? Children could measure the height of the growth, the number of leaves, or the number of seeds that successfully germinated.

They could explore how seed germination is affected by growing in the dark, either by placing the seeds in a dark box or cupboard. And once the seedlings appear, what if these are left in the dark too?

How can children preserve the herbs that they've grown? They could place their herbs in the jar lid and leave this in the Sun. Turning the herbs every day, within two to three days, children should have dried herbs.

WHAT IS HAPPENING?

PLANT LIFE CYCLES

As children are planting, ask them about what is happening at each stage. This is a chance to study plant life cycles. They should notice that by mixing sand and gravel with the soil, this ensures that plants don't get waterlogged. This could lead to their roots rotting away, and the plants will die. Equally, without sunlight and water, plants will die too. Plants use carbon dioxide in the air, and water with energy from the Sun, to make carbohydrates and oxygen through the process of photosynthesis. This is vital for us to live.

In their terrariums, children should see that before the seeds germinate, the water cycle will be taking place. Based on the temperature of the room, water from the soil will evaporate (turn from liquid to gas) and then condense (turn from gas to liquid), like little raindrops. Once the seedlings start to sprout and grow, there will be less evaporation as the water is used by the plant. This is why removing vegetation on the planet, such as deforestation, is bad news for our climate.

In the jar lid, children should see the seeds sprout in the same shape that they sowed them, i.e. their initial (unless the seeds moved during watering). By seeing (and if possible, tasting) what they've grown, children will learn to appreciate the patience required when growing plants. This can encourage a wider discussion about where our food comes from. After spending so long tending to food crops, is it wise to just throw it away? Discussing how to preserve what the children have grown is a way to encourage thinking about not wasting. If we can't eat or sell a crop we've grown, how can we turn it into something else that will keep for longer? If children have grown tomatoes, they could try preserving them as chutneys and relishes.

SEED GERMINATION

By rotating a growing bean, you can train shoots and roots to grow in a different way. Shoots grow upwards towards the Sun, and roots grow downwards responding to gravity, in order to find water. Simply rotating the terrarium or the jar lid sprouts, children will be able to see their seedlings move towards the sunlight too.

Seed germination is the process of growing a plant from a seed. Seeds are usually in a dormant, inactive state, waiting for the conditions to be just right to germinate and grow. Different media can affect seed germination mainly by how much water they hold. Once the seed has germinated, it also depends on which of the media allows the seedlings to grow upright and anchor well.

Seed germination itself is rarely a problem in the dark (although it depends on the species of plant), as most seeds germinate deep in the dark soil. However, new seedlings will need light. If they don't have light to produce chlorophyll (the pigment that makes them green and is vital for photosynthesis), they will look yellow, then wilt and die.

Sometimes fungi and moulds may grow in the children's terrariums, which can be a point for discussion. Spores in the air can land on the soil and begin to grow. While these might end up killing off the young seedlings, fungi and mould are vital in breaking down organic matter, such as in compost heaps, so that nutrients can be released back into the soil.

EVOLUTION AND INHERITANCE

If any children have grown coriander in this activity, an interesting taste test can be done. Some individuals have a gene that makes coriander taste like soap! Do any of the children find this happens to them too?

Sometimes we can get new plants from a parent plant. Potatoes are great to grow… from potatoes. As a stem tuber (a starchy storage part of the plant) that forms through asexual reproduction, the potatoes grown will be genetically identical to the parent. Children can leave some potatoes sitting on small jars or jar lids in a sunny area, to chit, or sprout. Then, once they see the small sprouts appear, they can plant them outdoors. (Unfortunately, a jar is too small, unless they want to grow one teeny potato!) Within days children should see a large green plant gradually start to appear… and eventually, under the soil will be potatoes!

1 LET IT GROW

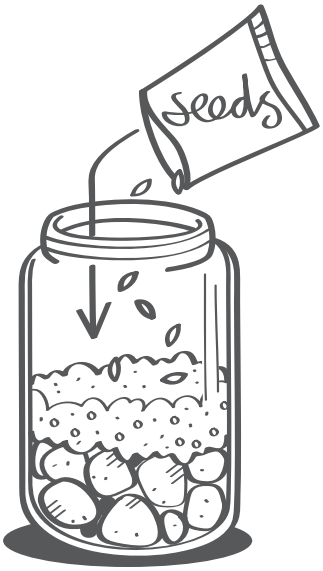
WORKSHEET

YOU WILL NEED:

- Jar and lid (larger ones work best, such as pickle jars)
- Extra jar lid
- Seeds (e.g. basil, coriander, cress, alfalfa, tomato)
- Kitchen roll
- Soil or compost
- Sand or gravel
- Teaspoon
- Water
- Beans (e.g. broad beans, mung beans, kidney beans)

INSTRUCTIONS

PICKLE JAR TERRARIUM



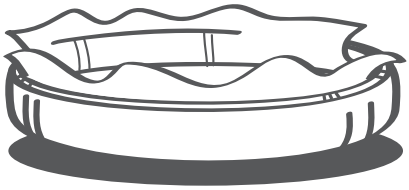
1. Place some stones at the bottom of your jar and add some soil or compost mixed with sand (to make sure the water drains well) until half your jar is full. This is your mini greenhouse, or terrarium.
2. Choose some seeds you'd like to grow.
3. Pour some water into your jar (or use a teaspoon) so that the soil looks and feels damp. Then make four or five small holes (spaced apart) in the soil with a teaspoon handle or pencil.
4. Drop a couple of seeds into each hole, making sure you're not overcrowding them too much. Seeds don't like to be in competition.
5. Add a little more soil to the top and water gently using a teaspoon.
6. Add the lid onto your terrarium and leave this in a sunny spot, but out of direct sunlight. Why do you think this is important?
7. Observe your terrarium over a few days. What does it look like inside the jar? You may need to add a little more water, using a teaspoon, if it starts to look a bit dry inside. You can record more of your observations below. When do you see your first seedling? How many of your seeds become seedlings?

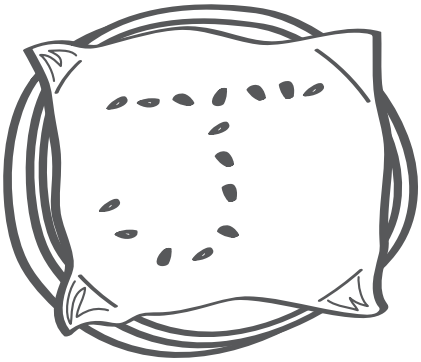
Date	Temperature	Observation inside terrarium

1 LET IT GROW

(CONTINUED)

WORKSHEET



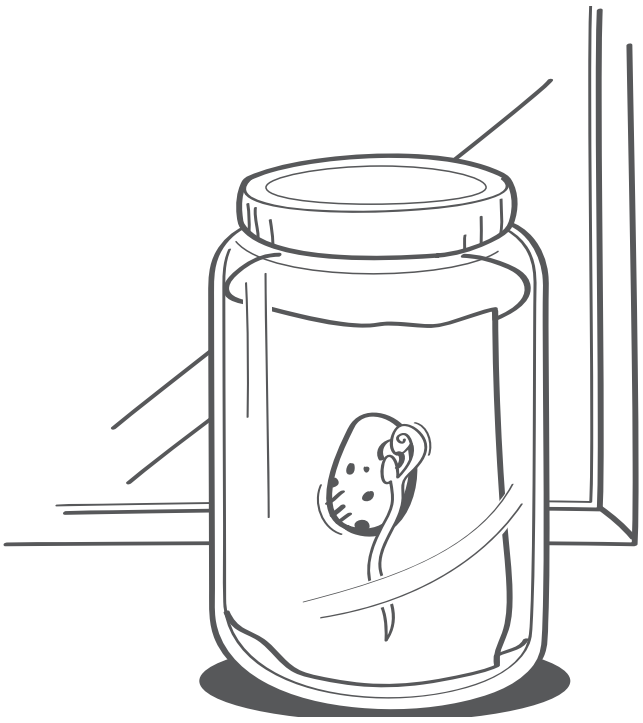


GROWING CRESS SEEDS

1. You can grow seeds in the shape of the first letter of your name by sprinkling them in the letter's shape onto some wet kitchen roll in a jar lid. Make sure you keep them watered.
2. While watching them grow, what happens if you move the jar lid away from the Sun? And what if the seedlings are moved to a dark place?

ZIG-ZAG PLANTS

1. Why not see if you can grow zig-zag plants? As shoots grow up towards the Sun and roots grow downwards looking for water, you can rotate a bean around as it grows and 'train' its shoots and roots.
2. Place a few sheets of kitchen roll to line the inside of a jar and press a bean between the glass jar wall and the kitchen roll.
3. Moisten the kitchen roll with water, close the jar with its lid, and leave it in a sunny place, but out of direct sunlight.
4. As you see the roots and the shoots appear, twirl the jar away from the Sun, or turn it upside down. Don't forget to water the kitchen roll to keep the bean well watered.



2 GO WITH THE FLOW

TIME TAKEN
30–40 minutes leaving the flower dye experiments overnight

These capillary action activities can help children understand how water travels through plants.

CURRICULUM LINKS

- Year 3 Programme of Study: Plants

OTHER ACTIVITIES

This works well with the 'Not a pigment of your imagination' and 'All the colours of the cabbage' activities, as these reinforce learning and you can reuse some of the equipment.

MATERIALS

REQUIRED:

- Two (or three) jars
- Strips of plain white kitchen roll (long enough to reach into both jars)
- Water
- Pencil, paper and scissors
- Jar lid

OPTIONAL:

- Red cabbage water
- Vinegar, lemon juice or bicarbonate of soda
- Food colouring
- Pale or white carnations or other white flowers
- Celery

RUNNING THE ACTIVITY

Using two jars, ask children to add water into one and dip one end of a strip of kitchen roll into it. They then need to place the other end of the strip into the second empty jar. Over time, children should notice something happen in the empty jar.

While waiting to see what happens, children can create a flower shape out of paper (using the template on the worksheet or they can invent their own), and fold the petals inwards. Ask them to pour some water into a jar lid, and place their folded flowers on top of the water. What do they see happening?

EXPLORE EVEN MORE

You could also set up three jars, with the first containing red cabbage water indicator, and the third containing vinegar or lemon juice (i.e. acid) or bicarbonate of soda (i.e. alkali). Both jars will need kitchen roll strips dipped into them but the free ends will dip into the empty second (middle) jar. What happens and why is there a different result for vinegar and for bicarbonate of soda?

Children could try adding food colours to some water in their jar and add a white or pale carnation, or celery stick, into the dyed water. They could even split the stem of the flower and place half the stem in a jar containing one colour and the other half in a second jar containing a different colour. Children could experiment with different flowers to find out which ones work best.

By looking closely at the flowers, can children see which parts of the flower become coloured and how? This gives them an opportunity to learn about the parts of a flower, or revisit what they have already been taught.

WHAT IS HAPPENING?

Water will slowly move from the water jar up the kitchen roll into the empty jar. Soon they will see the second jar fill up with water. This is because of capillary action and is how plants get the water they need in order to grow.

Water molecules can move through the holes in the kitchen roll because of attractive forces causing them to stick to each other, i.e. other water molecules (known as cohesion) and to the kitchen roll and glass surfaces (known as adhesion).

This method of using kitchen roll, fabric strips or even string, with one end in a pot of water and the other in a houseplant, is a great way to water your plants when you're off on holiday!

Using the red cabbage water, children should see a colour change in the middle jar based on whether their third jar is filled with the vinegar (acid) or bicarbonate of soda (alkali) (see the 'All the colours of the cabbage' activity).

The paper flower petals slowly begin to unfold in the water. Paper, just like kitchen roll, is made of plant fibres, which means the paper is porous (has holes in it). As water molecules travel through the paper, the paper starts to swell and the petals unfold. We see this when we add water to a wilting plant too.

In the flower and celery, there are fine vessels called xylem that transport water. The attraction between water molecules, and to the walls of the xylem vessels, causes water to move up through the roots and stems, and into the leaves and petals. These all become coloured by the dye. The water evaporates from the leaves, stems and flowers (through a process known as transpiration, which pulls more water up through the plant) and the dye is left behind. Children should now have newly coloured flowers!

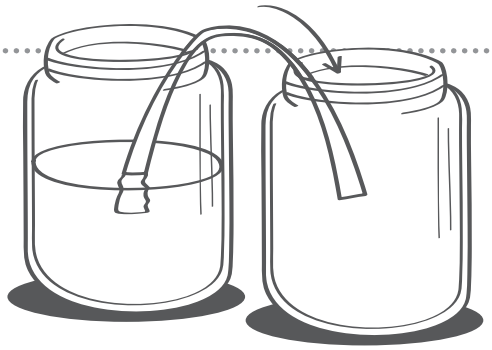
2 GO WITH THE FLOW

WORKSHEET

YOU WILL NEED:

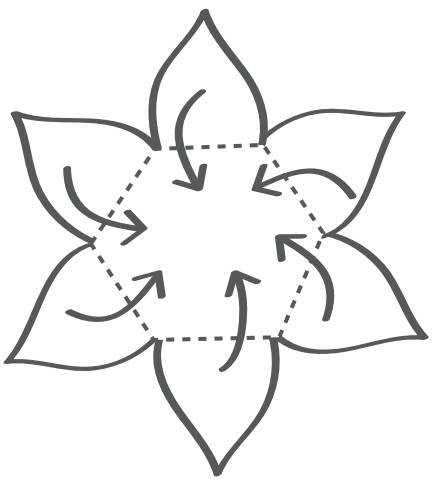
- Two jars
- Strips of kitchen roll (long enough to reach into both jars)
- Water
- Pencil, paper and scissors
- Jar lid

INSTRUCTIONS

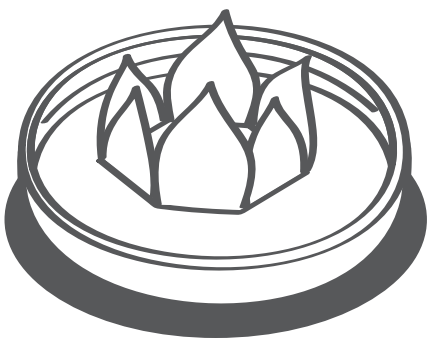


1. Take two jars, and pour water into one.
2. Cut a strip of kitchen roll, and dip one end of the strip into the jar of water.
3. Place the other end of the strip into the empty jar.
4. What do you see happening?

5. Add some water into your jar lid.
6. Trace or copy the flower template shown below onto a piece of paper, and cut out and fold as shown. (Or why not invent your own folded flower design?)



7. Place the folded flower on top of the water in your jar lid.



8. What happens to the flower? Why do you think this happens?